Sydney WATER

Sewage Treatment System Impact Monitoring Program

Volume 2: Appendices
Data Report 2018-19



Commercial-in-Confidence

Sydney Water

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Contents

Contents 2

Appendix A Glossary 11

Appendix B List of rainfall stations and location details 14

Appendix C Trends in discharge and reuse volumes, discharge quality and pollutant loads from coastal WWTPs 20

- Warriewood WWTP 21
- North Head WWTP 26
- Bondi WWTP 35
- Malabar WWTP 43
- Cronulla WWTP 51
- Wollongong WWTP 62
- Shellharbour WWTP 68
- Bombo WWTP 75
- Malabar storm WWTPs (Fairfield, Glenfield and Liverpool) 82

Appendix D Trends in discharge and reuse volumes, discharge quality and pollutant loads from inland WWTPs 87

- Picton WWTP 88
- West Camden WWTP 99
- Wallacia WWTP 109
- Penrith WWTP 116
- Winmalee WWTP 130
- North Richmond WWTP 138
- Richmond WWTP 146
- St Marys WWTP 156
- Quakers Hill WWTP 168
- Riverstone WWTP 181
- Castle Hill WWTP 191
- Rouse Hill WWTP 200
- Hornsby Heights WWTP 209
- West Hornsby WWTP 217
- Brooklyn WWTP 225

Appendix E Wastewater overflows 228

- Dry weather overflows 228
- Wet weather overflows 230

Appendix F Ocean receiving water 232

Appendix G Ocean sediment program 236

- Ocean sediment program - surveillance year 2019 236

Appendix H Harbour and beaches 252

Appendix I Chlorophyll-*a* trends at estuarine sites 299

Appendix J Water quality trends in lagoons 305

Appendix K Intertidal communities – Shoreline outfalls 312

Appendix L Intertidal communities of Sydney's estuaries 325

Appendix M Hawkesbury-Nepean River water quality trends 330

N92: Nepean River at Maldon Weir 331
N75: Nepean River at Sharpes Weir 337
N67: Nepean River at Wallacia Bridge 343
N57: Nepean River at Penrith Weir 349
N51: Nepean River opposite Fitzgerald Creek 355
N48A: Nepean River at Smith Road 361
N44: Nepean River at Yarramundi Bridge 367
N42: Hawkesbury River at North Richmond 373
N39: Hawkesbury River at Freemans Reach 379
NS04A: Lower South Creek at Fitzroy Bridge 385
N35: Hawkesbury River at Wilberforce 391
NC11A: Lower Cattai Creek at Cattai Ridge Road 397
N3001: Hawkesbury River off Cattai SRA 403
N26: Hawkesbury River at Sackville Ferry 409
N2202: Lower Colo River at Putty Road 415
N18: Hawkesbury River at Leets Vale 421
NB13: Berowra Creek at Calabash Bay 427
NB11: Berowra Creek off Square Bay 432

Appendix N Stream health of Hawkesbury-Nepean River 438

Appendix O Stream health of other Sydney rivers 515

List of figures

Figure B-1	Rainfall stations used for categorising wastewater data as dry or wet weather days	18
Figure B-2	Rainfall stations used for categorising receiving water quality data as dry or wet weather days	19
Figure G-1	Cumulative sediment particle size composition by three size classes for: top North Head; middle Bondi; and bottom Malabar 0 km 2000 to 2018-19	239
Figure G-2	Benthic macrofauna at Malabar 0 km location in 2019	241
Figure G-3	Counts and number of taxa at Malabar 0 km location each year from 2000 to 2019	242
Figure G-4	CAP plot with Malabar 0 km location 2018 sample prediction compared to past assessment years	243
Figure K-1	Barrack Point with a healthy intertidal rock platform community in 2018	315
Figure K-2	Barrack Point (in 2001) with an unhealthy intertidal rock platform community impacted by wastewater discharges from the Shellharbour WWTP prior to upgrade in the early to mid 2000's	315
Figure K-3	Two-dimensional nMDS ordination plot of 2008 to 2018 intertidal rock platform community data	317
Figure K-4	Three-dimensional nMDS ordination plot of 2008 to 2018 intertidal rock platform community data	318
Figure K-5	PCO ordination plot of 2008 to 2018 intertidal rock platform community data - dimensional	318
Figure K-6	CAP ordination plot of intertidal rock platform community data (2008 to 2018 for Control site 1 and Control site 2 and 2008 to 2017 outfall site) with 2018 outfall samples (orange squares) predicted	319
Figure L-1	Relatively lower salinity zone with year plotted against Principal Coordinates Analysis axis 1 of distance among centroids for sites	326
Figure L-2	Relatively higher salinity zone with year plotted against Principal Coordinates Analysis axis 1 of distance among centroids for sites	327
Figure L-3	Multiple mean comparison groupings of relatively high salinity locations for 2018-19. (Means covered by the same bar are not significantly different)	328
Figure L-4	Multiple mean comparison groupings of relatively lower salinity locations for 2018-19. (Means covered by the same bar are not significantly different)	329
Figure N-1	Stream health of Nepean River near Picton WWTP	439
Figure N-2	Stream health of Matahil Creek near West Camden WWTP	440
Figure N-3	Stream health of the Nepean River near West Camden WWTP	441
Figure N-4	Two-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of Matahil Creek upstream and downstream sites of West Camden WWTP	443
Figure N-5	Tree diagram of freshwater macroinvertebrate edge habitat community structure of Matahil Creek upstream and downstream sites of West Camden WWTP	443
Figure N-6	Shade plot of freshwater macroinvertebrate edge habitat community structure of Matahil Creek upstream and downstream sites of West Camden WWTP	447
Figure N-7	Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	449
Figure N-8	Tree diagram of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	449
Figure N-9	Shade plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	453
Figure N-10	Stream health of Warragamba River near Wallacia WWTP	454

Figure N-11 Stream health of Boundary Creek near Penrith WWTP 455
Figure N-12 Stream health of the Nepean River upstream-downstream of the confluence of Boundary Creek near Penrith WWTP 456
Figure N-13 Stream health of unnamed creek below Winmalee WWTP for two downstream sites 457
Figure N-14 Stream health of the Nepean River near Winmalee WWTP 458
Figure N-15 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP 461
Figure N-16 Three-dimensional ordination plot of freshwater macroinvertebrate riffle habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP 462
Figure N-17 Tree diagram of freshwater macroinvertebrate edge habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP 462
Figure N-18 Tree diagram of freshwater macroinvertebrate riffle habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP 463
Figure N-19 Shade plot of freshwater macroinvertebrate edge habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP 469
Figure N-20 Shade plot of freshwater macroinvertebrate riffle habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP 470
Figure N-21 Two-dimensional nMDS ordination plot of freshwater macroinvertebrate macrophyte habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 471
Figure N-22 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 471
Figure N-23 Tree diagram of freshwater macroinvertebrate macrophyte habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 472
Figure N-24 Tree diagram of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 472
Figure N-25 Shade plot of freshwater macroinvertebrate macrophyte habitat community structure of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 479
Figure N-26 Shade plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 480
Figure N-27 Stream health of Hawkesbury River upstream-downstream of the confluence of Redbank Creek near North Richmond WWTP 481
Figure N-28 Stream health of Redbank Creek near North Richmond WWTP 482
Figure N-29 Three-dimensional ordination plot of freshwater macroinvertebrate macrophyte habitat community structure of Redbank Creek upstream and downstream sites of North Richmond WWTP 484
Figure N-30 Tree diagram of freshwater macroinvertebrate macrophyte habitat community structure of Redbank Creek upstream and downstream sites of North Richmond WWTP 485
Figure N-31 Shade plot of freshwater macroinvertebrate macrophyte habitat community structure of Redbank Creek upstream and downstream sites of North Richmond WWTP 489
Figure N-32 Two-dimensional ordination plot of freshwater macroinvertebrate macrophyte habitat community structure of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 490
Figure N-33 Tree diagram of freshwater macroinvertebrate macrophyte habitat community structure of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 490

Figure N-34 Shade plot of freshwater macroinvertebrate macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 494
Figure N-35 Stream health of South Creek near St Mary's WWTP 495
Figure N-36 Stream health of Breakfast Creek near Quakers Hill WWTP 496
Figure N-37 Stream health of Eastern Creek near Riverstone WWTP 497
Figure N-38 Stream health of Cattai Creek near Castle Hill WWTP 498
Figure N-39 Stream health of Second Ponds Creek near Rouse Hill WWTP 499
Figure N-40 Stream health of Calna Creek near Hornsby Heights WWTP 500
Figure N-41 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP 502
Figure N-42 Two-dimensional ordination plot of freshwater macroinvertebrate riffle habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP 503
Figure N-43 Tree diagram of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP 503
Figure N-44 Tree diagram of freshwater macroinvertebrate riffle habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP 504
Figure N-45 Shade plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP 510
Figure N-46 Shade plot of freshwater macroinvertebrate riffle habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP 511
Figure N-47 Stream health of Waitara Creek near West Hornsby WWTP 512
Figure O-1 Stream health of Lane Cove and Parramatta rivers in comparison to control sites 516
Figure O-2 Stream health of lower freshwater Georges River sites compared to control sites in the upper Georges River system 516

List of tables

Table B-1	Rainfall stations used for categorising wastewater data as dry or wet weather days	14
Table B-2	Rainfall stations used for categorising receiving water quality data as dry or wet weather days	16
Table E-1	Trend in dry weather wastewater overflow frequency and volumes for coastal WWTPs wastewater system (2013-14 to 2018-19)	228
Table E-2	Trend in dry weather wastewater overflow frequency and volumes for inland wastewater systems (2013-14 to 2018-19)	229
Table E-3	Trend in wet weather wastewater overflow frequency and volumes for ocean WWTPs wastewater system (2013-14 to 2018-19)	230
Table E-4	Trend in wet weather wastewater overflow frequency and volumes for inland WWTPs wastewater system (2013-14 to 2018-19)	231
Table F-1	Comparison of modelled chemical concentrations near the deepwater ocean outfalls for STSIMP (for last ten financial years) to ANZG (2018) guideline values for North Head WWTP	233
Table F-2	Comparison of modelled chemical concentrations near the deepwater ocean outfalls for STSIMP (for last ten financial years) to ANZG (2018) guideline values for Bondi WWTP	234
Table F-3	Comparison of modelled chemical concentrations near the deepwater ocean outfalls for STSIMP (for last financial years) to ANZG (2018) guideline values for Malabar WWTP	235
Table G-1.	Locations and analytes measured in 2018-19	236
Table G-2.	Summary statistics of TOC and sediment grain size measured in 2018-19	237
Table G-3.	TOC and sediment grain size for each sample measured in 2018-19	237
Table G-4.	TOC replicate values above 1.2% content from 2001 to 2019	238
Table G-5	Summary of benthic macrofauna at Malabar 0 km location in 2019	240
Table G-6	Allocated location group for Malabar 0 km samples of 2019 which were predicted onto the base CAP analysis of samples collected from all nine locations in 2002, 2005, 2008, 2011, 2014 and 2016 assessment years	244
Table G-7	Statistics from the cross validation leave-one-out allocation of samples to location groups of 2002, 2005, 2008, 2011, 2014 and 2016 from base CAP analysis	244
Table G-8.	EPA sampling site coordinate grid centres	245
Table G-9.	Actual sub-sampling coordinates from collection of 2019 samples from sites 1 and 2 of three locations with replicate samples numbers	246
Table G-10	Invertebrate data from the Malabar 0 km location in 2019 from sites 1 and 2	248
Table H-1.	Short-listed dry weather *Enterococci* exceptions data (>35 cfu/100mL) based on catchment rainfall condition	295
Table K-1	Asymmetrical PERMANOVA of 2018 intertidal assemblages	313
Table K-2	SIMPER 2018 - intertidal assemblages by site	314
Table K-3	- Asymmetrical PERMANOVA of 2008 to 2018 intertidal assemblages	320
Table K-4	CAP analysis of 2008 to 2017 intertidal assemblages with 2018 outfall site samples predicted	321
Table N-1	t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Nepean River near Picton WWTP	439
Table N-2	t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Matahil Creek near West Camden WWTP	440
Table N-3	t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Nepean River near West Camden WWTP	441

Table N-4	ANOSIM test of ‘Site’ factor for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP	444
Table N-5	PERMANOVA test of ‘Site’ and ‘Year’ factors for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP	444
Table N-6	PERMDISP test of ‘Site’ factor for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP	445
Table N-7	ANOSIM test of ‘Site period’ samples for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP	446
Table N-8	Genera subset whose multivariate pattern matches full genera set of the edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP	446
Table N-9	ANOSIM test of Site for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	450
Table N-10	PERMANOVA test of Site and Year factors for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	450
Table N-11	PERMDISP test of Site for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	451
Table N-12	ANOSIM test of Site period for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	452
Table N-13	Genera subset whose multivariate pattern matches full genera set of the edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges	452
Table N-14	t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Warragamba River near Wallacia WWTP	454
Table N-15	t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Boundary Creek near Penrith WWTP	456
Table N-16	t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Nepean River near Penrith WWTP	456
Table N-17	t-test of both downstream site SIGNAL-SG scores from 2018-19 for unnamed creek below Winmalee WWTP	458
Table N-18	t-test of upstream-downstream SIGNAL-SG scores from 2018-19 for the Nepean River near Winmalee WWTP	458
Table N-19	ANOSIM test of ‘Site’ factor for edge habitat unnamed creek near Winmalee WWTP	463
Table N-20	ANOSIM test of ‘Site’ factor for riffle habitat unnamed creek below Winmalee WWTP	463
Table N-21	PERMANOVA test of ‘Site’ and ‘Year’ factors for edge habitat unnamed creek below Winmalee WWTP	464
Table N-22	PERMANOVA test of ‘Site’ and ‘Year’ factors for riffle habitat unnamed creek below Winmalee WWTP	465
Table N-23	PERMDISP test of ‘Site’ factor for edge habitat unnamed creek below Winmalee WWTP	465
Table N-24	PERMDISP test of ‘Site’ factor for riffle habitat unnamed creek below Winmalee WWTP	466
Table N-25	ANOSIM test of ‘Site period’ samples for edge habitat unnamed creek below Winmalee WWTP	467
Table N-26	ANOSIM test of ‘Site period’ samples for riffle habitat unnamed creek below Winmalee WWTP	467
Table N-27	Genera subset whose multivariate pattern matches full genera set of the edge habitat unnamed creek below Winmalee WWTP	468
Table N-28	Genera subset whose multivariate pattern matches full genera set of the riffle habitat unnamed creek below Winmalee WWTP	468

Table N-29 ANOSIM test of Site for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 473
Table N-30 ANOSIM test of Site for edge habitat Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 473
Table N-31 PERMANOVA test of Site and Year factors for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 474
Table N-32 PERMANOVA test of Site and Year factors for edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 475
Table N-33 PERMDISP test of Site for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 476
Table N-34 PERMDISP test of Site for edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 476
Table N-35 ANOSIM test of Site period for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 477
Table N-36 ANOSIM test of Site period for edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 477
Table N-37 Genera subset whose multivariate pattern matches full genera set of the macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 478
Table N-38 Genera subset whose multivariate pattern matches full genera set of the edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges 478
Table N-39 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Hawkesbury River near North Richmond WWTP 482
Table N-40 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Redbank Creek near North Richmond WWTP 482
Table N-41 PERMDISP test of ‘Site’ factor for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP 485
Table N-42 ANOSIM test of ‘Site’ factor for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP 486
Table N-43 ANOSIM test of ‘Period’ factor for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP 486
Table N-44 PERMANOVA test of ‘Site’ and ‘Year’ factors for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP 486
Table N-46 ANOSIM test of ‘Site period’ samples for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP 488
Table N-47 Genera subset whose multivariate pattern matches full genera set of the macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP 488
Table N-48 PERMDISP test of ‘Site’ factor for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 491
Table N-49 ANOSIM test of ‘Site’ factor for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 491
Table N-50 PERMANOVA test of Site and Year factors for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 492

Table N-52 ANOSIM test of Site period for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 493
Table N-53 Genera subset whose multivariate pattern matches full genera set of the macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges 493
Table N-54 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from South Creek near St Mary's WWTP 495
Table N-55 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Breakfast Creek near Quakers Hill WWTP 496
Table N-56 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Eastern Creek near Riverstone WWTP 497
Table N-57 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Cattai Creek near Castle Hill WWTP 498
Table N-58 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Second Ponds Creek near Rouse Hill WWTP 499
Table N-59 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Calna Creek near Hornsby Heights WWTP 500
Table N-60 ANOSIM test of 'Site' factor for edge habitat of Calna Creek near Hornsby Heights WWTP 504
Table N-61 ANOSIM test of 'Site' factor for riffle habitat of Calna Creek near Hornsby Heights WWTP 504
Table N-62 PERMANOVA test of 'Site' and 'Year' factors for edge habitat of Calna Creek near Hornsby Heights WWTP 505
Table N-63 PERMANOVA test of 'Site' and 'Year' factors for riffle habitat of Calna Creek near Hornsby Heights WWTP 506
Table N-64 PERMDISP test of 'Site' factor for edge habitat of Calna Creek near Hornsby Heights WWTP 507
Table N-65 PERMDISP test of 'Site' riffle habitat of Calna Creek near Hornsby Heights WWTP 507
Table N-66 ANOSIM test of 'Site period' for edge habitat of Calna Creek near Hornsby Heights WWTP 508
Table N-67 ANOSIM test of 'Site period' for riffle habitat of Calna Creek near Hornsby Heights WWTP 508
Table N-68 Genera subset whose multivariate pattern matches full genera set of the edge habitat Calna Creek near Hornsby Heights WWTP 509
Table N-69 Genera subset whose multivariate pattern matches full genera set of the riffle habitat Calna Creek near Hornsby Heights WWTP 509
Table N-70 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Waitara Creek near West Hornsby WWTP 512

Appendix A Glossary

Acronyms/ Abbreviations	Full meanings
APHA	American Public Health Association
ANOSIM	Analysis of similarities
ANOVA	Analysis of variance
ANZECC	Australian and New Zealand Environment and Conservation Council.
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
AWI	Antecedent Wetness Index
AWTP	Advanced Water Treatment Plant
BOM	Bureau of Meteorology
BOOS	Bondi Ocean Outfall Sewer
CAP	Canonical Analysis of Principal coordinates
CBOD	Carbonaceous Biochemical Oxygen Demand
CCTV	Closed-Circuit Television
cfu/100mL	Colony forming units per 100 millilitres
COOS	Cronulla Ocean Outfall Sewer
CRM	Certified reference material
CTD	A CTD or Sonde is an oceanography instrument used to measure the conductivity, temperature, and pressure of seawater (the D stands for "depth," which is closely related to pressure
DF	Degrees of freedom
DPIE	Department of Planning, Industry and Environment
DWLP	Dry weather leakage program
EC_{50}	Effect Concentration for immobilization of 50% of exposed target biota
EES	Environment, Energy and Science Branch, NSW DPIE
EMS	Effluent Management Strategy
EOP	Emergency Operations Protocol
EPA	Environment Protection Authority
EPL	Environment Protection Licence
ER	Environmental Response
FOG	Fats, Oils and Grease
GS	Grain Size
HRC	Healthy River Commission
IOT	Internet Of Things
KL	Kilolitre
km	kilometre(s)
m	metre
MOF	Maximum overflow frequency
Maximum	Maximum value of set of observations
MCI	Macroinvertebrate Community Index
MDS	Multidimensional Scaling
Mean	Mean value of a set of observation

Acronyms/ Abbreviations	Full meanings
Median	Median or 50th percentile value
mg/L	milligrams per litre
Minimum	Minimum value of a set of observations
mL	Millilitre
ML	Megalitre
mm	millimetre(s)
mm^3/L	Algal biovolume millimetre cube per litre
NATA	National Association of Testing Authorities
NHMRC	National Health and Medical Research Council
nMDS	Non-metric multidimensional scaling
No. of Obs	Number of observations
NSOOS	Northern Suburbs Ocean Outfall Sewer
NST	Northside Storage Tunnel
NSW	New South Wales
NTU	Nephelometric Turbidity unit
OECD	Organisation for Economic Cooperation and Developments
ORS	Ocean Reference Station
OSP	Ocean Sediments Program
PCA	Principal Component Analysis
PCB	Polychlorinated Biphenyls
PCO	Principal Coordinates Ordination
PERMANOVA	Permutational Analysis of Variance
PSR	Pressure-State-Response
PST	Primary sedimentation tank
R	Regression co-efficient
RDT	Rotary drum thickeners
SCAMP	Sewer Catchment Area Management Plan
SIGNAL-SG	Stream Invertebrate Grade Number Average Level - Genus taxonomic level for the greater Sydney region. Which is a biotic index based on freshwater macroinvertebrate diversity, abundance and tolerance to organic pollution
SIMPER	Similarity percentage
SOV	System overflow volume
SRA	State Recreation Area
Stats	Statistics
Std dev	Standard deviation
STSIMP	Sewage Treatment System Impact Monitoring Program
SWOOS	Southern and Western Suburbs Ocean Outfall Sewer
TOC	Total organic carbon
TSS	Total suspended solids
USEPA	United States Environmental Protection Agency
WET	Whole Effluent Toxicity
WWTP or plant	Wastewater treatment plant

Acronyms/ Abbreviations	Full meanings
µg/L	micrograms per litre
µS/cm	micro Siemens per centimetre (unit of conductivity)

Appendix B List of rainfall stations and location details

Table B-1 Rainfall stations used for categorising wastewater data as dry or wet weather days

Catchments	Rainfall station (Hydstra code and site name/ description)	Latitude	Longitude	WWTP
Upper Nepean	568053 Picton WWTP	-34.2029	150.6148	Picton and West Camden WWTPs
	568130 West Camden WWTP (composite)	-34.0590	150.6809	
Mid Nepean	567163 Regent Ville Rural Fire Service	-33.7745	150.6716	Penrith and St Marys WWTPs Glenbrook*, Warragamba* and Wallacia WWTPs
	567087 St Marys WWTP	-33.7342	150.7692	
	568044 Warragamba Water Filtration Plant	-33.8915	150.5983	
Lower Nepean	567084 Quakers Hill WWTP	-33.7365	150.8783	Quakers Hill, Richmond, North Richmond, Winmalee and Riverstone WWTPs
	567085 Richmond WWTP	-33.6080	150.7671	
	563069 North Richmond WWTP	-33.5748	150.7156	
	563146 Winmalee WWTP	-33.6767	150.6250	
	567100 Riverstone WWTP	-33.6562	150.8477	
Blue Mountains	563062 Blackheath WWTP	-33.6189	150.2994	Blackheath*, Mount Victoria* and Round Corner* WWTPs
	563148 Mount Victoria WWTP	-33.5825	150.2519	
	563059 Katoomba (Cascade Ck, Dam 1)	-33.6897	150.3008	
	563061 Wentworth Falls (Bodington)	-33.7327	150.3885	
Lower Hawkesbury	567076 Castle Hill WWTP	-33.7111	150.9842	Castle Hill and Rouse Hill WWTPs
	567102 Dural (WPS14)	-33.6969	151.0277	
Berowra	567120 Brooklyn WWTP	-33.5513	151.1959	Brooklyn, West Hornsby and Hornsby Heights WWTPs
	566055 Hornsby Bowling Club	-33.7067	151.1070	
	566073 Pymble Bowling Club	-33.7408	151.1394	
	566053 Hornsby Heights WWTP	-33.6672	151.1047	
South West Sydney	567077 Fairfield WWTP	-33.8807	150.9504	Fairfield WWTP Glenfield WWTP
	567078 Glenfield WWTP	-33.9827	150.9071	

Catchments	Rainfall station (Hydstra code and site name/ description)	Latitude	Longitude	WWTP
	566049 Liverpool WWTP	-33.9218	150.9386	Liverpool WWTP
Cronulla	566078 South Cronulla	-34.0700	151.1517	Cronulla WWTP
	566018 Cronulla WWTP	-34.0307	151.1635	
Illawarra	568162 Balgownie Reservoir	-34.3928	150.8703	Bellambi, Port Kembla, Shellharbour, Wollongong and Bombo WWTPs
	568173 Berkeley (Berkeley Sports and Social Club)	-34.4830	150.8473	
	568171 Albion Park Bowling Club	-34.5703	150.7684	
	568181 Figtree Bowling Club	-34.4363	150.8646	
	568188 Kiama Water Tank	-34.6735	150.8434	
North Sydney Coast	566089 Manly Croquet Club (formerly Manly Golf Course)	-33.7906	151.2758	North Head and Warriewood WWTPs
	566100 North Head WWTP	-33.8080	151.3019	
	566051 Warriewood WWTP (Composite)	-33.6912	151.2993	
Malabar	566026 Marrickville Bowling Club	-33.9099	151.1641	Malabar WWTP
	567077 Fairfield WWTP	-33.8807	150.9504	
	567078 Glenfield WWTP	-33.9827	150.9071	
	566049 Liverpool WWTP	-33.9218	150.9386	
Bondi	566032 Paddington (Composite)	-33.8870	151.2253	Bondi WWTP
	566038 Vaucluse Bowling club	-33.8578	151.2788	

* WWTP decommissioned but included to calculate historical volume and loads.

Table B-2 Rainfall stations used for categorising receiving water quality data as dry or wet weather days

Catchments	Rainfall station (Hydstra code and site name/ description)	Latitude	Longitude	Water quality monitoring Sites
Upper Nepean	568053 Picton WWTP	-34.2029	150.6148	N92, N75 and N67
	568130 West Camden WWTP (composite)	-34.0590	150.6809	
	568044 Warragamba Water Filtration Plant	-33.8915	150.5983	
Mid Nepean	567163 Regentville Rural Fire Service	-33.7745	150.6716	N57 and N51
	567087 St Marys WWTP	-33.7342	150.7692	
Lower Nepean	567084 Quakers Hill WWTP	-33.7365	150.8783	N48A, N44, N39, N35 and NS04A
	567085 Richmond WWTP	-33.6080	150.7671	
	563069 North Richmond WWTP	-33.5748	150.7156	
	563146 Winmalee WWTP	-33.6767	150.6250	
	567100 Riverstone WWTP	-33.6562	150.8477	
Lower Hawkesbury	567076 Castle Hill WWTP	-33.7111	150.9842	N3001, N26, N18, N2202 and NC11A
	567102 Dural (WPS14)	-33.6969	151.0277	
Berowra	566055 Hornsby Bowling Club	-33.7067	151.1070	NB13 and NB11
	566073 Pymble Bowling Club	-33.7408	151.1394	
	566053 Hornsby Heights WWTP	-33.6672	151.1047	
Port Jackson Lower	566087 Gladesville Bowling Club	-33.8226	151.1294	PJLC and PJTB
	566073 Pymble Bowling Club	-33.7408	151.1394	
Port Jackson Upper	566087 Gladesville Bowling Club	-33.8226	151.1294	PJ015, PJPRA, PJCB2 and PJDFP
	566082 Auburn RSL Bowling Club	-33.8602	151.0190	
	566032 Paddington (composite)	-33.8870	151.2253	
Middle Harbour	566089 Manly Golf Course	-33.7906	151.2758	PJDR, PJSB and PJCB1
	566100 North Head WWTP	-33.8080	151.3019	
	566051 Warriewood WWTP (composite)	-33.6912	151.2993	

Catchments	Rainfall station (Hydstra code and site name/ description)	Latitude	Longitude	Water quality monitoring Sites
Georges River Lower	566026 Marrickville Bowling Club	-33.9099	151.1641	GR01, CR04A, GRRB and GRFB
	566020 Enfield (composite site)	-33.9005	151.0879	
	566028 Eastlakes Sydney Water Depot	-33.9256	151.2203	
Georges River Upper	567077 Fairfield WWTP	-33.8807	150.9504	GR19, GR22 and GROB
	567078 Glenfield WWTP	-33.9827	150.9071	
	566049 Liverpool WWTP	-33.9218	150.9386	
Port Hacking	566078 South Cronulla Bowling Club	-34.0700	151.1517	PHLPB, WL83
	566018 Cronulla WWTP	-34.0307	151.1635	
Lagoons	566051 Warriewood WWTP (composite)	-33.6912	151.2993	Lagoon sites (CC-sites, DW-sites, ML sites and NL_sites)
	566089 Manly Golf Course	-33.7906	151.2758	



Figure B-1 Rainfall stations used for categorising wastewater data as dry or wet weather days



Figure B-2 Rainfall stations used for categorising receiving water quality data as dry or wet weather days

Appendix C Trends in discharge and reuse volumes, discharge quality and pollutant loads from coastal WWTPs

The coastal WWTPs are presented in the following order from North coast to South coast:

- Warriewood WWTP
- North Head WWTP
- Bondi WWTP
- Malabar WWTP
- Cronulla WWTP
- Wollongong WWTP
- Shellharbour WWTP
- Bombo WWTP

- Malabar storm WWTPs (Fairfield, Glenfield and Liverpool WWTPs) discharging to inland waters

Tests conducted on wastewater are specified under the Environment Protection Licences (EPL) issued by the NSW EPA for each WWTP. All measured analytes that have EPL concentration and load limits are presented in this Appendix.

Under each WWTP, trend plots are presented on:

- Discharge and reuse volume
- Discharge quality
- Discharge loads

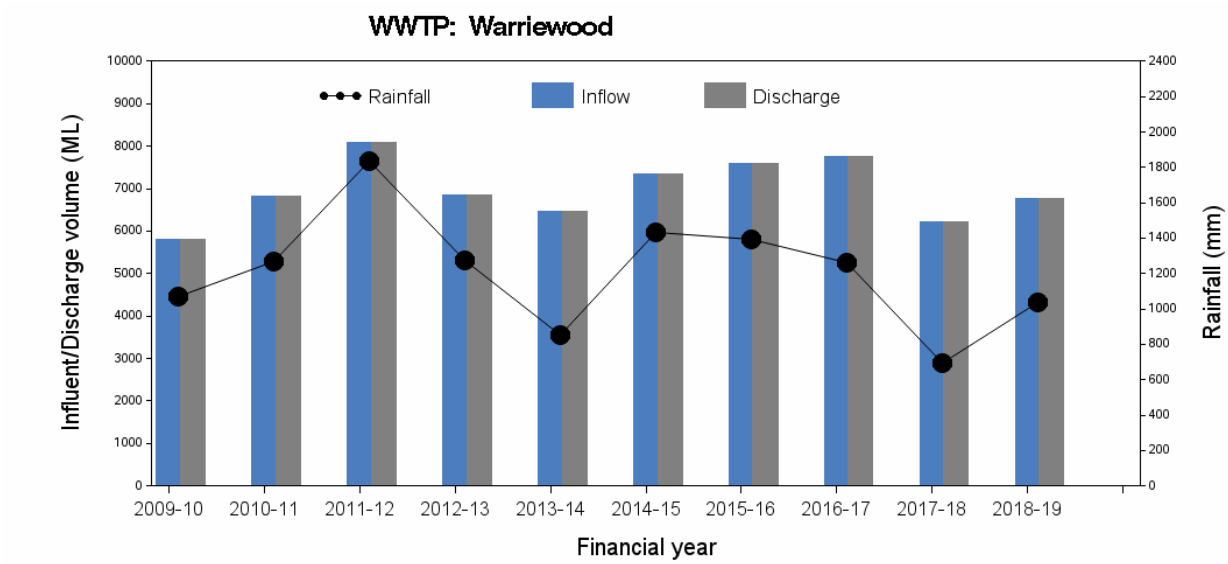
Discharge quality and load plots are included in following sub-groups and then analytes presented in alphabetical order:

- Nutrients
- Major conventional analytes
- Toxicity
- Trace metals
- Other chemicals and organics (including pesticides)

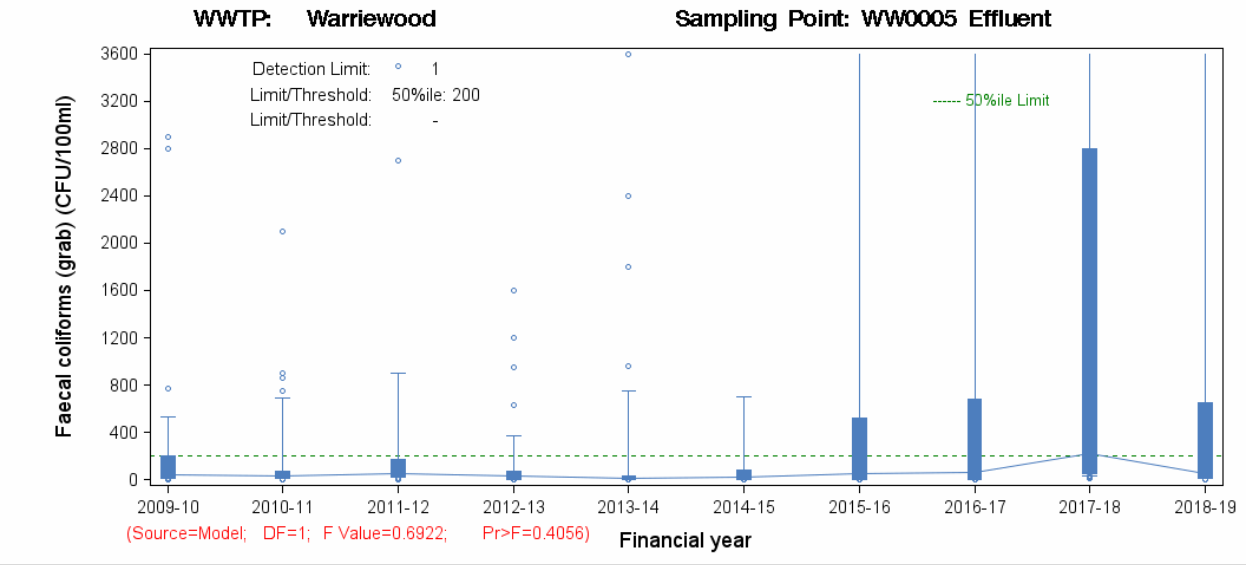
Where an analyte shows a trend (positive or negative) two plots are presented (where required) - one with the licence limits and one zoomed in to provide a clearer view of the trend.

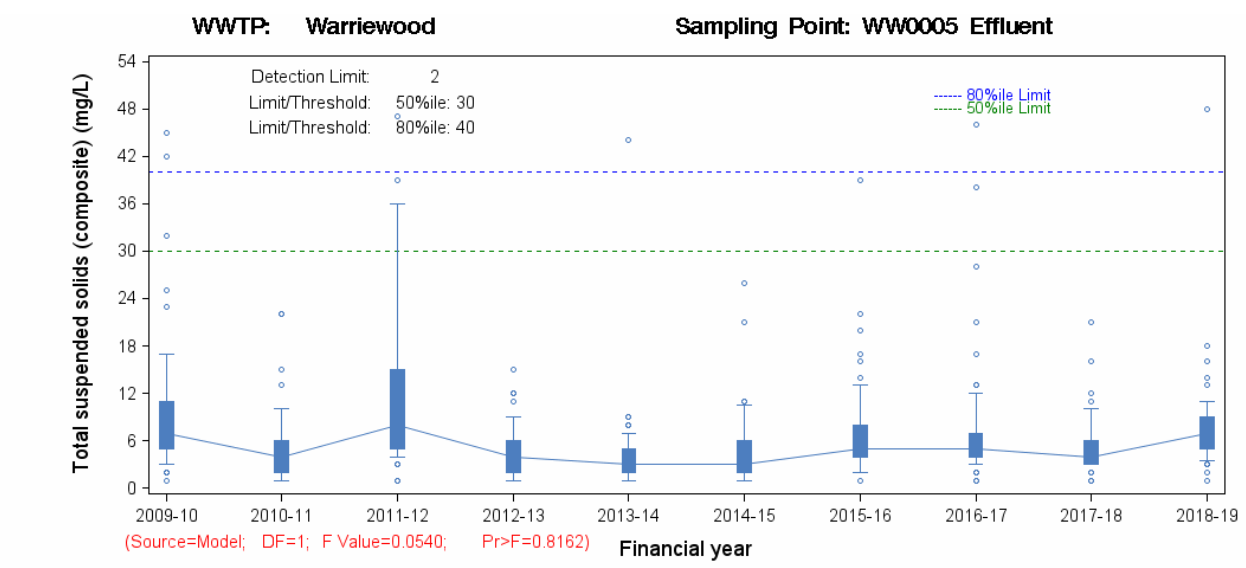
Warriewood WWTP

Discharge volume and rainfall

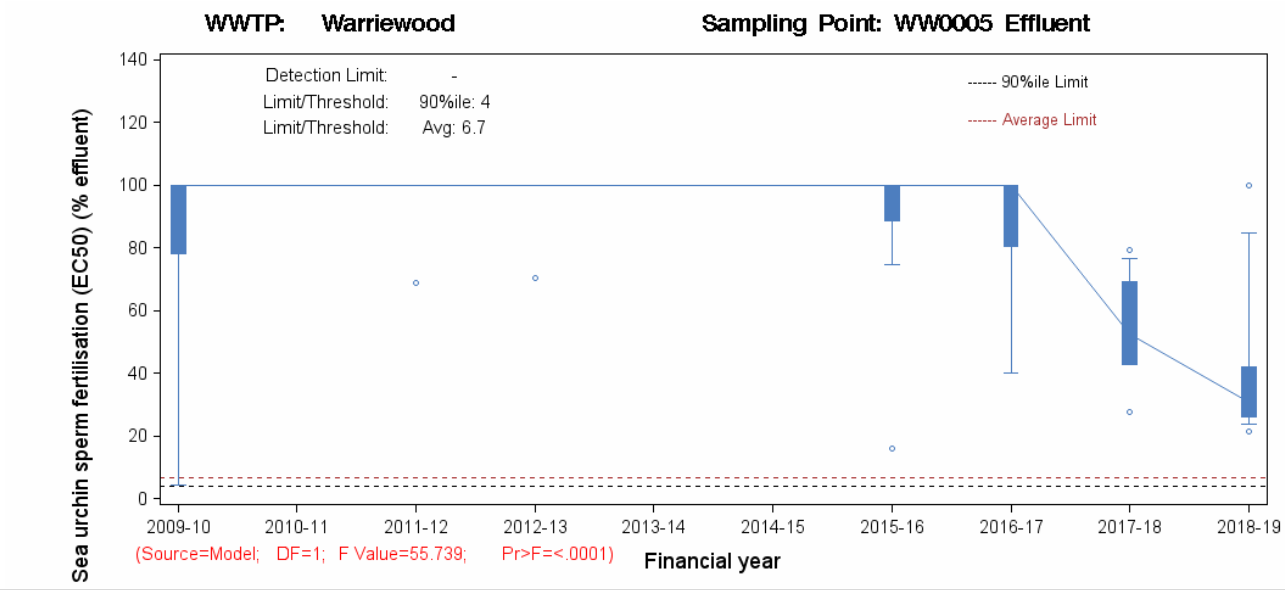


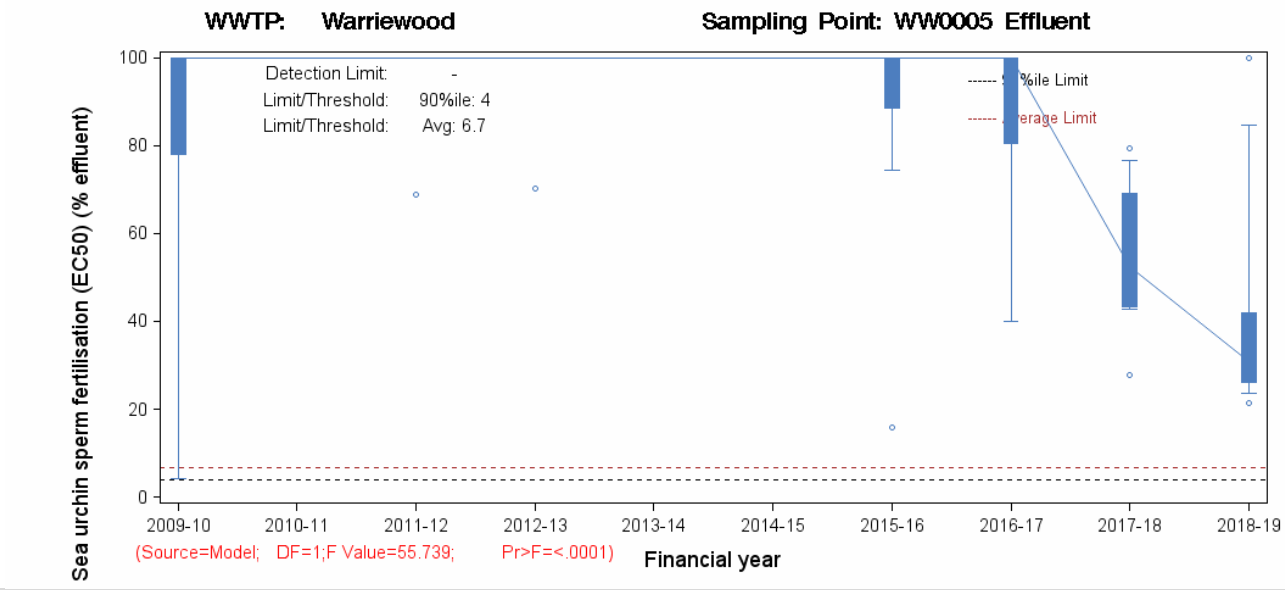
Discharge quality: Major conventional analytes



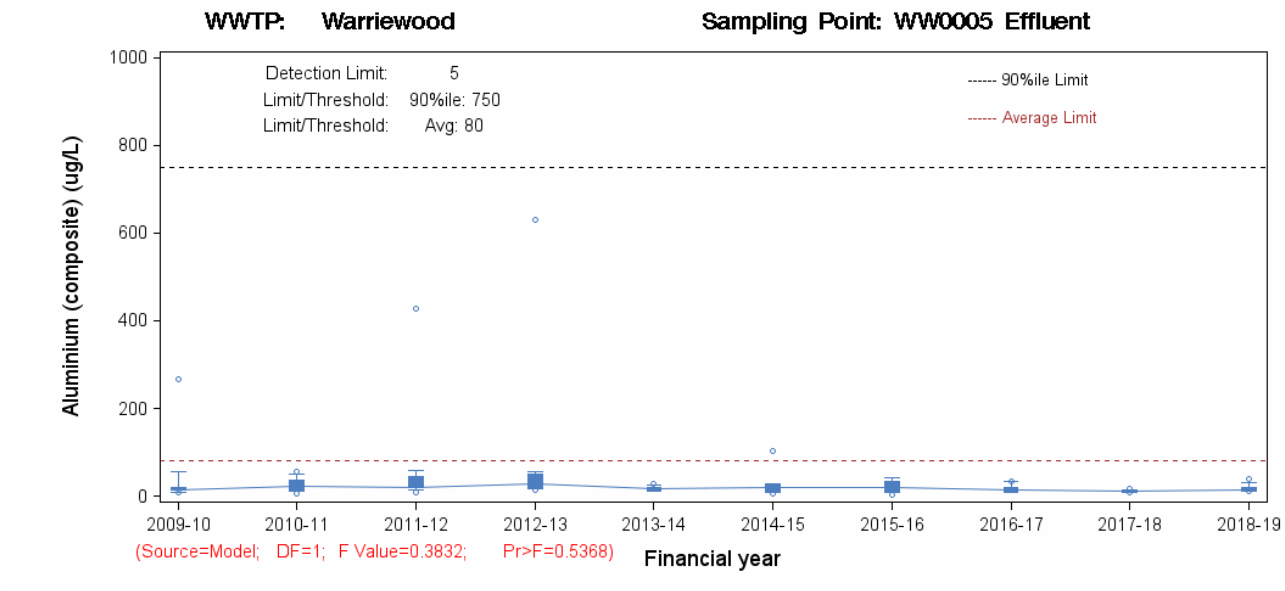


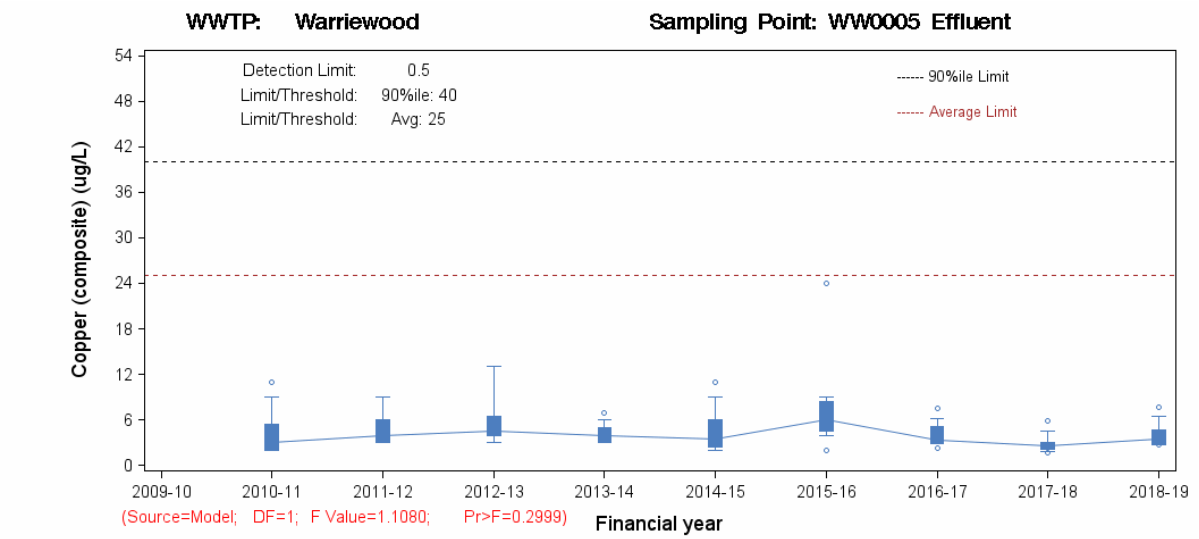
Discharge quality: Toxicity





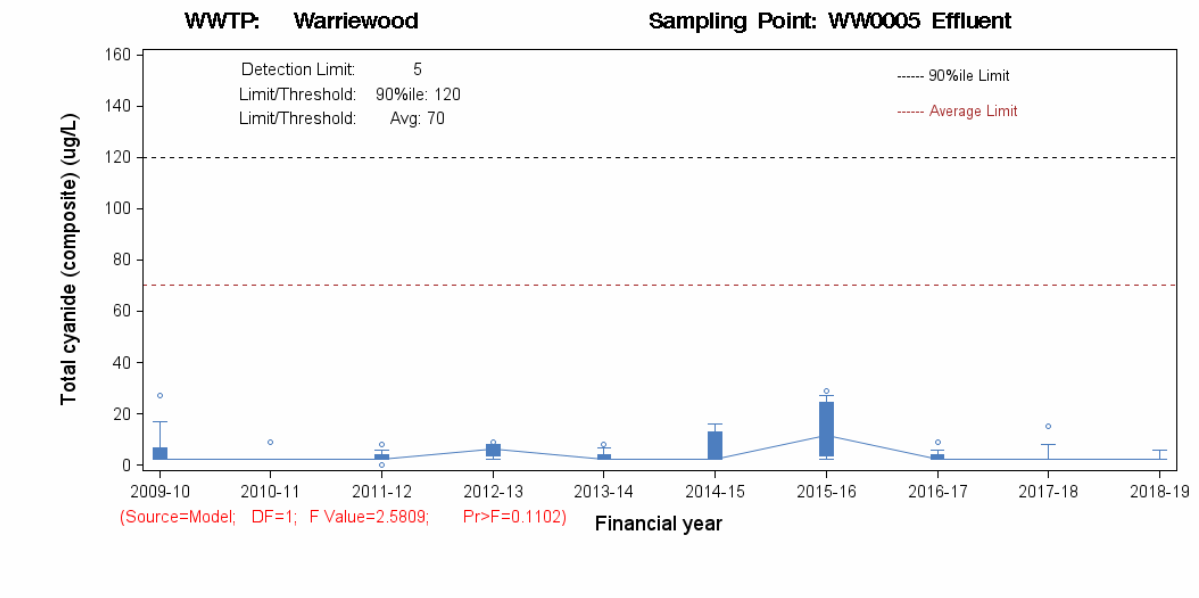
Discharge quality: Trace metals

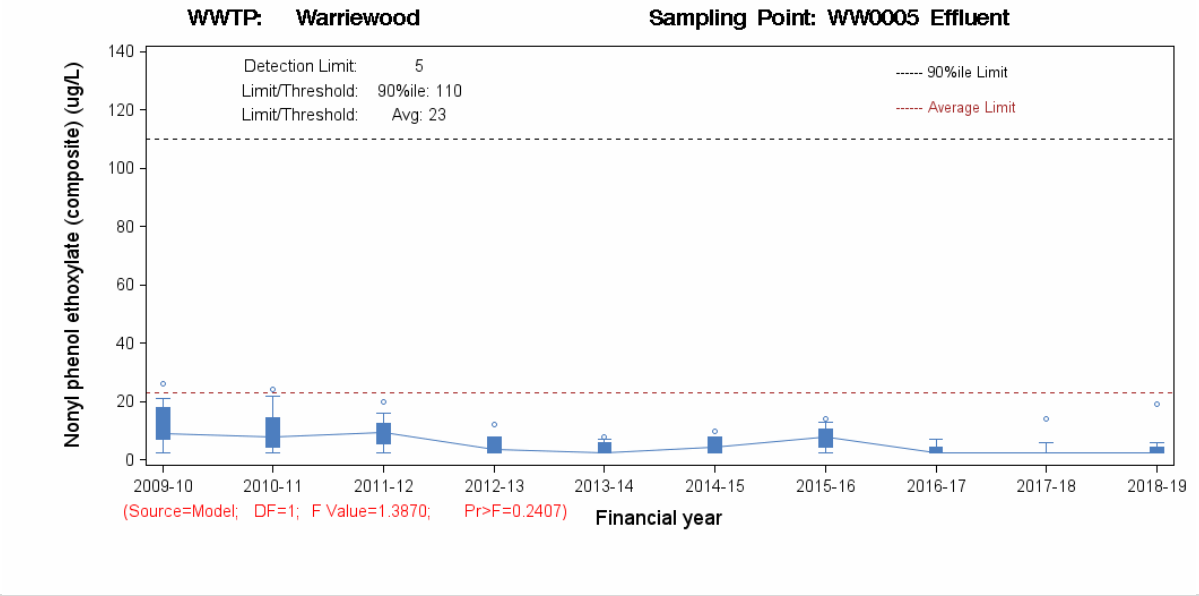




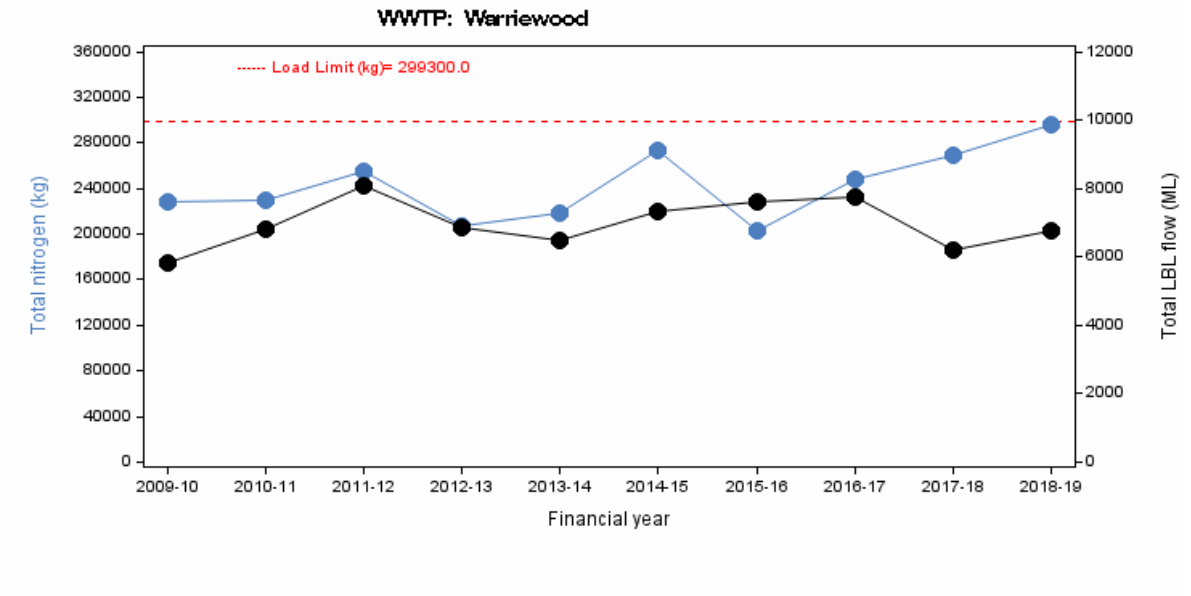
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

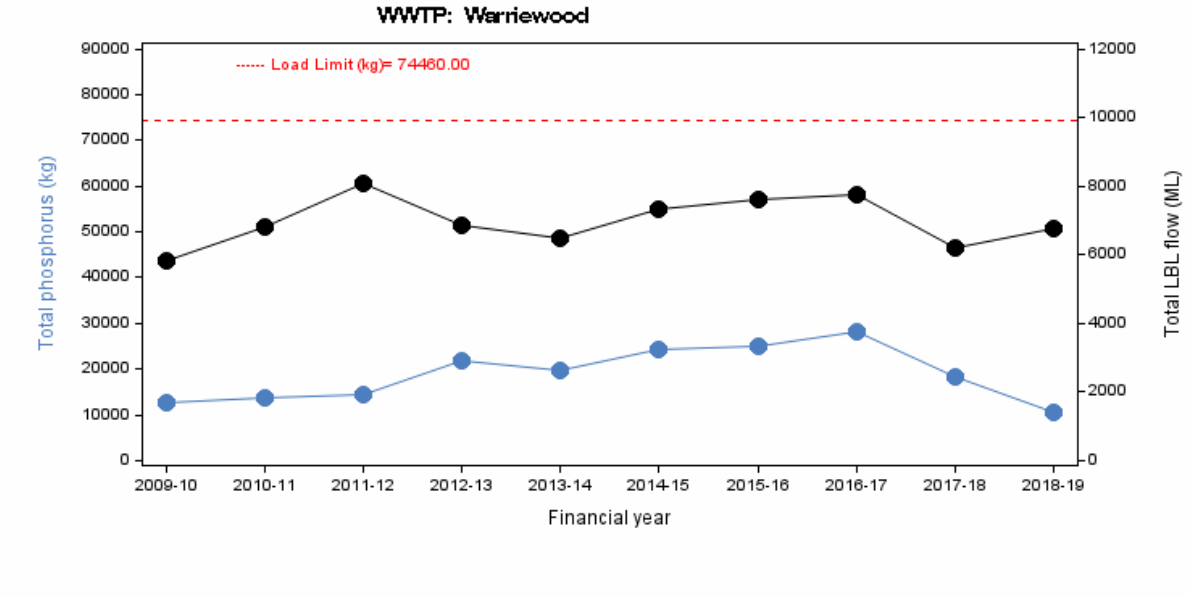
Discharge quality: Other chemicals and organics (including pesticides)



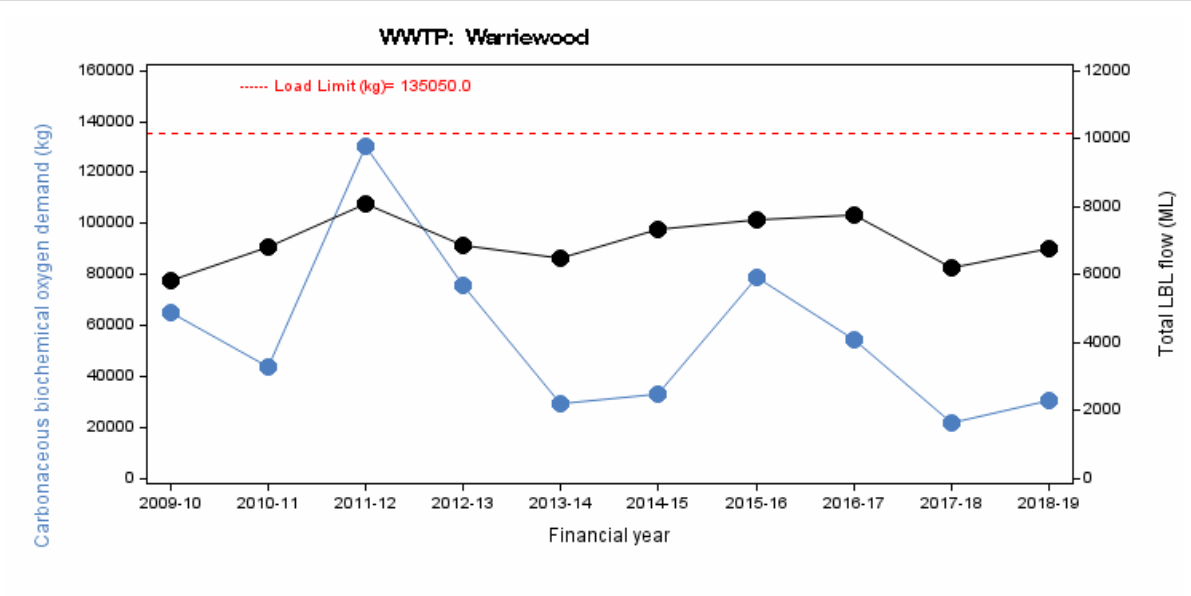


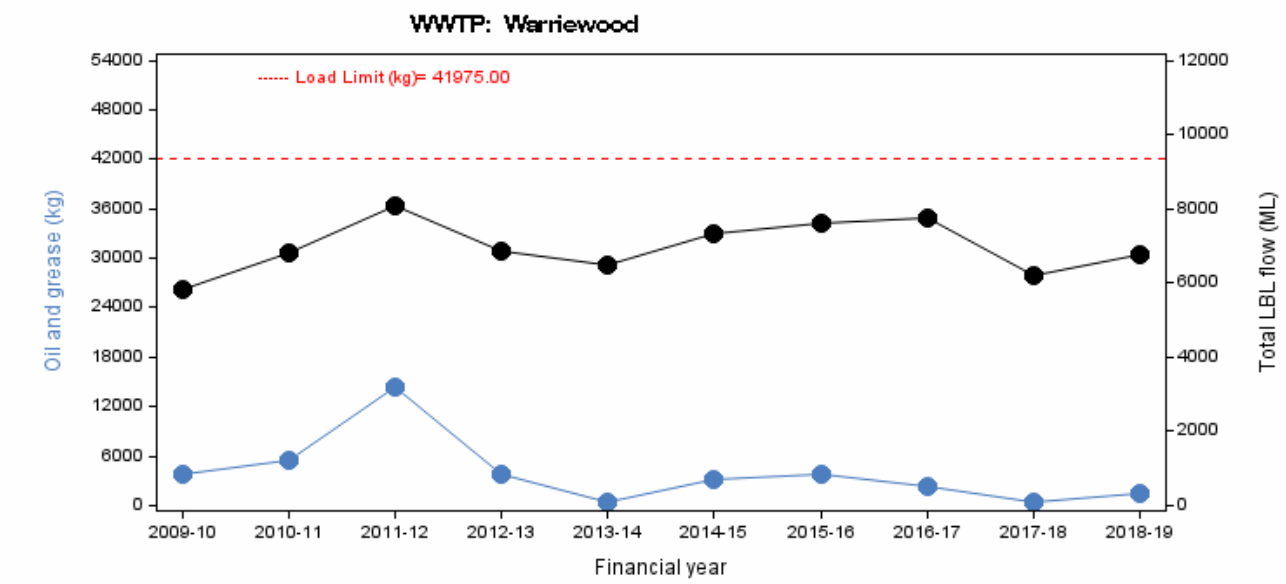
Discharge load: Nutrients

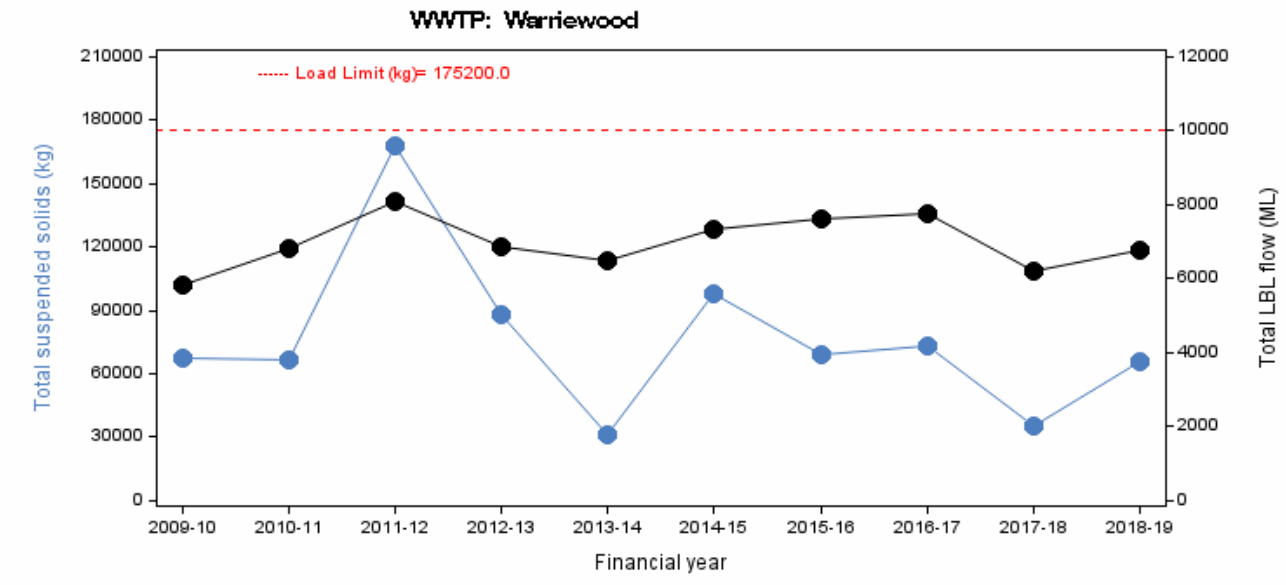




Discharge load: Major conventional analytes

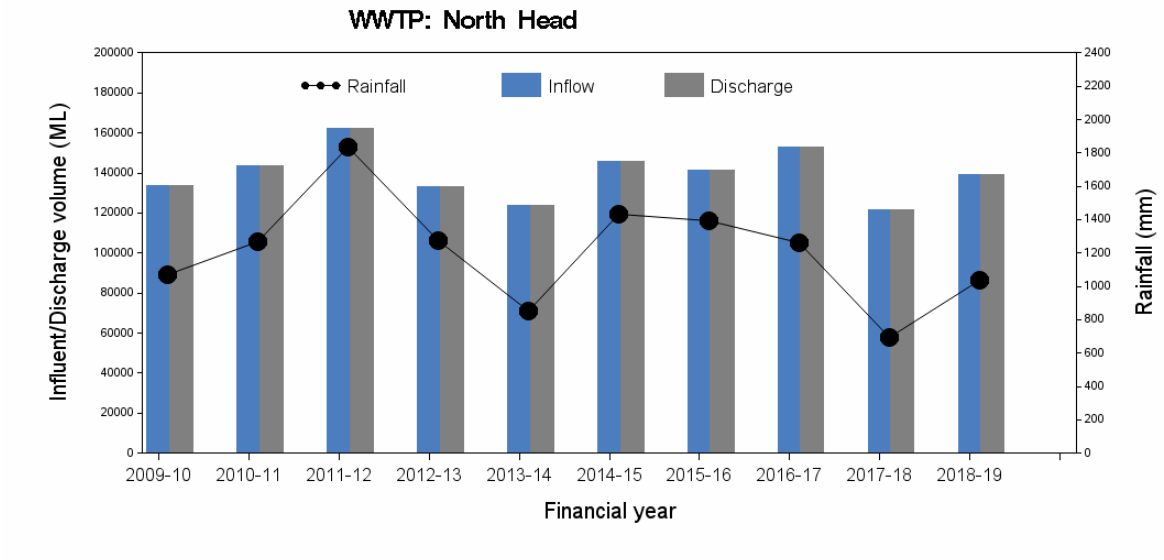



WWTP: Warriewood
Load Limit (kg)= 41975.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

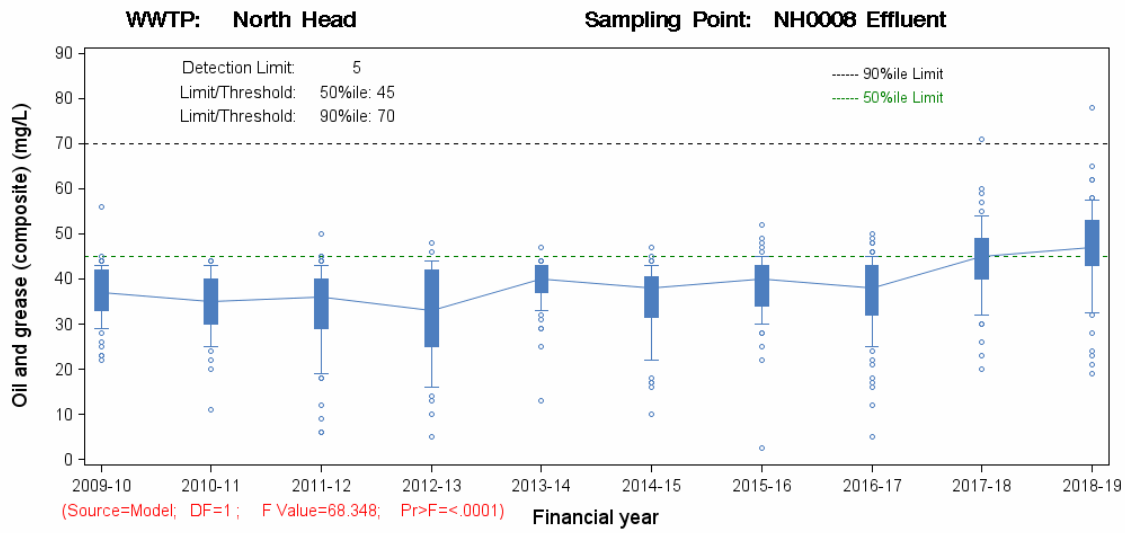

WWTP: Warriewood
Load Limit (kg)= 175200.0
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

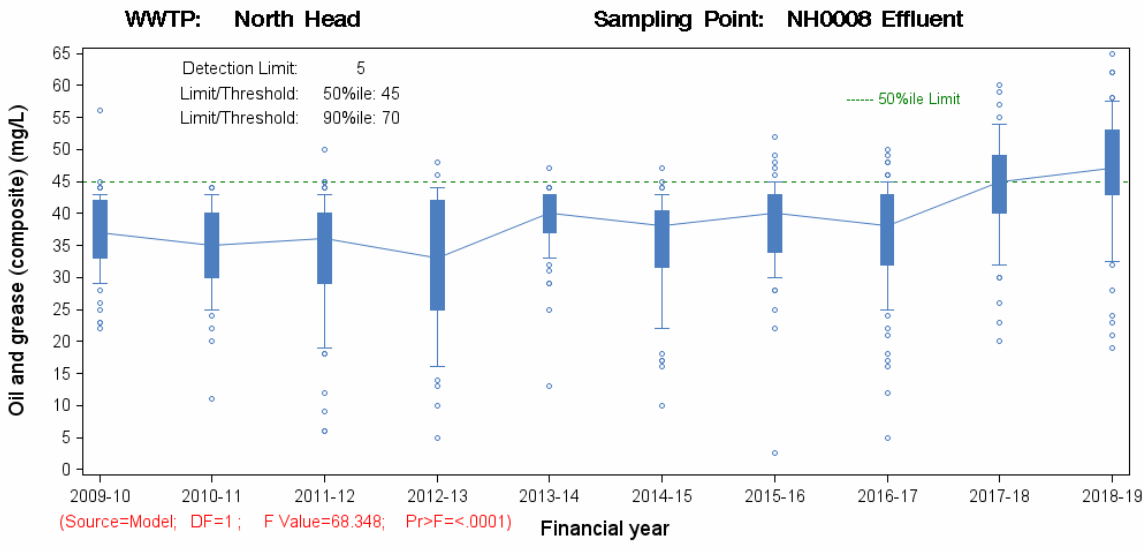
North Head WWTP

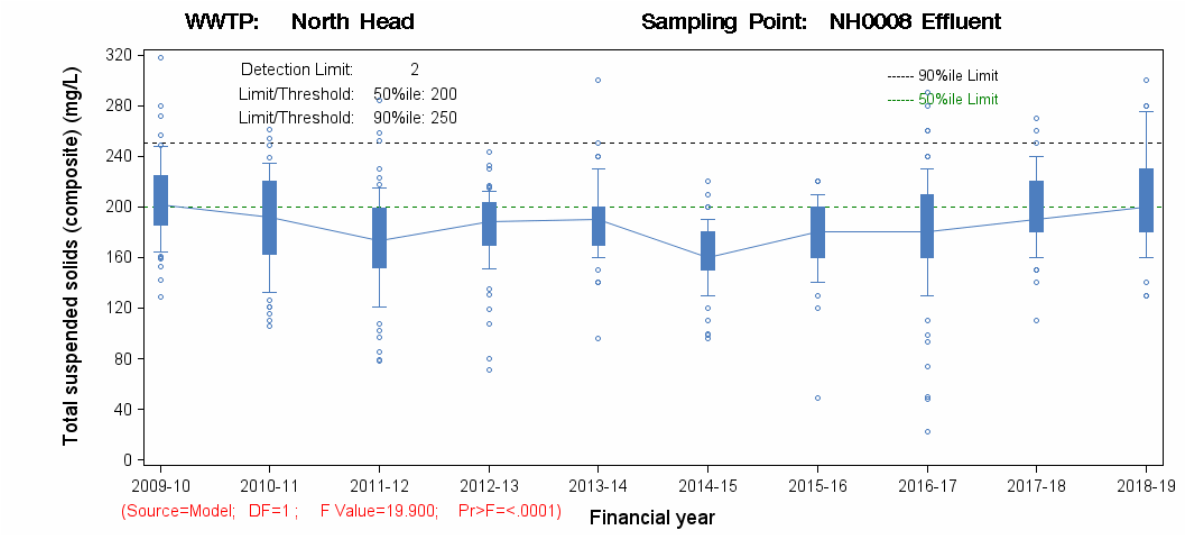
Discharge volume and rainfall

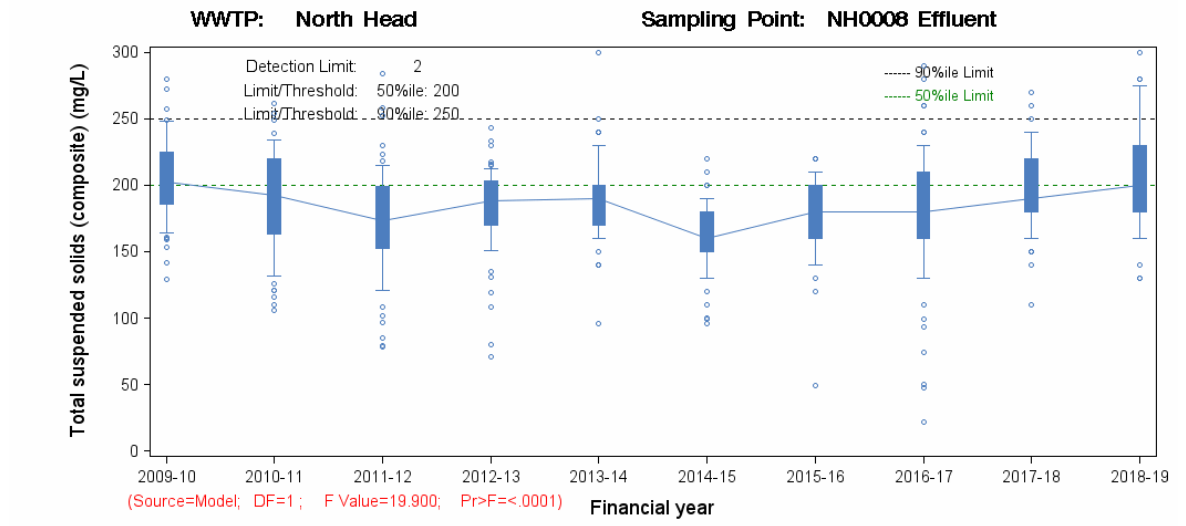


Discharge quality: Major conventional analytes

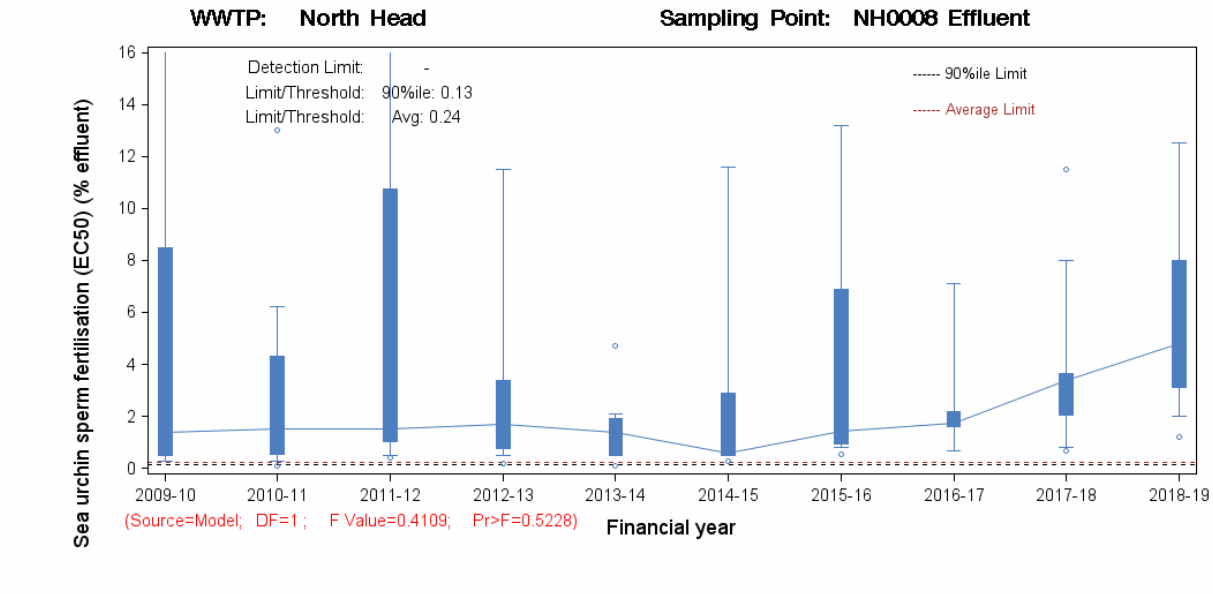




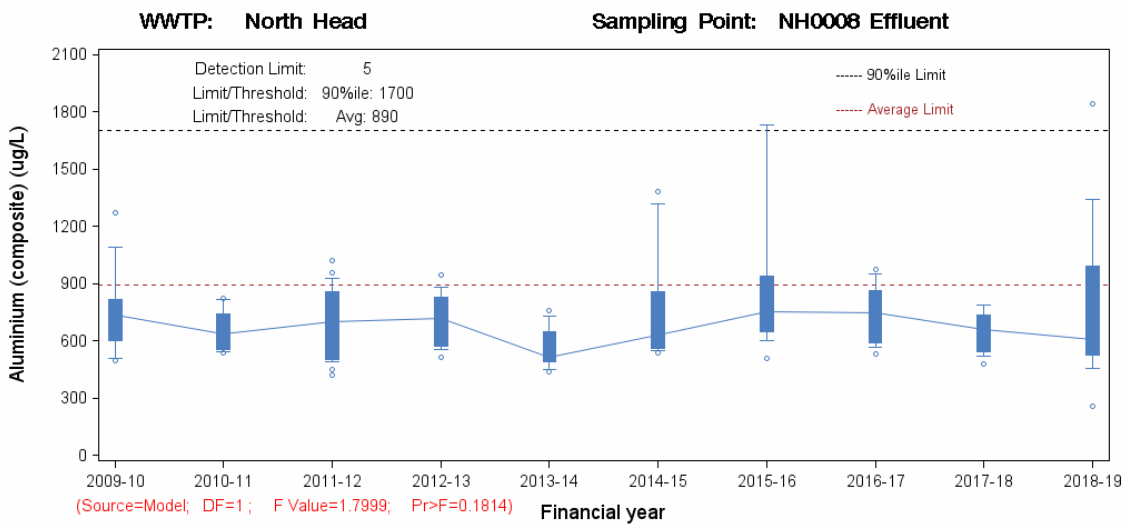


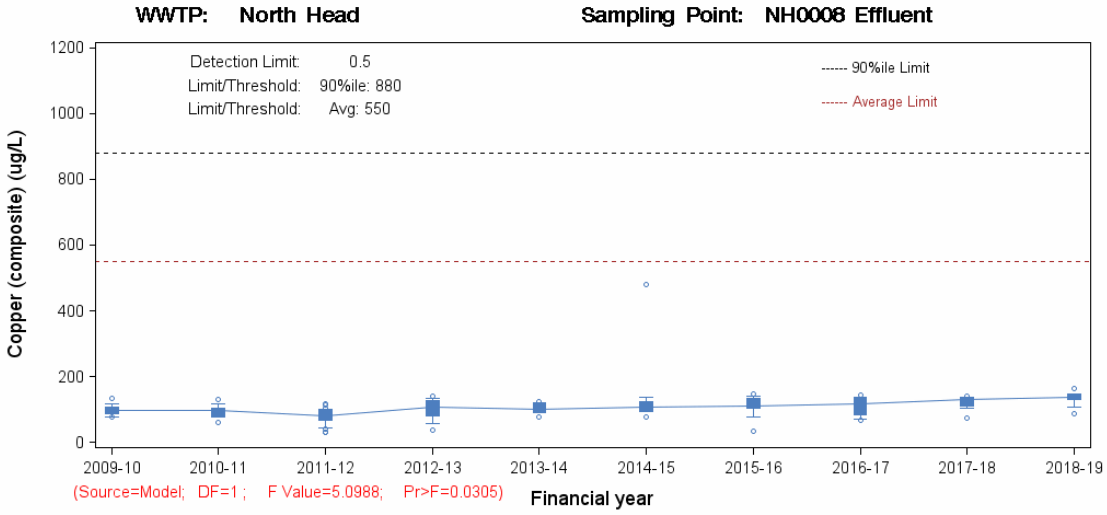


Discharge quality: Toxicity

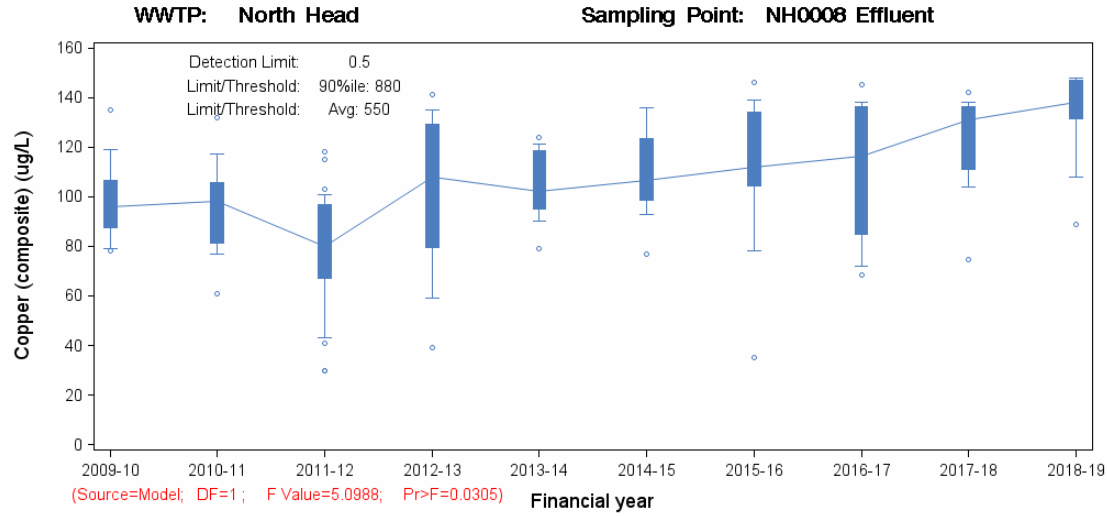


Discharge quality: Trace metals



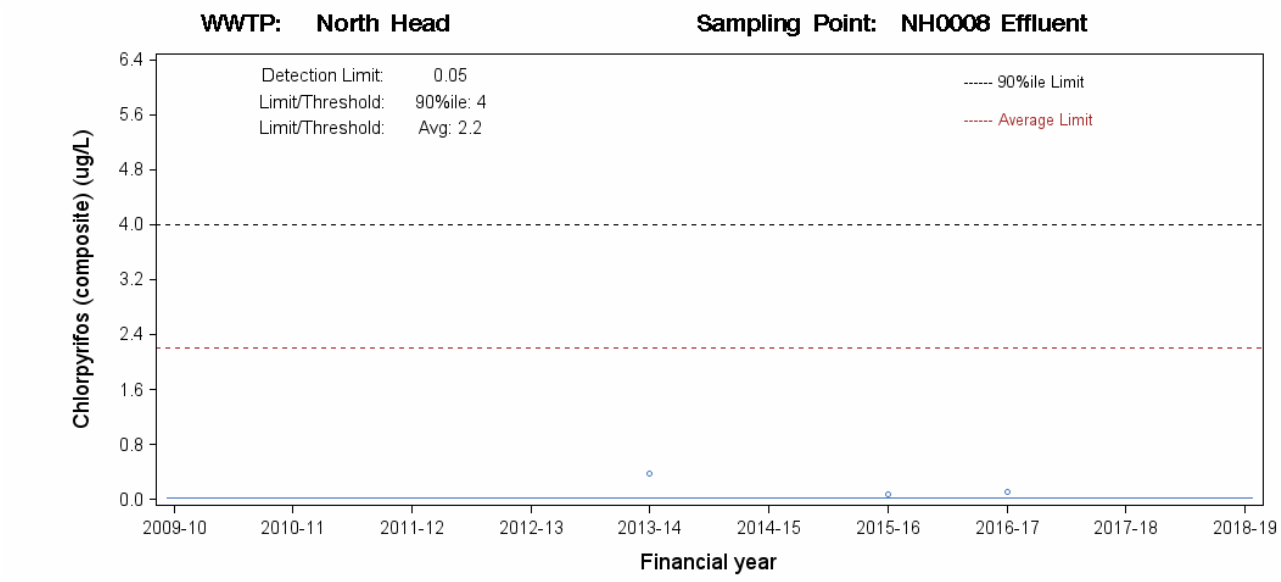


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

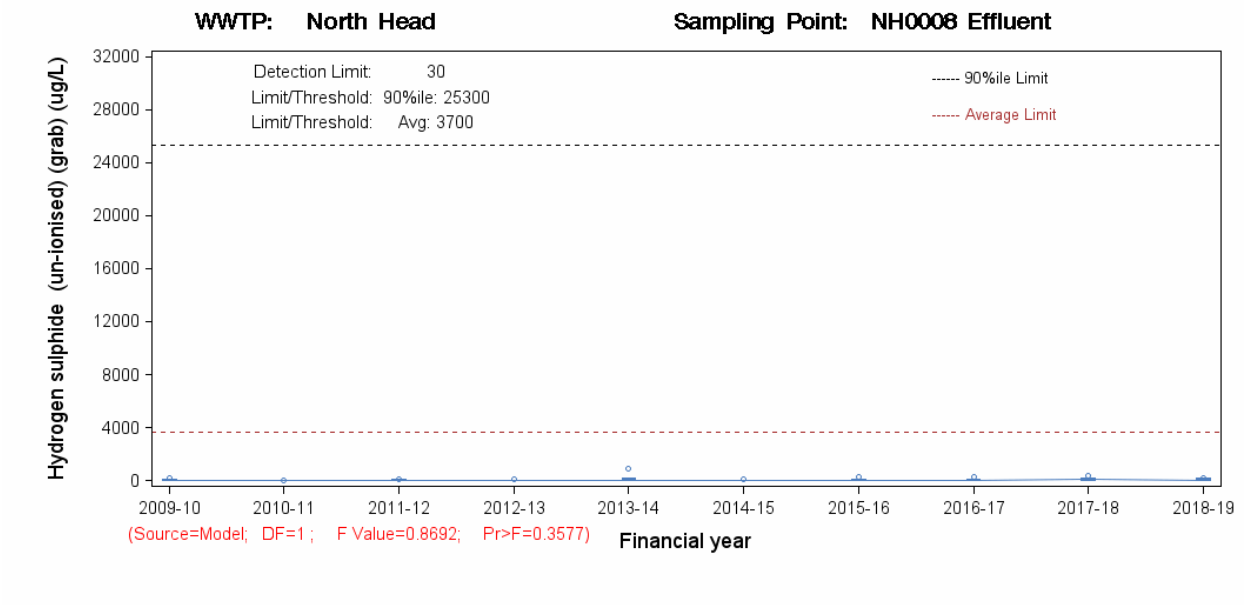


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

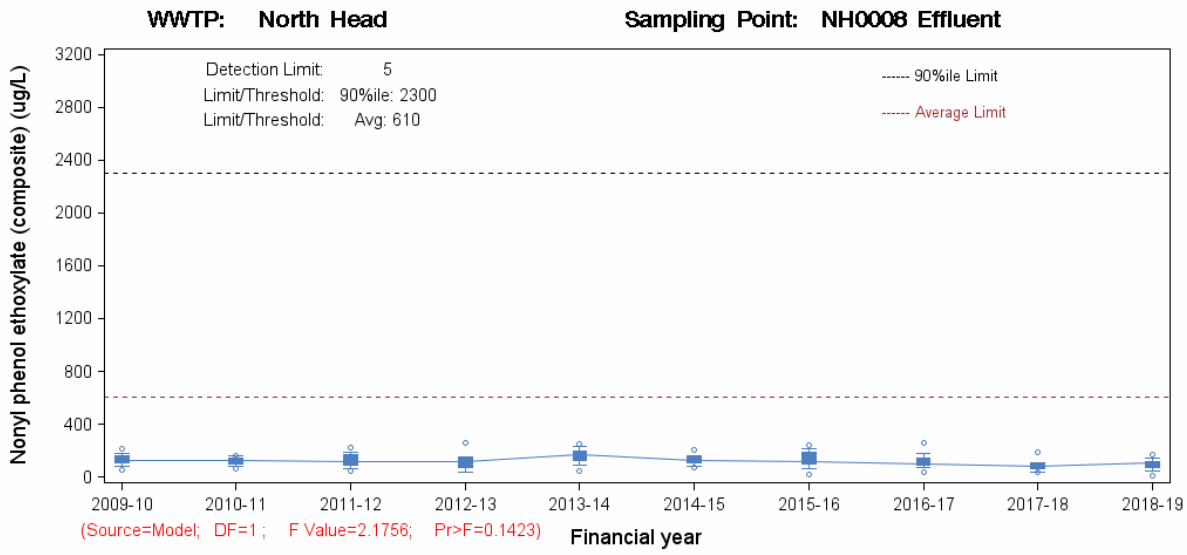
Discharge quality: Other chemicals and organics (including pesticides)



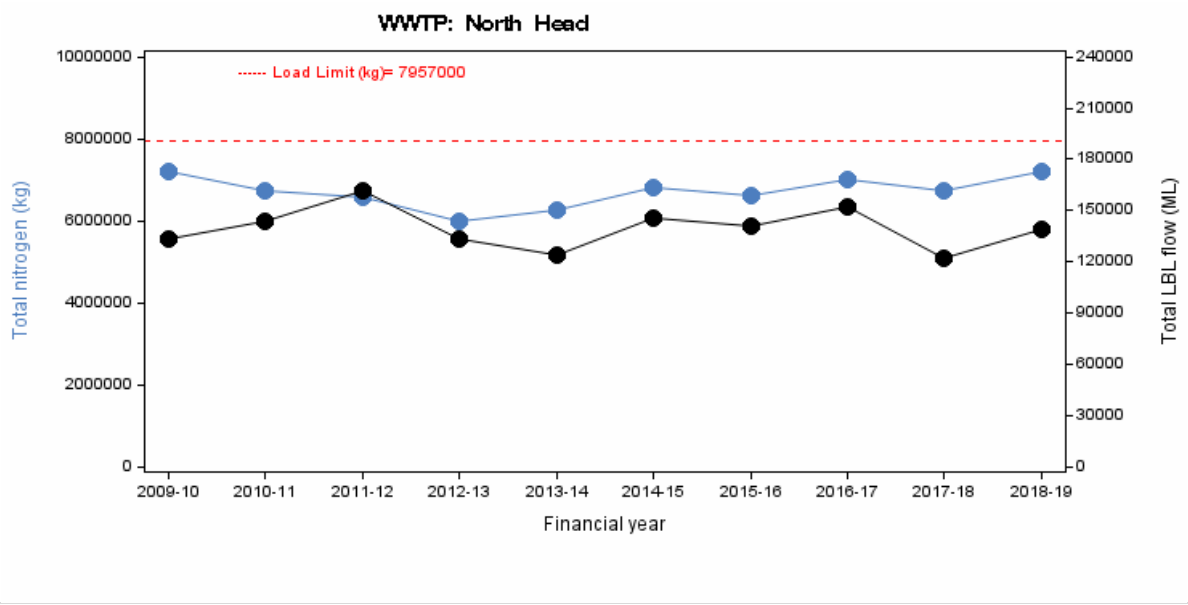
Note: Statistical test was not conducted because >90% of results were below the detection limit.

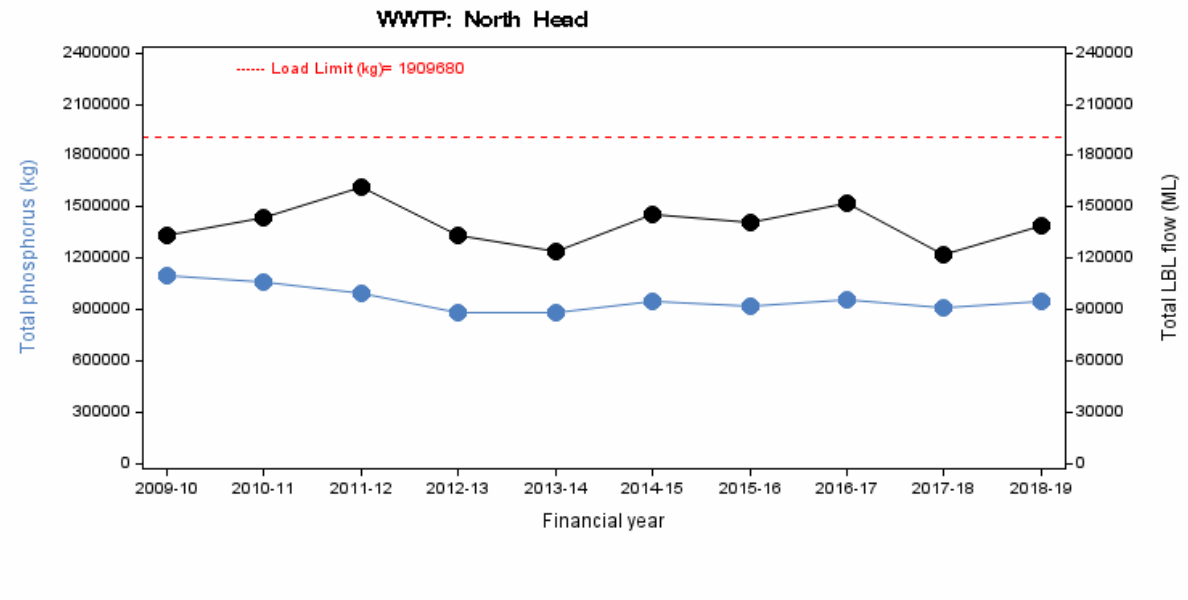


Note: There was a detection limit change in 2016-17. So, statistical test was based on 2018-19 data with previous two years data (2016-2018).

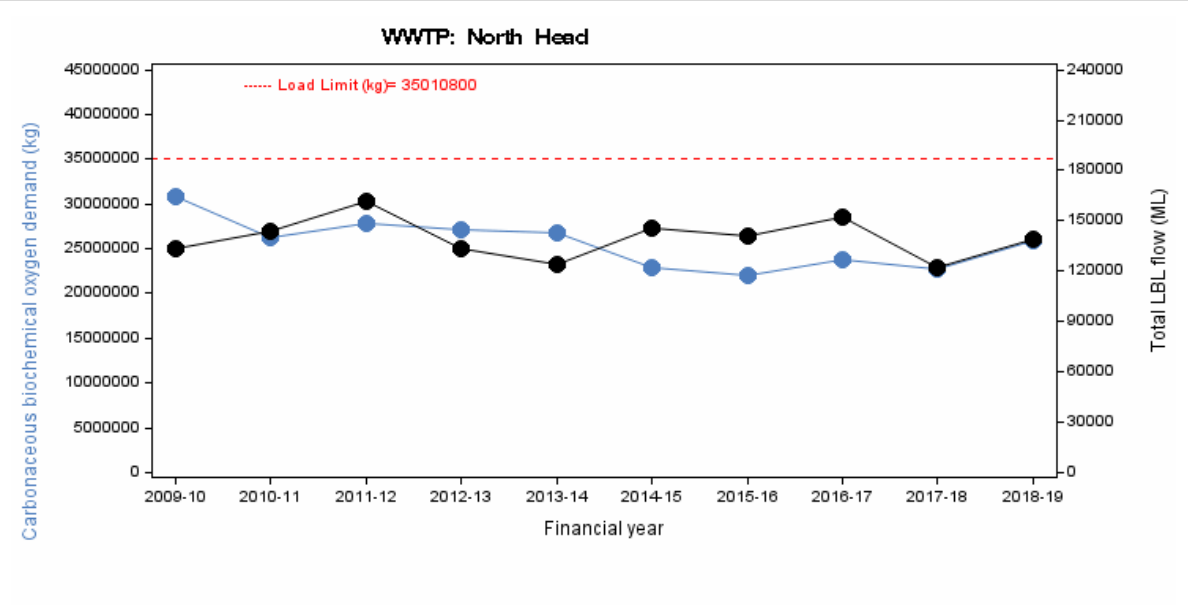


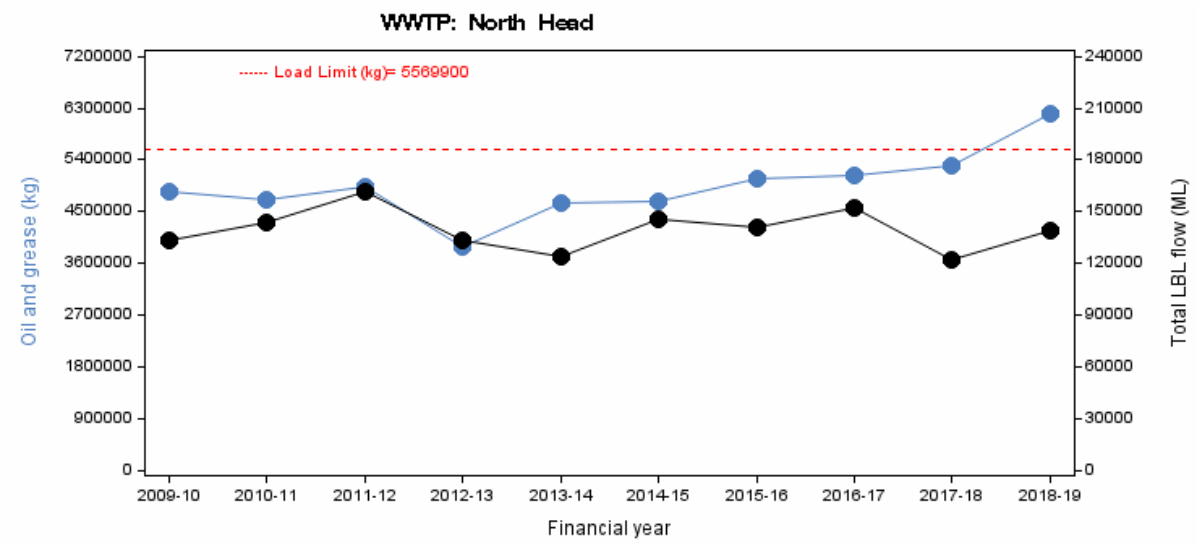
Discharge load: Nutrients

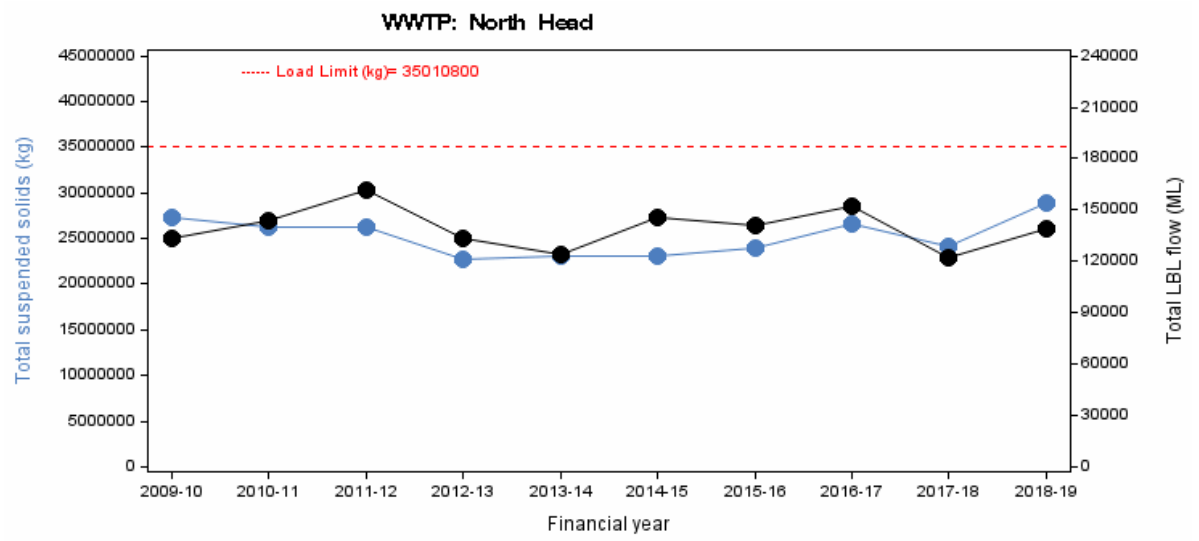




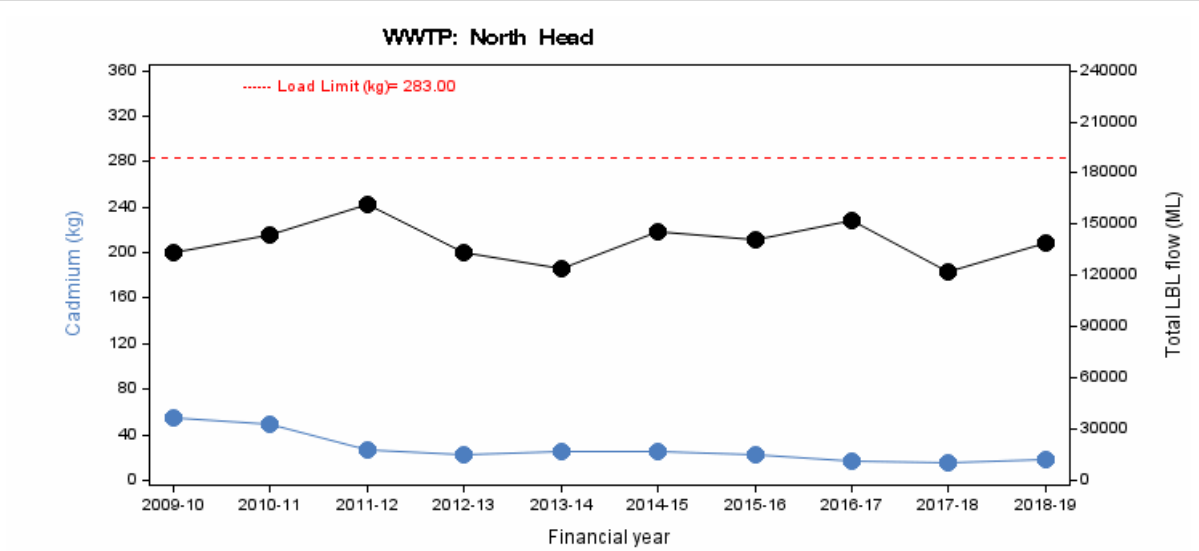
Discharge load: Major conventional analytes

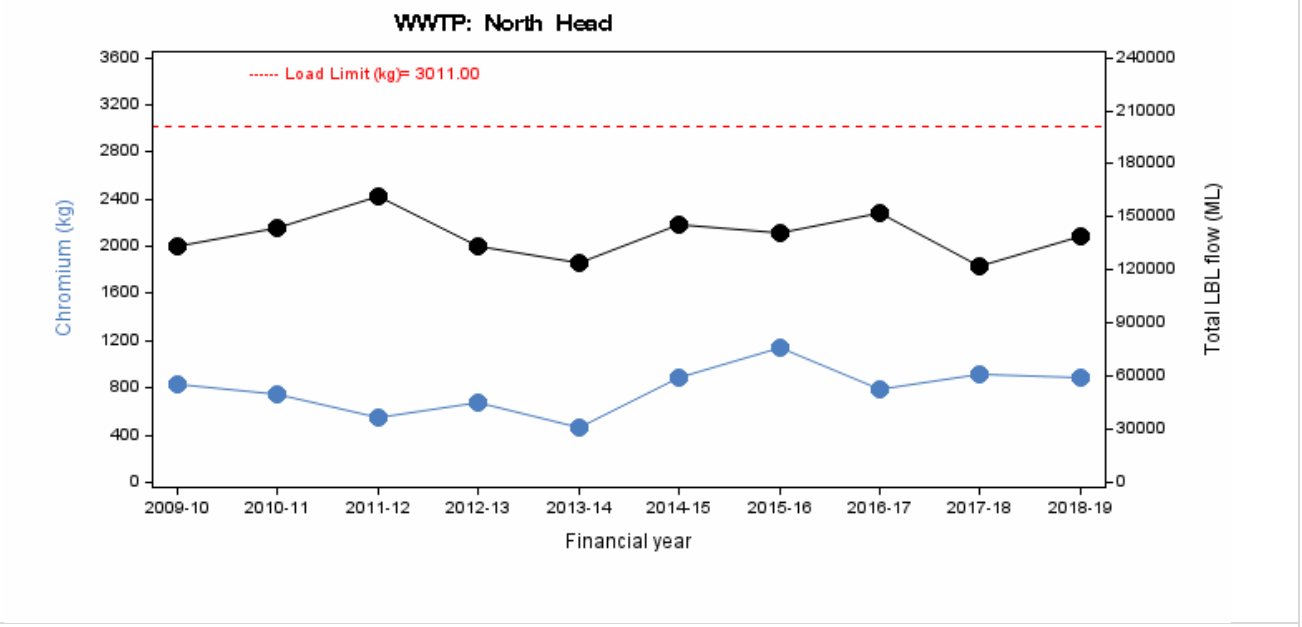


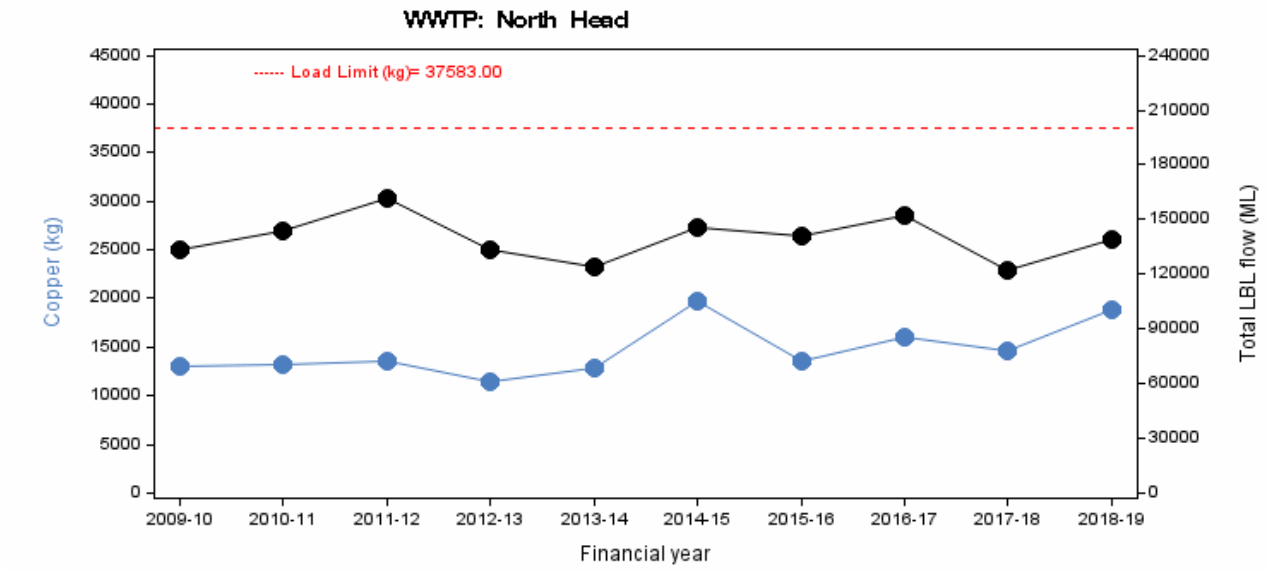


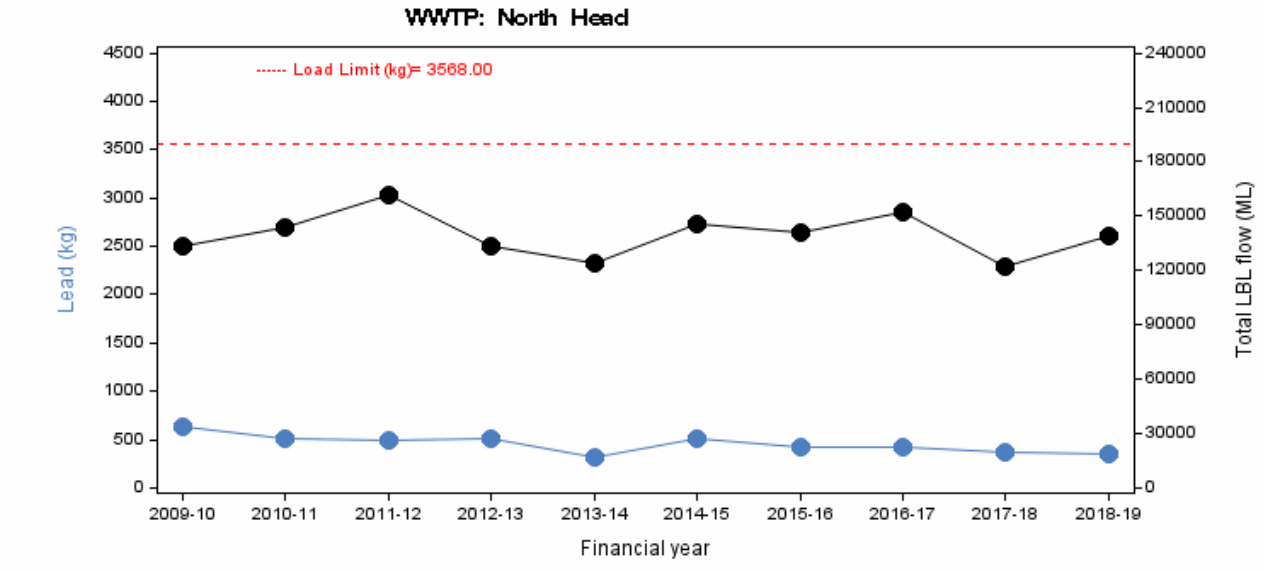


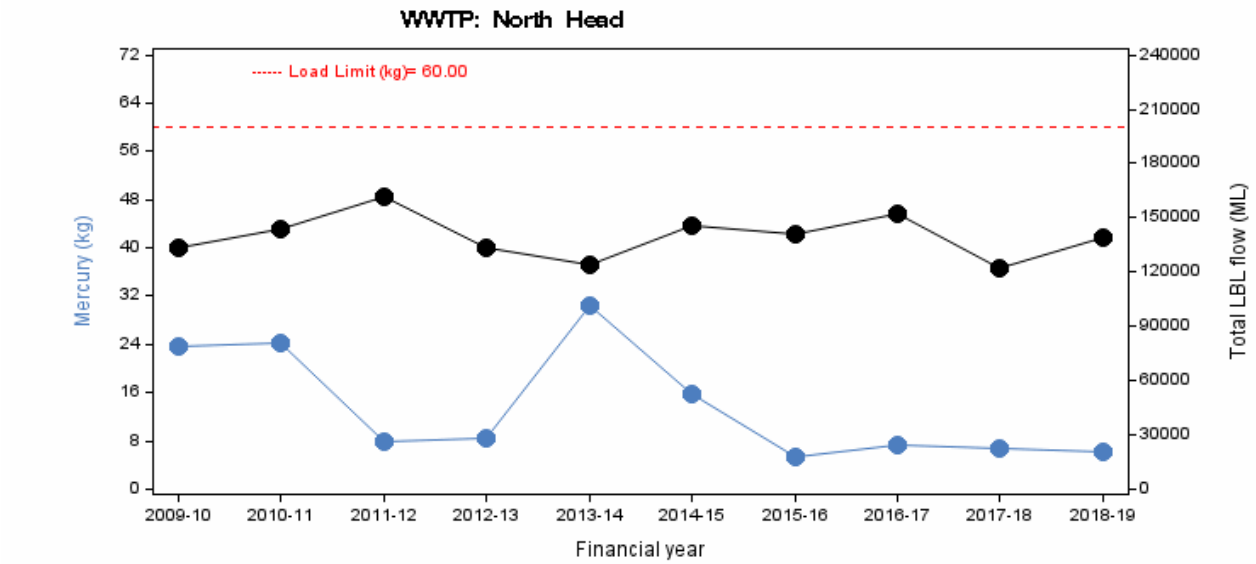
Discharge load: Trace metals

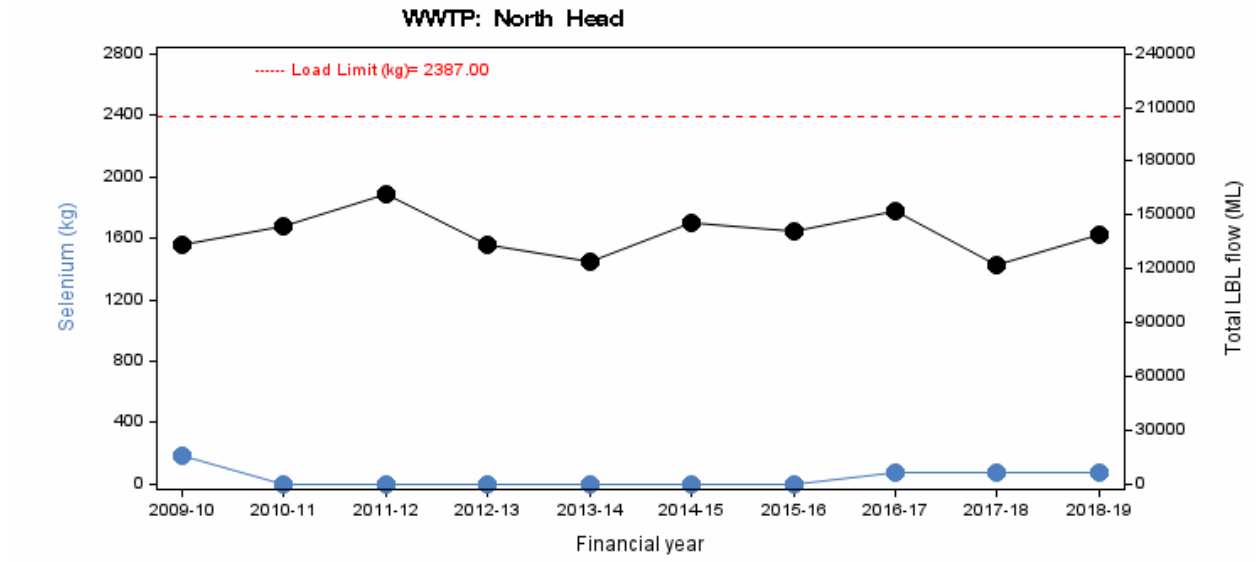


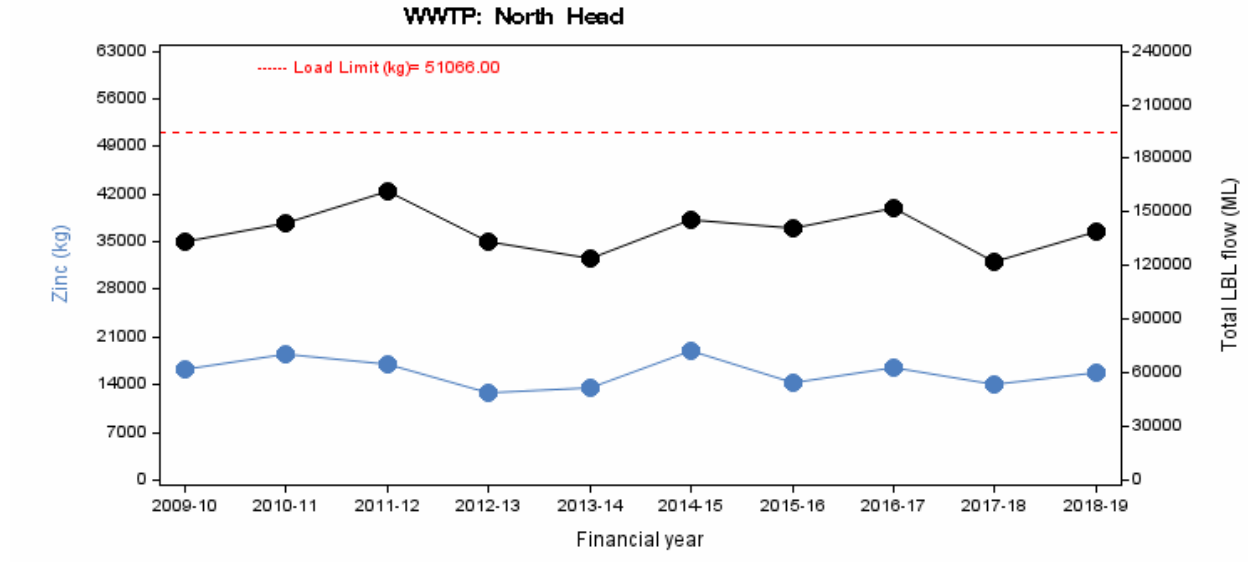

WWTP: North Head
Load Limit (kg)= 3011.00
Chromium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: North Head
Load Limit (kg)= 37583.00
Copper (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

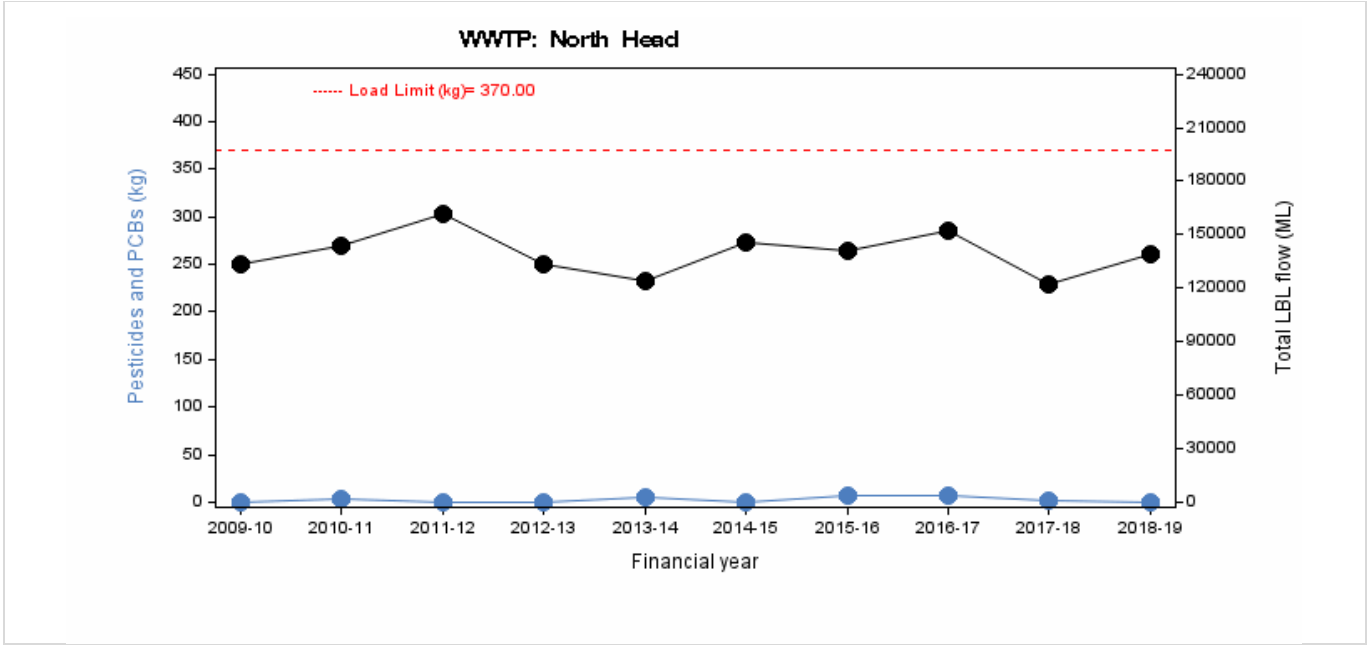

WWTP: North Head
Load Limit (kg)= 3568.00
Lead (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19





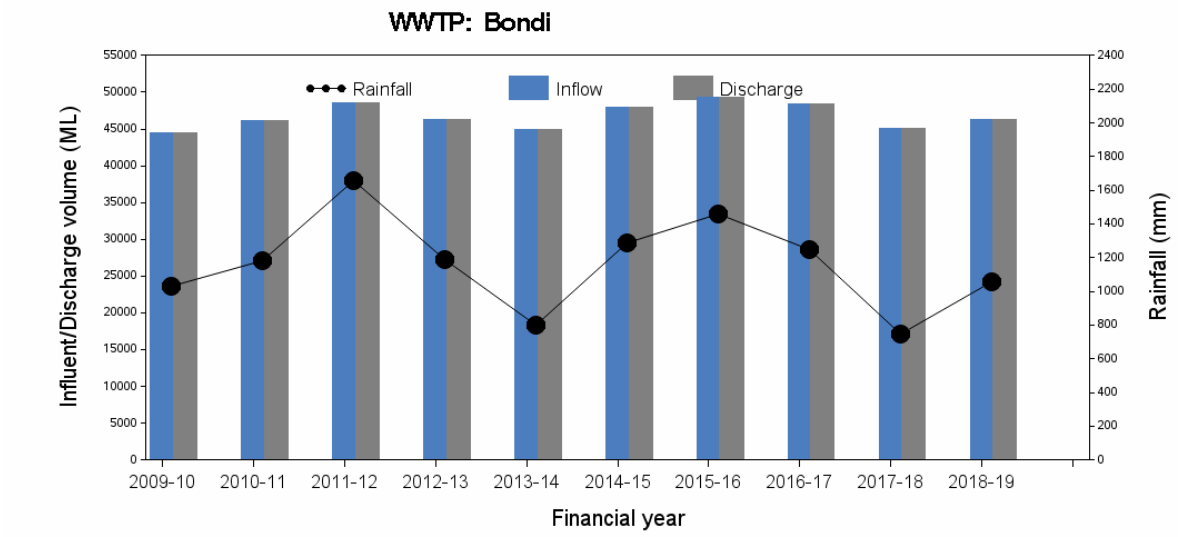


Discharge load: Other chemicals and organics (including pesticides)

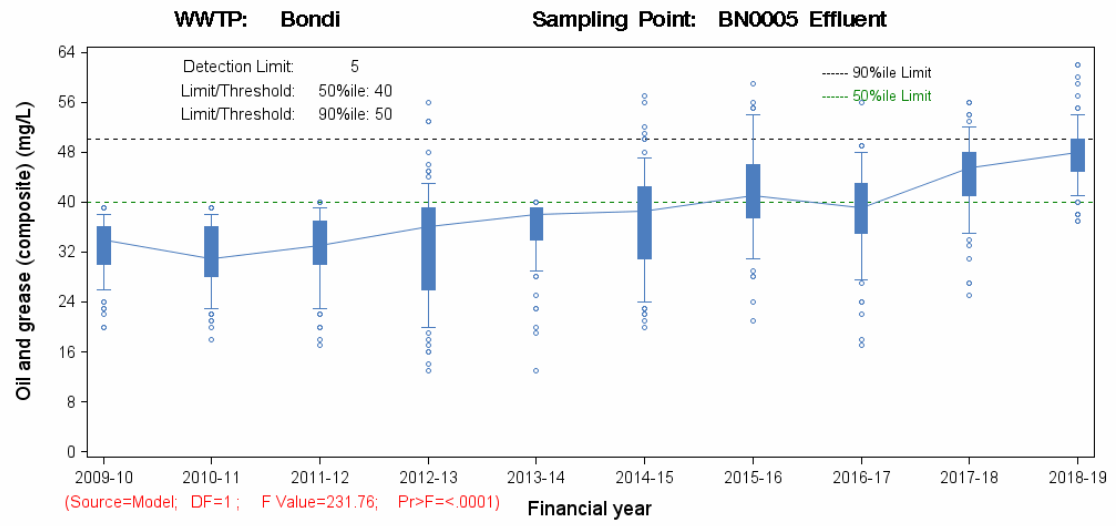

WWTP: North Head
Load Limit (kg)= 370.00
Pesticides and PCBs (kg)
Total LBL flow (ML)
450
400
350
300
250
200
150
100
50
0
240000
210000
180000
150000
120000
90000
60000
30000
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
Financial year

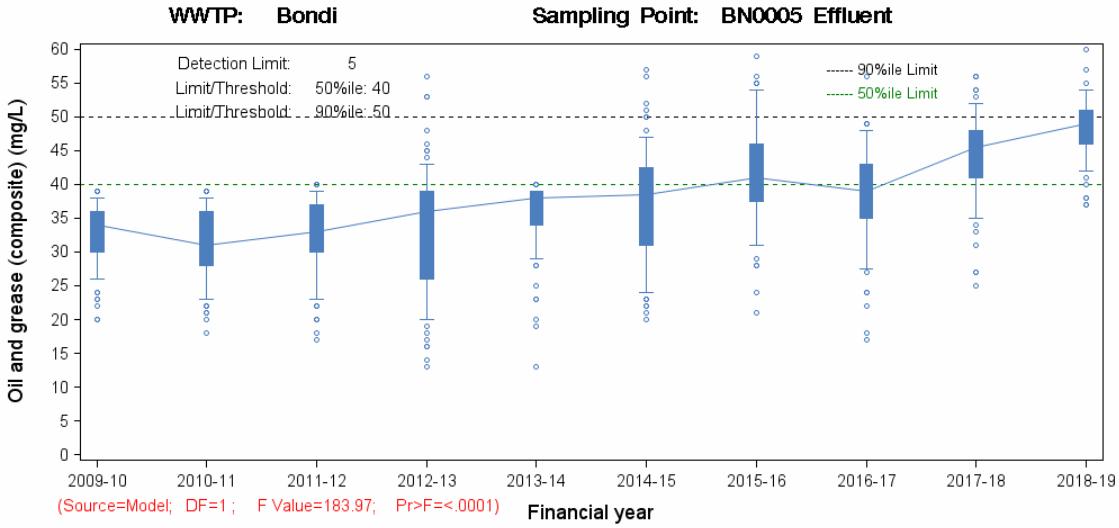
Bondi WWTP

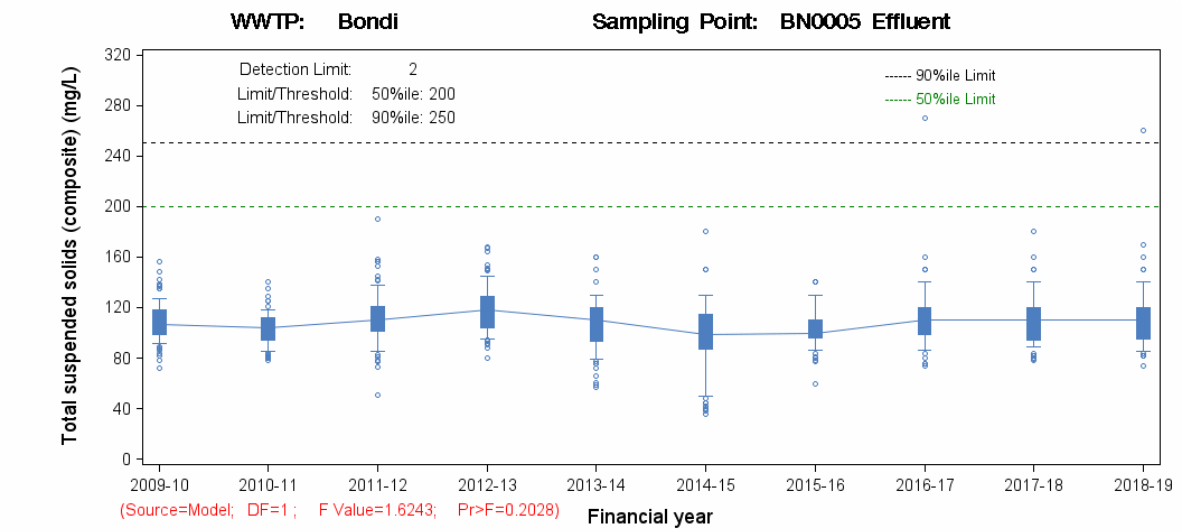
Discharge volume and rainfall

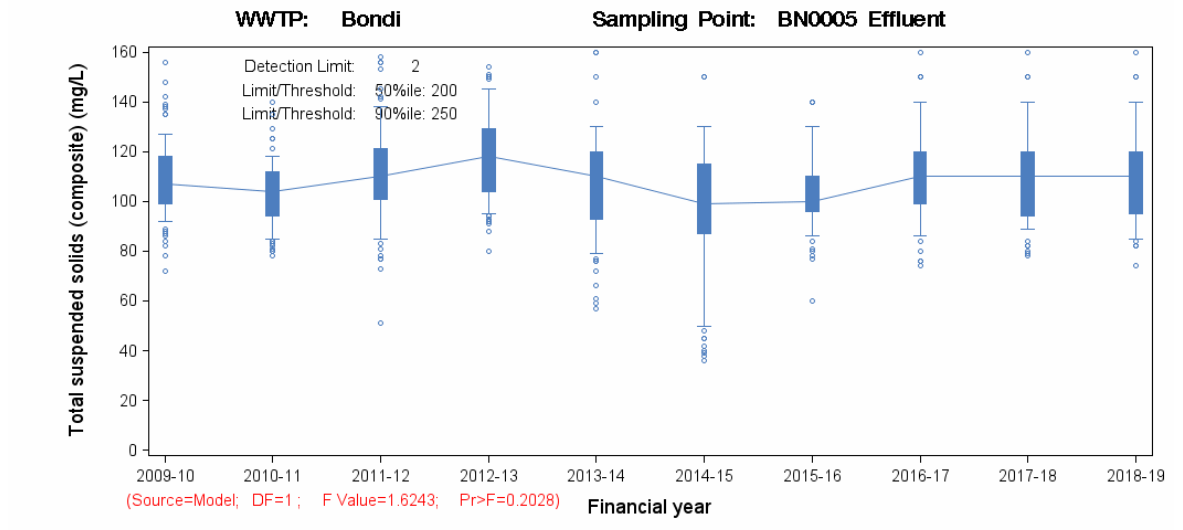


Discharge quality: Major conventional analytes

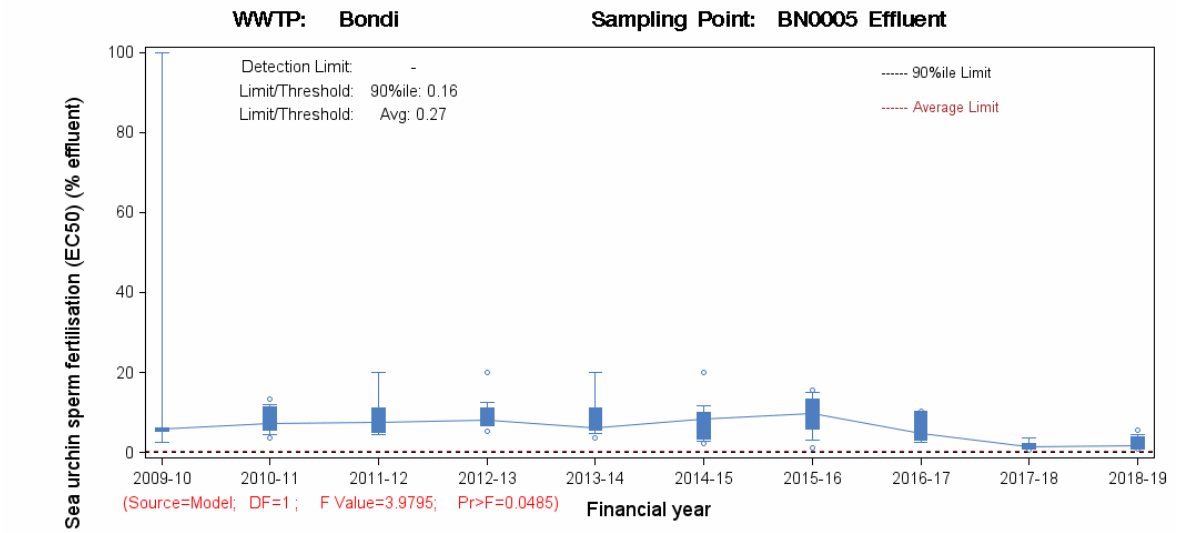


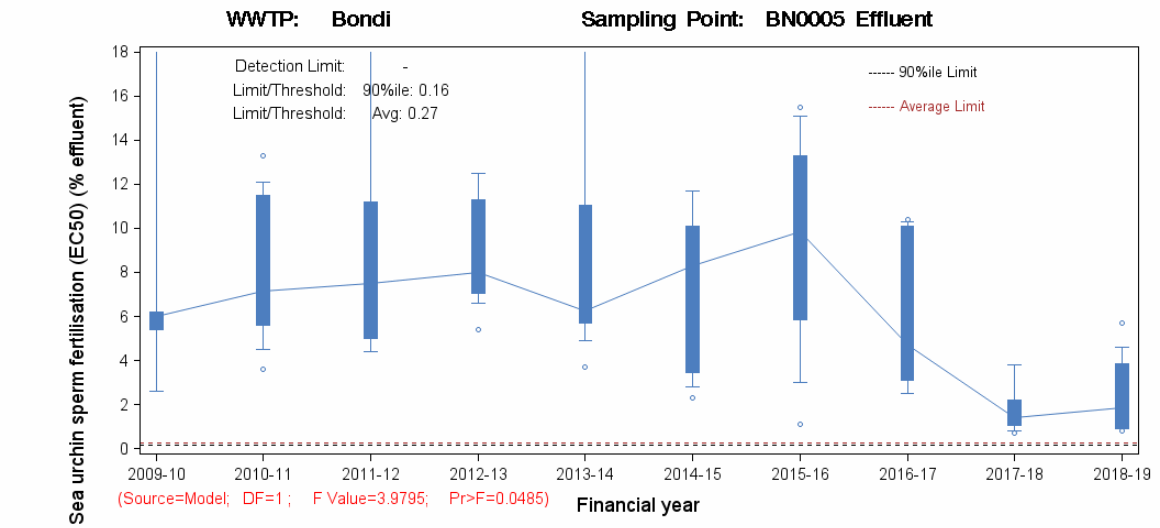




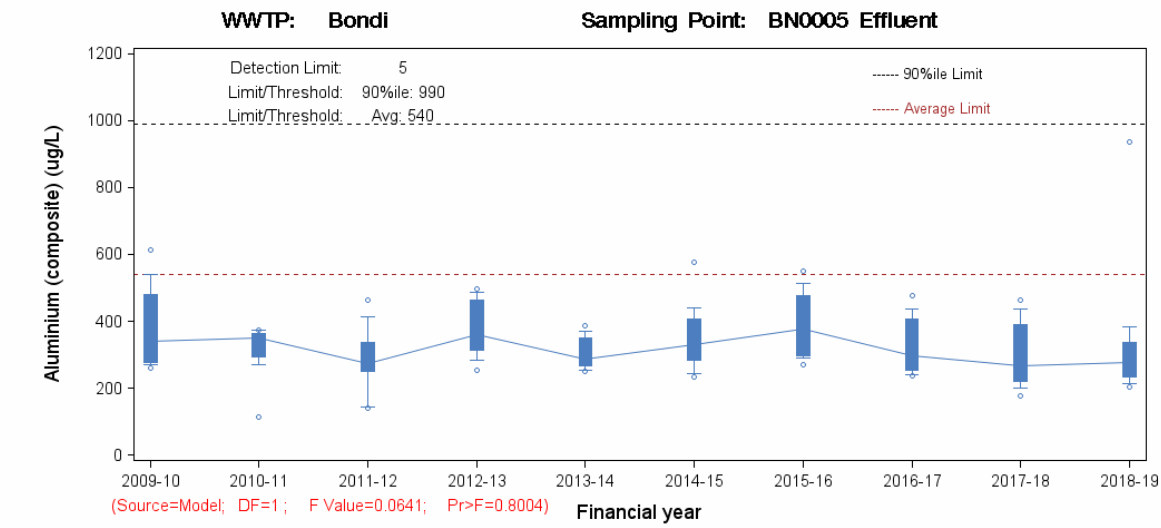


Discharge quality: Toxicity

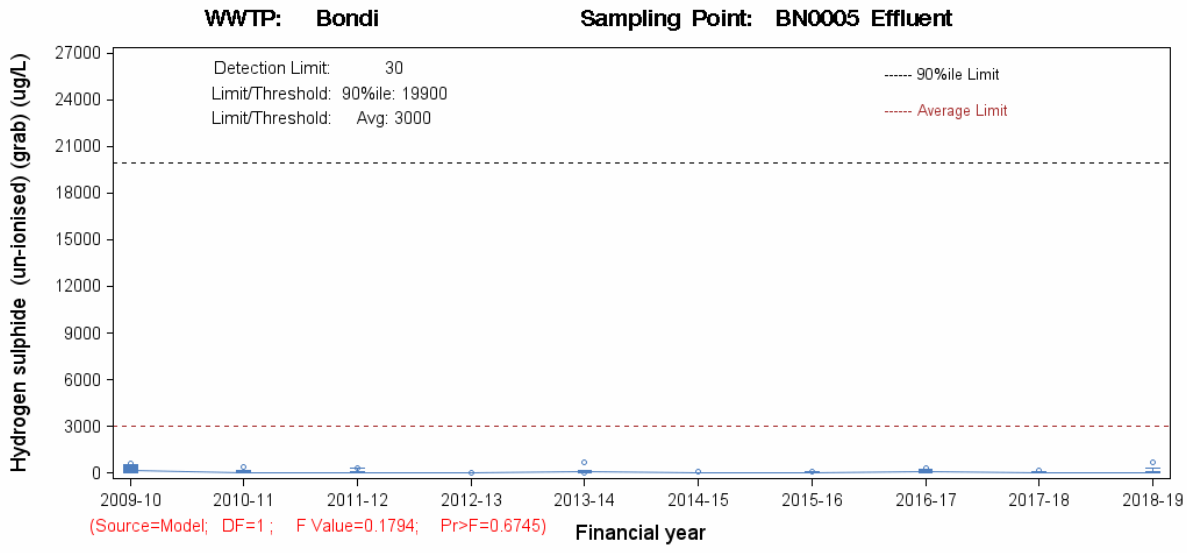




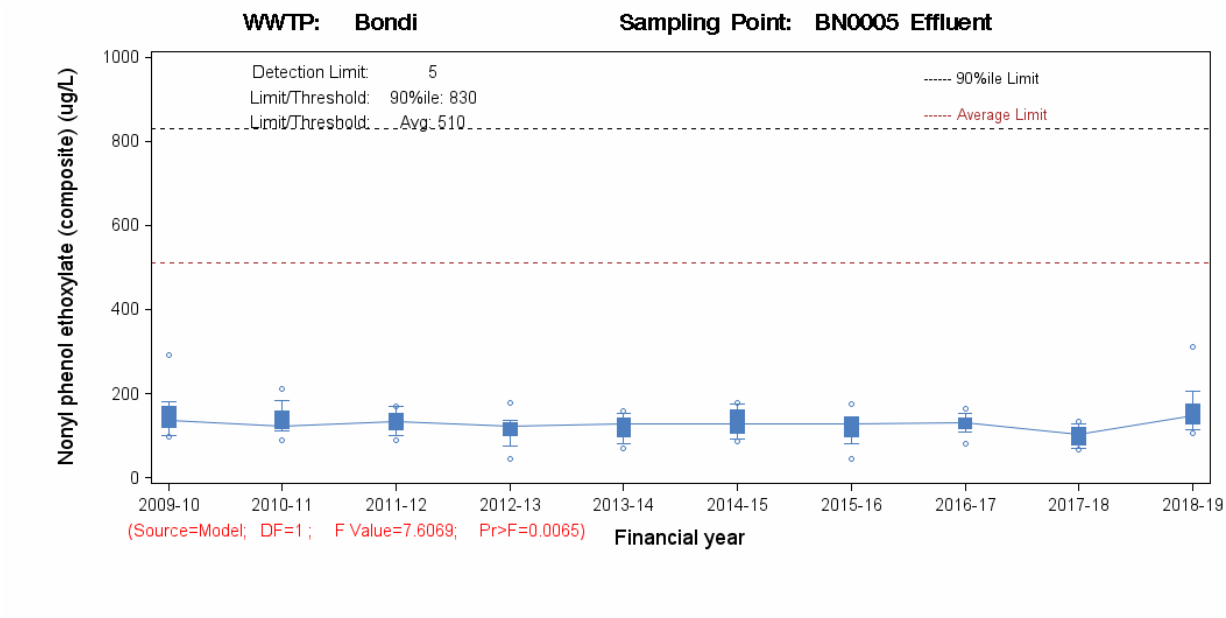
Discharge quality: Trace metals

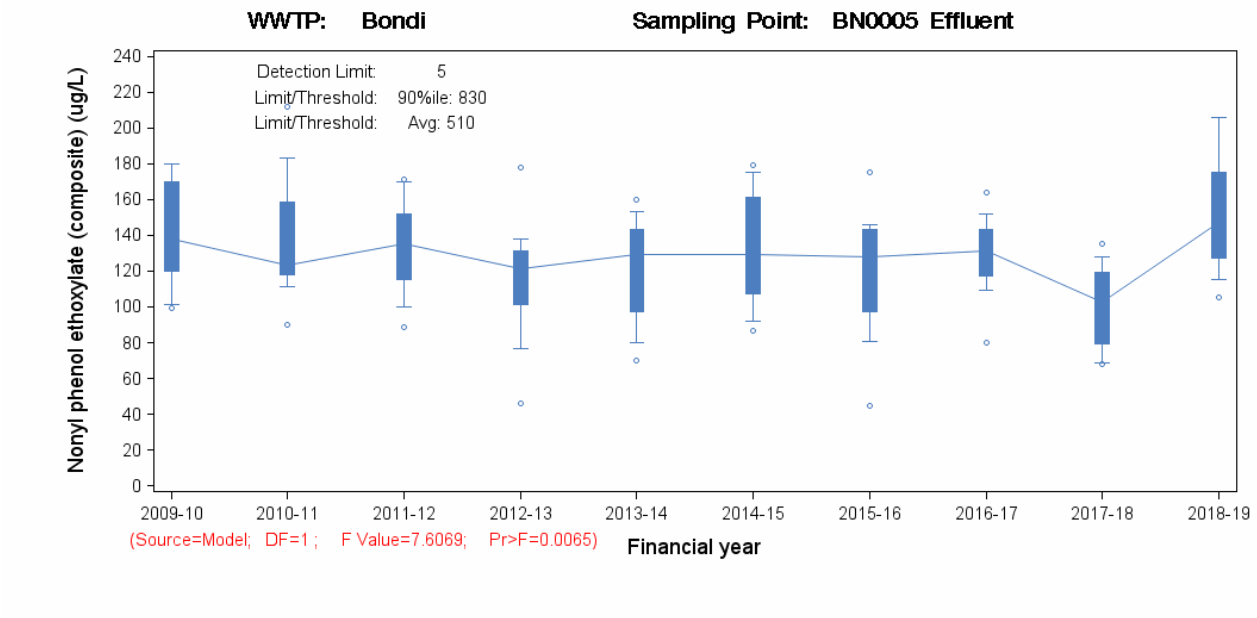


Discharge quality: Other chemicals and organics (including pesticides)

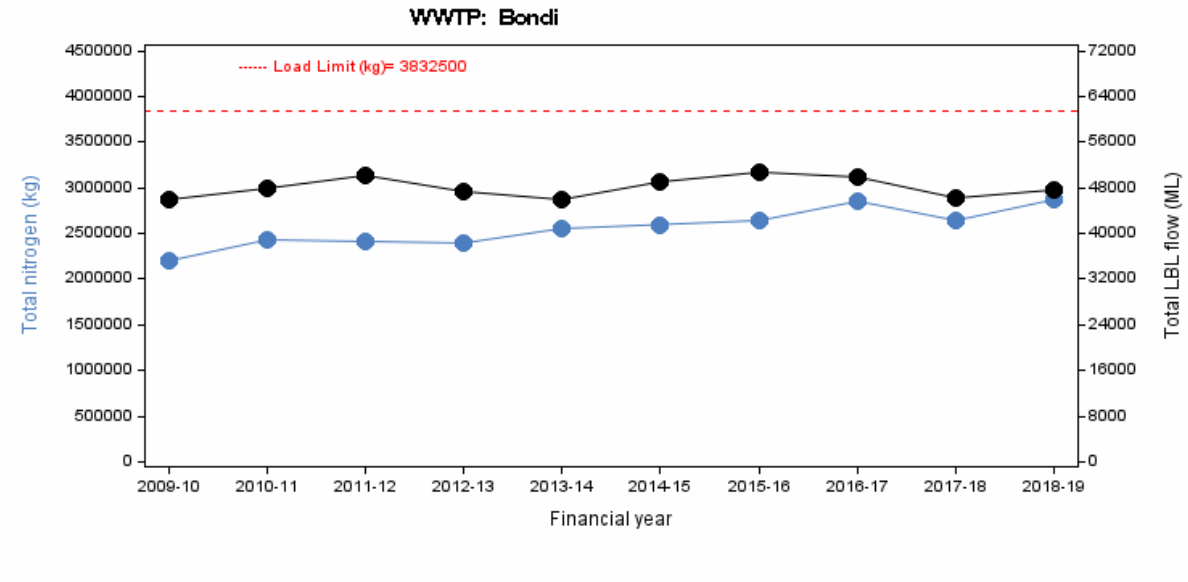


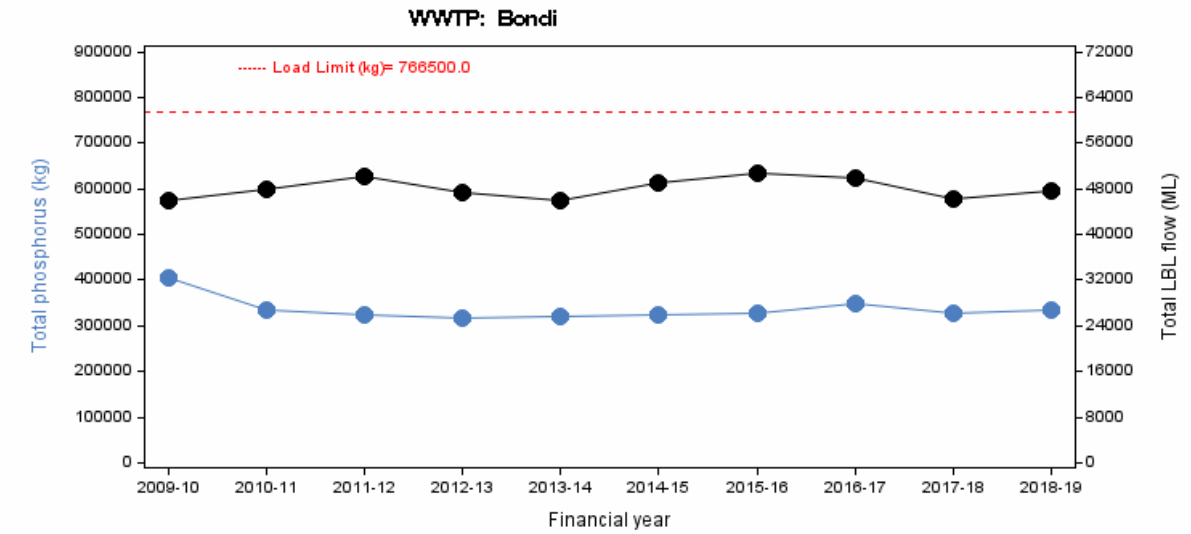
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



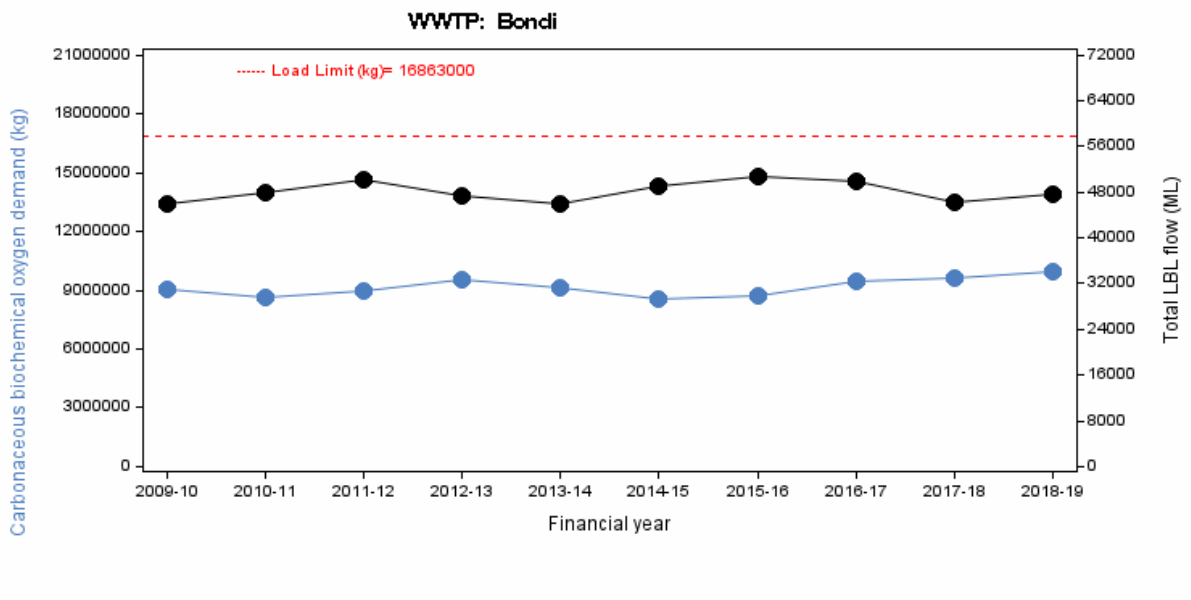


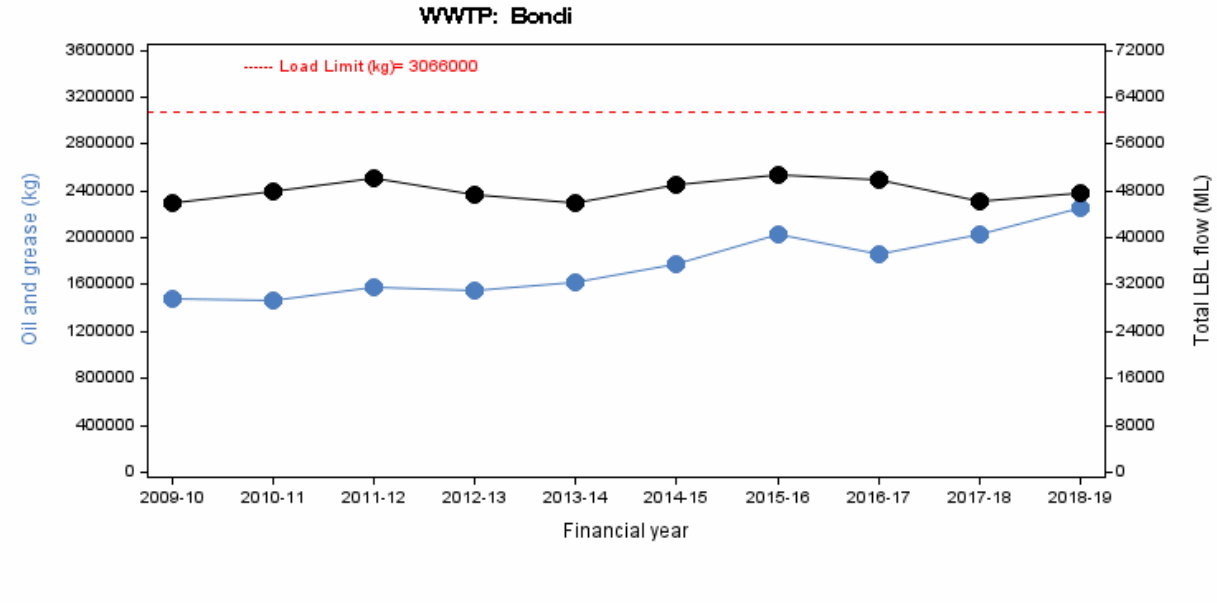
Discharge load: Nutrients

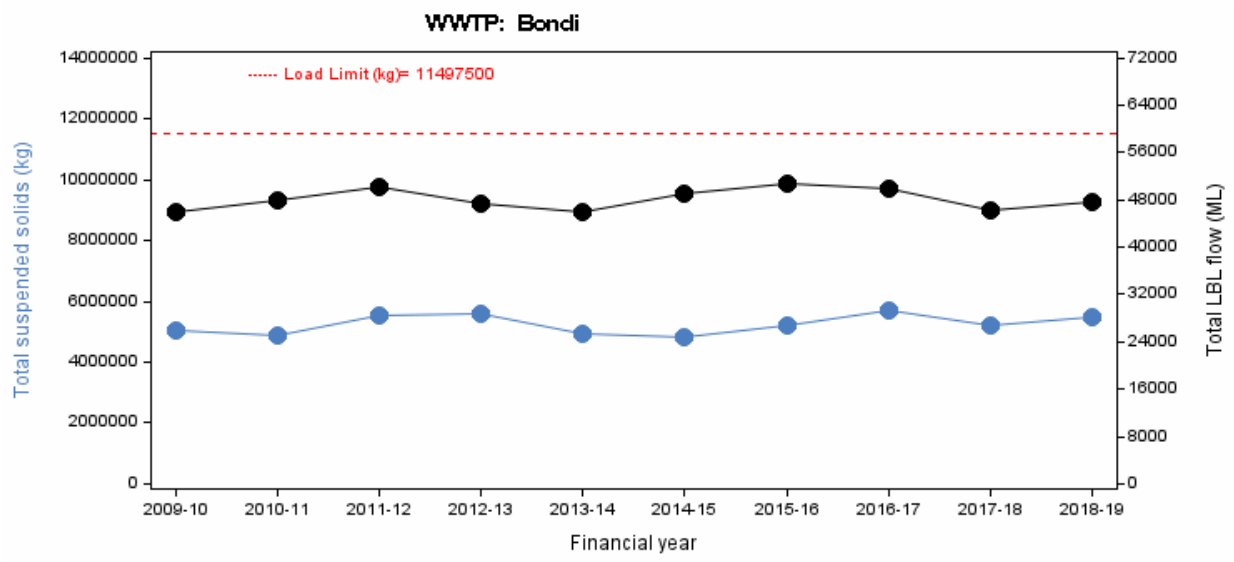




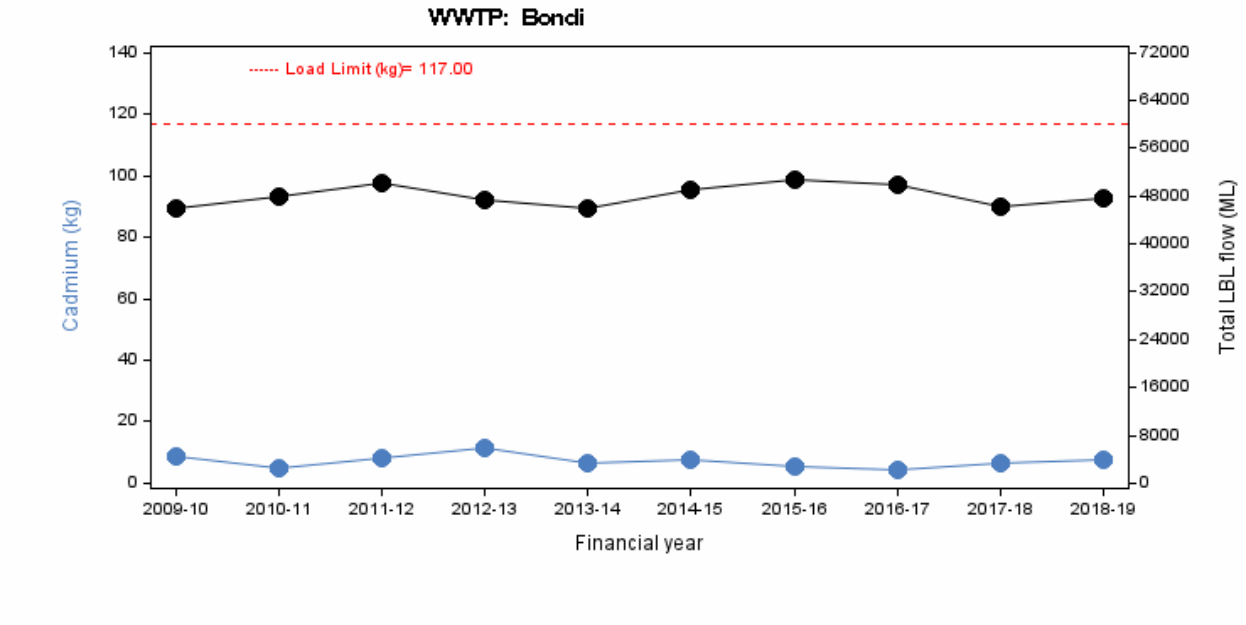
Discharge load: Major conventional analytes

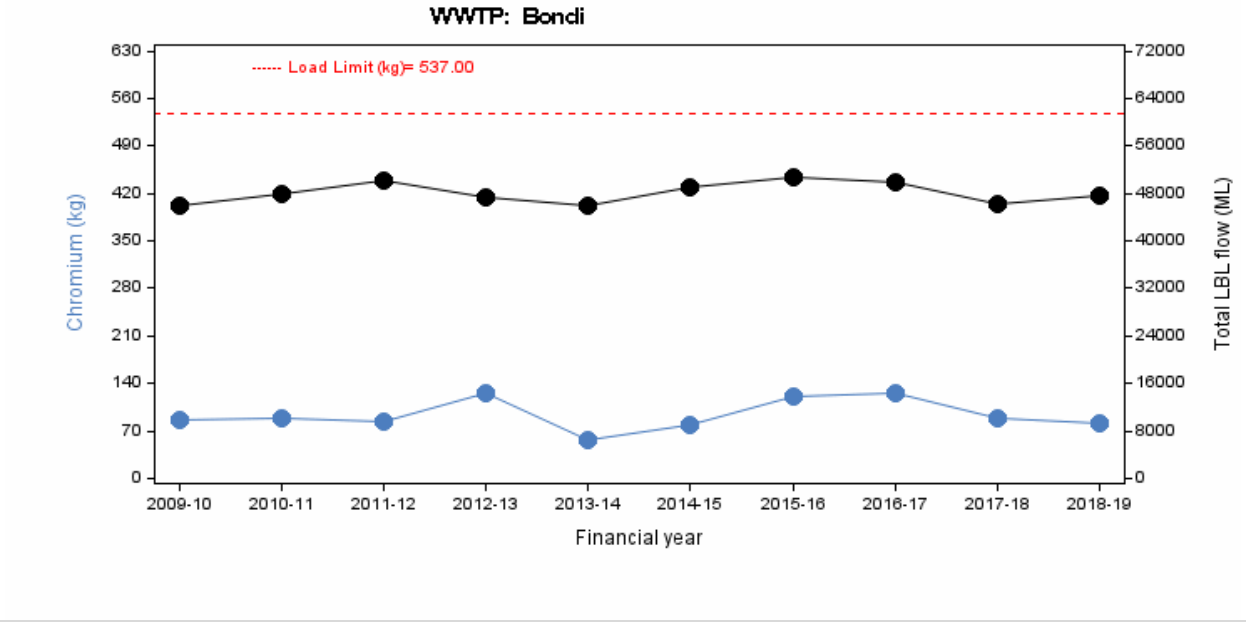


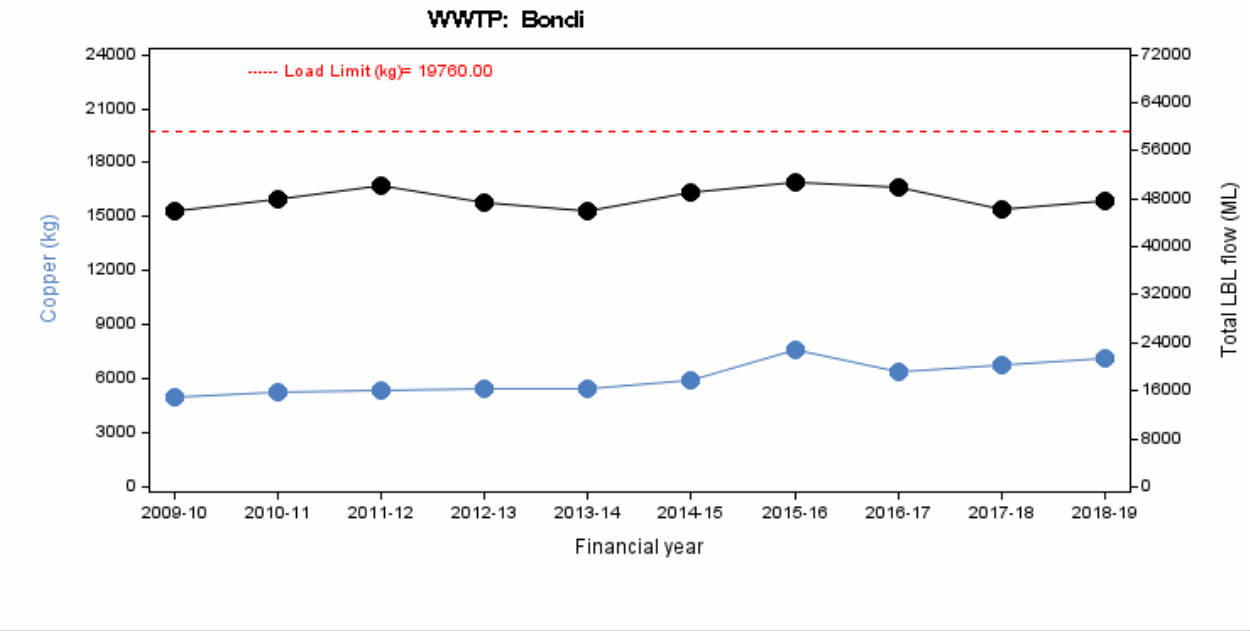


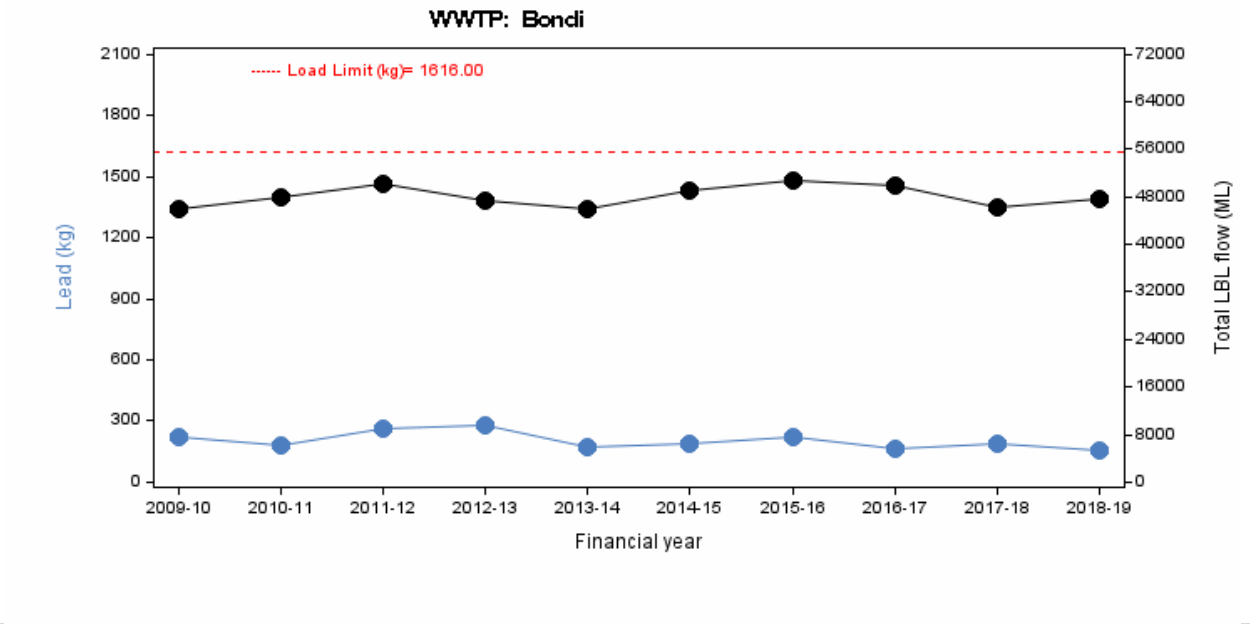


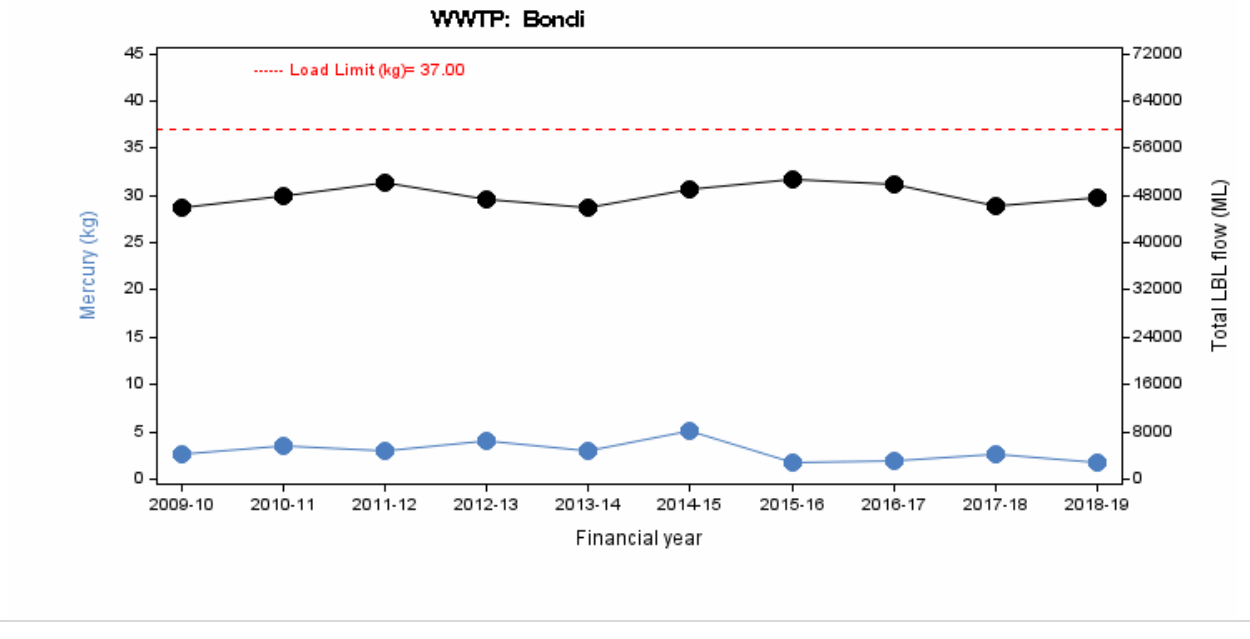
Discharge load: Trace metals

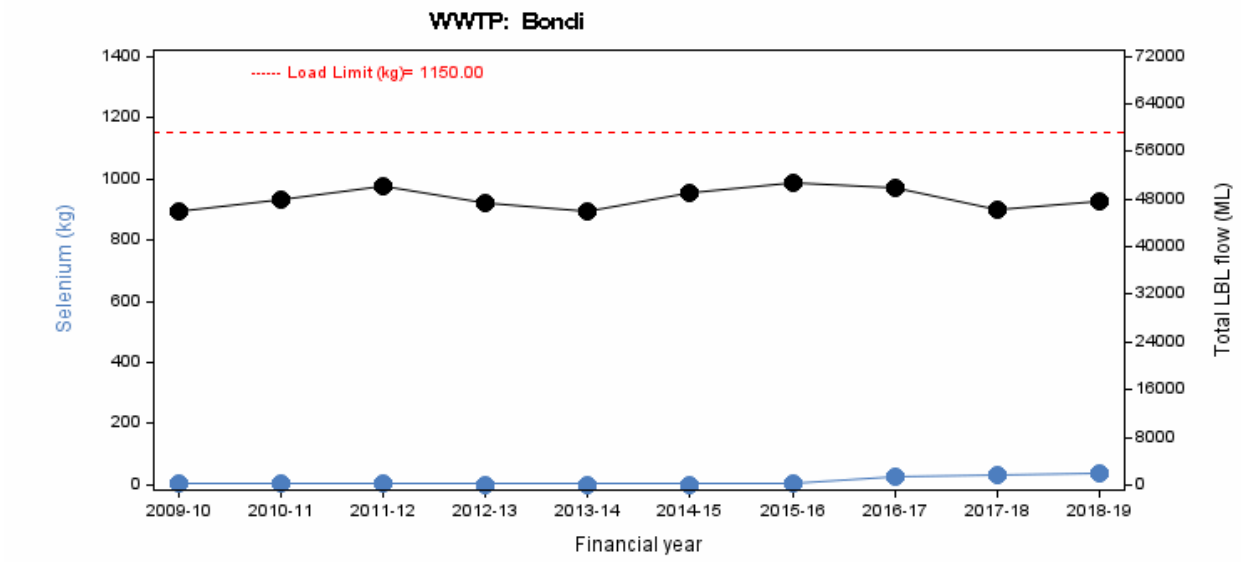


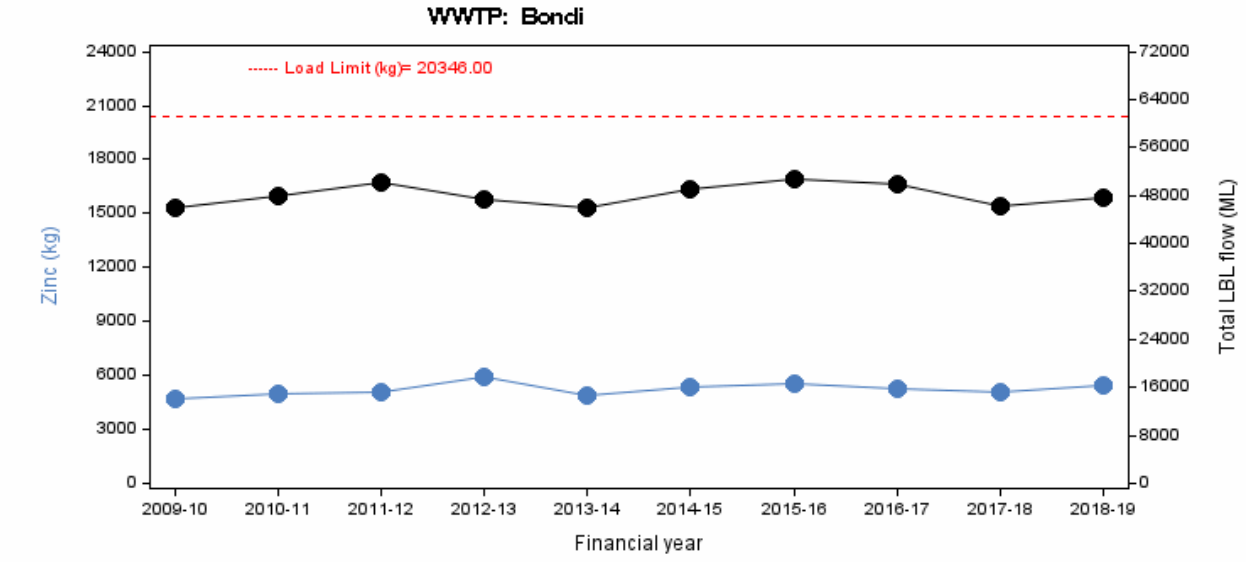



WWTP: Bondi
Load Limit (kg)= 19760.00
Copper (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

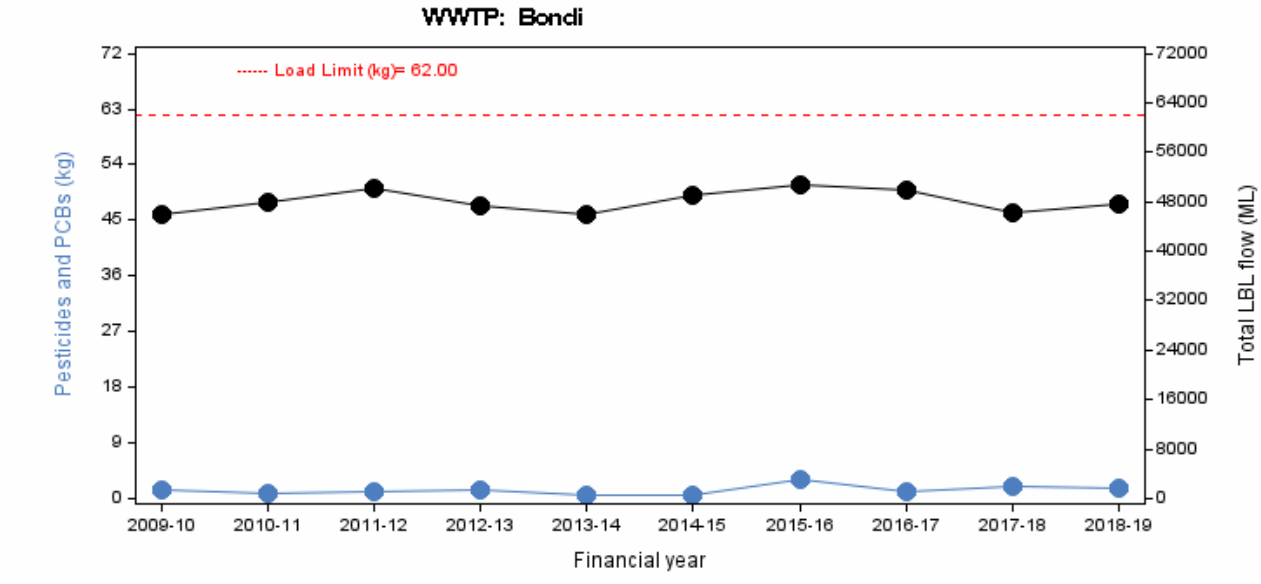

WWTP: Bondi
Load Limit (kg)= 1616.00
Lead (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Bondi
Load Limit (kg)= 37.00
Mercury (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19



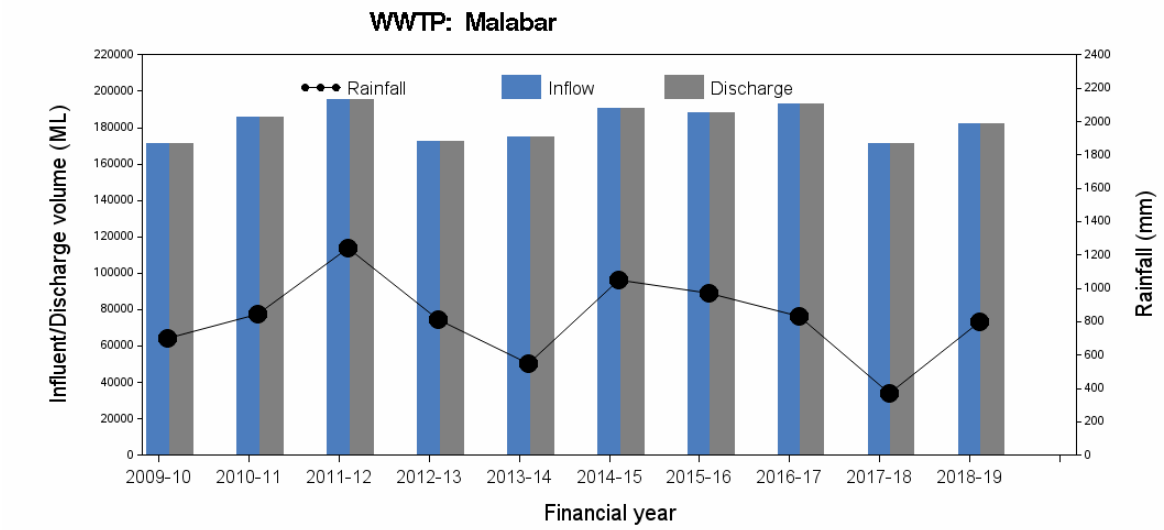


Discharge load: Other chemicals and organics (including pesticides)

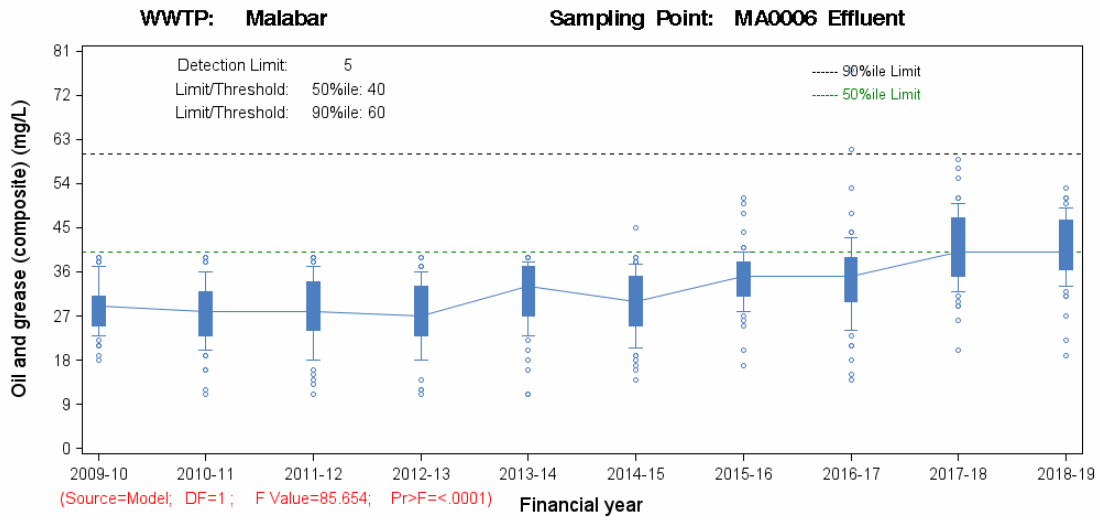


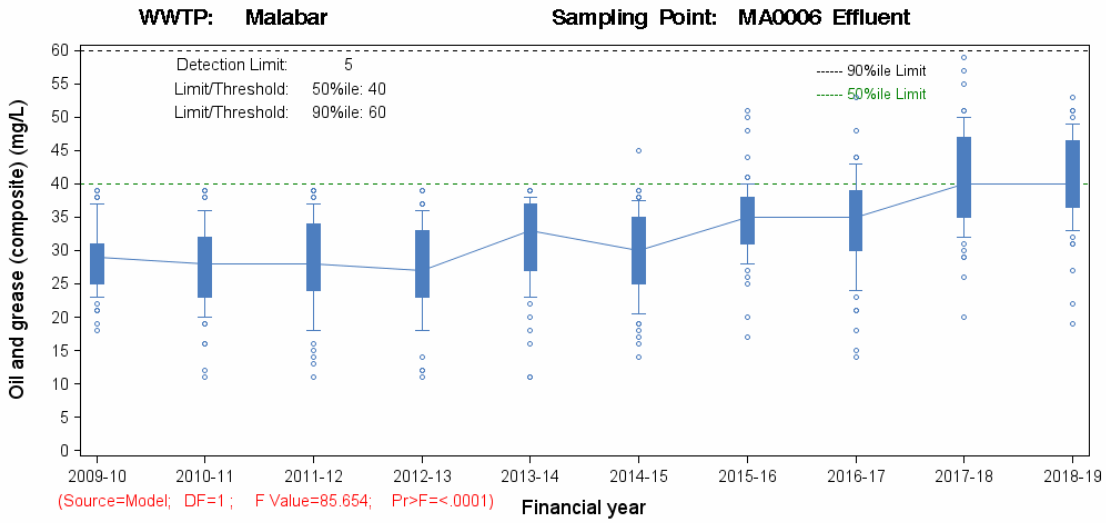
Malabar WWTP

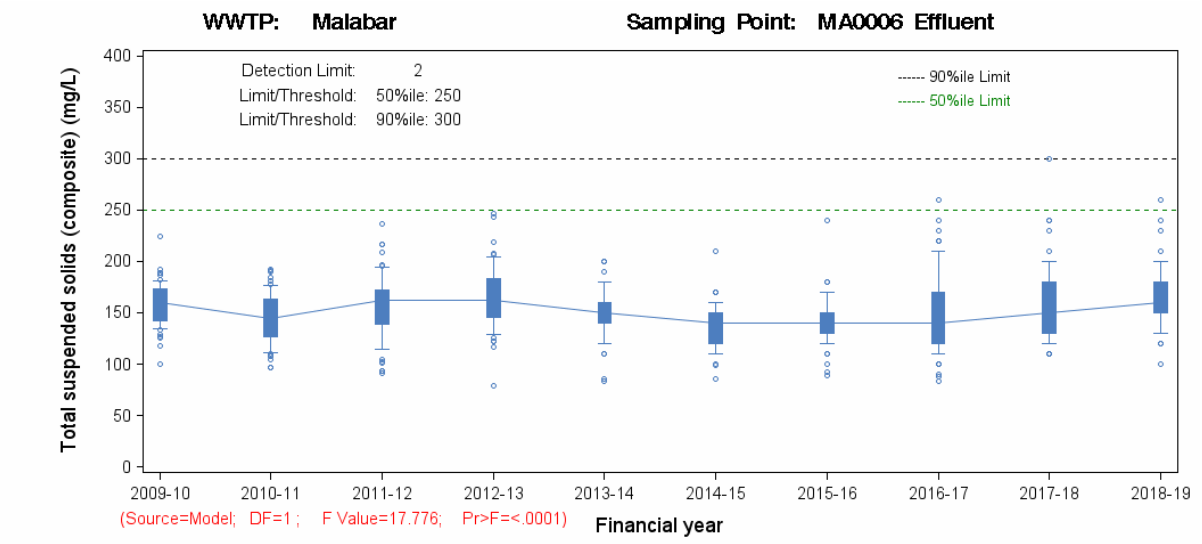
Discharge volume and rainfall

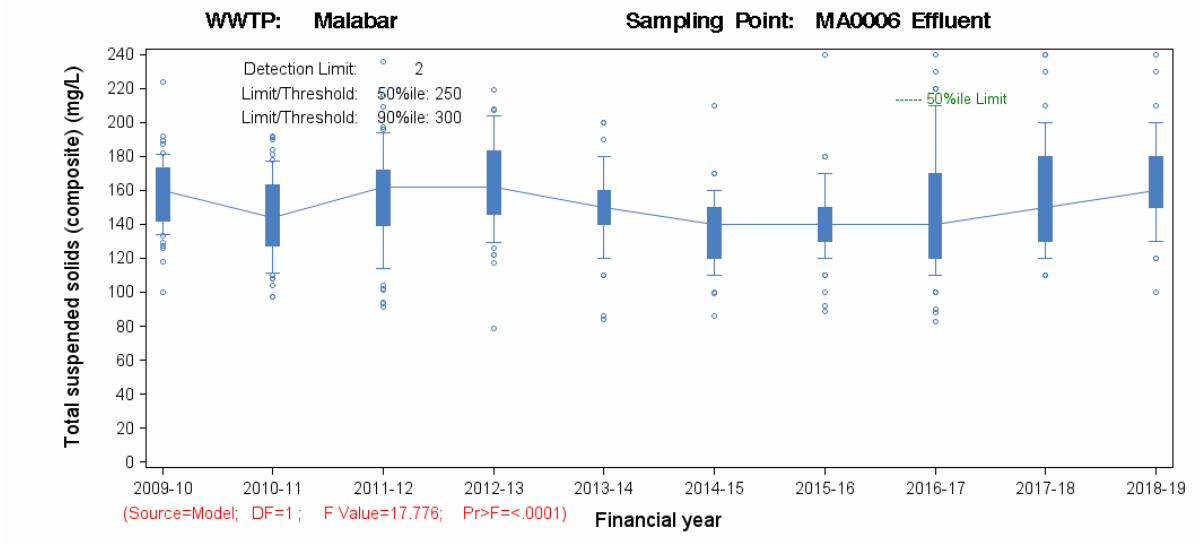


Discharge quality: Major conventional analytes

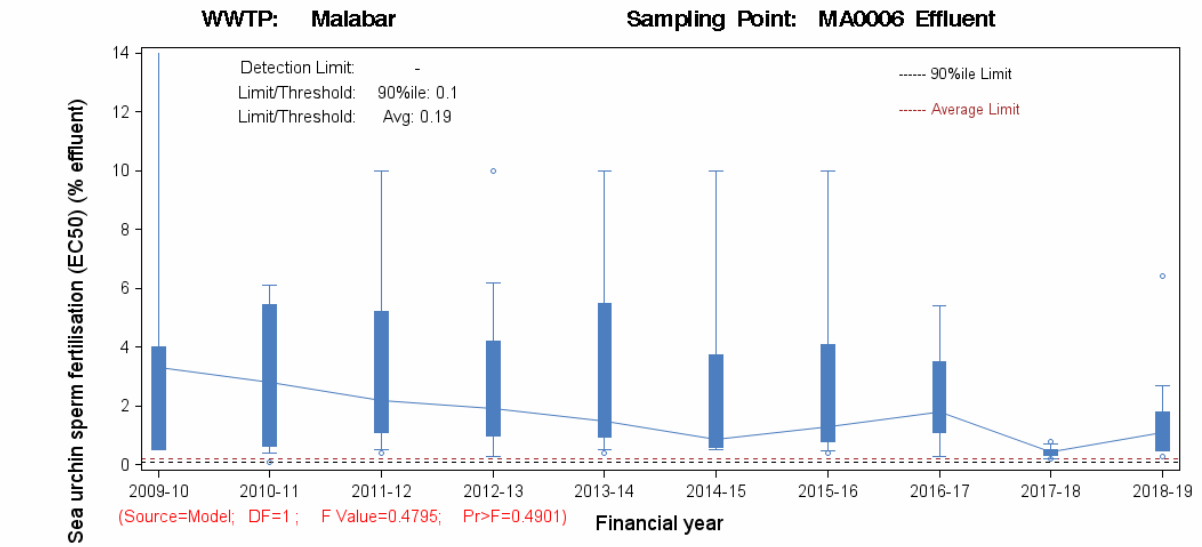




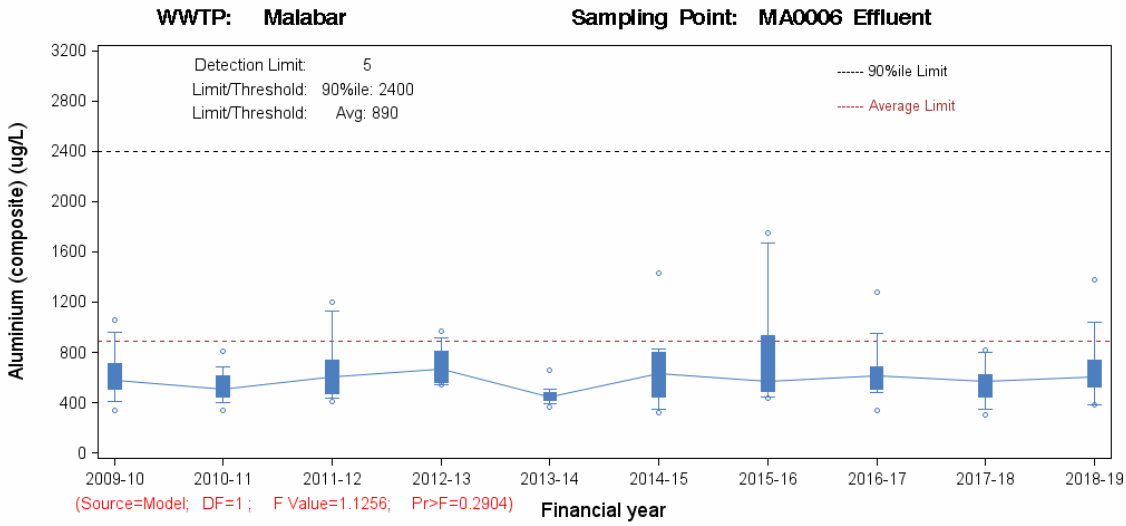




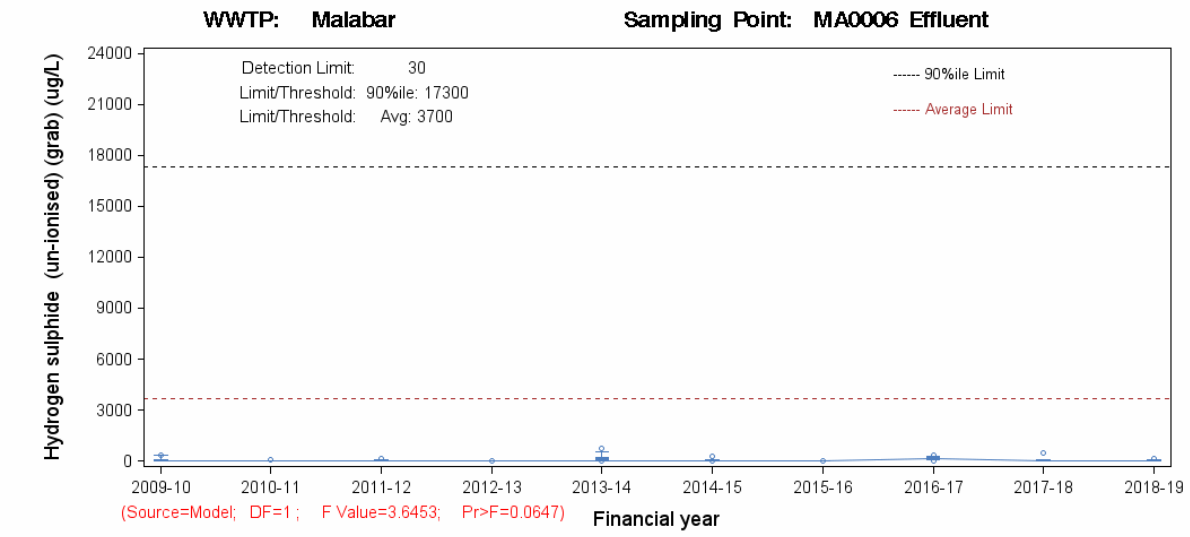
Discharge quality: Toxicity



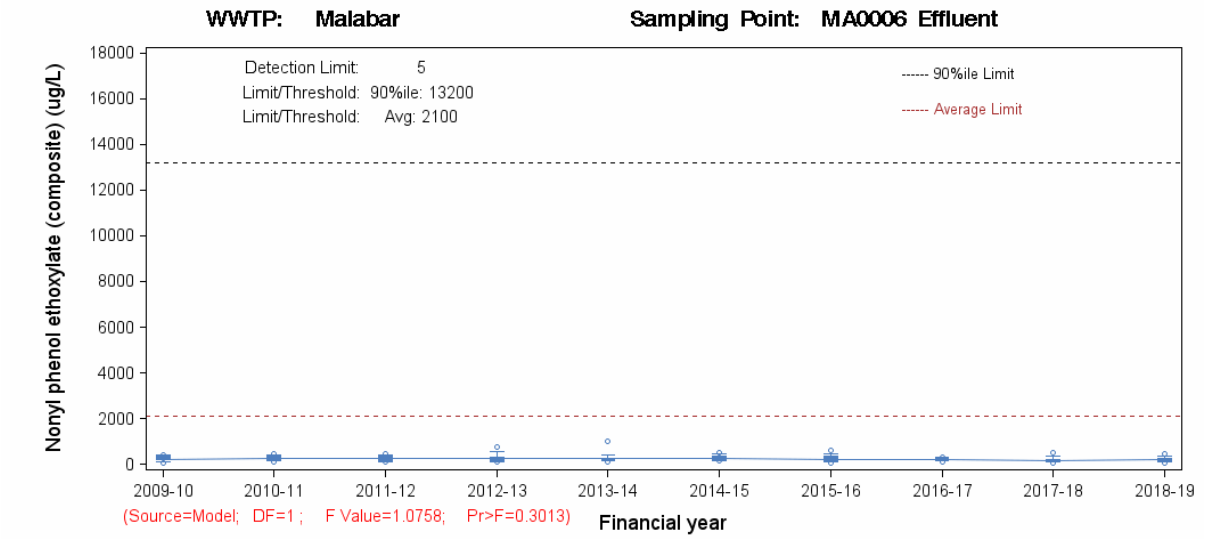
Discharge quality: Trace metals



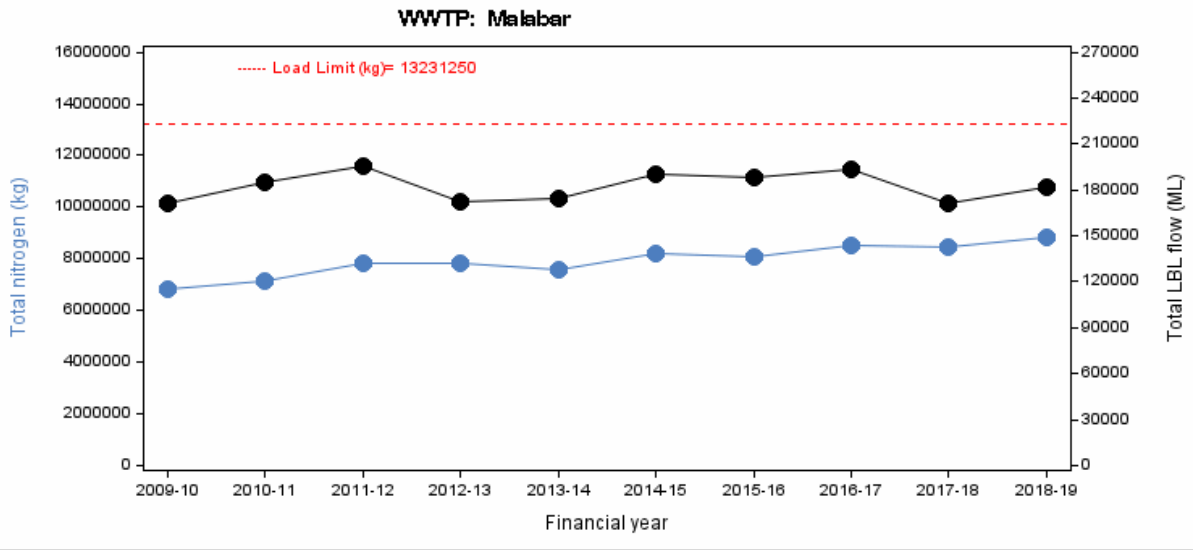
Discharge quality: Other chemicals and organics (including pesticides)

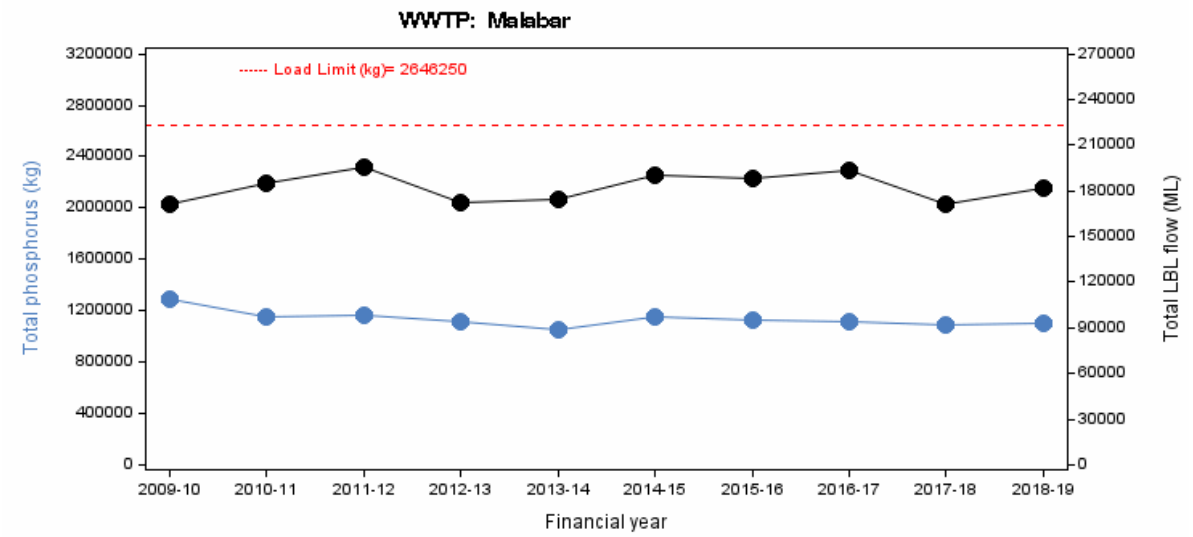


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

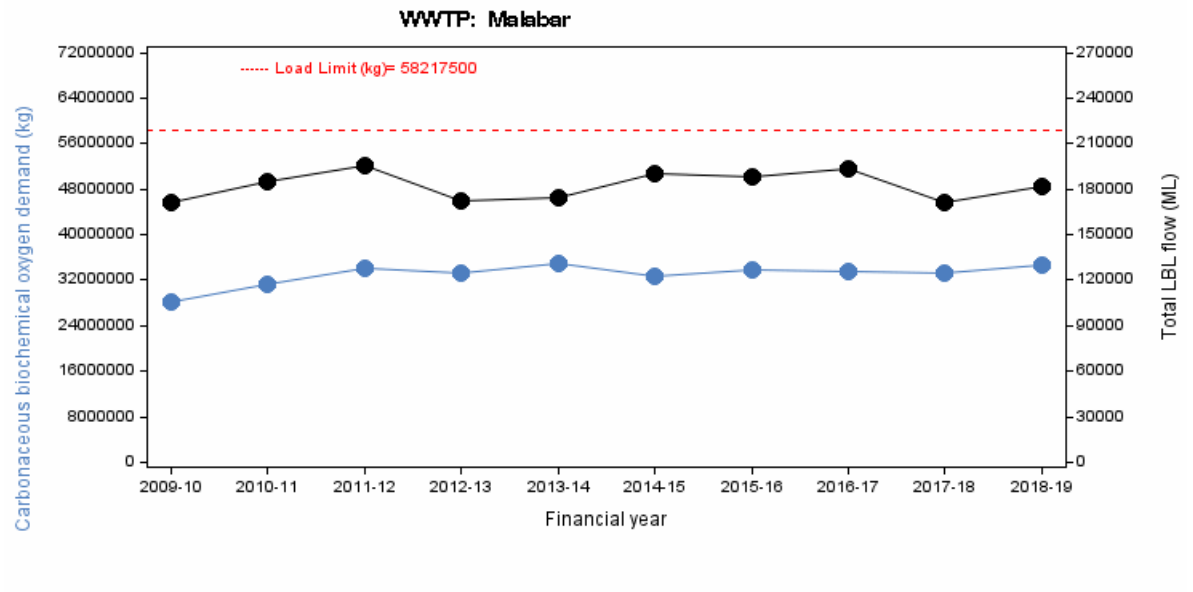


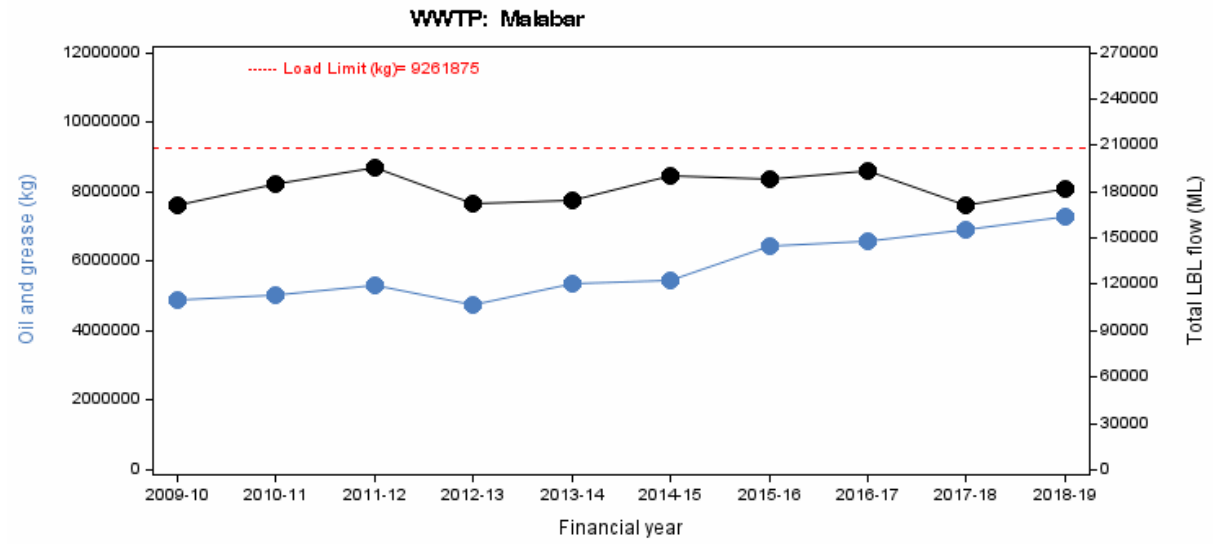
Discharge load: Nutrients

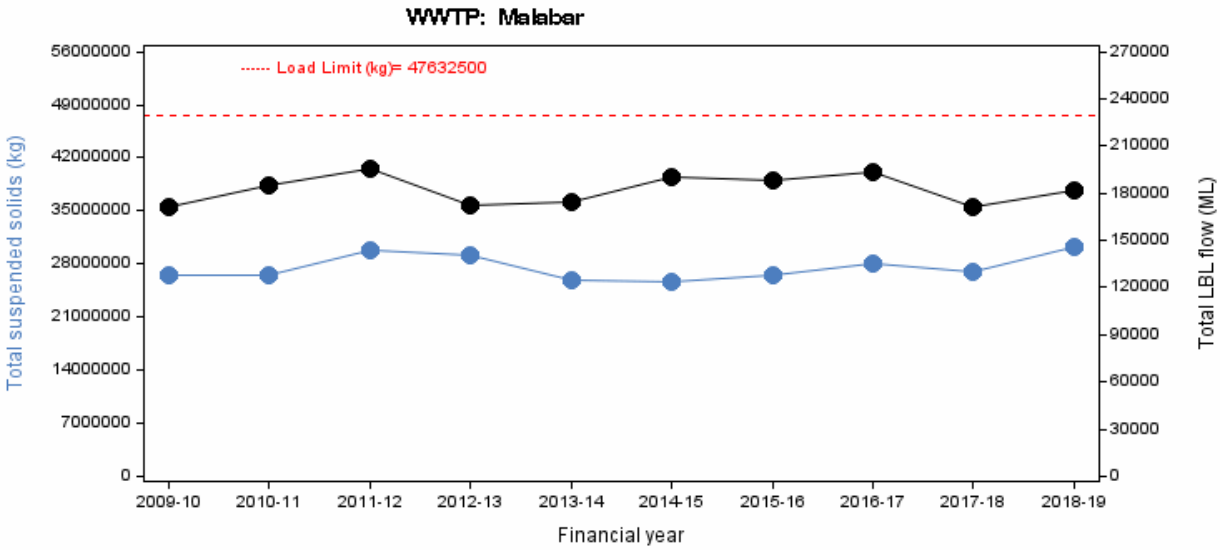




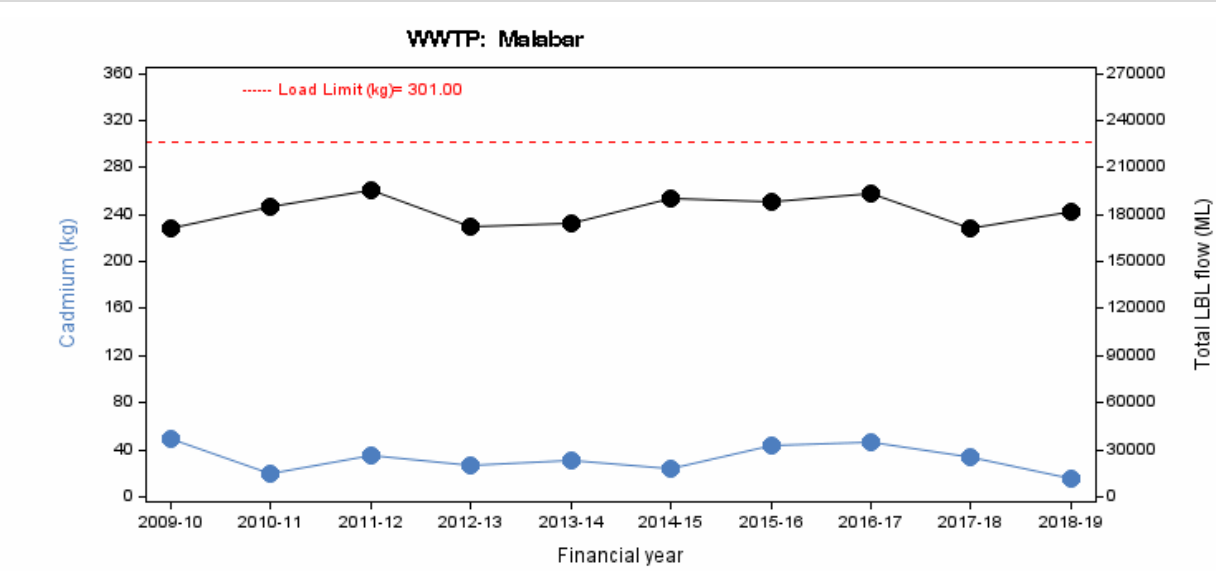
Discharge load: Major conventional analytes

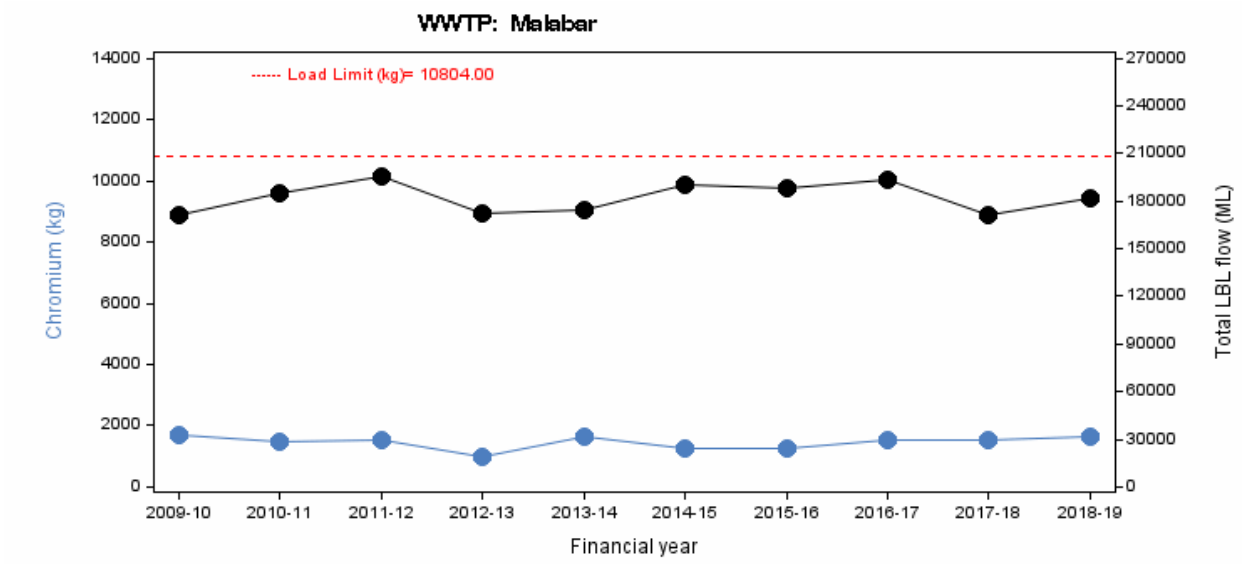


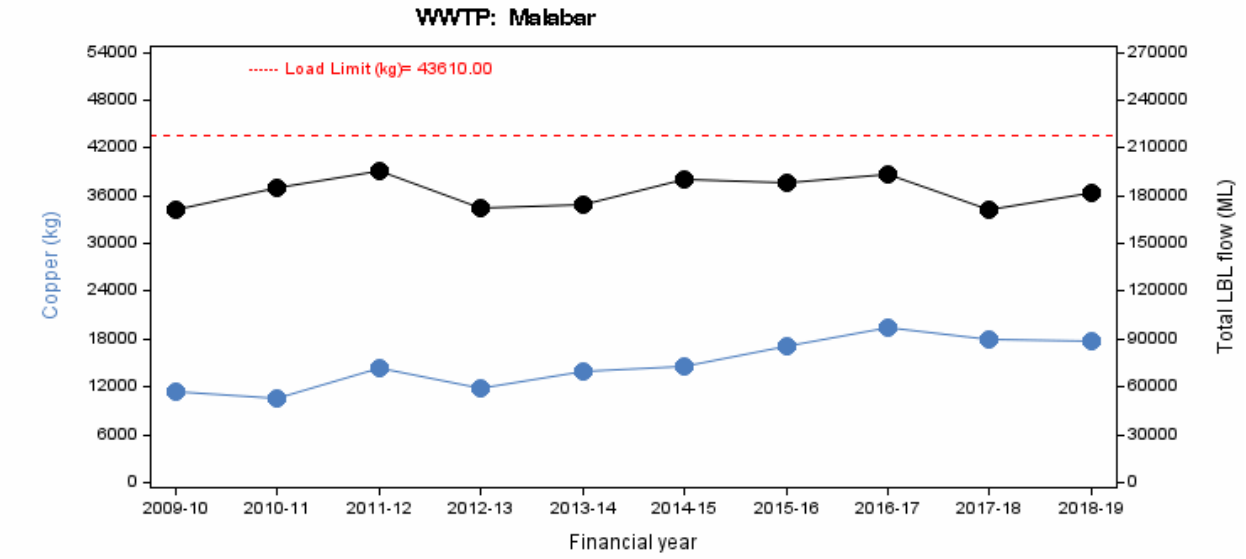


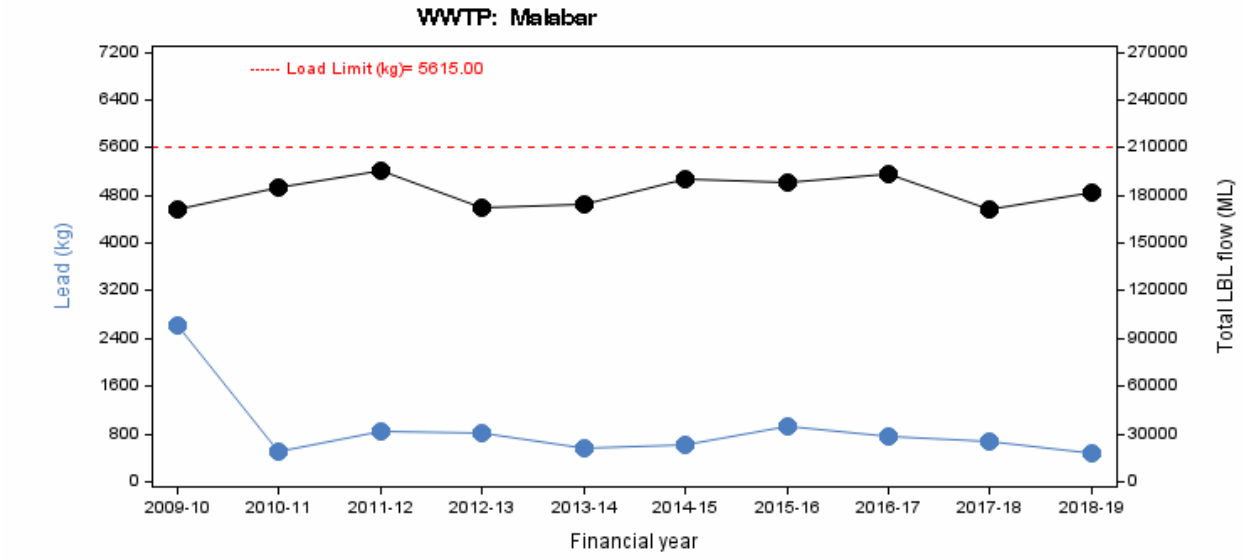


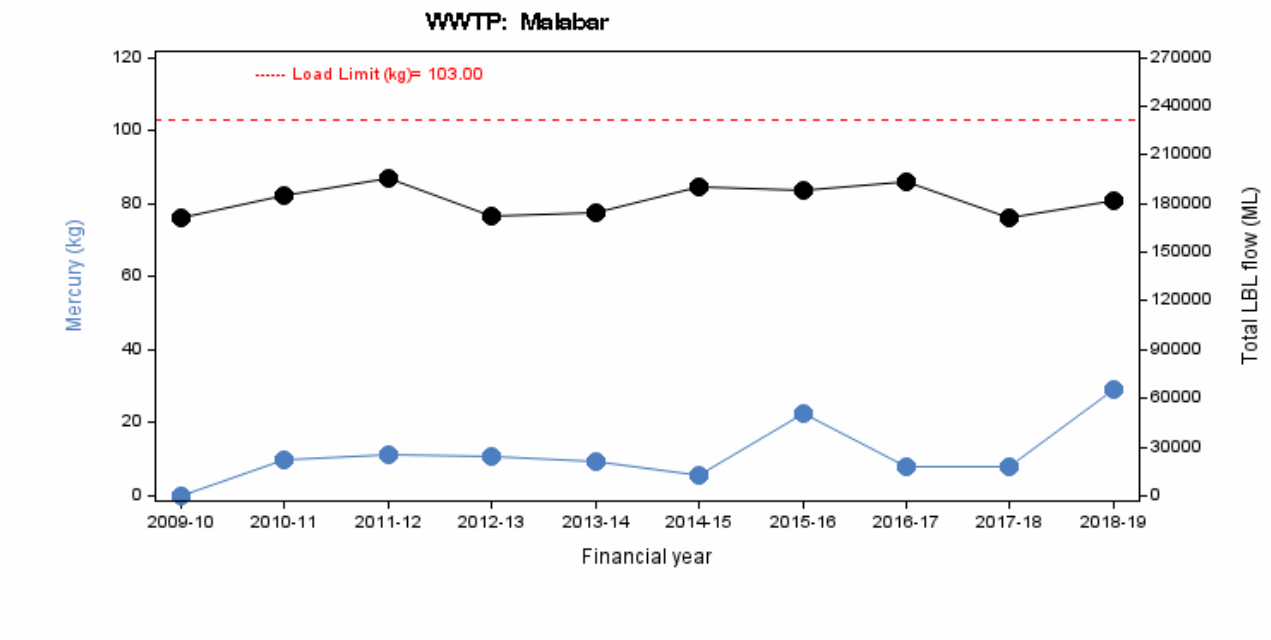
Discharge load: Trace metals

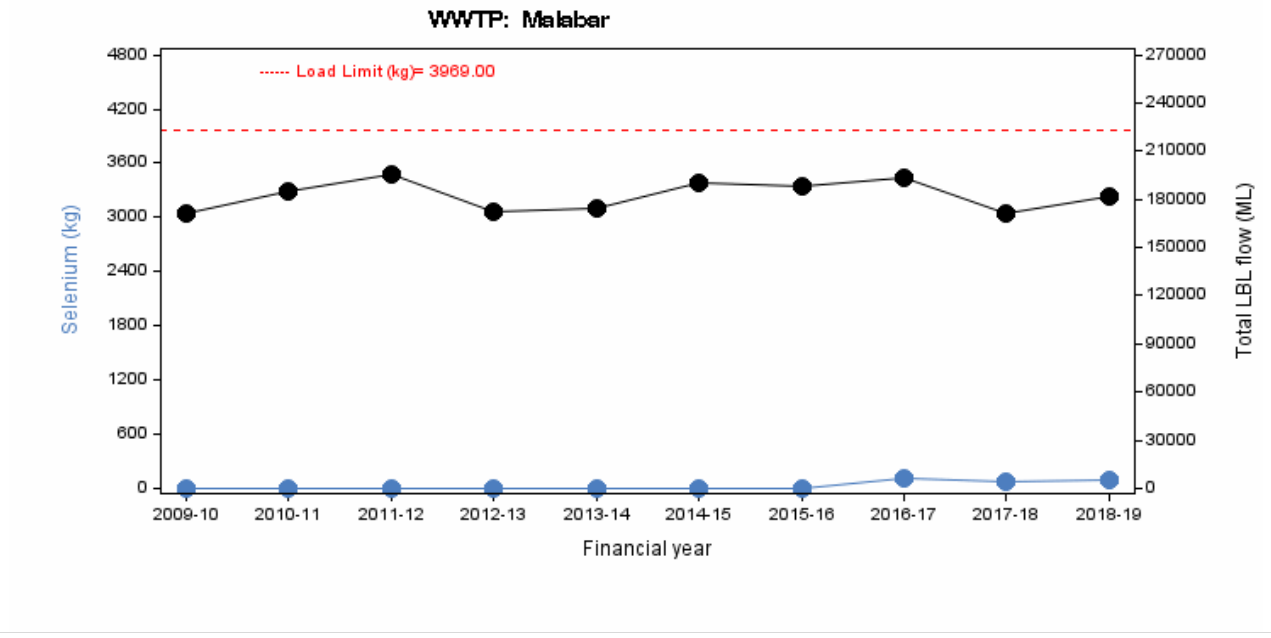


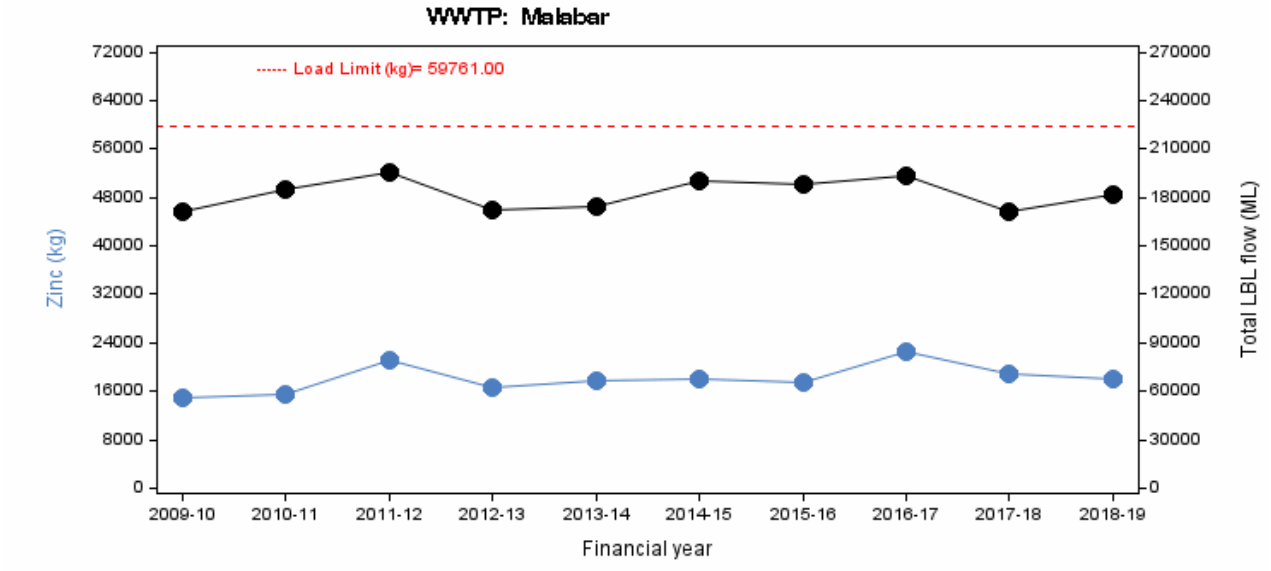

WWTP: Malabar
Load Limit (kg)= 10804.00
Chromium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Malabar
Load Limit (kg)= 43610.00
Copper (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

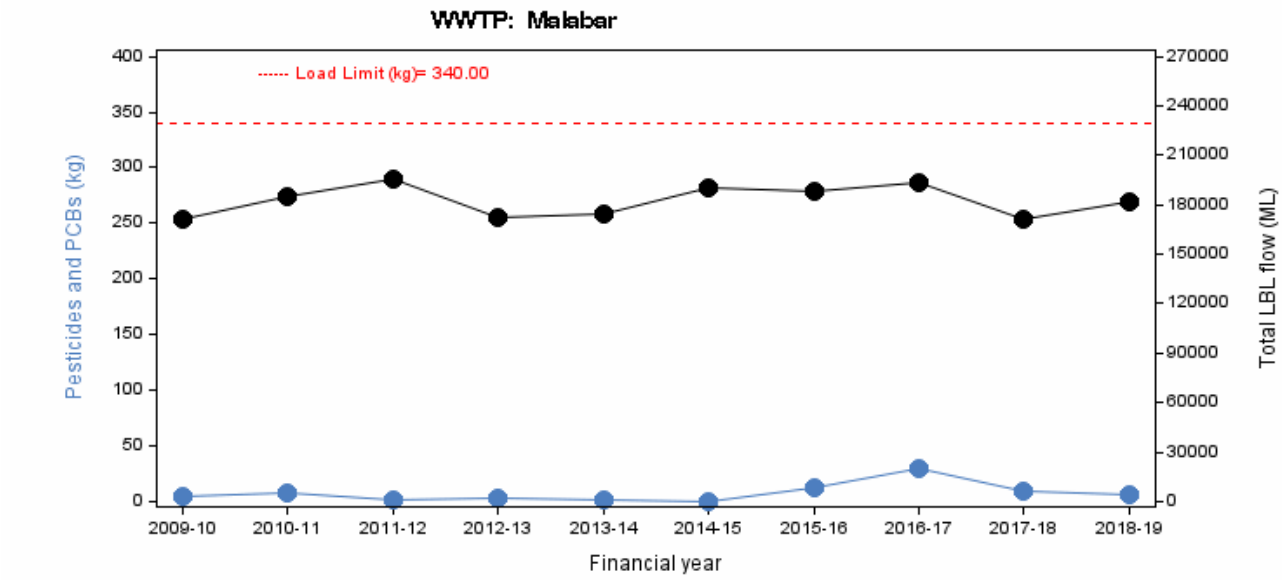

WWTP: Malabar
Load Limit (kg)= 5615.00
Lead (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19





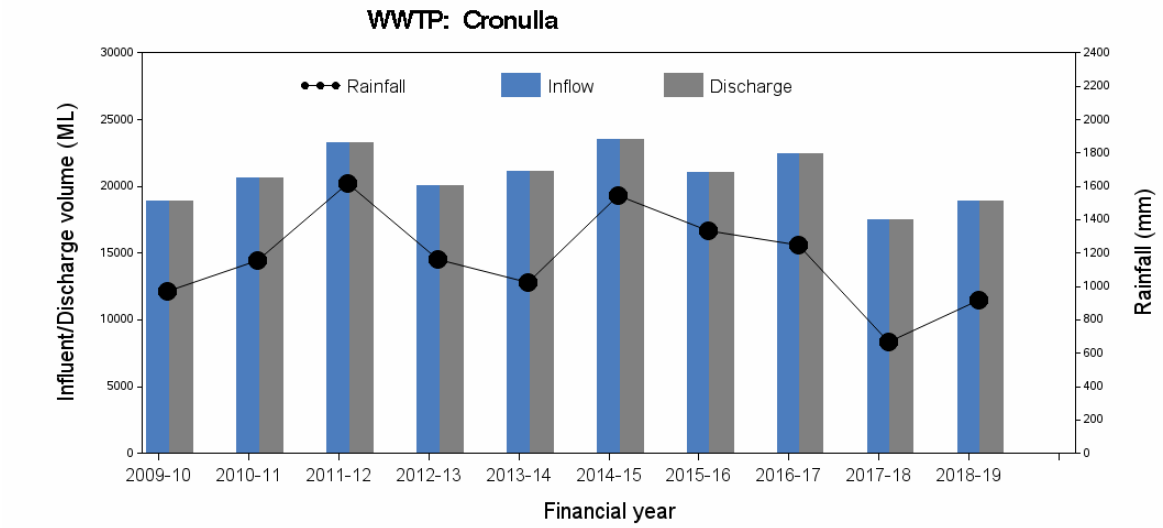


Discharge load: Other chemicals and organics (including pesticides)

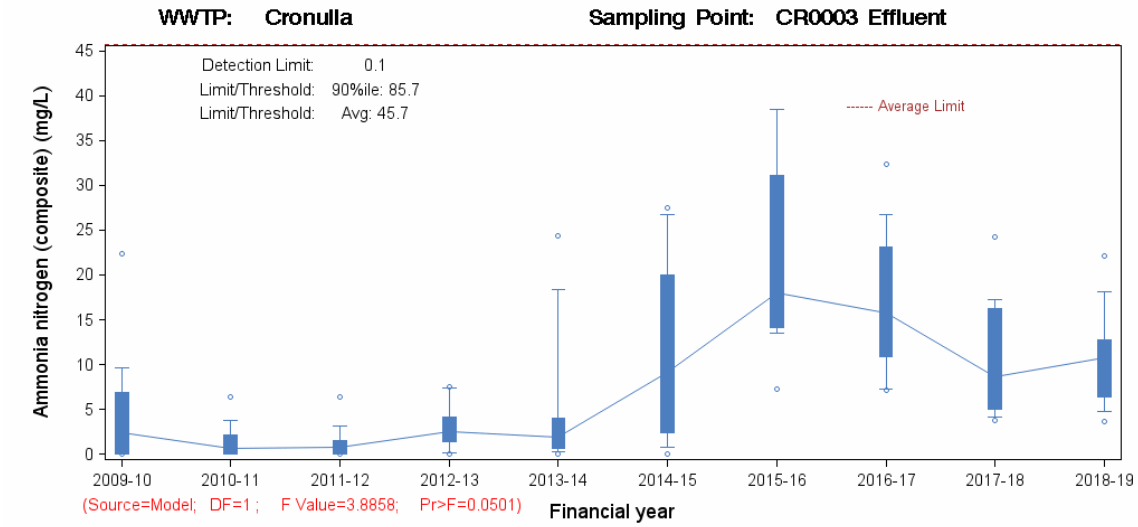

WWTP: Malabar
Load Limit (kg)= 340.00
Pesticides and PCBs (kg)
Total LBL flow (ML)
Financial year
400
350
300
250
200
150
100
50
0
270000
240000
210000
180000
150000
120000
90000
60000
30000
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

Cronulla WWTP

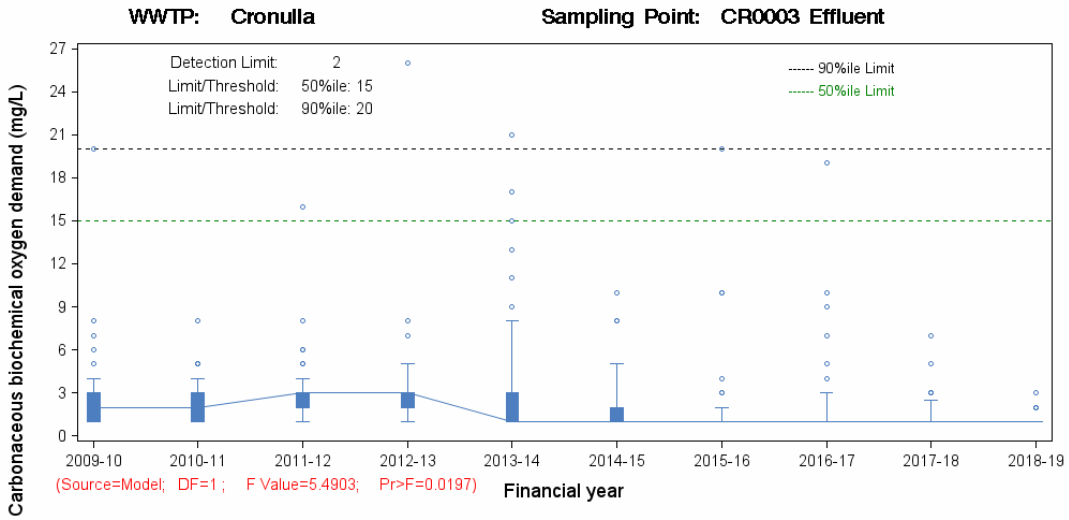
Discharge volume and rainfall



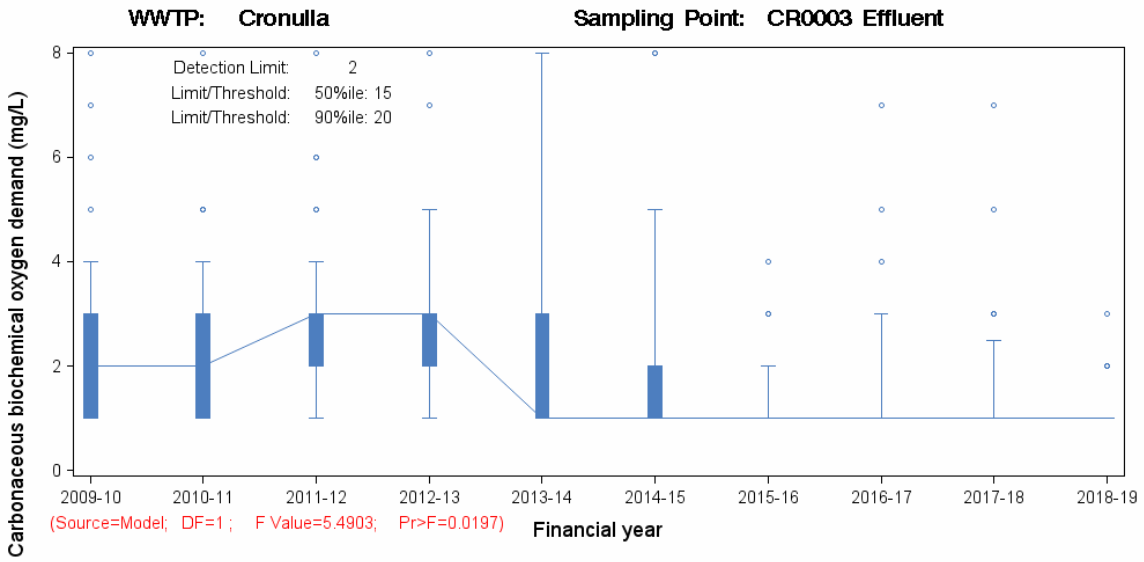
Discharge quality: Nutrients



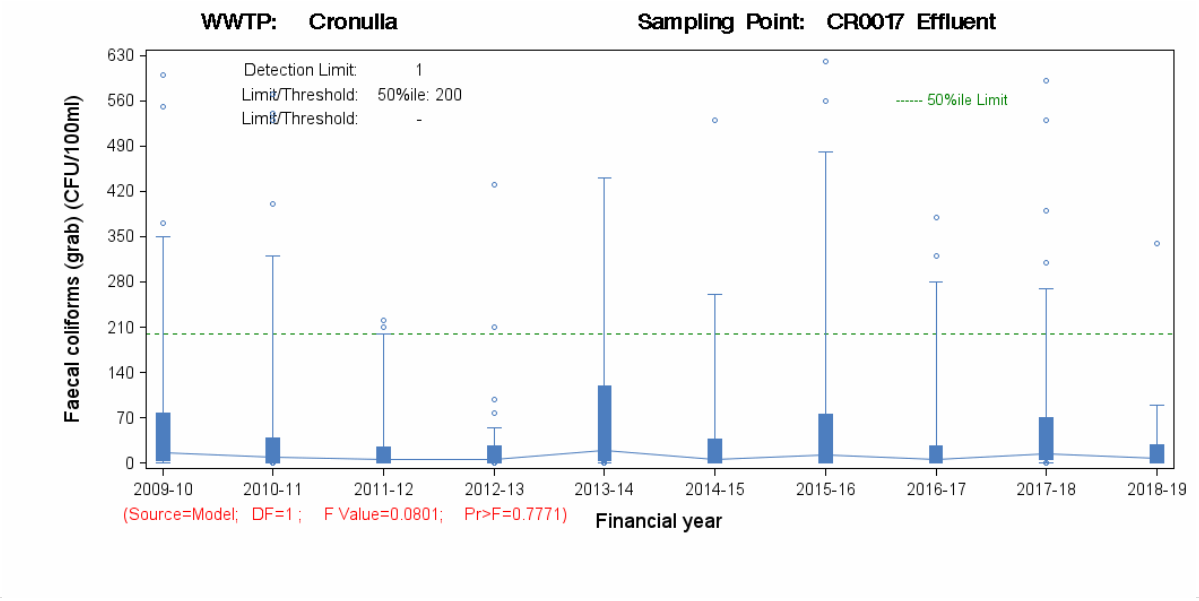
Discharge quality: Major conventional analytes

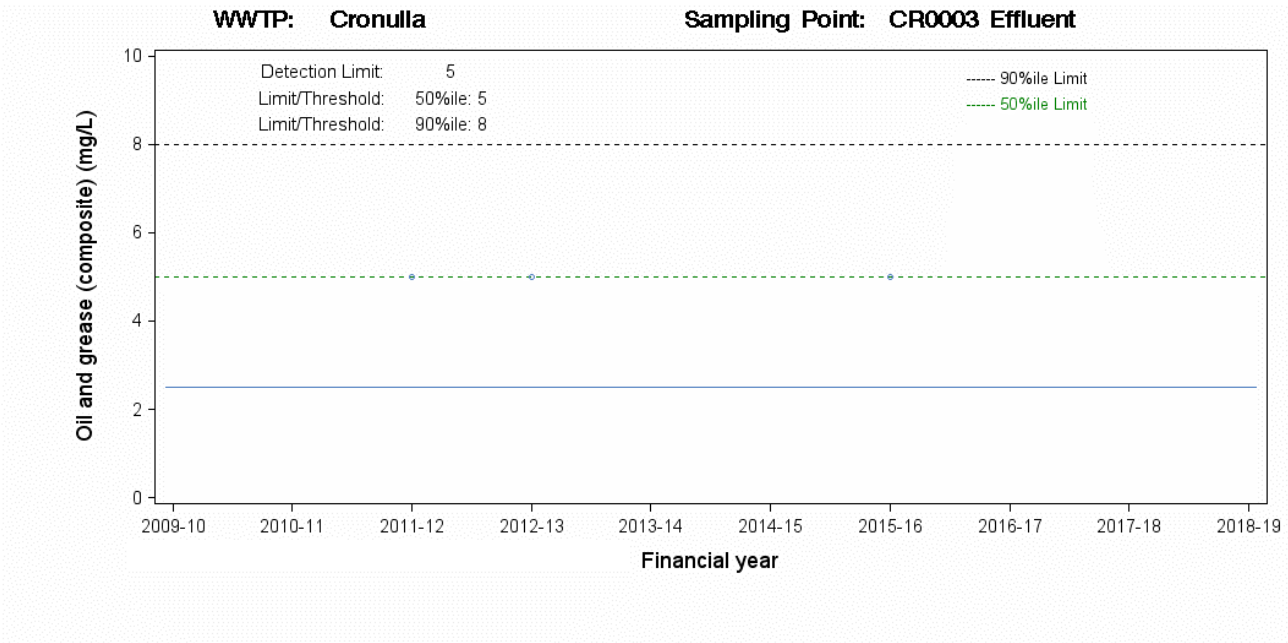


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

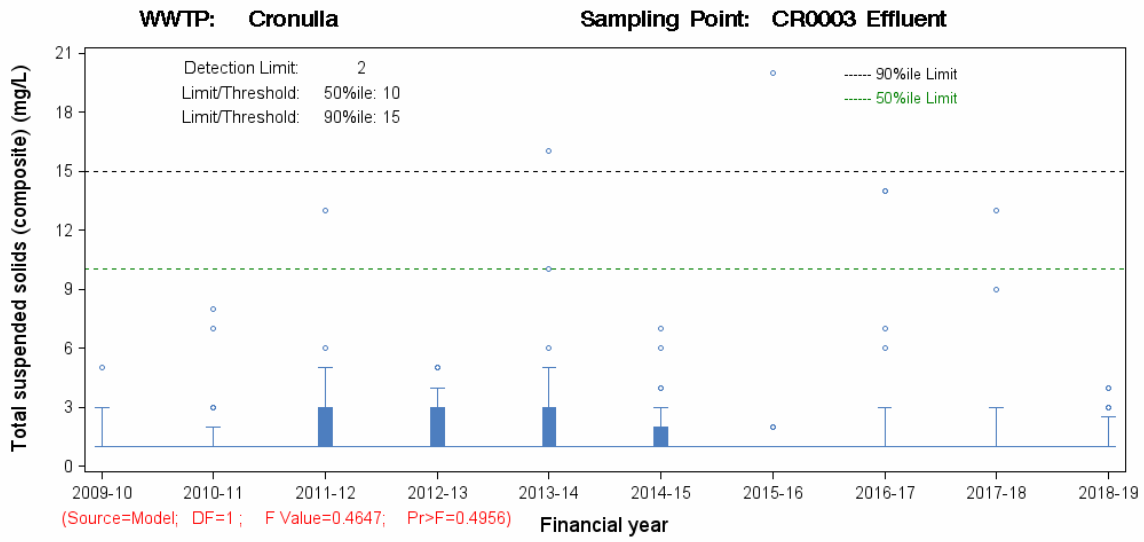


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15

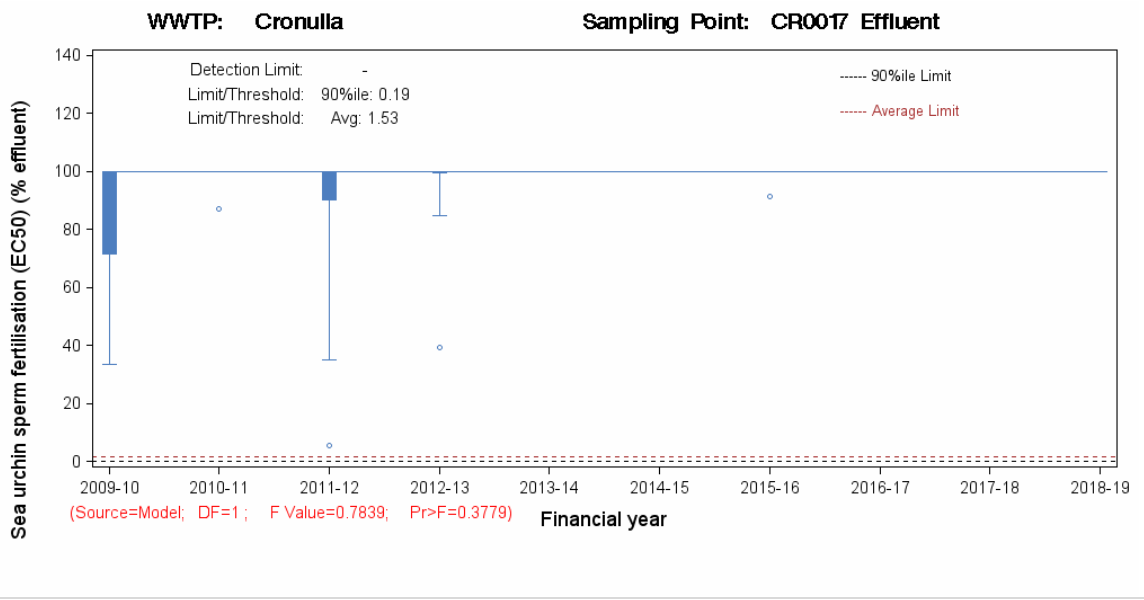




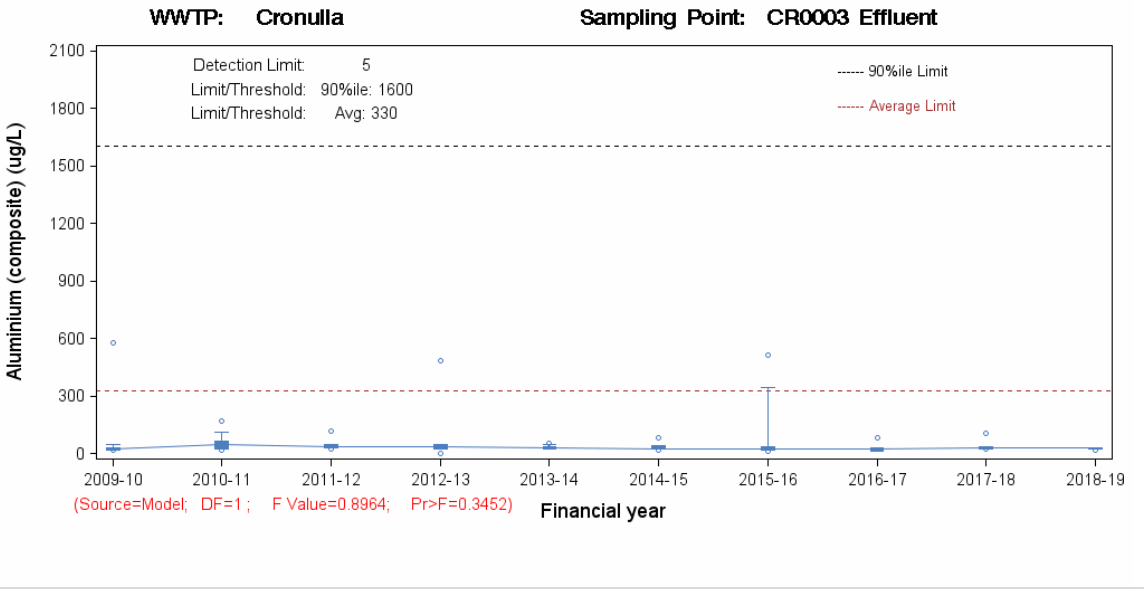
Note: Statistical test was not conducted because >90% of results were below the detection limit.

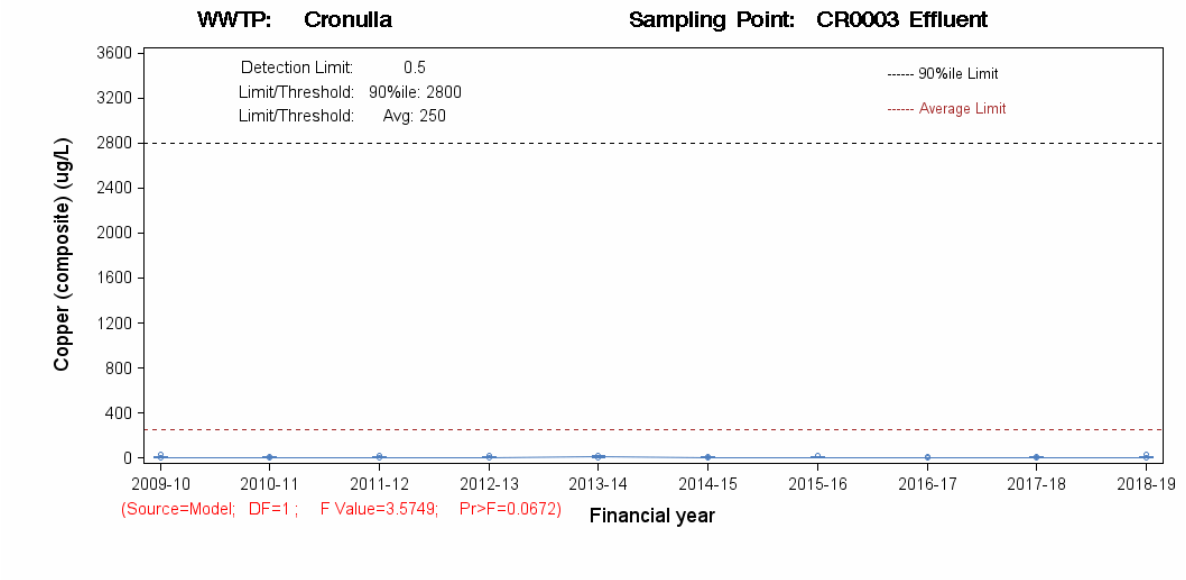


Discharge quality: Toxicity

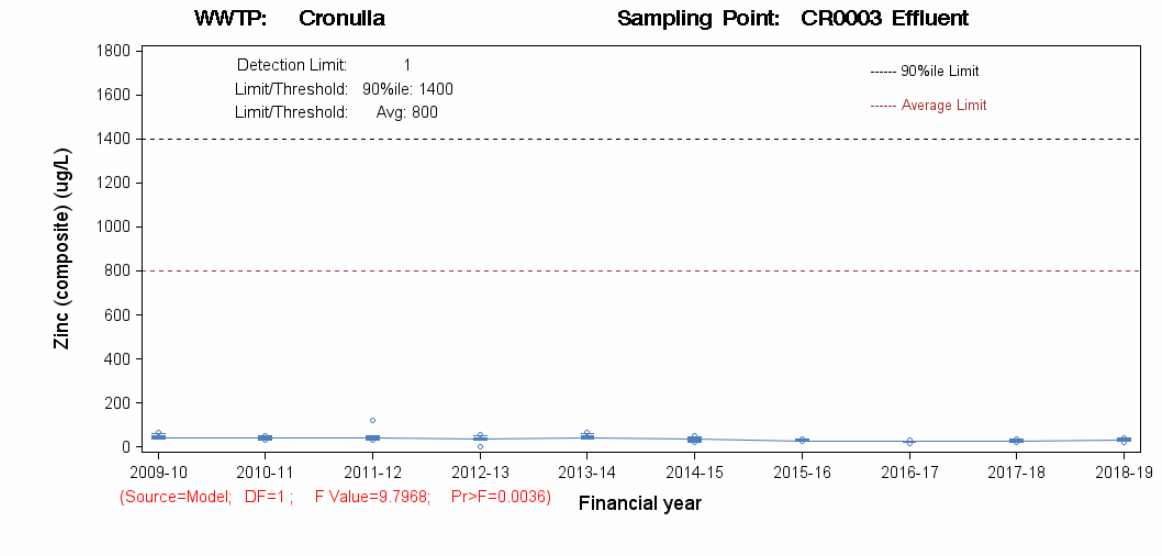


Discharge quality: Trace metals

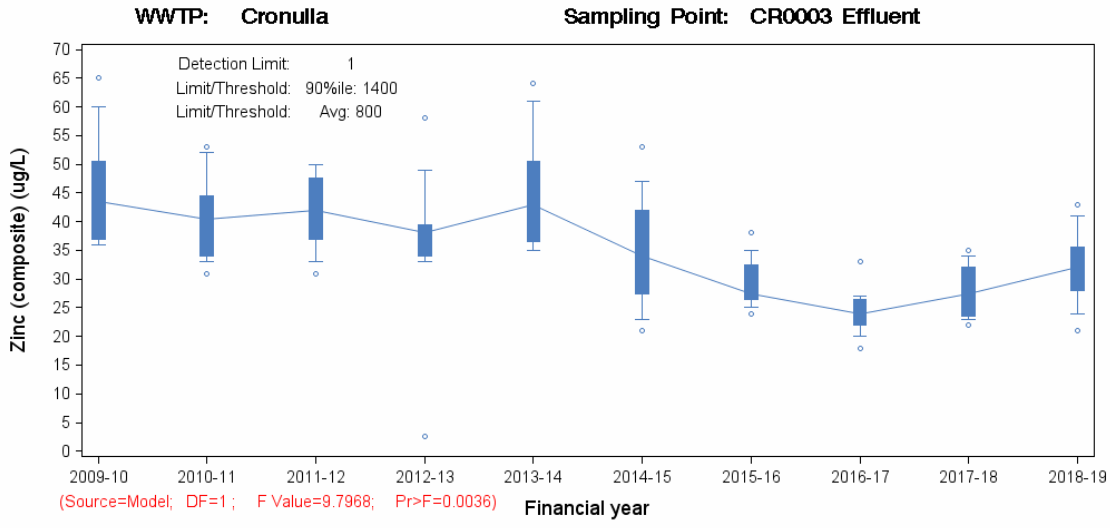




Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

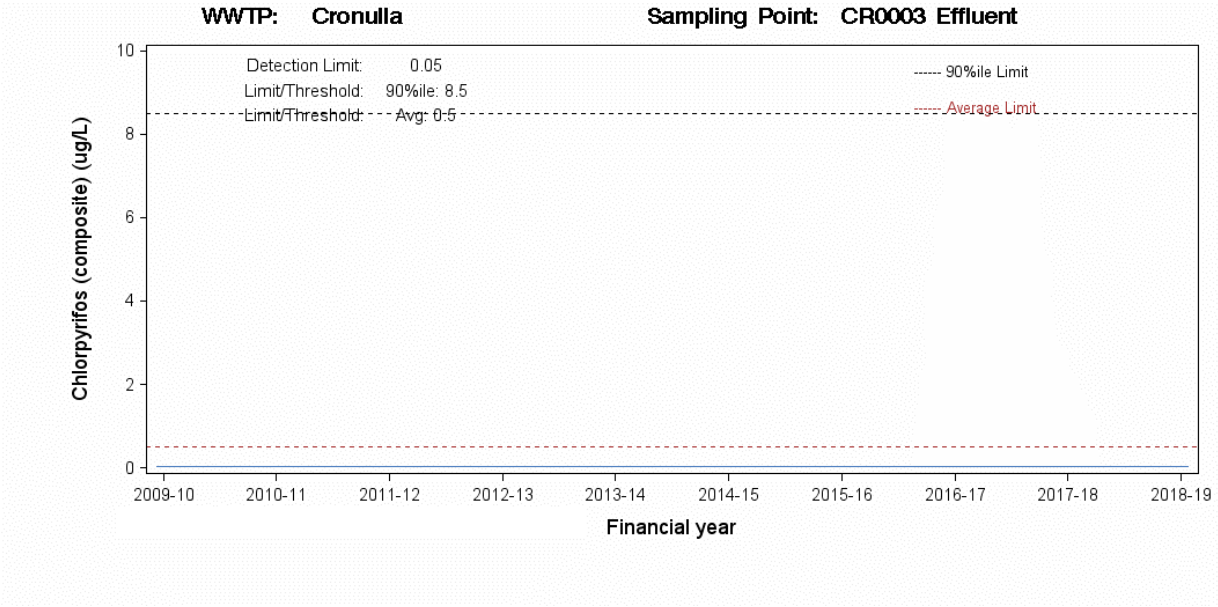


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

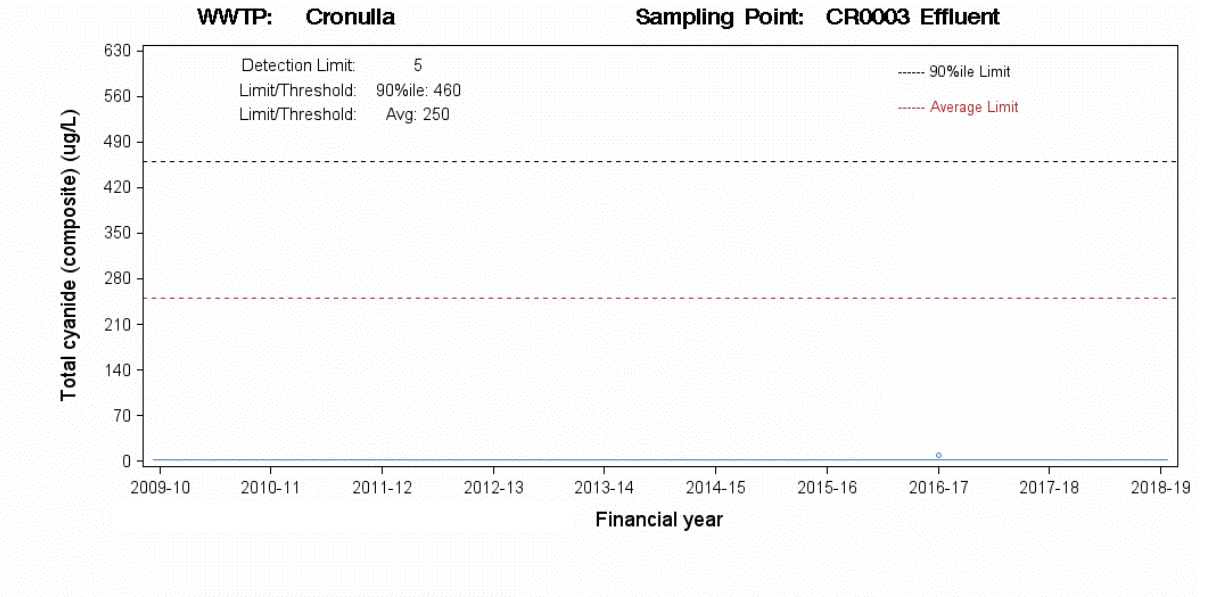


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

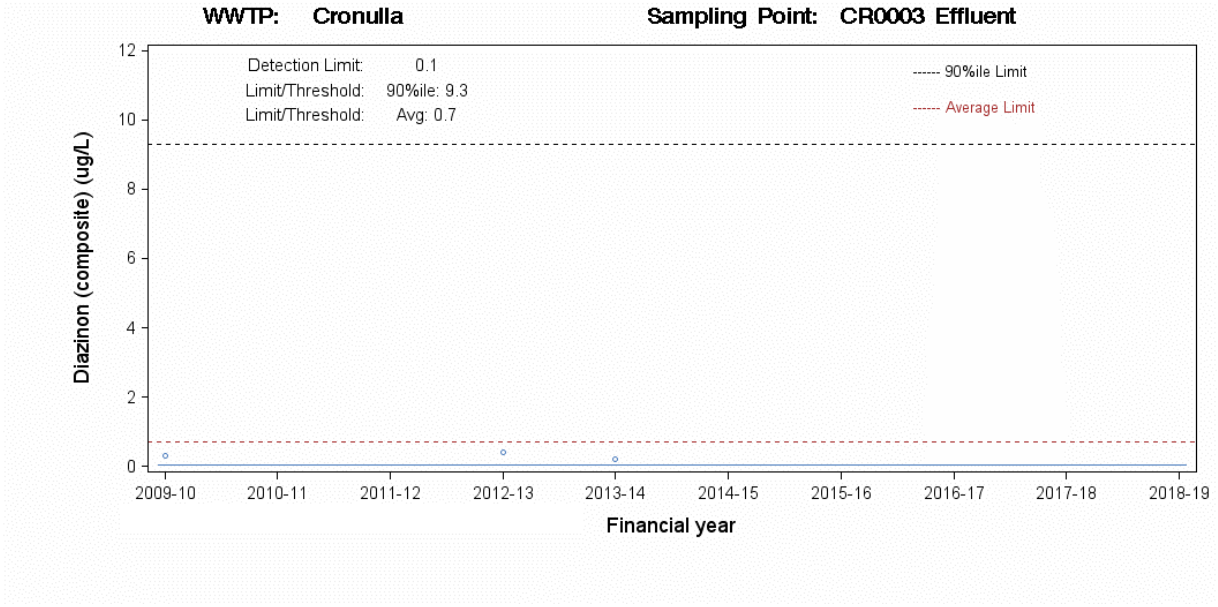
Discharge quality: Other chemicals and organics (including pesticides)



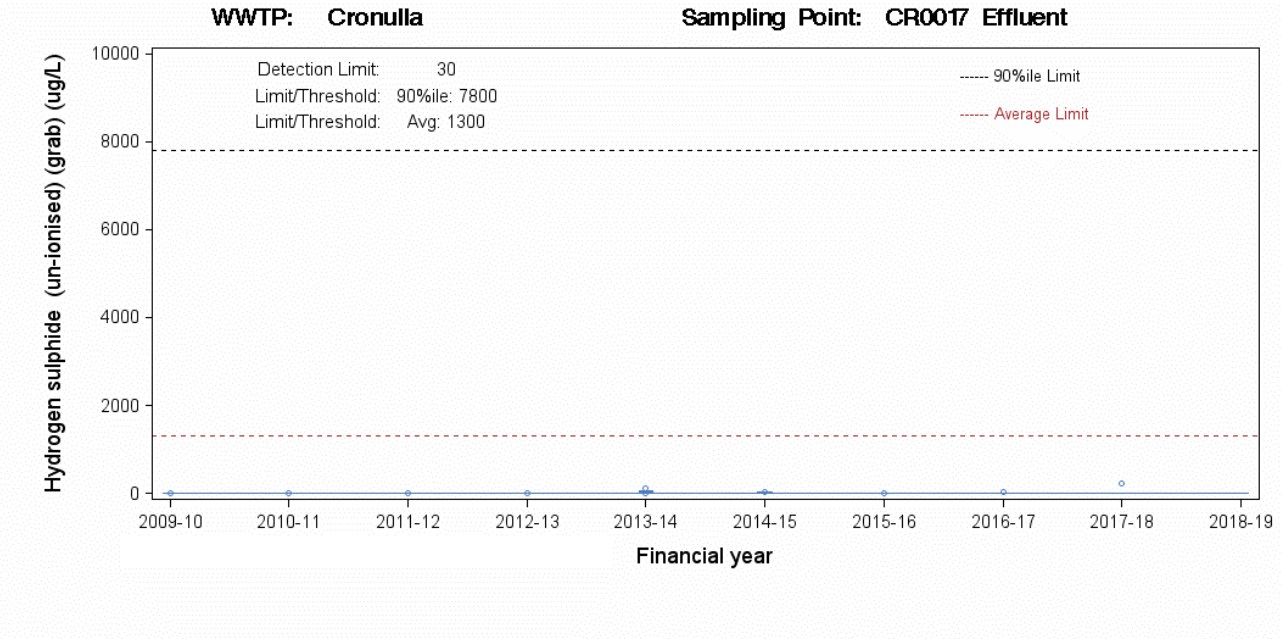
Note: Statistical test was not conducted because >90% of results were below the detection limit.



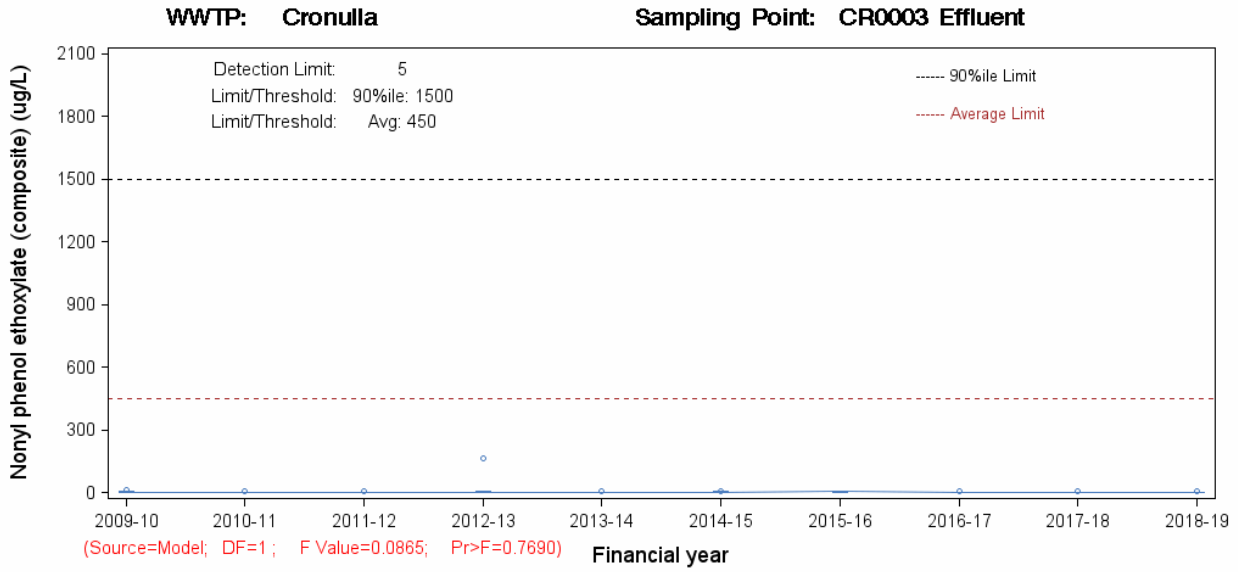
Note: Statistical test was not conducted because >90% of results were below the detection limit.



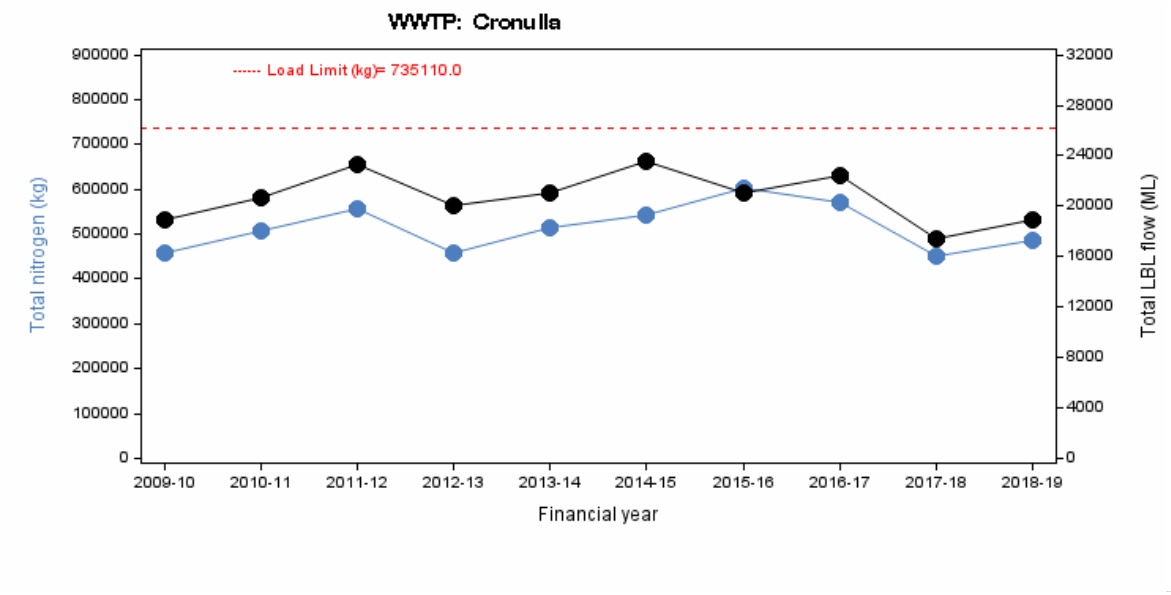
Note: Statistical test was not conducted because >90% of results were below the detection limit.

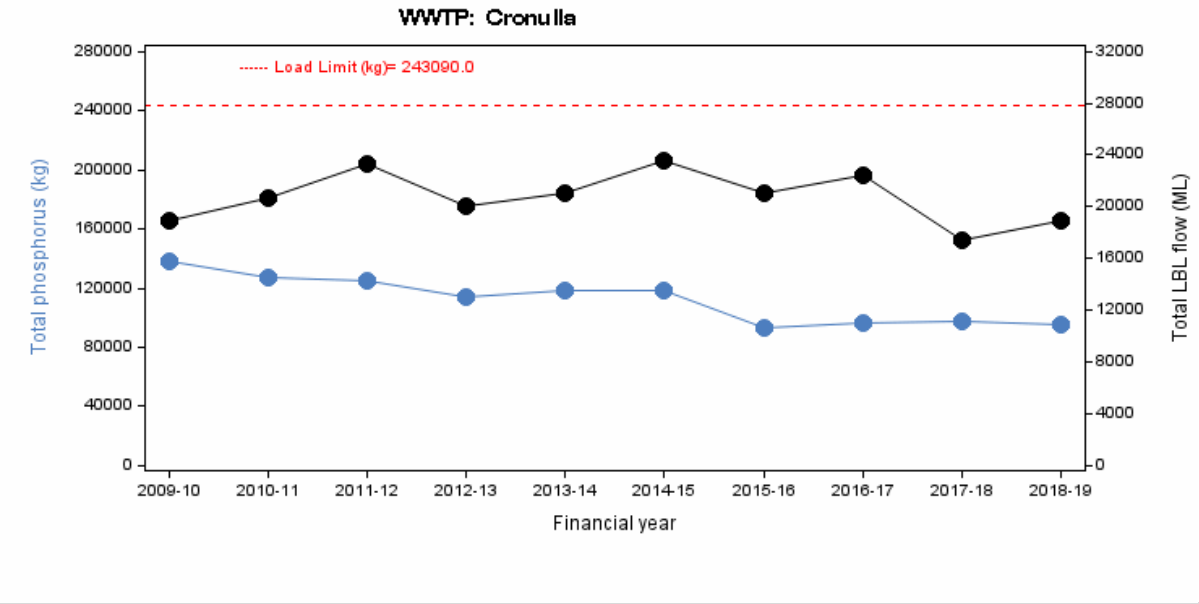


Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

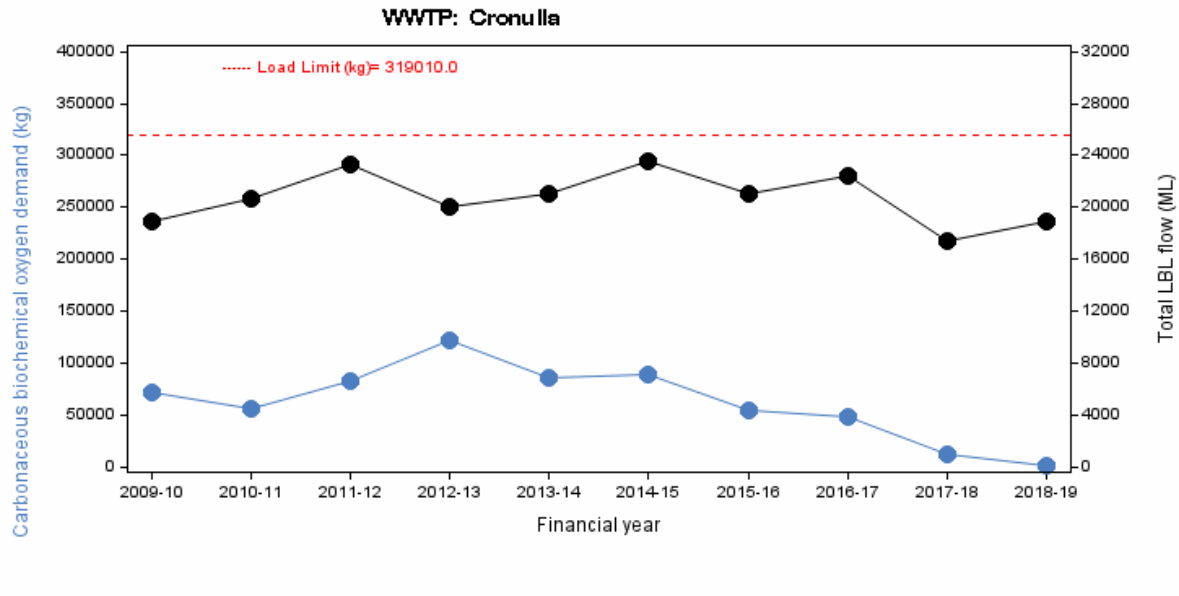


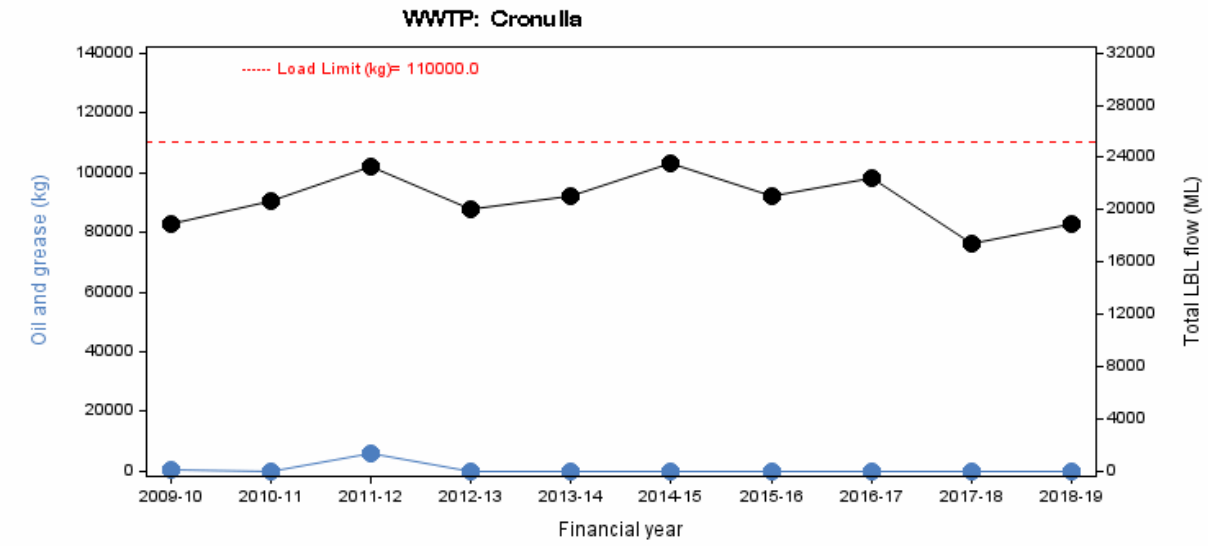
Discharge load: Nutrients

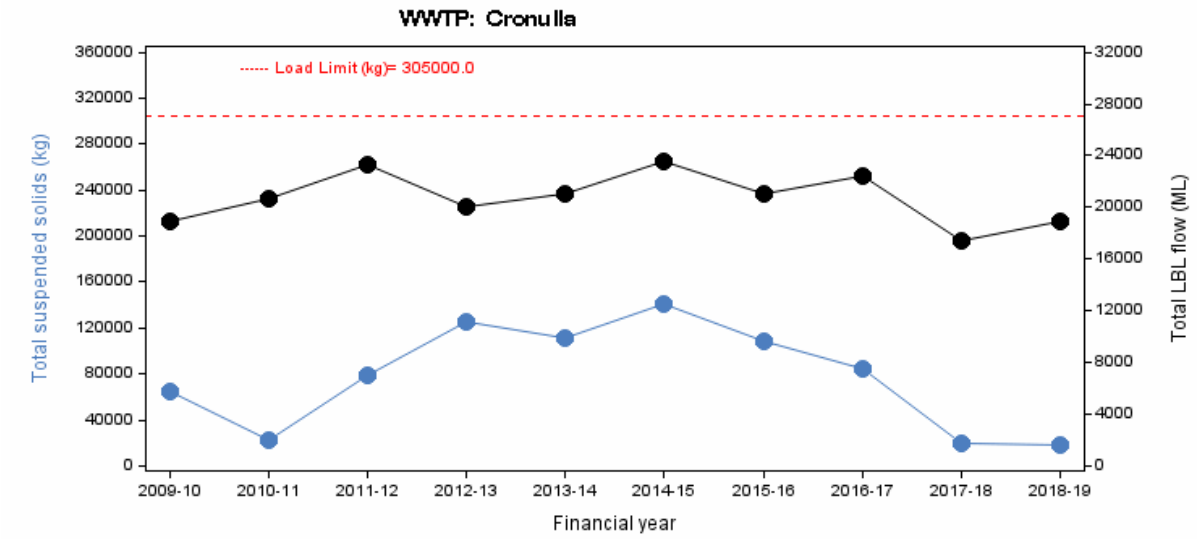




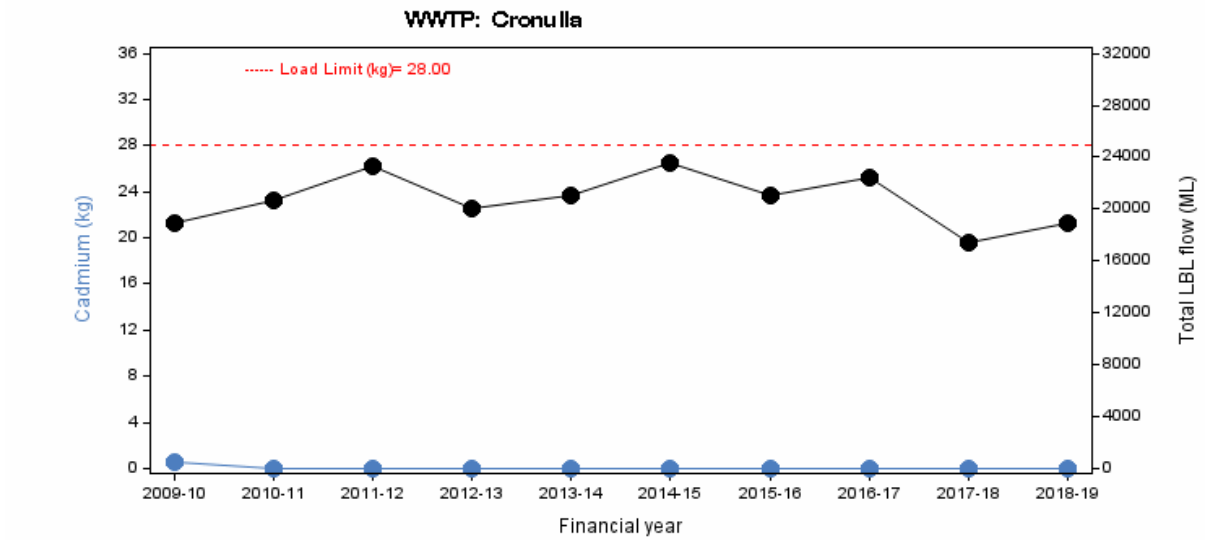
Discharge load: Major conventional analytes

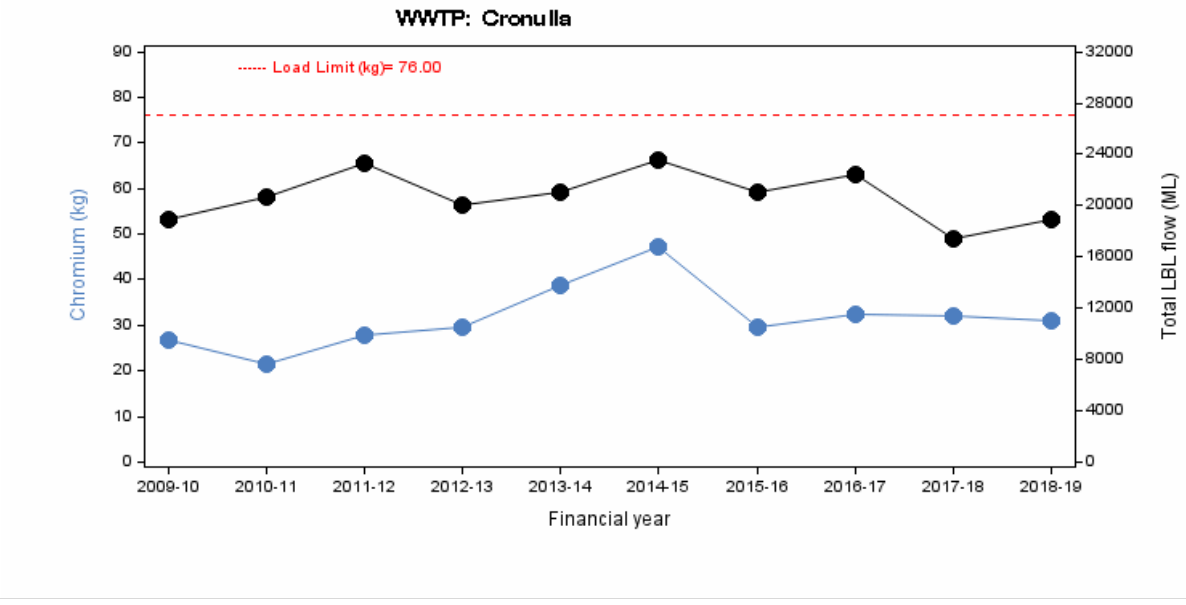


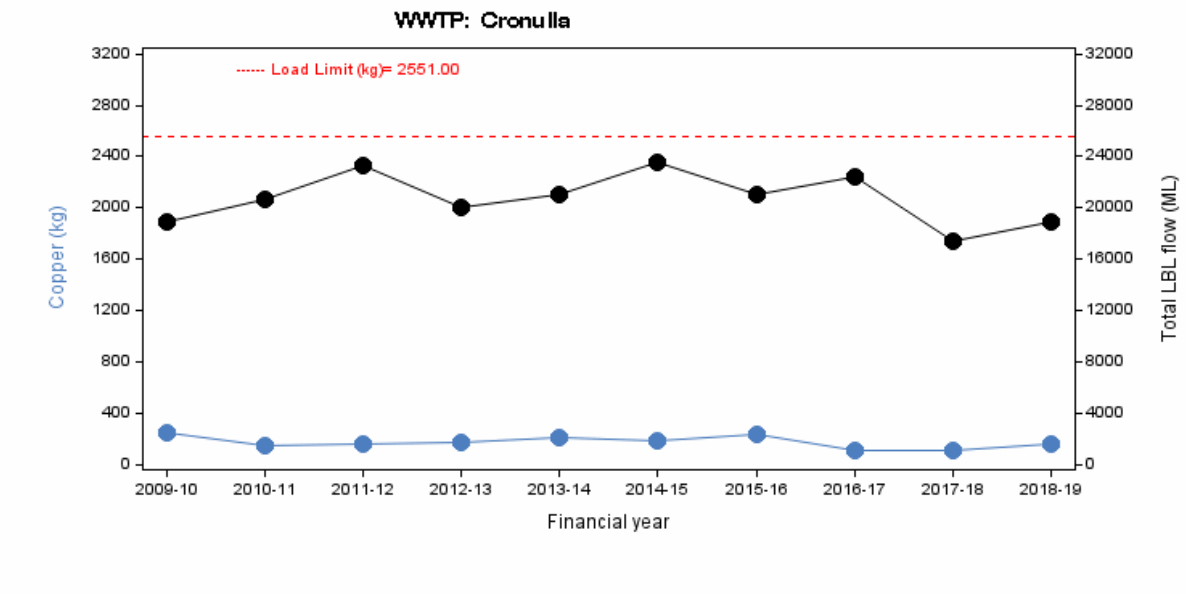


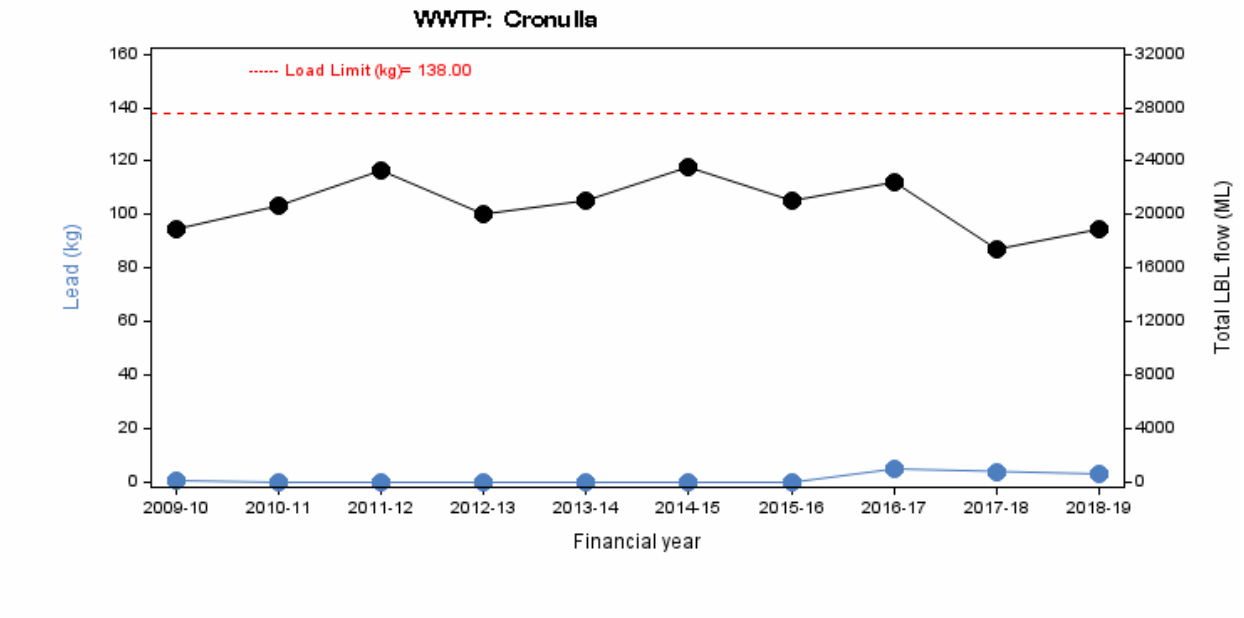


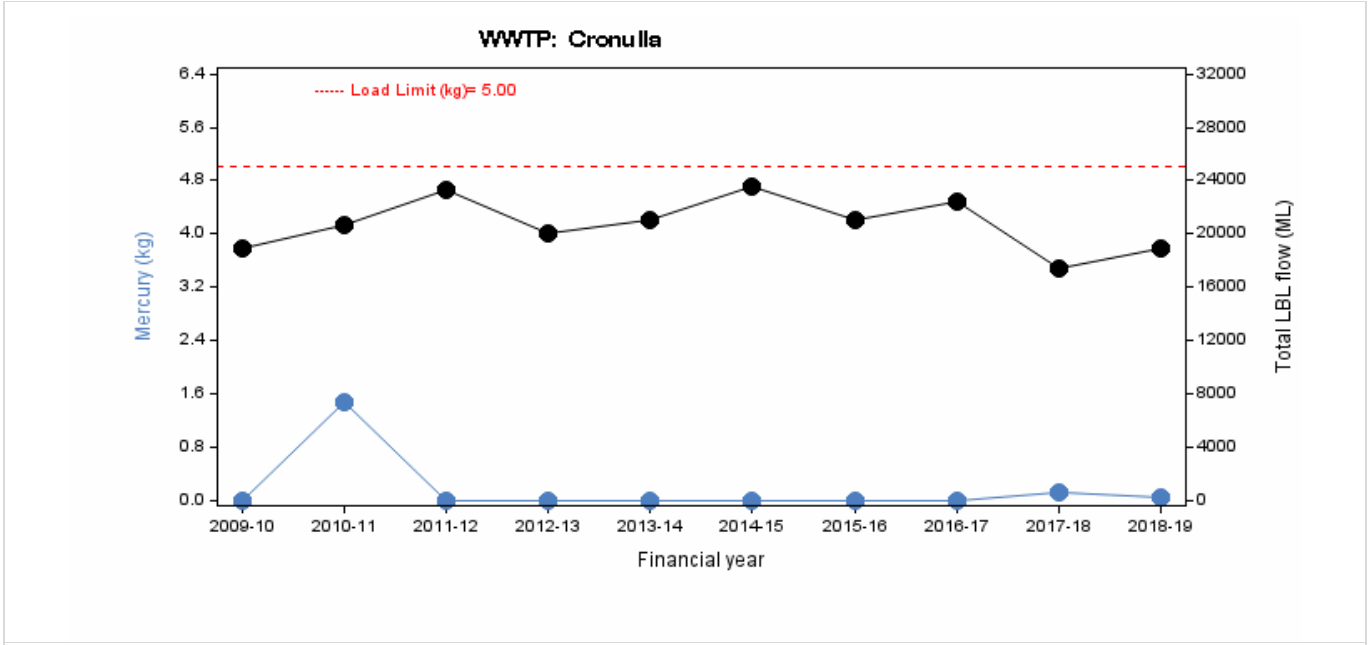
Discharge load: Trace metals

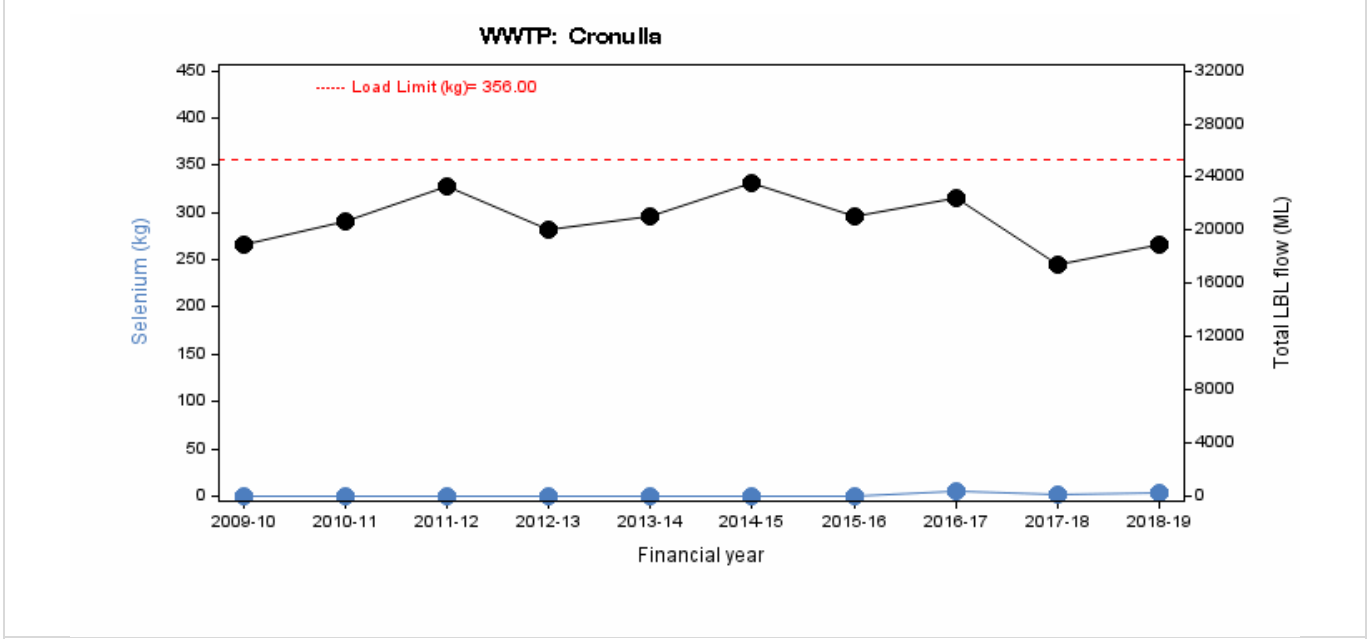


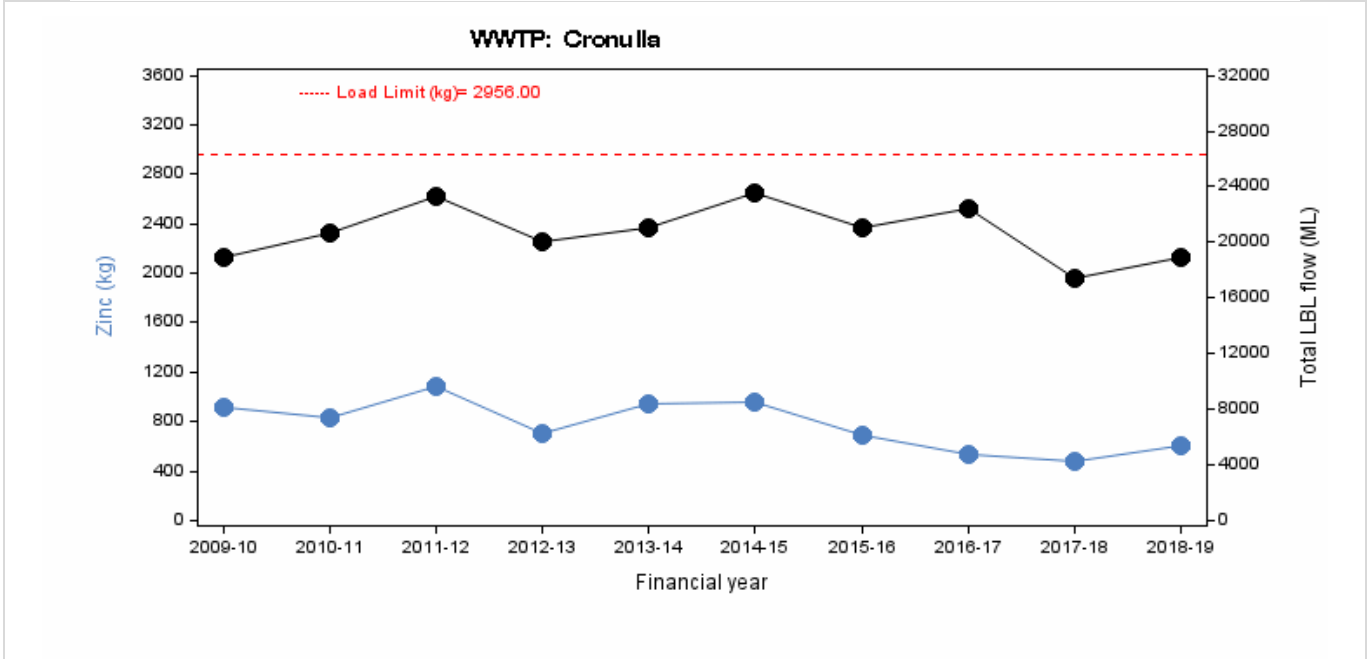

WWTP: Cronulla
Load Limit (kg)= 76.00
Chromium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Cronulla
Load Limit (kg)= 2551.00
Copper (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

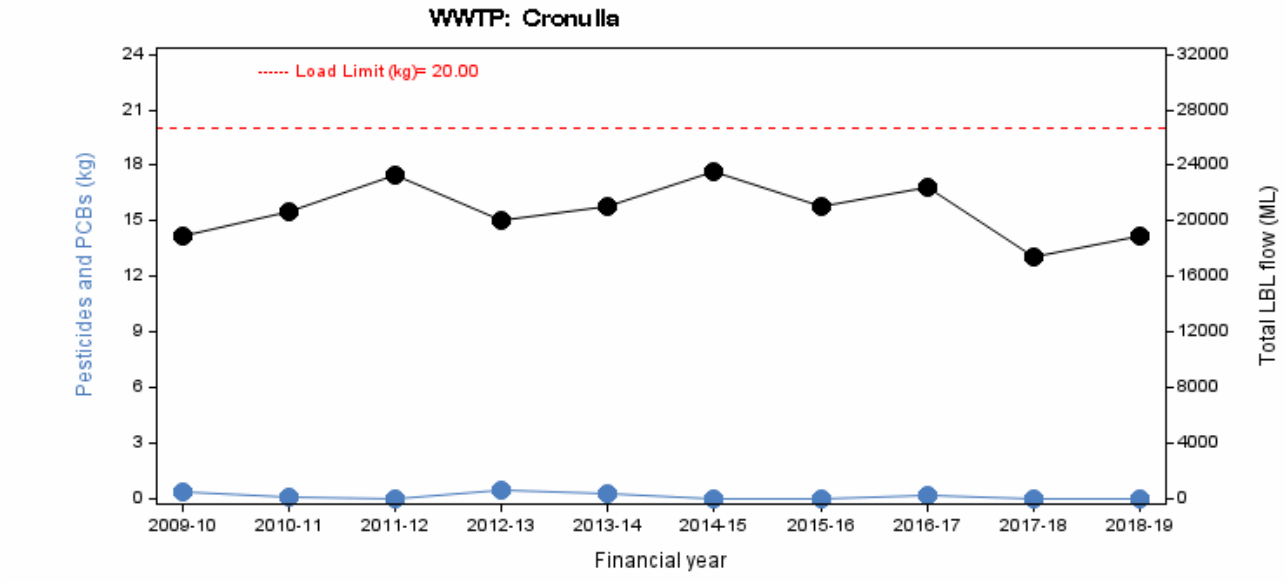

WWTP: Cronulla
Load Limit (kg)= 138.00
Lead (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Cronulla
Load Limit (kg)= 5.00
Mercury (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Cronulla
Load Limit (kg)= 356.00
Selenium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

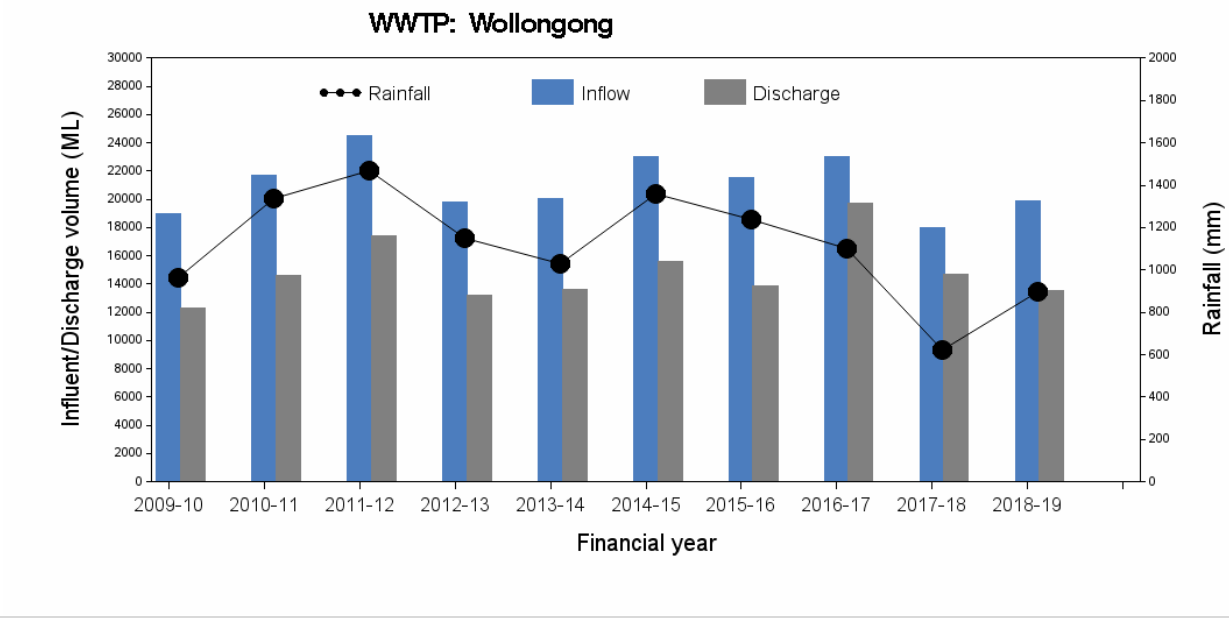

WWTP: Cronulla
Load Limit (kg)= 2956.00
Zinc (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

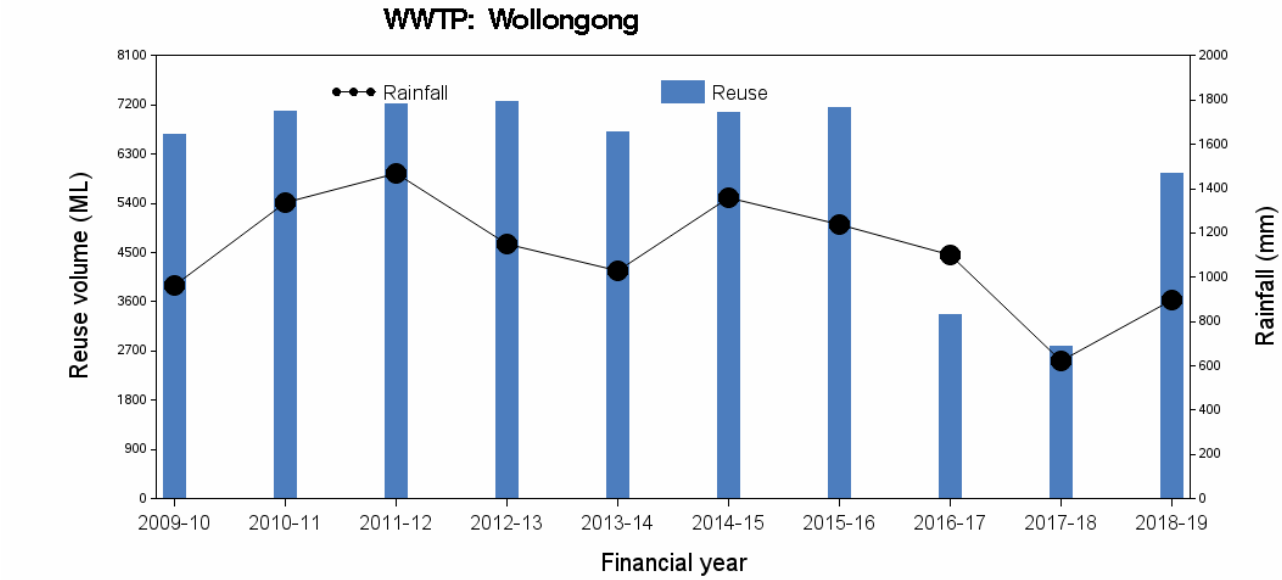
Discharge load: Other chemicals and organics (including pesticides)



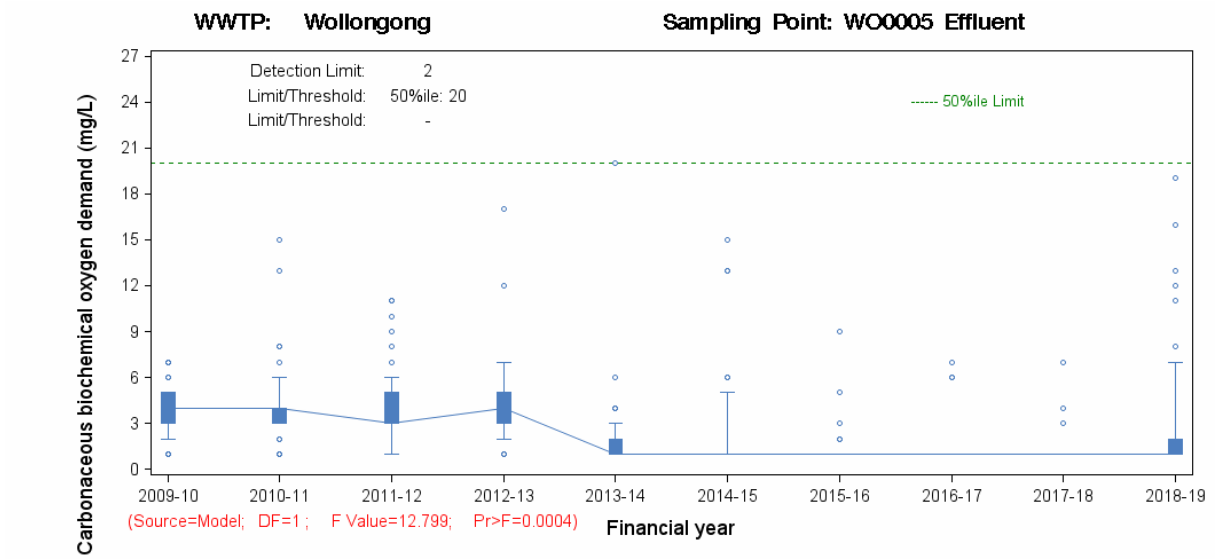
Wollongong WWTP

Discharge volume and rainfall

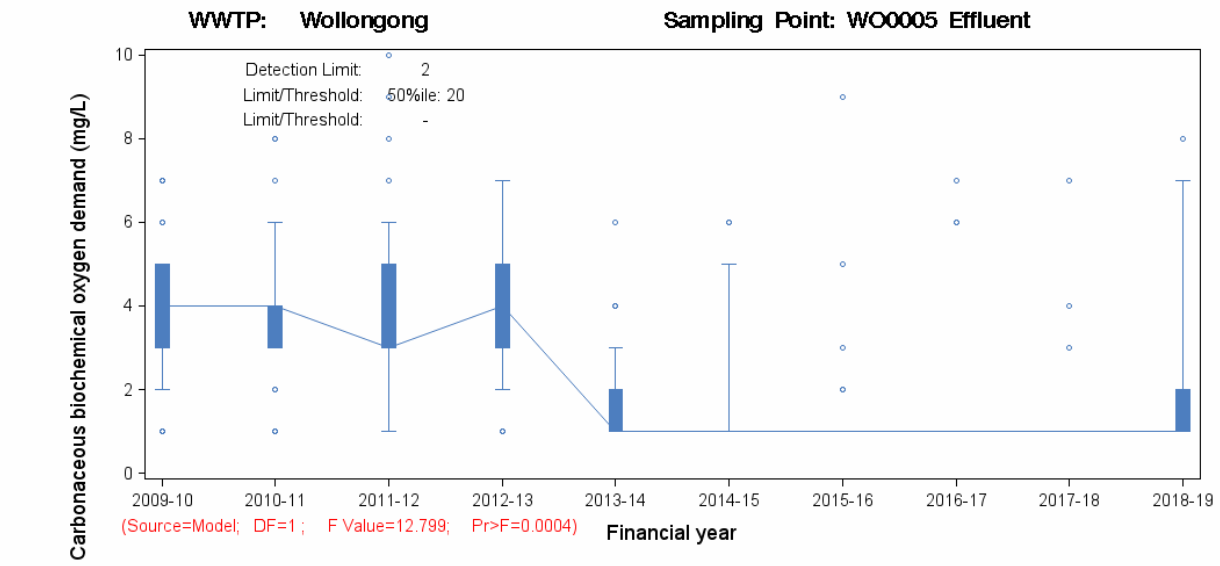




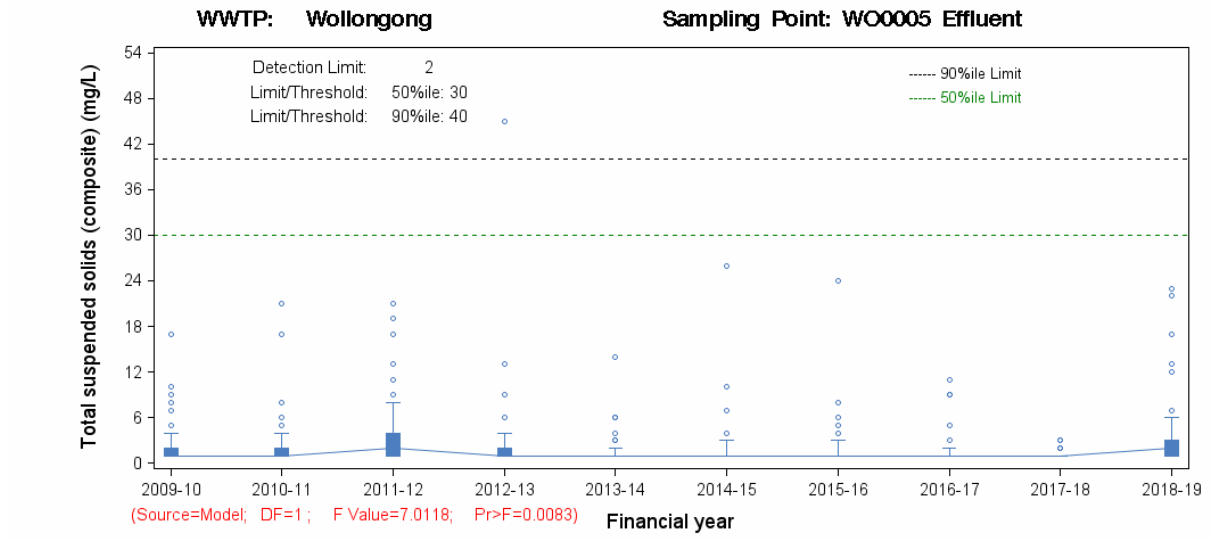
Discharge quality: Major conventional analytes

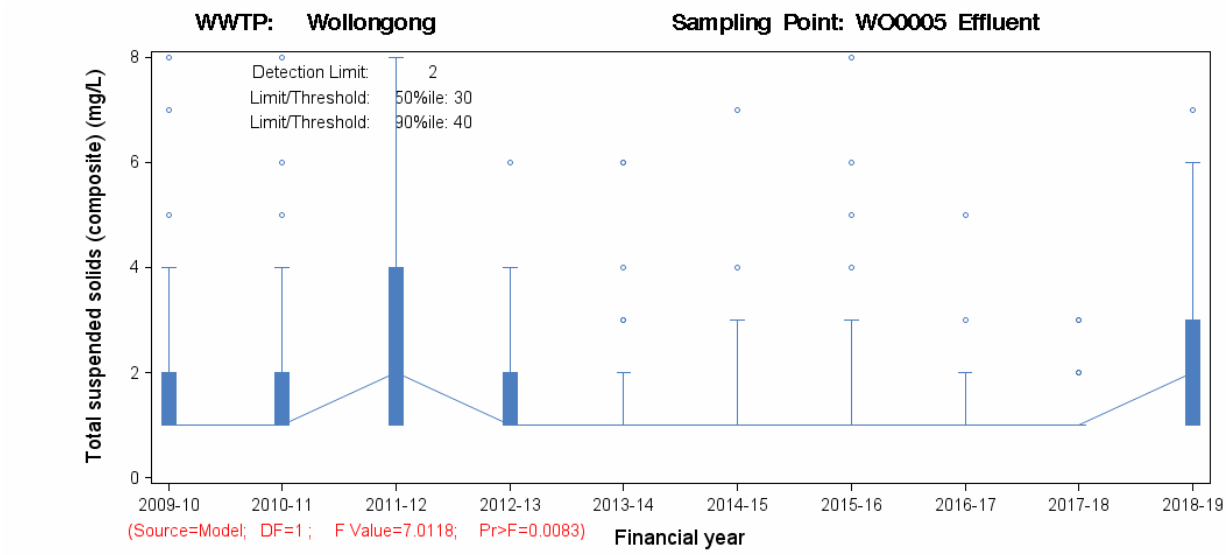


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

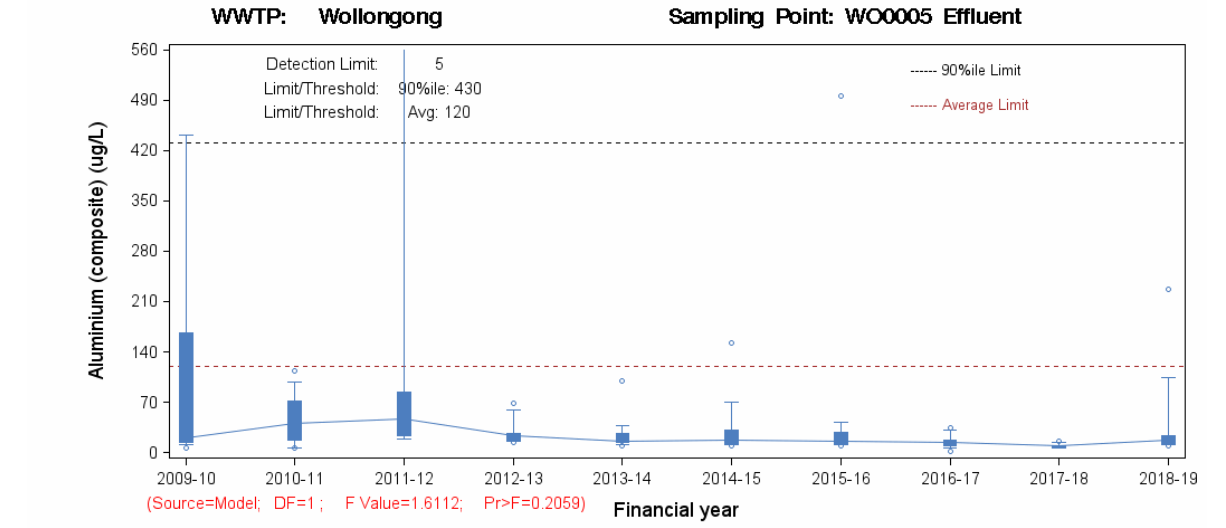


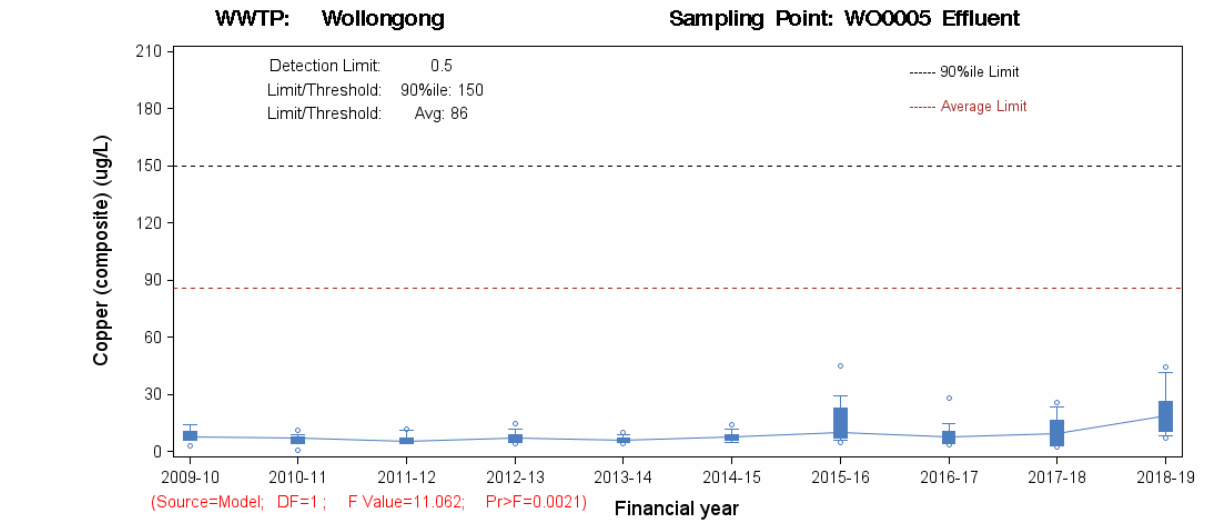
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



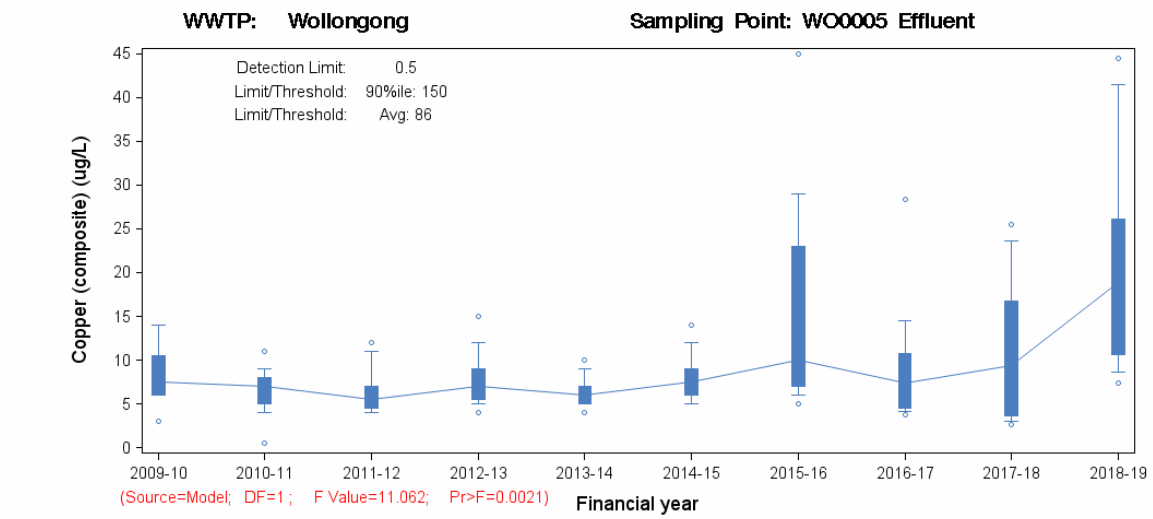


Discharge quality: Trace metals



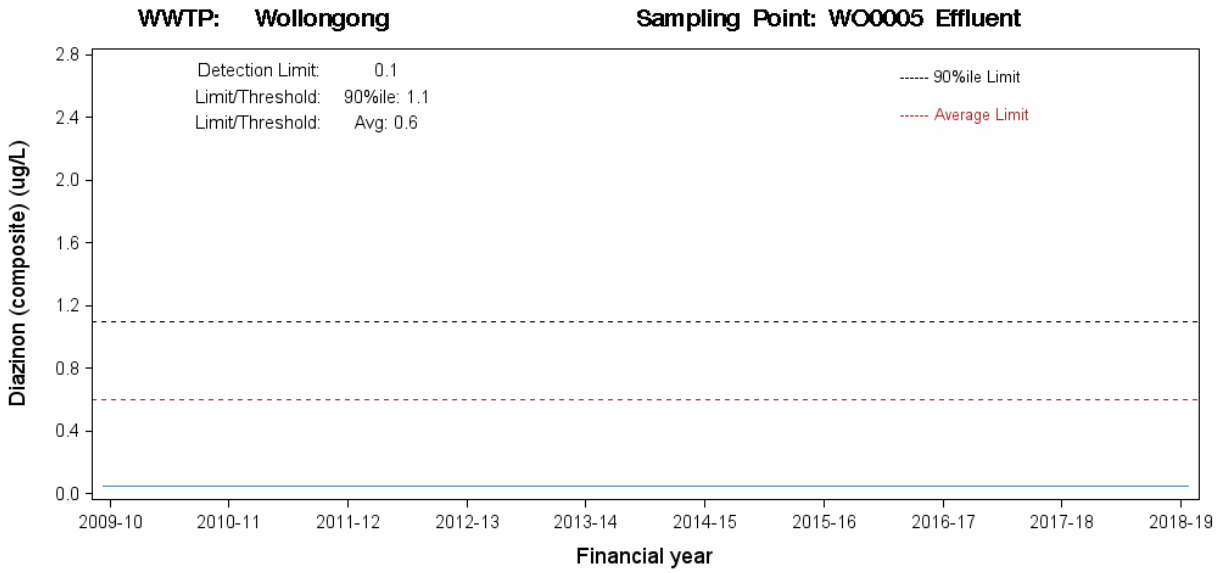


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

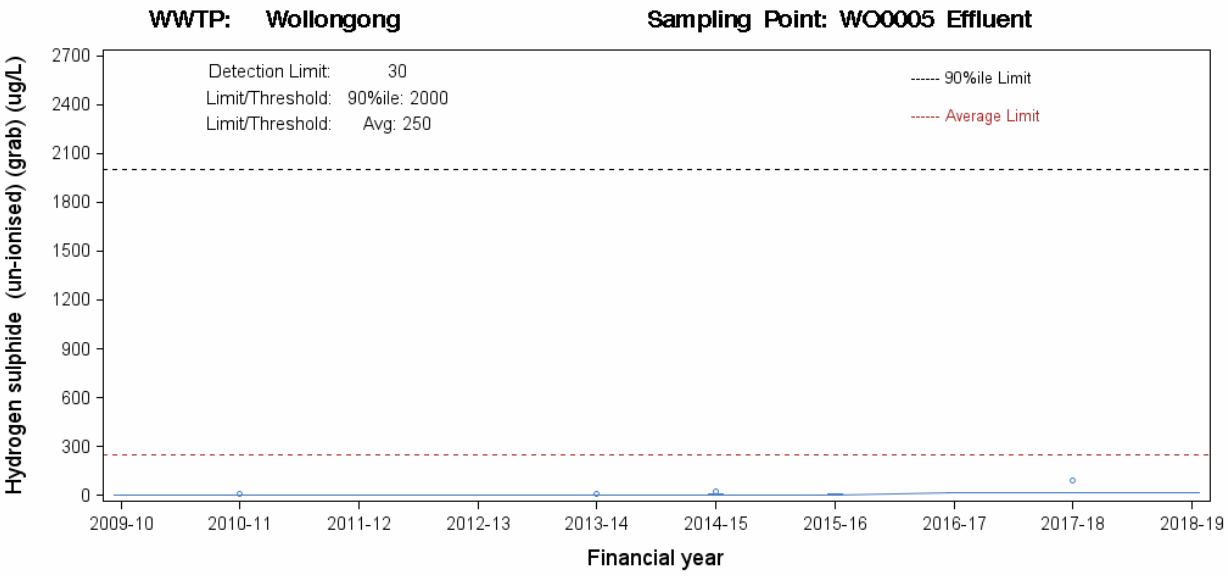


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

Discharge quality: Other chemicals and organics (including pesticides)

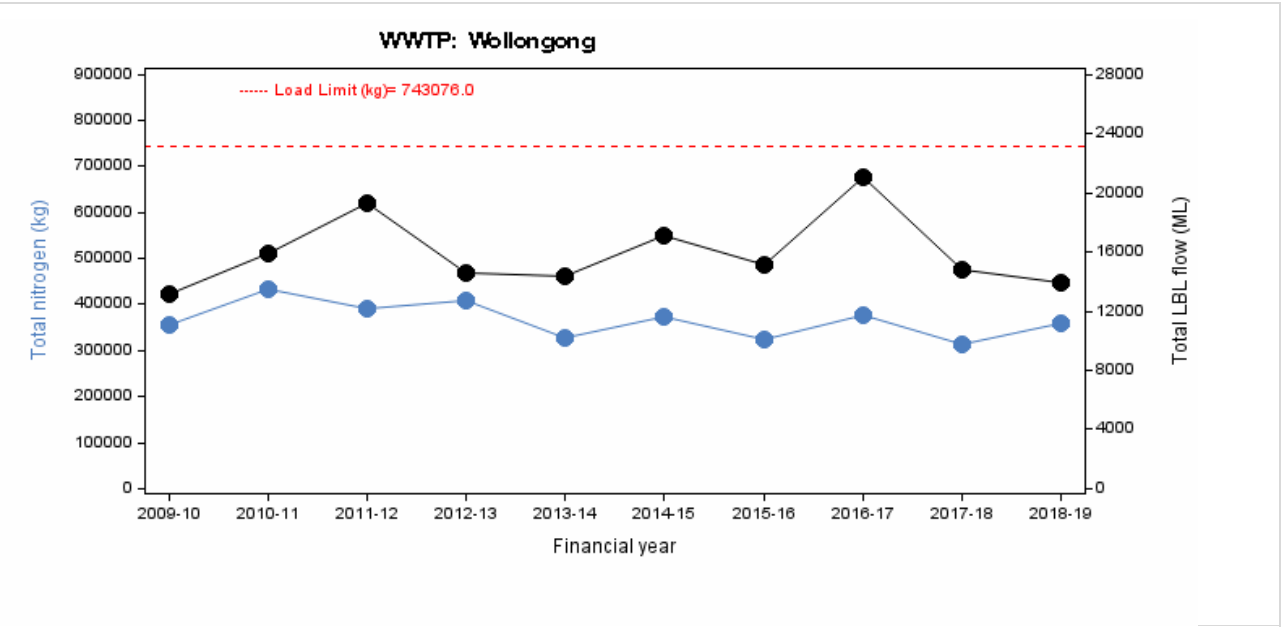


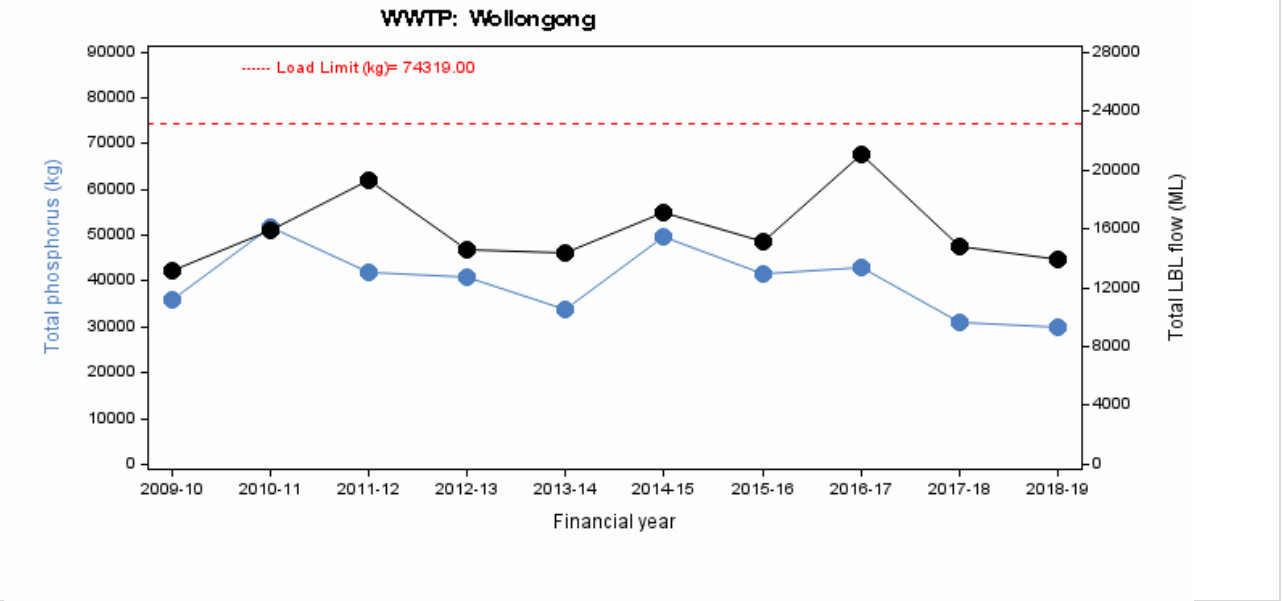
Note: Statistical test was not conducted because >90% of results were below the detection limit.



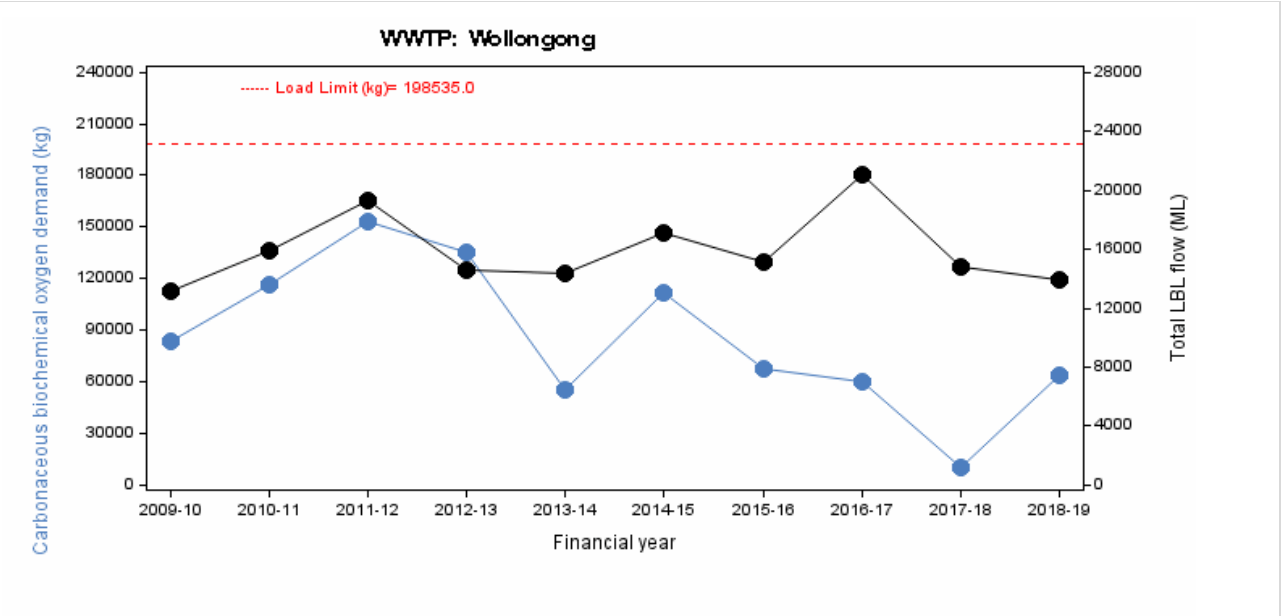
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

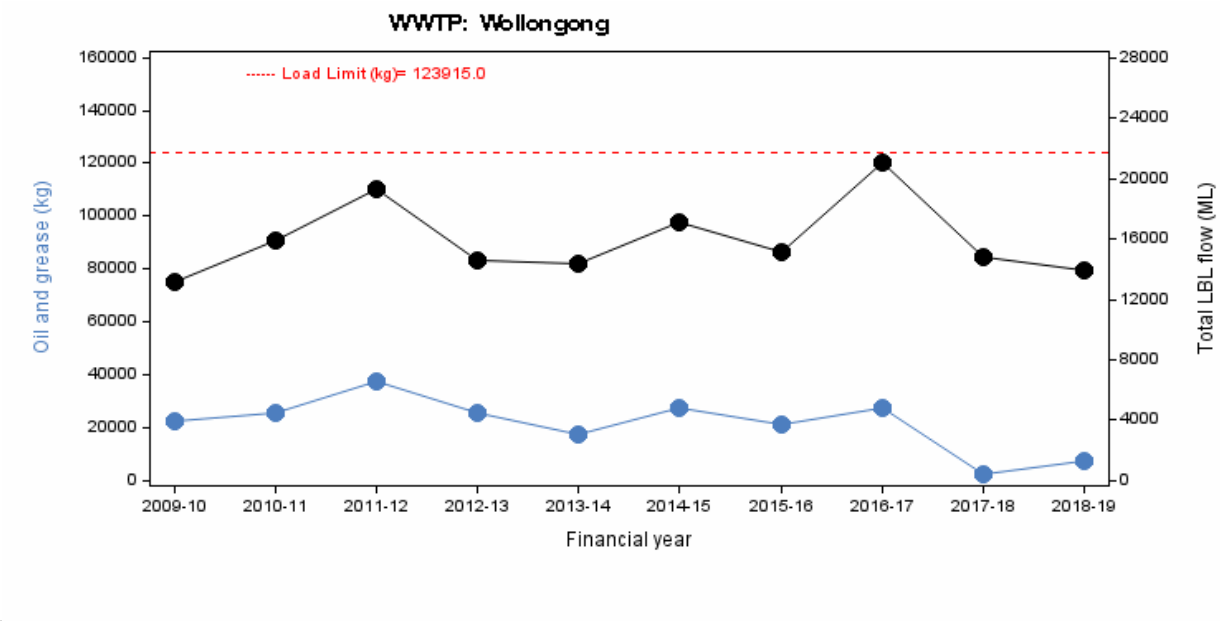
Discharge load: Nutrients

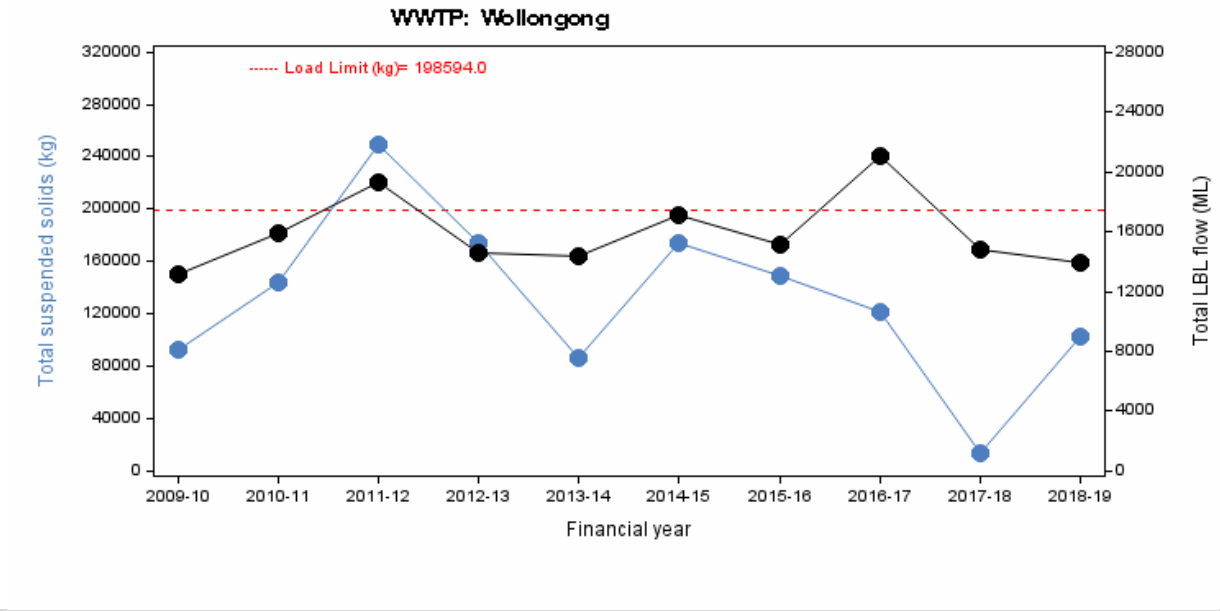




Discharge load: Major conventional analytes

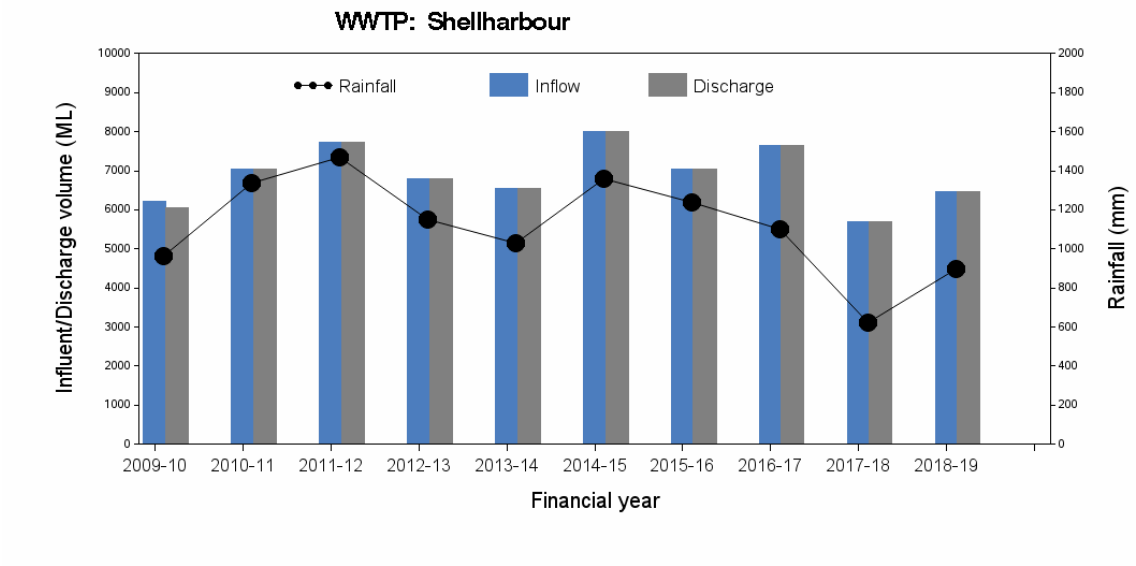



WWTP: Wollongong
Load Limit (kg)= 123915.0
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

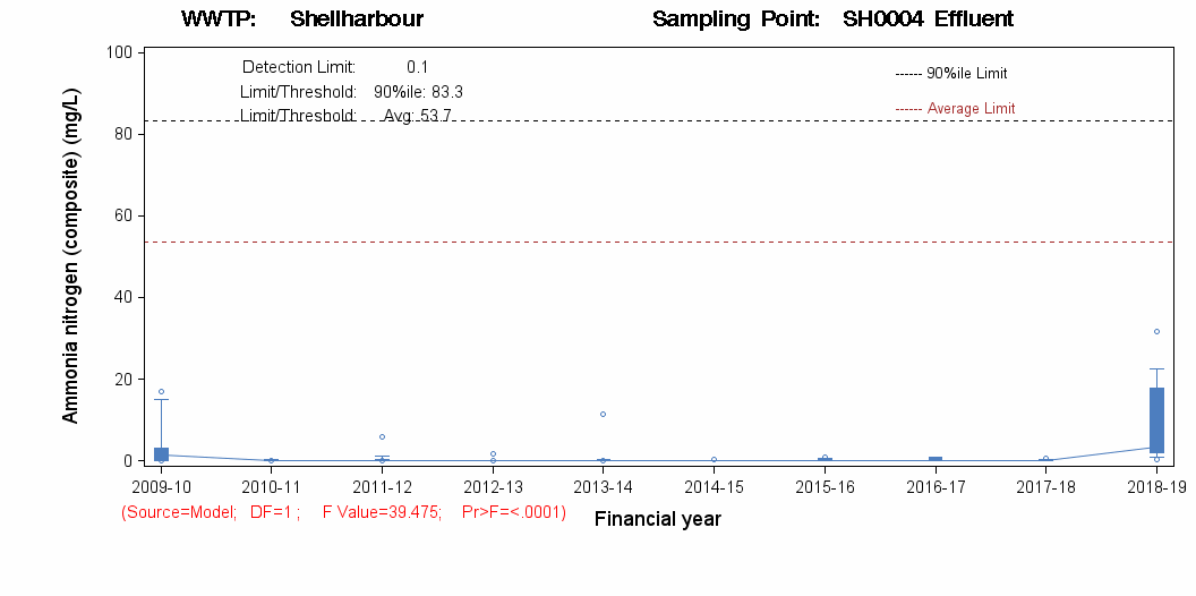

WWTP: Wollongong
Load Limit (kg)= 198594.0
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

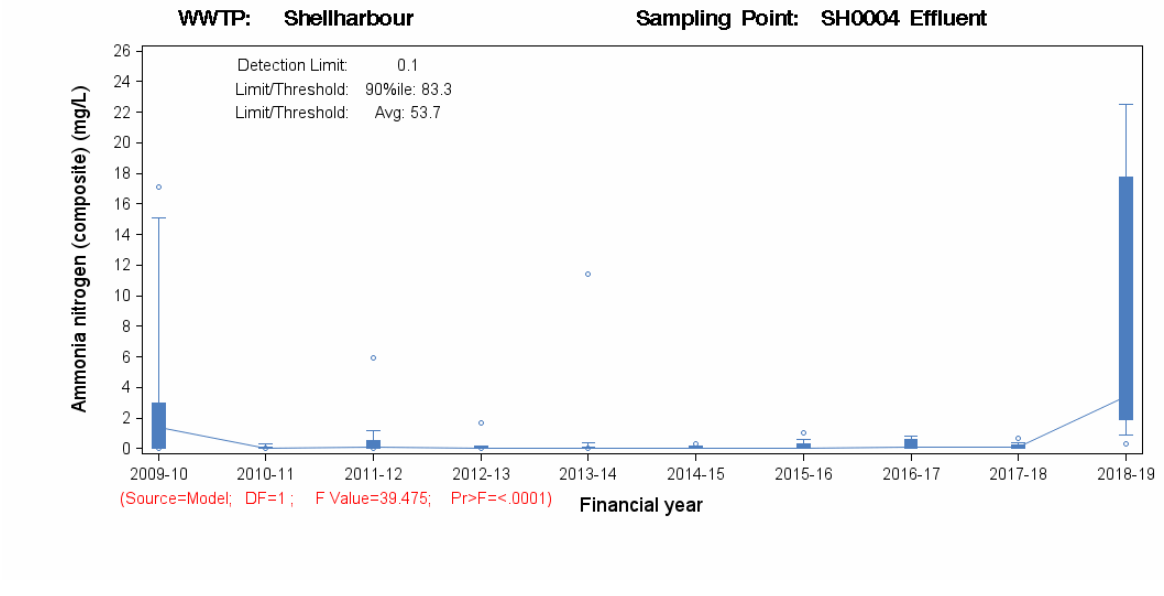
Shellharbour WWTP

Discharge volume and rainfall

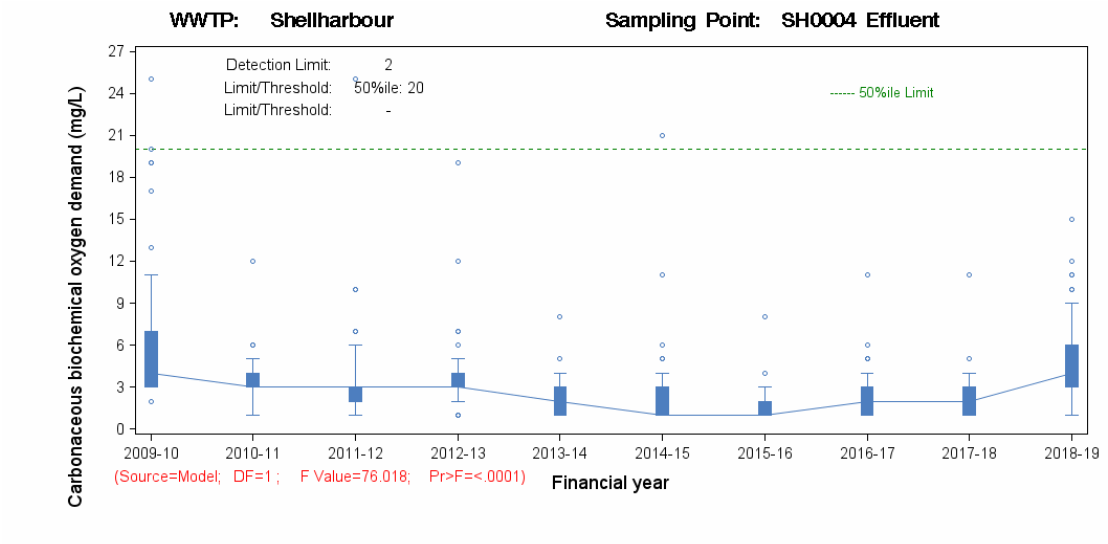


Discharge quality: Nutrients

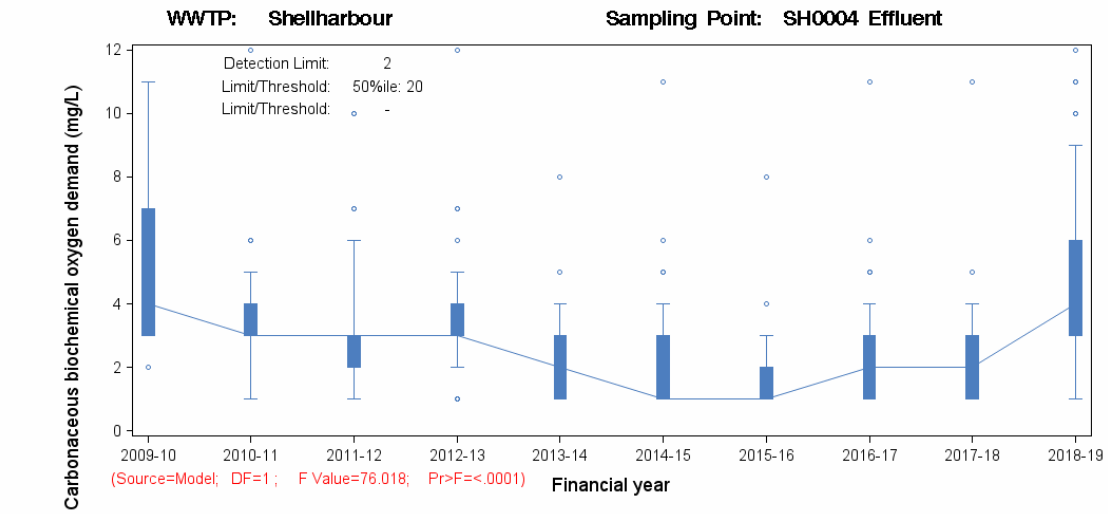




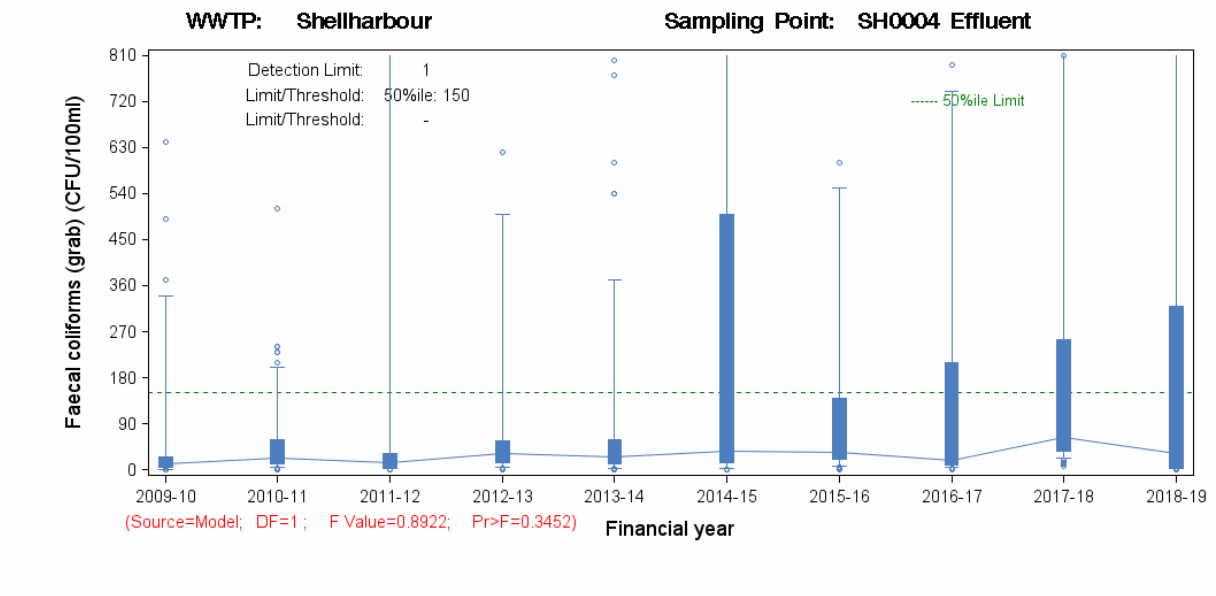
Discharge quality: Major conventional analytes

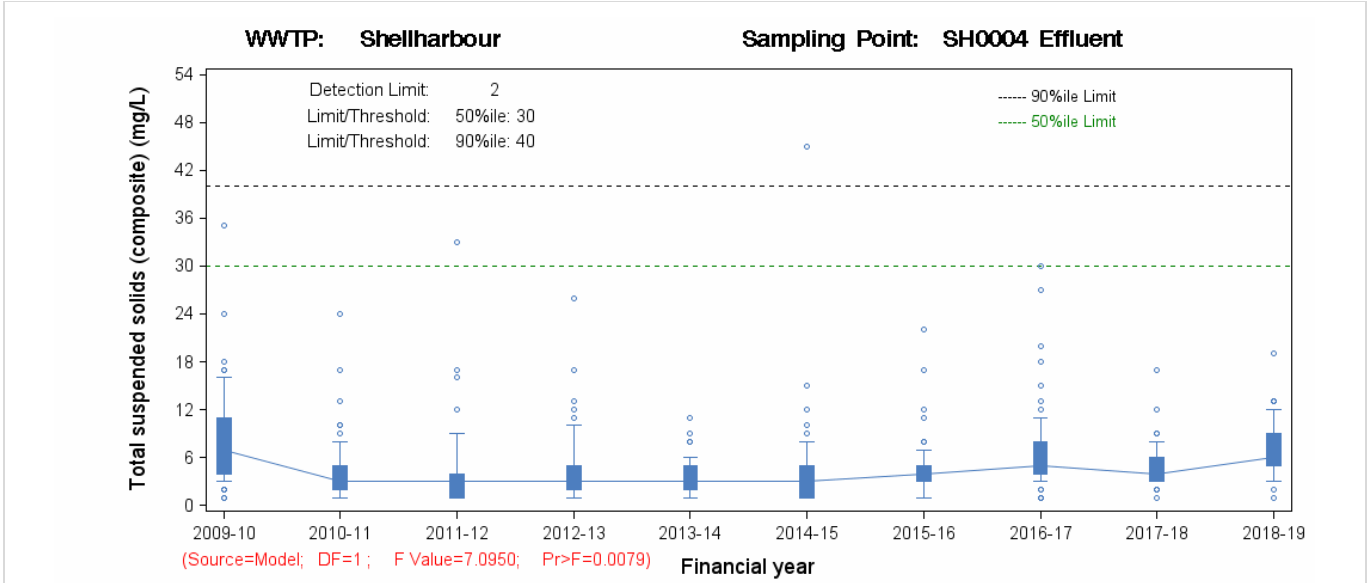


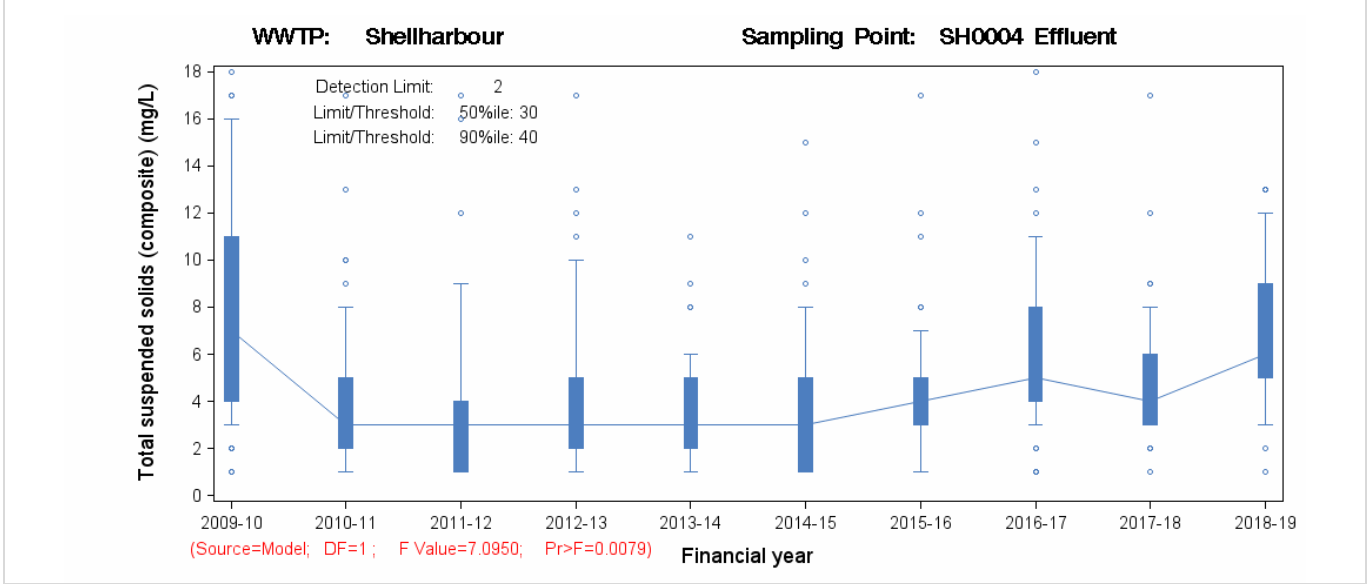
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



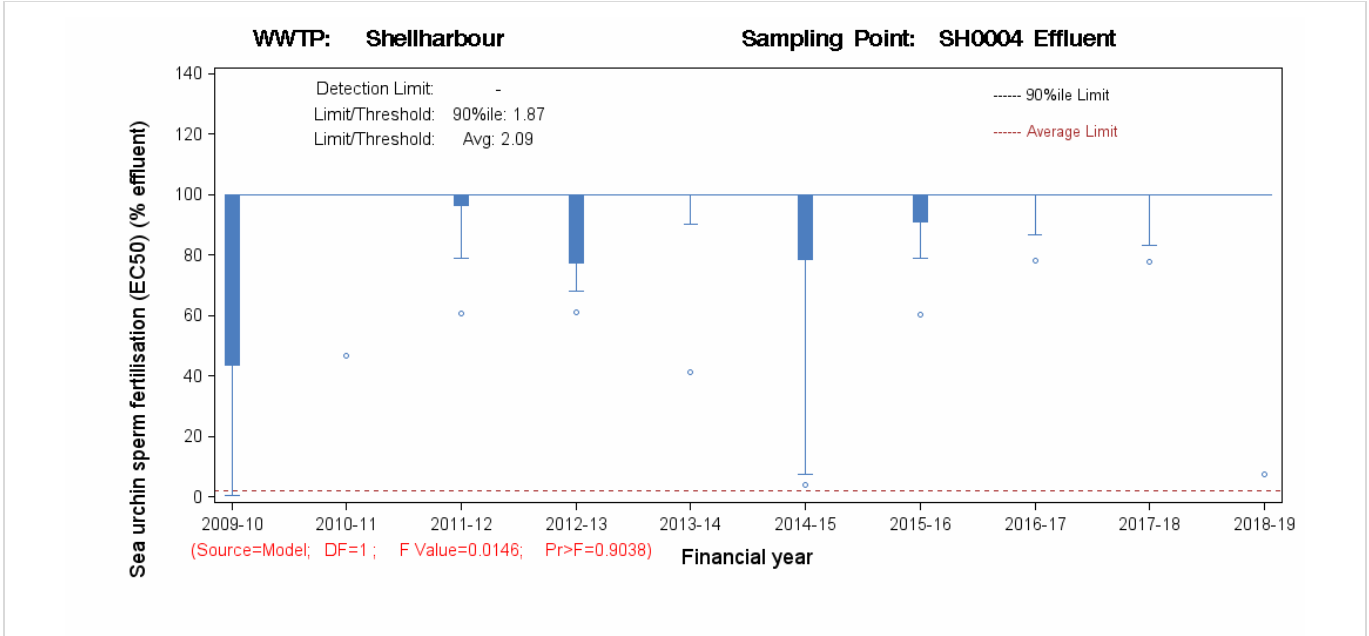
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15



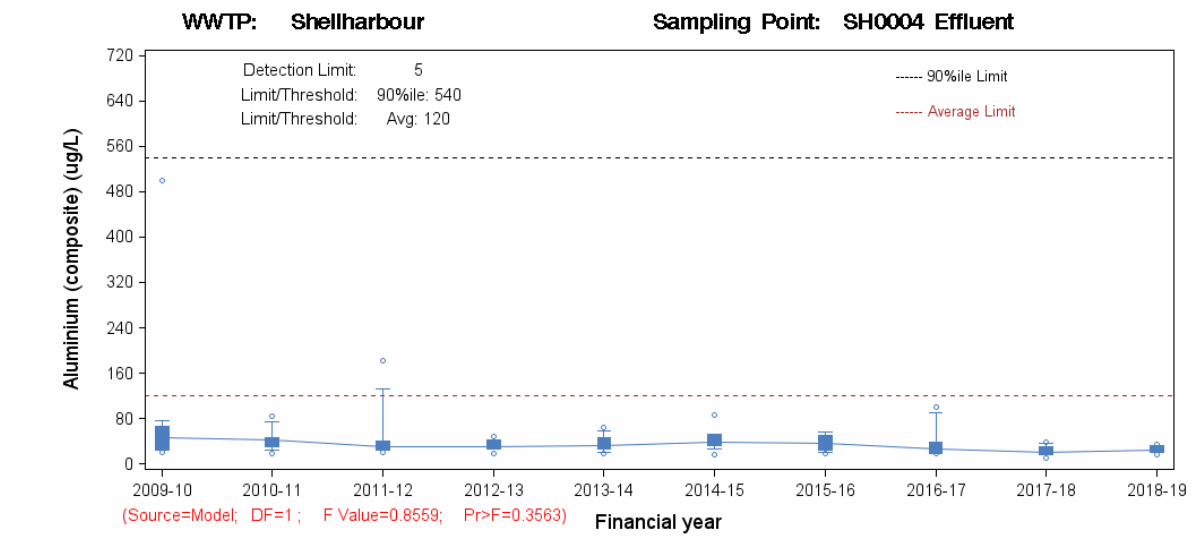


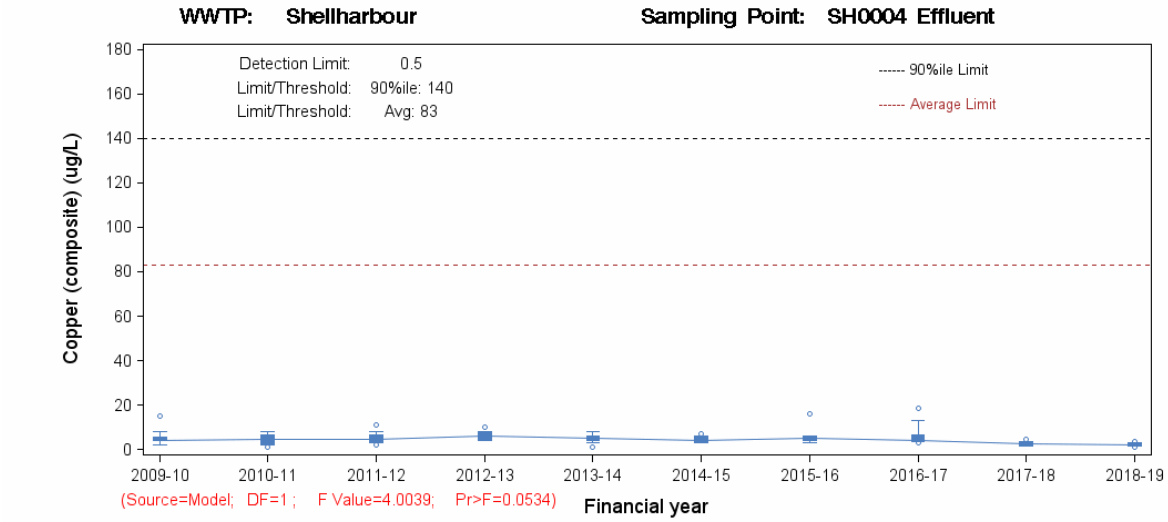


Discharge quality: Toxicity



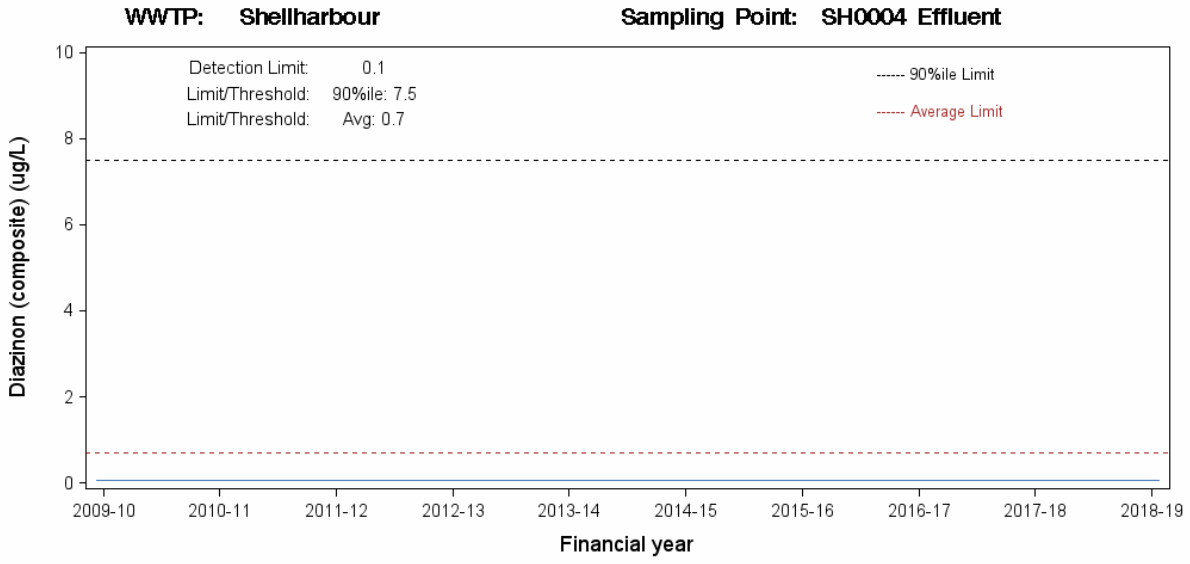
Discharge quality: Trace metals



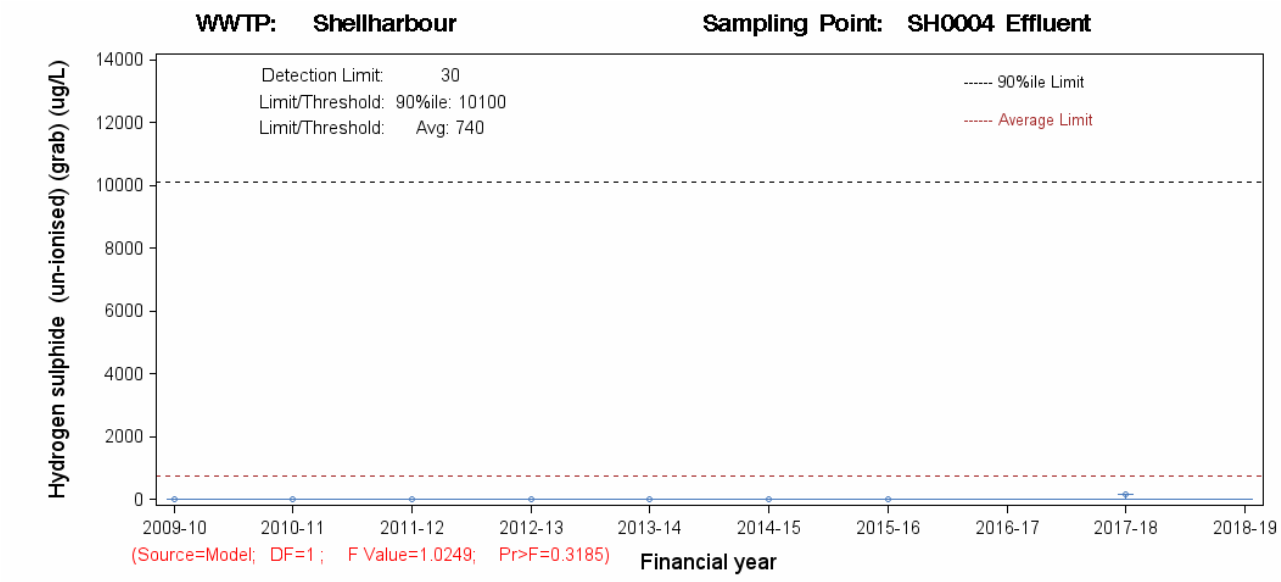


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

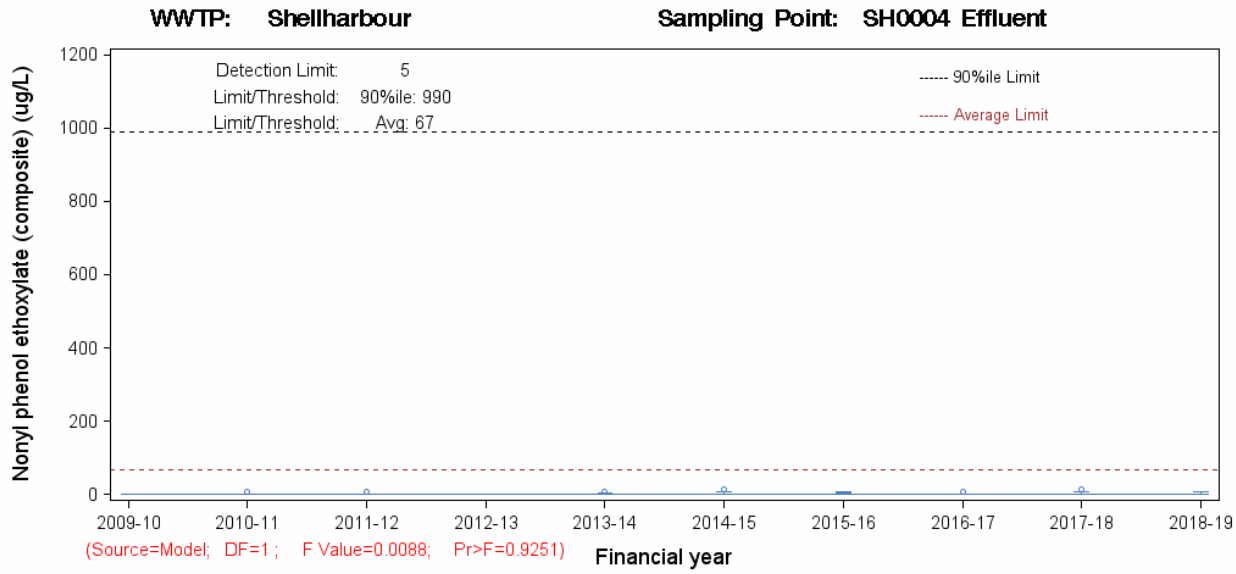
Discharge quality: Other chemicals and organics (including pesticides)



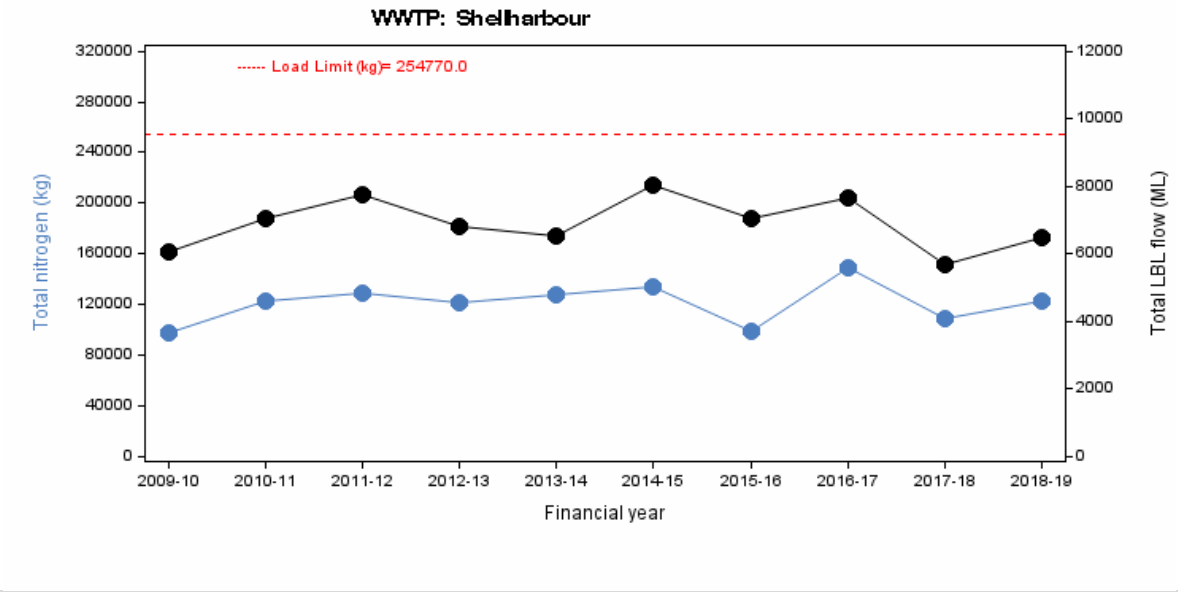
Note: Statistical test was not conducted because >90% of results were below the detection limit.

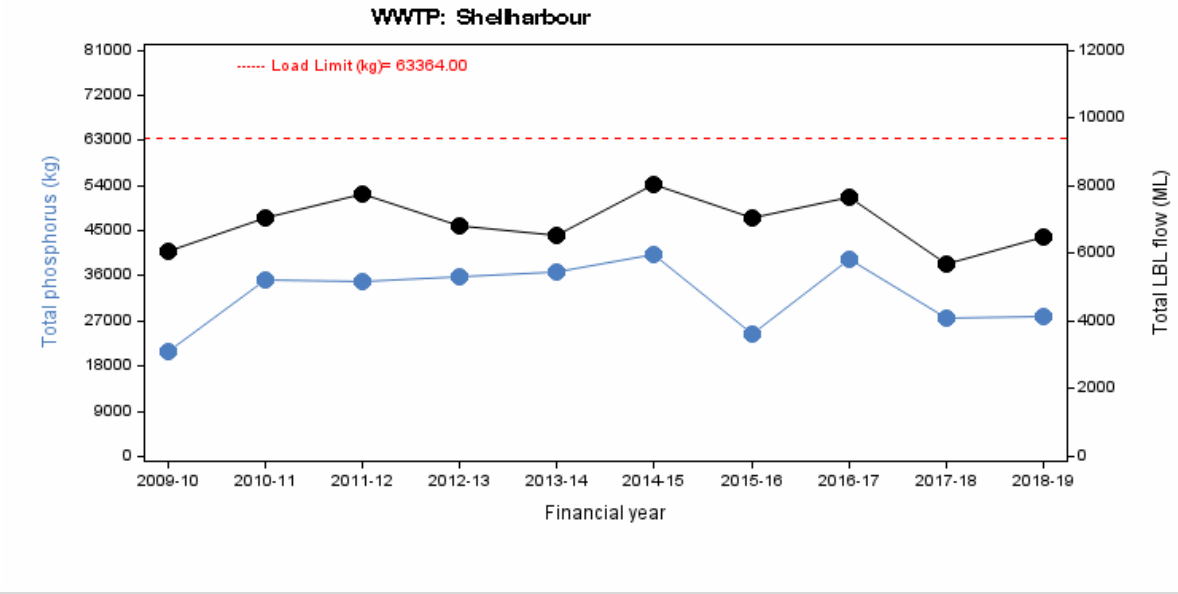


Note: There was a detection limit change in 2016-17. So, statistical test was based on 2018-19 data with previous two years data (2016-2018).

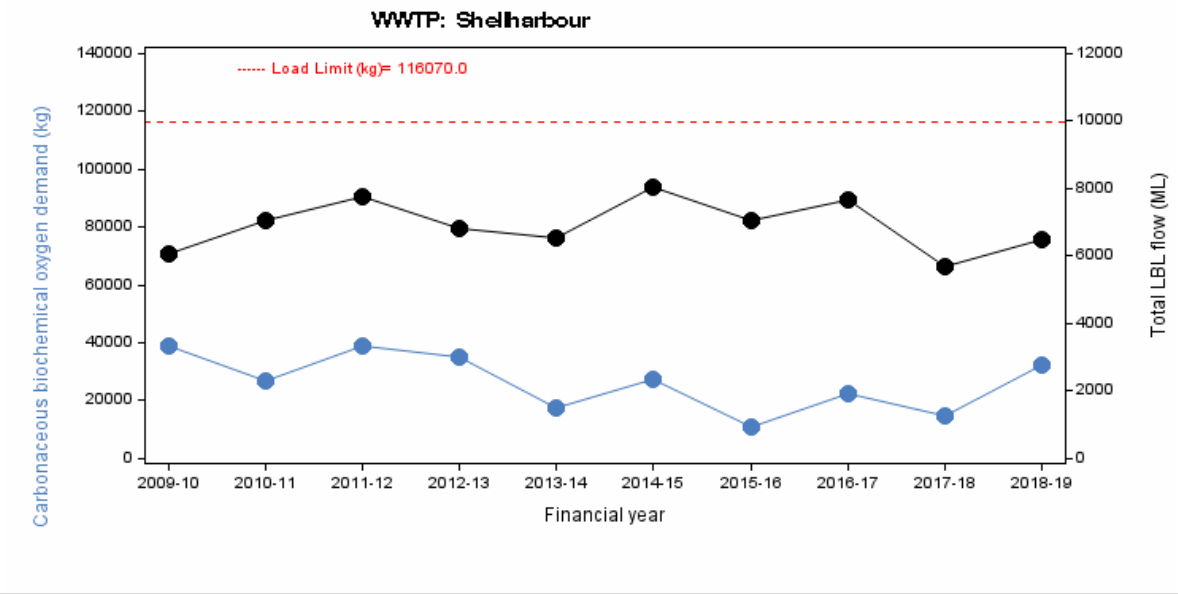


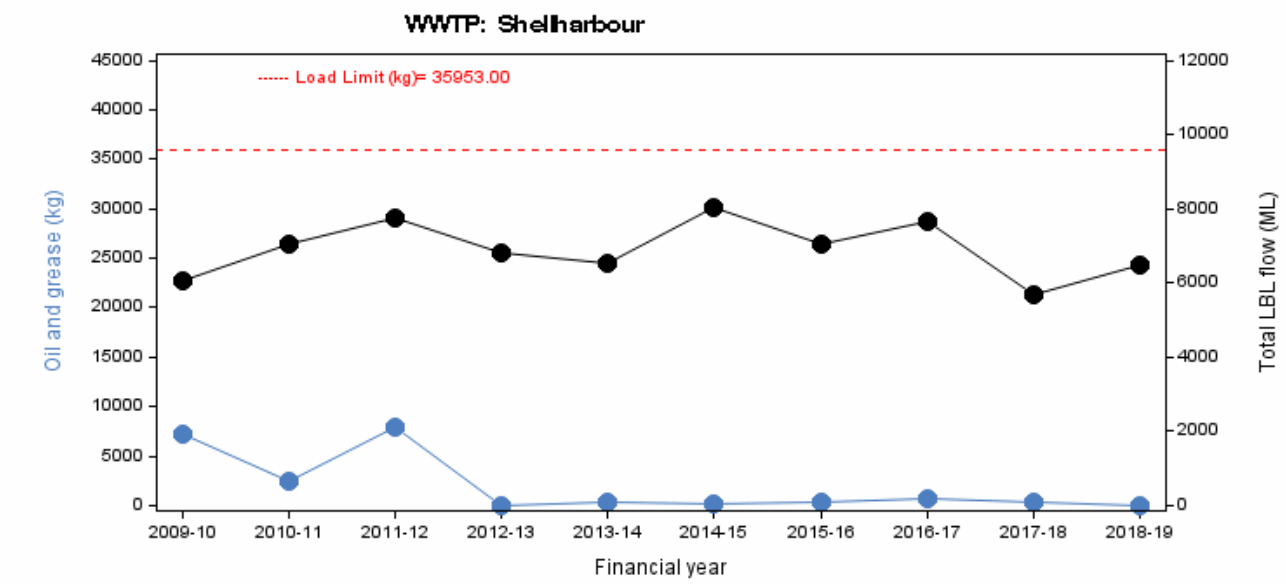
Discharge load: Nutrients

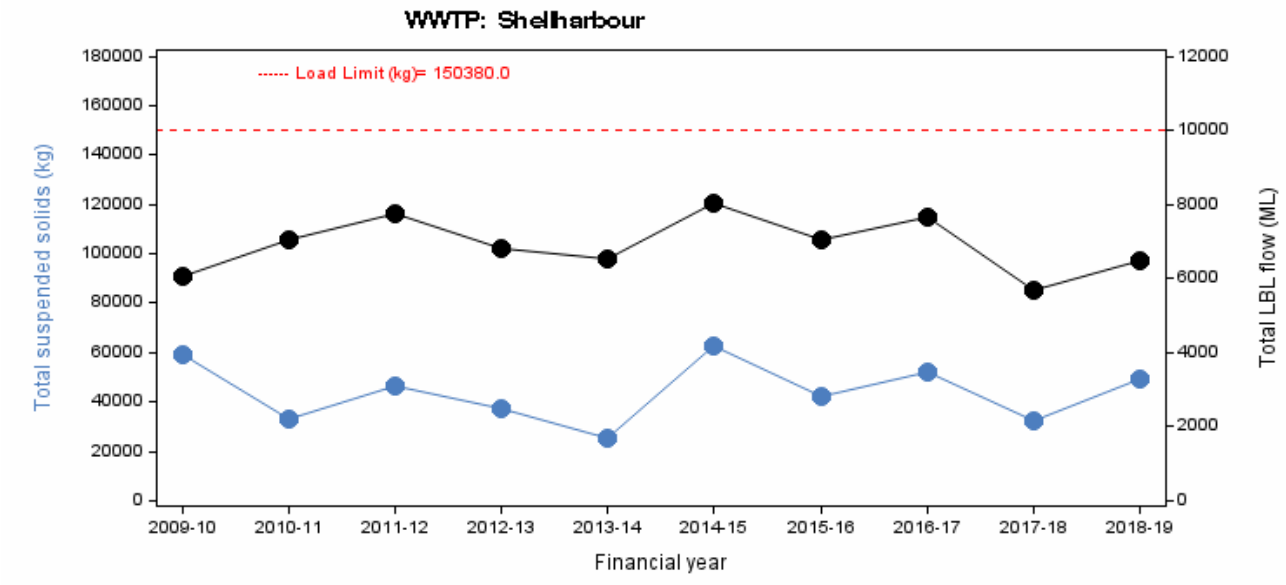




Discharge load: Major conventional analytes

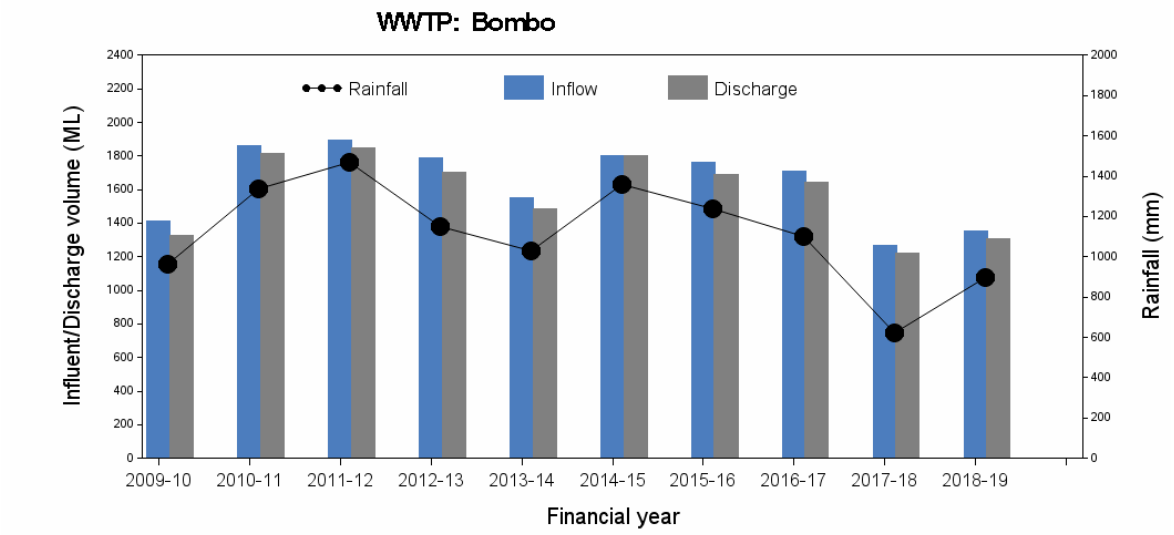


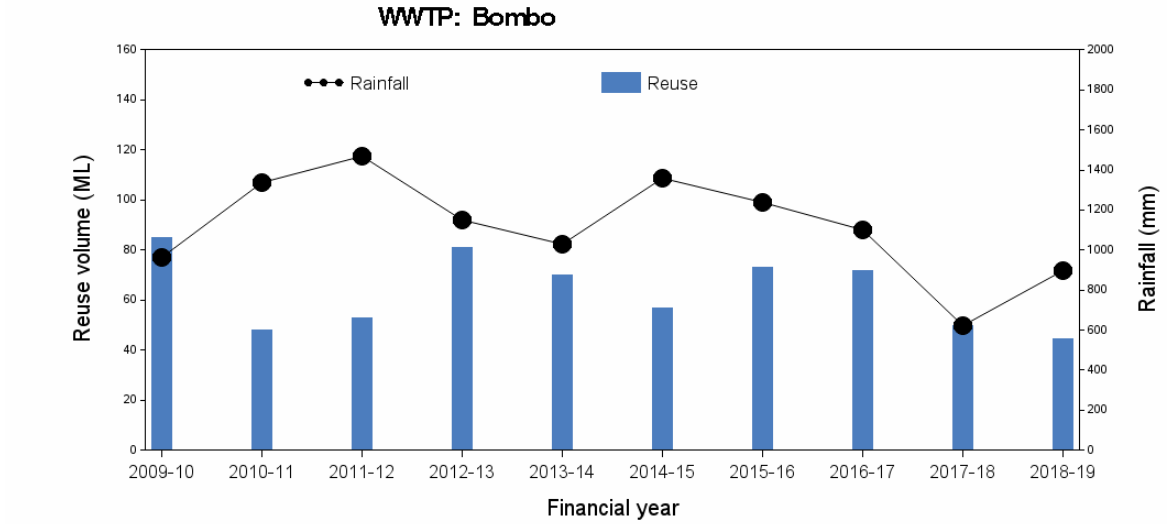

WWTP: Shellharbour
Load Limit (kg)= 35953.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Shellharbour
Load Limit (kg)= 150380.0
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

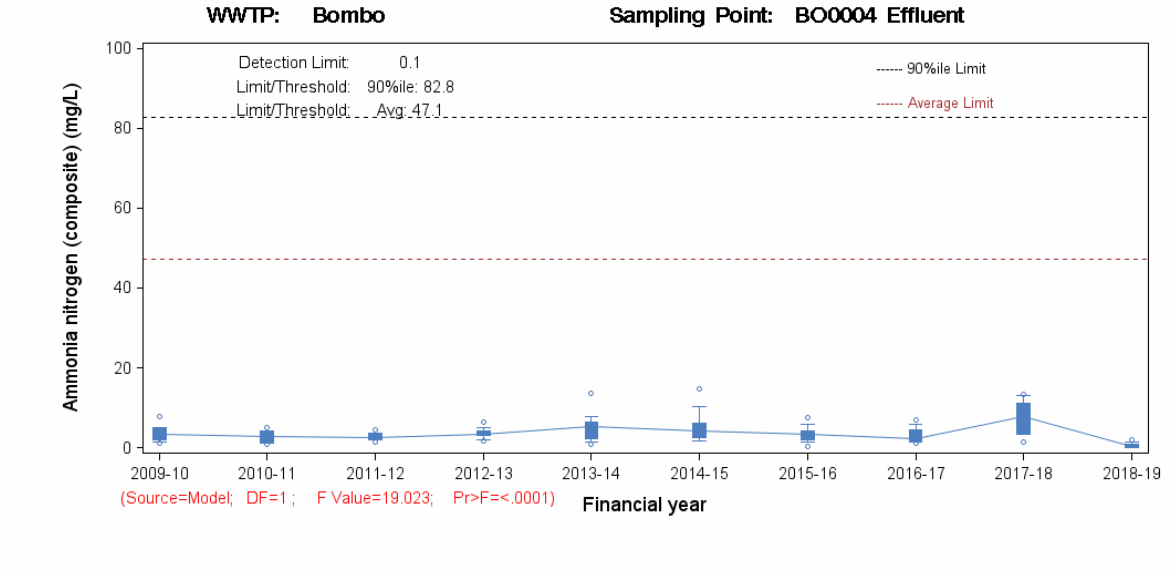
Bombo WWTP

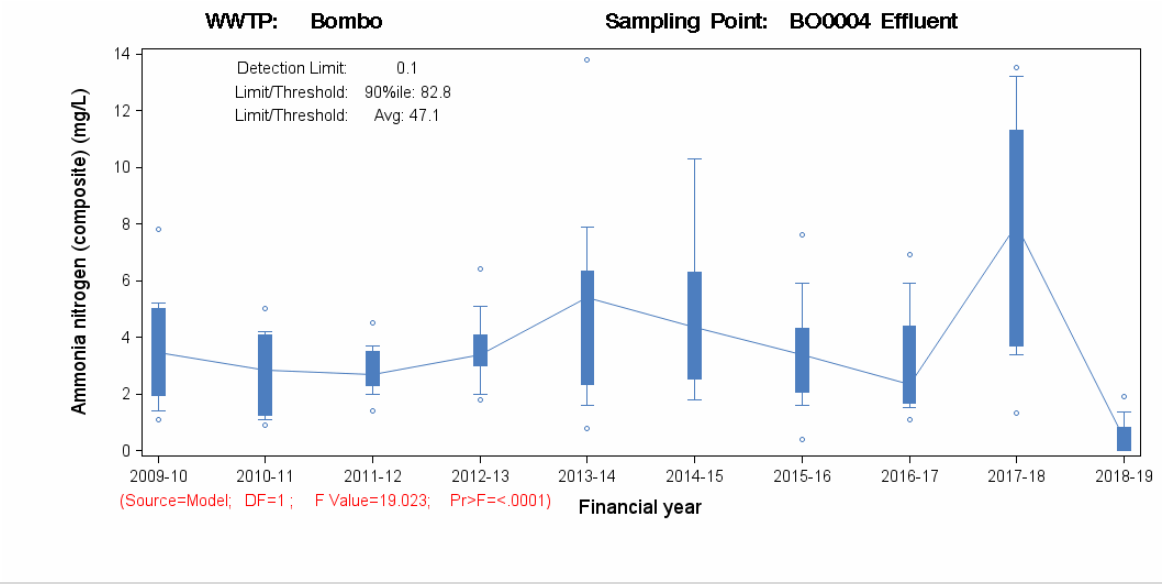
Discharge volume and rainfall



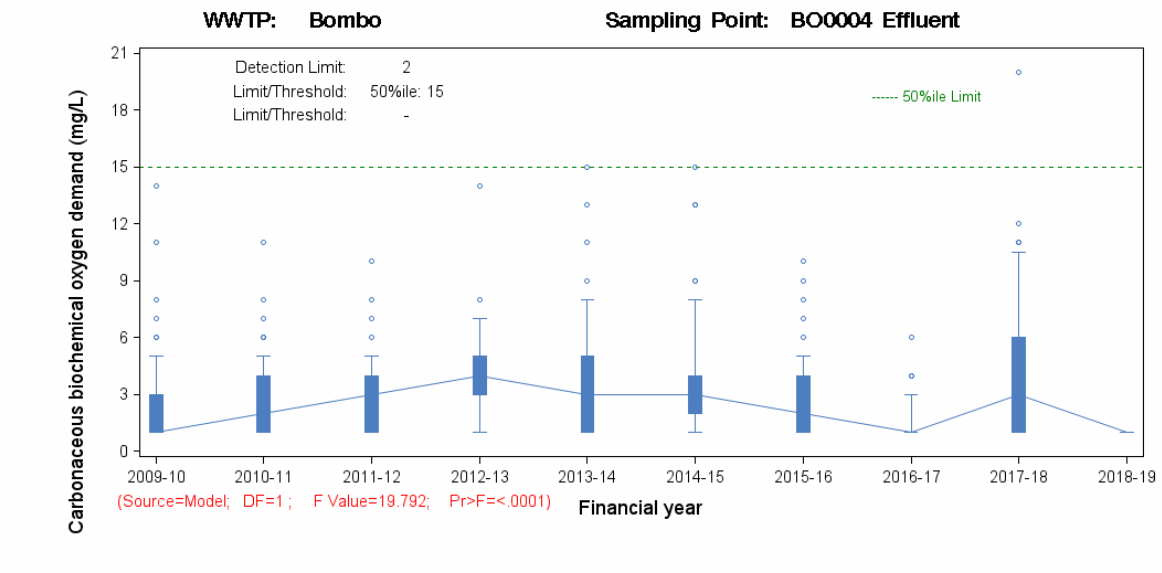


Discharge quality: Nutrients

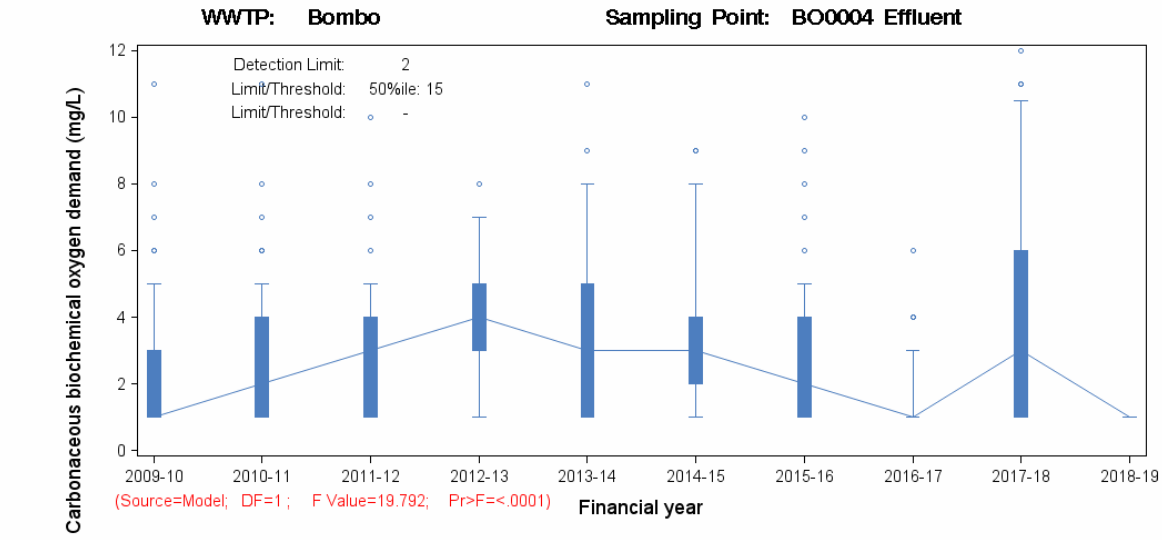




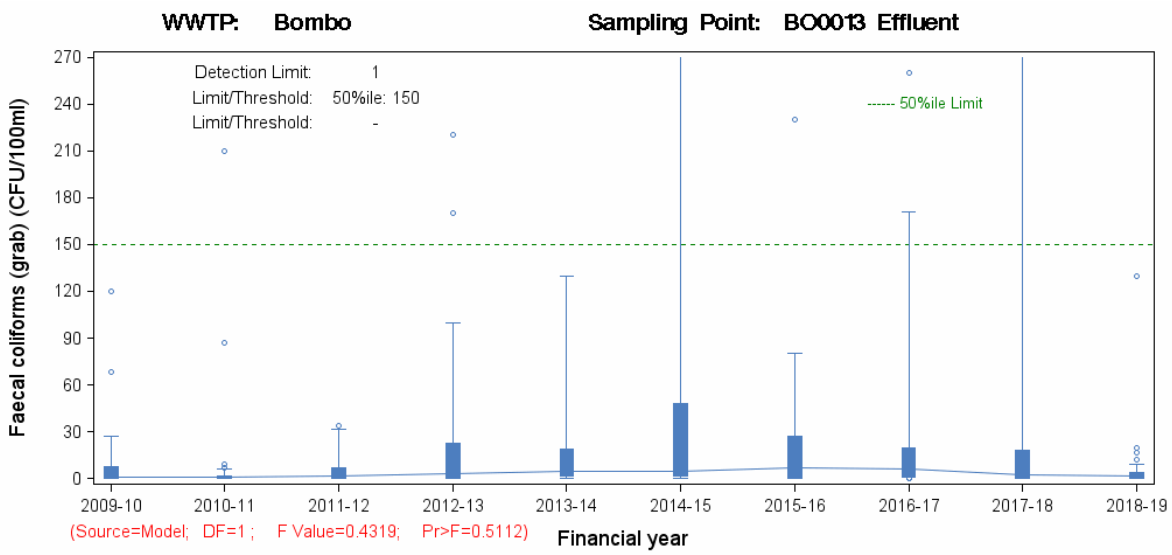
Discharge quality: Major conventional analytes

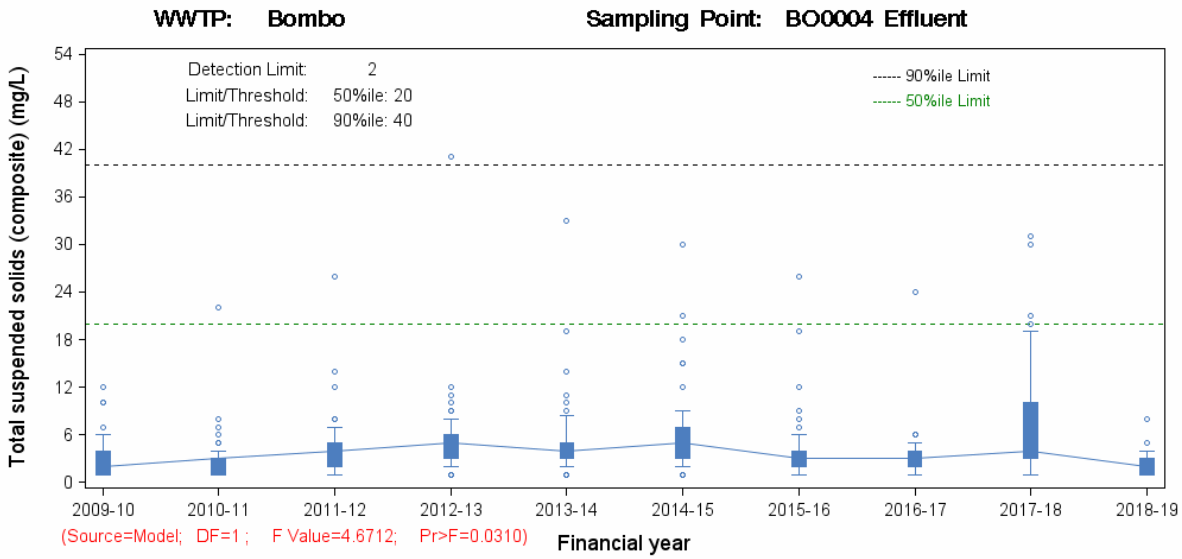


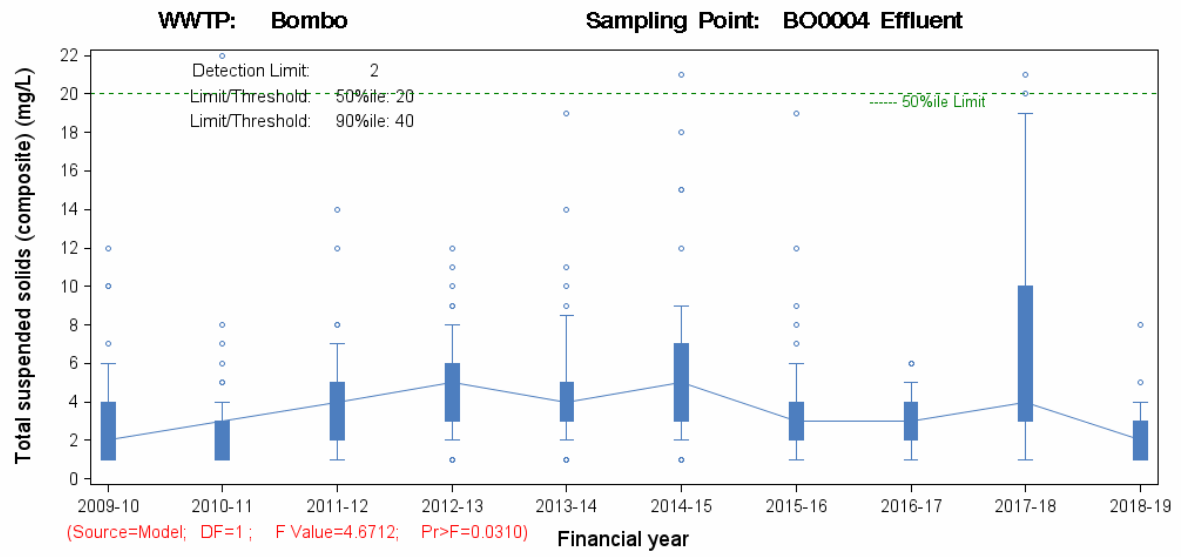
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



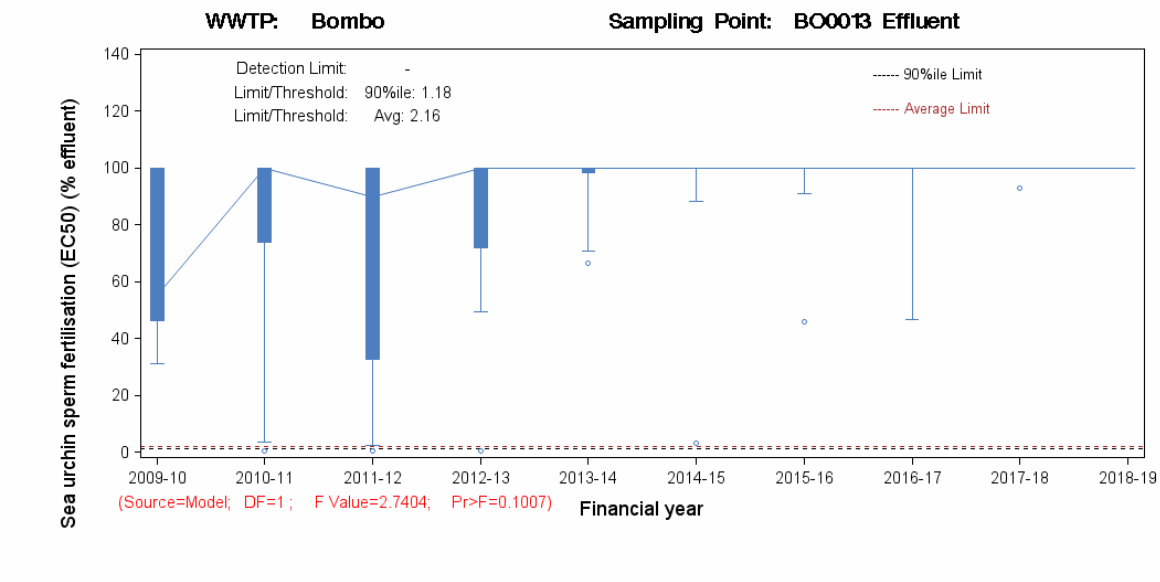
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.


WWTP: Bombo
Sampling Point: BO0013 Effluent
Detection Limit: 1
Limit/Threshold: 50%ile: 150
Limit/Threshold: -
----- 50%ile Limit
Faecal coliforms (grab) (CFU/100ml)
270
240
210
180
150
120
90
60
30
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.4319; Pr>F=0.5112)
Financial year

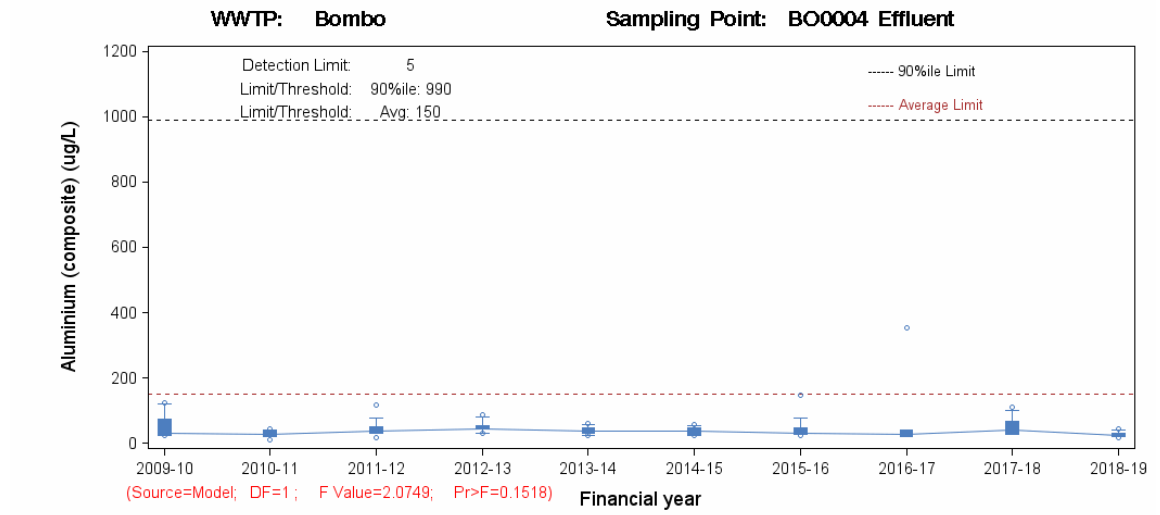

WWTP: Bombo
Sampling Point: BO0004 Effluent
Detection Limit: 2
Limit/Threshold: 50%ile: 20
Limit/Threshold: 90%ile: 40
----- 90%ile Limit
----- 50%ile Limit
Total suspended solids (composite) (mg/L)
54
48
42
36
30
24
18
12
6
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.6712; Pr>F=0.0310)
Financial year

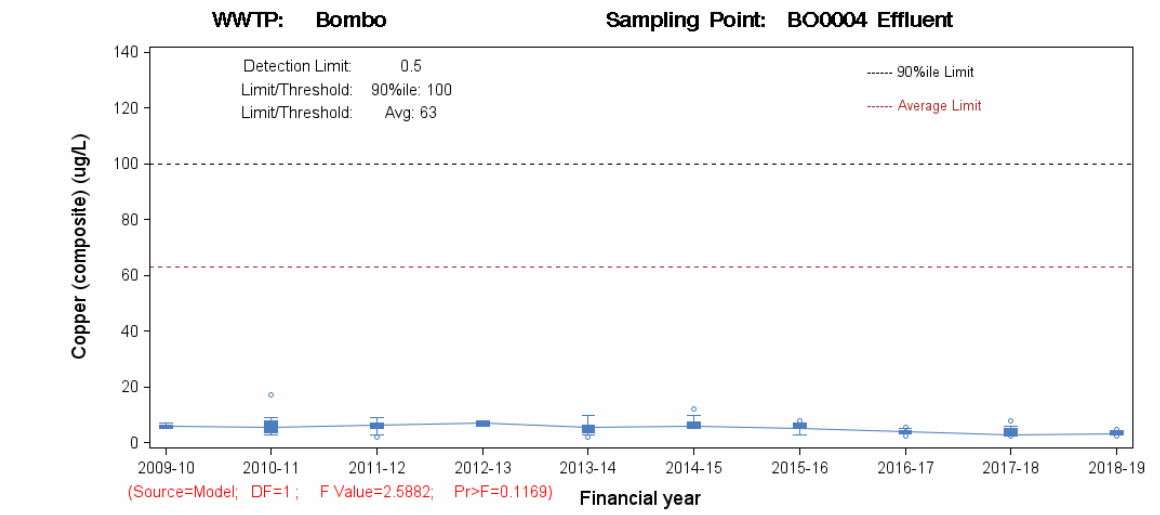

WWTP: Bombo
Sampling Point: BO0004 Effluent
Detection Limit: 2
Limit/Threshold: 50%ile: 20
Limit/Threshold: 90%ile: 40
----- 50%ile Limit
Total suspended solids (composite) (mg/L)
22
20
18
16
14
12
10
8
6
4
2
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.6712; Pr>F=0.0310)
Financial year

Discharge quality: Toxicity



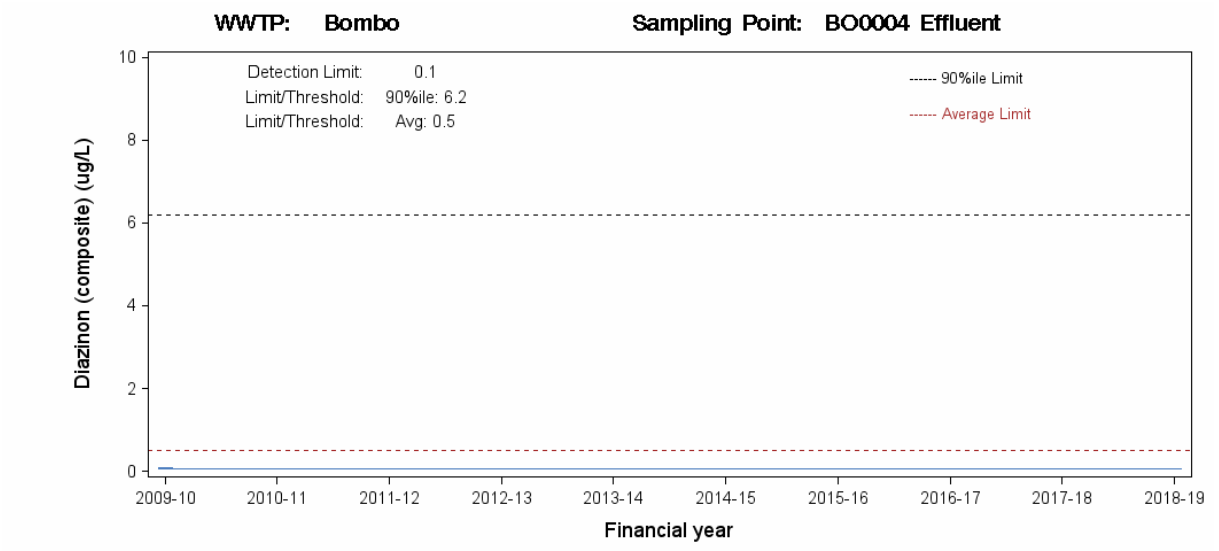
Discharge quality: Trace metals



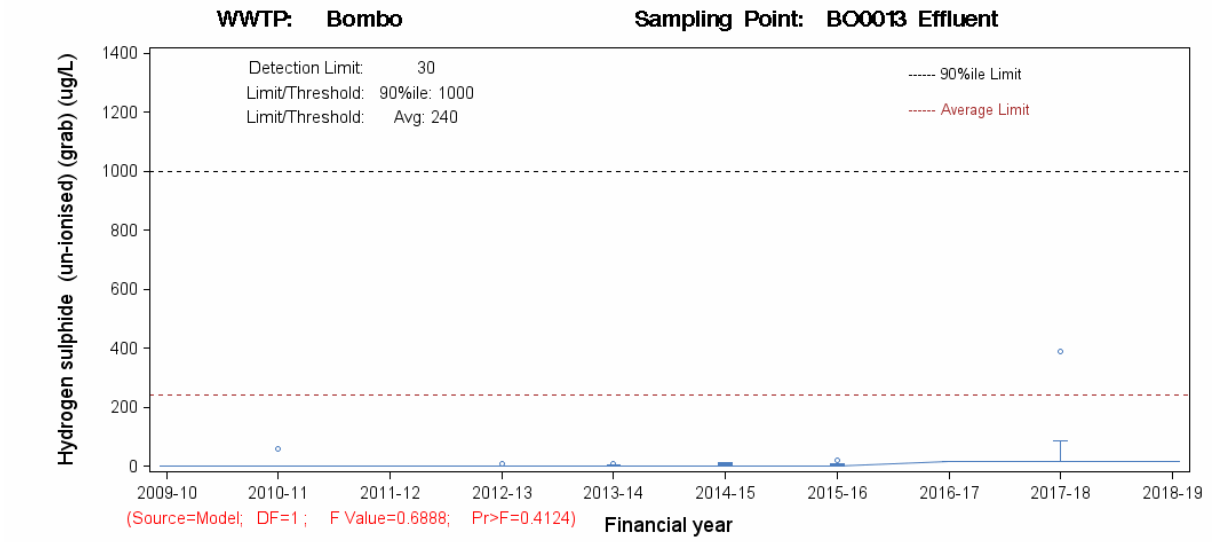


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

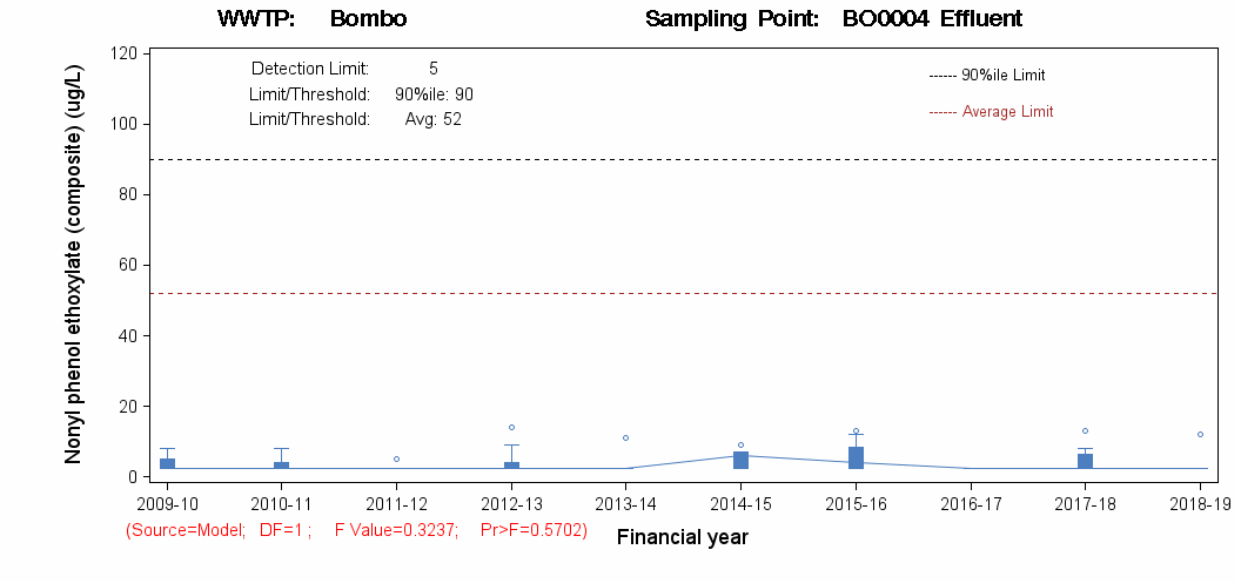
Discharge quality: Other chemicals and organics (including pesticides)



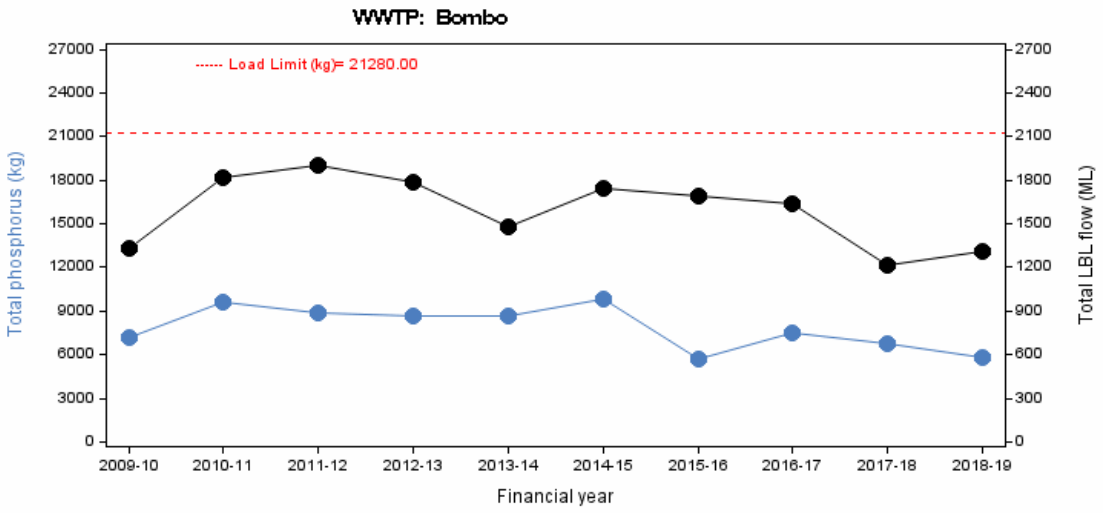
Note: Statistical test was not conducted because >90% of results were below the detection limit.

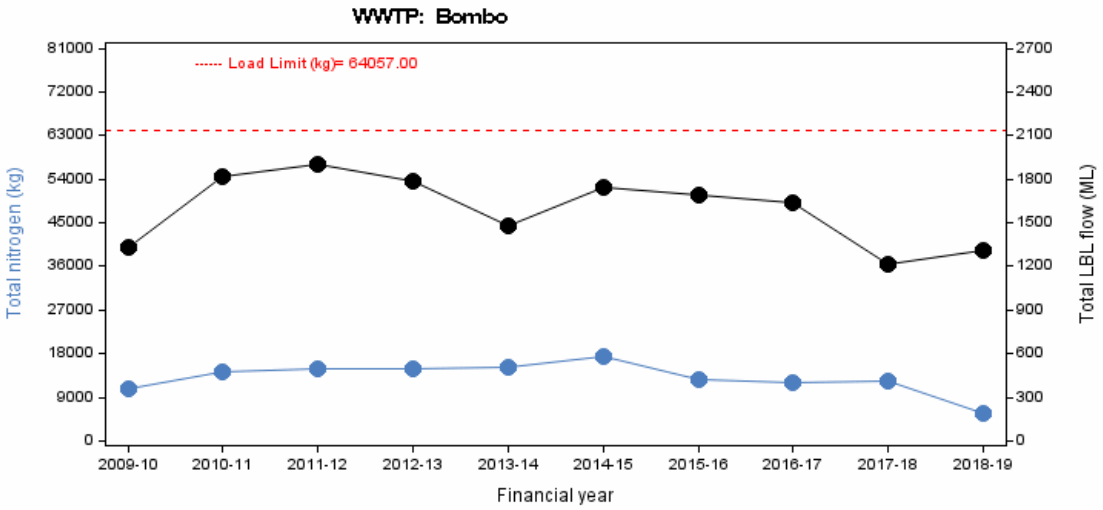


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

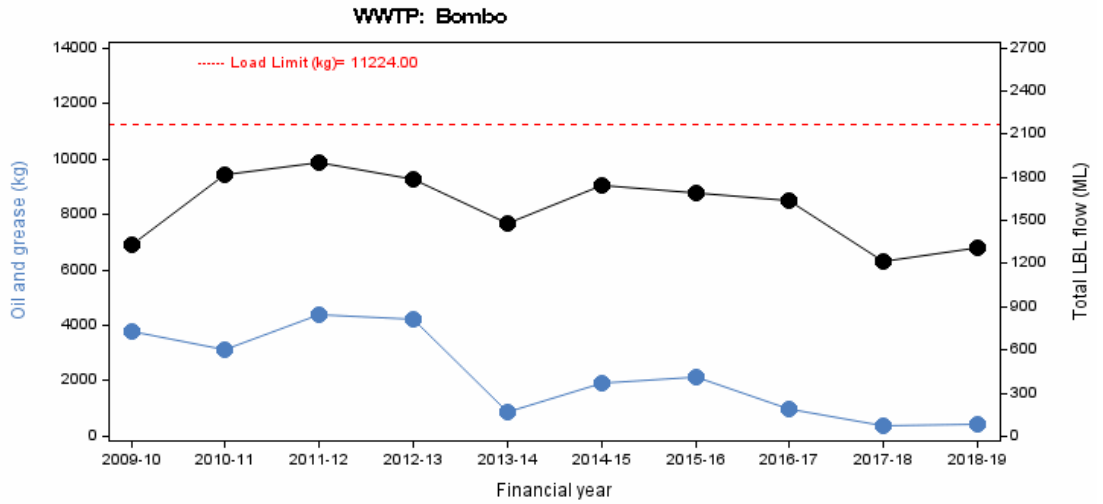


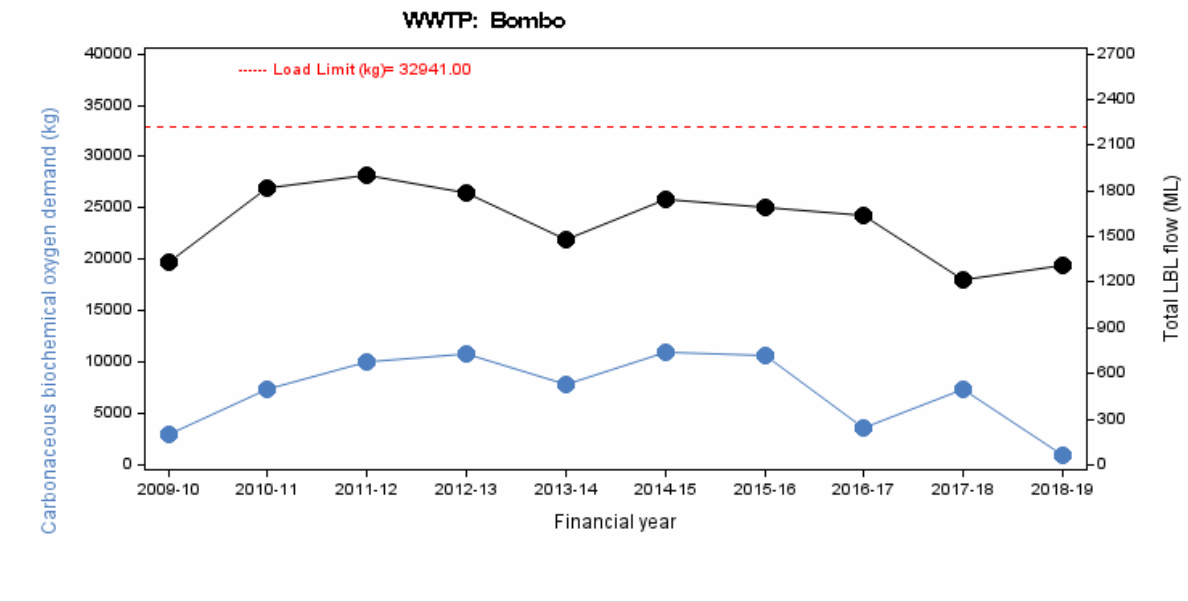
Discharge load: Nutrients

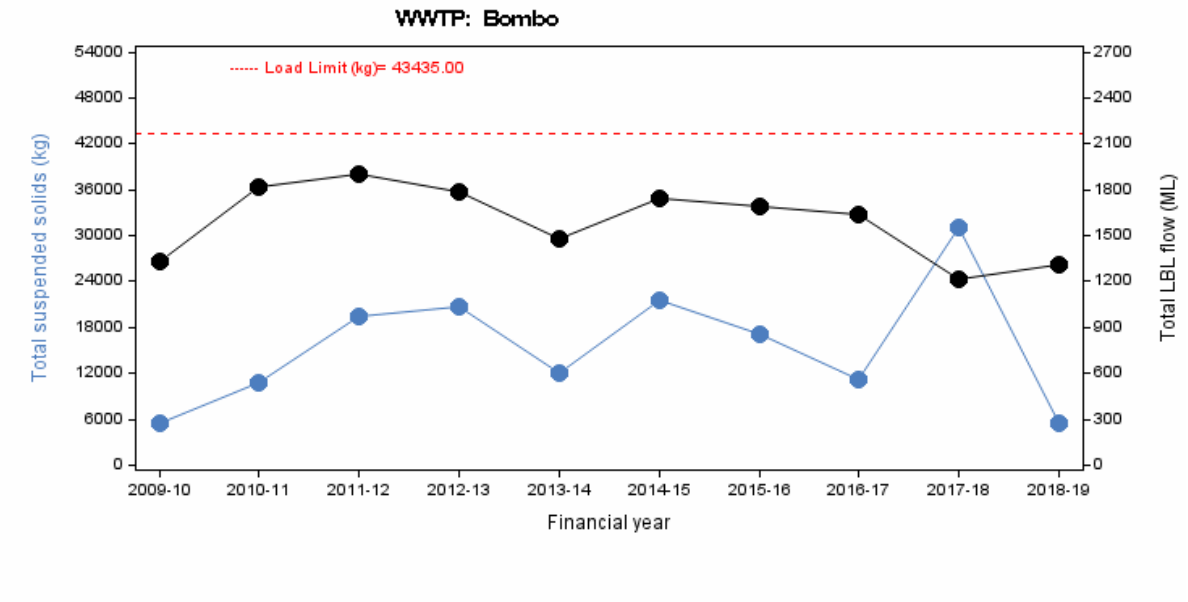




Discharge load: Major conventional analytes

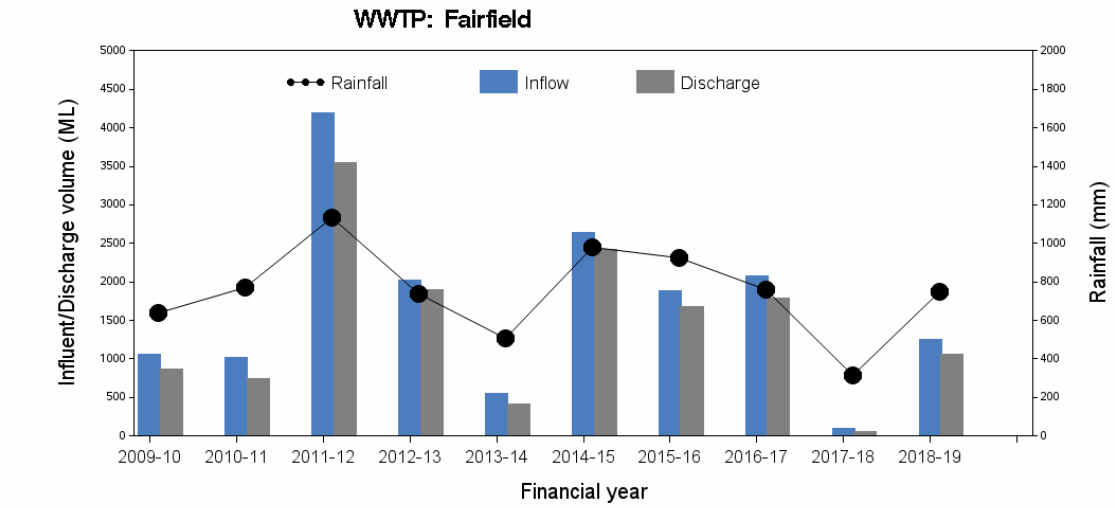



WWTP: Bombo
Load Limit (kg)= 32941.00
Carbonaceous biochemical oxygen demand (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

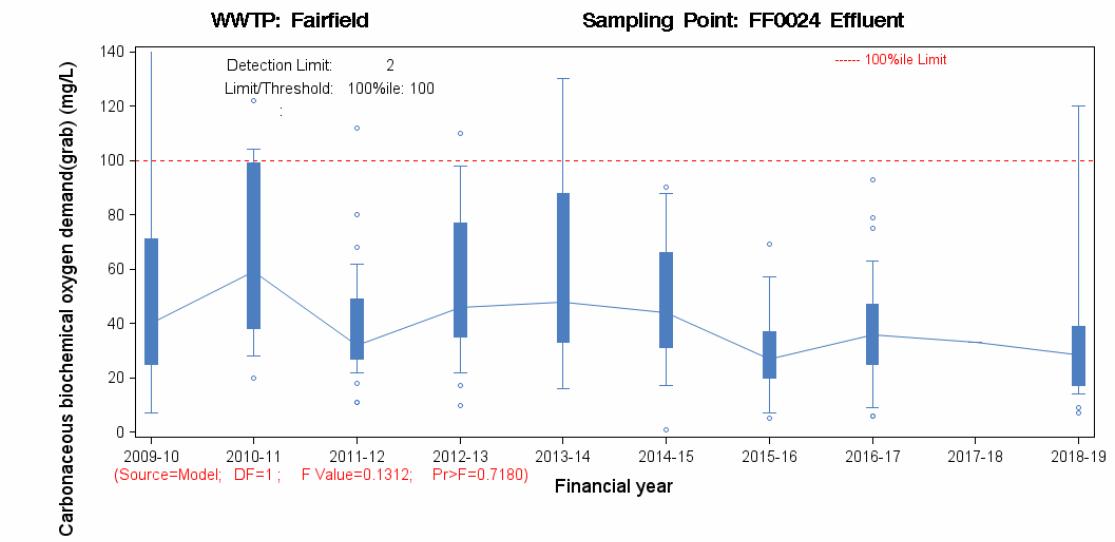

WWTP: Bombo
Load Limit (kg)= 43435.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

Malabar storm WWTPs (Fairfield, Glenfield and Liverpool)

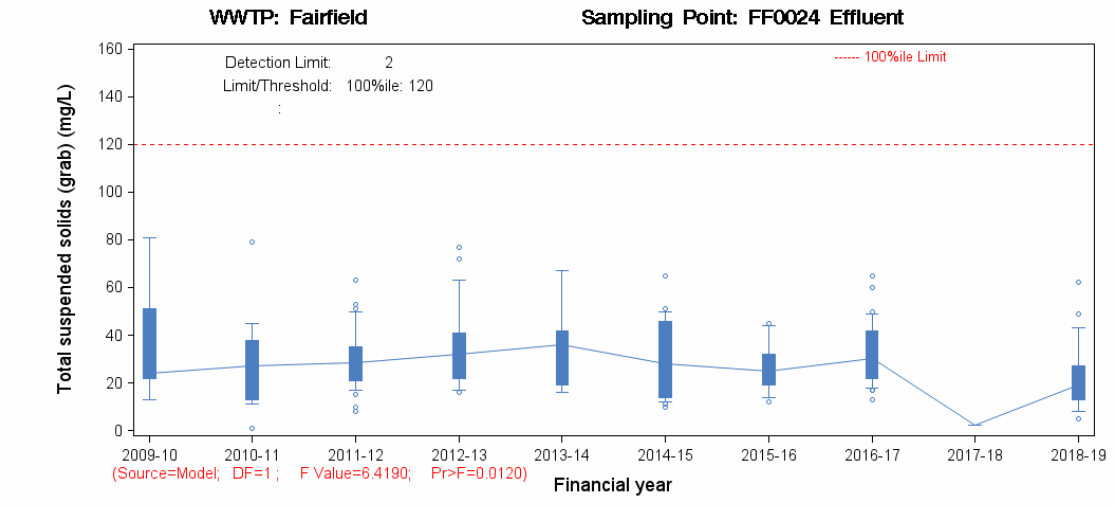
Discharge volume and rainfall (Fairfield)



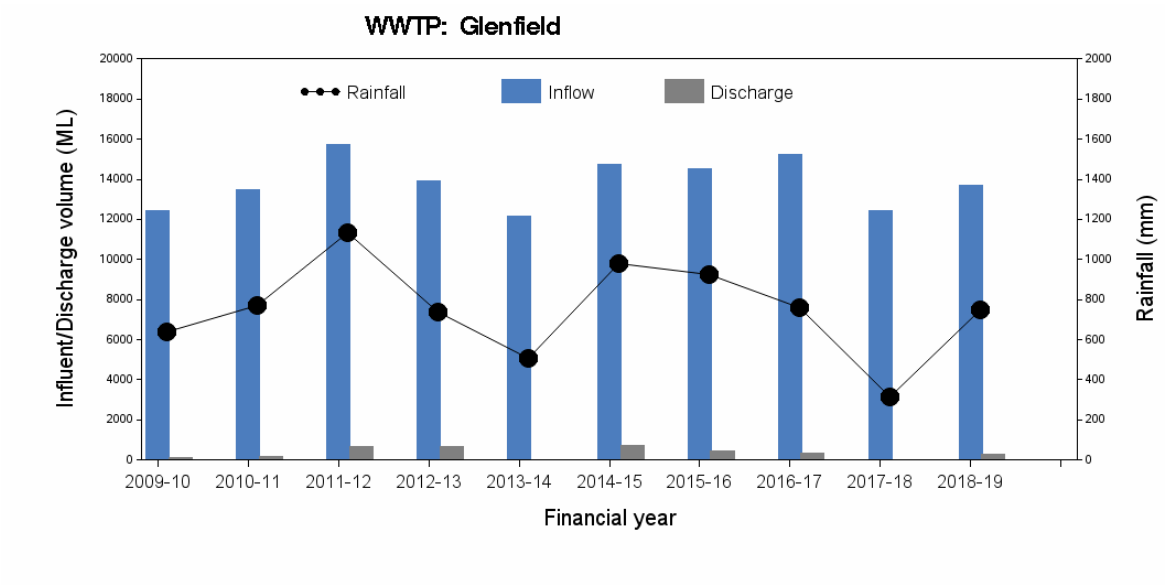
Discharge quality: Major conventional analytes (Fairfield)



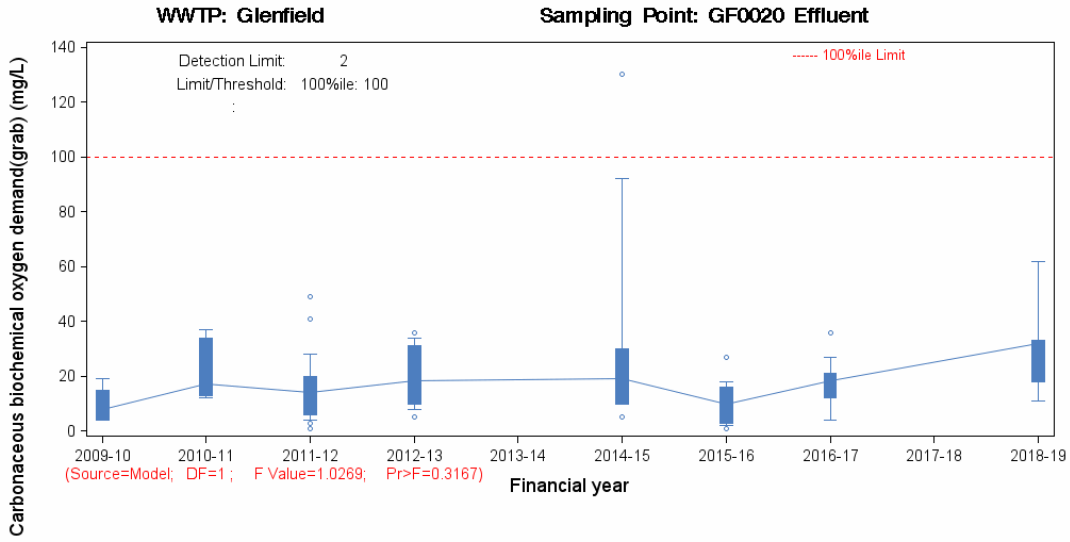
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



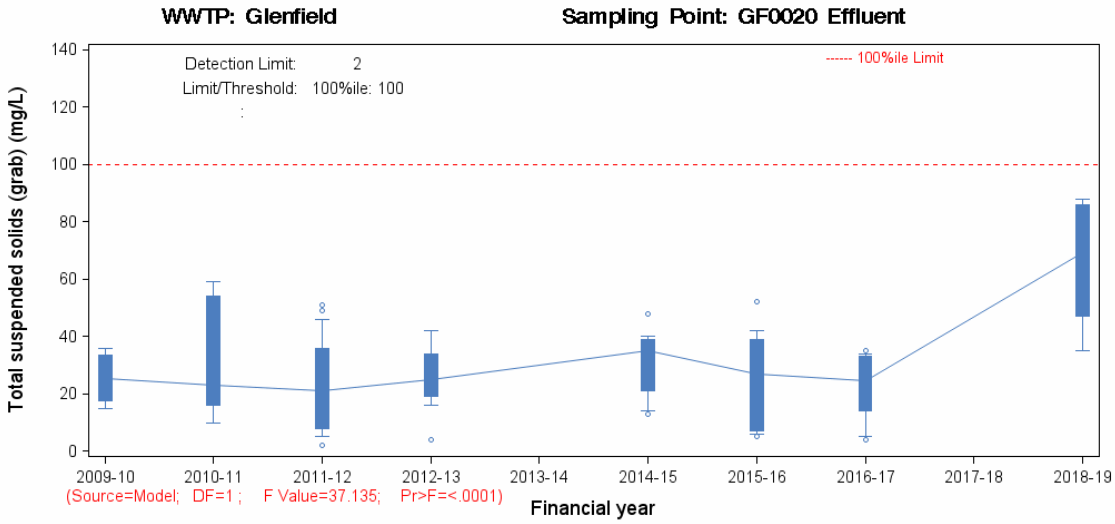
Discharge volume and rainfall (Glenfield)



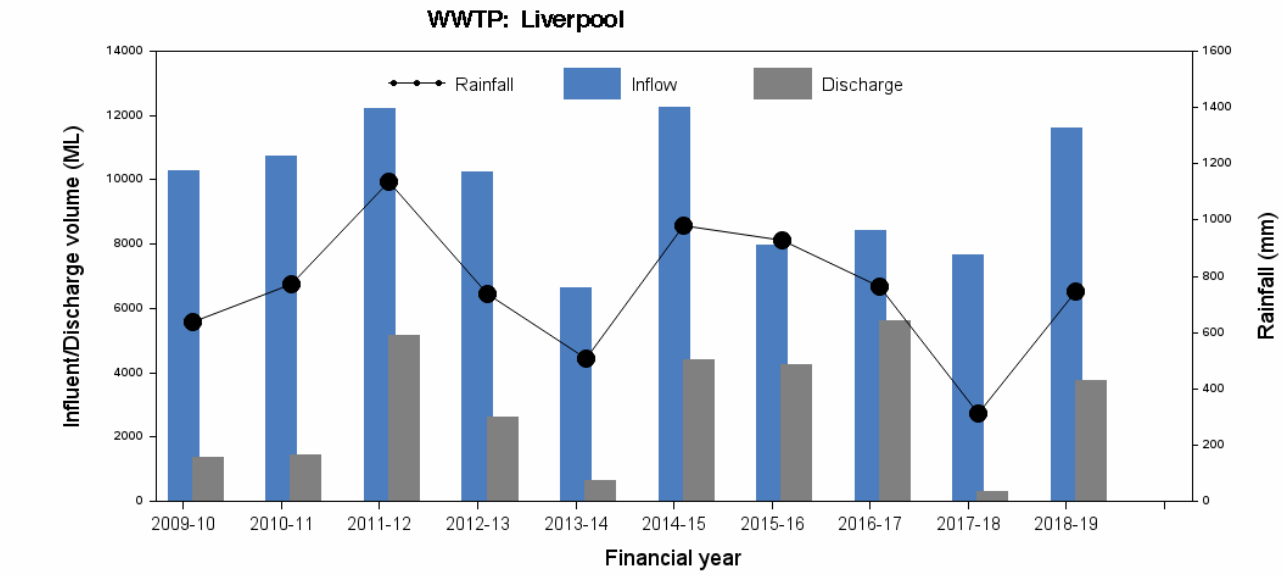
Discharge quality: Major conventional analytes (Glenfield)



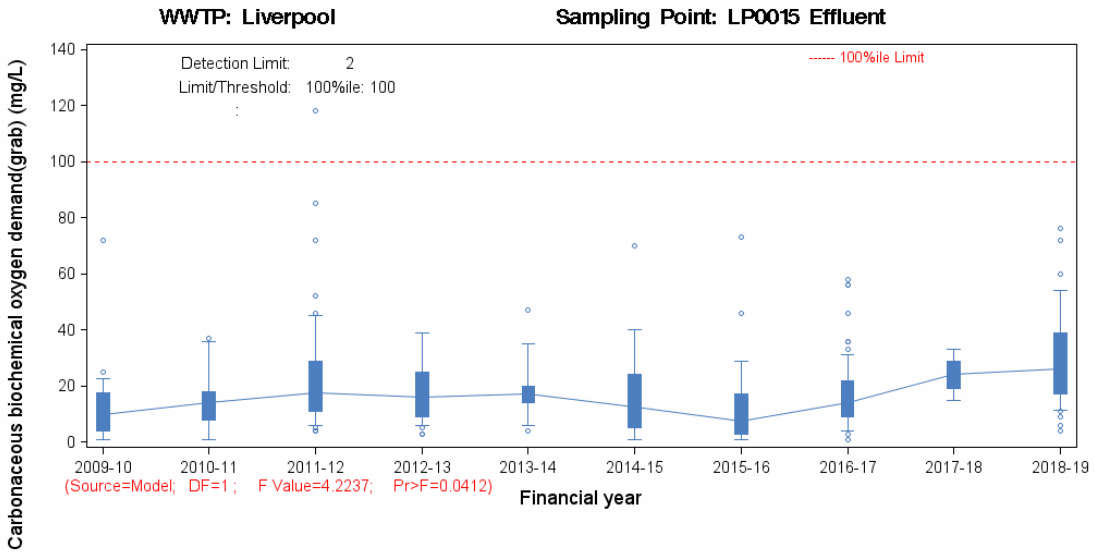
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



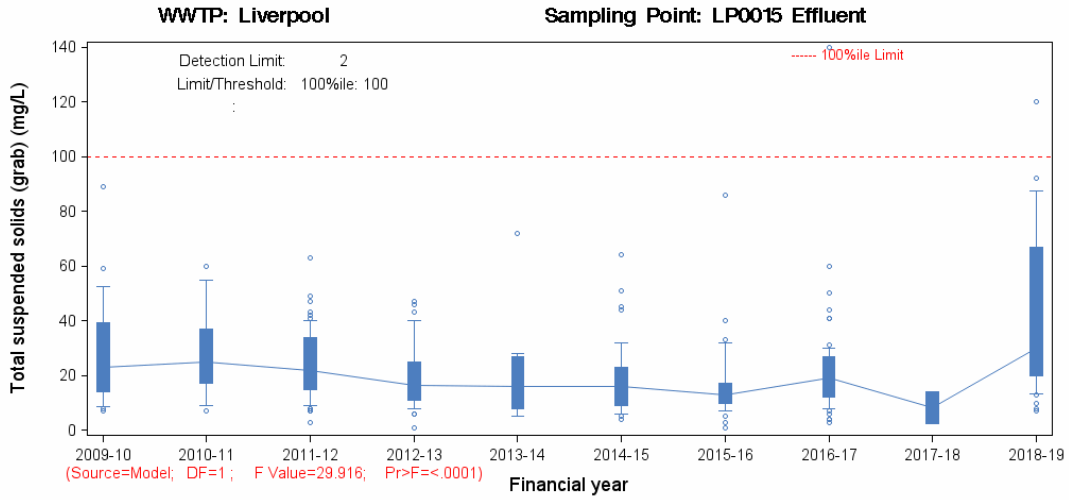
Discharge volume and rainfall (Liverpool)



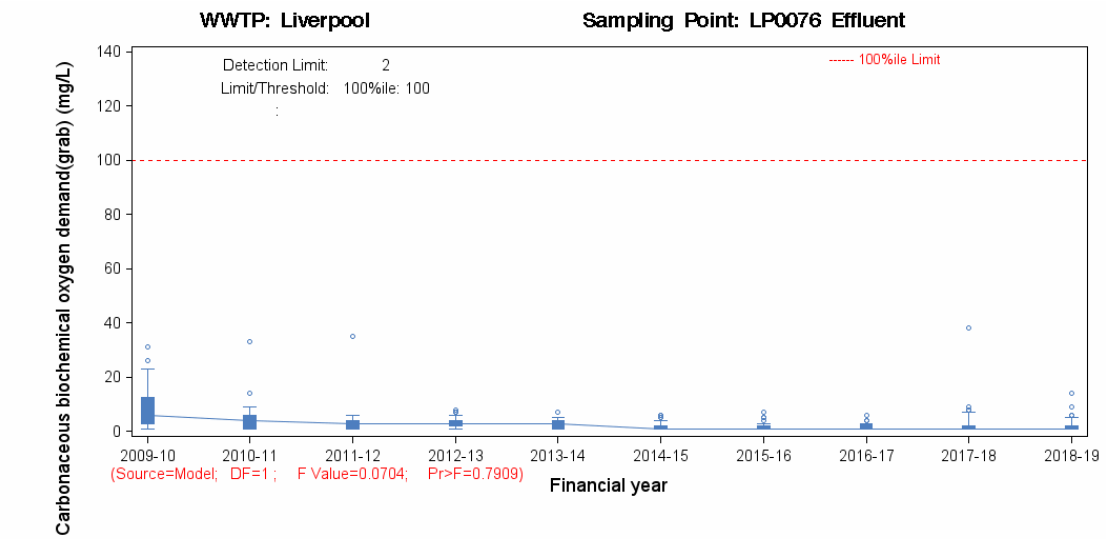
Discharge quality: Major conventional analytes (Liverpool: LP0015 – effluent diversion structure at Chipping Norton)



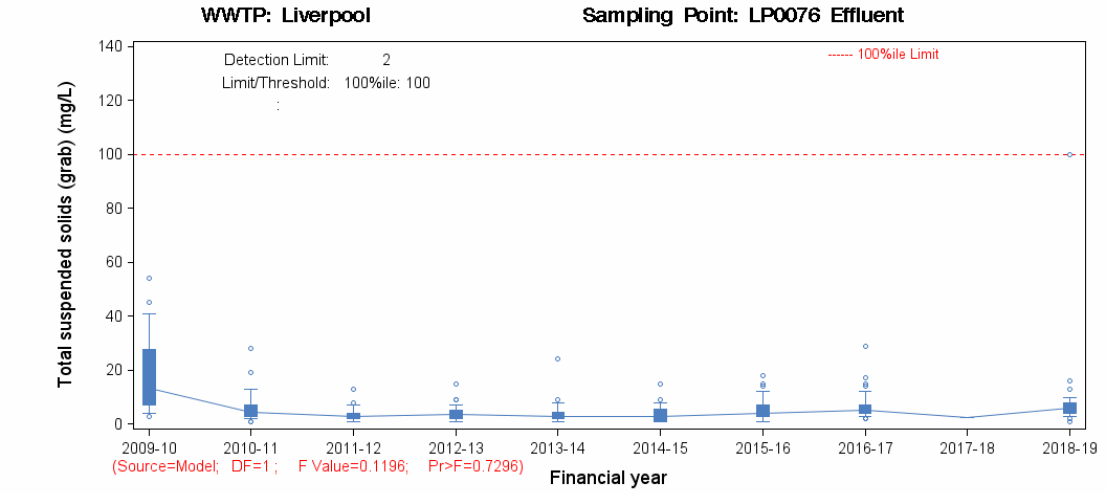
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



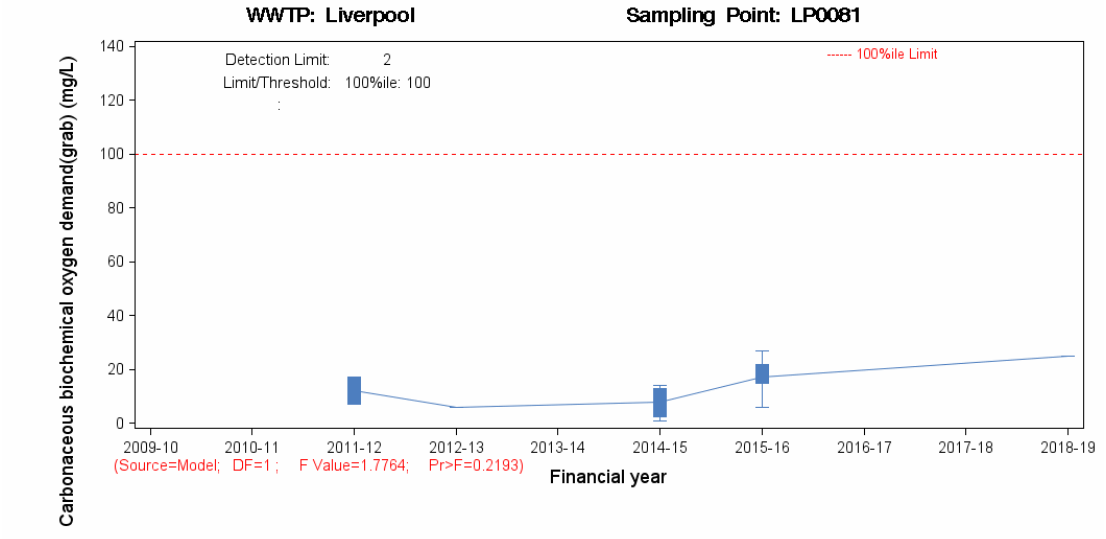
Discharge quality: Major conventional analytes (Liverpool: LP0076 – recycled water chlorine contact tank)



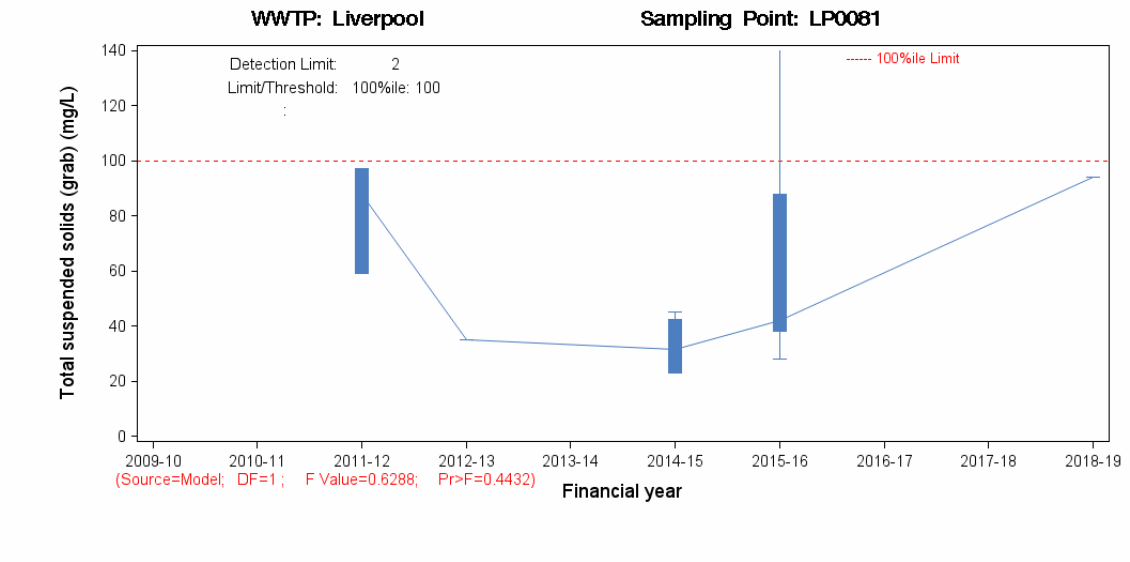
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



Discharge quality: Major conventional analytes (Liverpool: LP0081 – overflow chamber downstream of chlorine contact tank)



Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.


WWTP: Liverpool
Sampling Point: LP0081
Detection Limit: 2
Limit/Threshold: 100%ile: 100
100%ile Limit
Total suspended solids (grab) (mg/L)
140
120
100
80
60
40
20
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6288; Pr>F=0.4432)
Financial year

Appendix D Trends in discharge and reuse volumes, discharge quality and pollutant loads from inland WWTPs

The inland WWTPs are presented in upstream to downstream locations of the Hawkesbury-Nepean River:

- Picton WWTP
- West Camden WWTP
- Wallacia WWTP
- Penrith WWTP
- Winmalee WWTP
- North Richmond WWTP
- Richmond WWTP
- St Marys WWTP
- Quakers Hill WWTP
- Riverstone WWTP
- Castle Hill WWTP
- Rouse Hill WWTP
- Hornsby Heights WWTP
- West Hornsby WWTP
- Brooklyn WWTP

Tests conducted on wastewater are specified in the Environment Protection Licences (EPL) issued by the NSW EPA for each WWTP. All measured analytes that have EPL concentration and load limits are presented on the following pages.

Under each WWTP, trend plots are presented on:

- Discharge and reuse volume
- Discharge quality
- Discharge loads

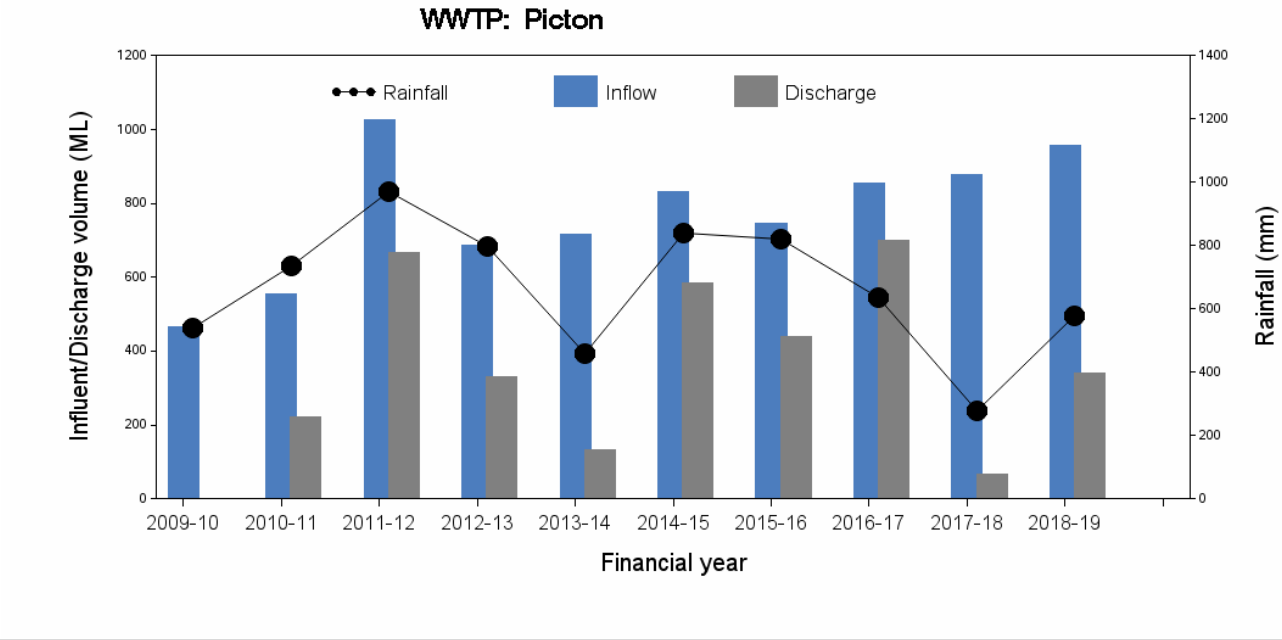
Discharge quality and load plots are included in following sub-groups and then analytes presented in alphabetical order:

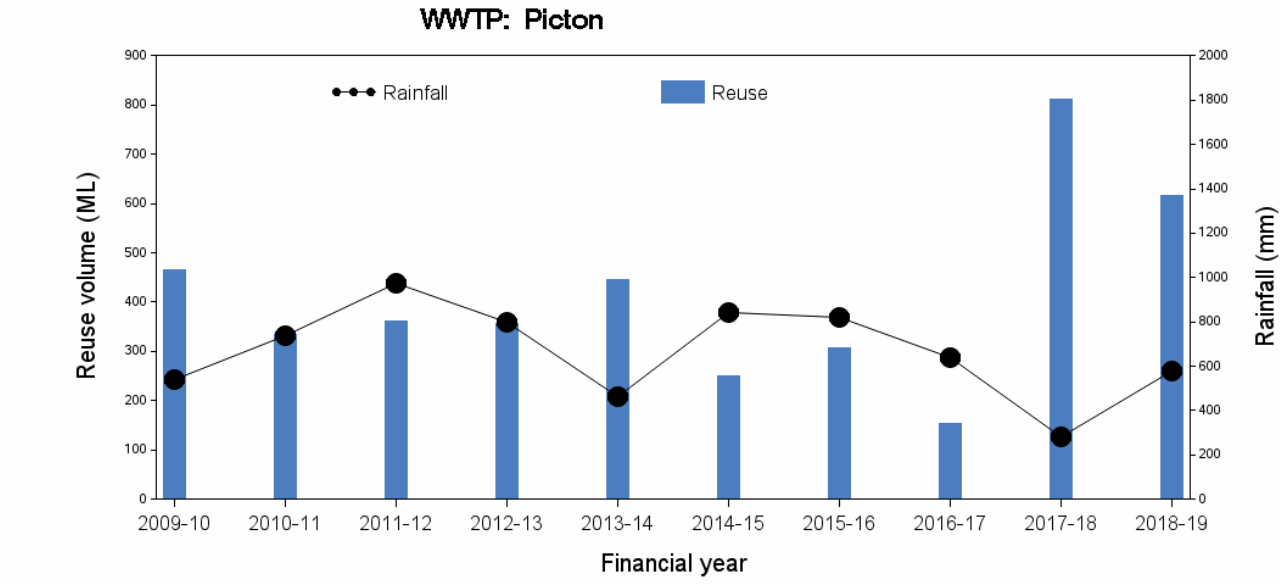
- Nutrients
- Major conventional analytes
- Toxicity
- Trace metals
- Other chemicals and organics (including pesticides)

Where an analyte shows a trend (positive or negative) two plots are presented (where required) - one with the licence limits and one zoomed in to provide a clearer view of the trend.

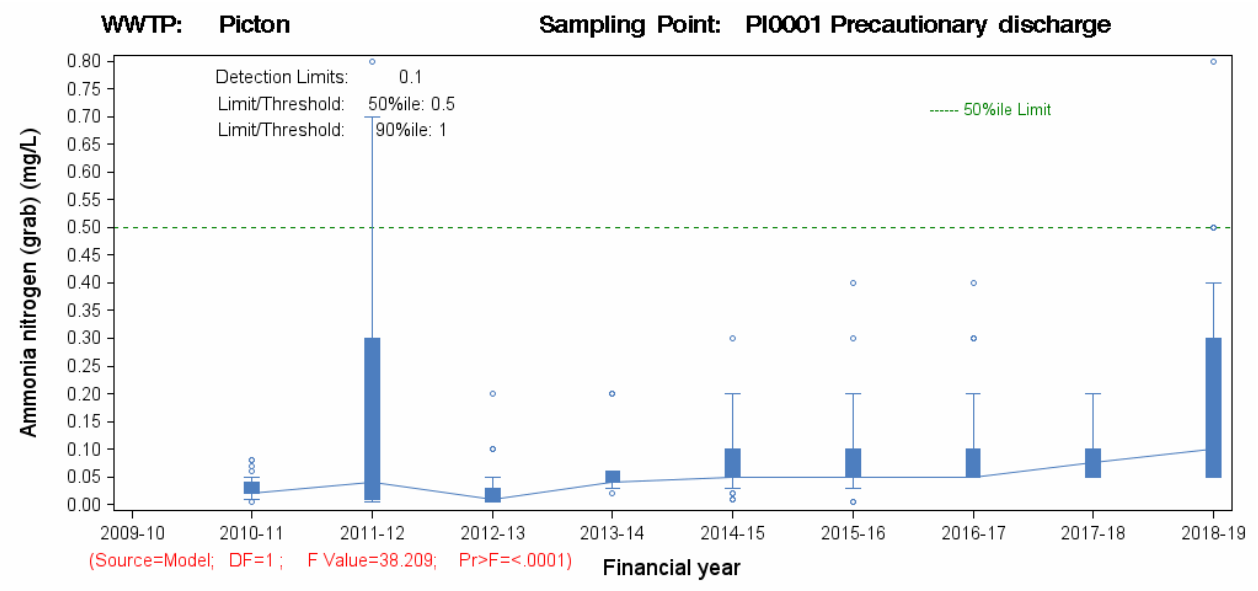
Picton WWTP

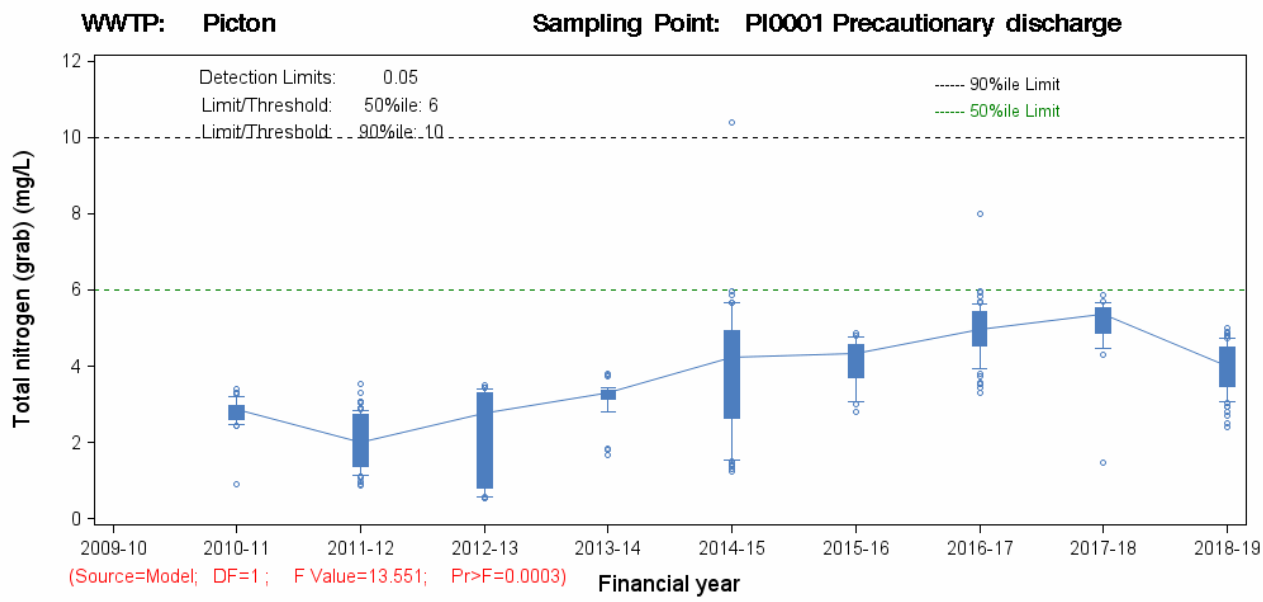
Discharge volume and rainfall

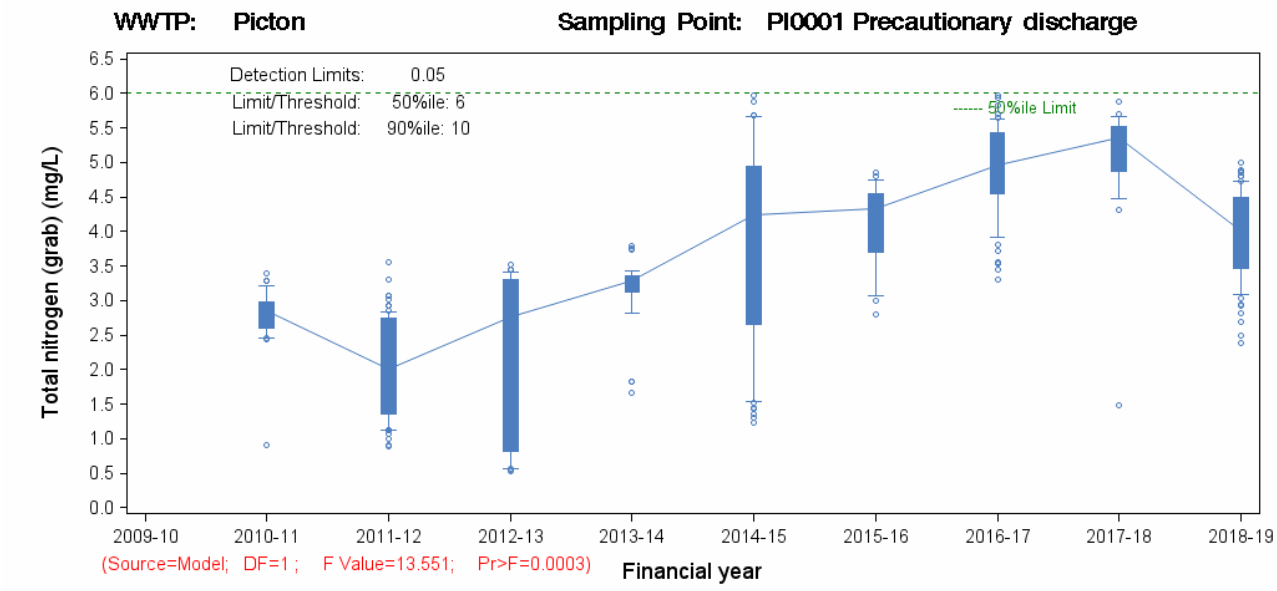


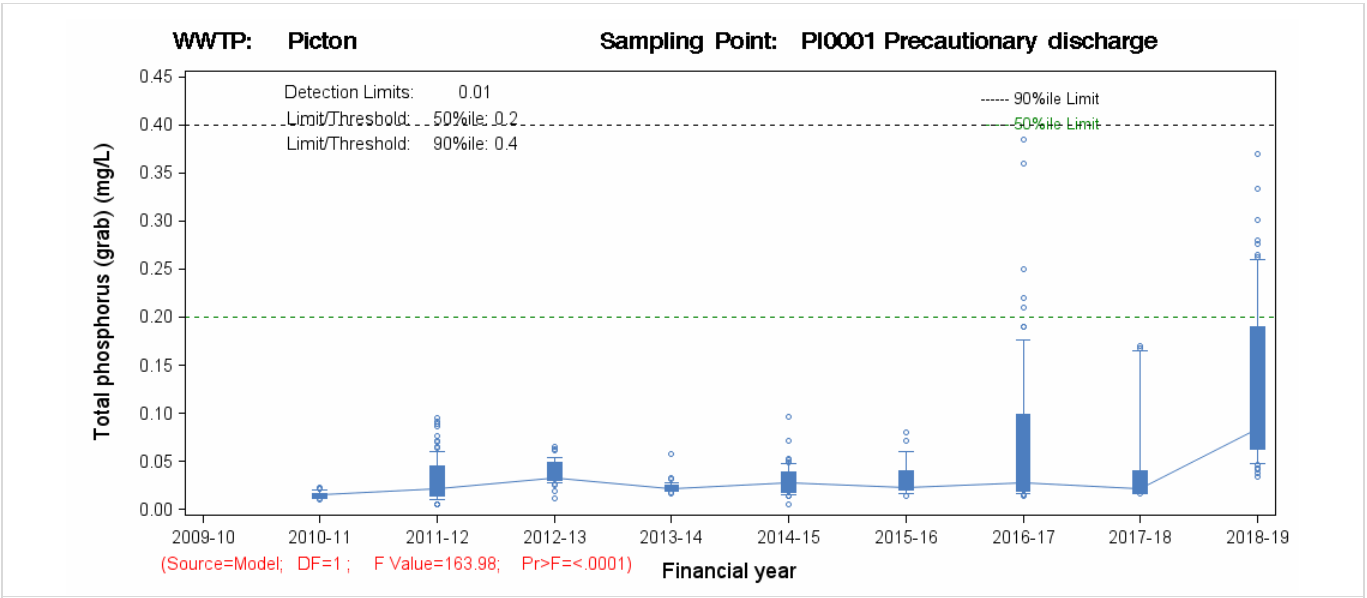


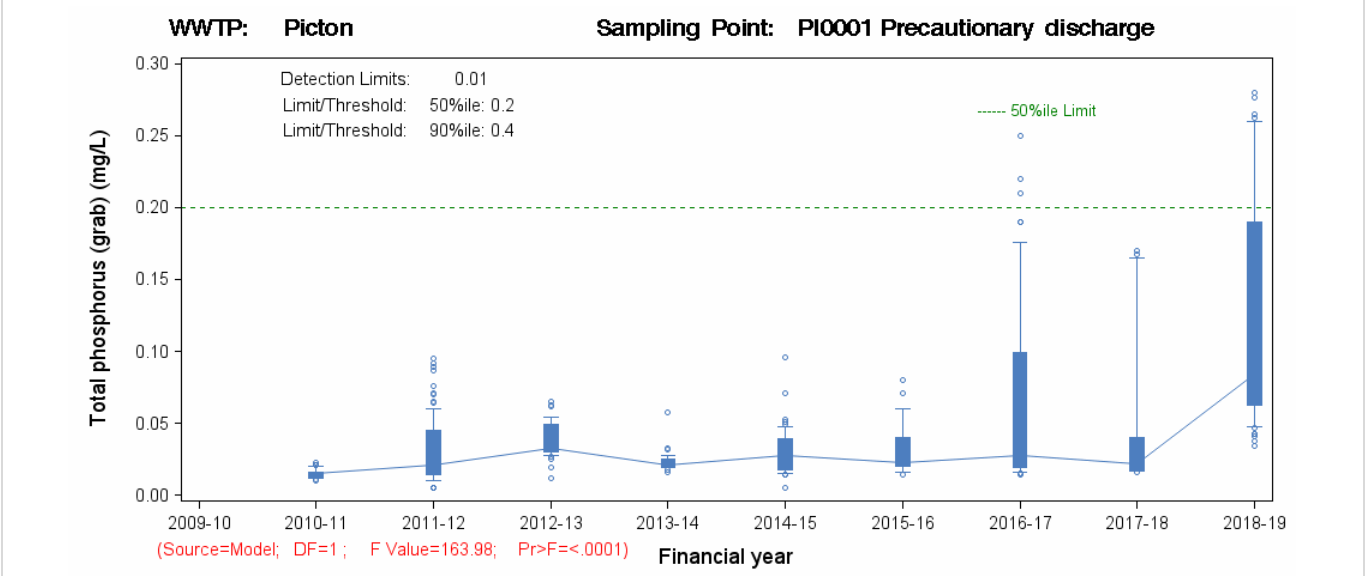
Discharge quality: Nutrients (PI0001 Precautionary discharge)



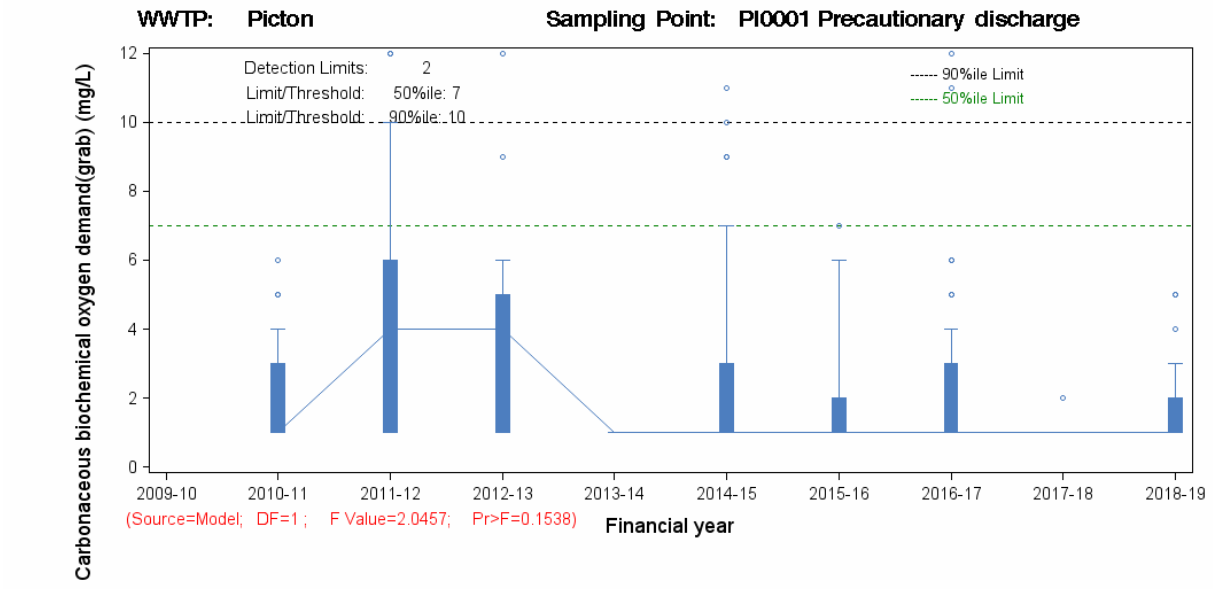




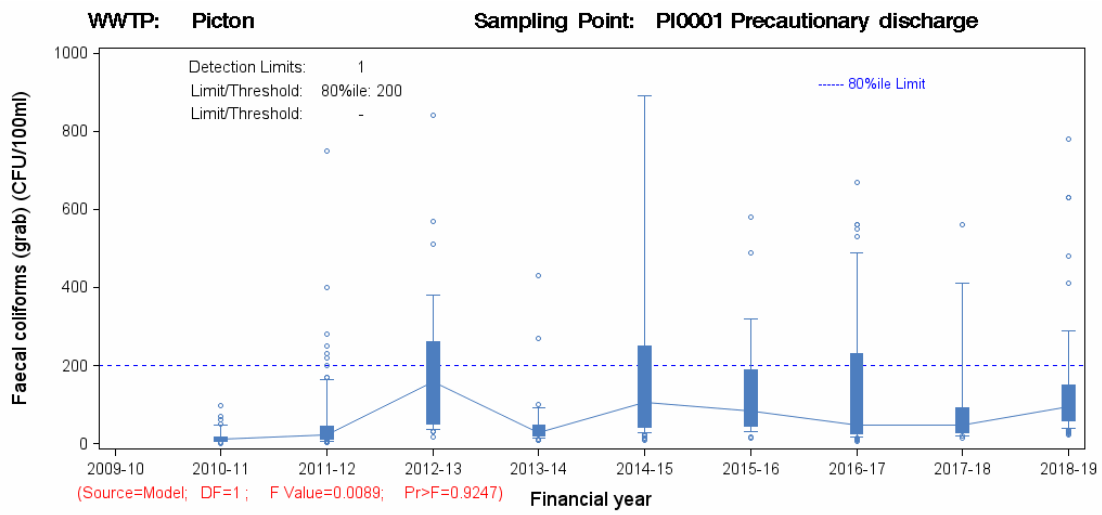


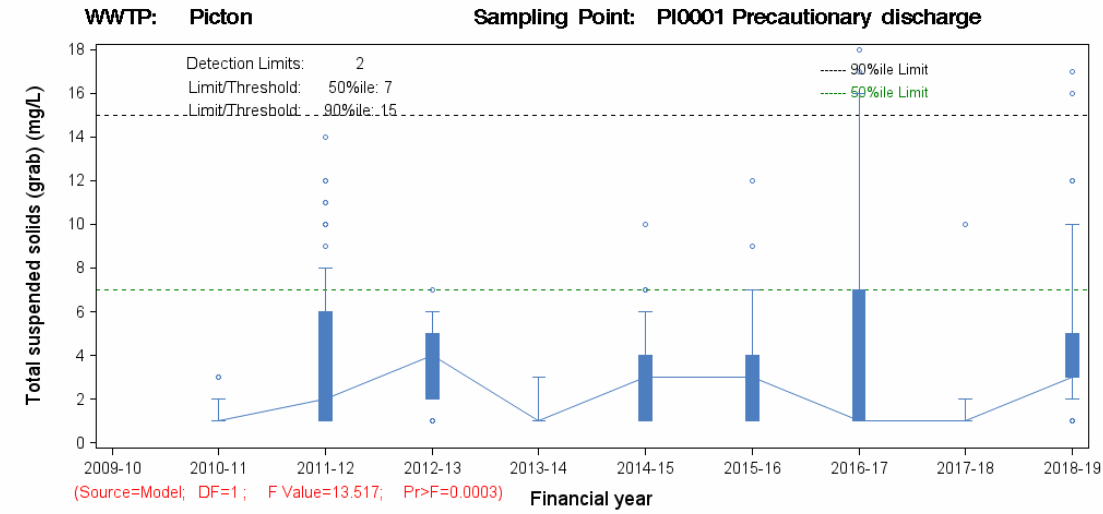


Discharge quality: Major conventional analytes (PI0001 Precautionary discharge)

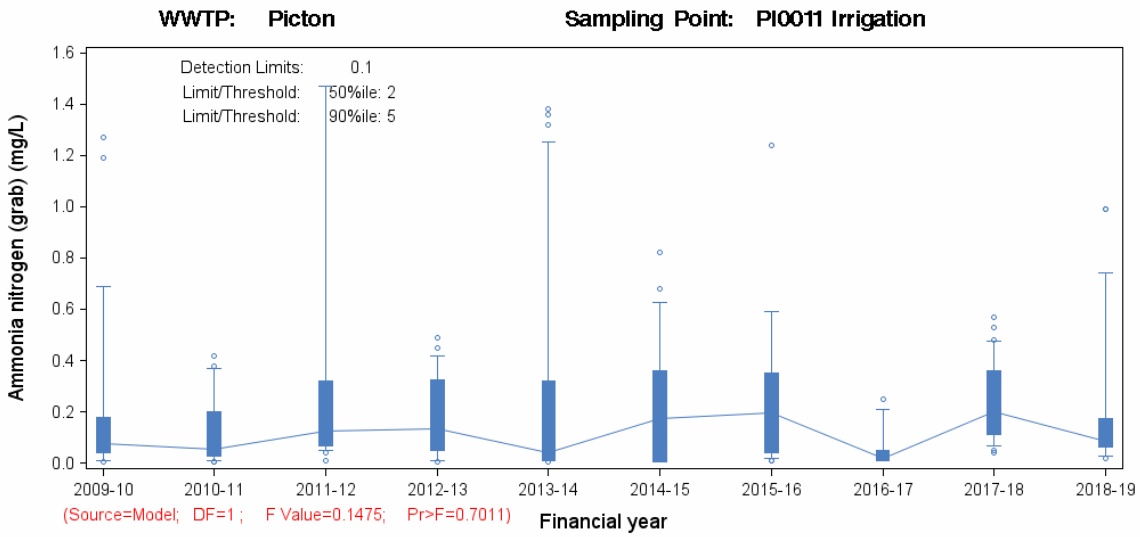


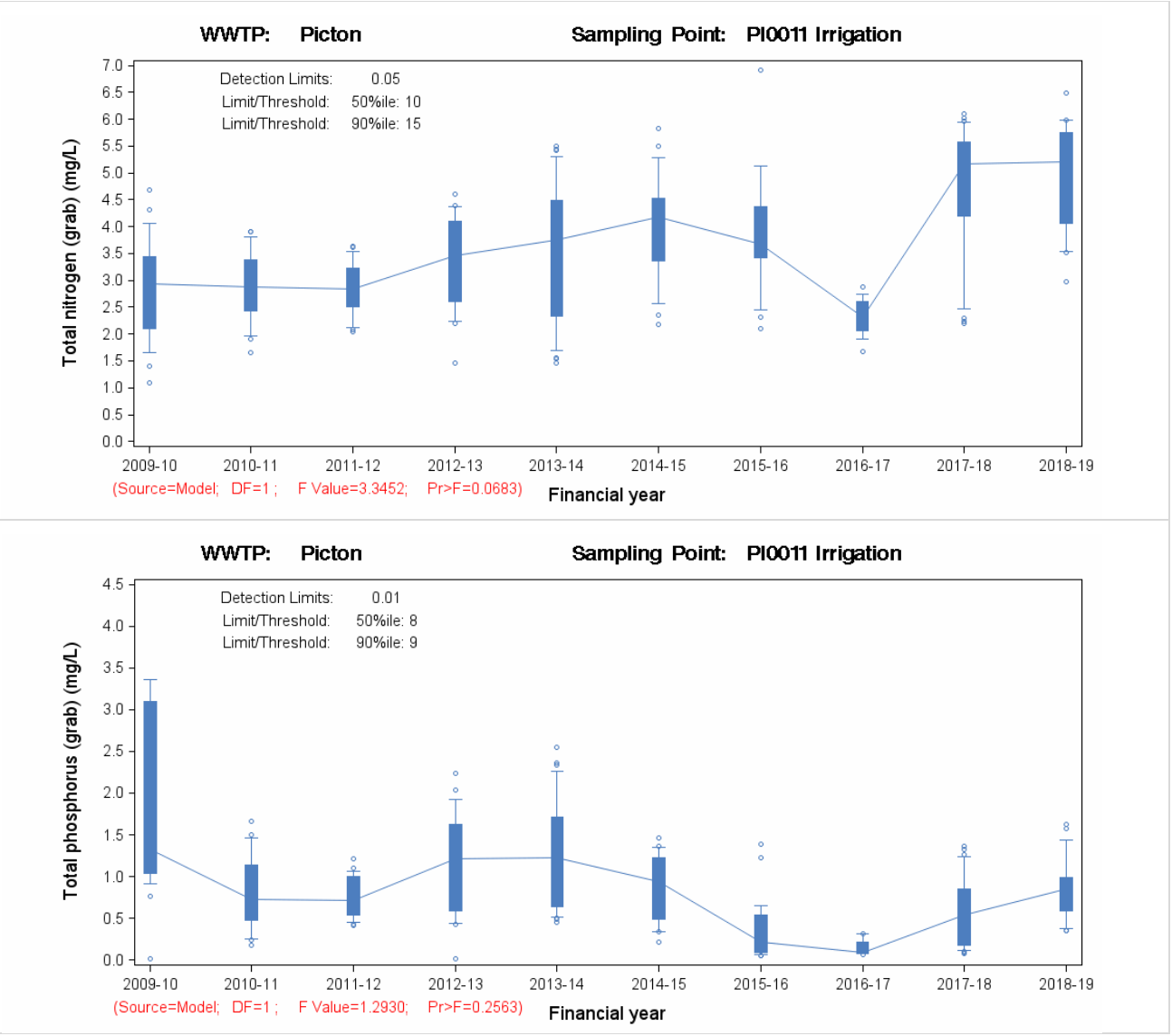
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



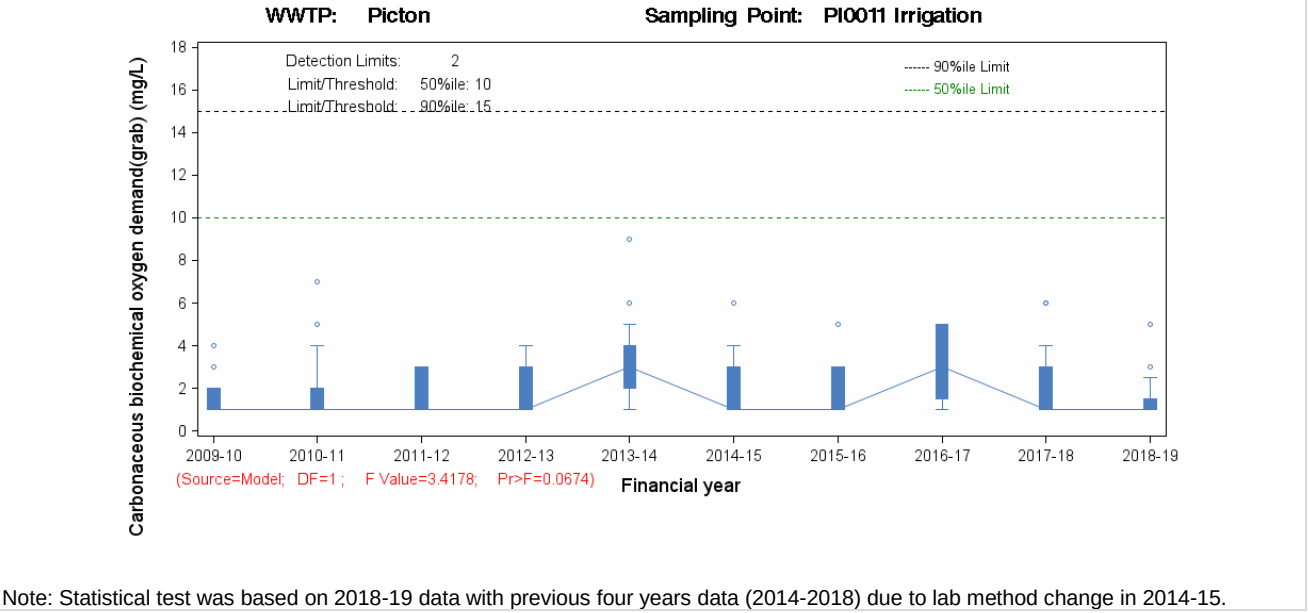


Discharge quality: Nutrients (PI0011 Irrigation)

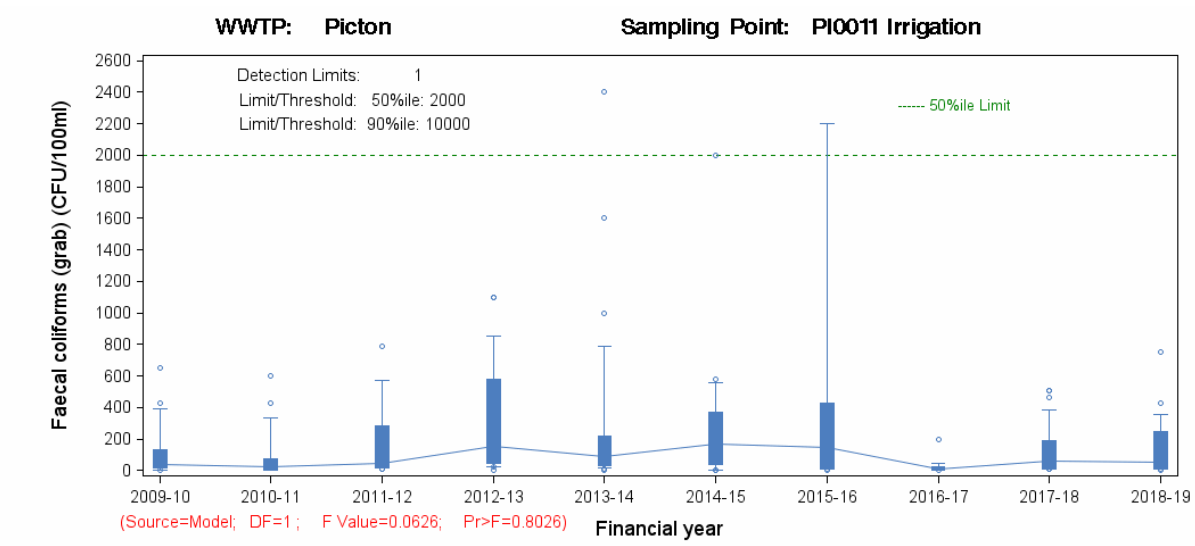


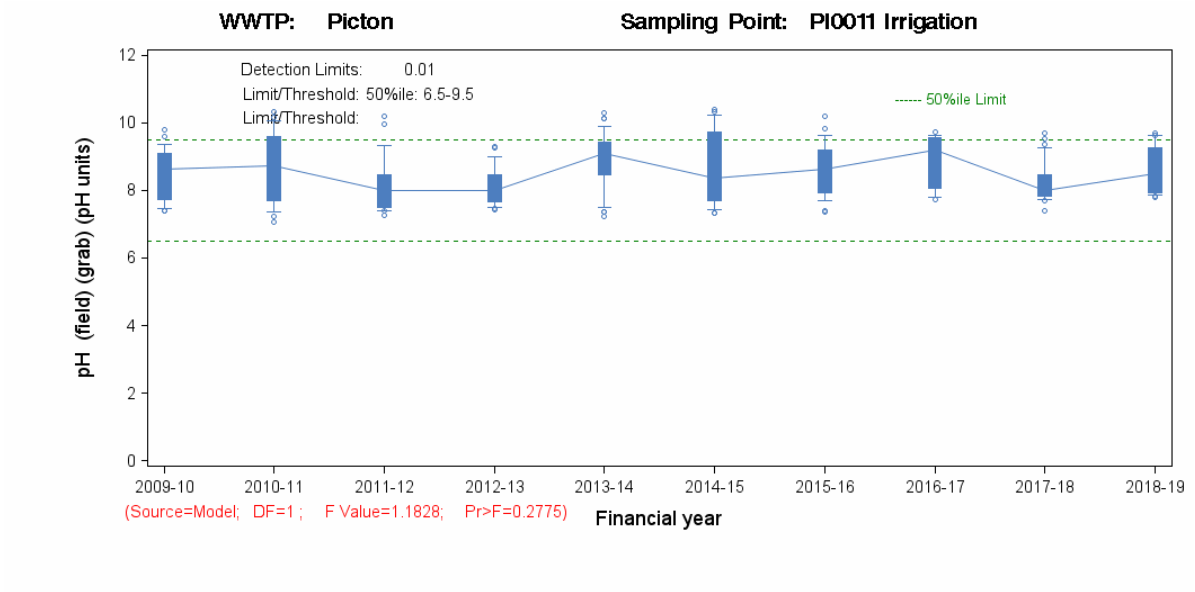


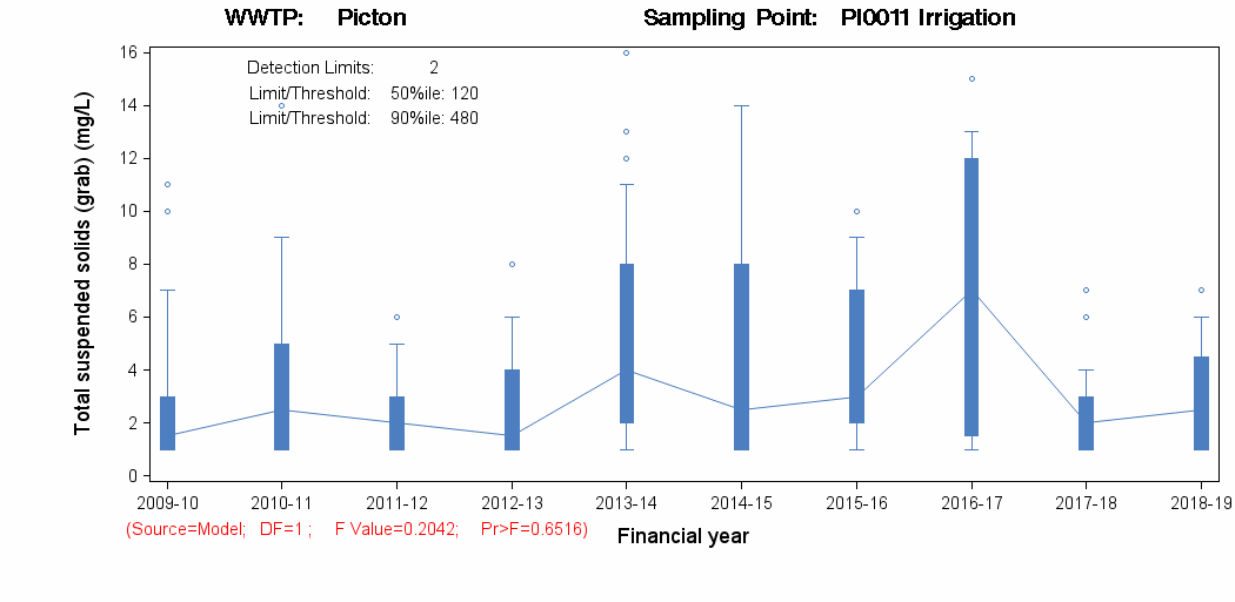
Discharge quality: Major conventional analytes (PI0011 Irrigation)



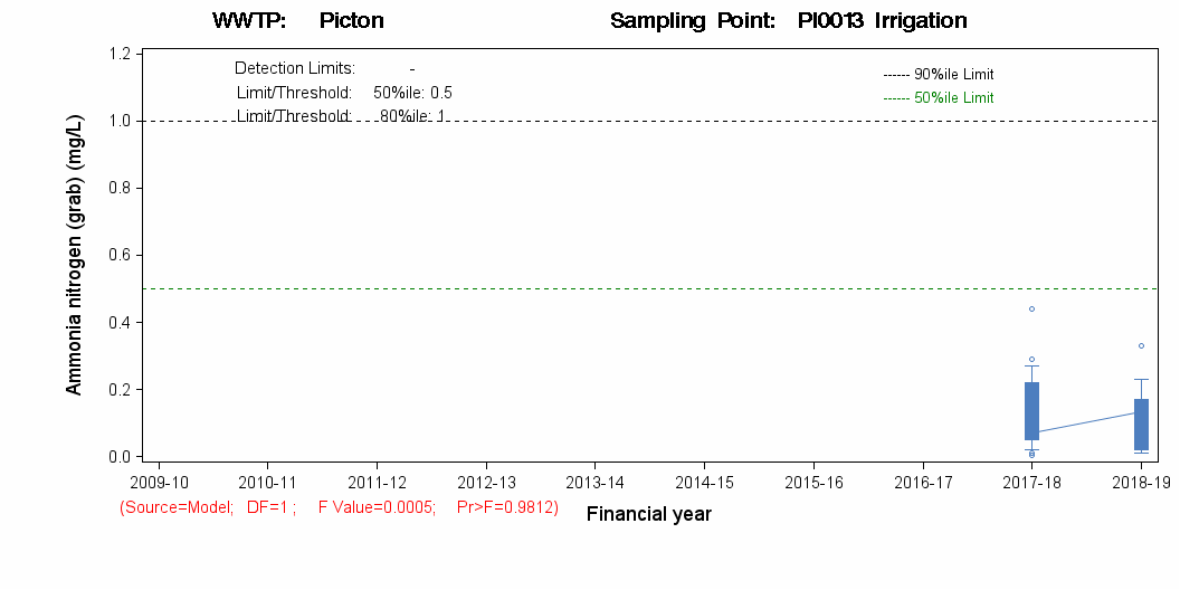
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

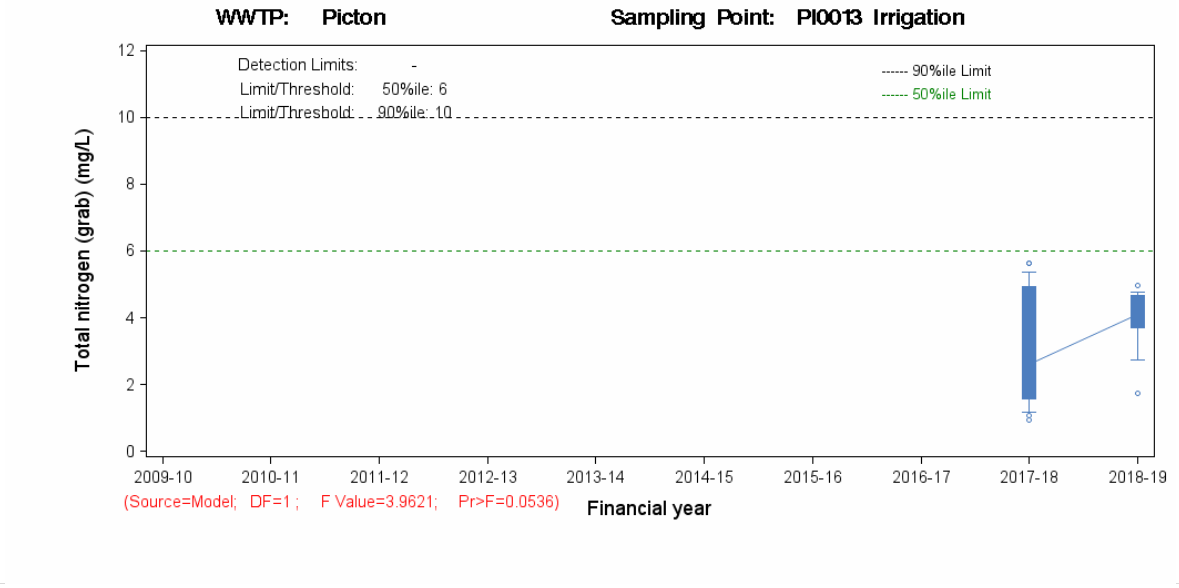

WWTP: Picton
Sampling Point: PI0011 Irrigation
Detection Limits: 1
Limit/Threshold: 50%ile: 2000
Limit/Threshold: 90%ile: 10000
----- 50%ile Limit
Faecal coliforms (grab) (CFU/100ml)
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0626; Pr>F=0.8026)
Financial year

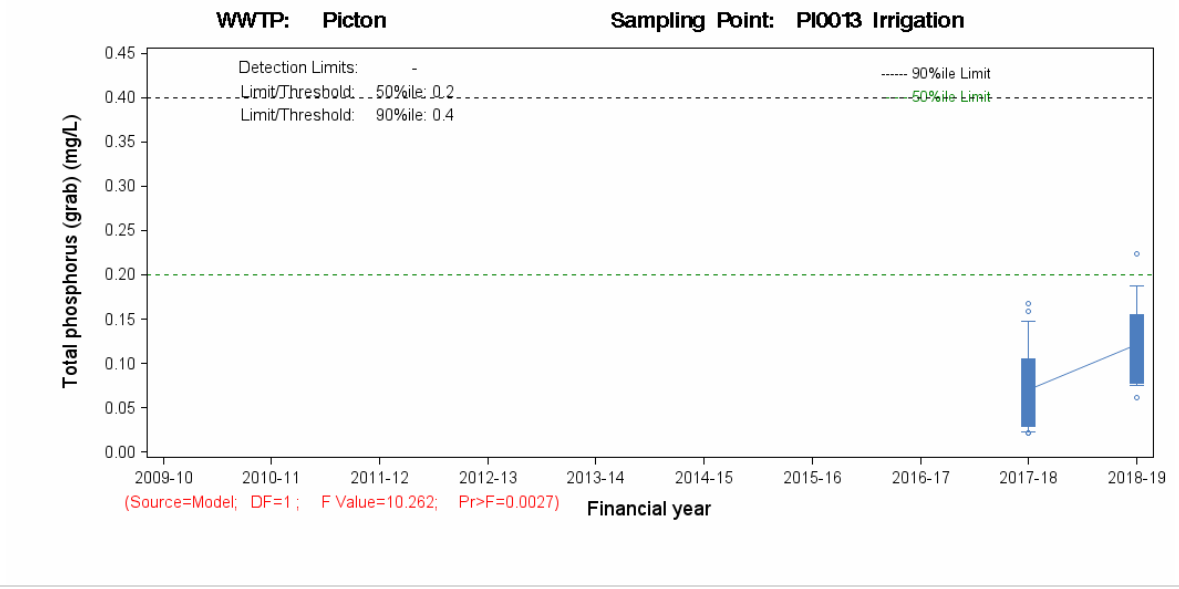

WWTP: Picton
Sampling Point: PI0011 Irrigation
Detection Limits: 0.01
Limit/Threshold: 50%ile: 6.5-9.5
Limit/Threshold:
----- 50%ile Limit
pH (field) (grab) (pH units)
12
10
8
6
4
2
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.1828; Pr>F=0.2775)
Financial year


WWTP: Picton
Sampling Point: PI0011 Irrigation
Detection Limits: 2
Limit/Threshold: 50%ile: 120
Limit/Threshold: 90%ile: 480
Total suspended solids (grab) (mg/L)
16
14
12
10
8
6
4
2
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2042; Pr>F=0.6516)
Financial year

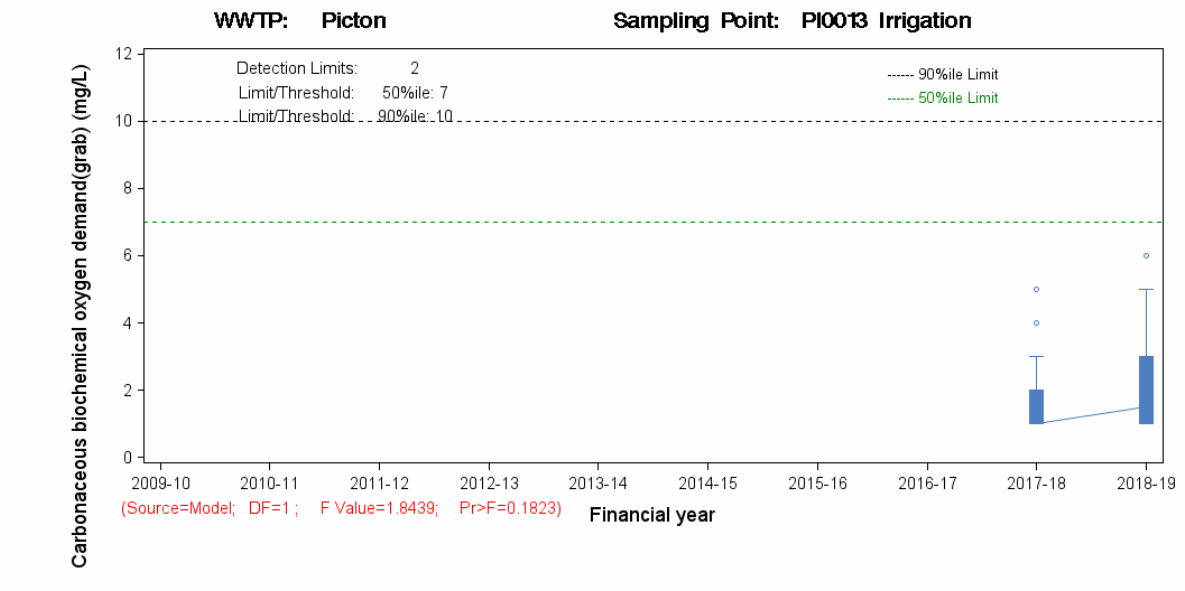
Discharge quality: Nutrients (PI0013 Irrigation)

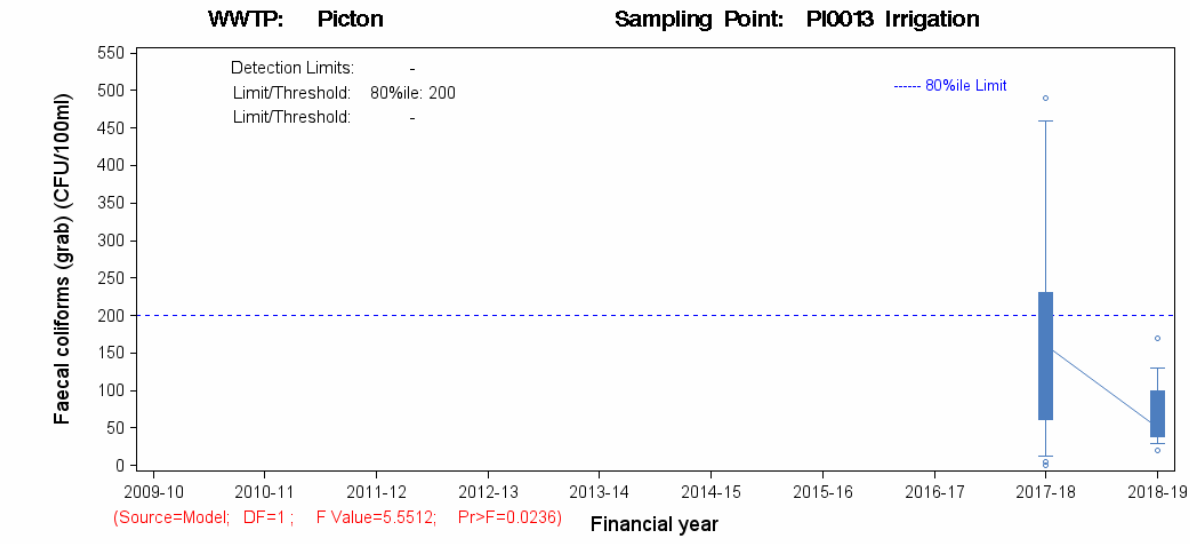


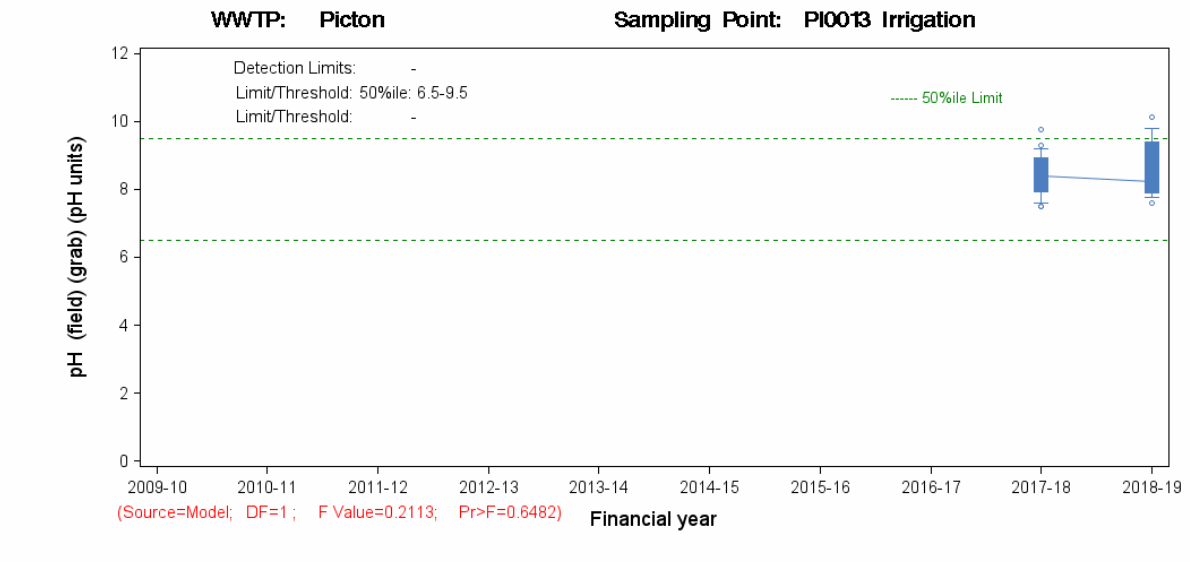


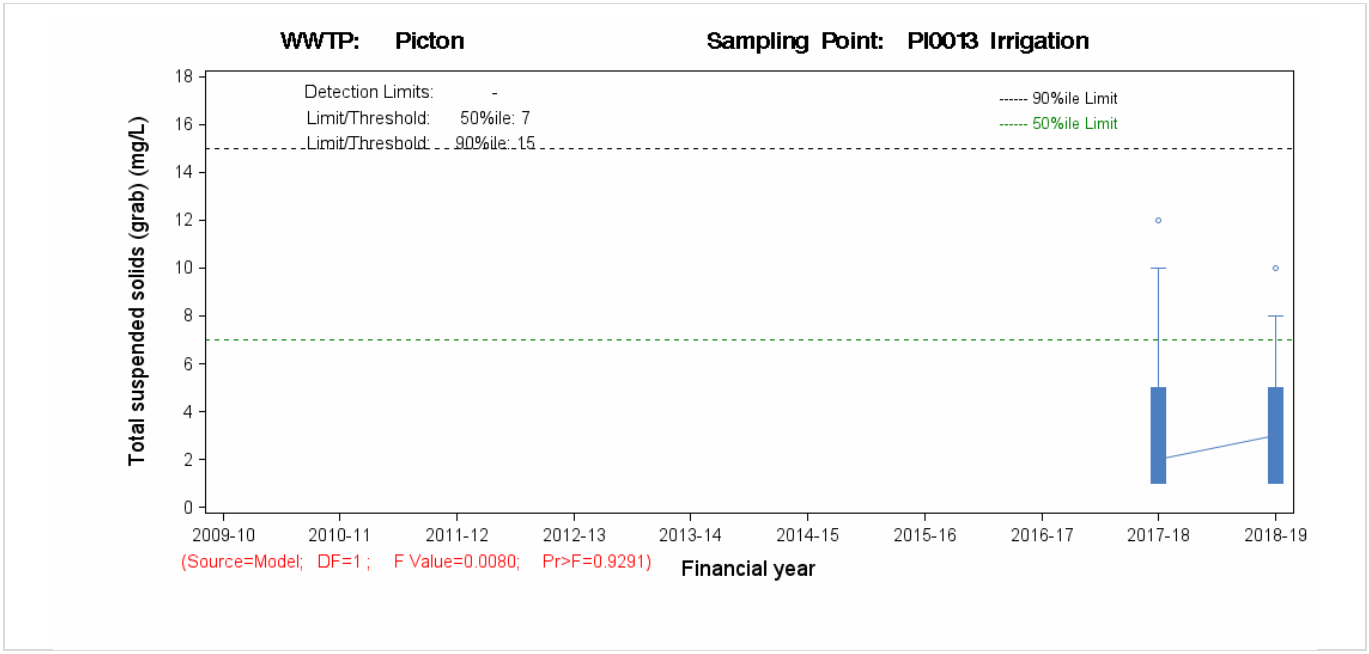


Discharge quality: Major conventional analytes (PI0013 Irrigation)

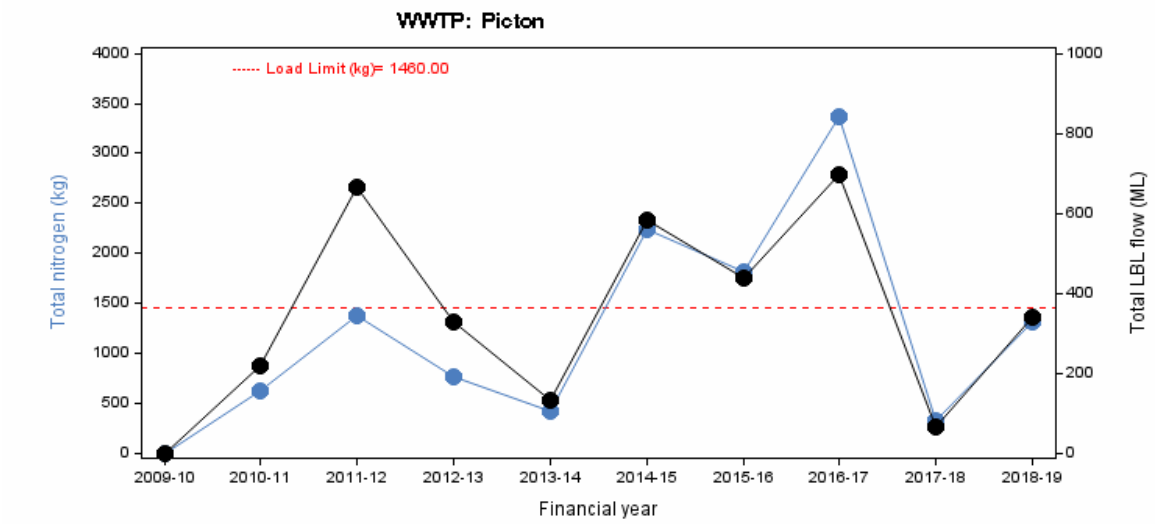


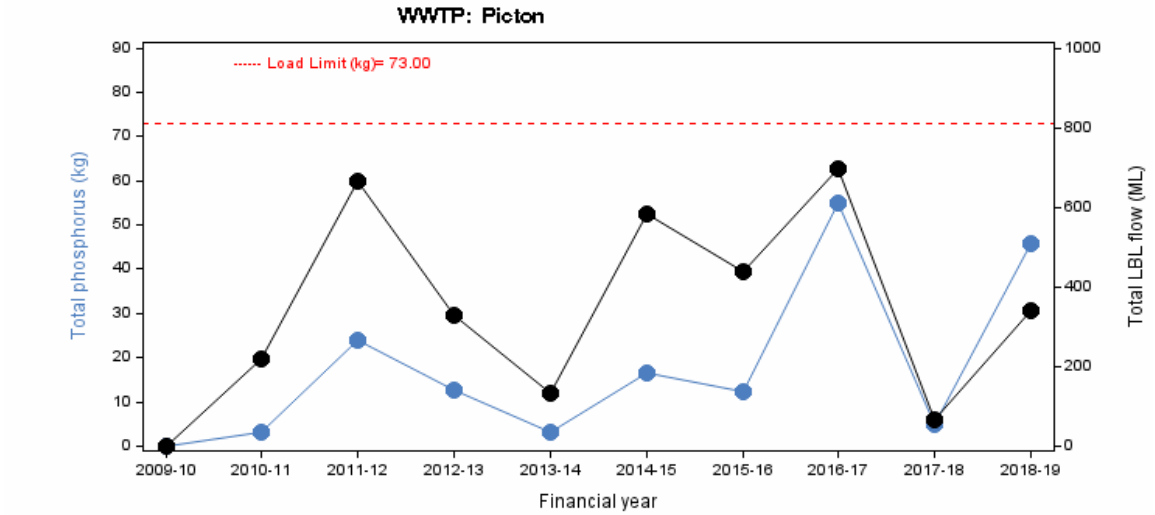




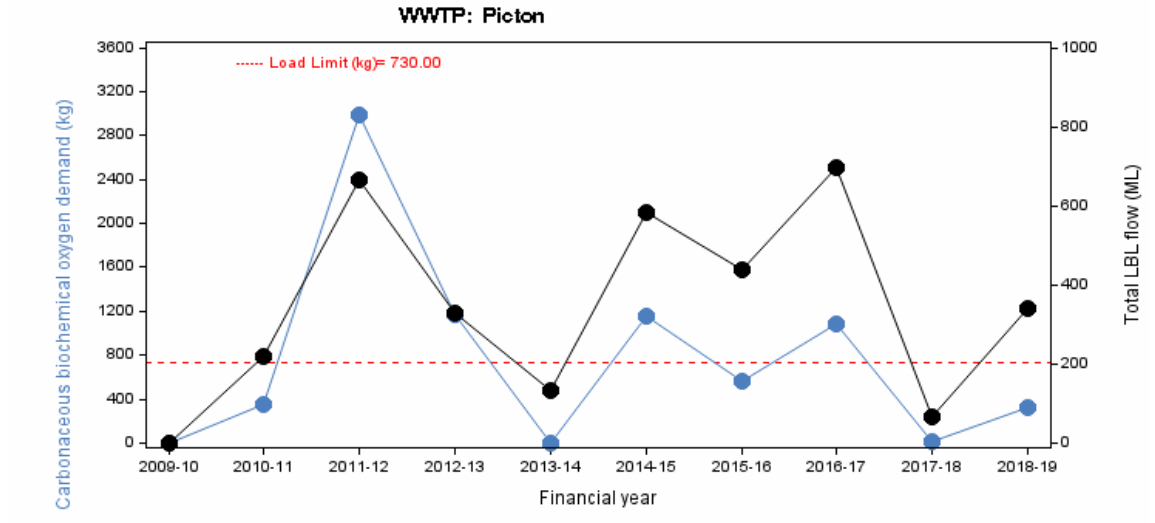

WWTP: Picton
Sampling Point: PI0013 Irrigation
Detection Limits: -
Limit/Threshold: 50%ile: 7
Limit/Threshold: 90%ile: 15
------ 90%ile Limit
------ 50%ile Limit
Total suspended solids (grab) (mg/L)
0
2
4
6
8
10
12
14
16
18
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0080; Pr>F=0.9291)
Financial year

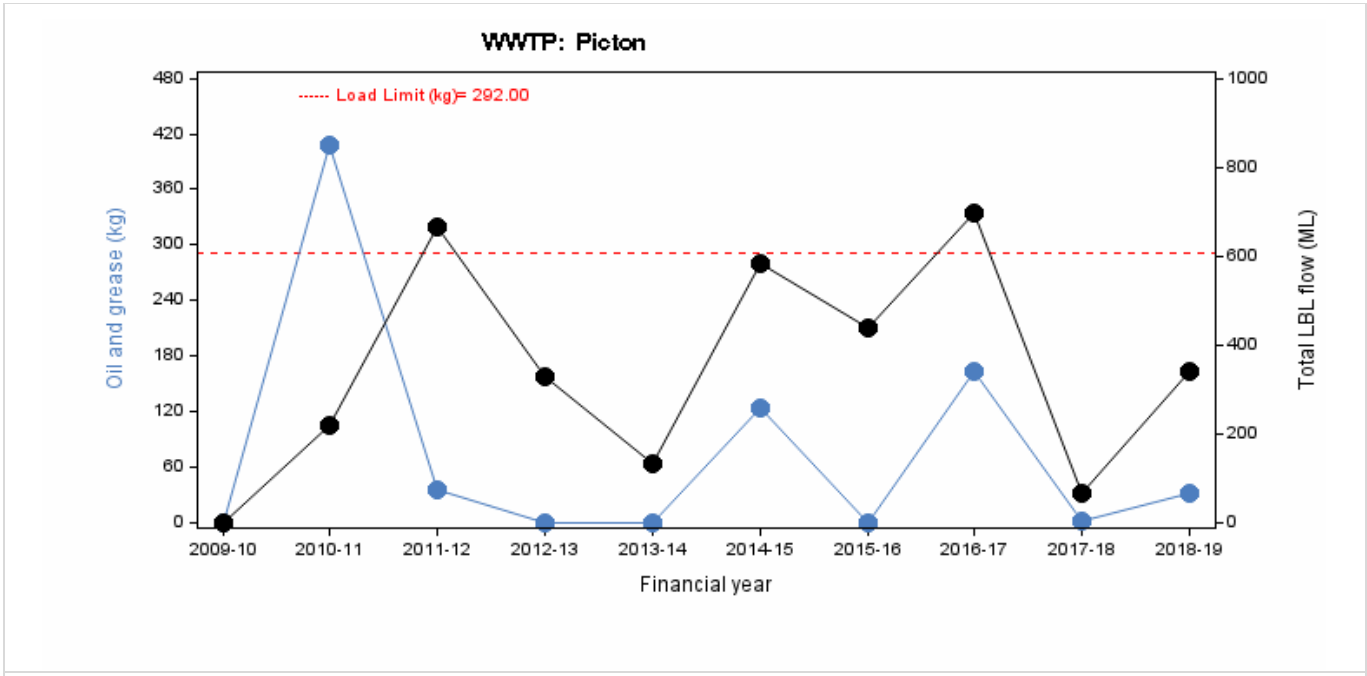
Discharge load: Nutrients

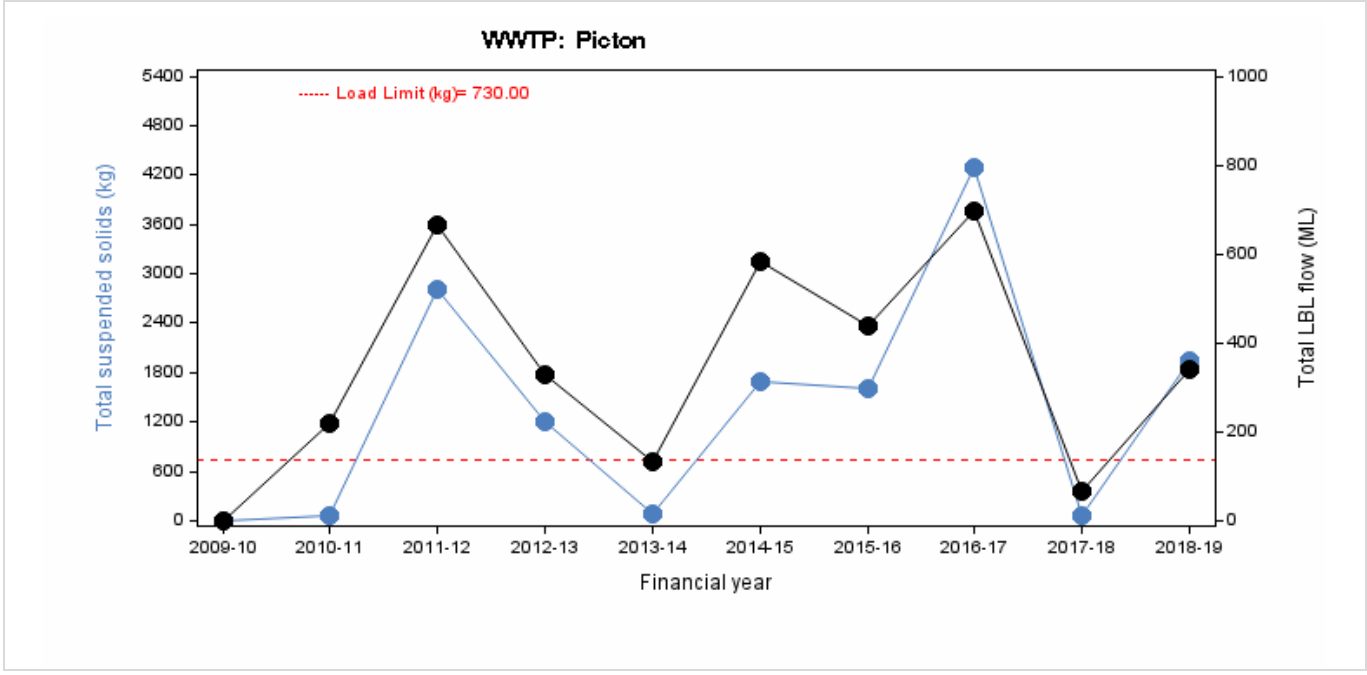




Discharge load: Major conventional analytes

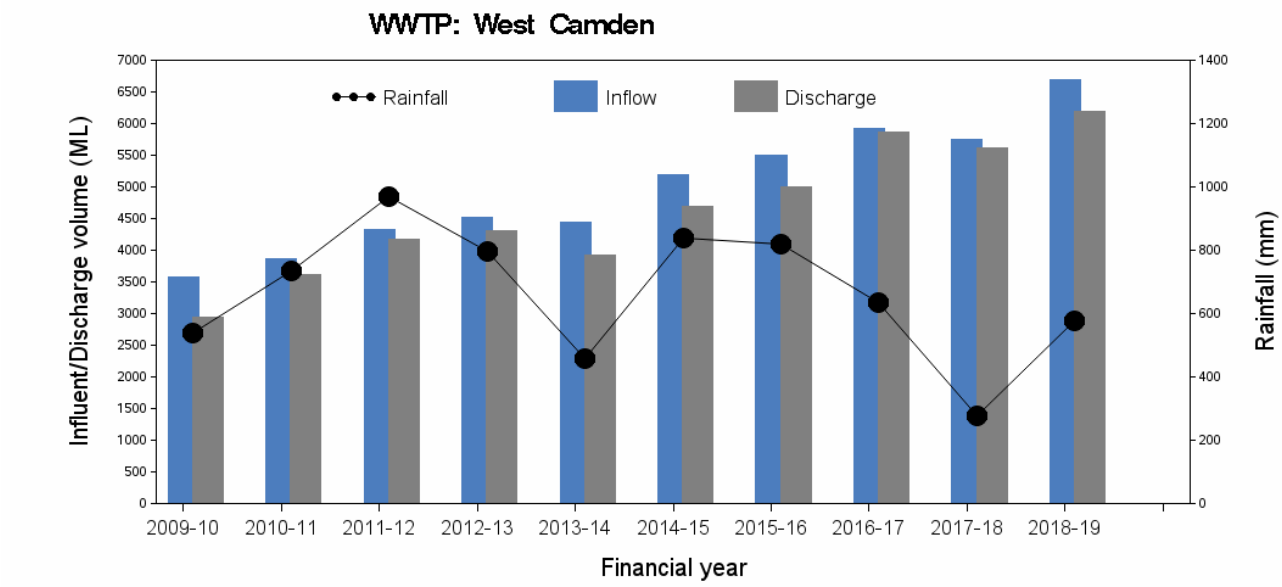


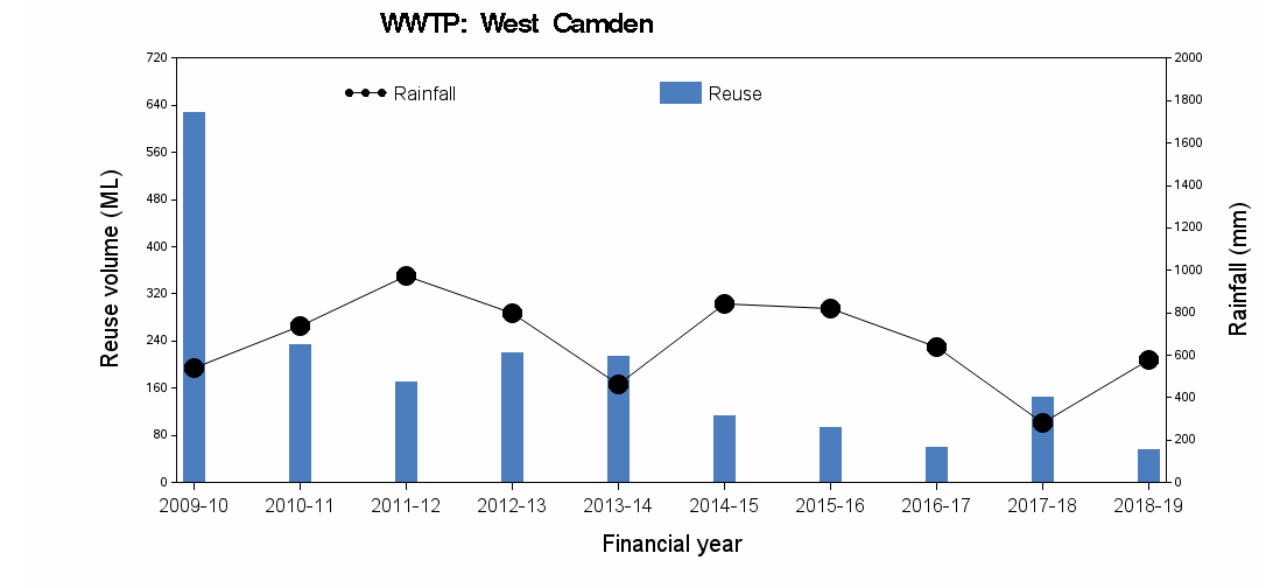

WWTP: Picton
Load Limit (kg)= 292.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Picton
Load Limit (kg)= 730.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

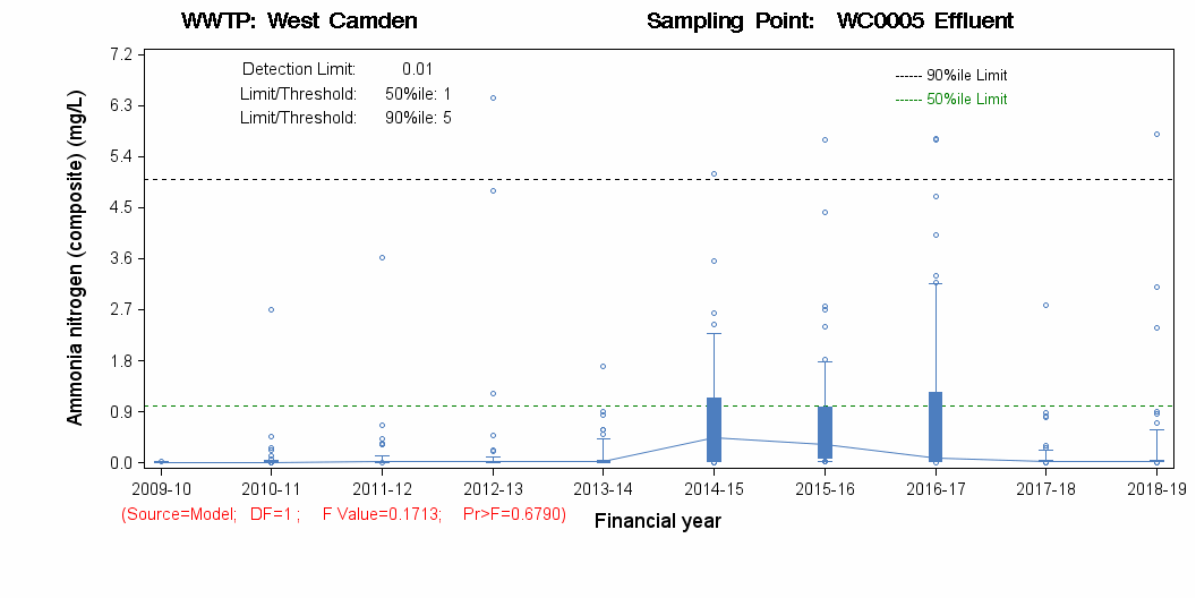
West Camden WWTP

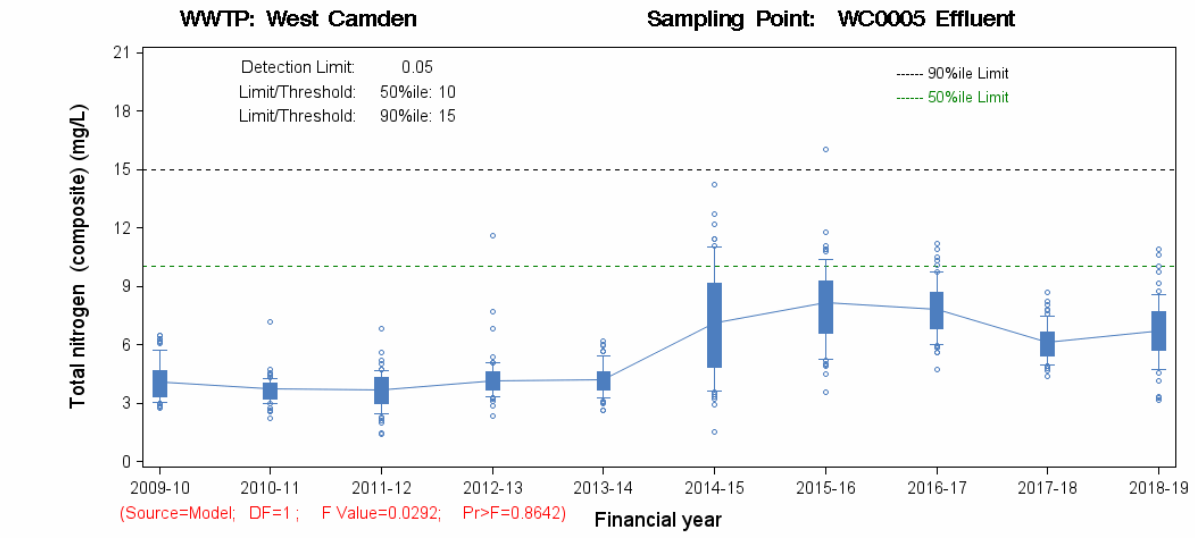
Discharge volume and rainfall

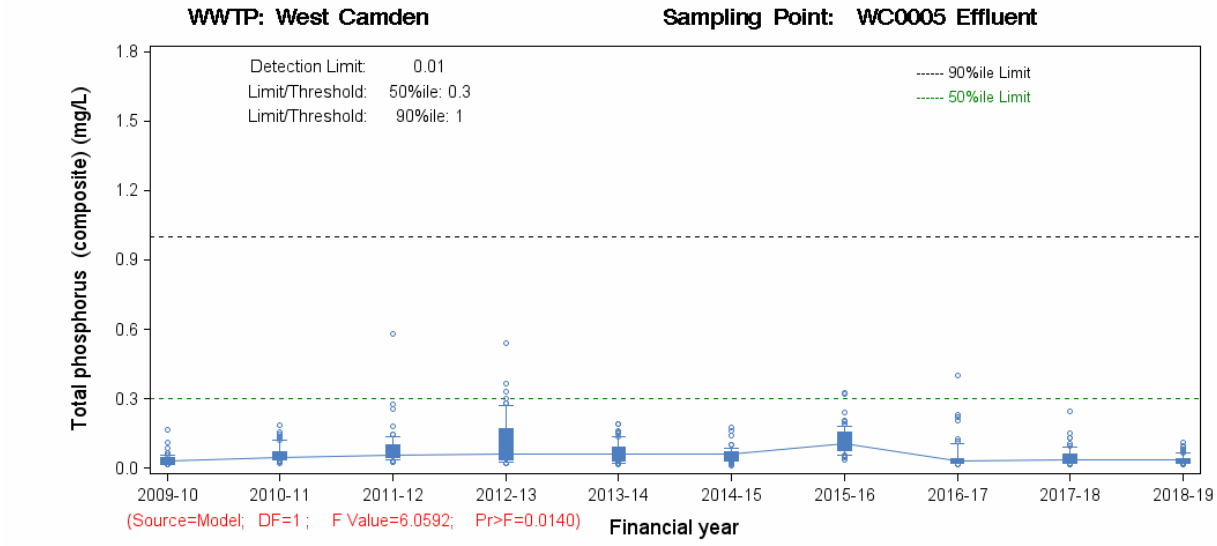


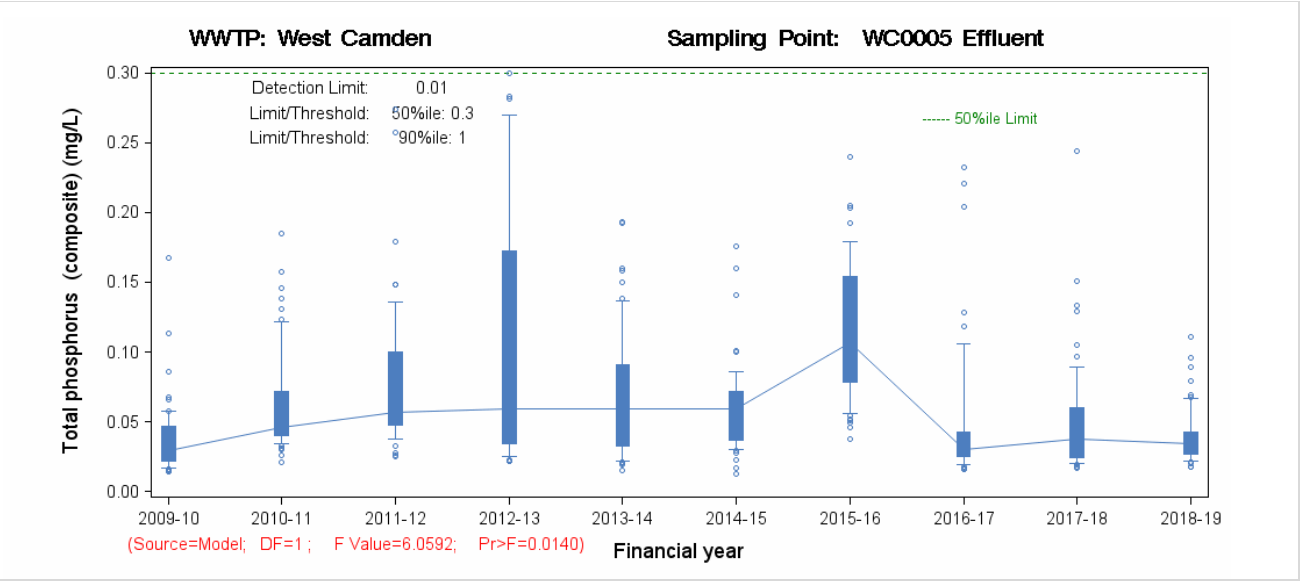


Discharge quality: Nutrients

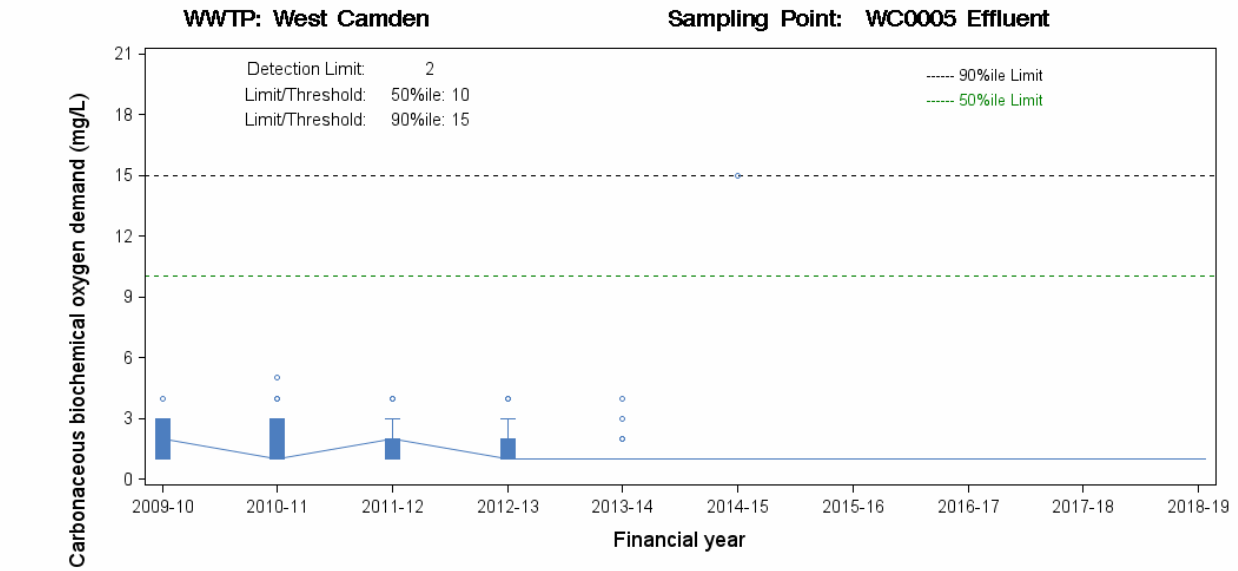




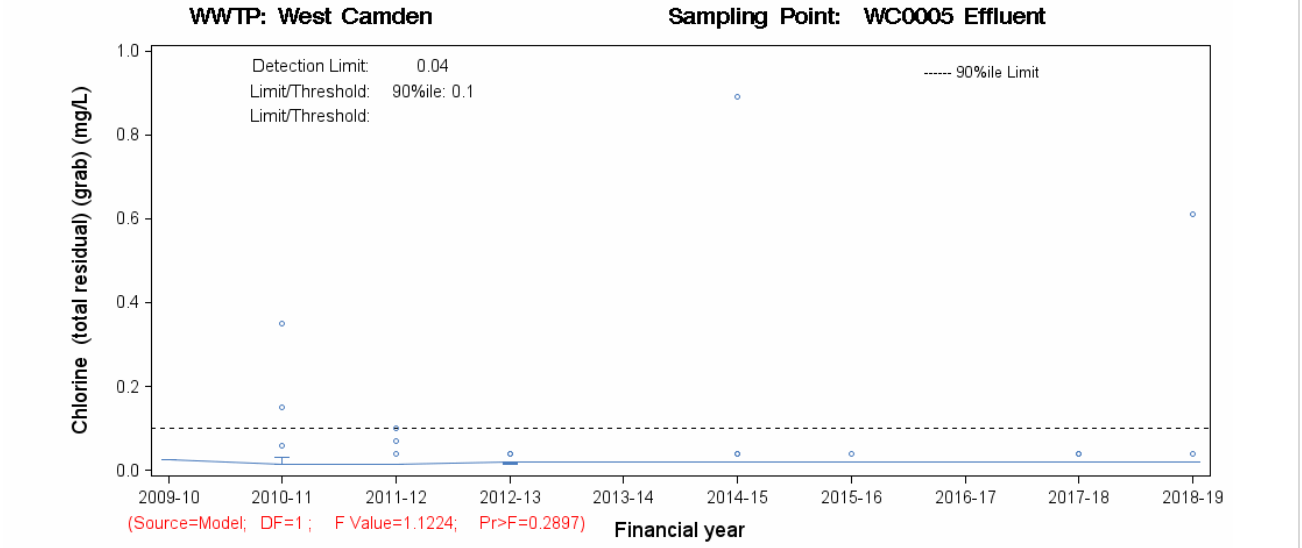


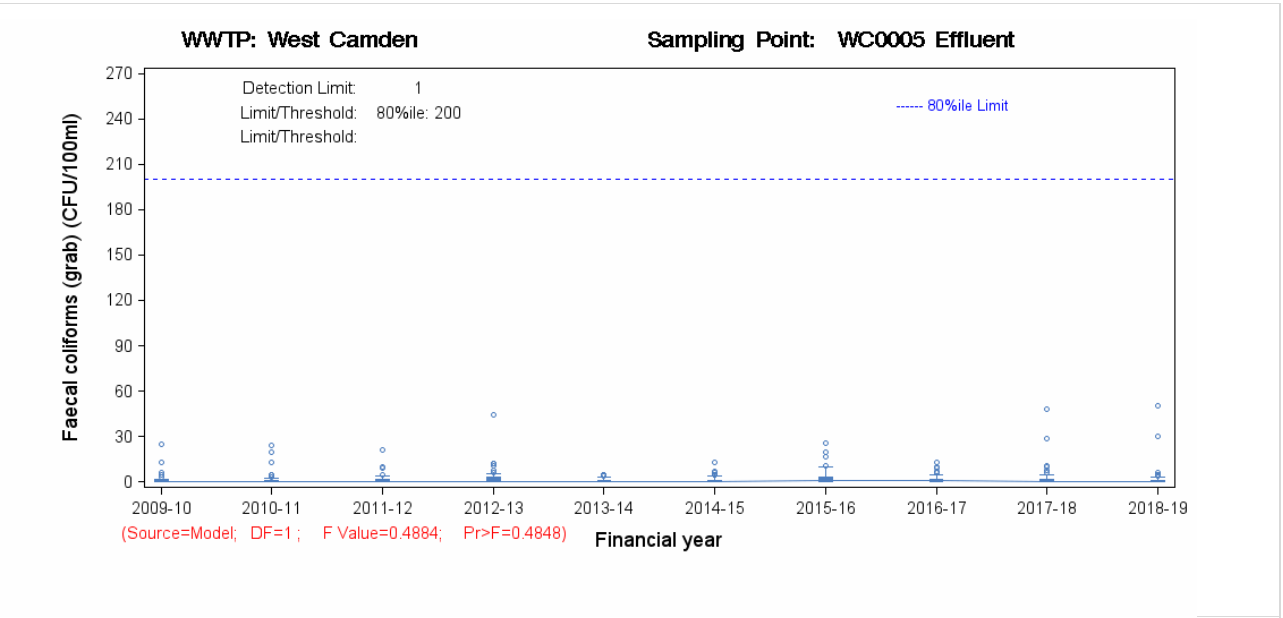


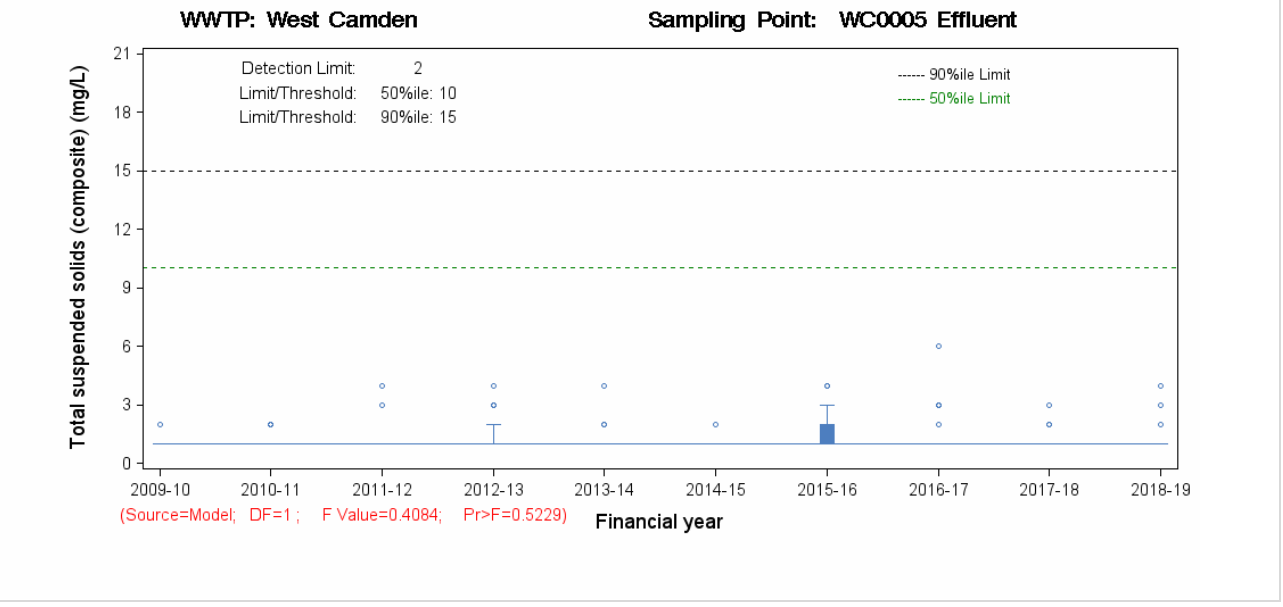
Discharge quality: Major conventional analytes



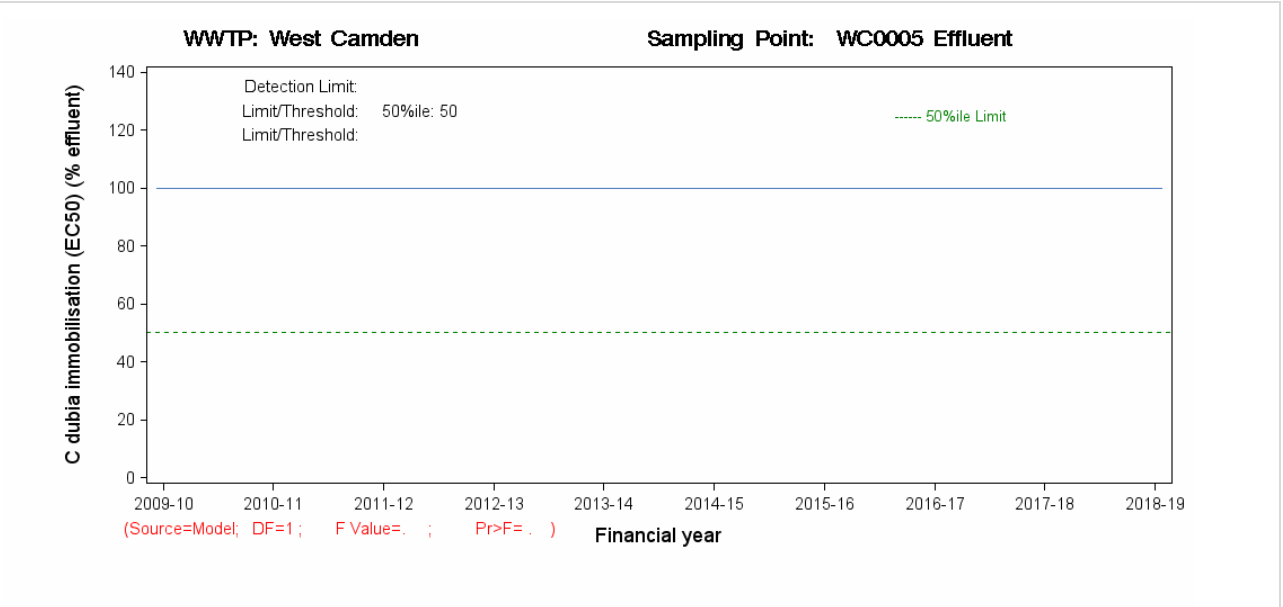
Note: 2018-19 data was compared with previous four years data (2014-2018) due to lab method change in 2014-15. Statistical test was not conducted because >90% of results were below the detection limit.



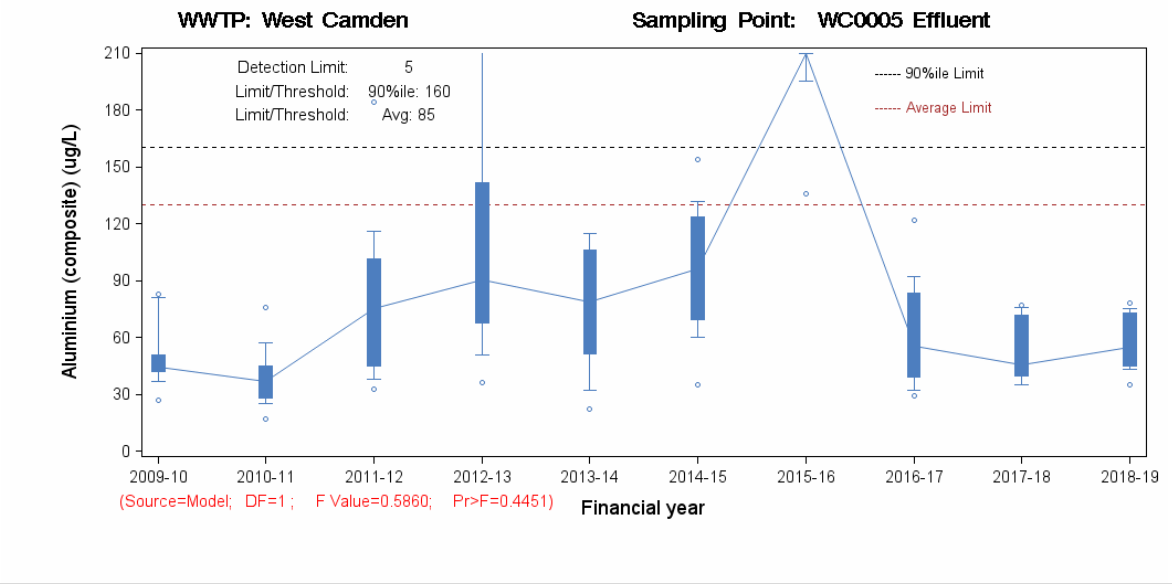


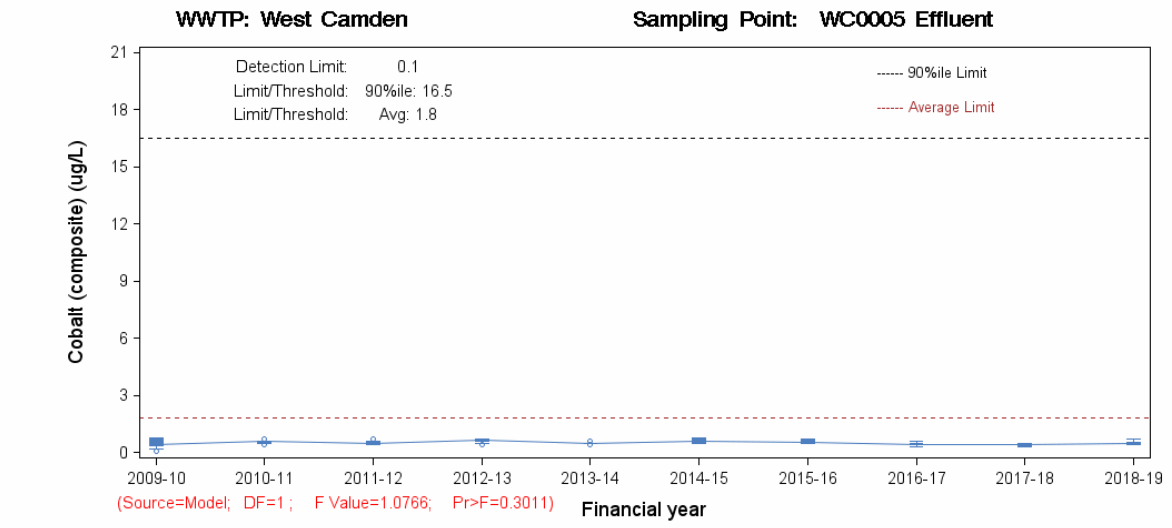


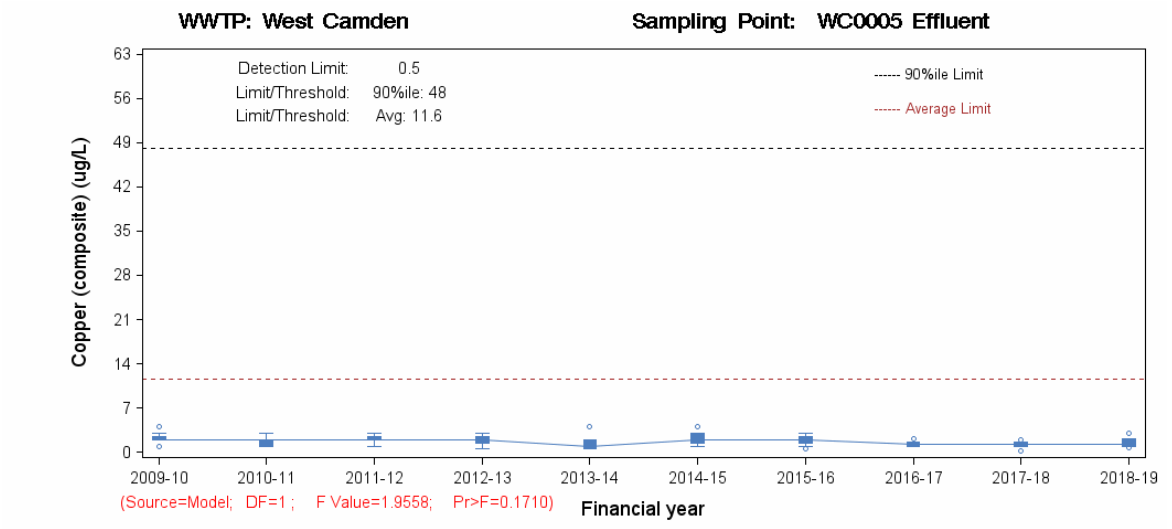
Discharge quality: Toxicity



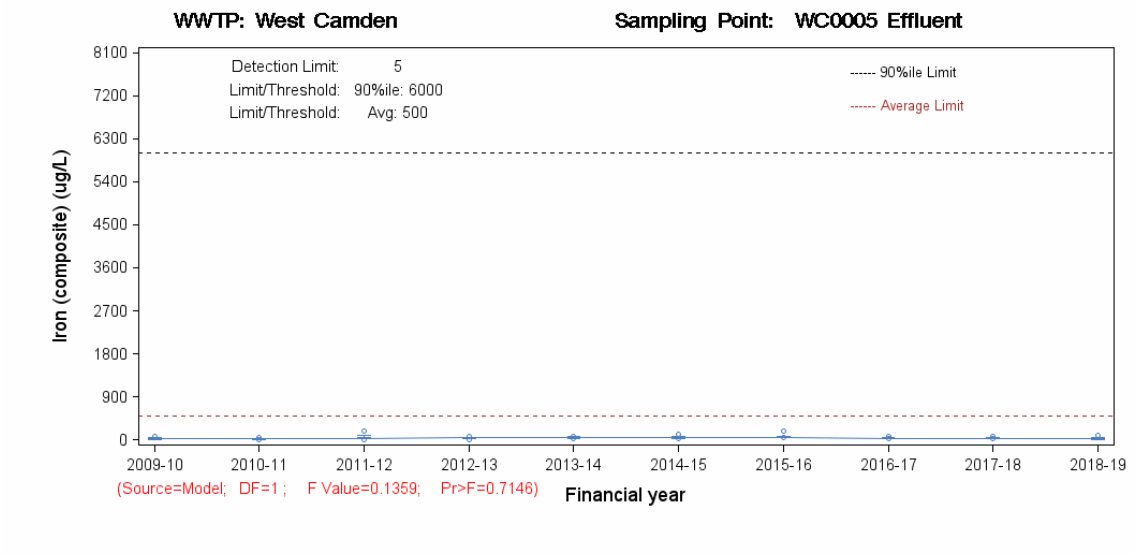
Discharge quality: Trace metals



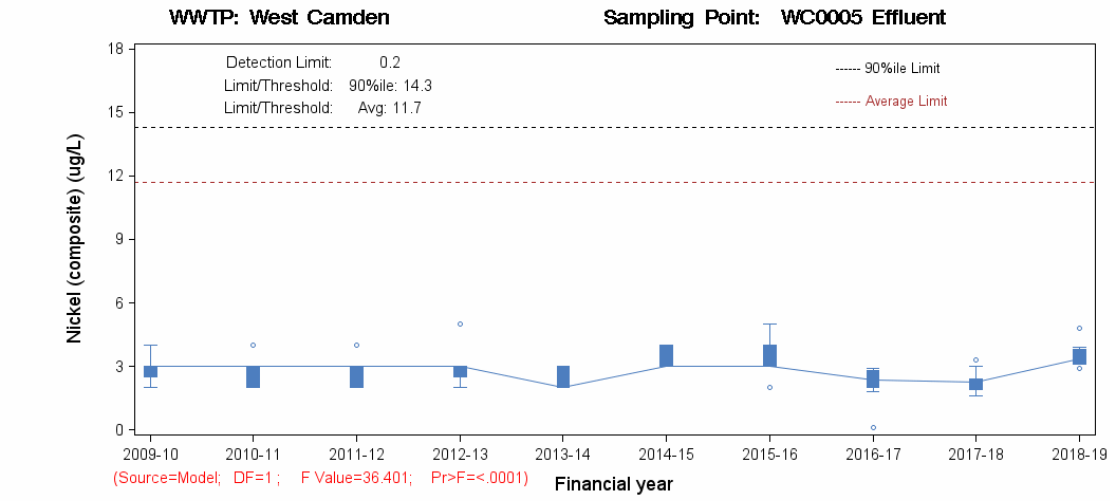




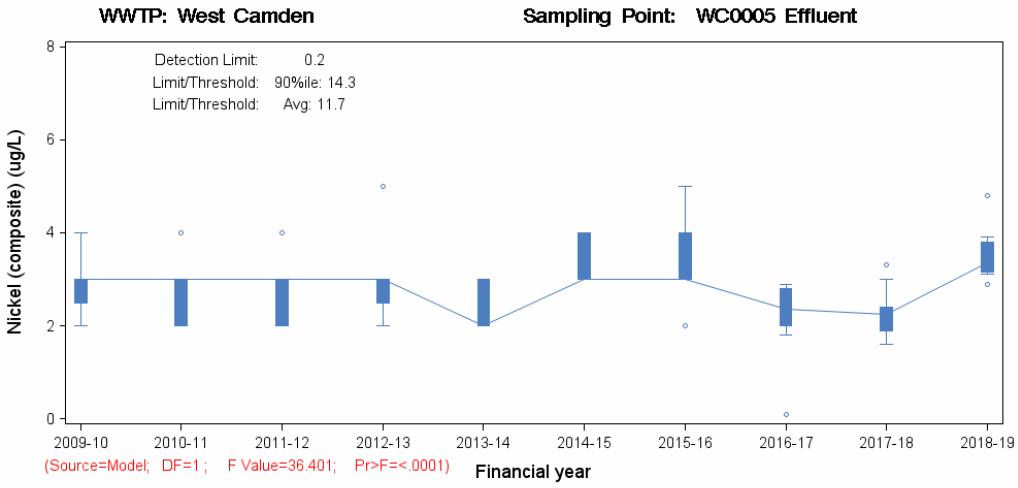
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



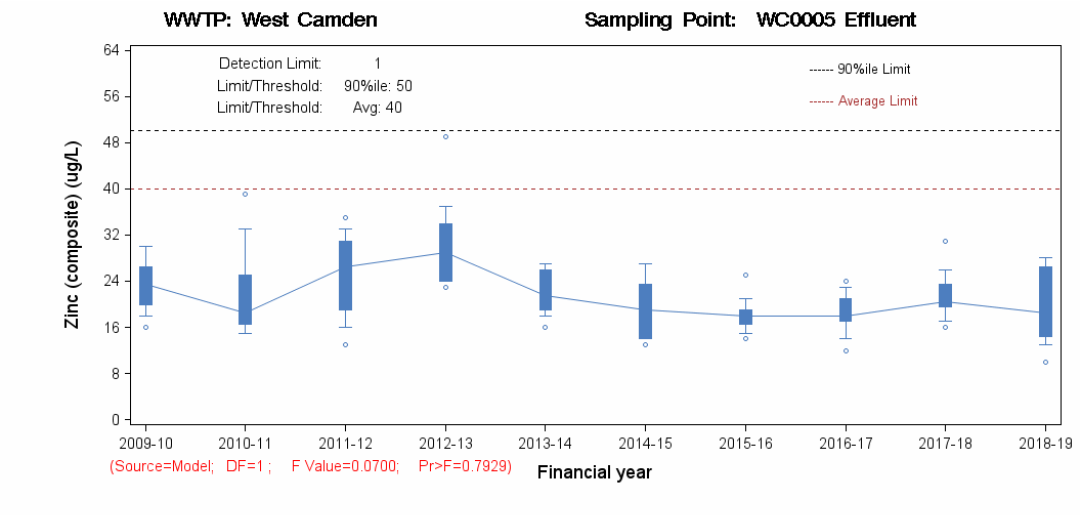
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

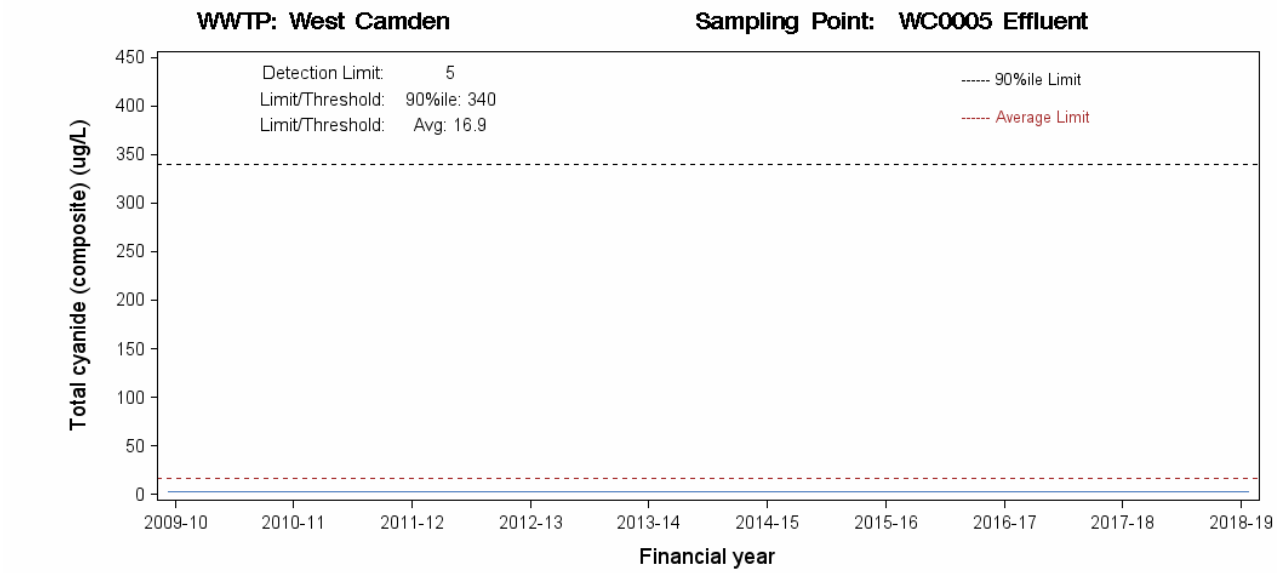


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

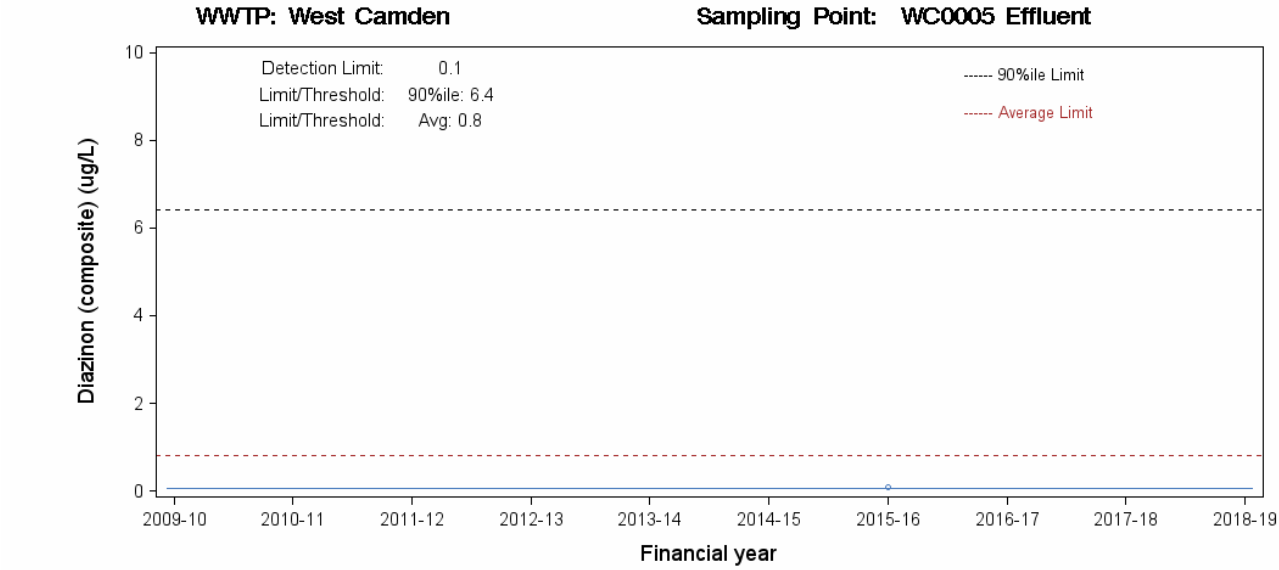


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

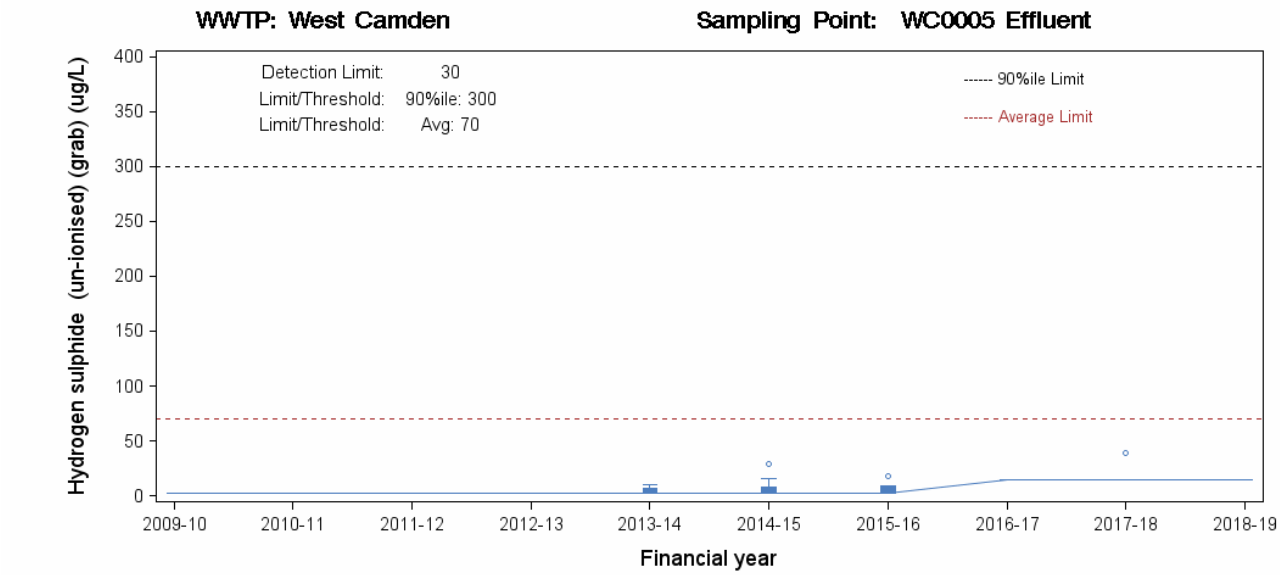
Discharge quality: Other chemicals and organics (including pesticides)



Note: Statistical test was not conducted because >90% of results were below the detection limit.

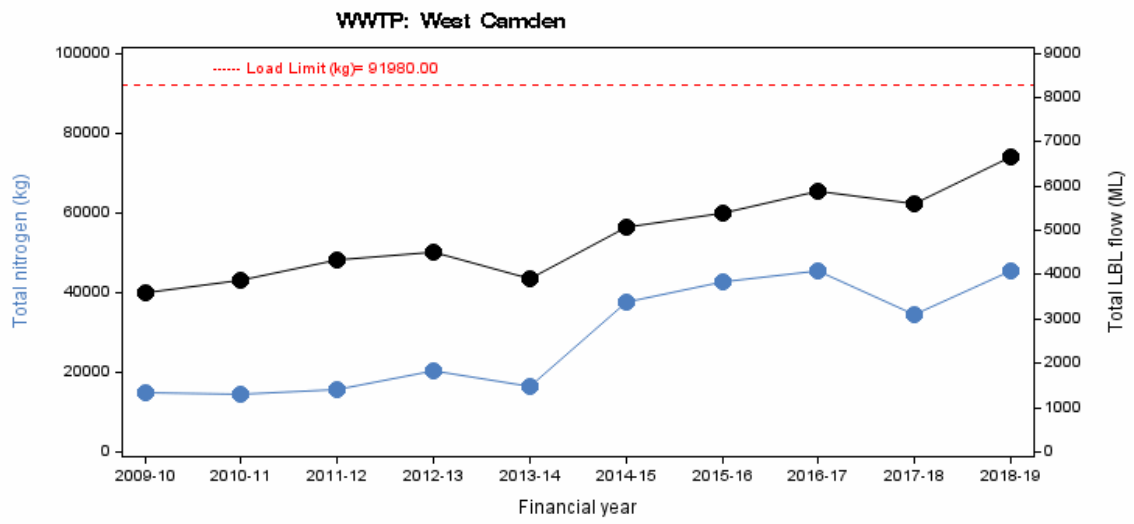


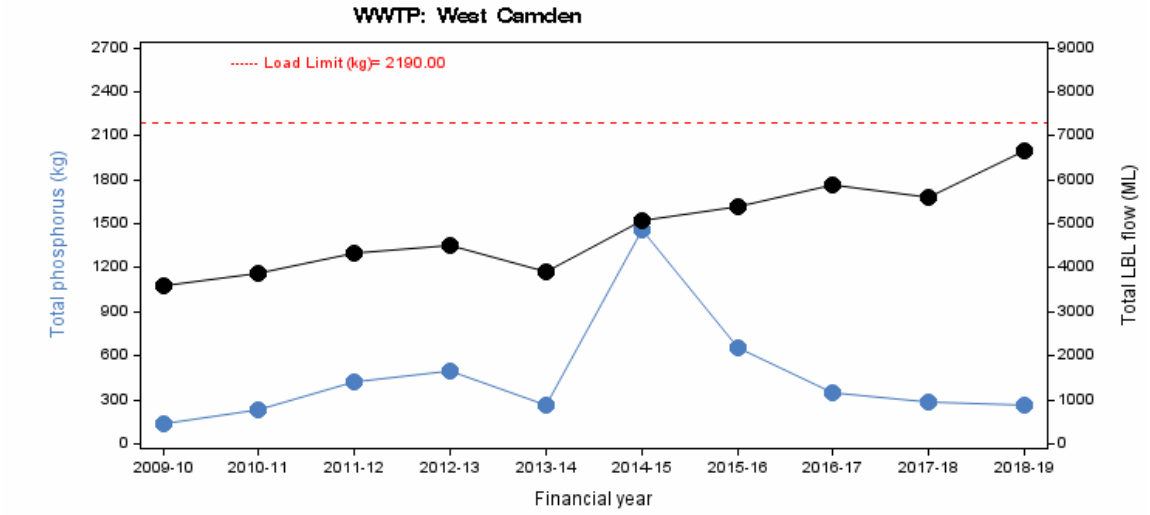
Note: Statistical test was not conducted because >90% of results were below the detection limit.



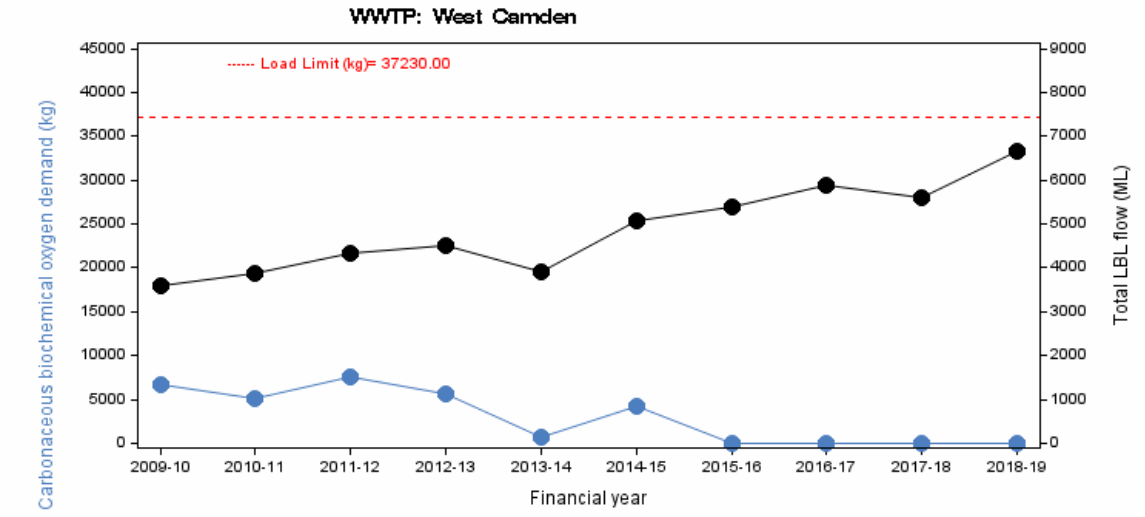
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

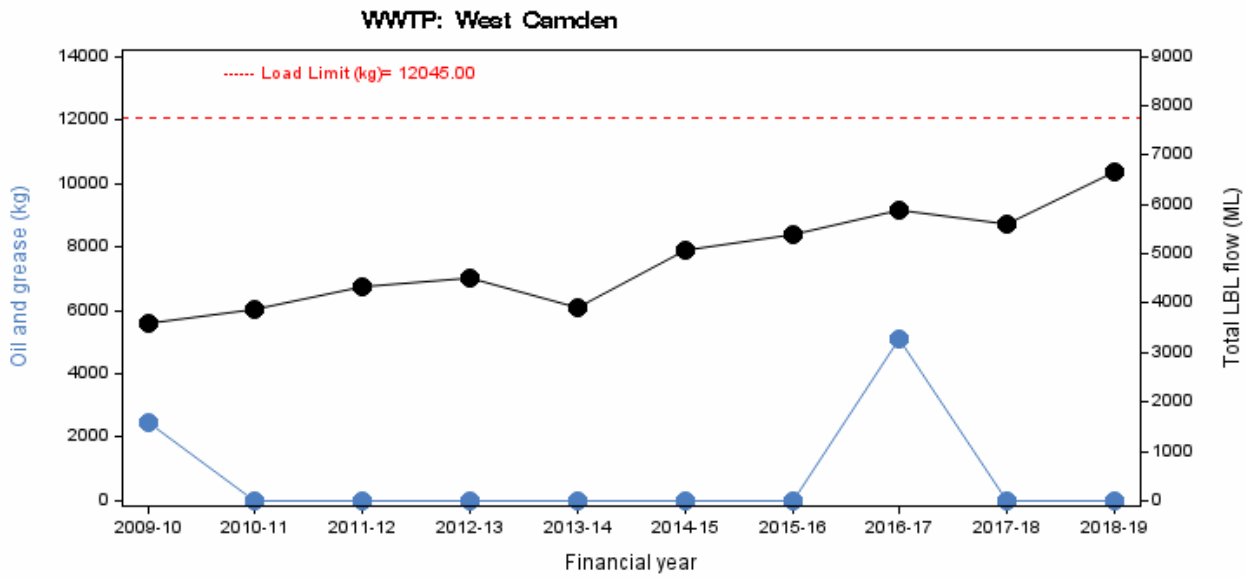
Discharge load: Nutrients

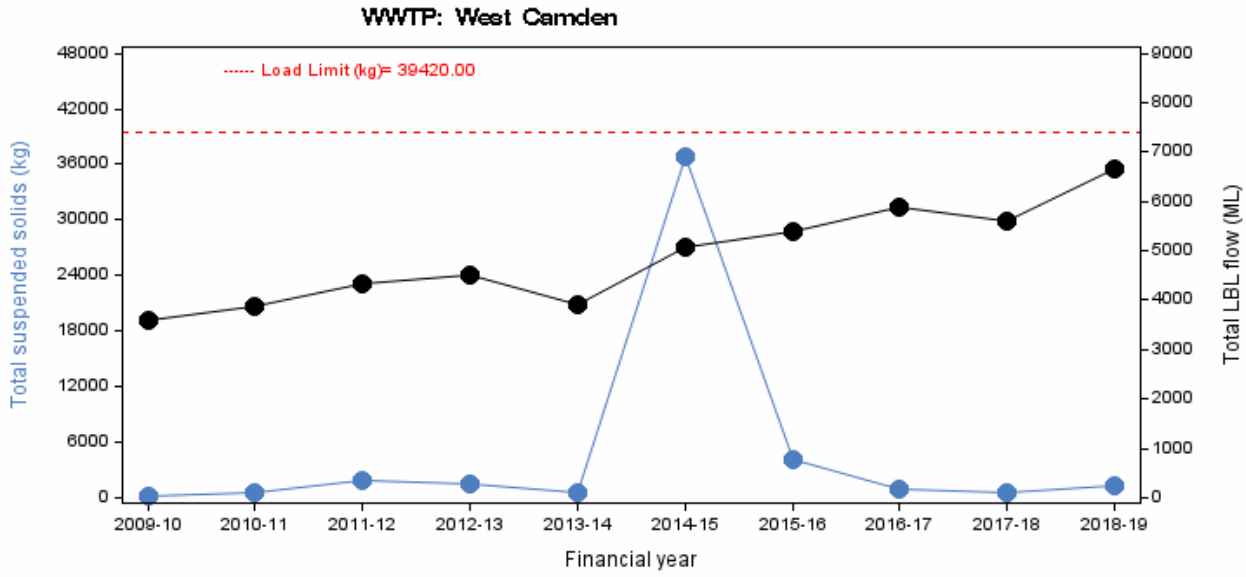




Discharge load: Major conventional analytes

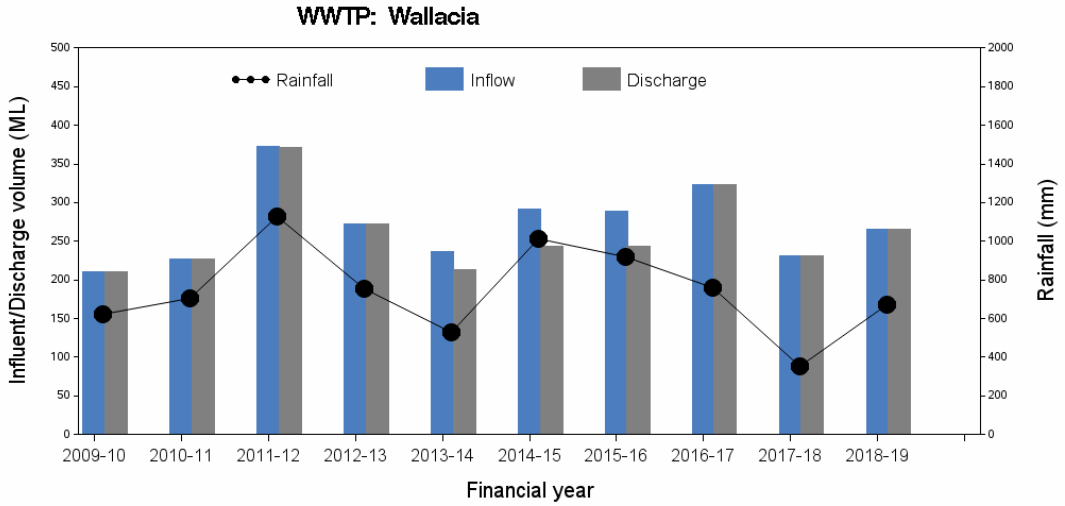



WWTP: West Camden
Load Limit (kg)= 12045.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

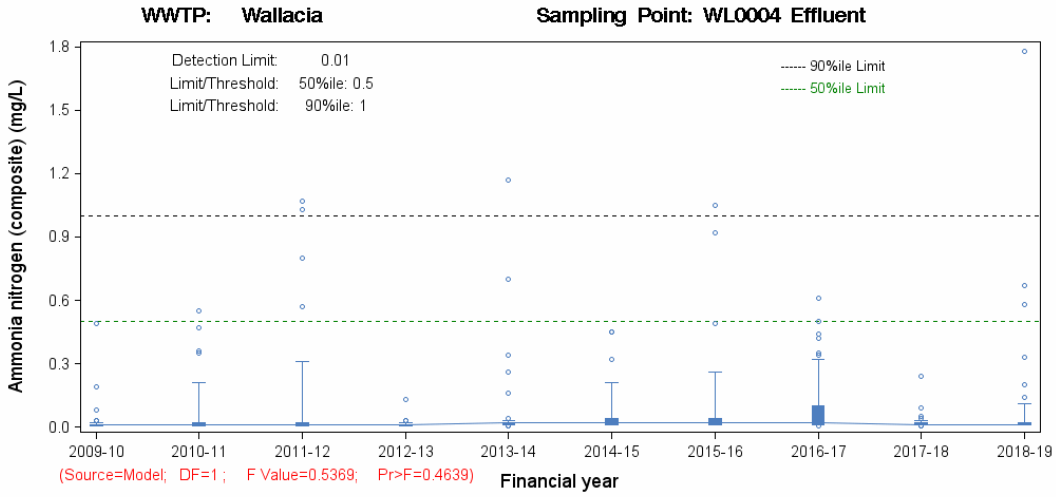

WWTP: West Camden
Load Limit (kg)= 39420.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

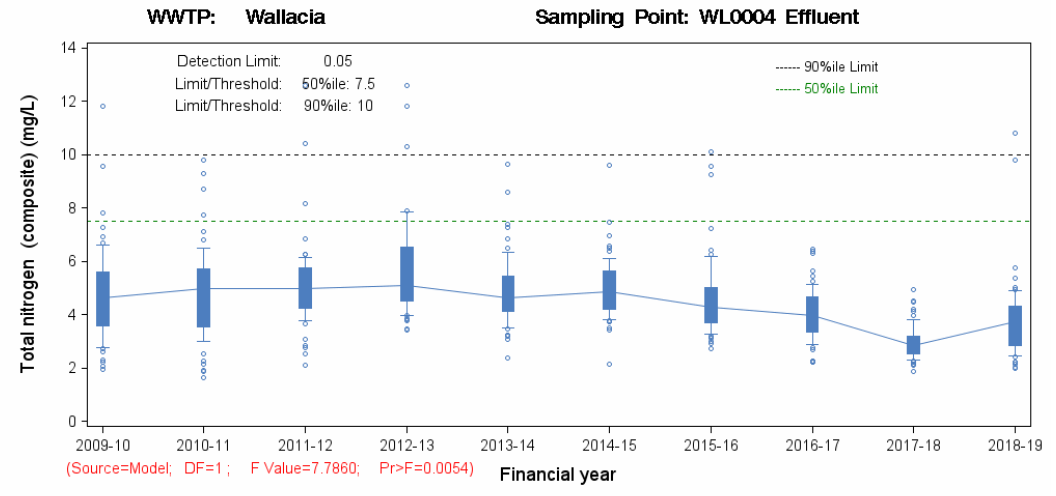
Wallacia WWTP

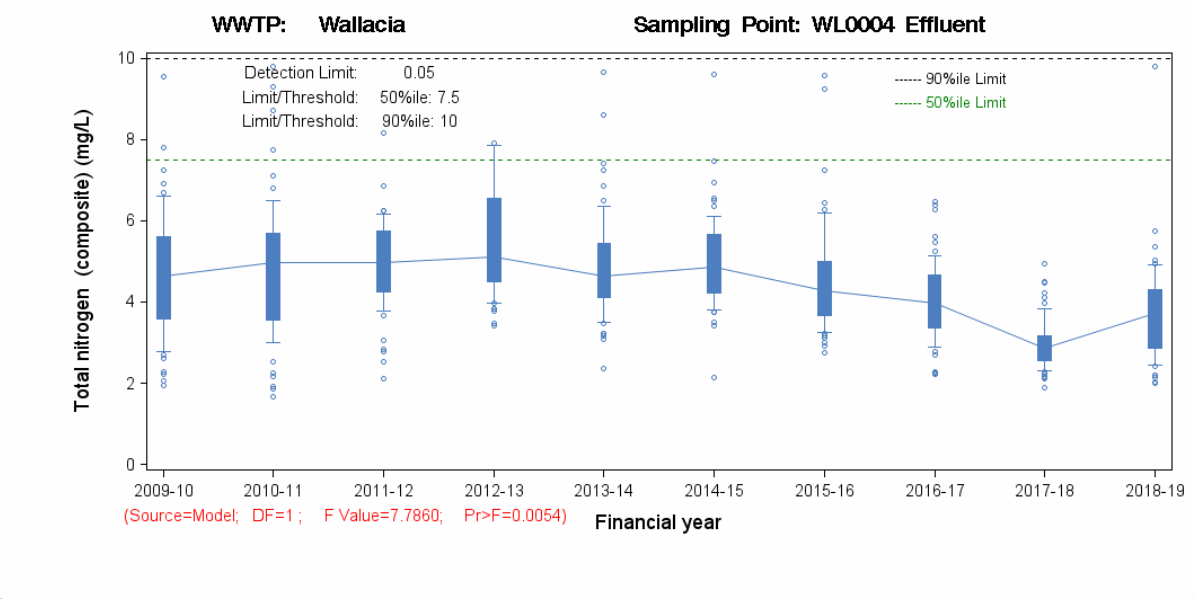
Discharge volume and rainfall

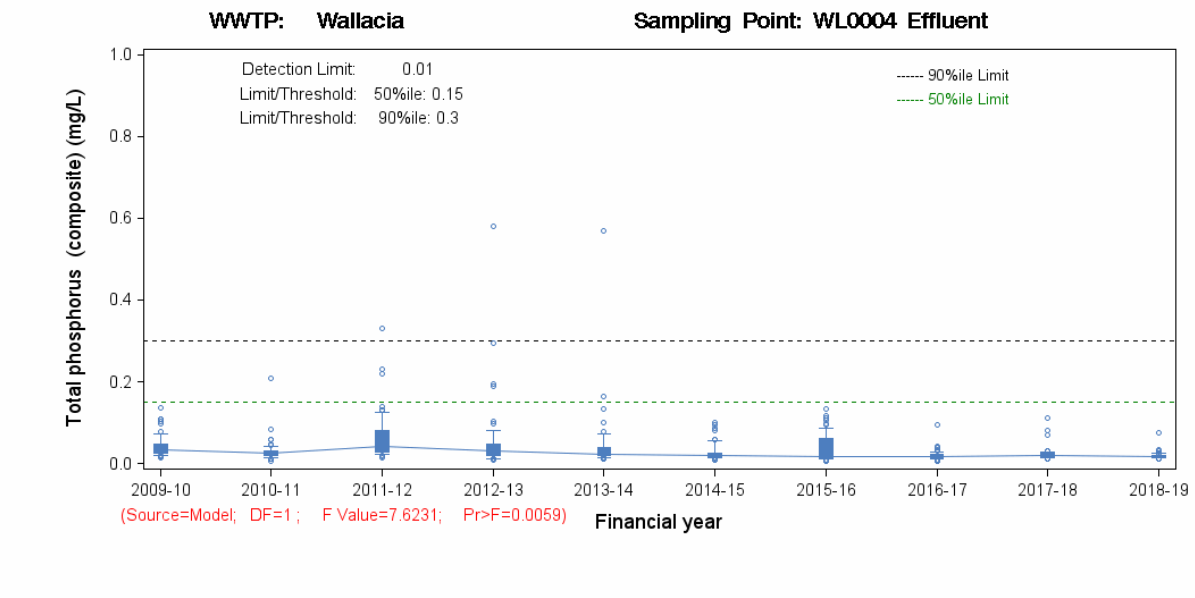


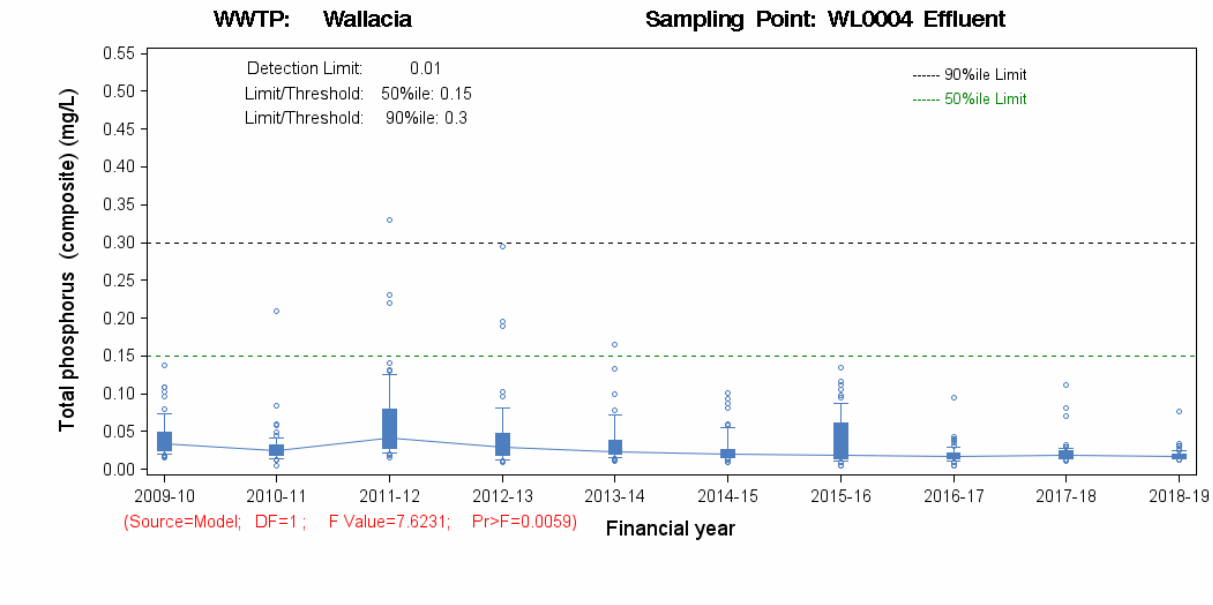
Discharge quality: Nutrients



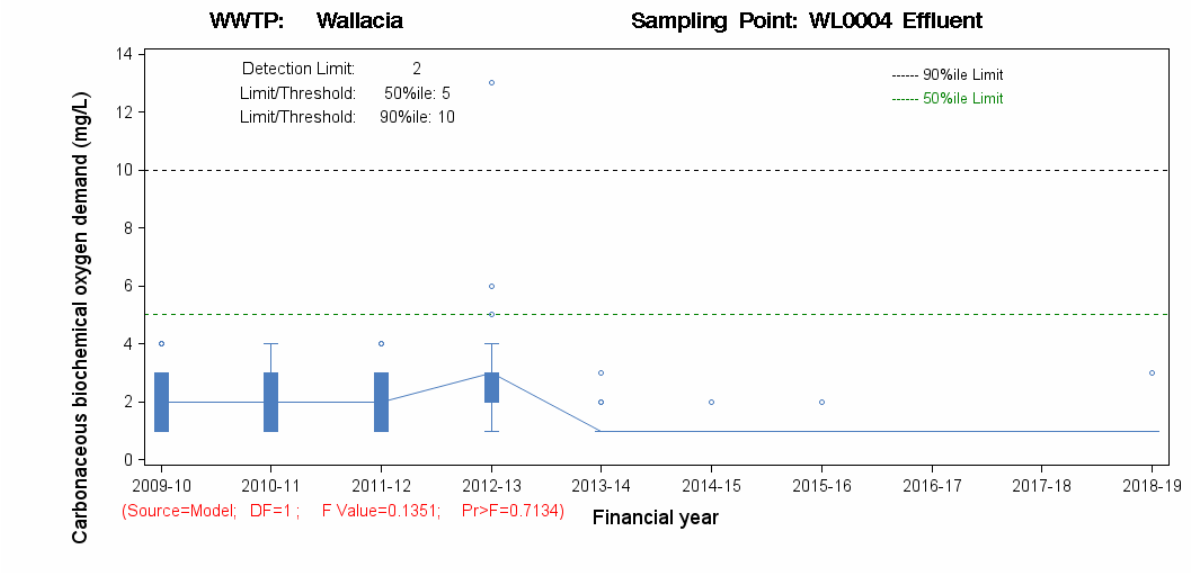



WWTP: Wallacia
Sampling Point: WL0004 Effluent
Detection Limit: 0.05
Limit/Threshold: 50%ile: 7.5
Limit/Threshold: 90%ile: 10
----- 90%ile Limit
----- 50%ile Limit
Total nitrogen (composite) (mg/L)
0
2
4
6
8
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.7860; Pr>F=0.0054)
Financial year

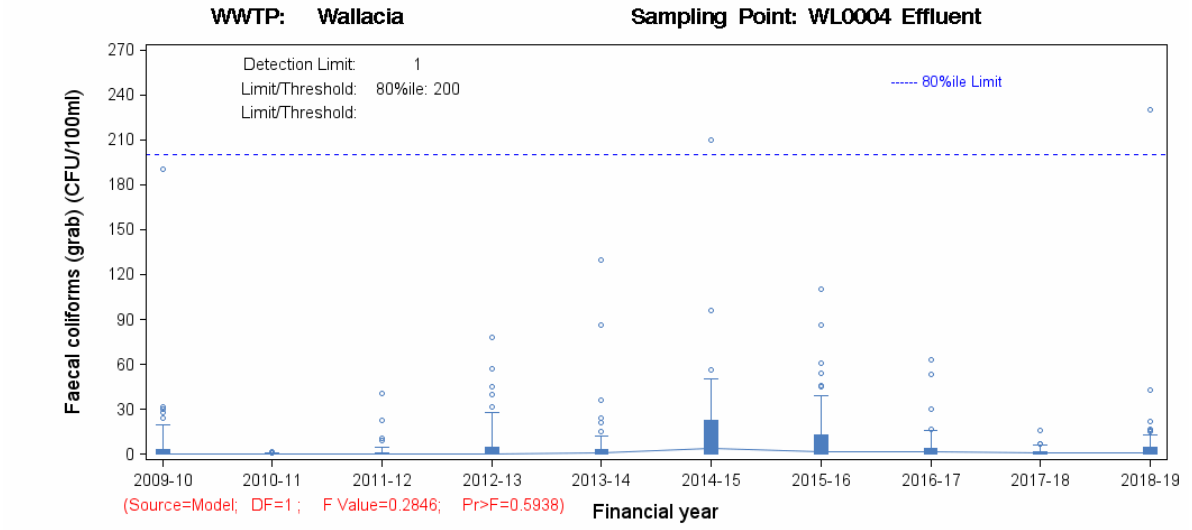

WWTP: Wallacia
Sampling Point: WL0004 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 0.15
Limit/Threshold: 90%ile: 0.3
----- 90%ile Limit
----- 50%ile Limit
Total phosphorus (composite) (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.6231; Pr>F=0.0059)
Financial year

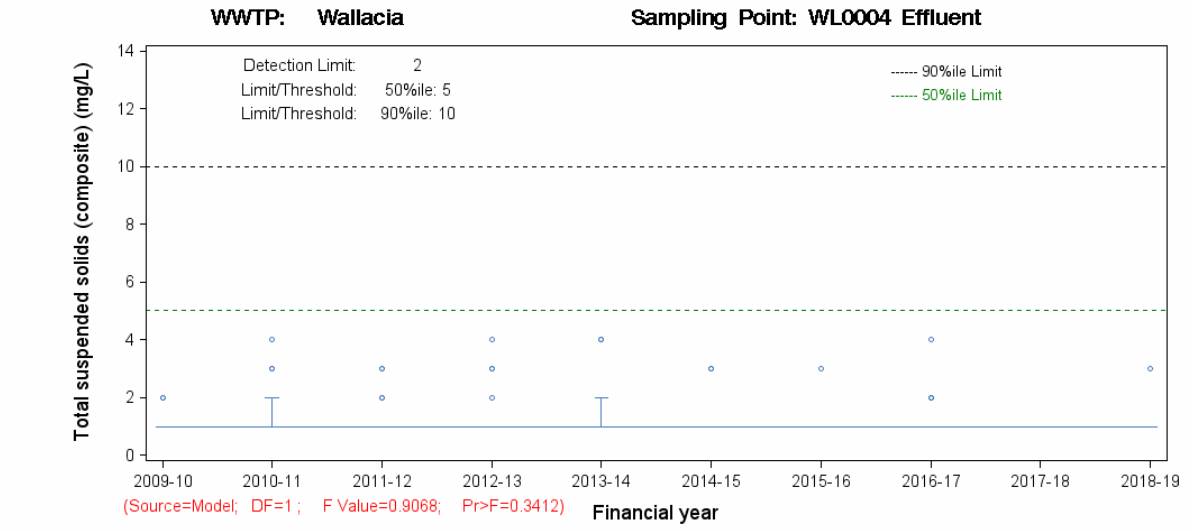

WWTP: Wallacia
Sampling Point: WL0004 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 0.15
Limit/Threshold: 90%ile: 0.3
----- 90%ile Limit
----- 50%ile Limit
Total phosphorus (composite) (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.6231; Pr>F=0.0059)
Financial year

Discharge quality: Major conventional analytes

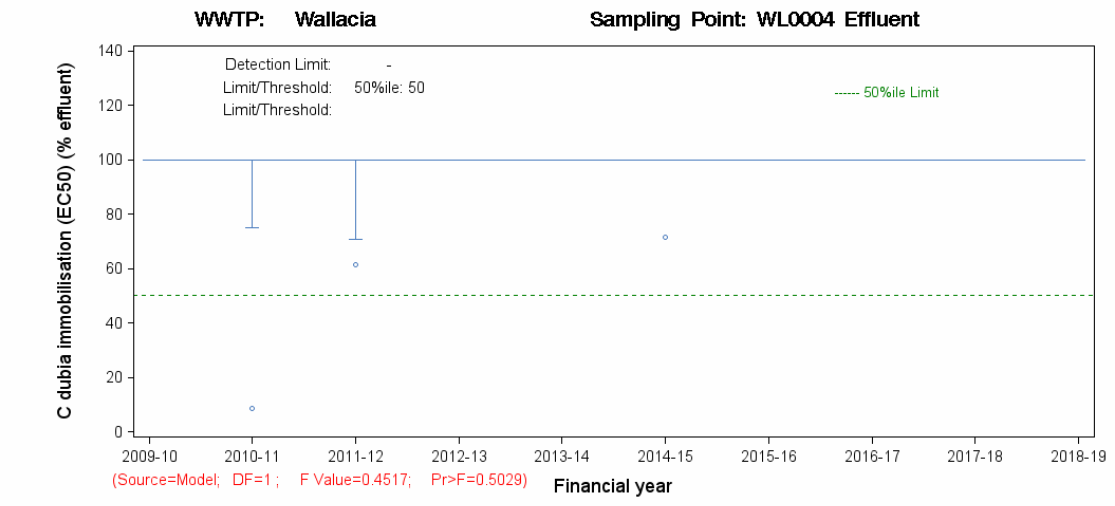


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

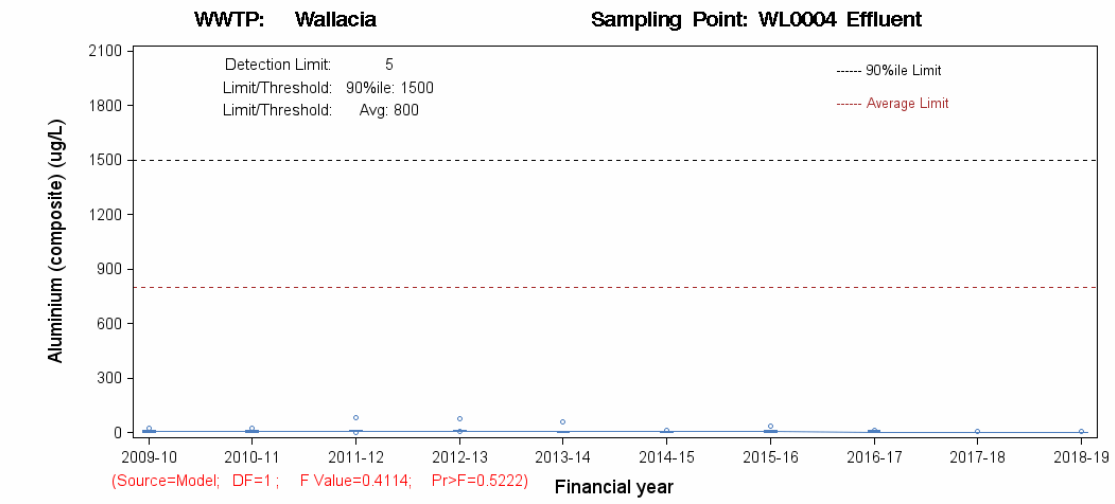


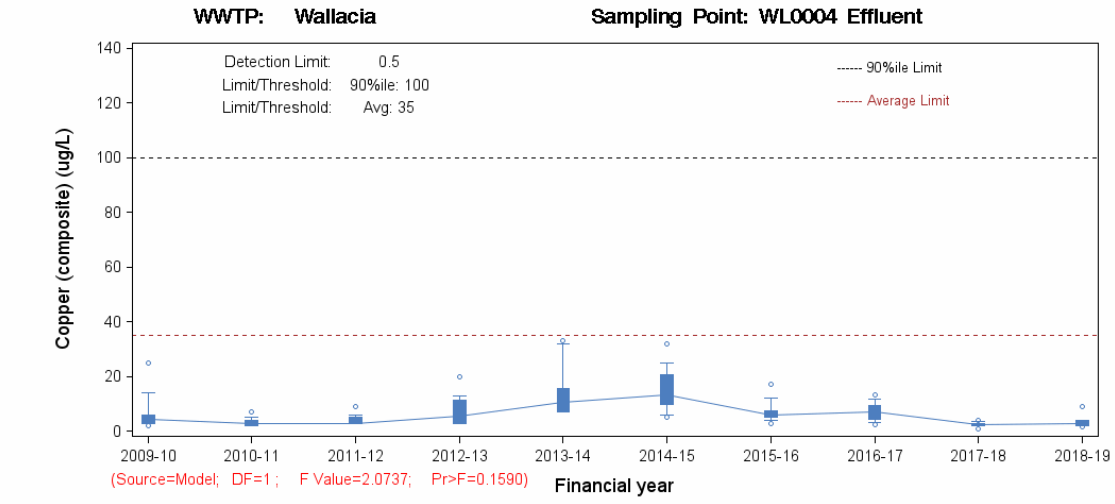


Discharge quality: Toxicity

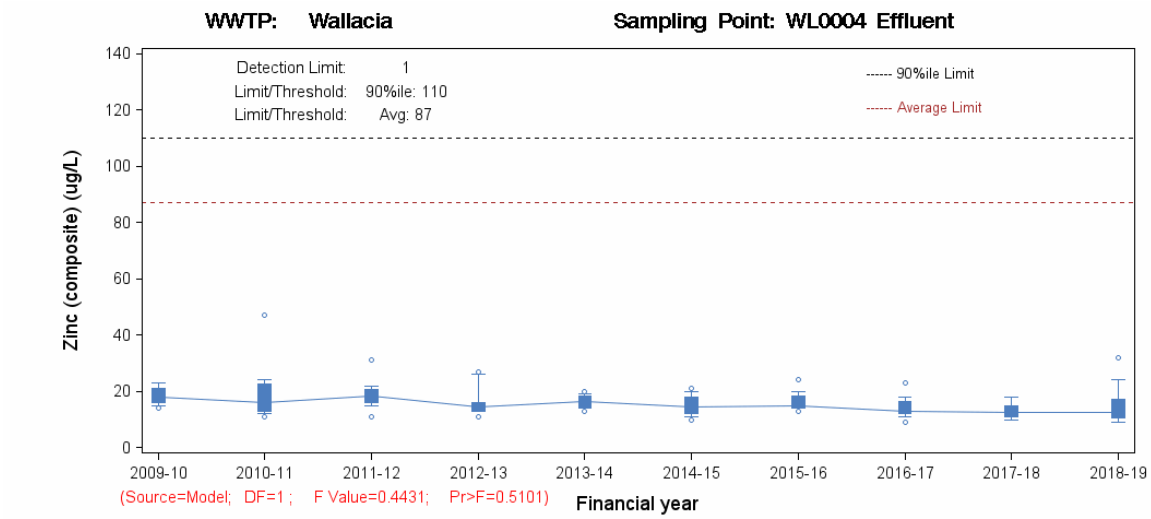


Discharge quality: Trace metals



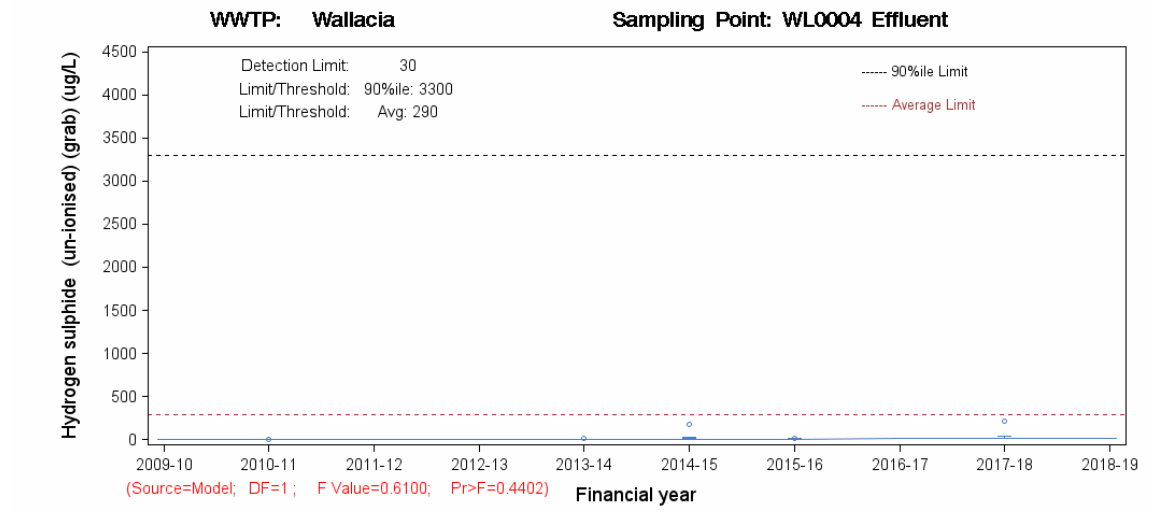


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

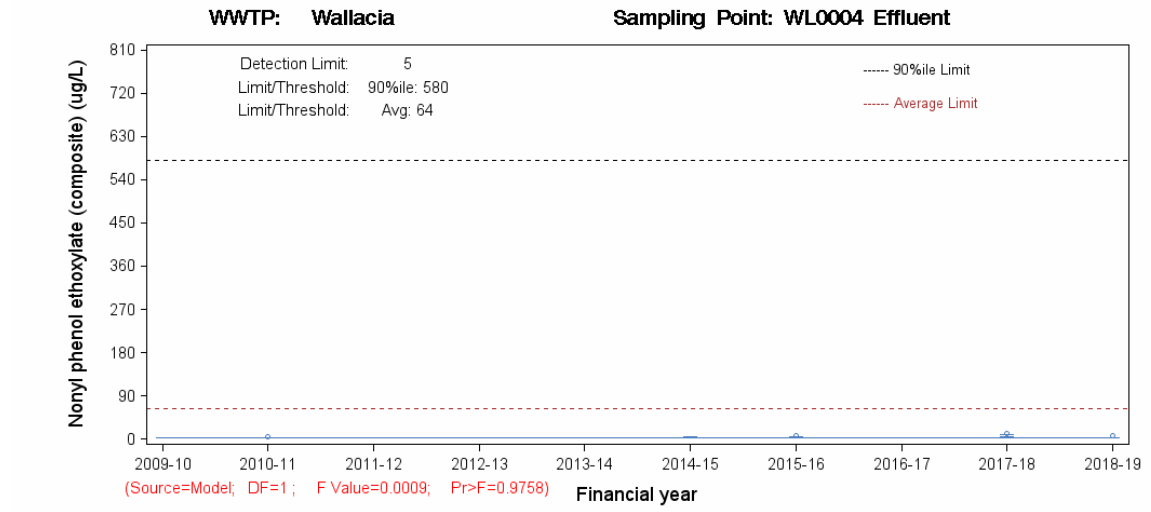


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

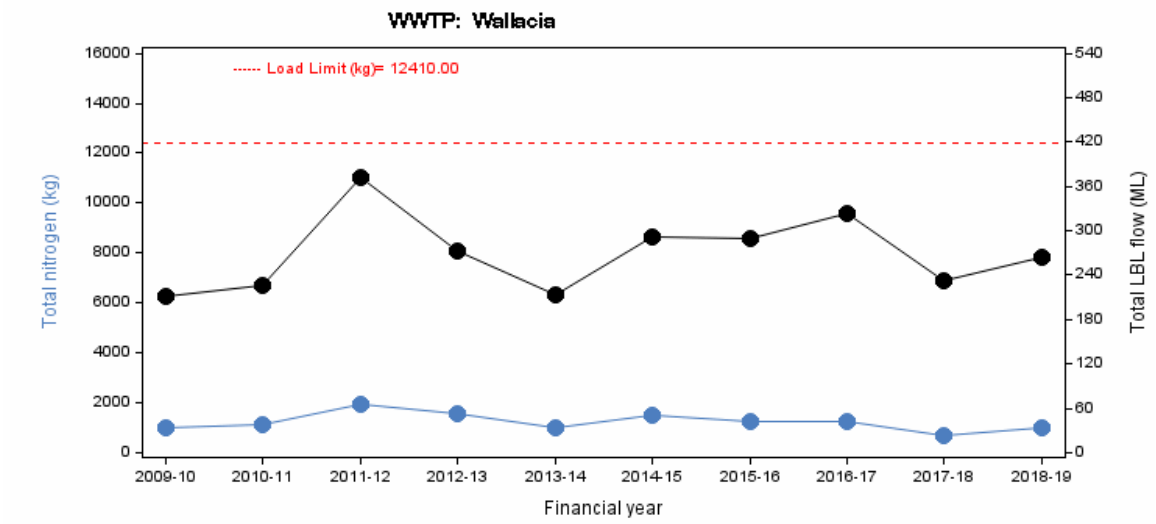
Discharge quality: Other chemicals and organics (including pesticides)

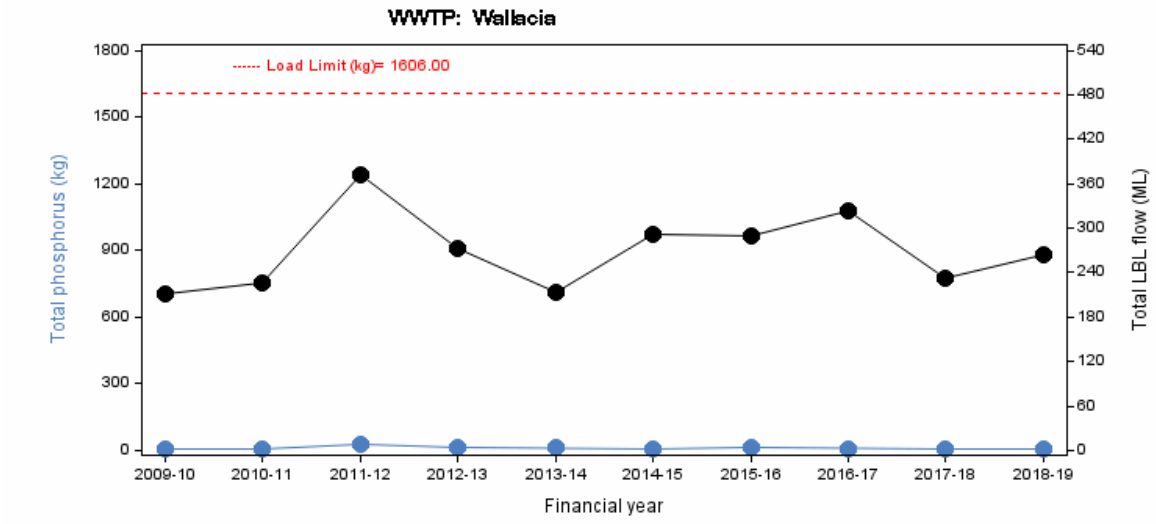


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

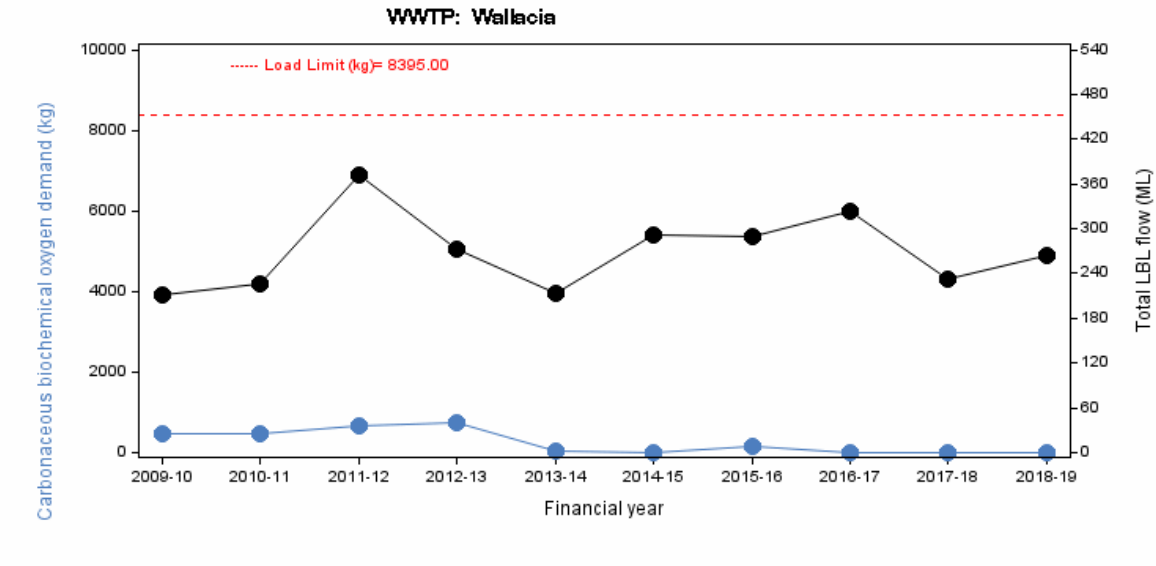


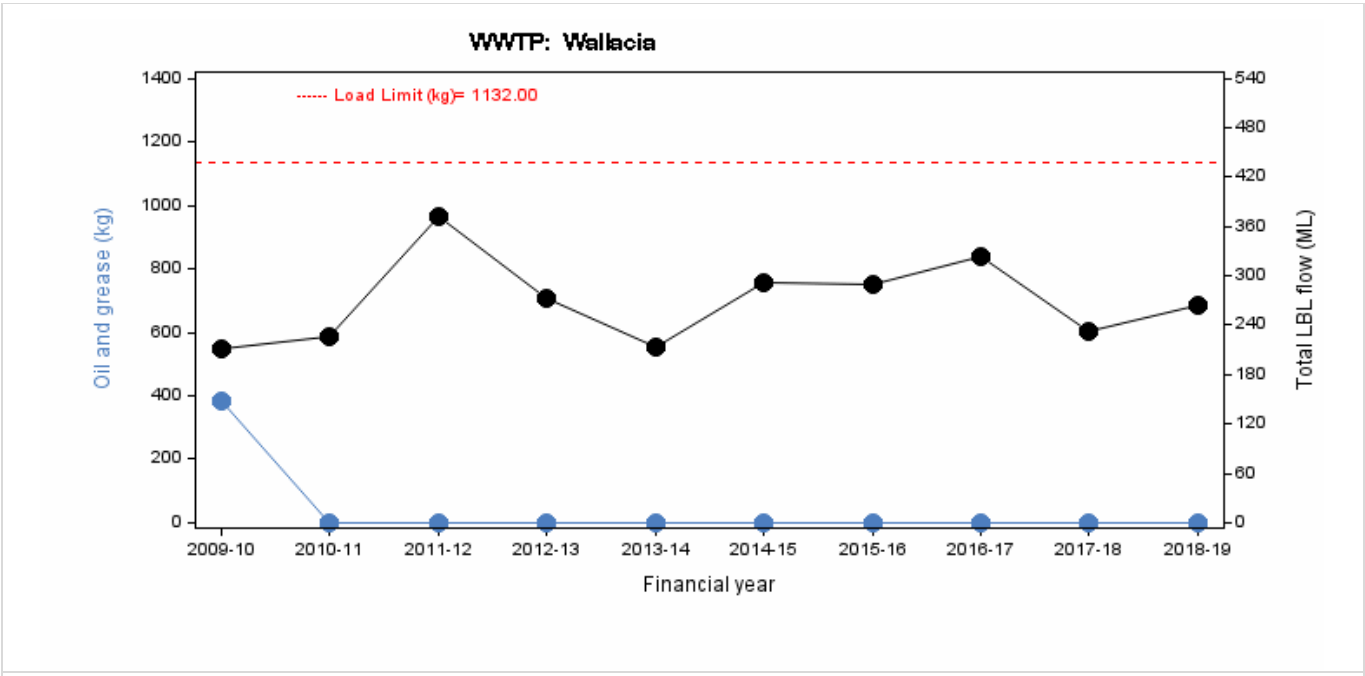
Discharge load: Nutrients

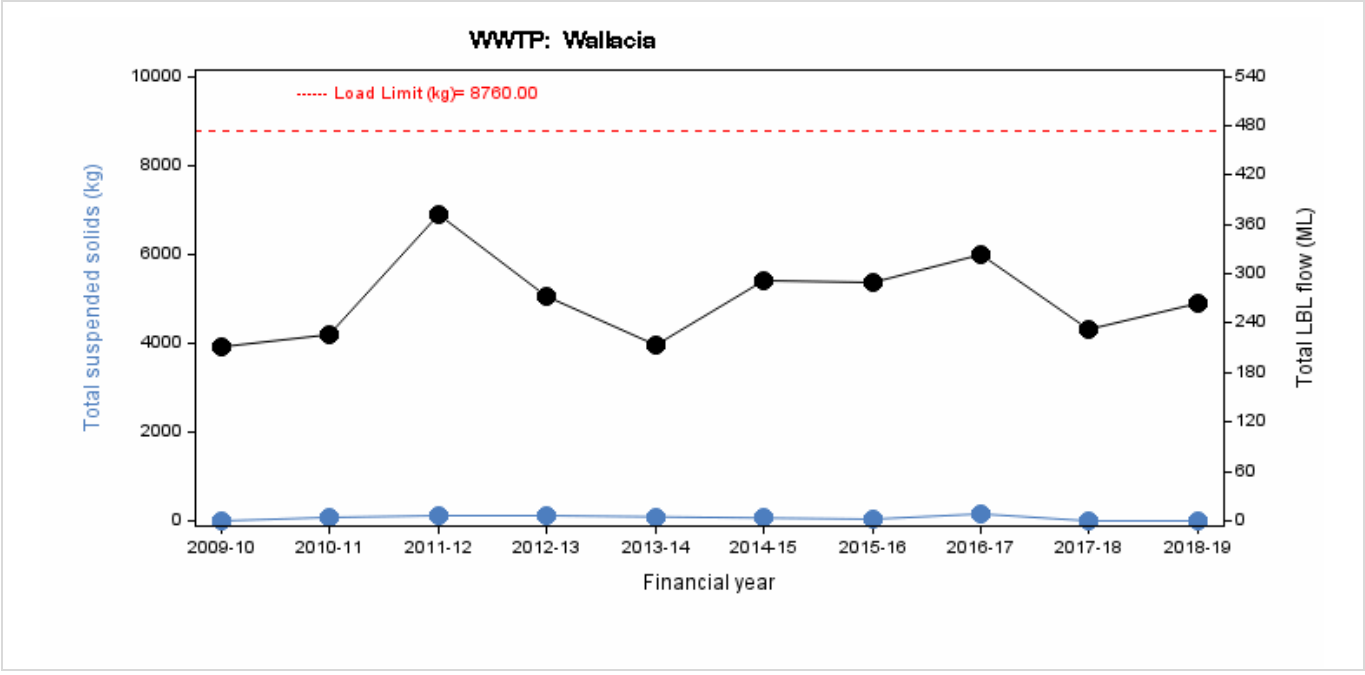




Discharge load: Major conventional analytes

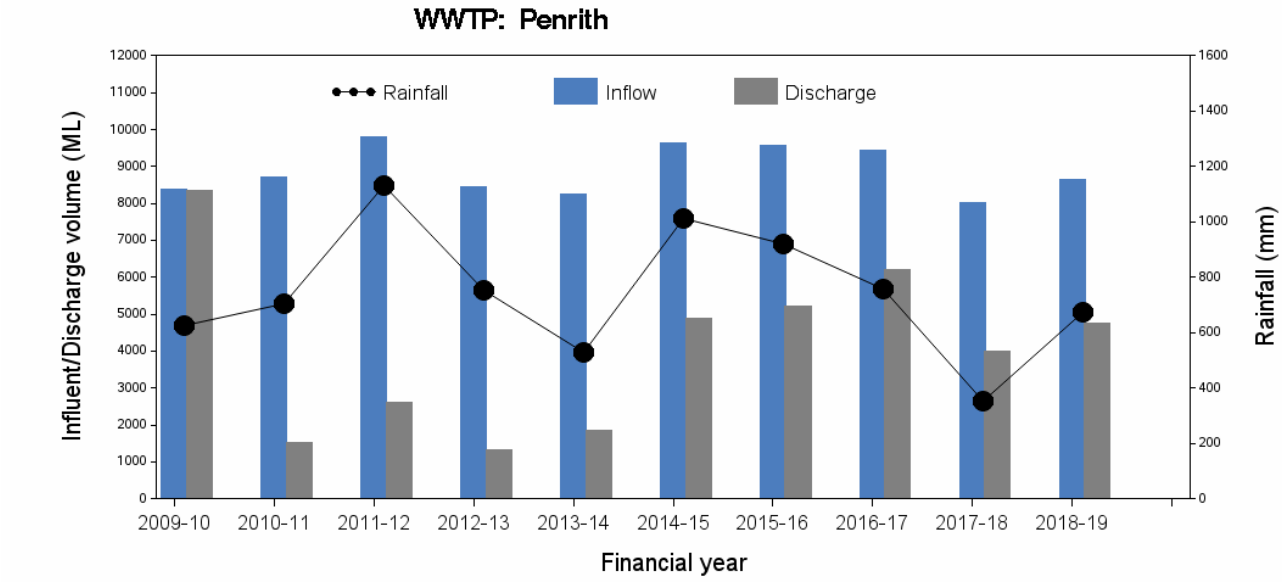


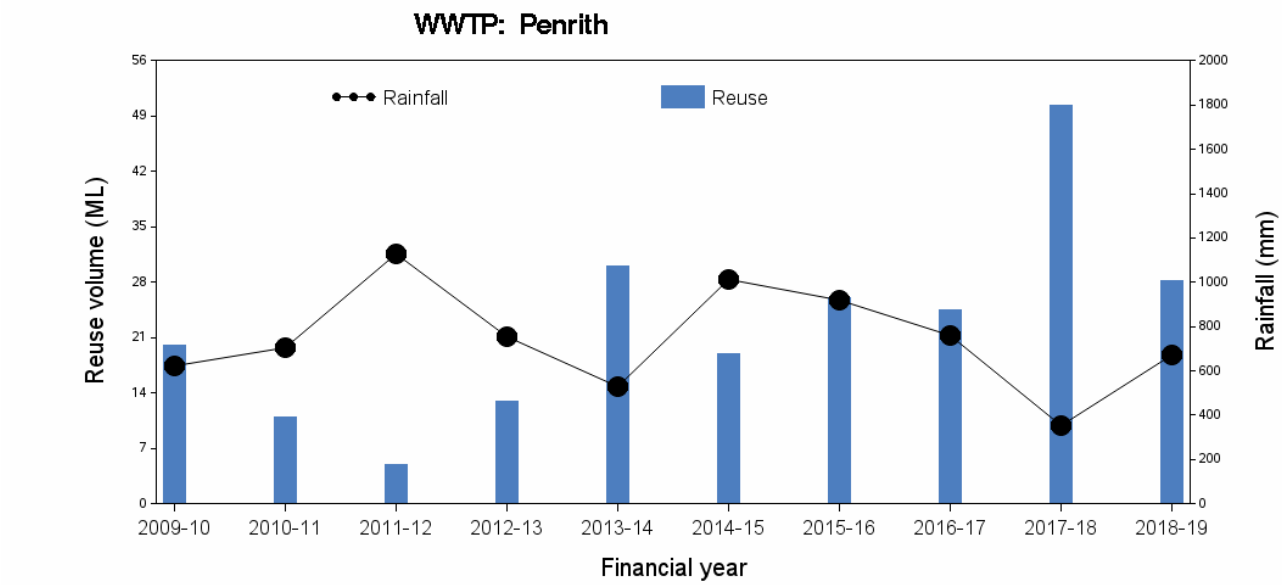

WWTP: Wallacia
Load Limit (kg)= 1132.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Wallacia
Load Limit (kg)= 8760.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

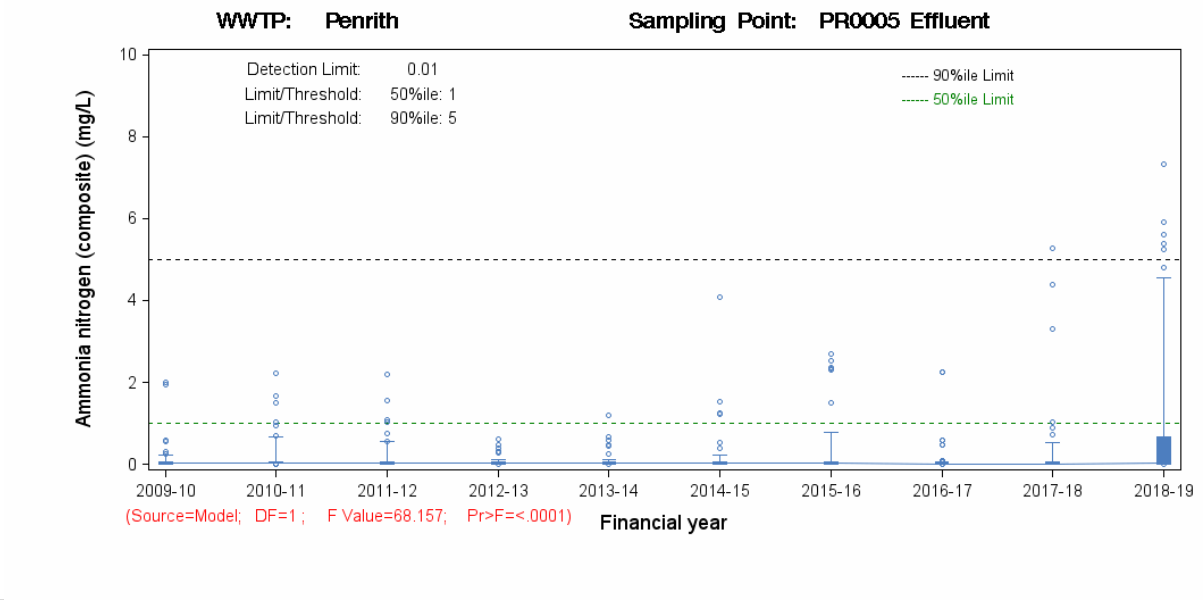
Penrith WWTP

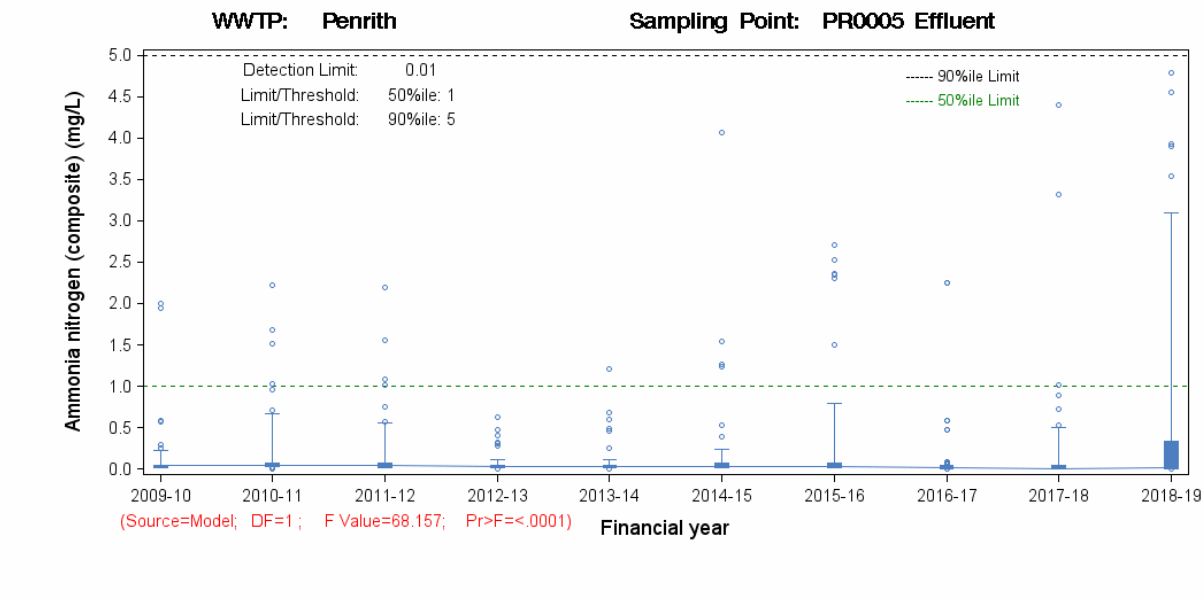
Discharge volume and rainfall

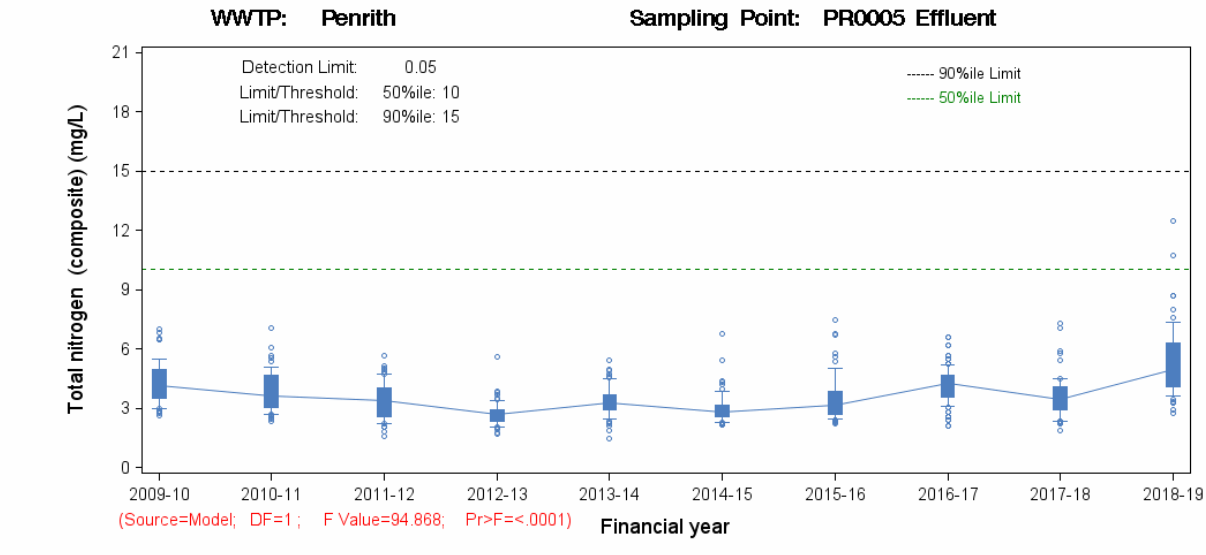


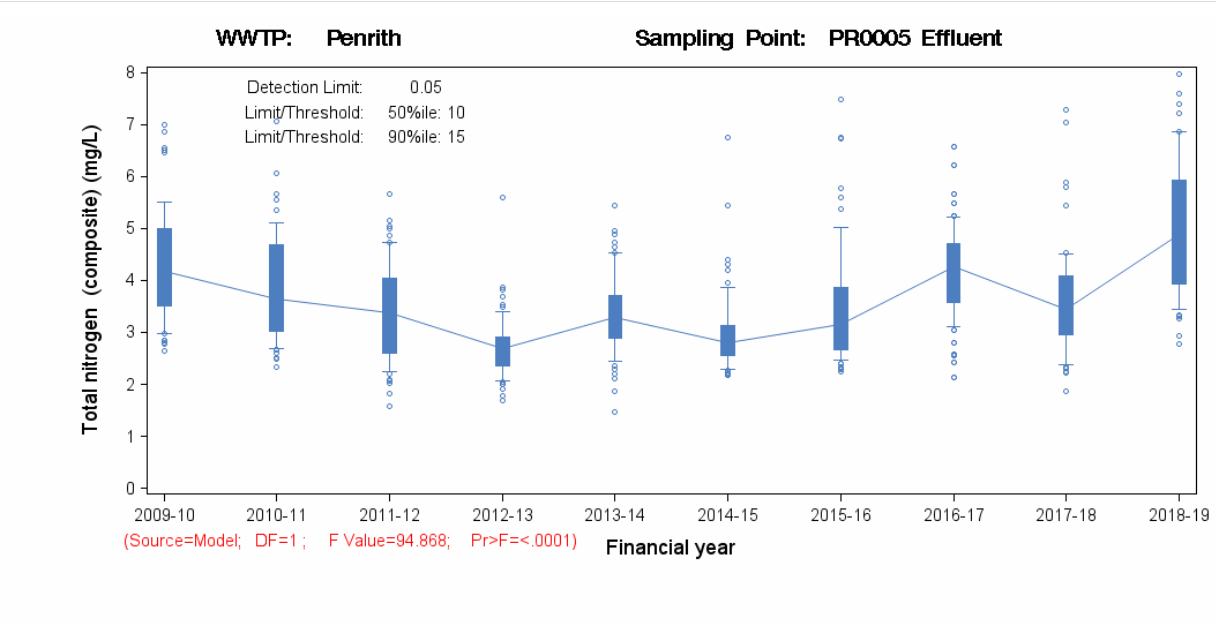


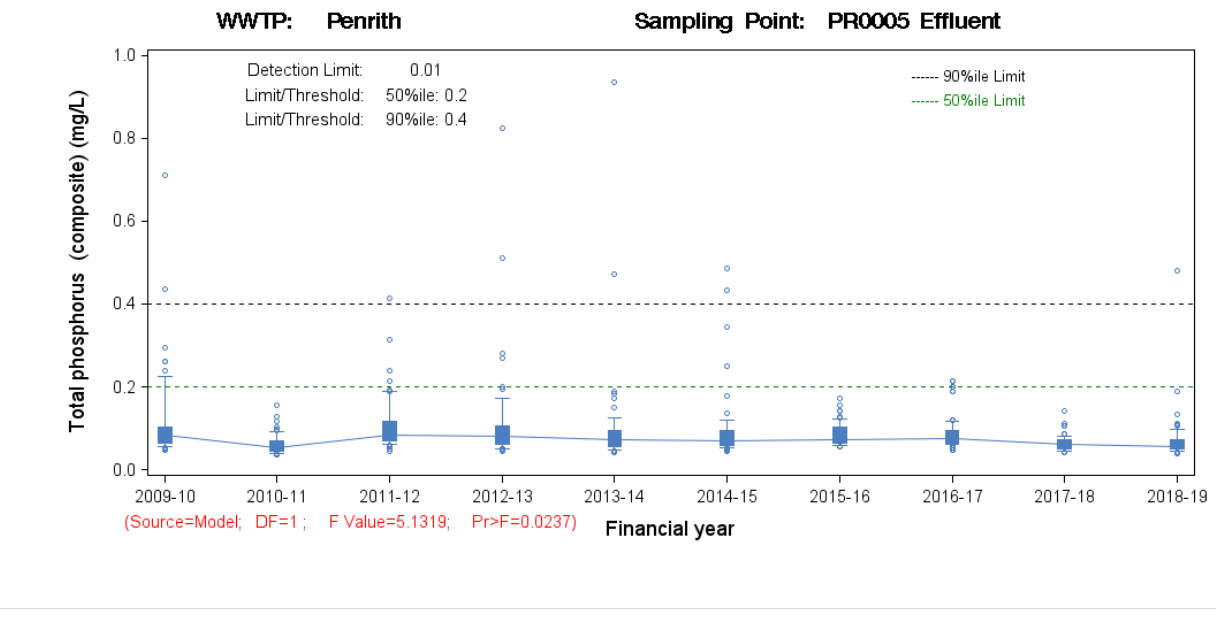
Discharge quality: Nutrients

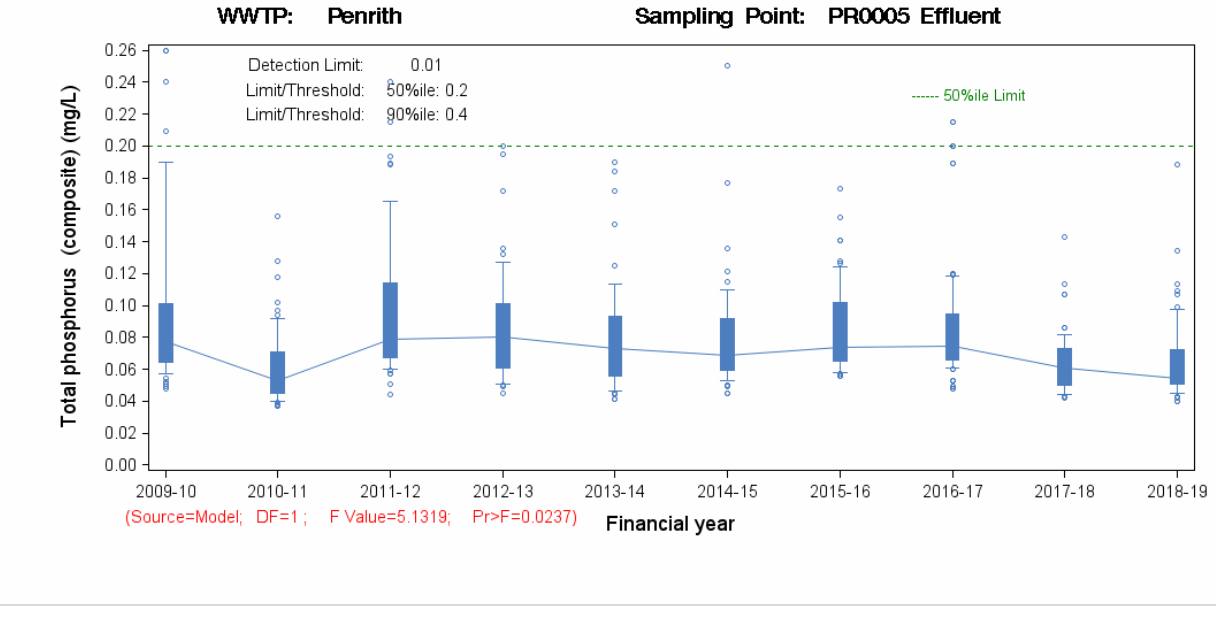




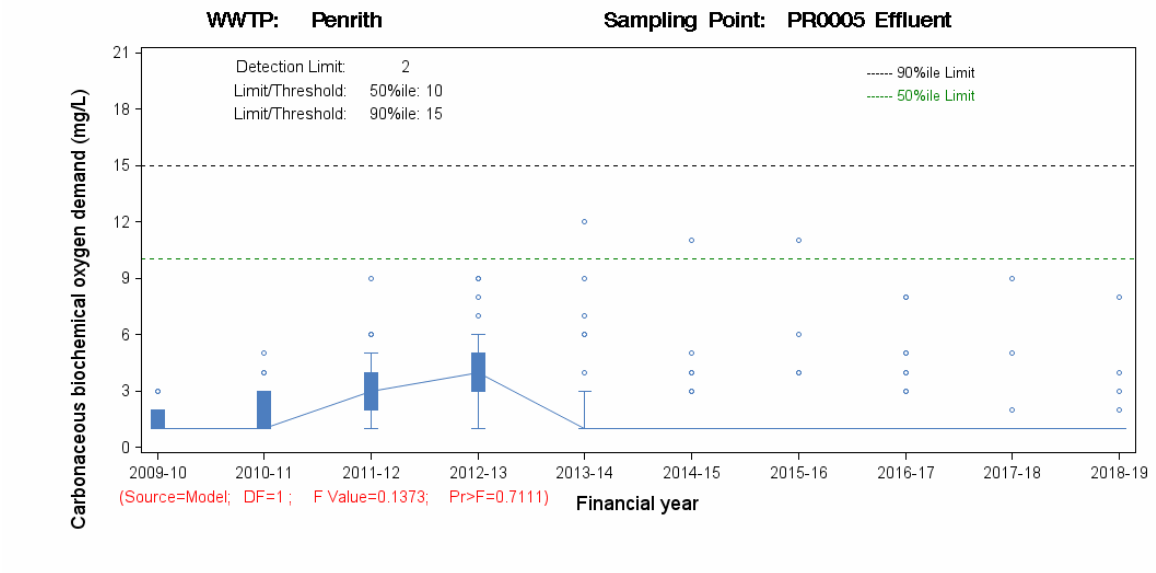



WWTP: Penrith
Sampling Point: PR0005 Effluent
Detection Limit: 0.05
Limit/Threshold: 50%ile: 10
Limit/Threshold: 90%ile: 15
Total nitrogen (composite) (mg/L)
0
1
2
3
4
5
6
7
8
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=94.868; Pr>F=<.0001)
Financial year

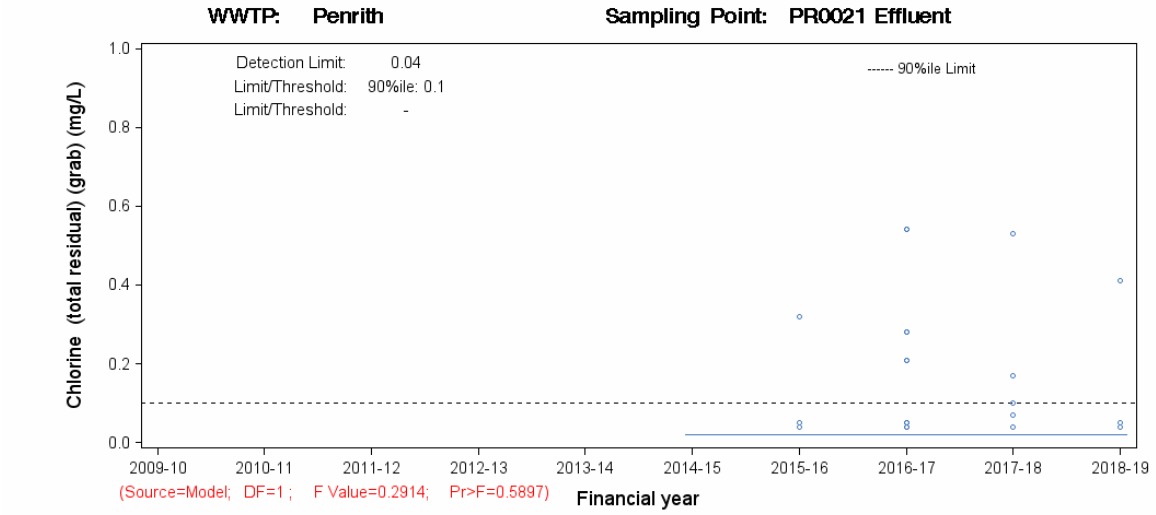

WWTP: Penrith
Sampling Point: PR0005 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 0.2
Limit/Threshold: 90%ile: 0.4
----- 90%ile Limit
----- 50%ile Limit
Total phosphorus (composite) (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.1319; Pr>F=0.0237)
Financial year


WWTP: Penrith
Sampling Point: PR0005 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 0.2
Limit/Threshold: 90%ile: 0.4
----- 50%ile Limit
Total phosphorus (composite) (mg/L)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.22
0.24
0.26
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.1319; Pr>F=0.0237)
Financial year

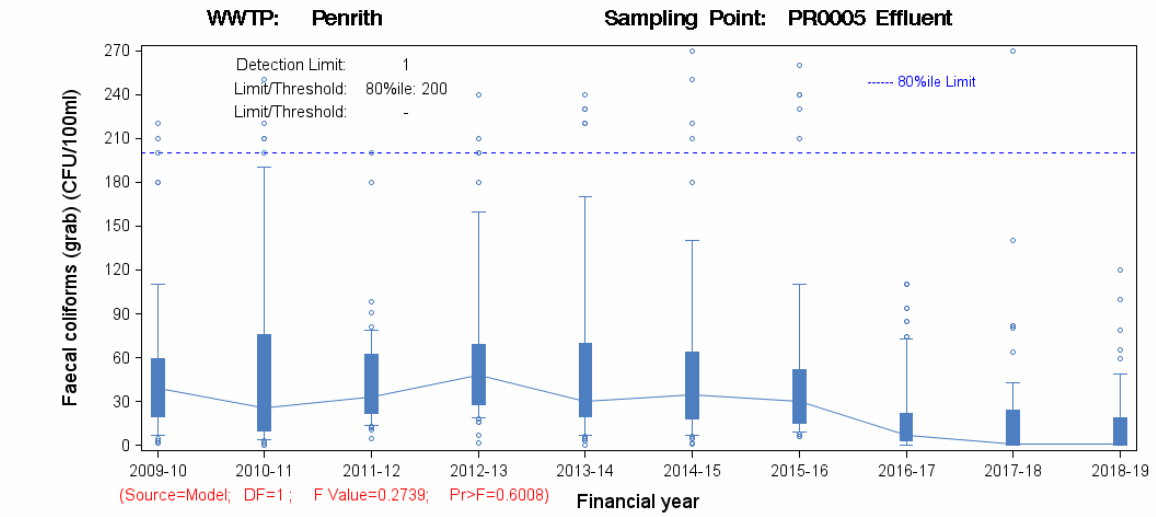
Discharge quality: Major conventional analytes

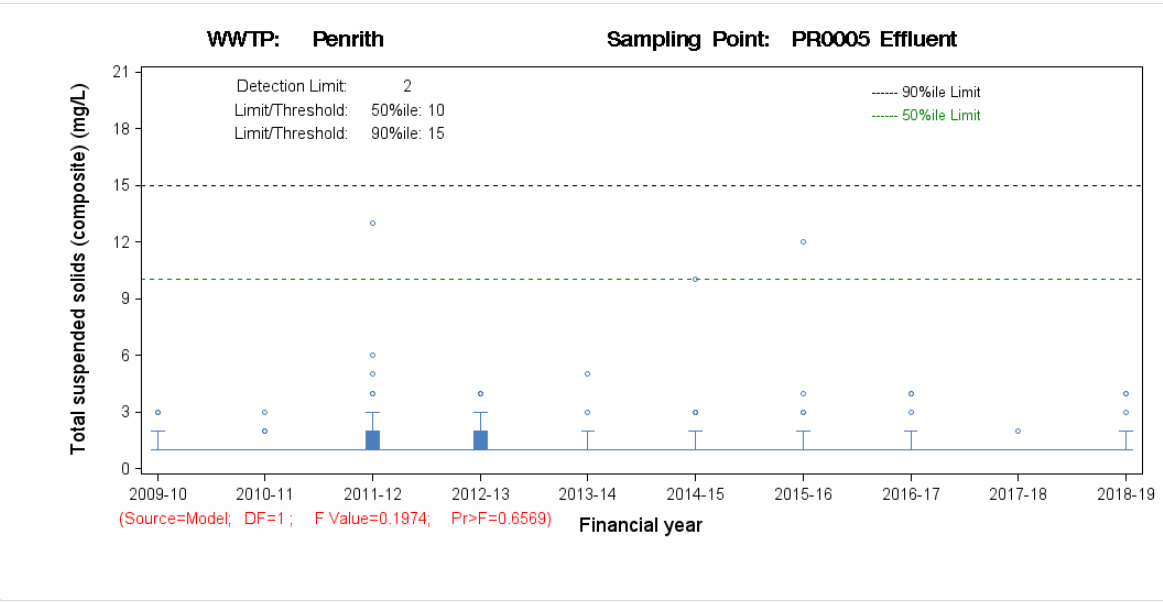


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

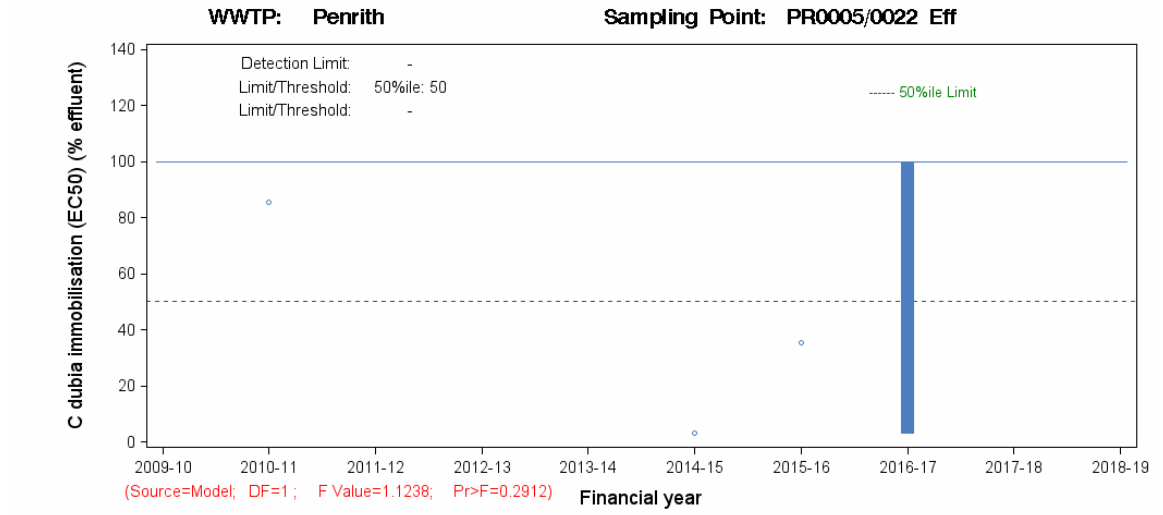


Note: Monitoring of total chlorine residual started in January 2015.

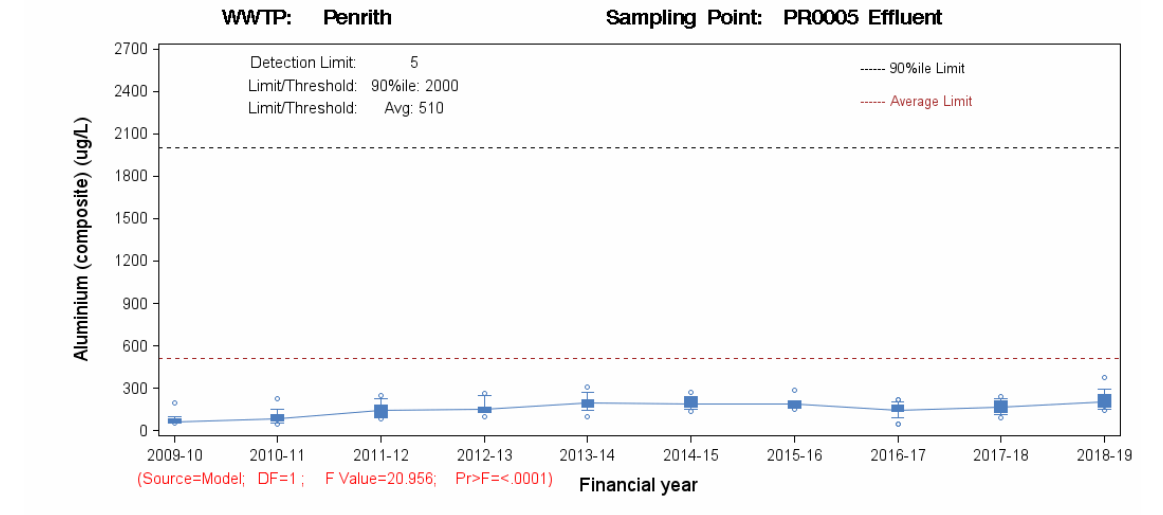


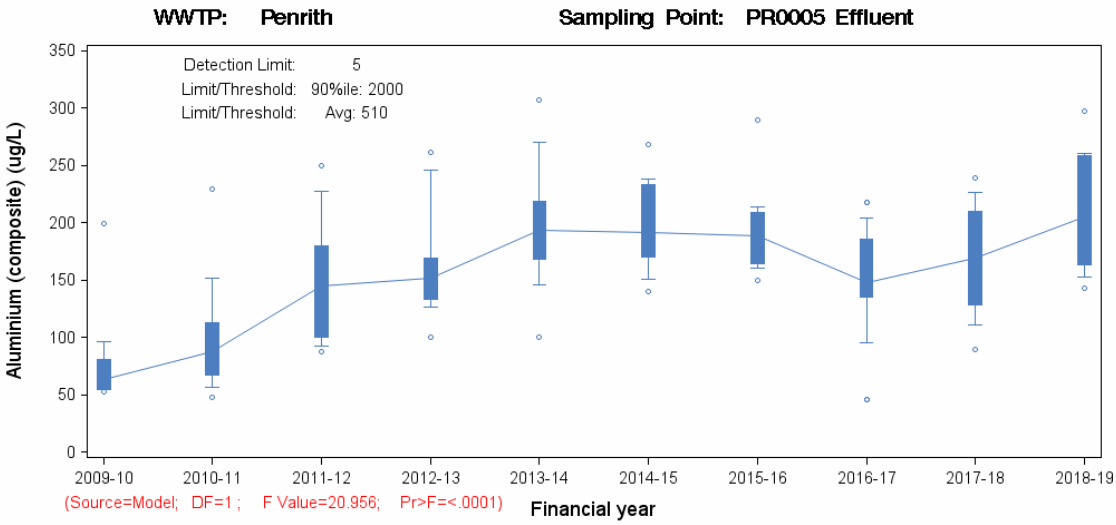


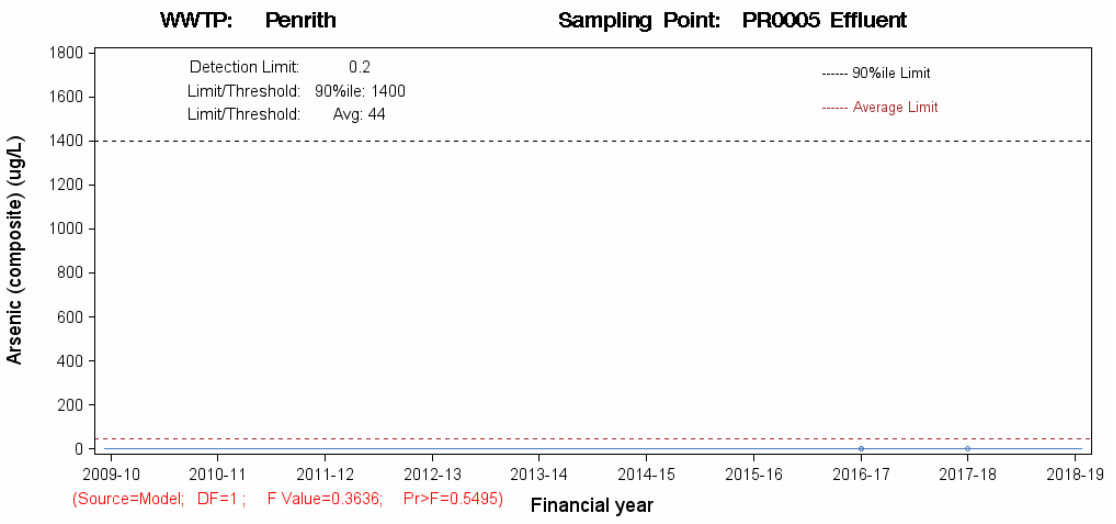
Discharge quality: Toxicity



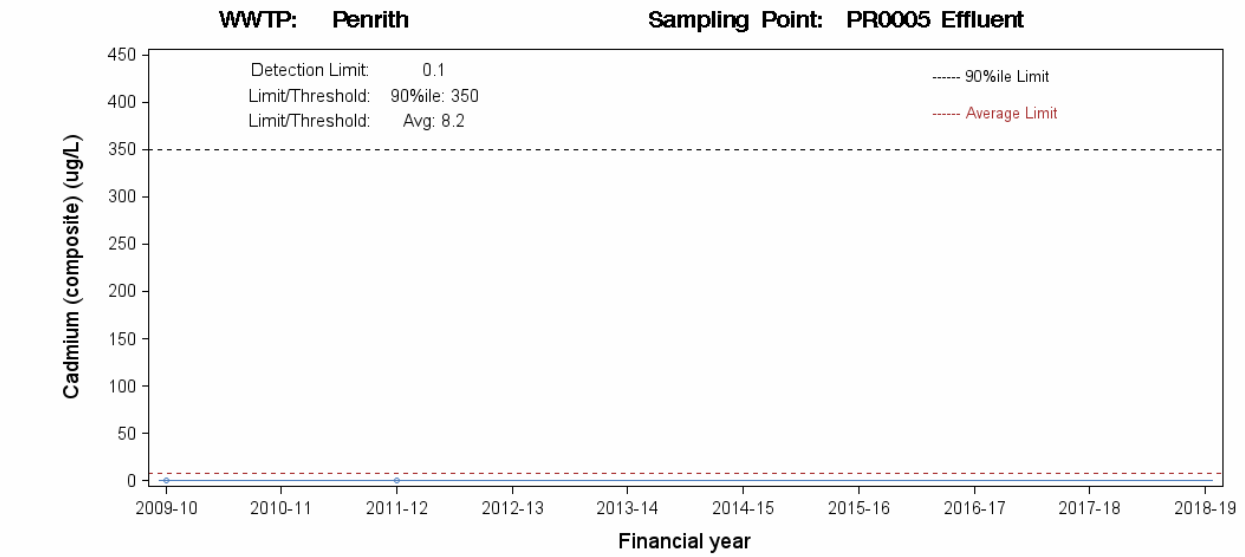
Discharge quality: Trace metals



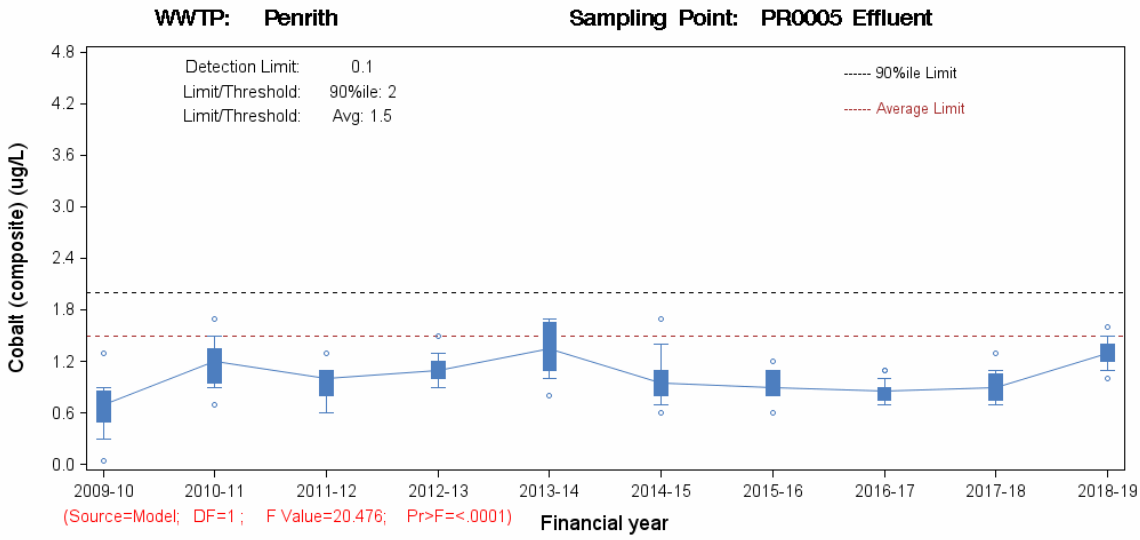


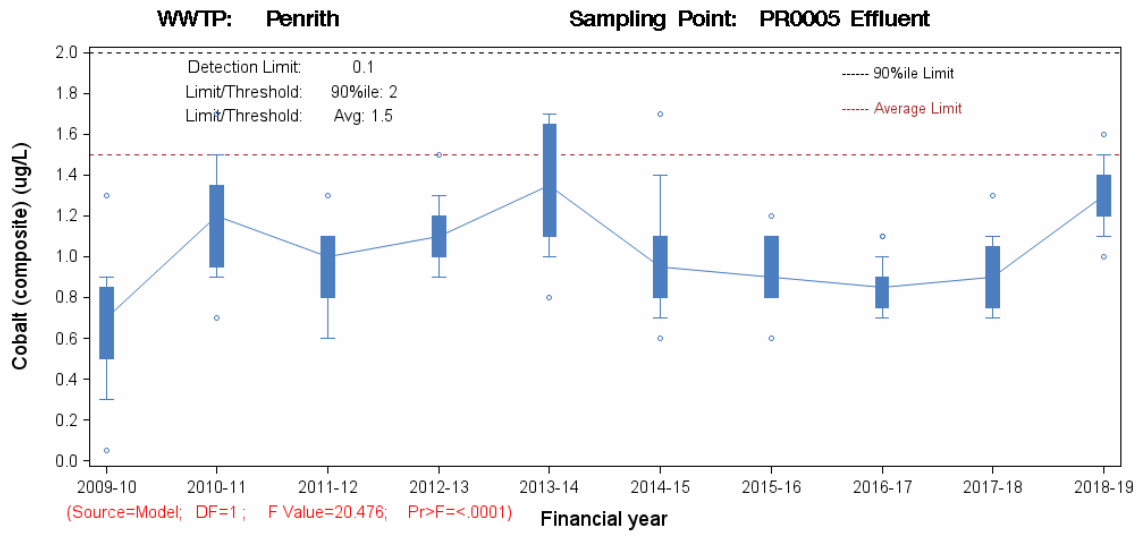


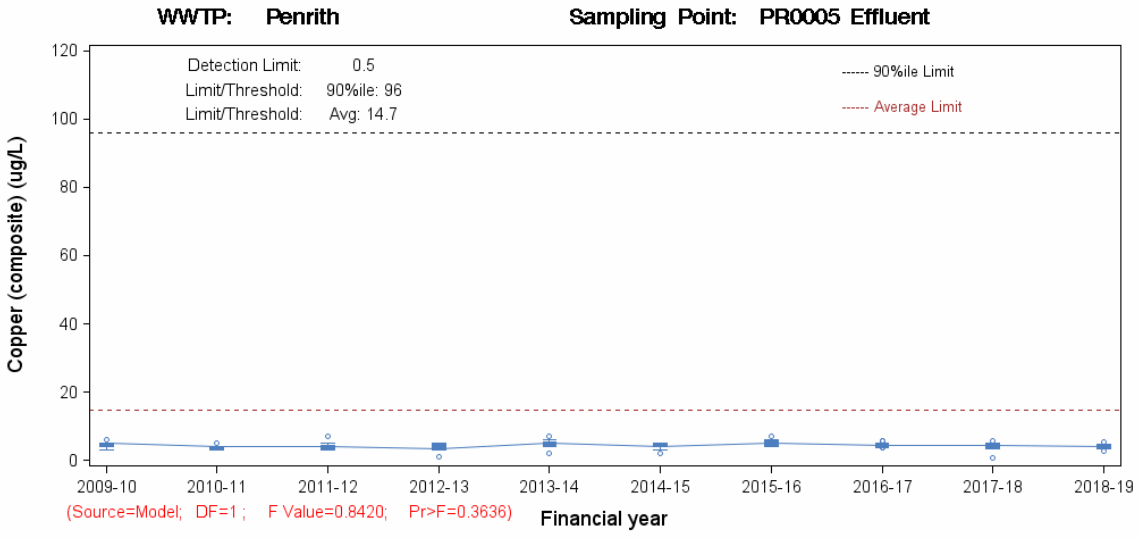
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



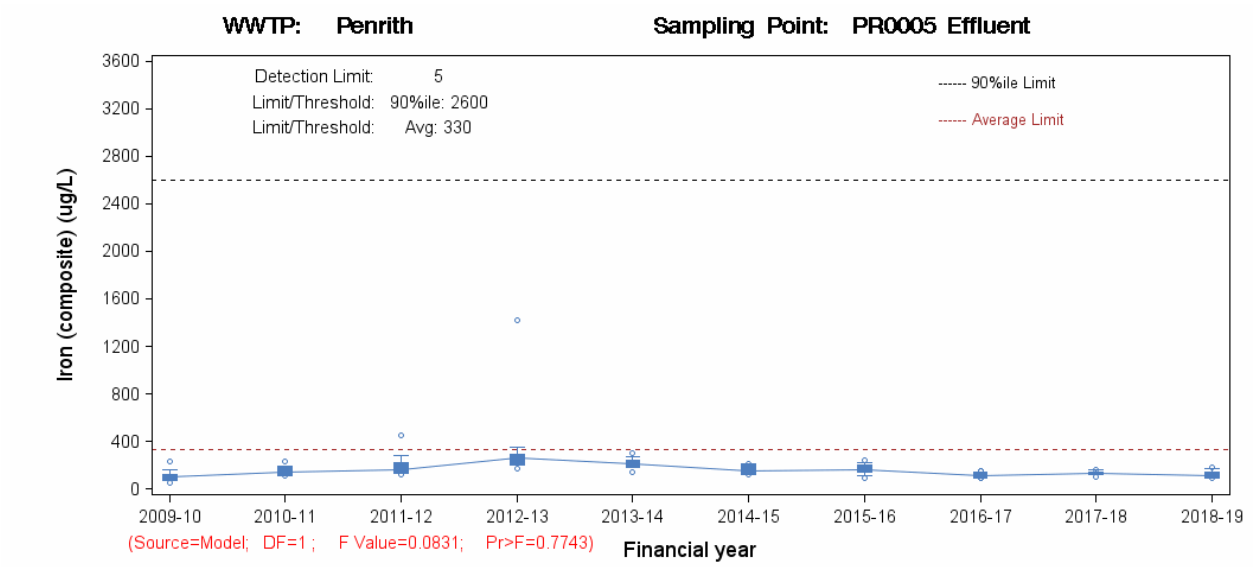
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.



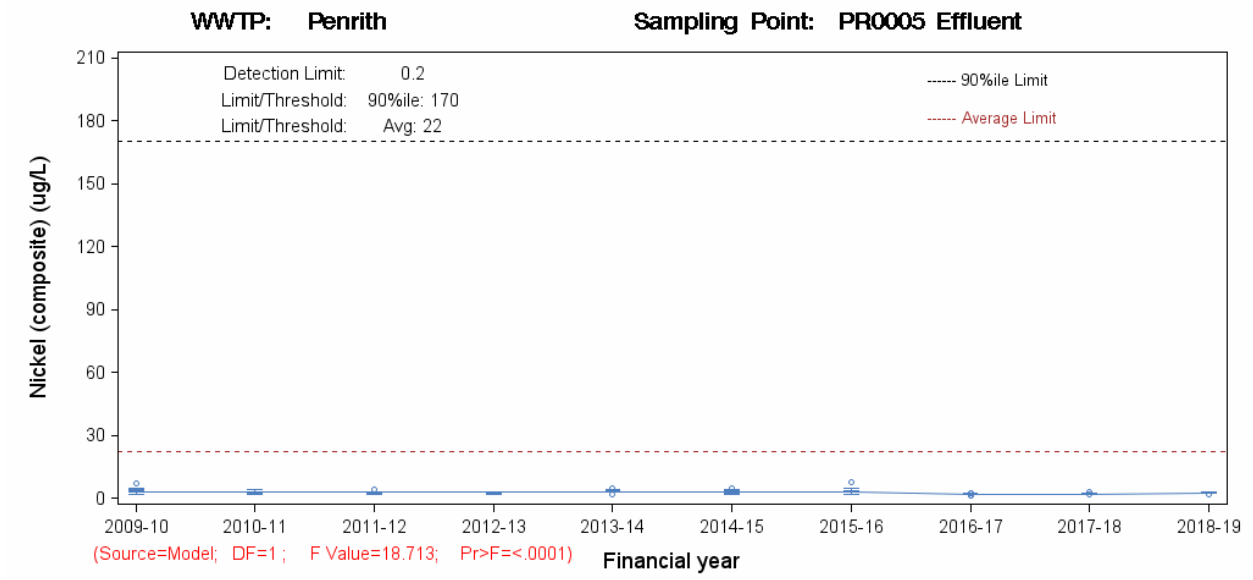




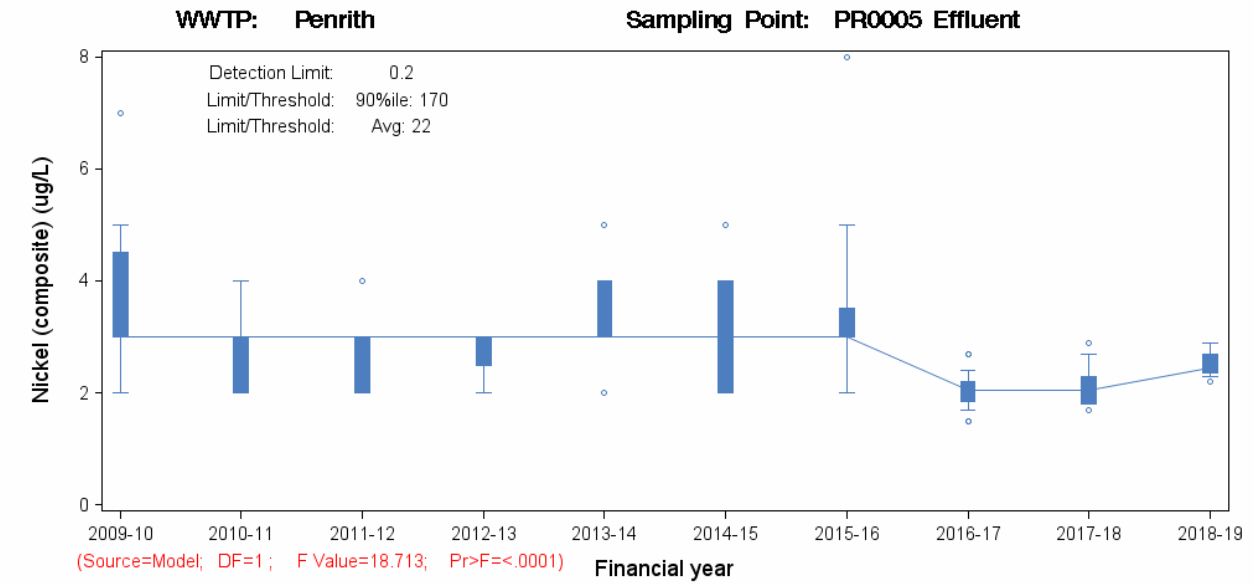
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



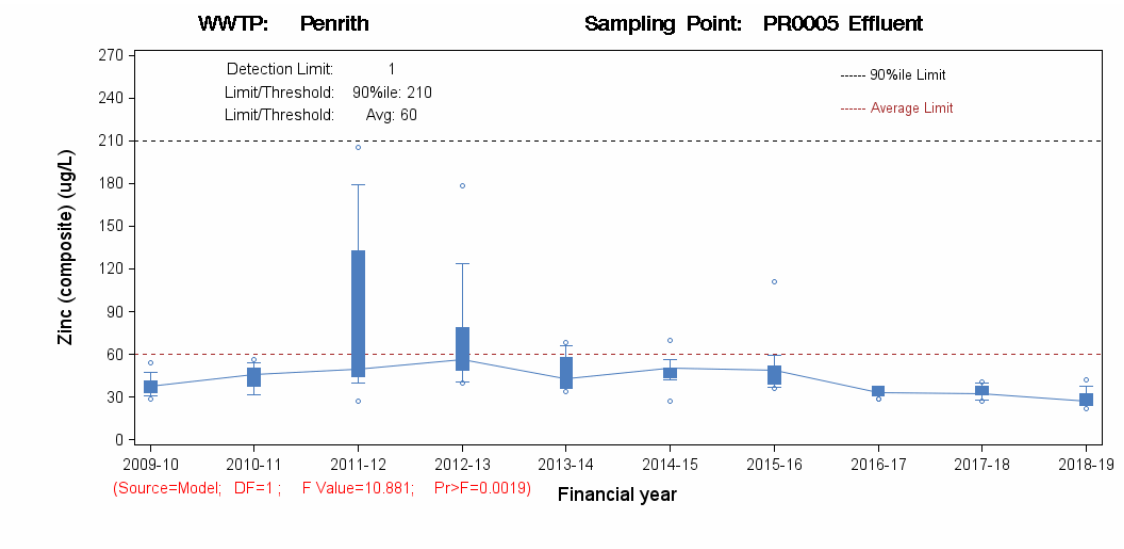
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



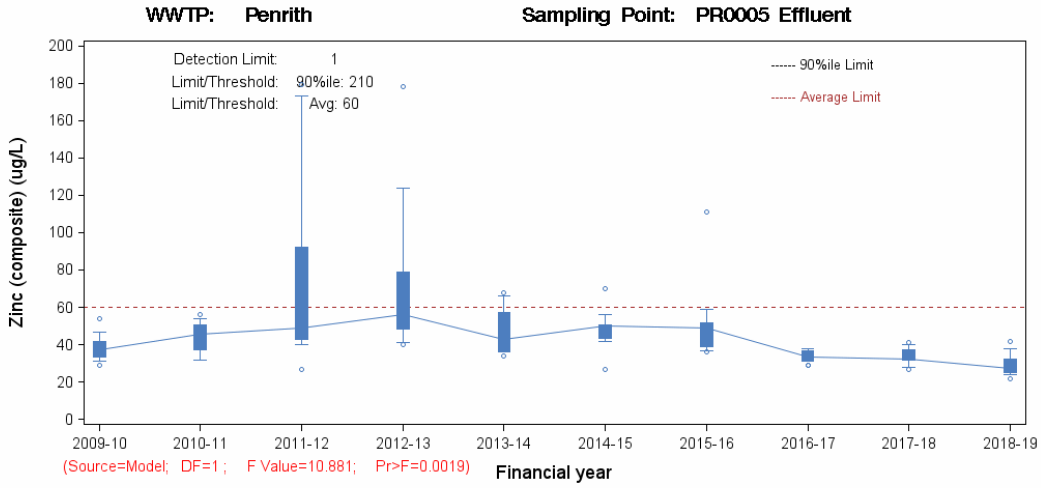
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17

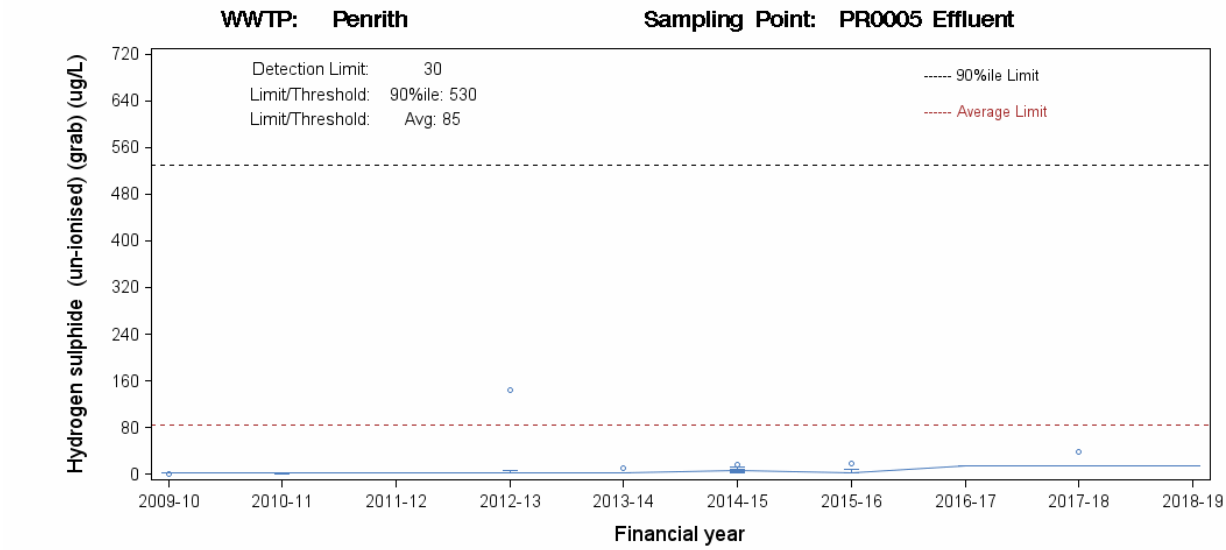


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



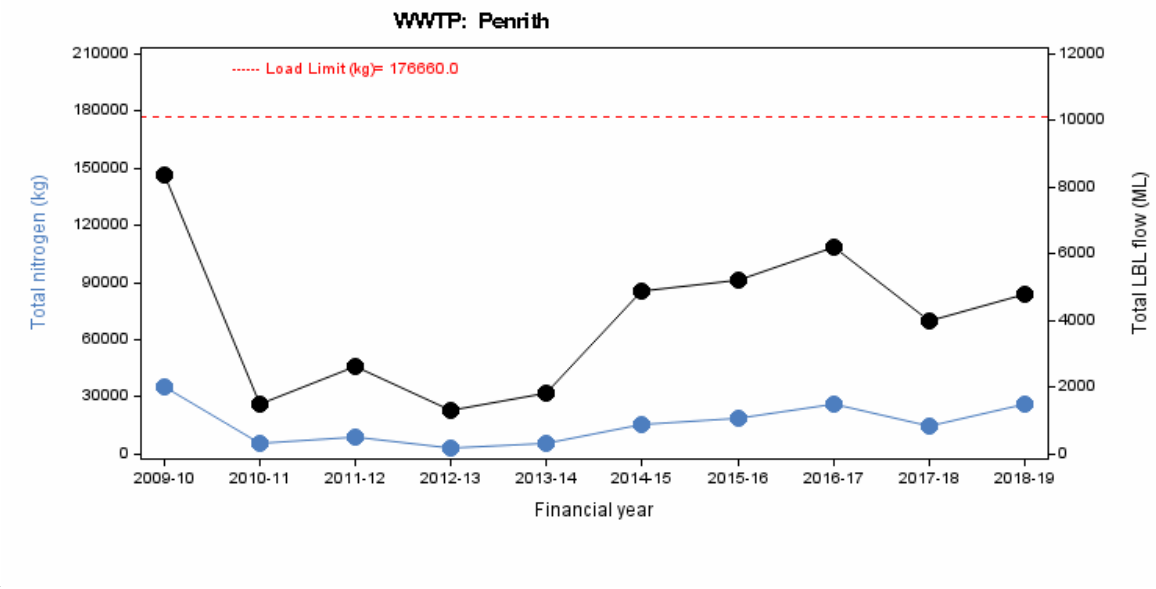
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

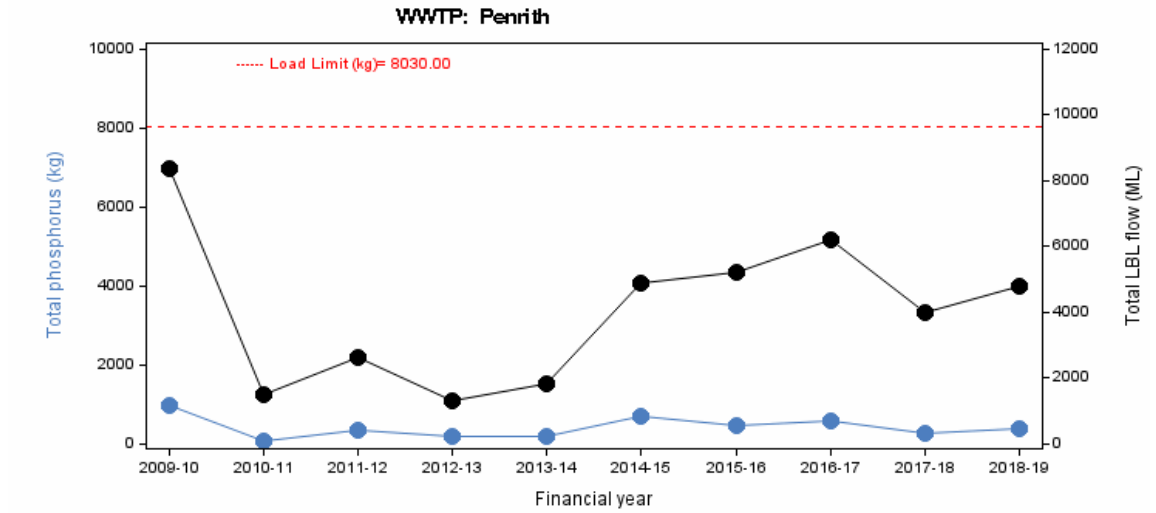
Discharge quality: Other chemicals and organics (including pesticides)



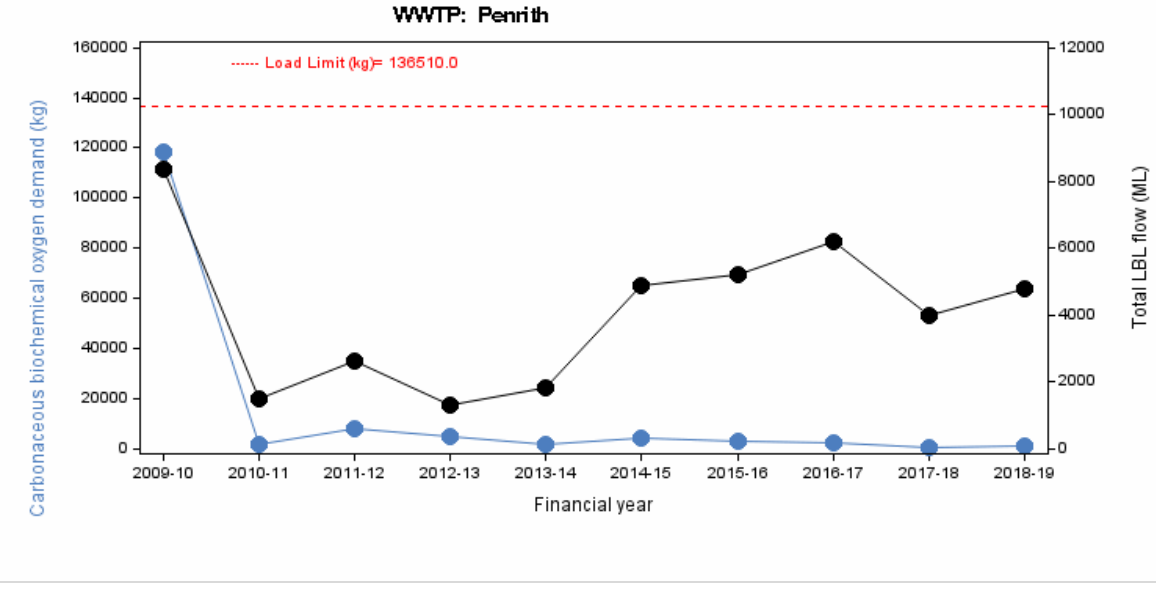
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

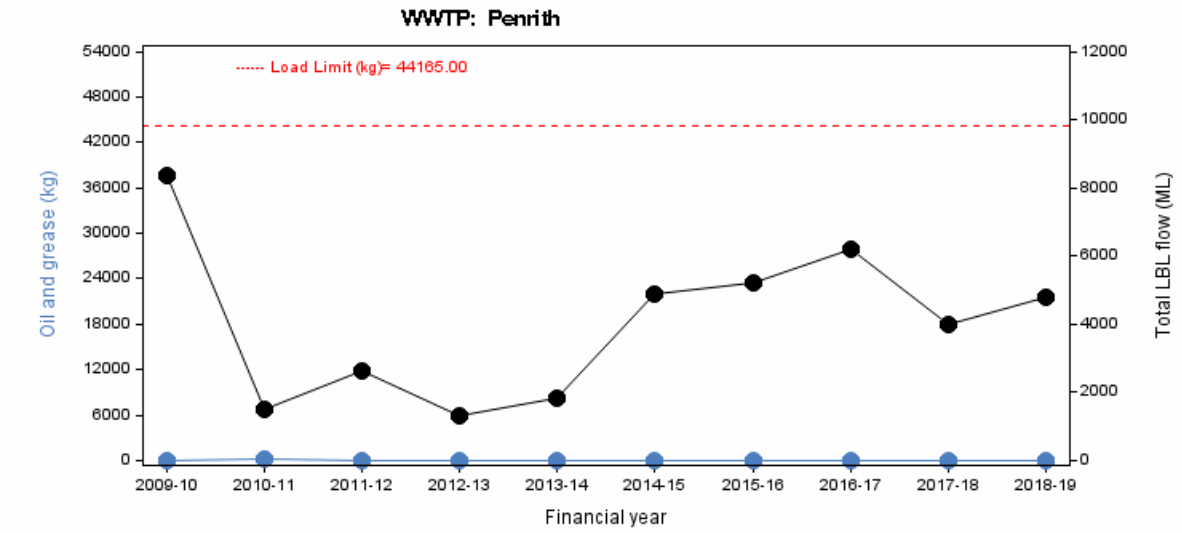
Discharge load: Nutrients

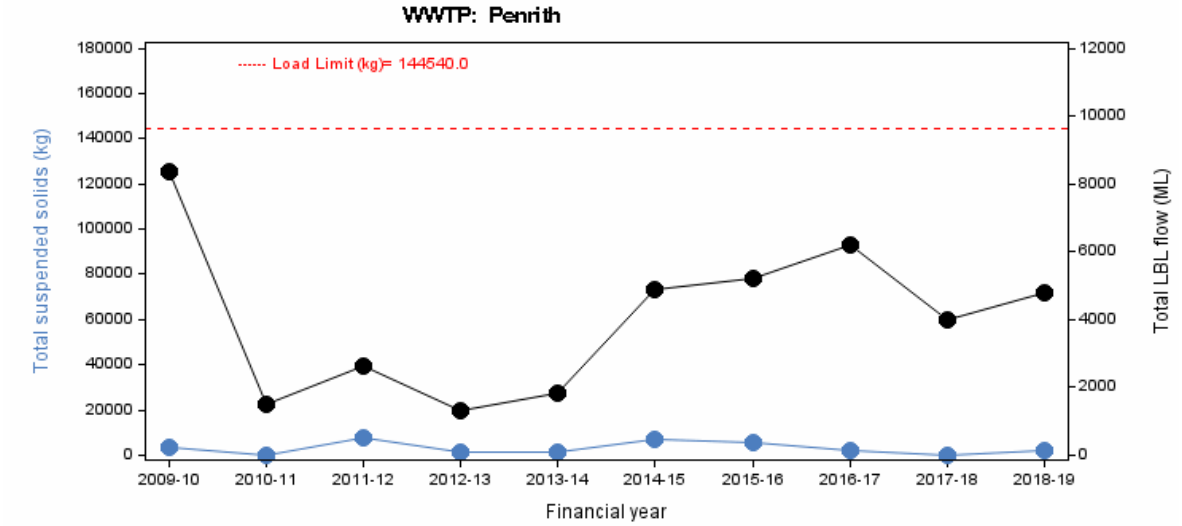




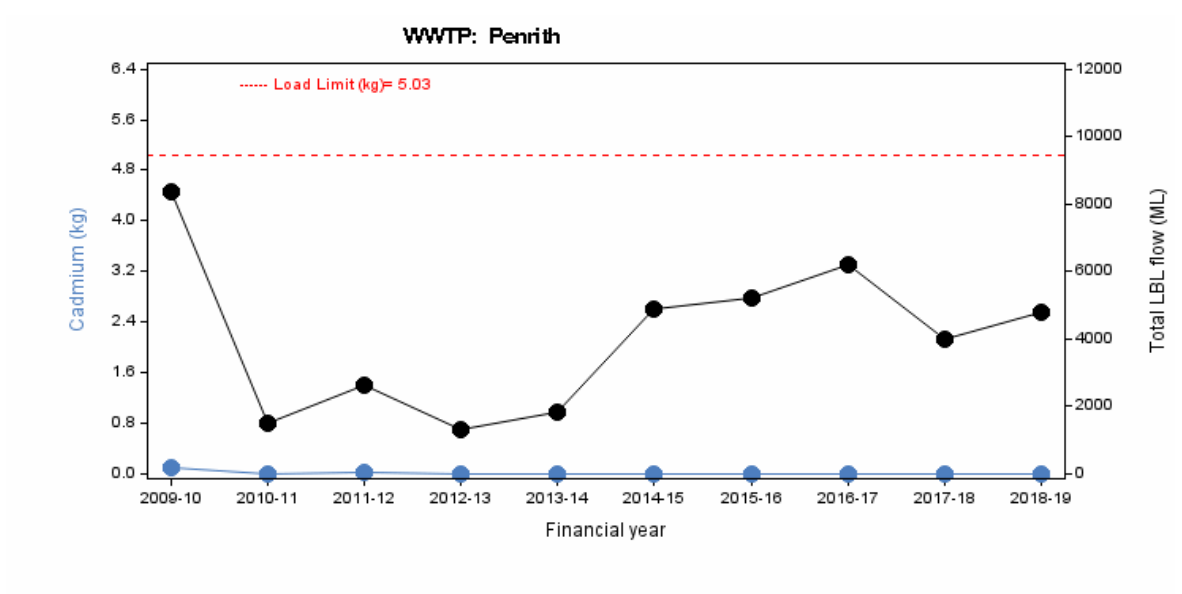
Discharge load: Major conventional analytes

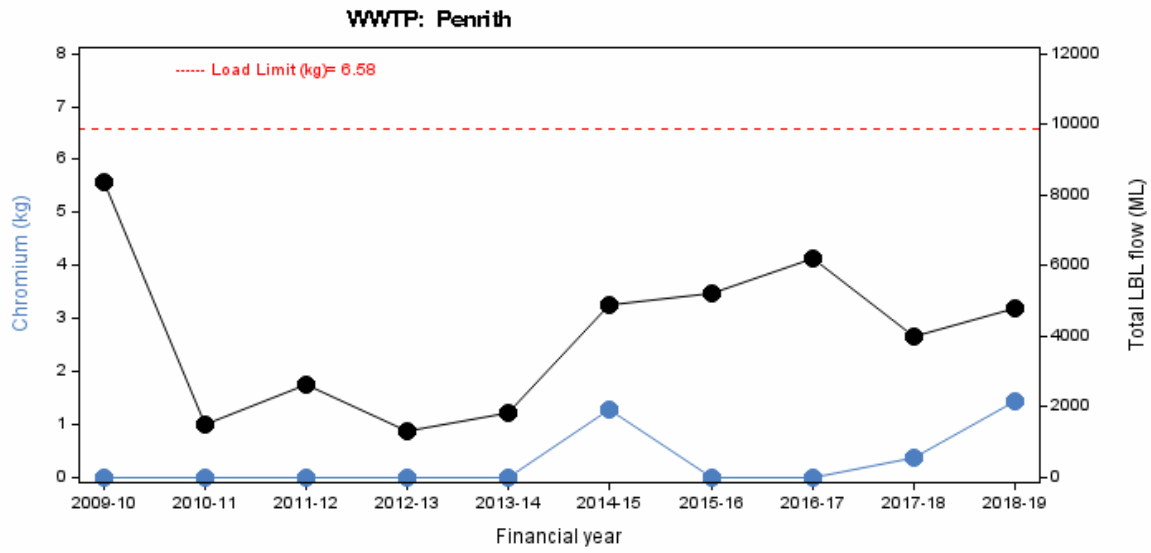


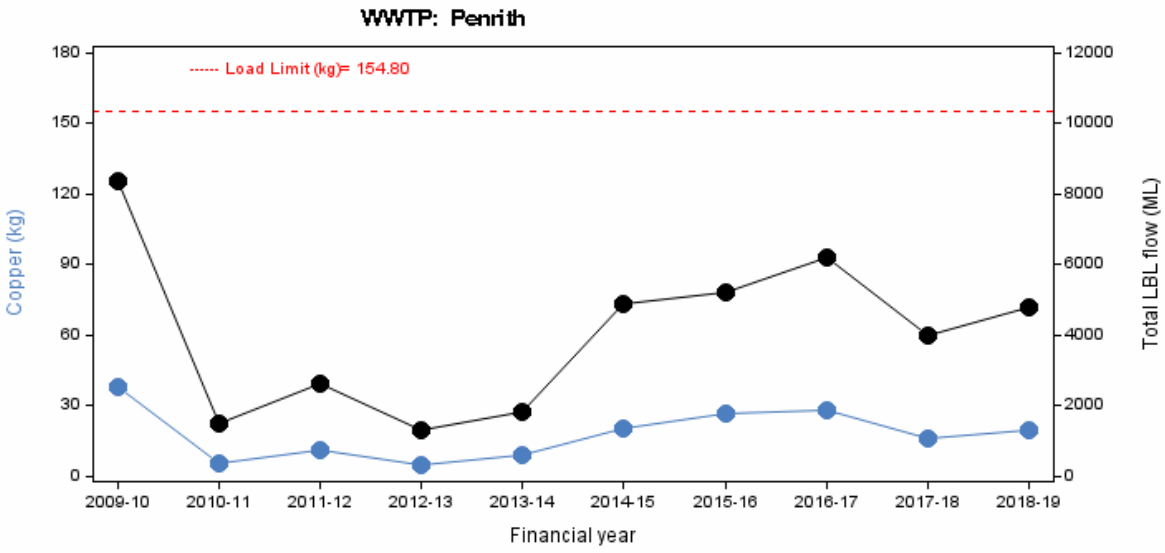


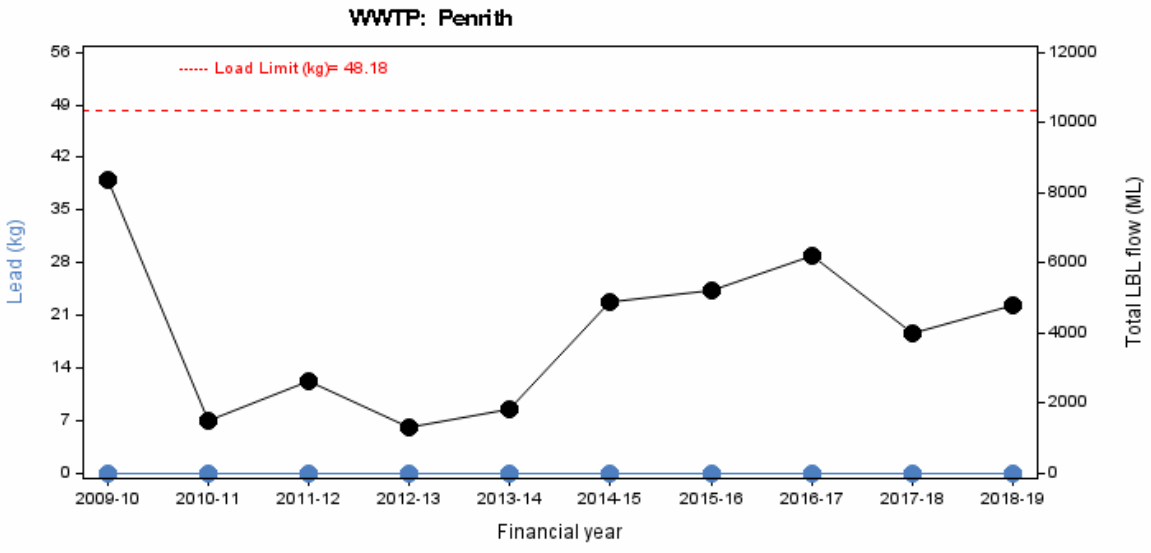


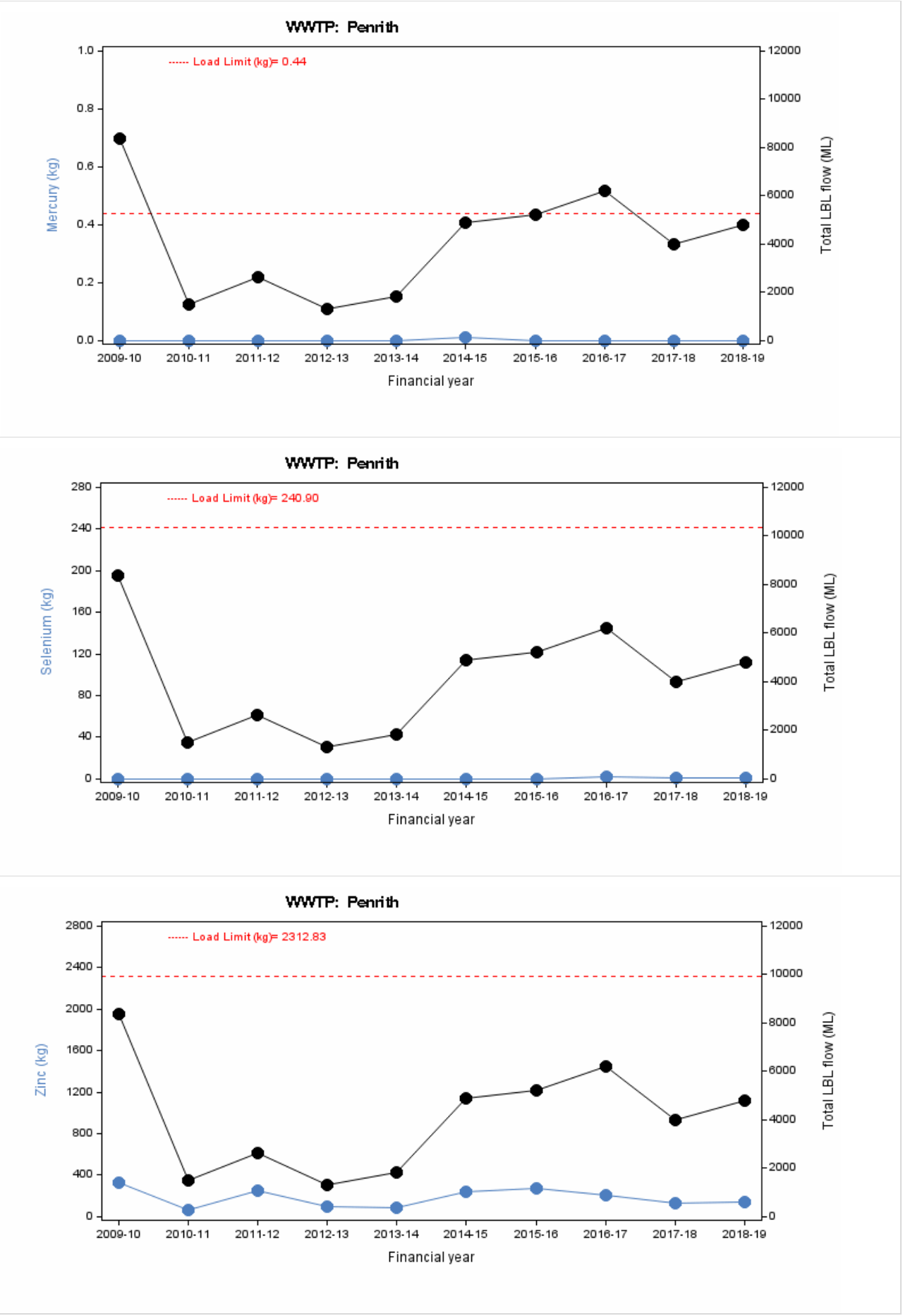
Discharge load: Trace metals



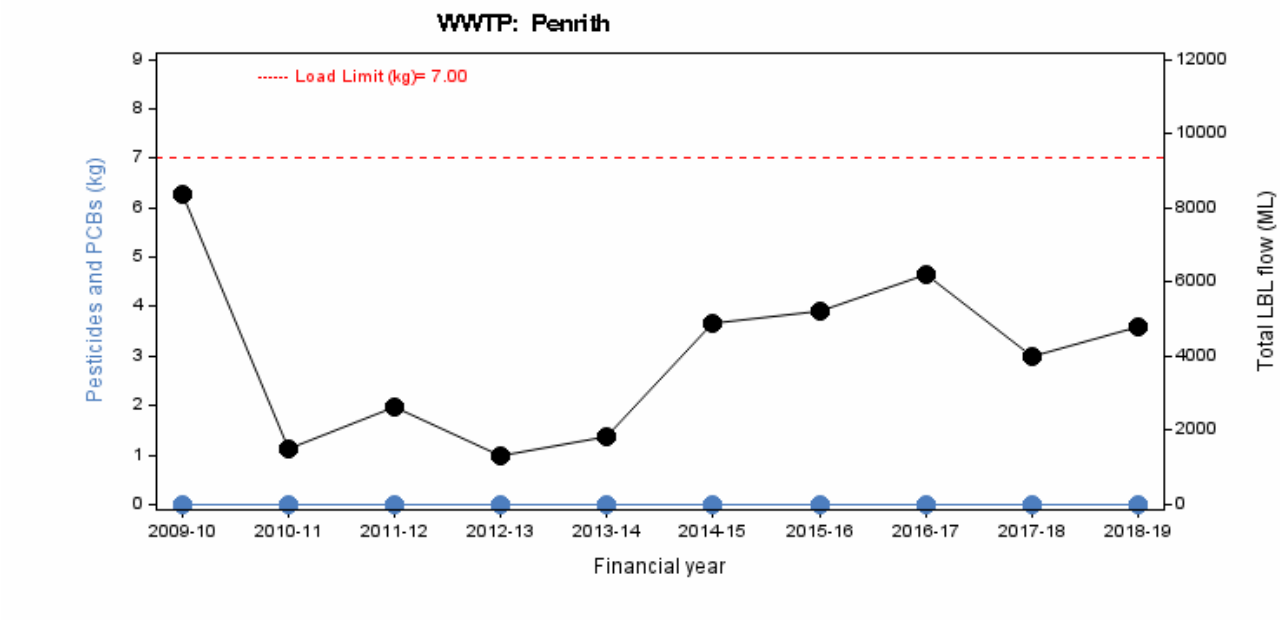

WWTP: Penrith
Load Limit (kg)= 6.58
Chromium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Penrith
Load Limit (kg)= 154.80
Copper (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Penrith
Load Limit (kg)= 48.18
Lead (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

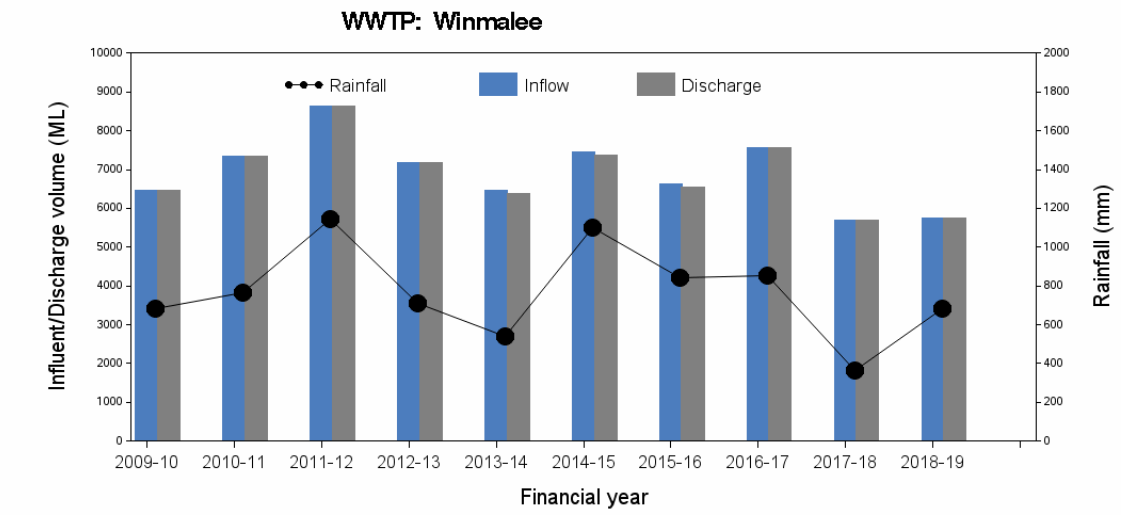

WWTP: Penrith
Load Limit (kg)= 0.44
Mercury (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
WWTP: Penrith
Load Limit (kg)= 240.90
Selenium (kg)
Total LBL flow (ML)
Financial year
WWTP: Penrith
Load Limit (kg)= 2312.83
Zinc (kg)
Total LBL flow (ML)
Financial year

Discharge load: Other chemical and organics (including pesticides)

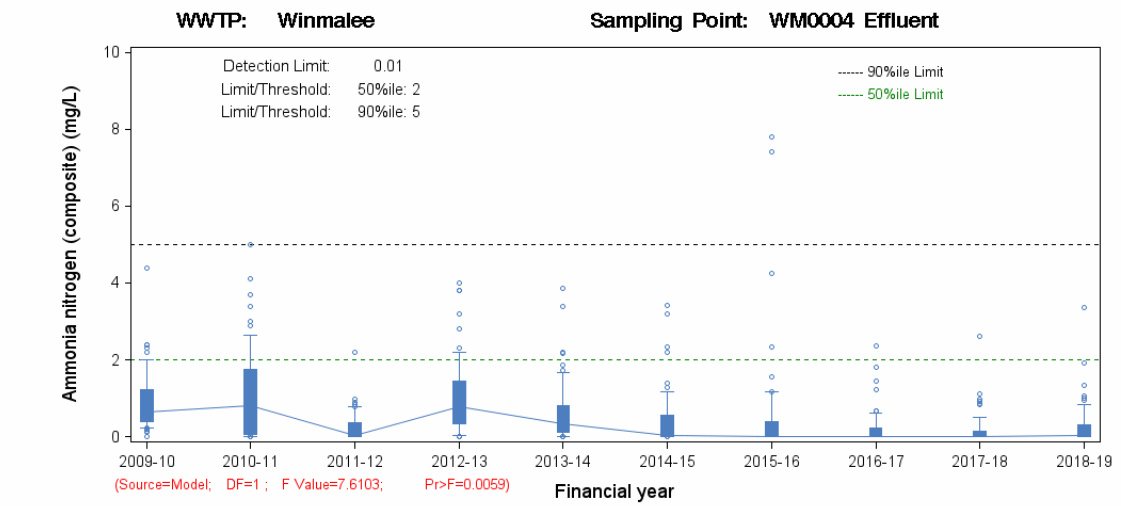


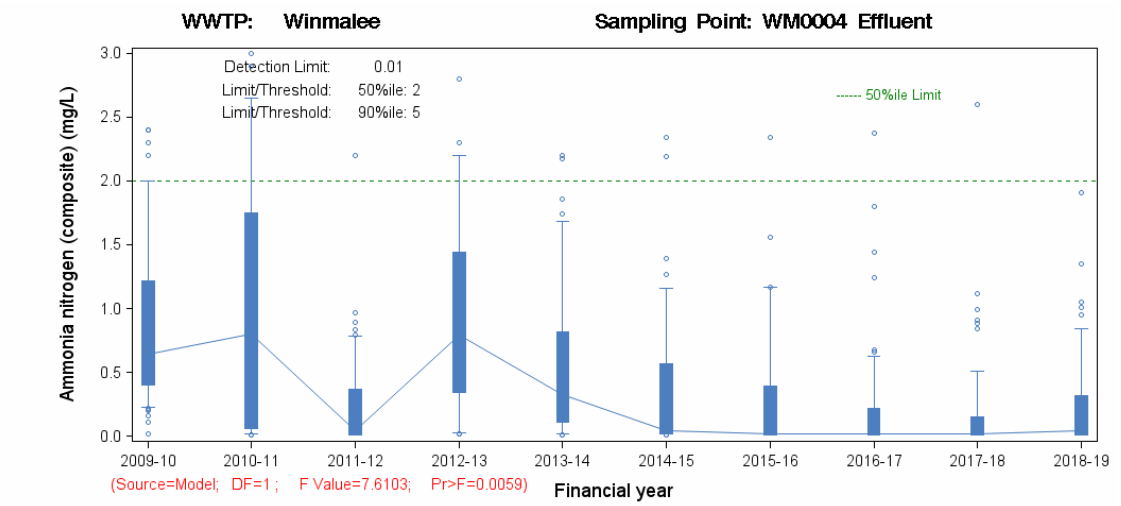
Winmalee WWTP

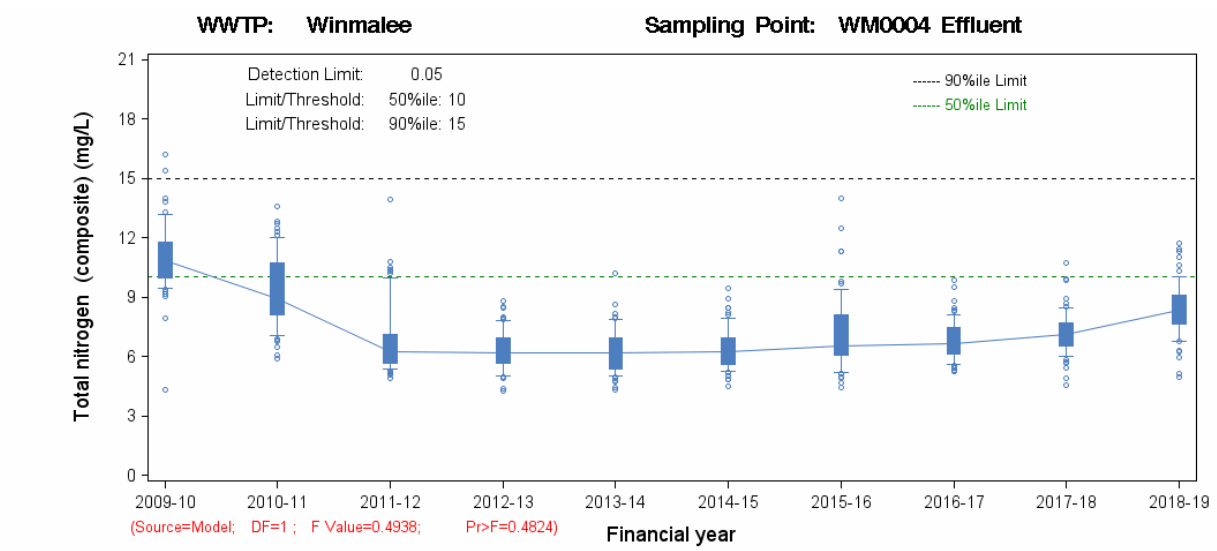
Discharge volume and rainfall

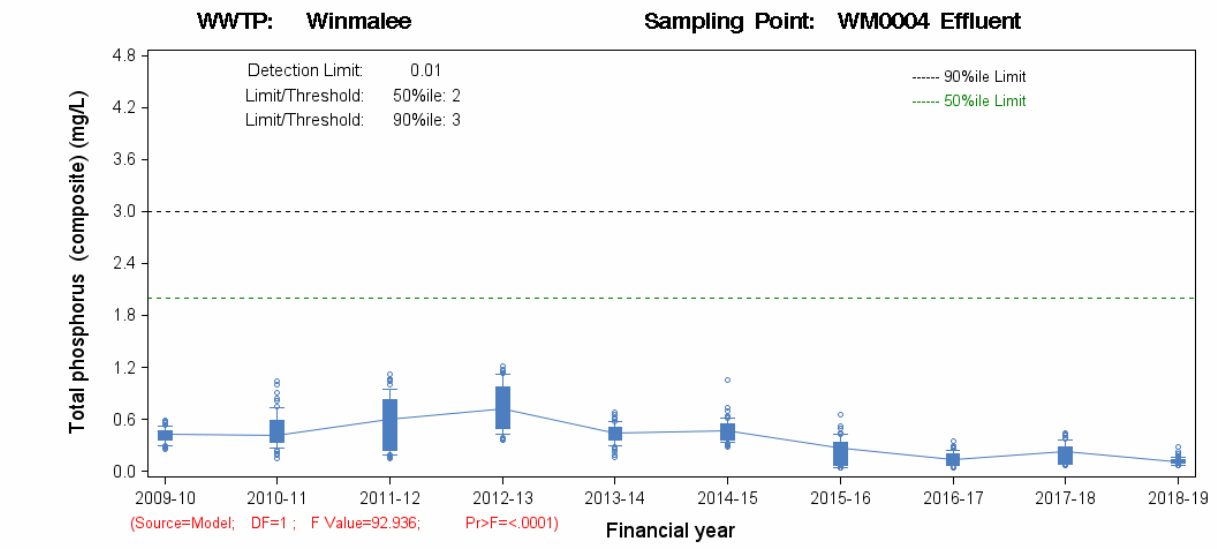


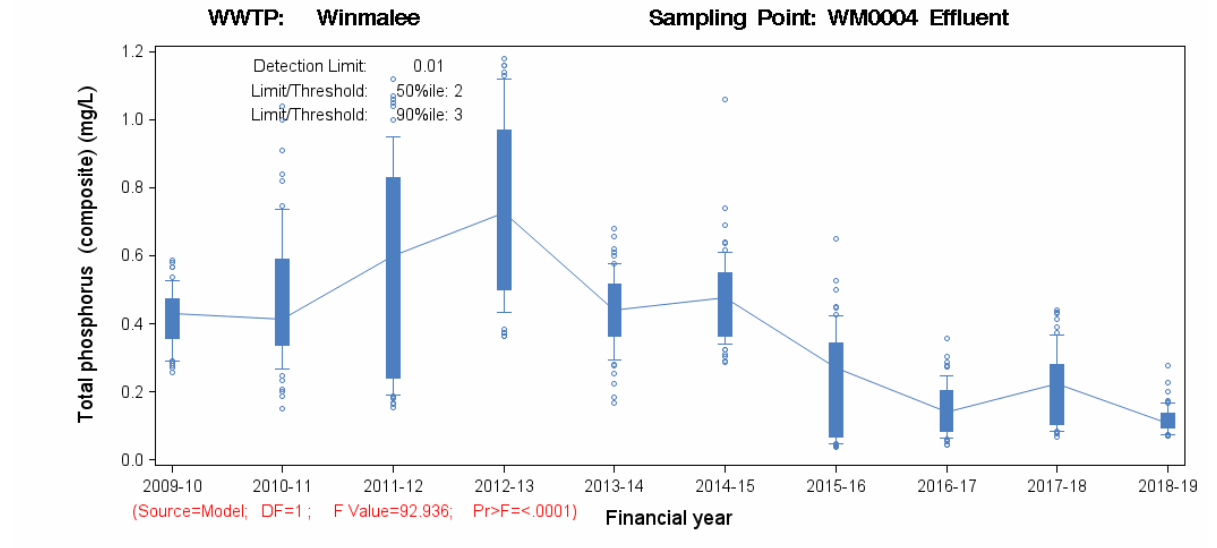
Discharge quality: Nutrients



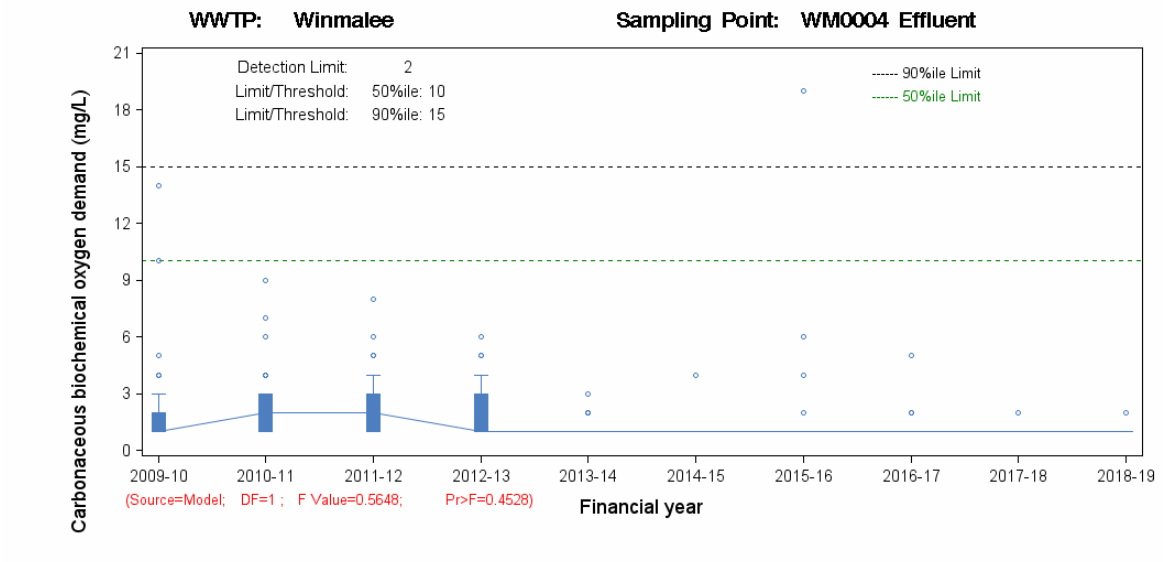



WWTP: Winmalee
Sampling Point: WM0004 Effluent
Detection Limit: 0.05
Limit/Threshold: 50%ile: 10
Limit/Threshold: 90%ile: 15
------ 90%ile Limit
------ 50%ile Limit
Total nitrogen (composite) (mg/L)
0
3
6
9
12
15
18
21
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.4938; Pr>F=0.4824)
Financial year

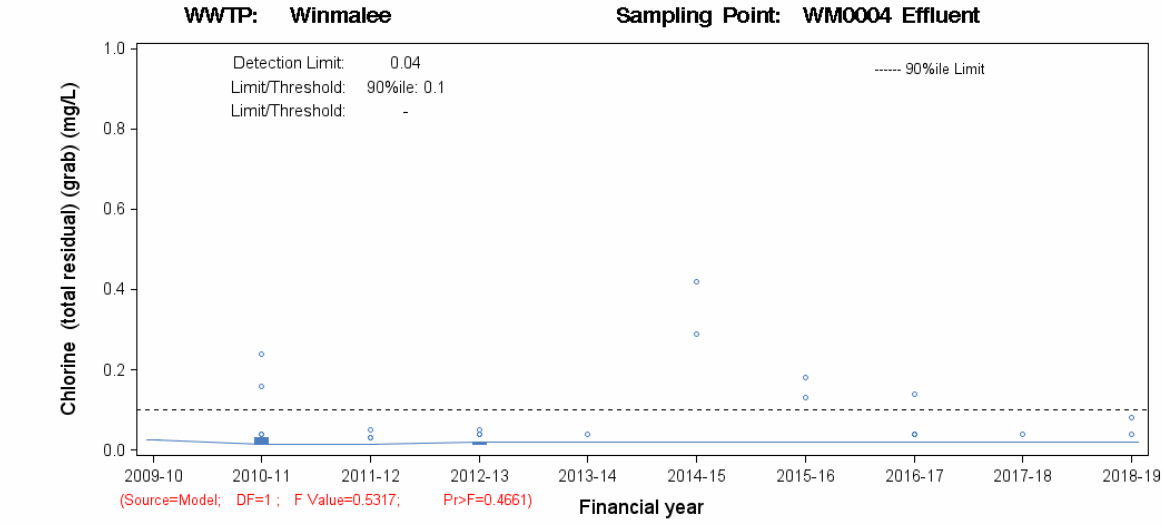

WWTP: Winmalee
Sampling Point: WM0004 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 2
Limit/Threshold: 90%ile: 3
------ 90%ile Limit
------ 50%ile Limit
Total phosphorus (composite) (mg/L)
0.0
0.6
1.2
1.8
2.4
3.0
3.6
4.2
4.8
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=92.936; Pr>F=<.0001)
Financial year

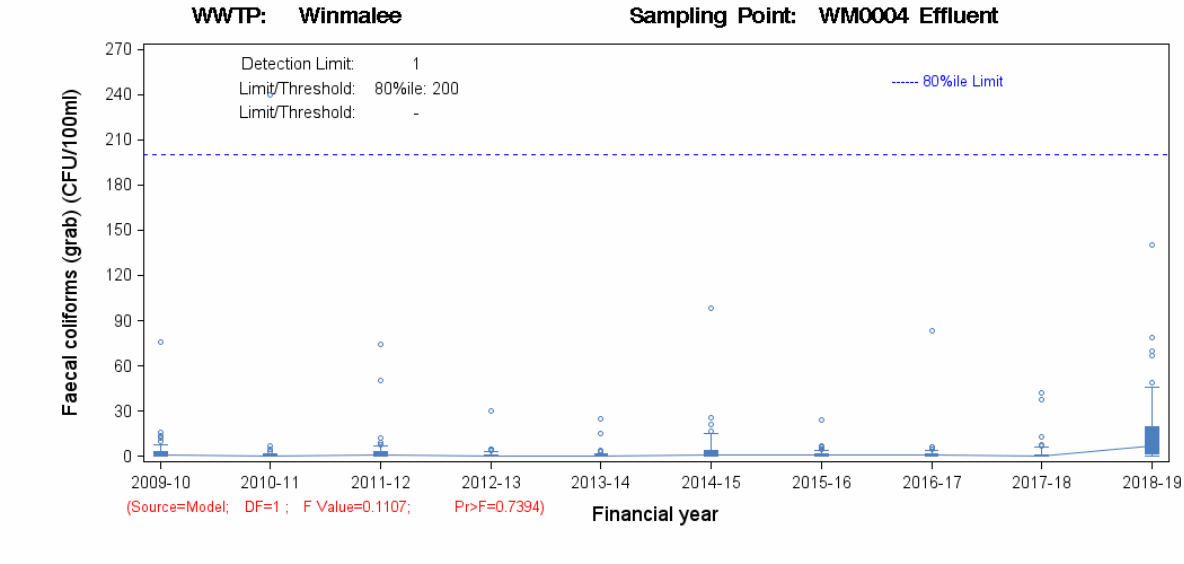

WWTP: Winmalee
Sampling Point: WM0004 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 2
Limit/Threshold: 90%ile: 3
Total phosphorus (composite) (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=92.936; Pr>F=<.0001)
Financial year

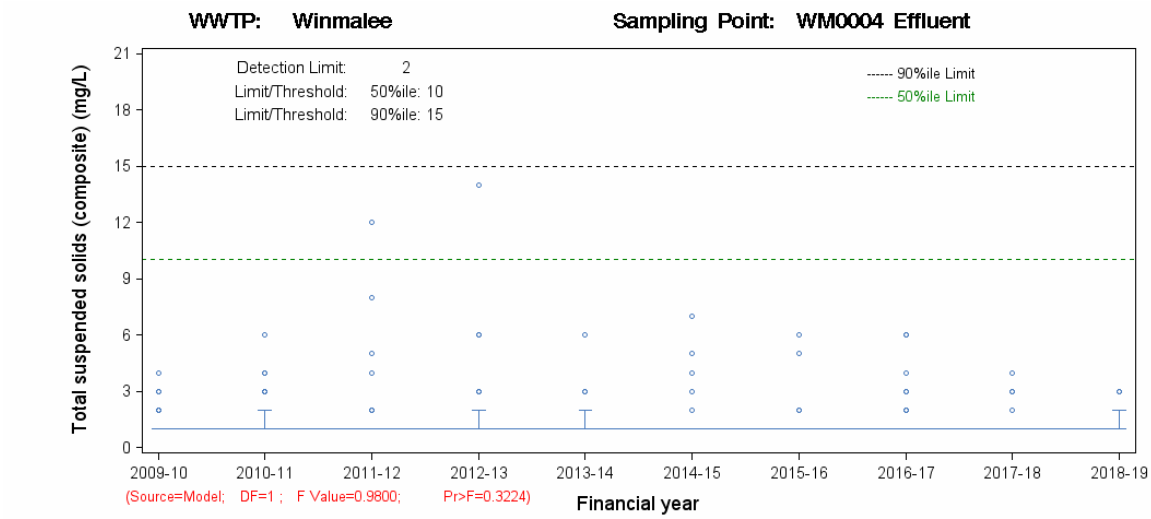
Discharge quality: Major conventional analytes



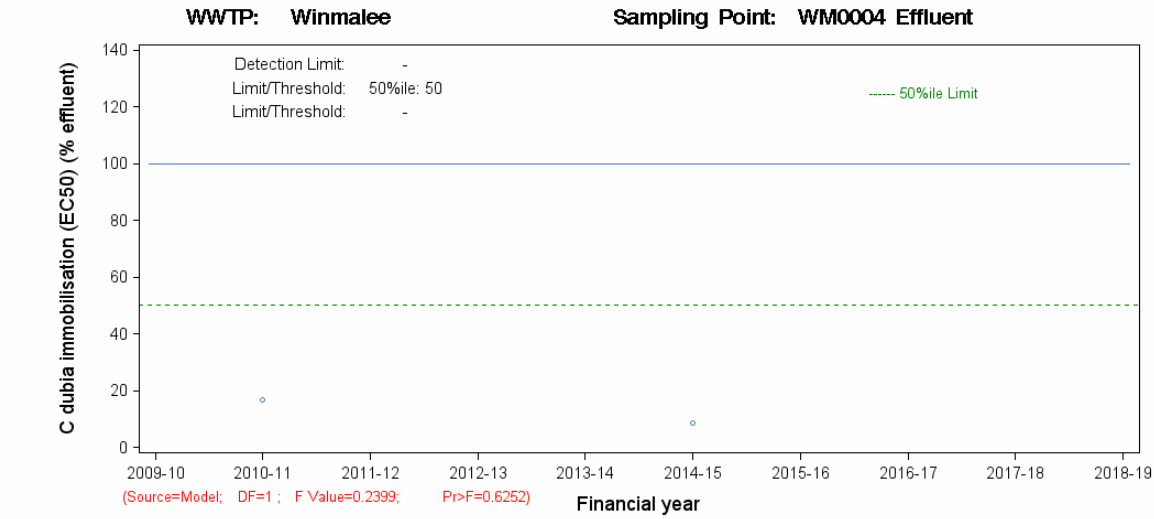
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



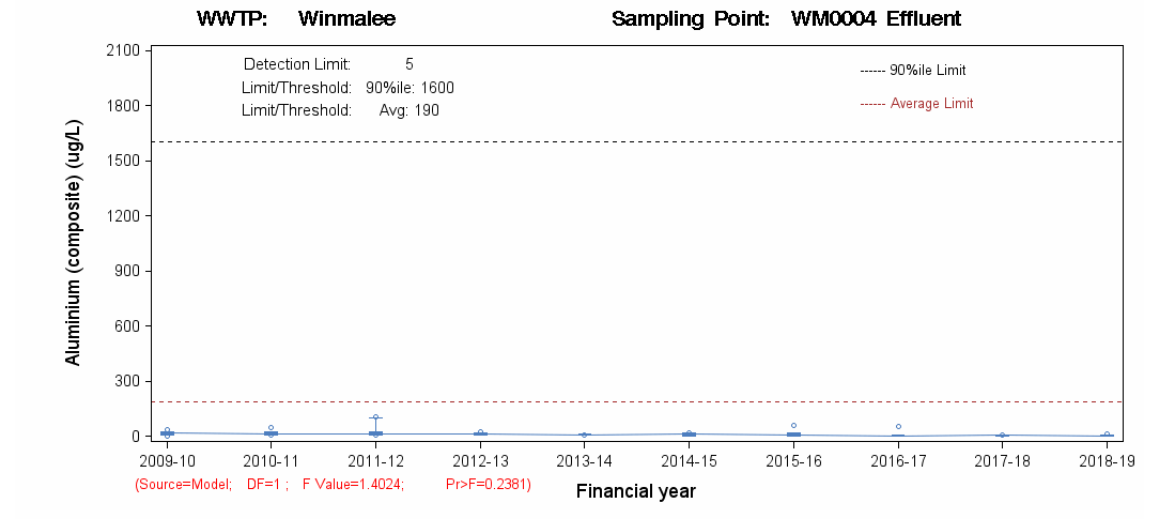


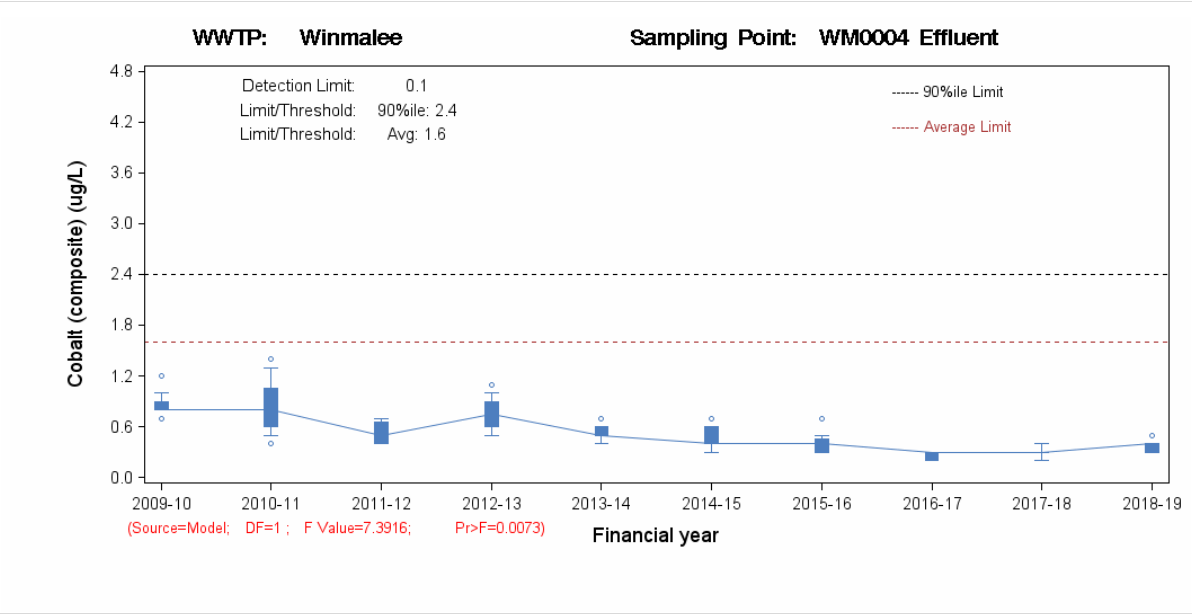


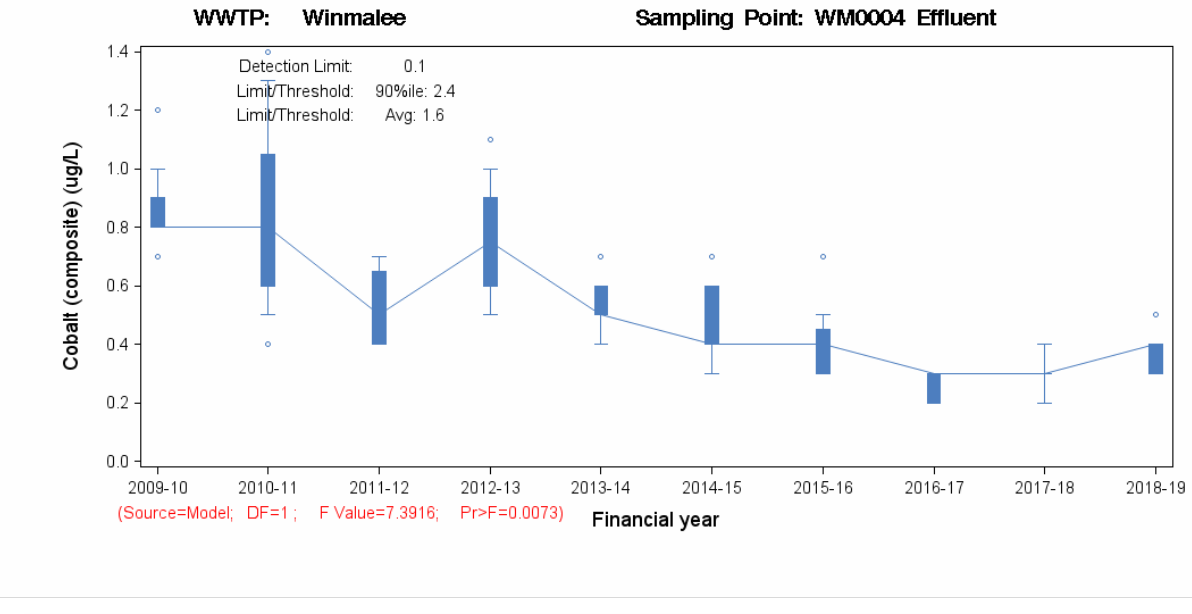
Discharge quality: Toxicity

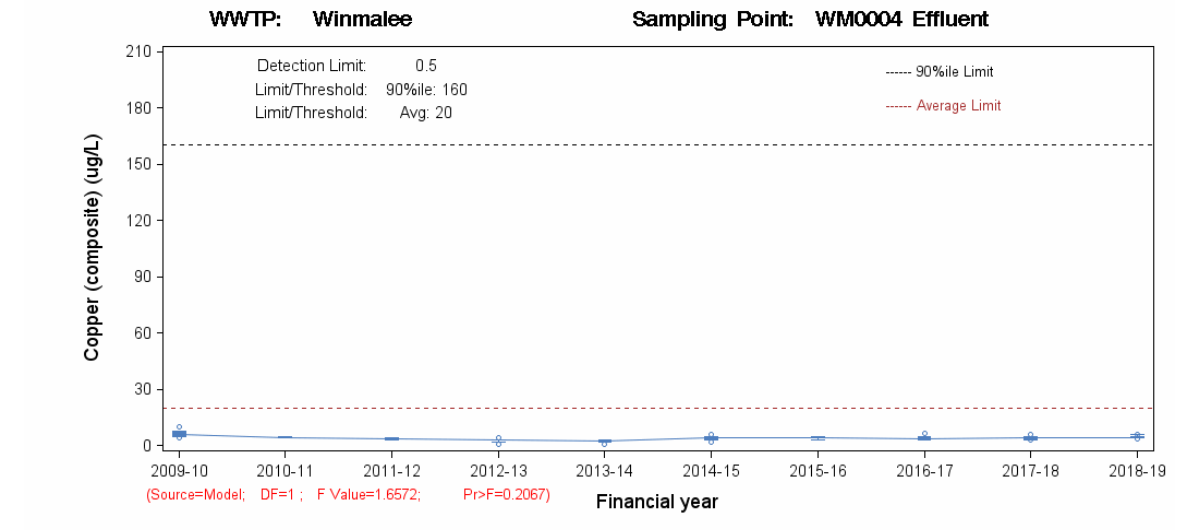


Discharge quality: Trace metals

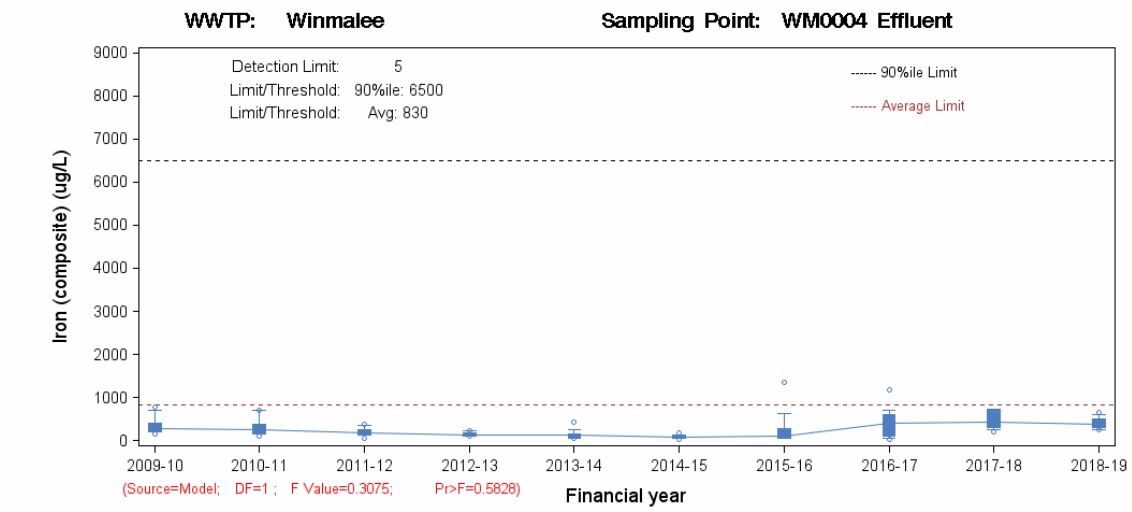




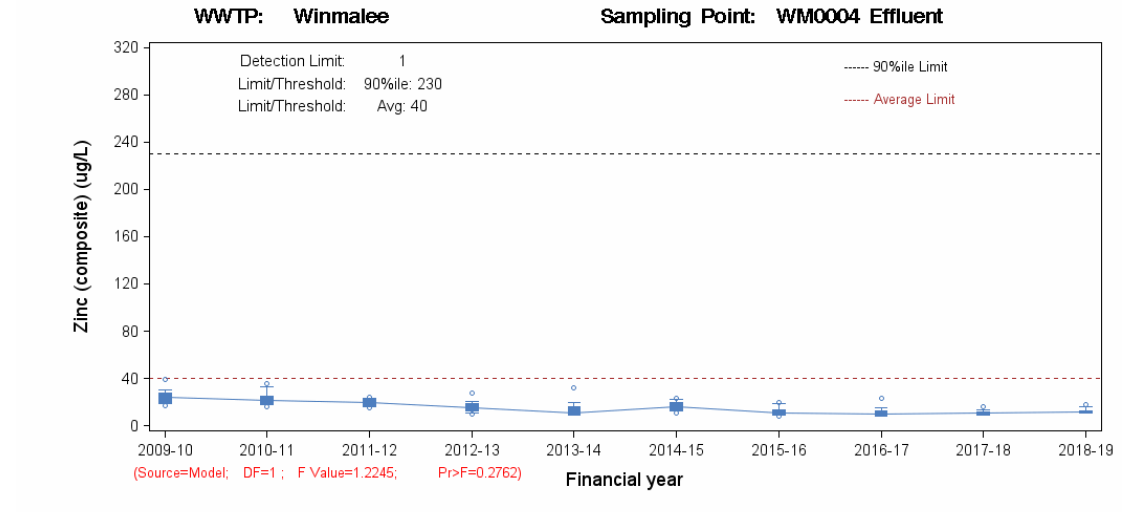




Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

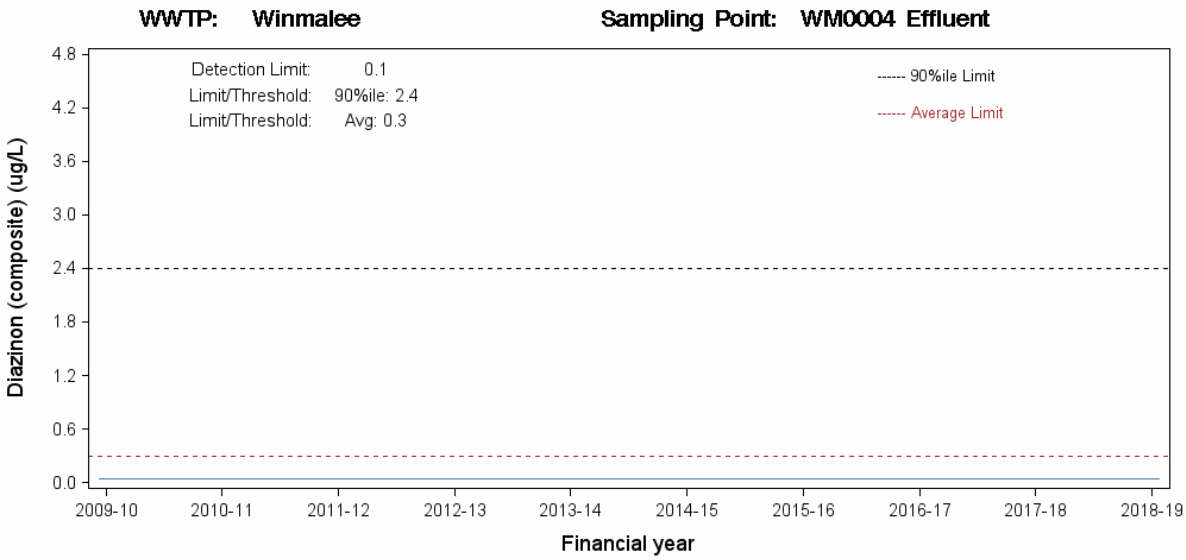


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



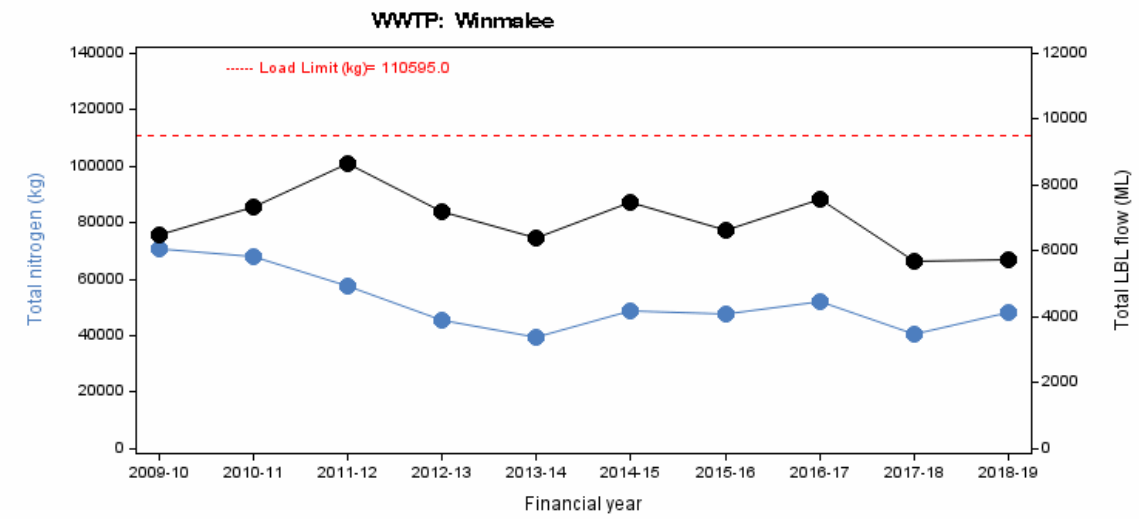
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

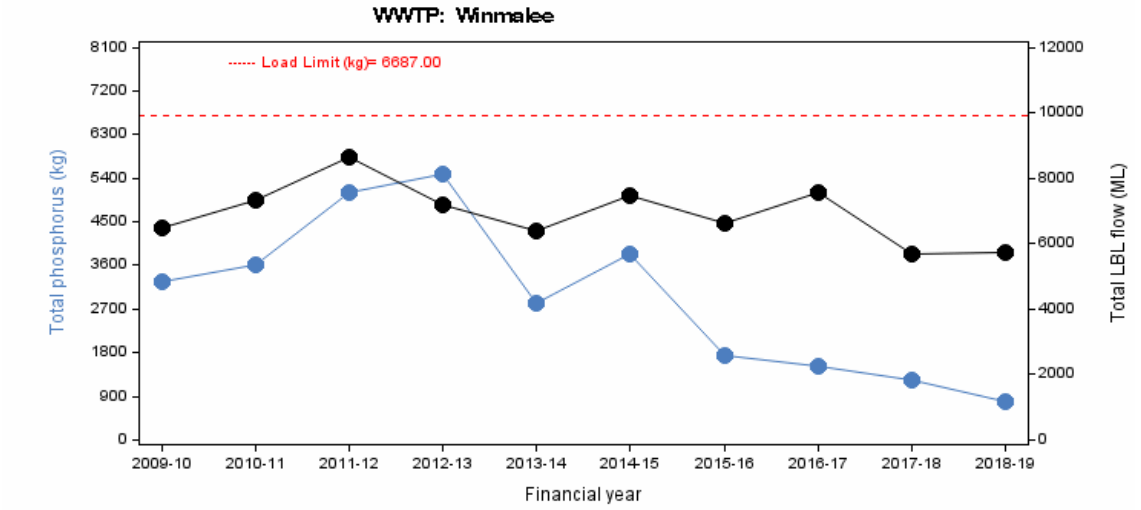
Discharge quality: Other chemicals and organics (including pesticides)



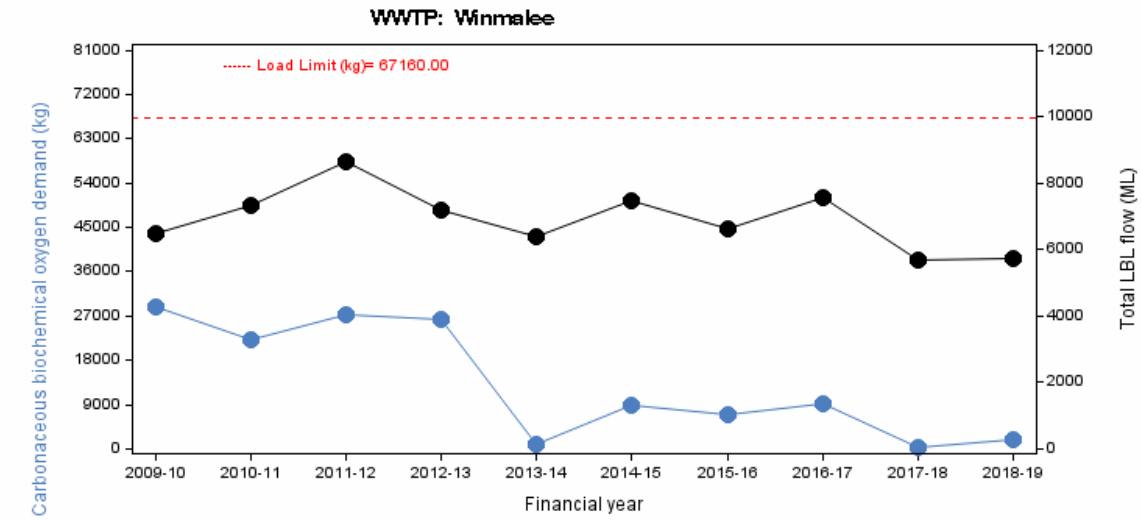
Note: Statistical test was not conducted because >90% of results were below the detection limit.

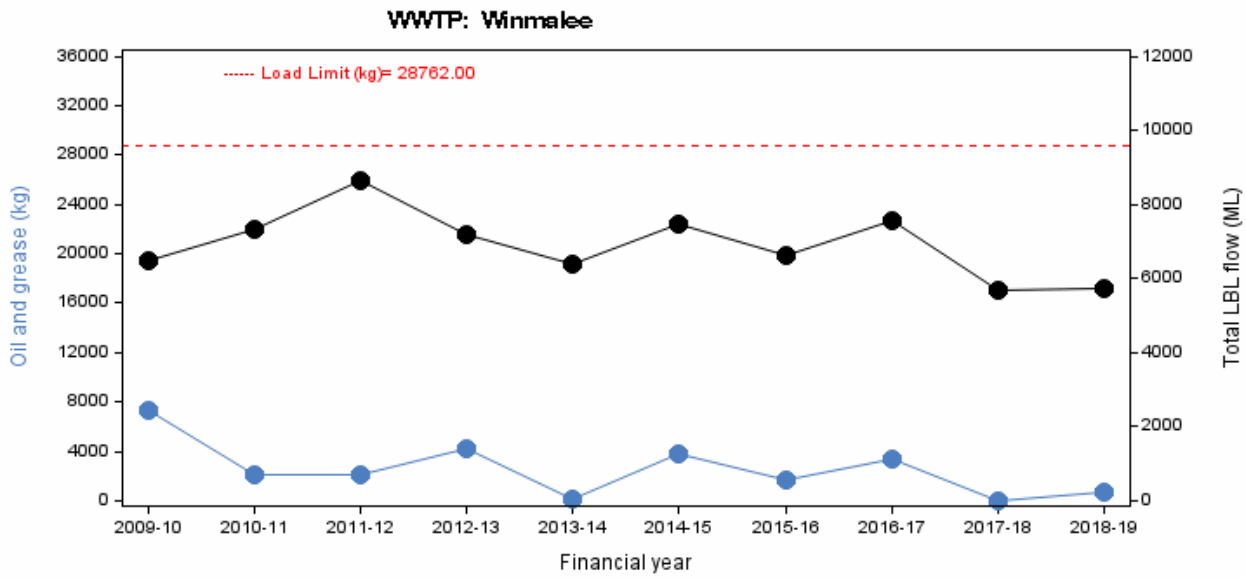
Discharge load: Nutrients

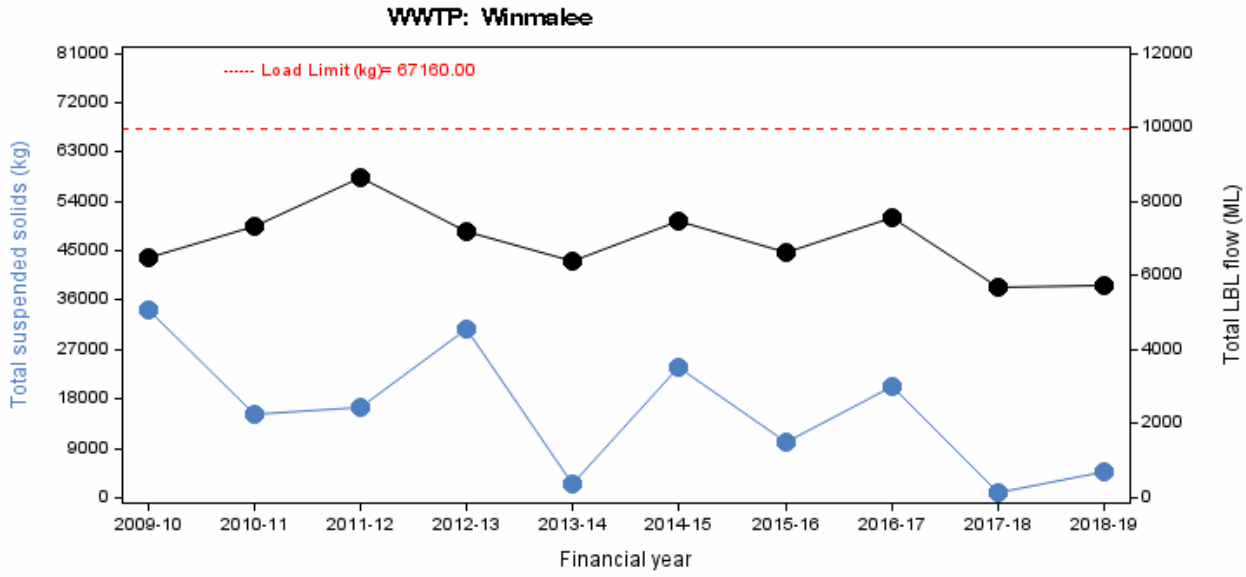




Discharge load: Major conventional analytes

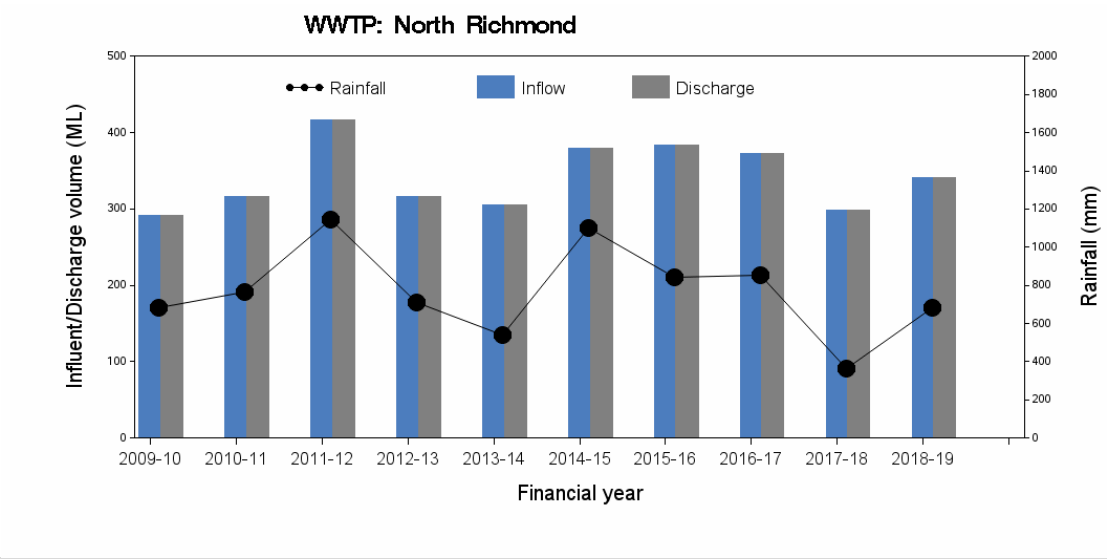



WWTP: Winmalee
Load Limit (kg)= 28762.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

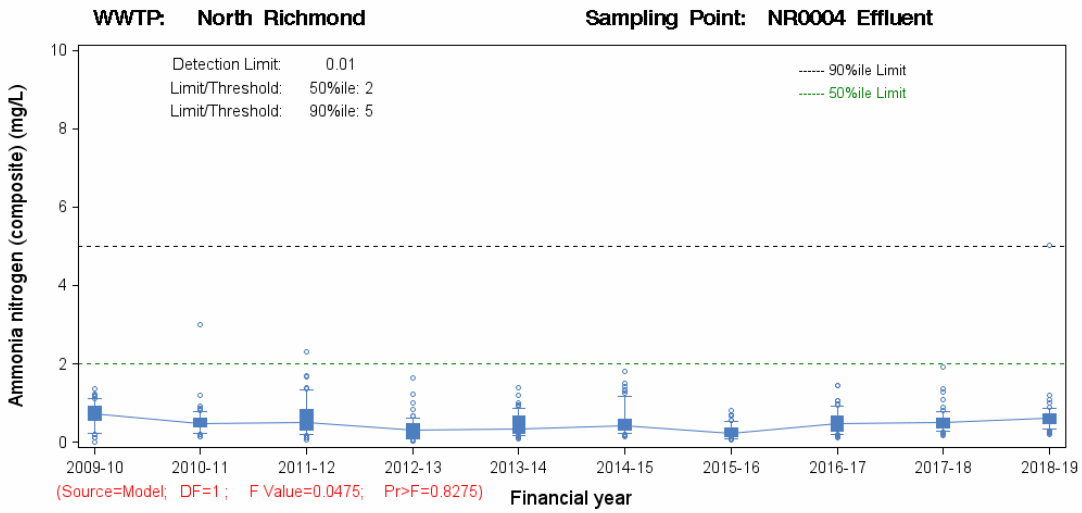

WWTP: Winmalee
Load Limit (kg)= 67160.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

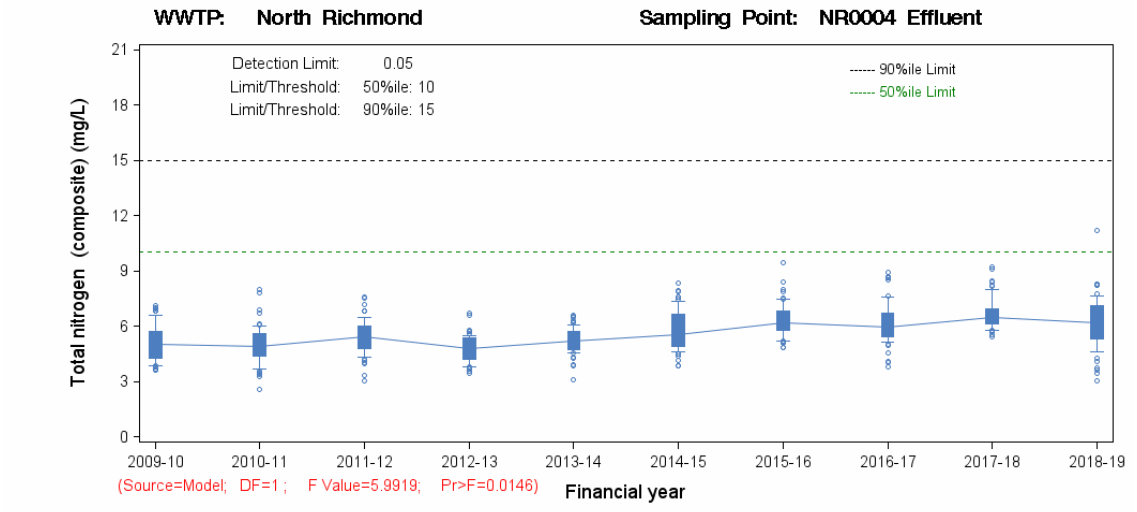
North Richmond WWTP

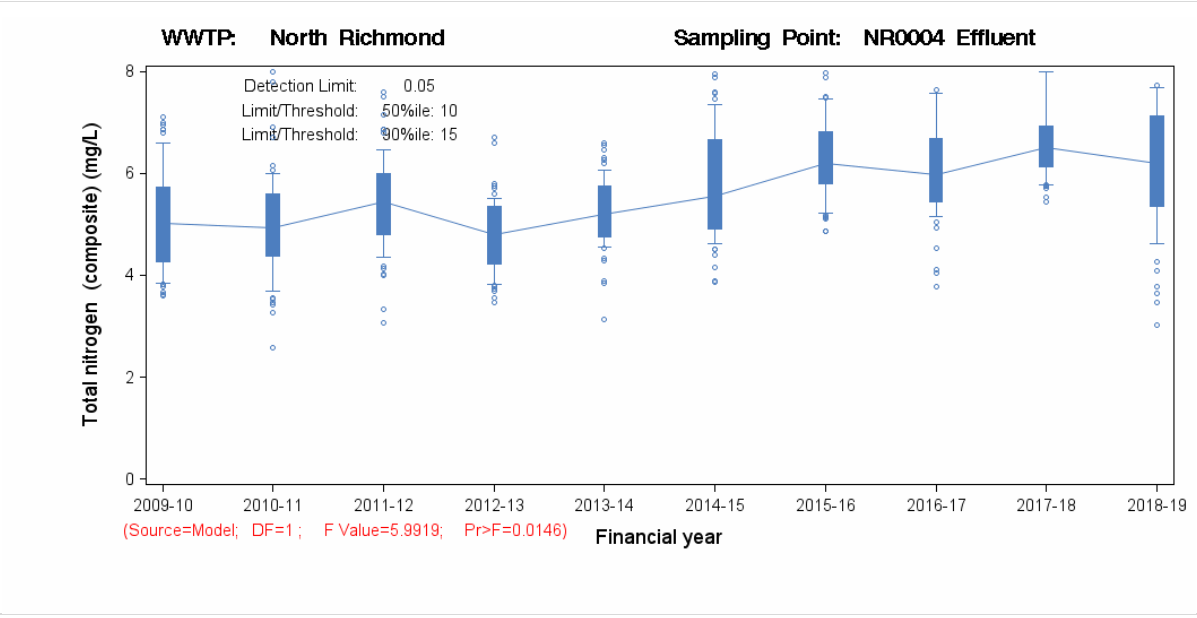
Discharge volume and rainfall

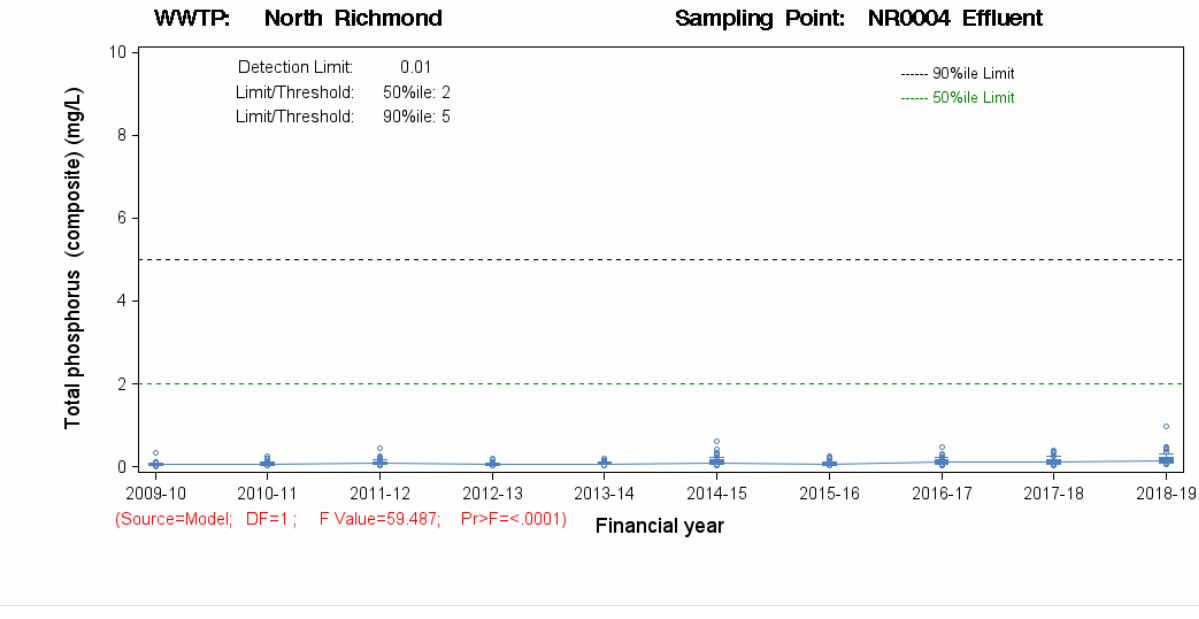


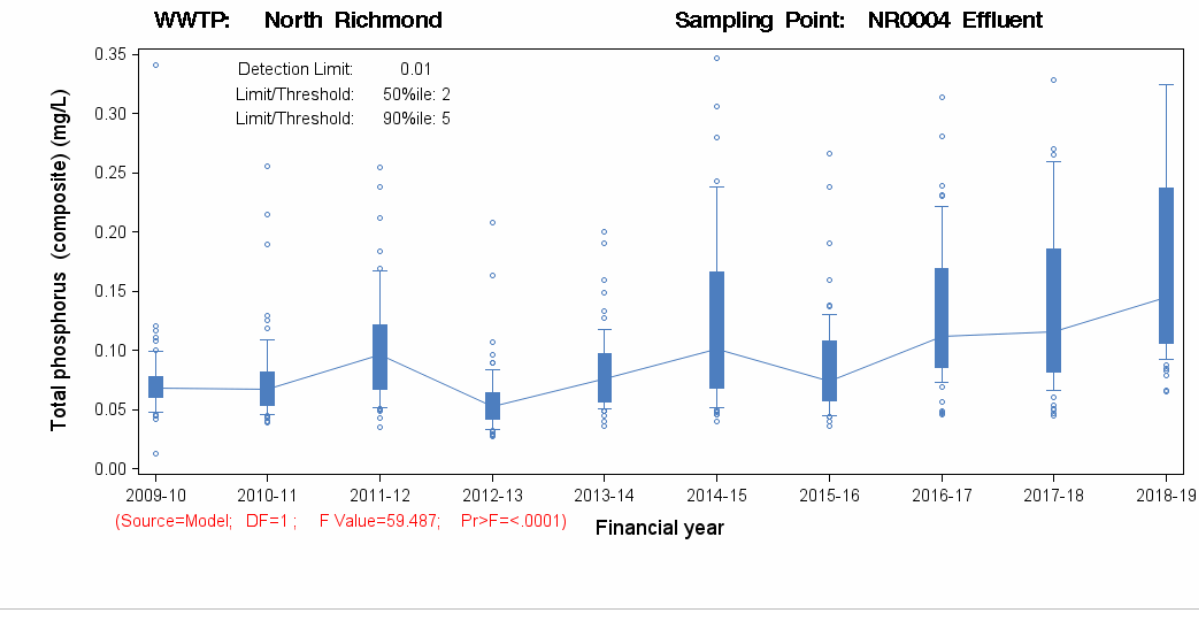
Discharge quality: Nutrients



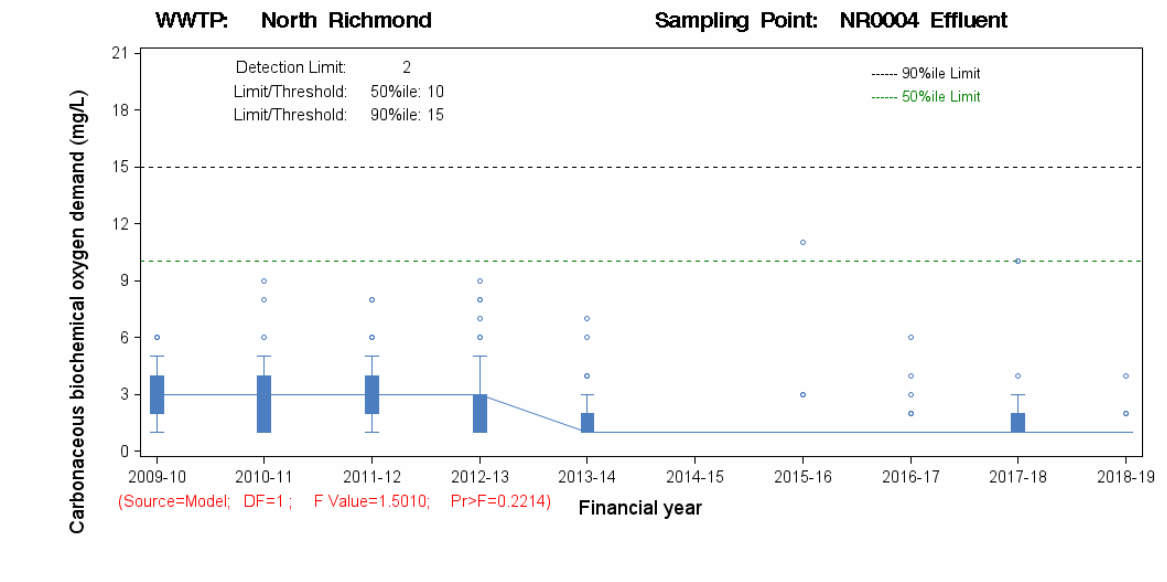



WWTP: North Richmond
Sampling Point: NR0004 Effluent
Detection Limit: 0.05
Limit/Threshold: 50%ile: 10
Limit/Threshold: 90%ile: 15
Total nitrogen (composite) (mg/L)
0
2
4
6
8
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.9919; Pr>F=0.0146)
Financial year

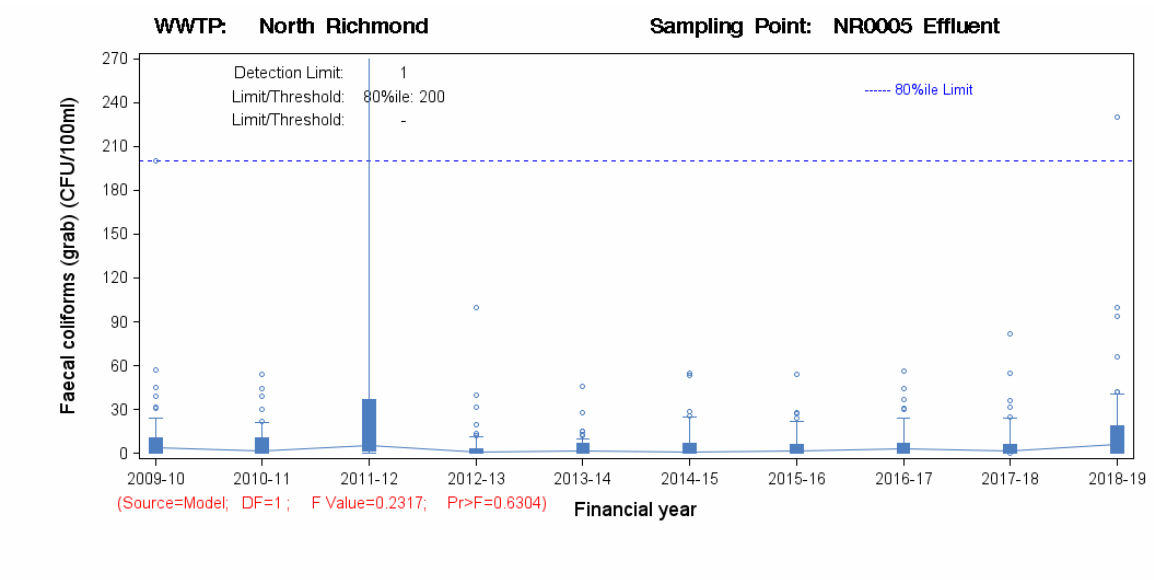

WWTP: North Richmond
Sampling Point: NR0004 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 2
Limit/Threshold: 90%ile: 5
----- 90%ile Limit
----- 50%ile Limit
Total phosphorus (composite) (mg/L)
0
2
4
6
8
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=59.487; Pr>F=<.0001)
Financial year

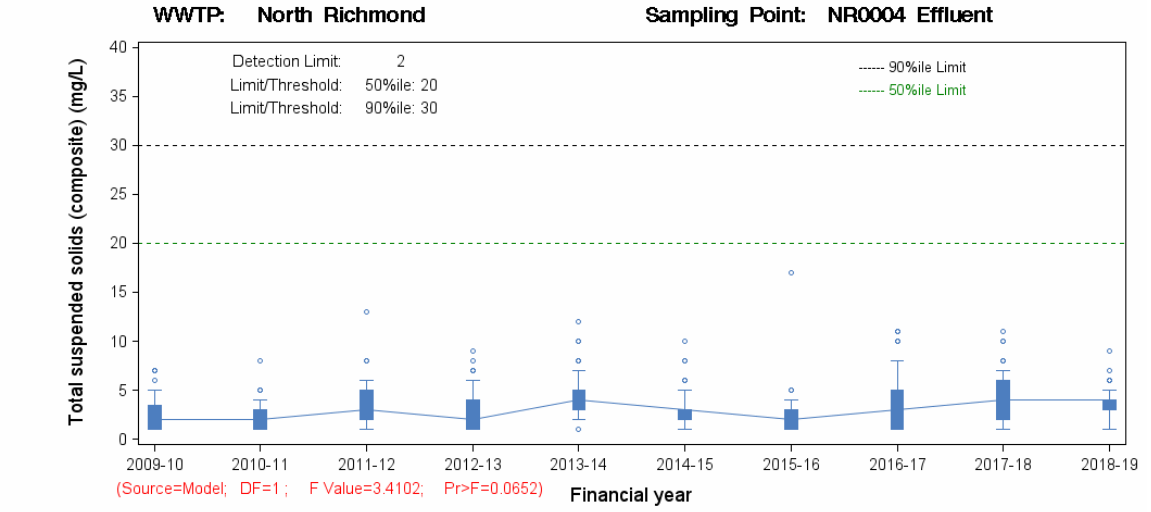

WWTP: North Richmond
Sampling Point: NR0004 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 2
Limit/Threshold: 90%ile: 5
Total phosphorus (composite) (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=59.487; Pr>F=<.0001)
Financial year

Discharge quality: Major conventional analytes

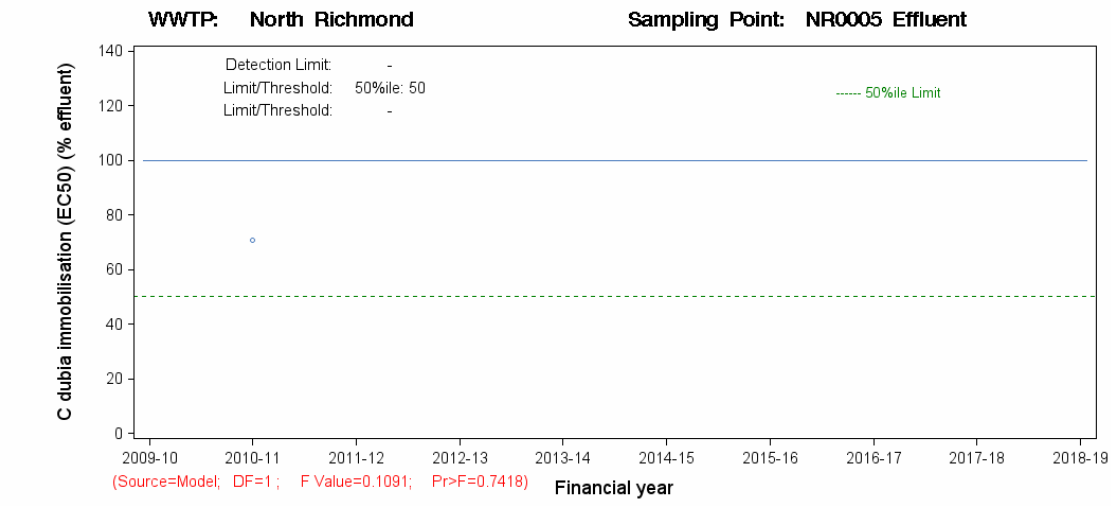


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

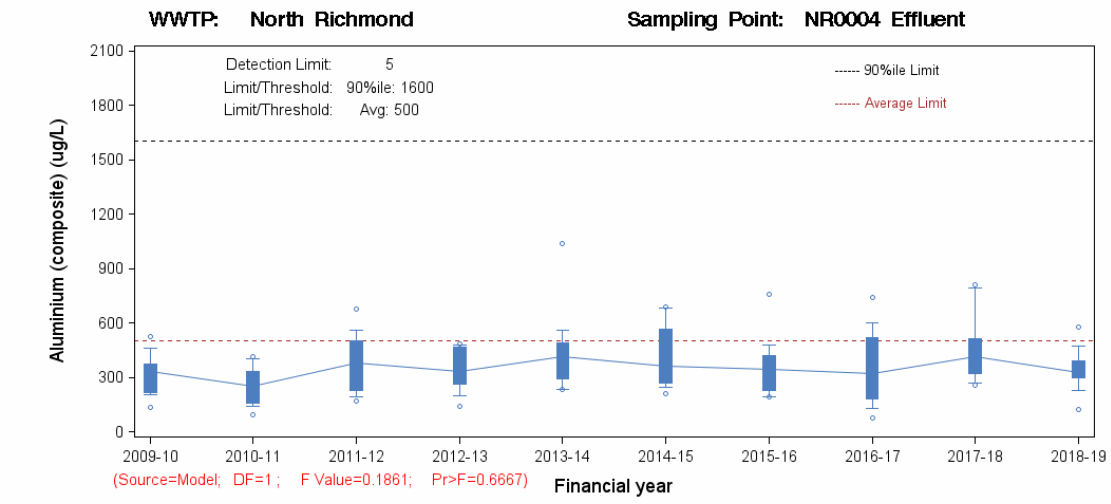


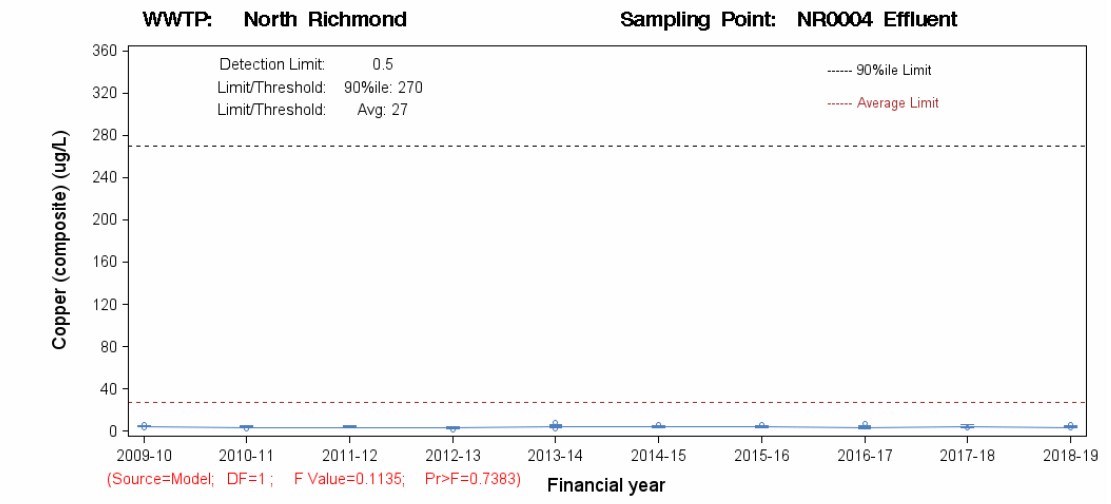


Discharge quality: Toxicity

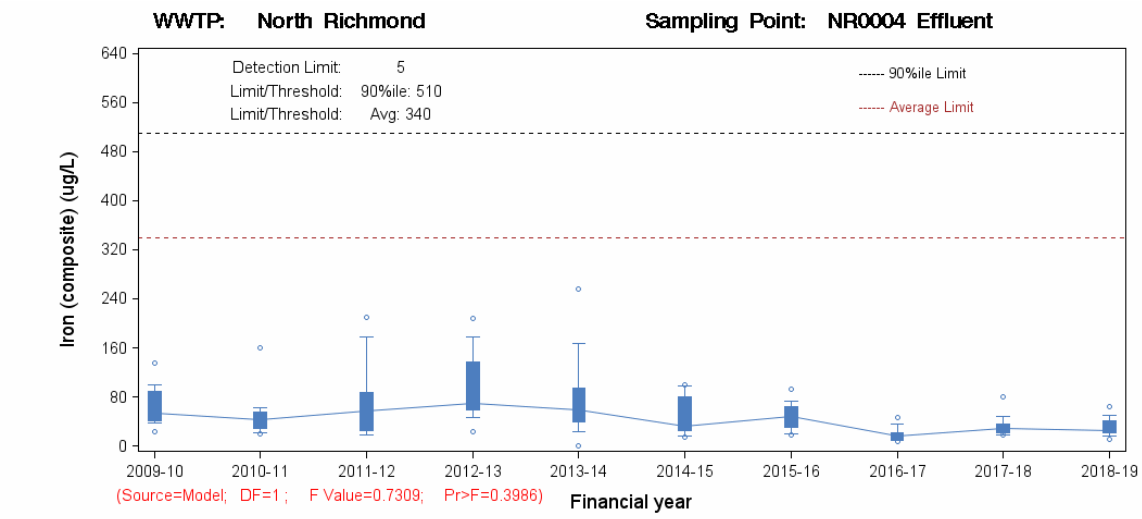


Discharge quality: Trace metals

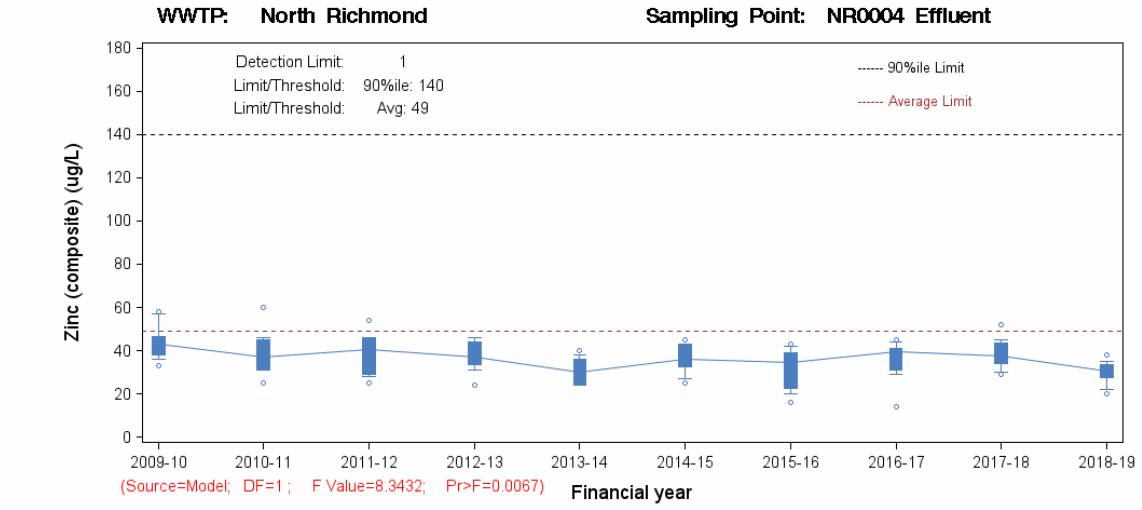




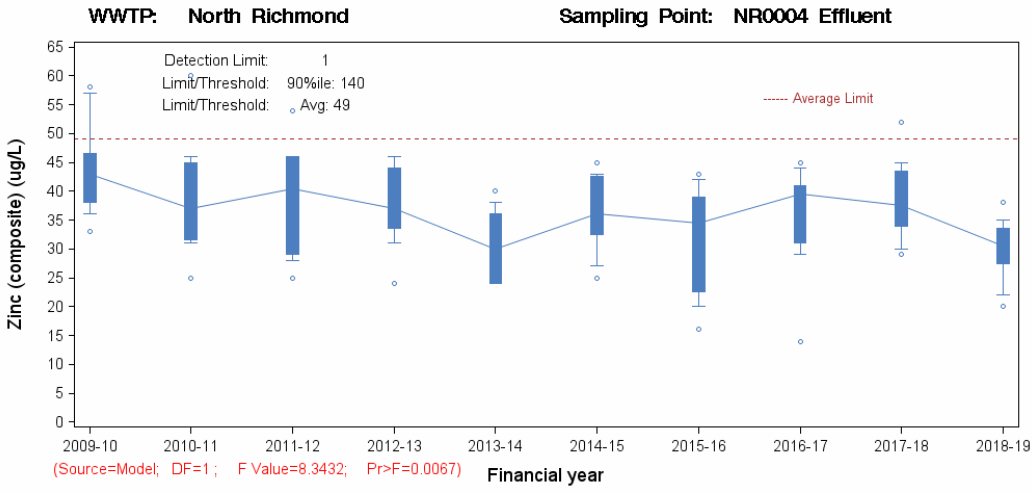
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

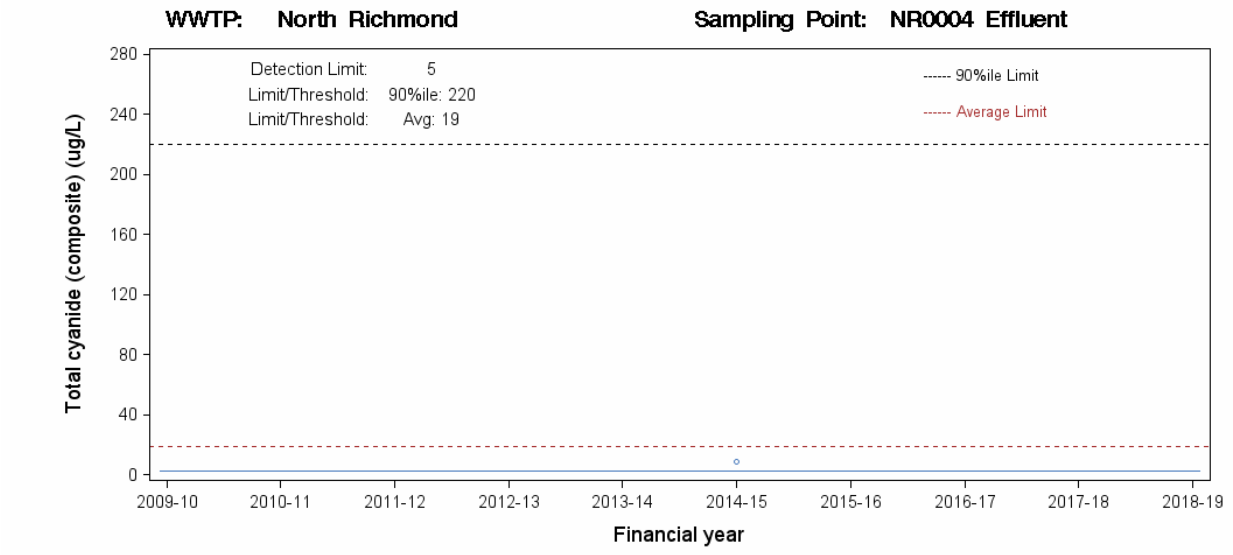


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

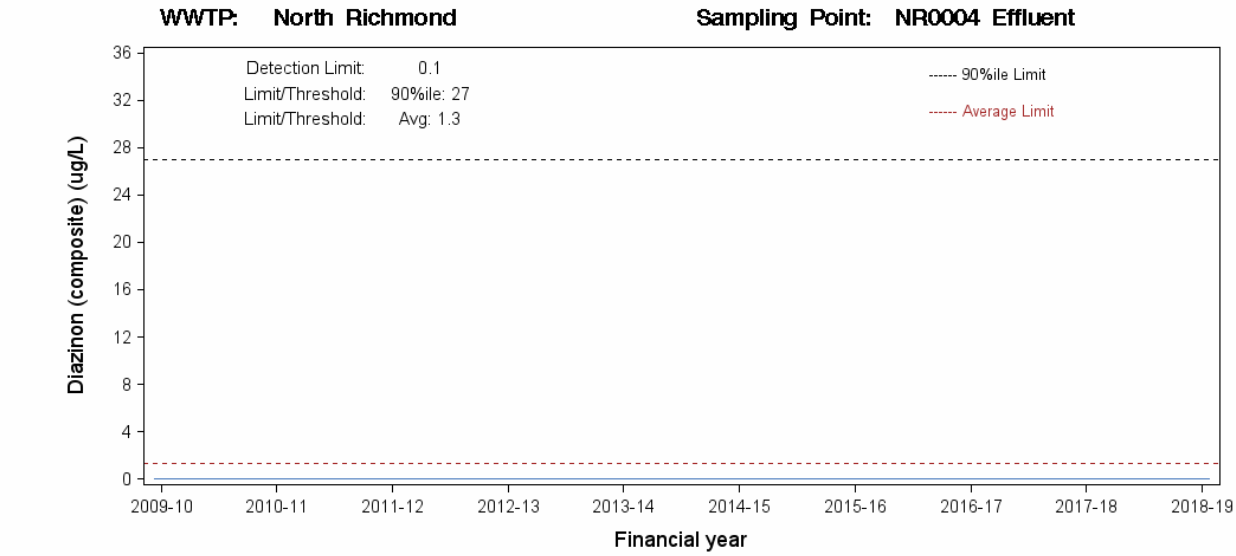


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

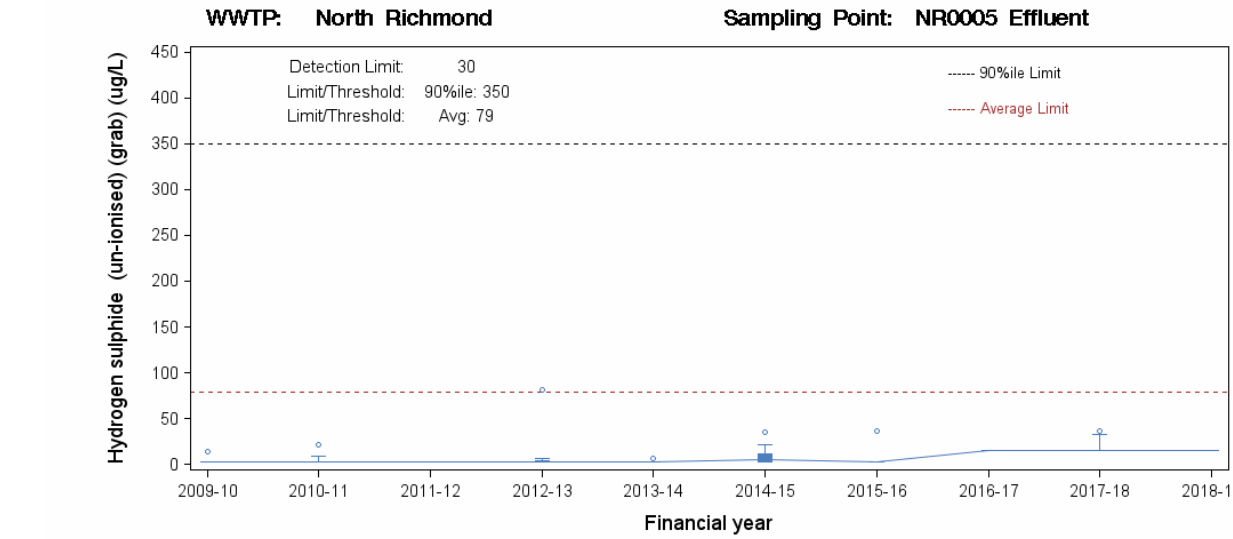
Discharge quality: Other chemicals and organics (including pesticides)



Note: Statistical test was not conducted because >90% of results were below the detection limit.

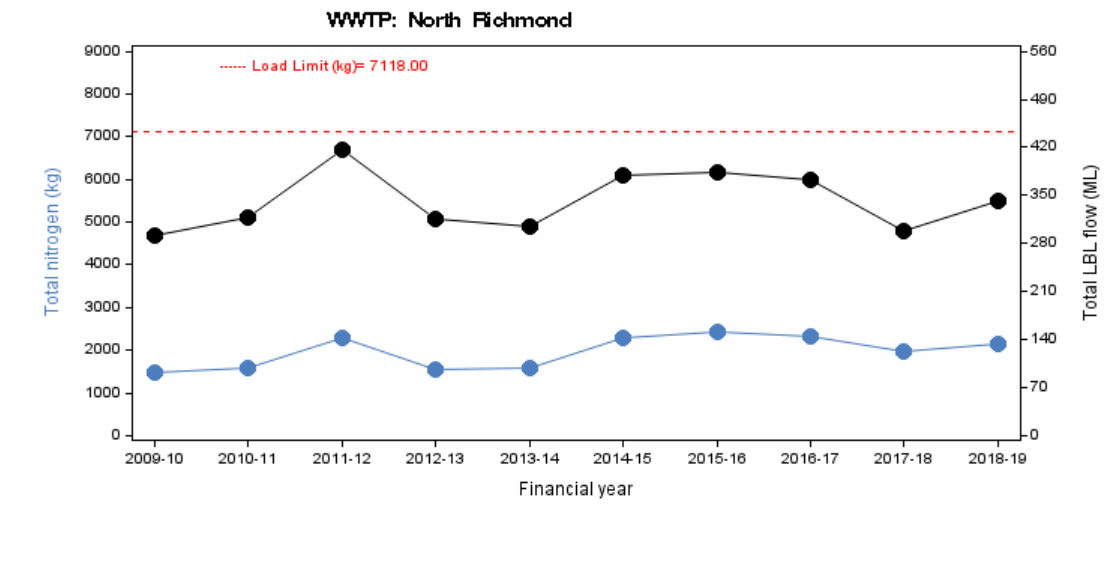


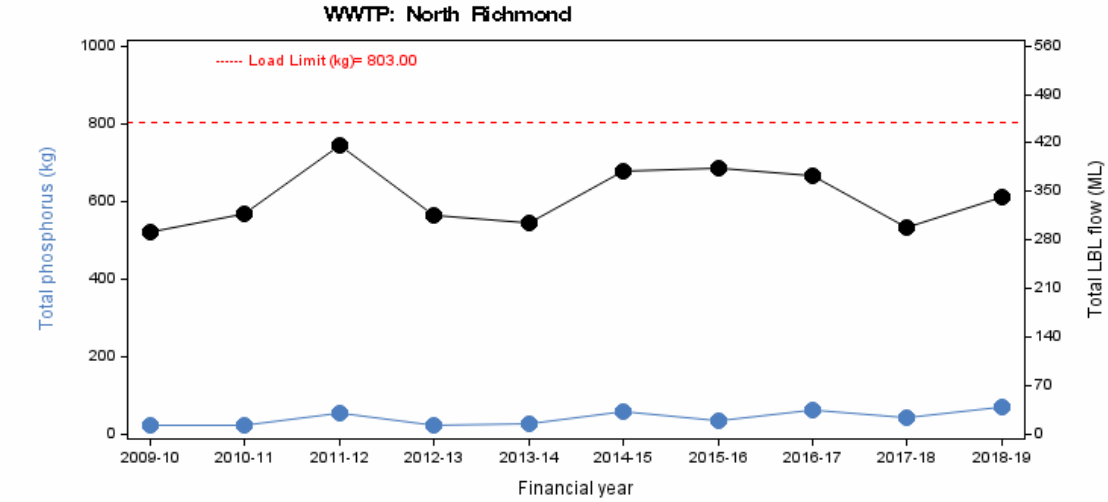
Note: Statistical test was not conducted because >90% of results were below the detection limit.



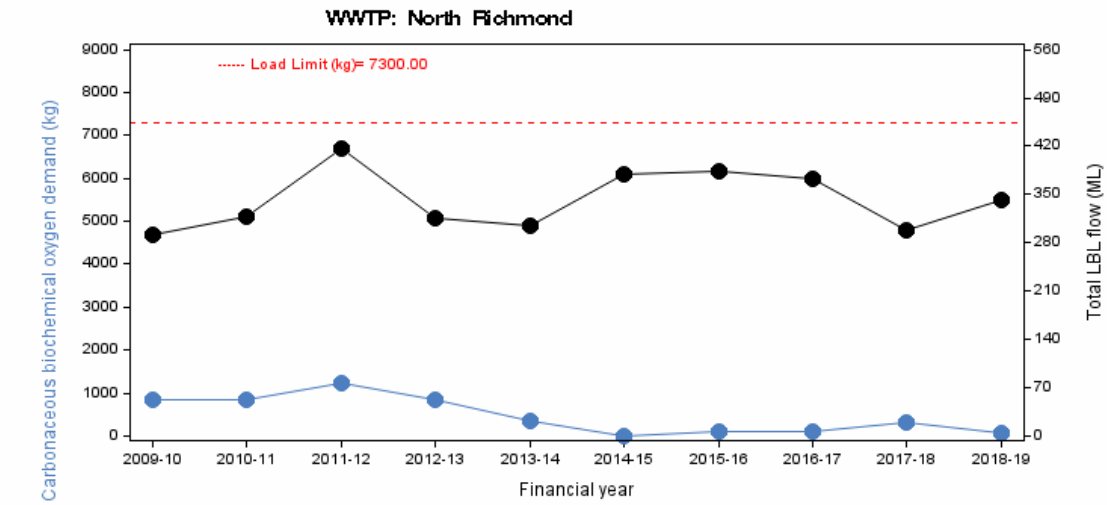
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

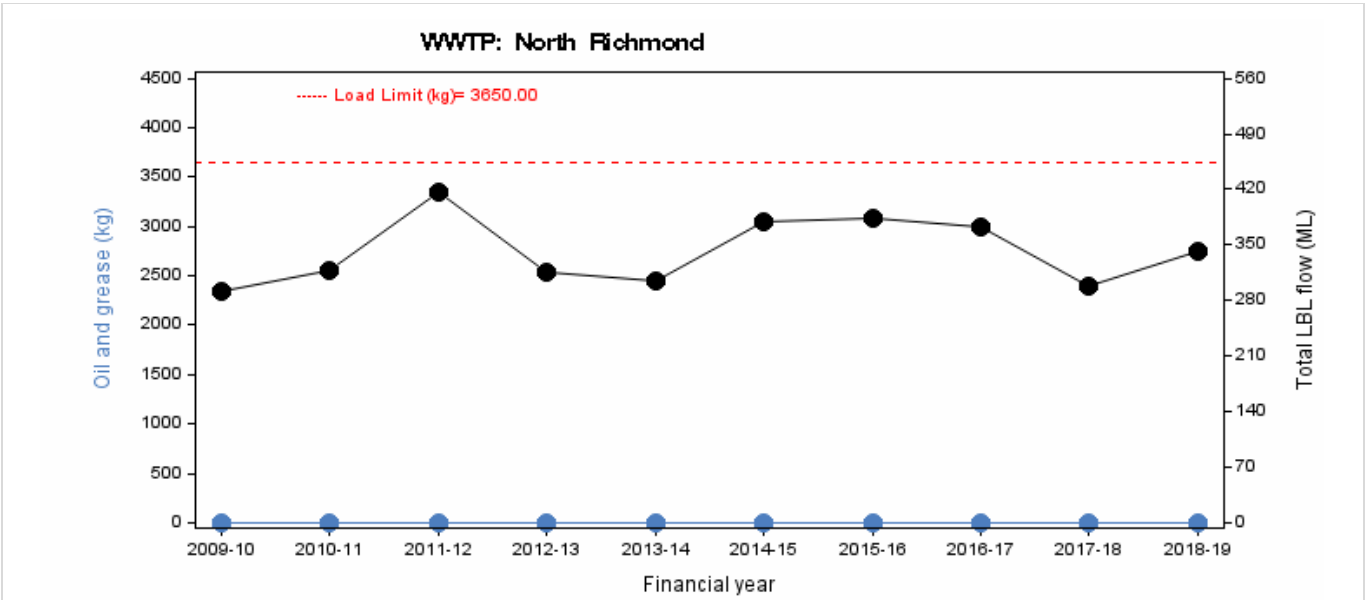
Discharge load: Nutrients

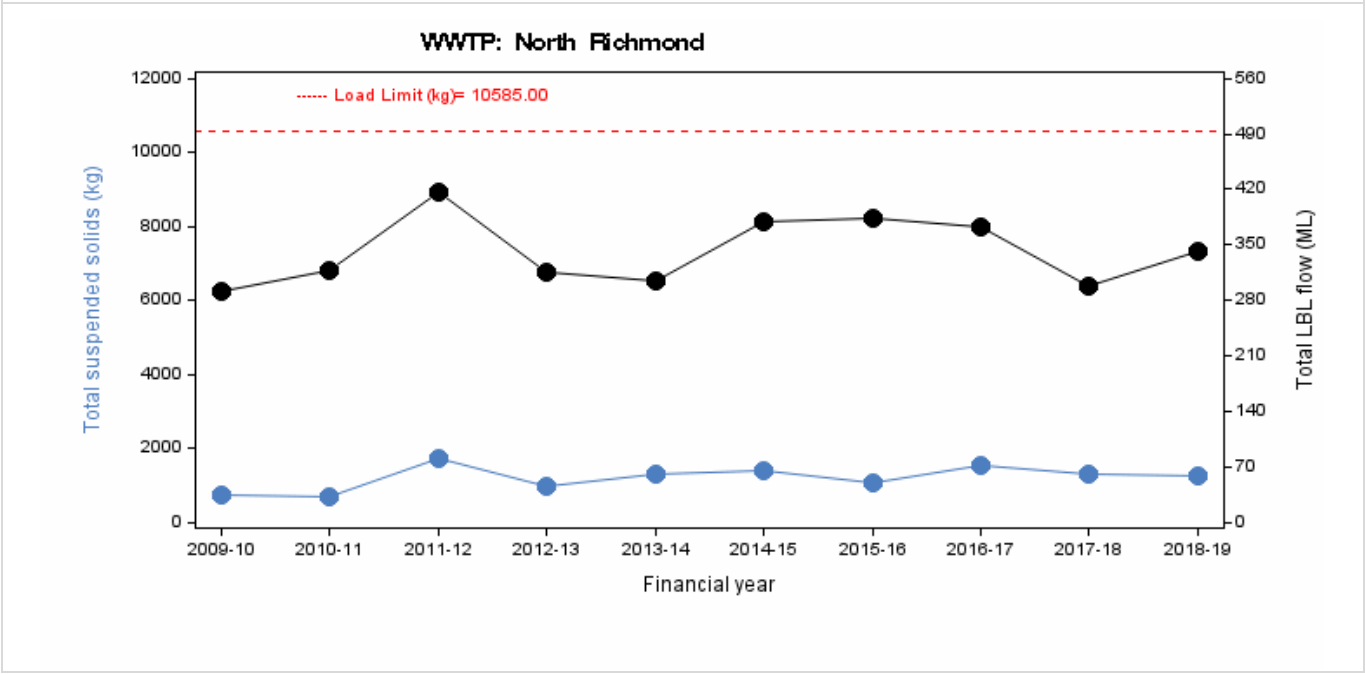




Discharge load: Major conventional analytes

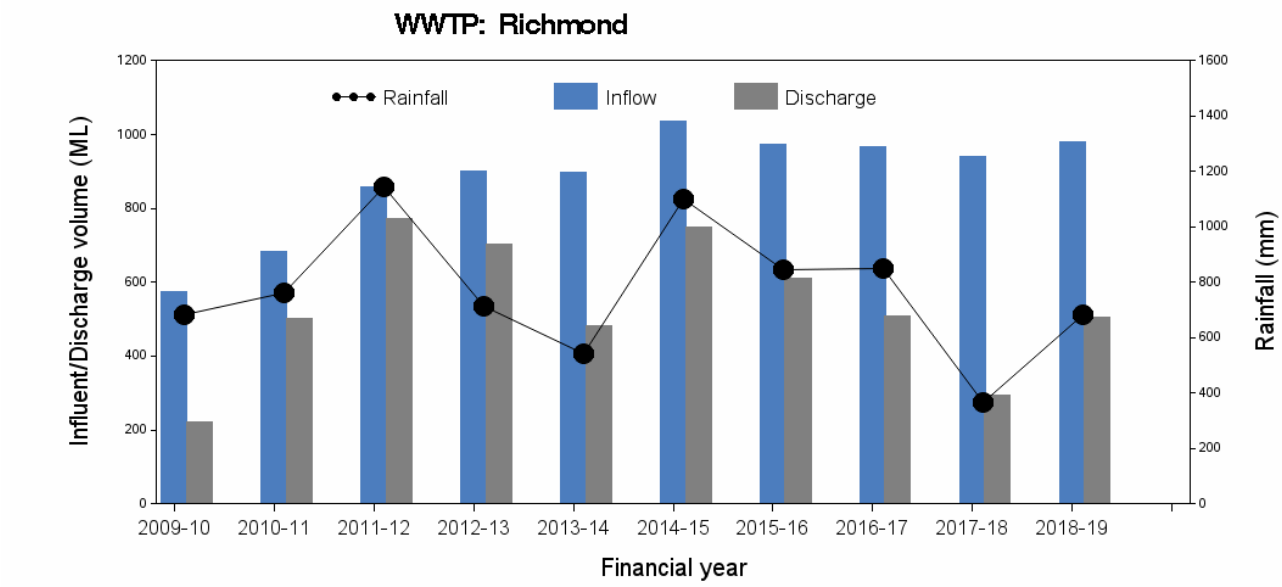


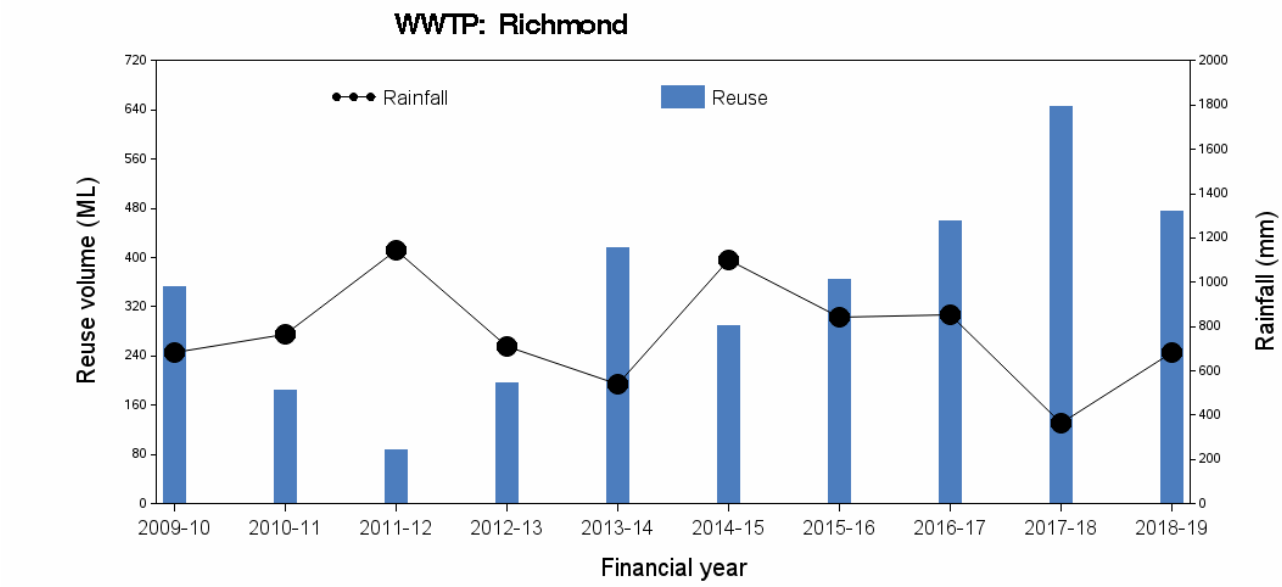

WWTP: North Richmond
Load Limit (kg)= 3650.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: North Richmond
Load Limit (kg)= 10585.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

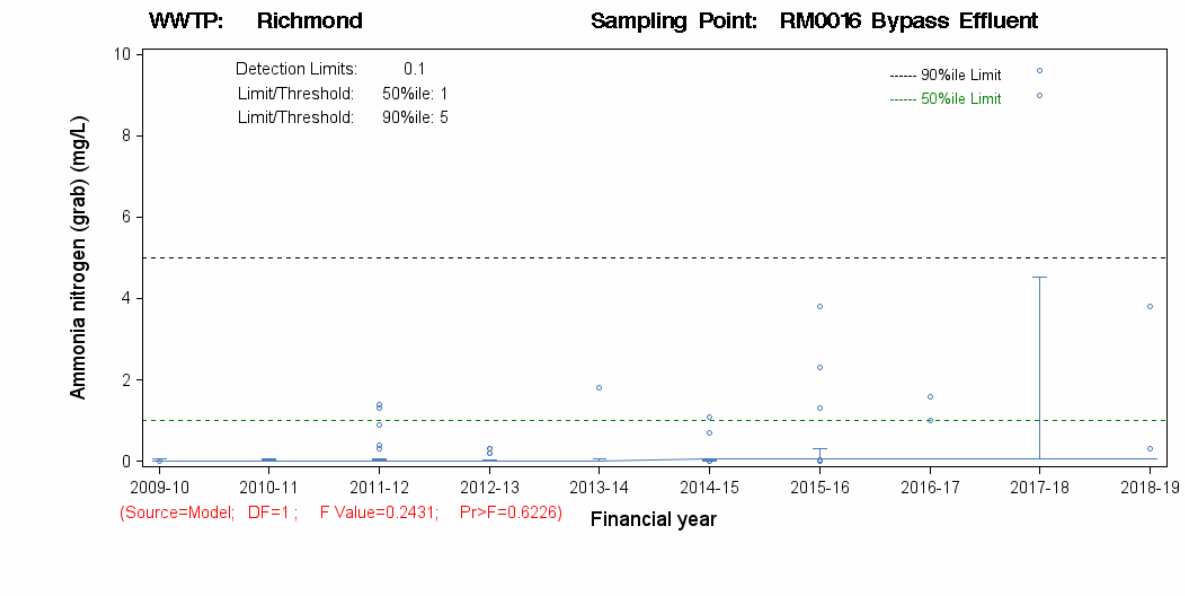
Richmond WWTP

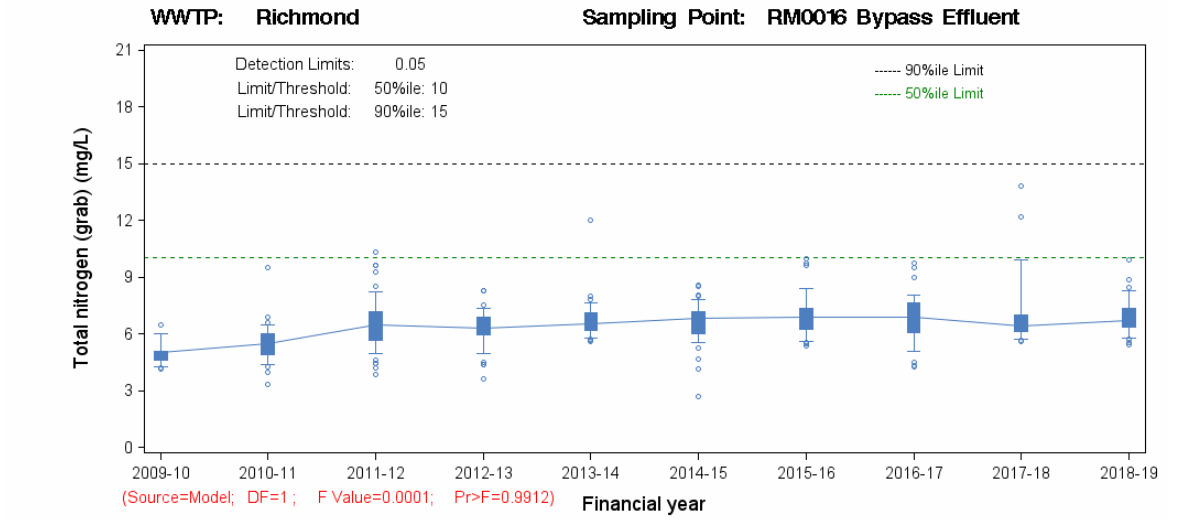
Discharge volume and rainfall

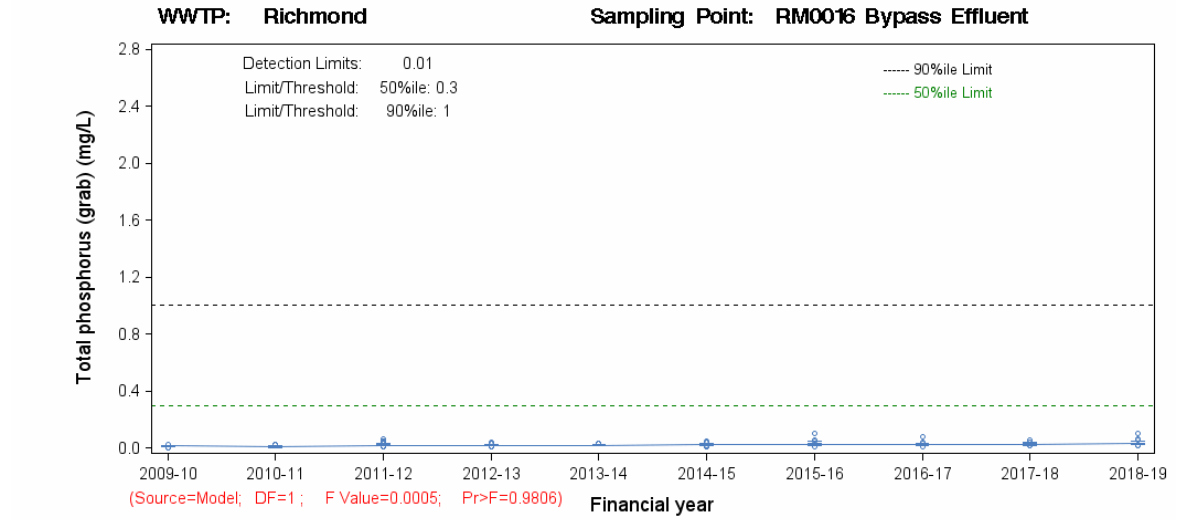




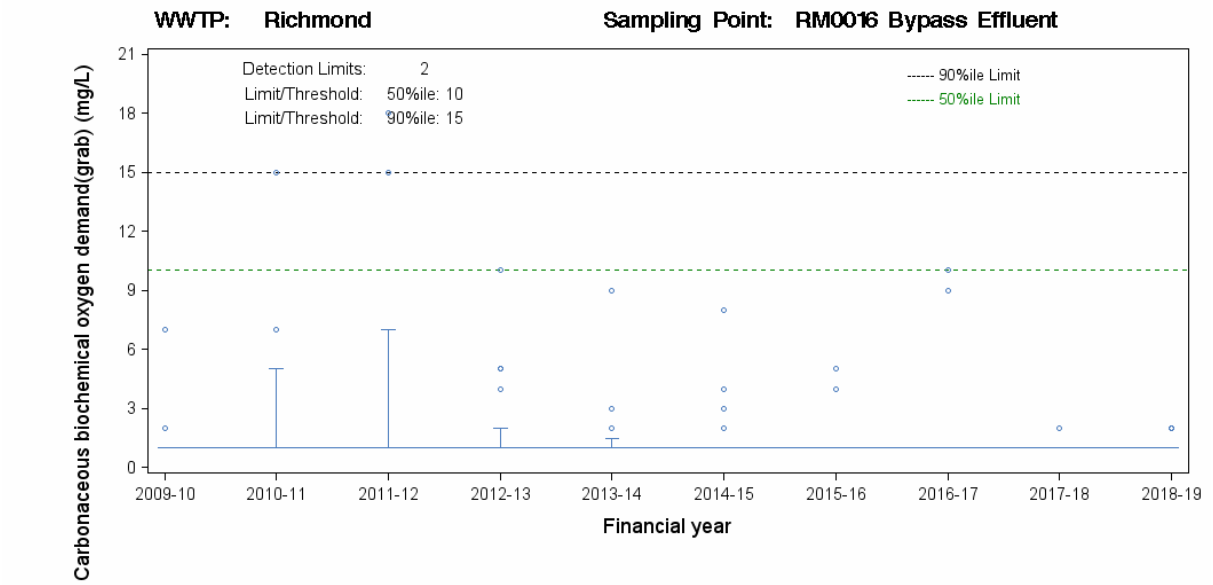
Discharge quality: Nutrients (RM0016 Bypass Effluent)



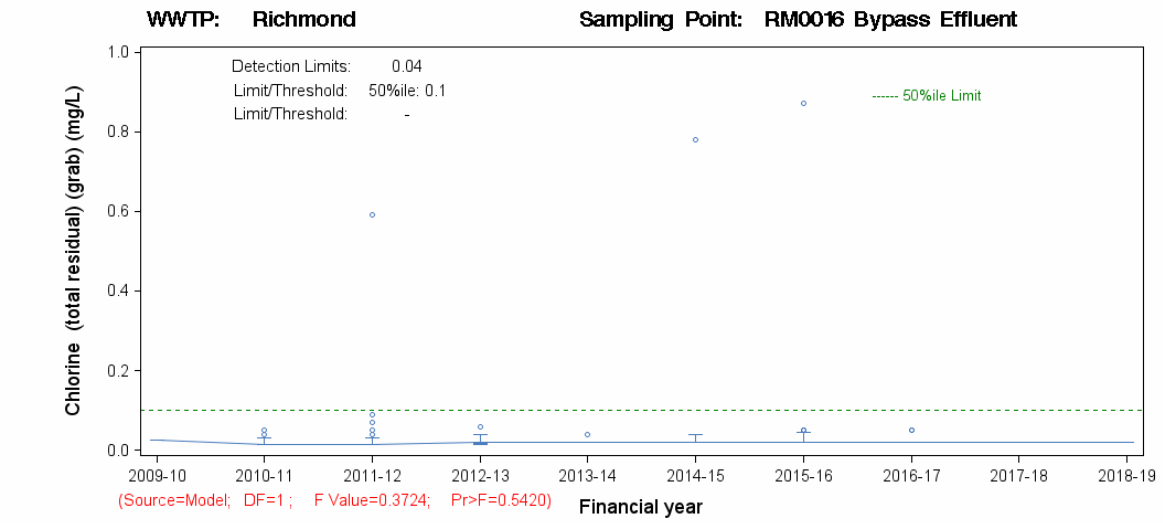


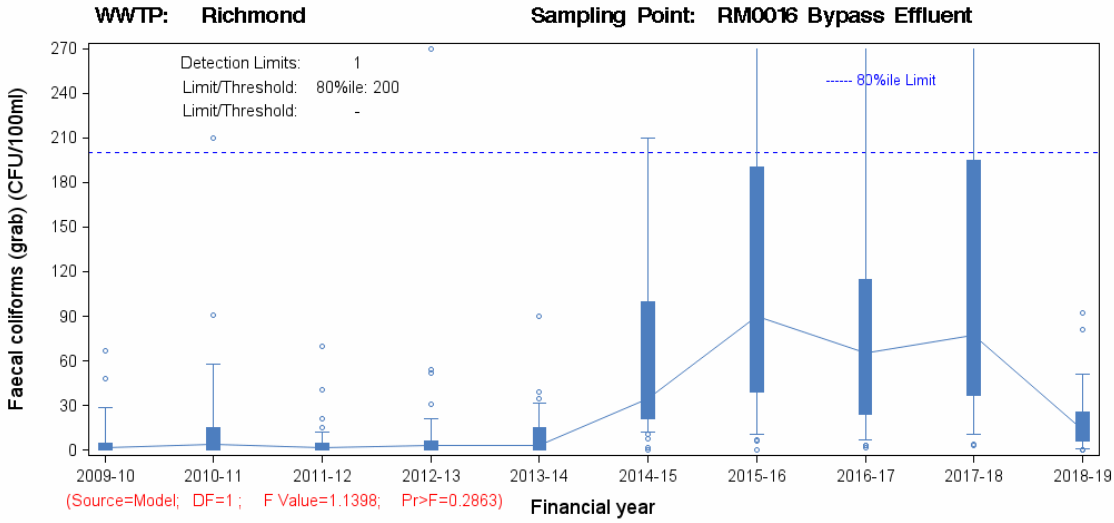


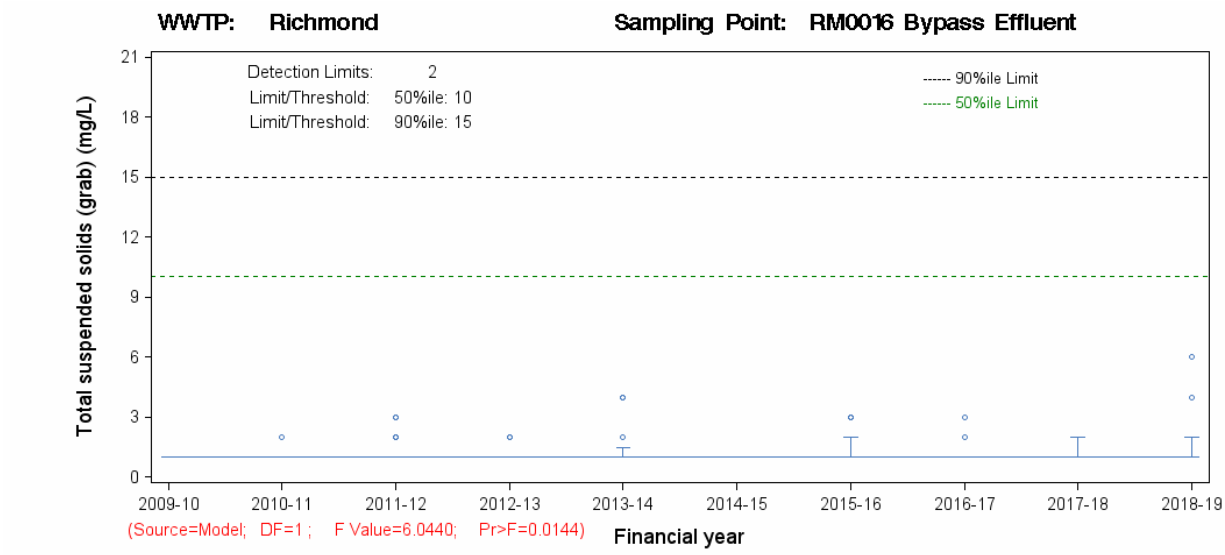
Discharge quality: Major conventional analytes (RM0016 Bypass Effluent)

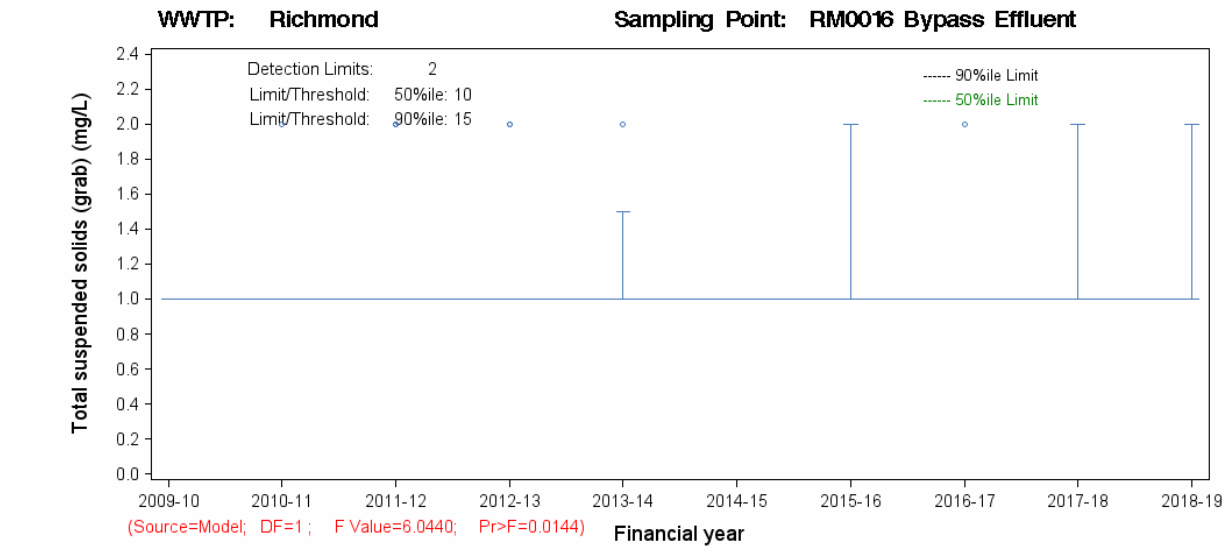


Note: 2018-19 data was compared with previous four years data (2014-2018) due to lab method change in 2014-15. Statistical test was not conducted because >90% of results were below the detection limit.

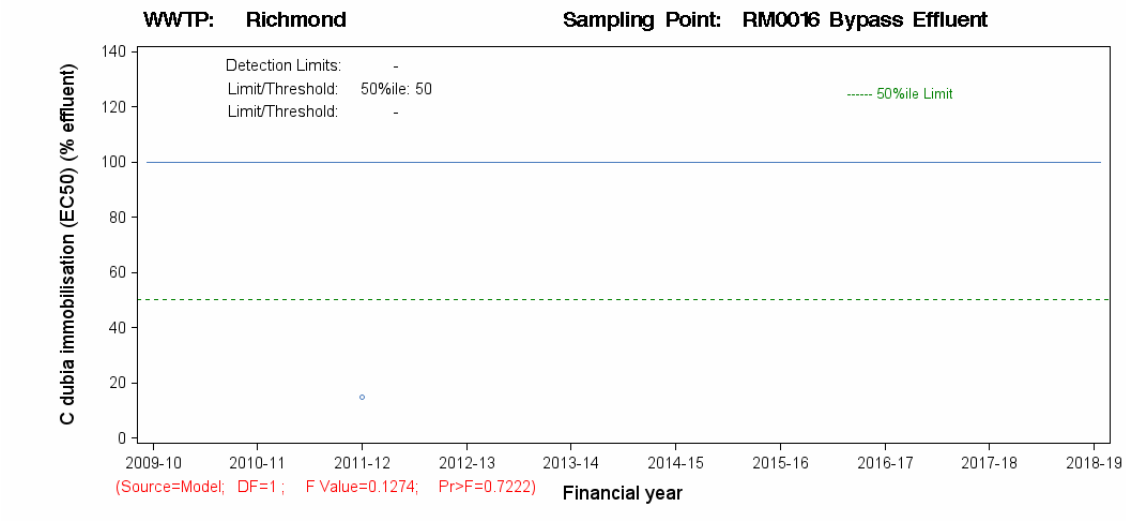




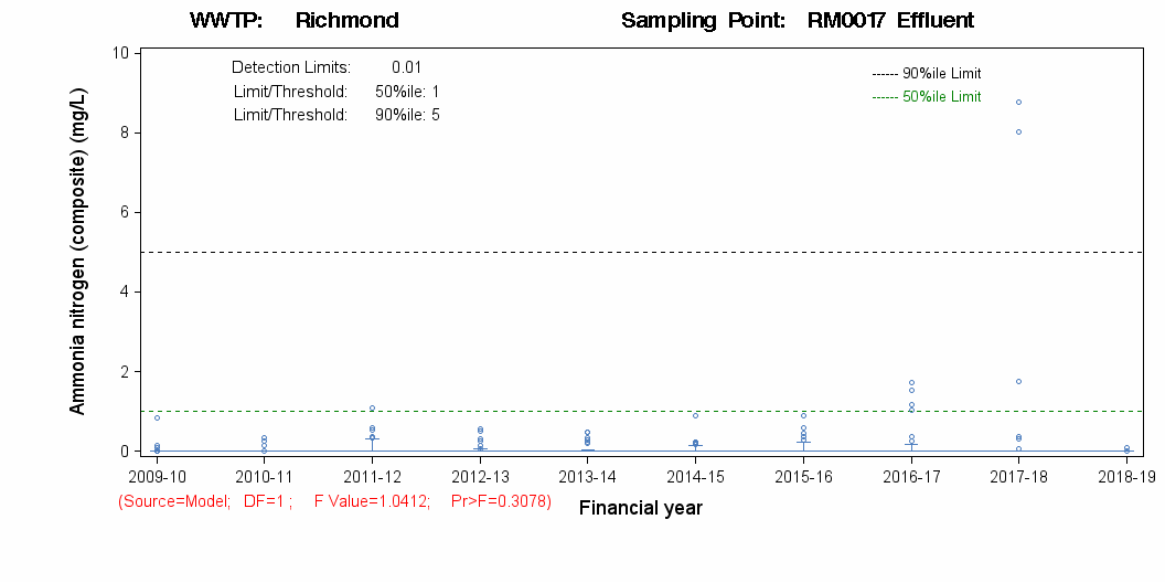


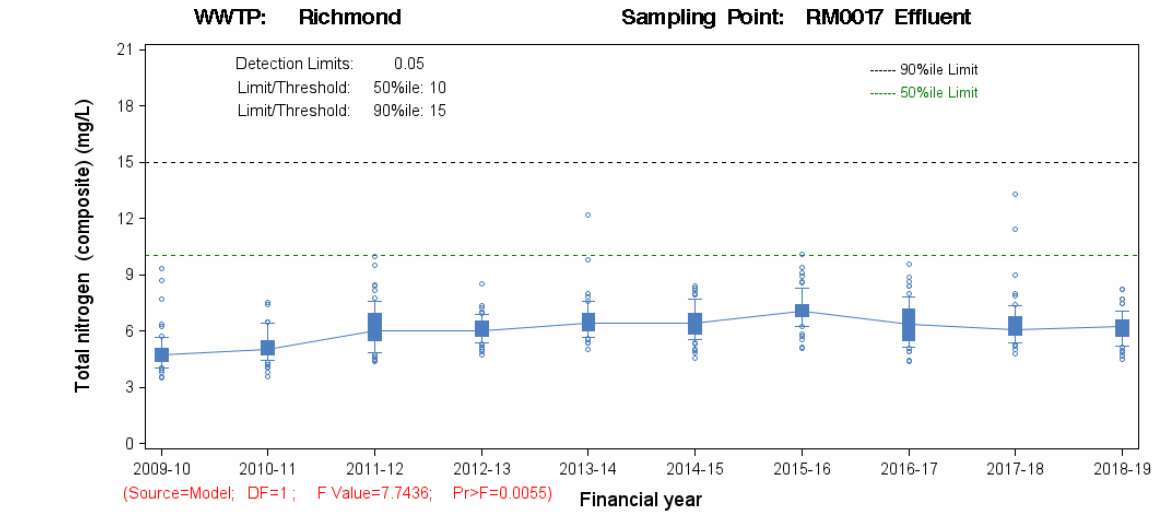


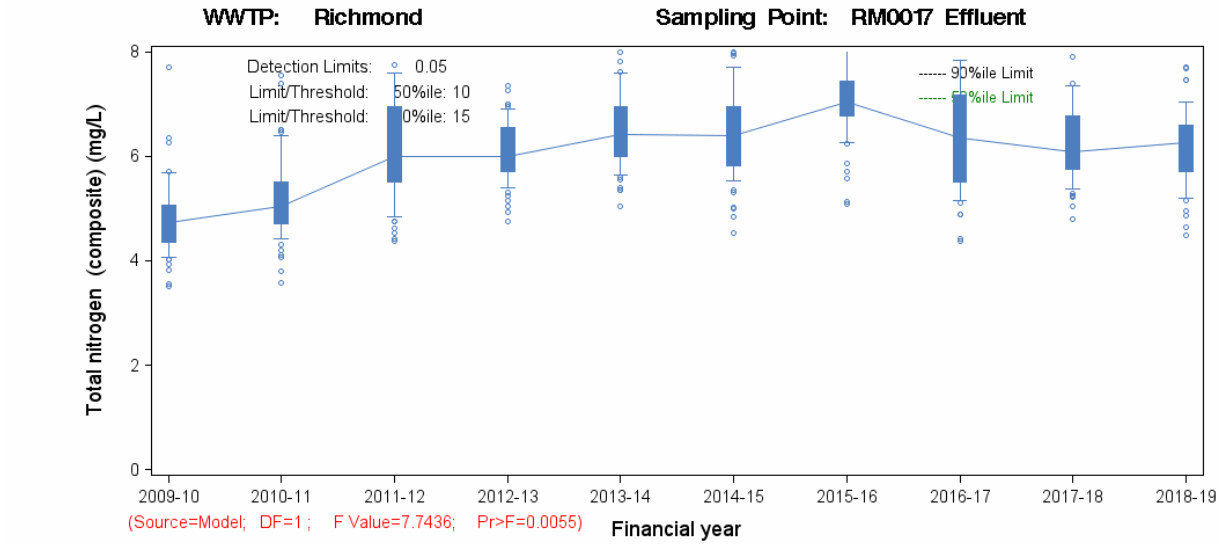
Discharge quality: Toxicity (RM0016 Bypass Effluent)

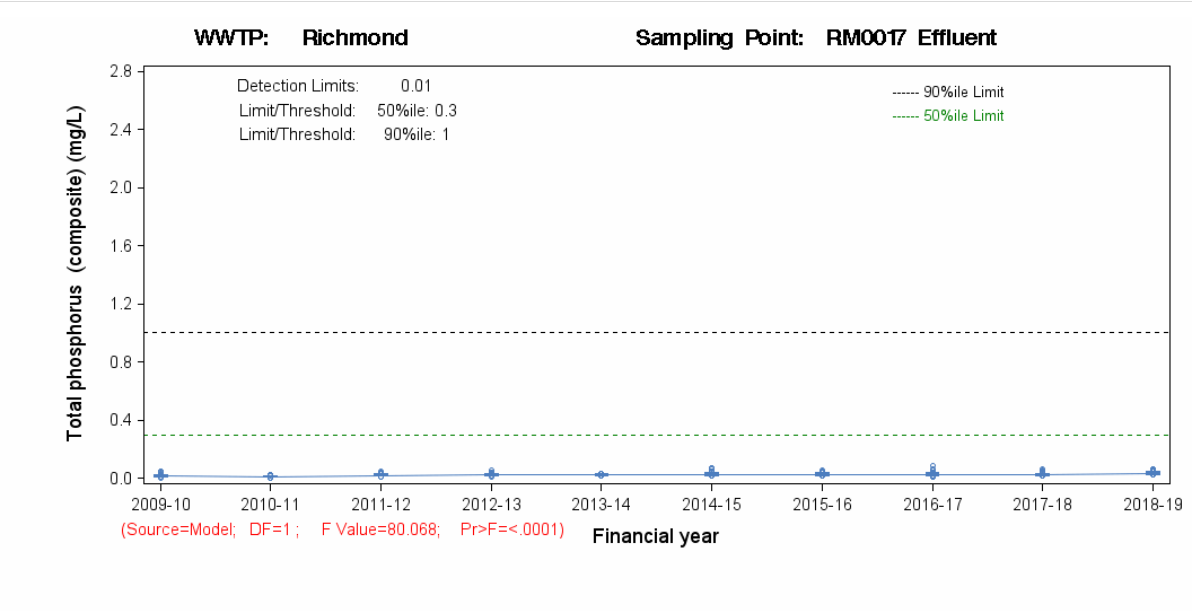


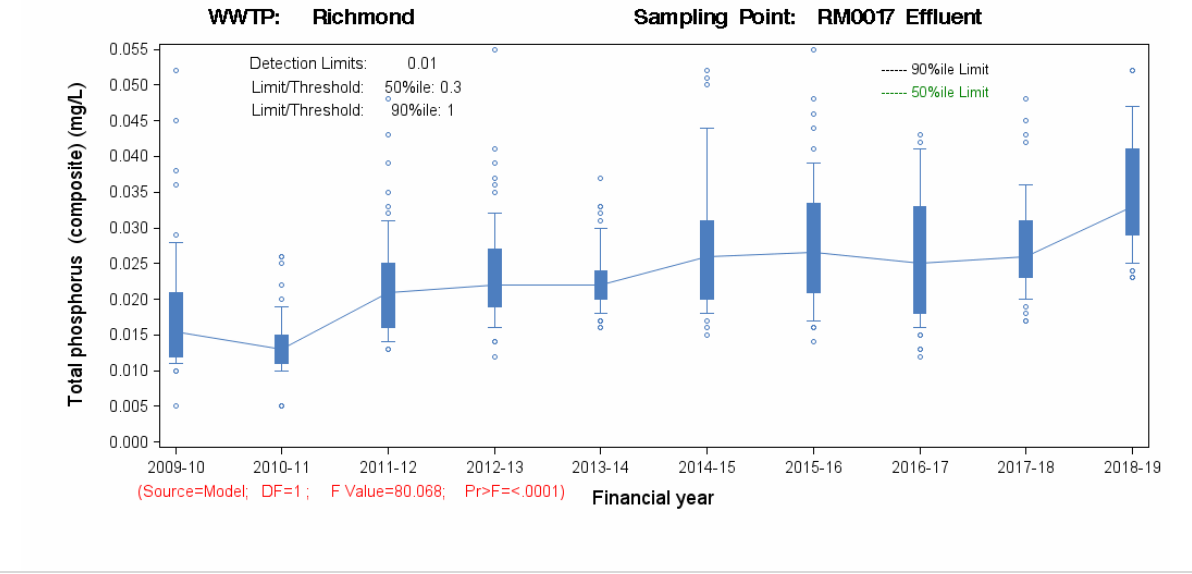
Discharge quality: Nutrients (RM0017 Effluent)



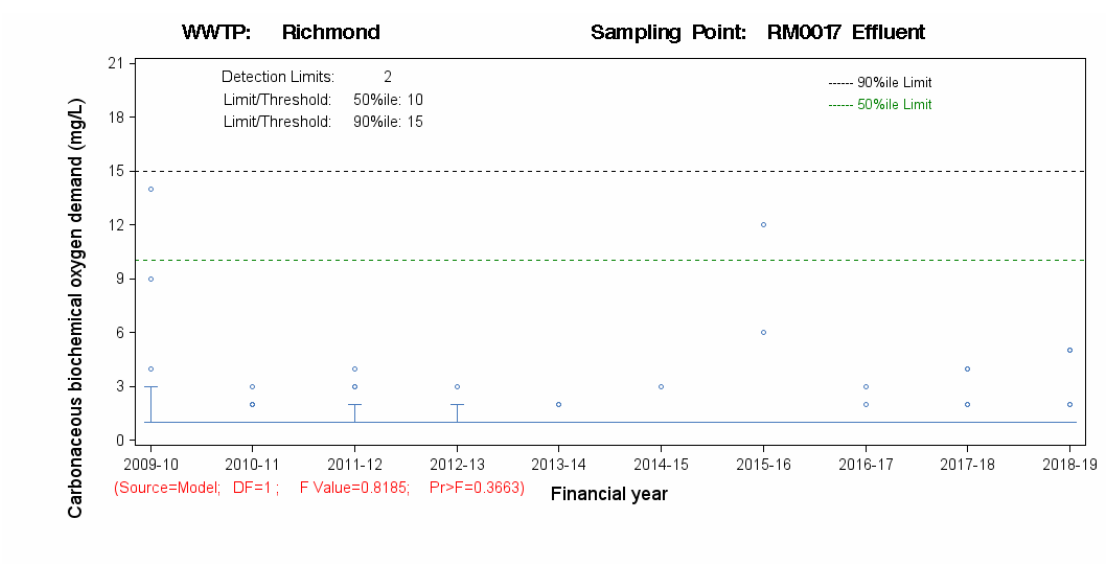




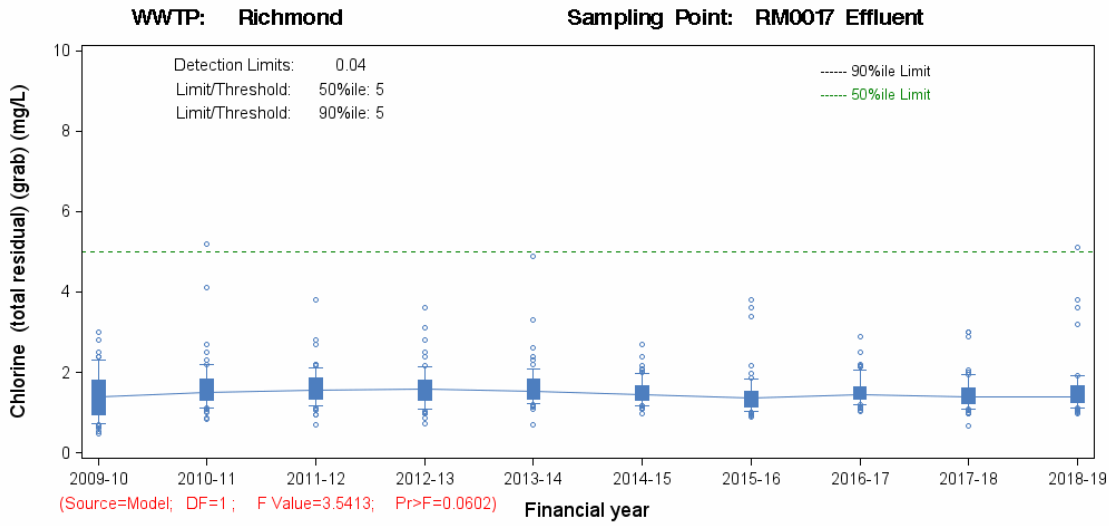


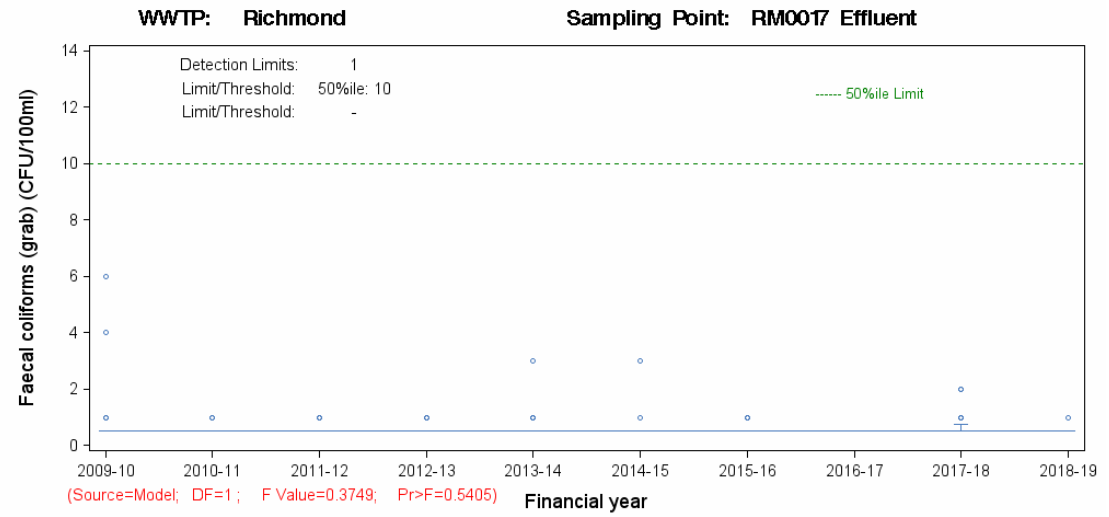


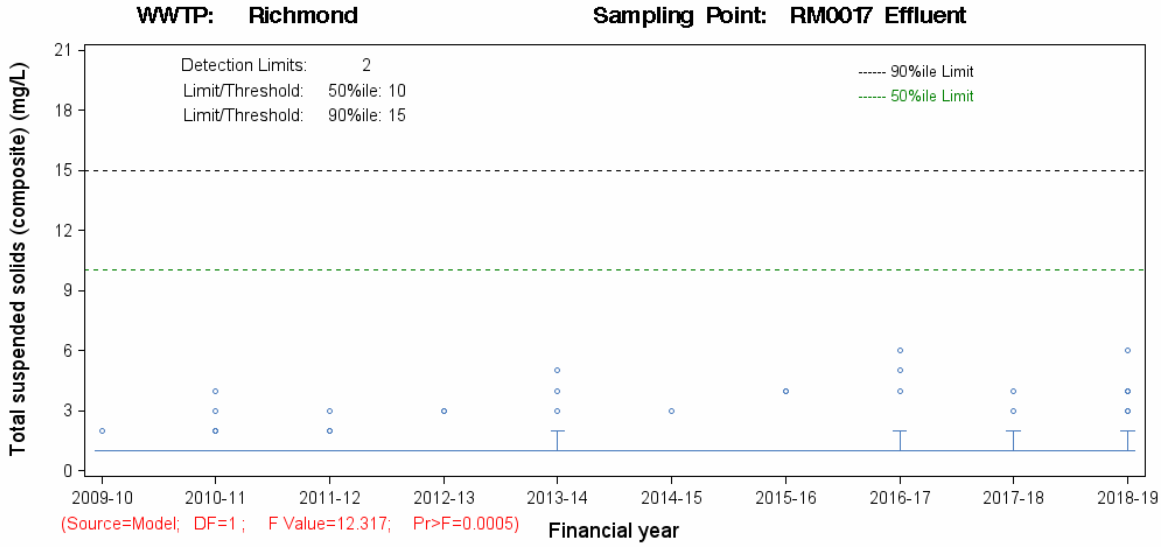
Discharge quality: Major conventional analytes (RM0017 Effluent)

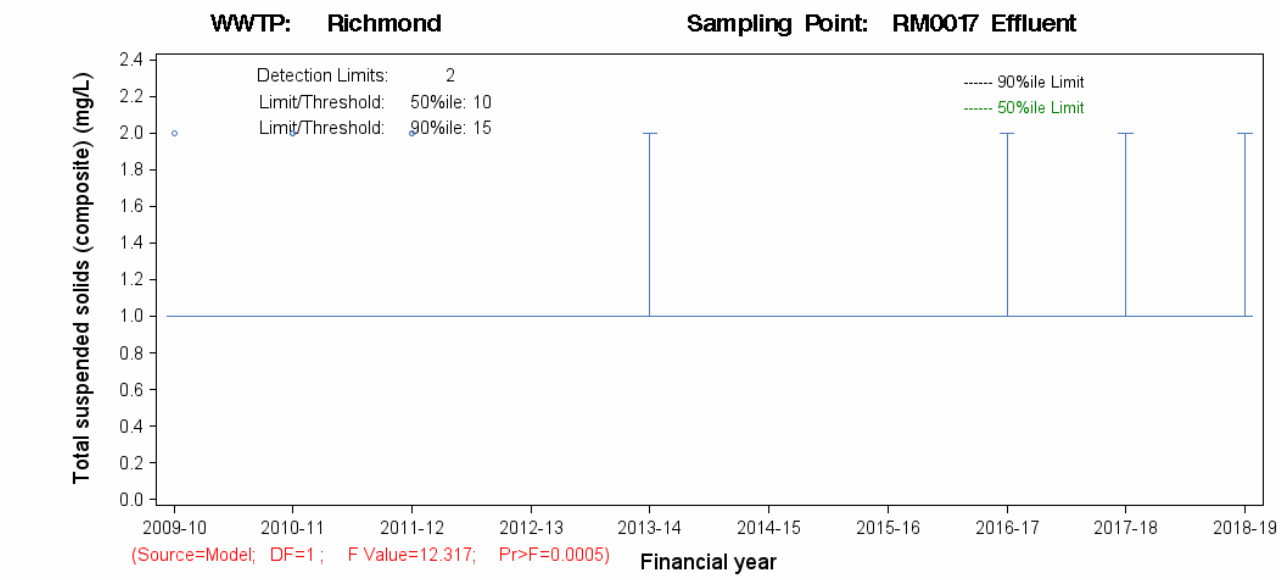


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

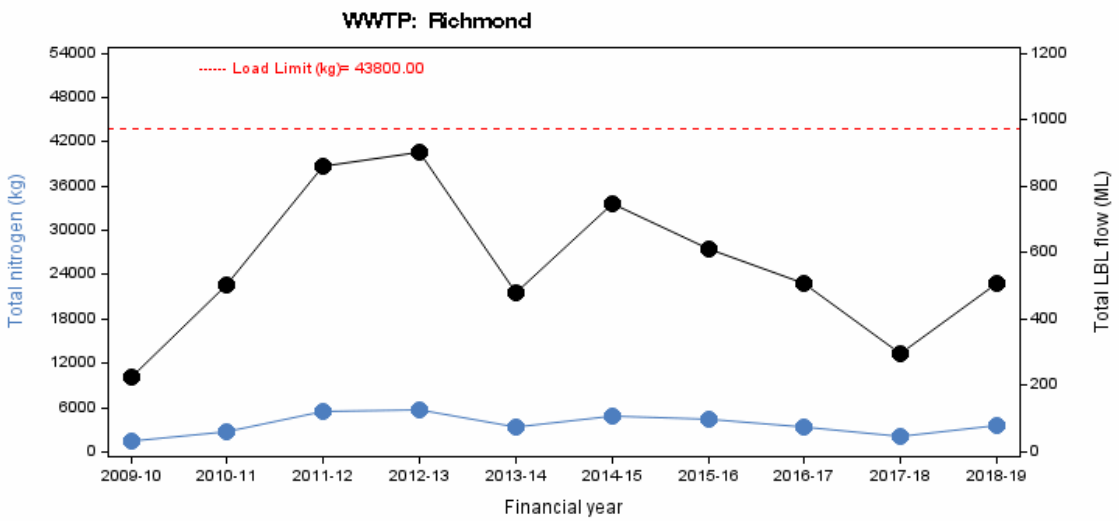

WWTP: Richmond
Sampling Point: RM0017 Effluent
Detection Limits: 0.04
Limit/Threshold: 50%ile: 5
Limit/Threshold: 90%ile: 5
------ 90%ile Limit
------ 50%ile Limit
Chlorine (total residual) (grab) (mg/L)
0
2
4
6
8
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.5413; Pr>F=0.0602)
Financial year

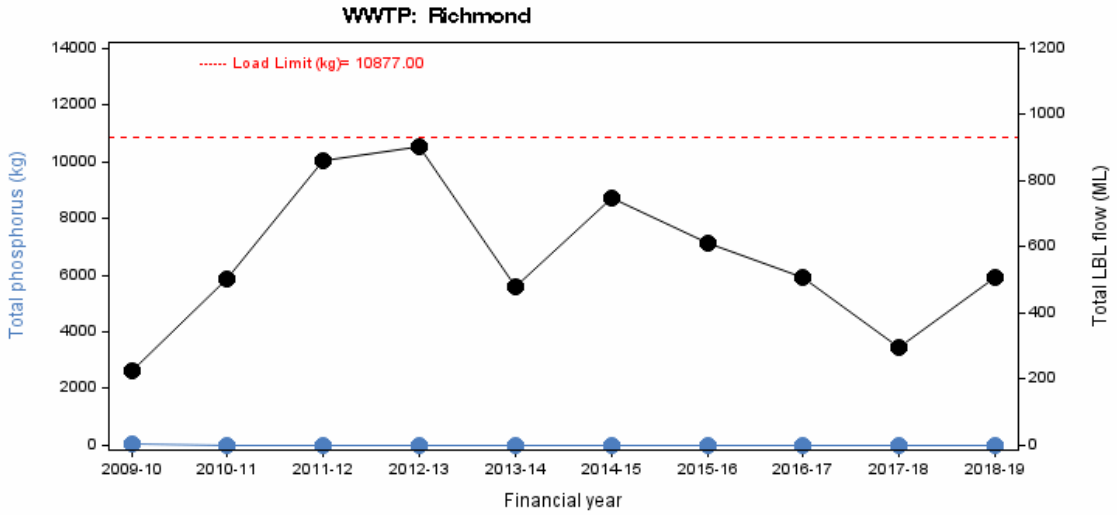

WWTP: Richmond
Sampling Point: RM0017 Effluent
Detection Limits: 1
Limit/Threshold: 50%ile: 10
Limit/Threshold: -
------ 50%ile Limit
Faecal coliforms (grab) (CFU/100ml)
0
2
4
6
8
10
12
14
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3749; Pr>F=0.5405)
Financial year


WWTP: Richmond
Sampling Point: RM0017 Effluent
Detection Limits: 2
Limit/Threshold: 50%ile: 10
Limit/Threshold: 90%ile: 15
------ 90%ile Limit
------ 50%ile Limit
Total suspended solids (composite) (mg/L)
0
3
6
9
12
15
18
21
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=12.317; Pr>F=0.0005)
Financial year

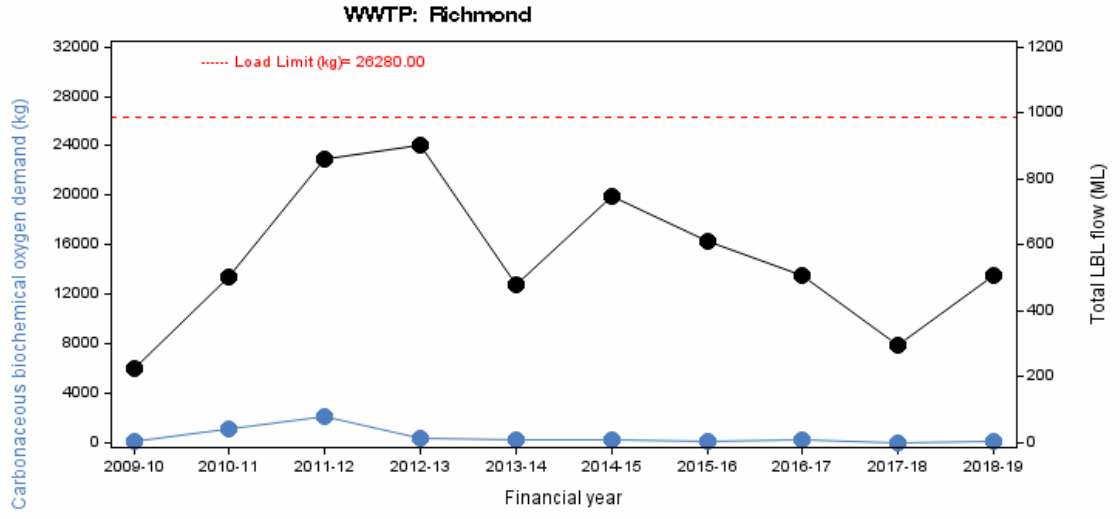

WWTP: Richmond
Sampling Point: RM0017 Effluent
Detection Limits: 2
Limit/Threshold: 50%ile: 10
Limit/Threshold: 90%ile: 15
------ 90%ile Limit
------ 50%ile Limit
Total suspended solids (composite) (mg/L)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=12.317; Pr>F=0.0005)
Financial year

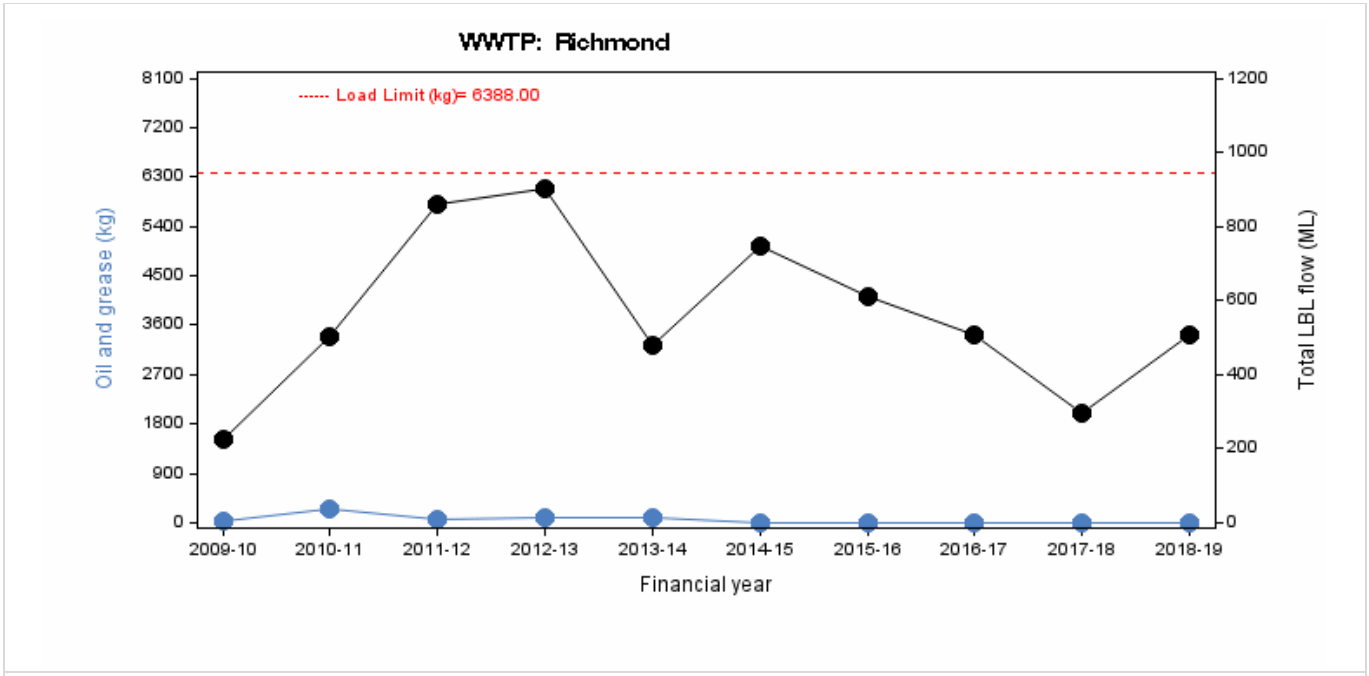
Discharge load: Nutrients

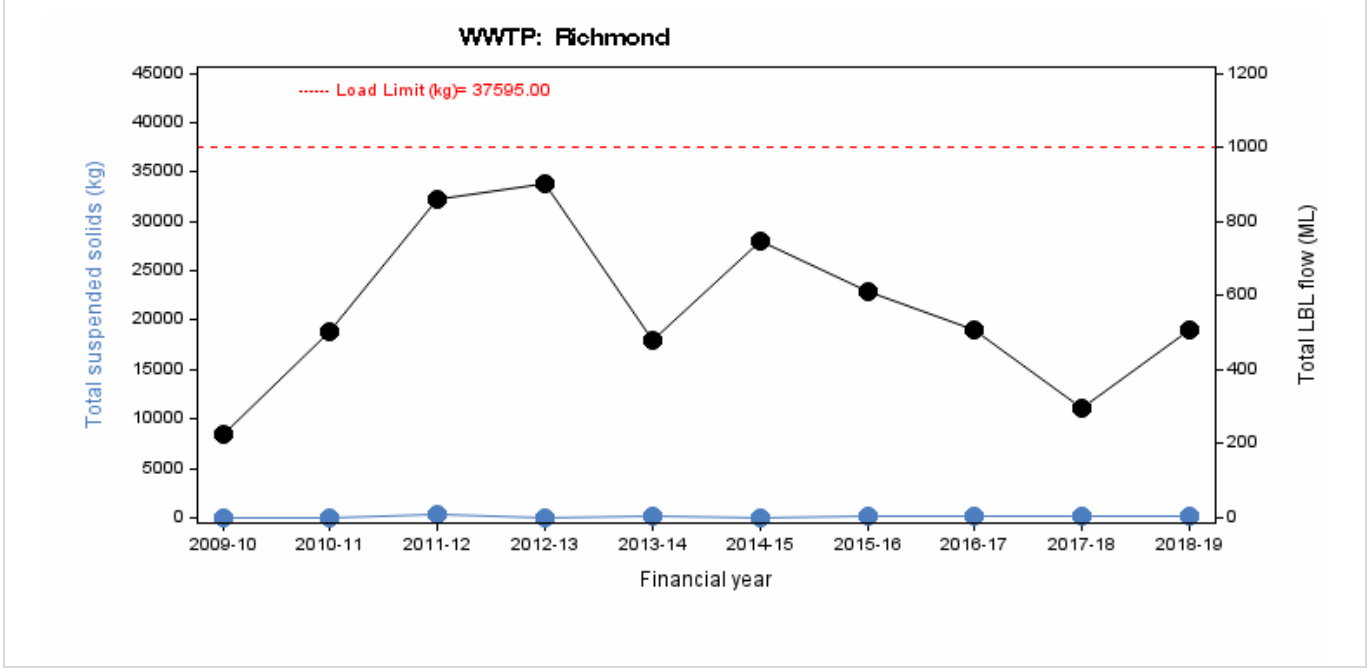




Discharge load: Major conventional analytes

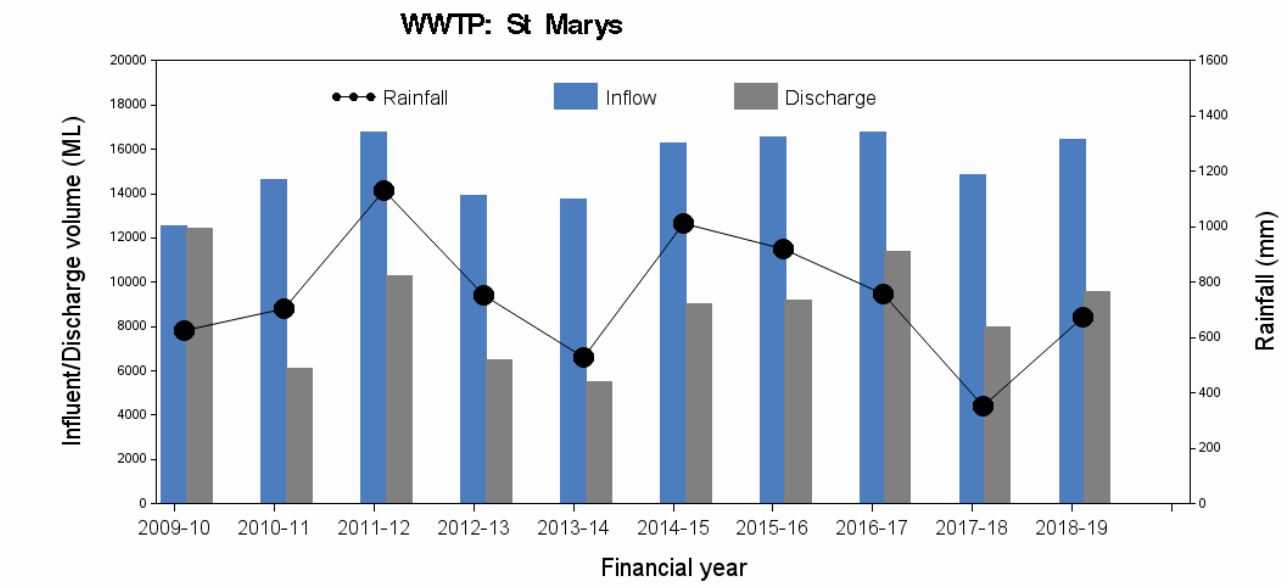


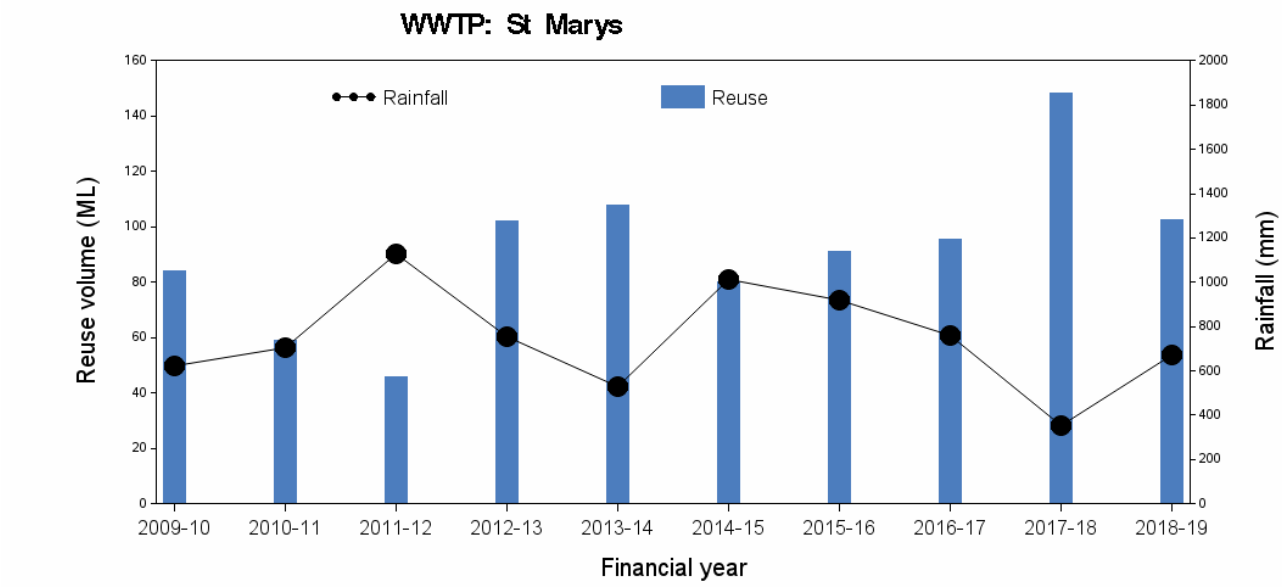

WWTP: Richmond
Load Limit (kg)= 6388.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Richmond
Load Limit (kg)= 37595.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

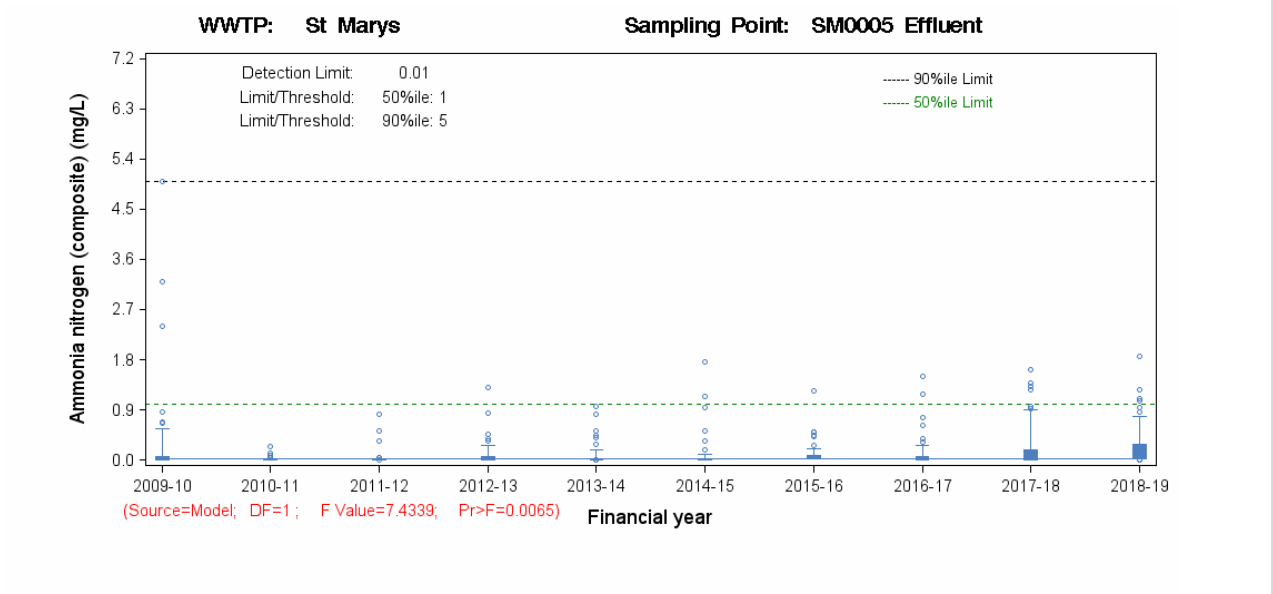
St Marys WWTP

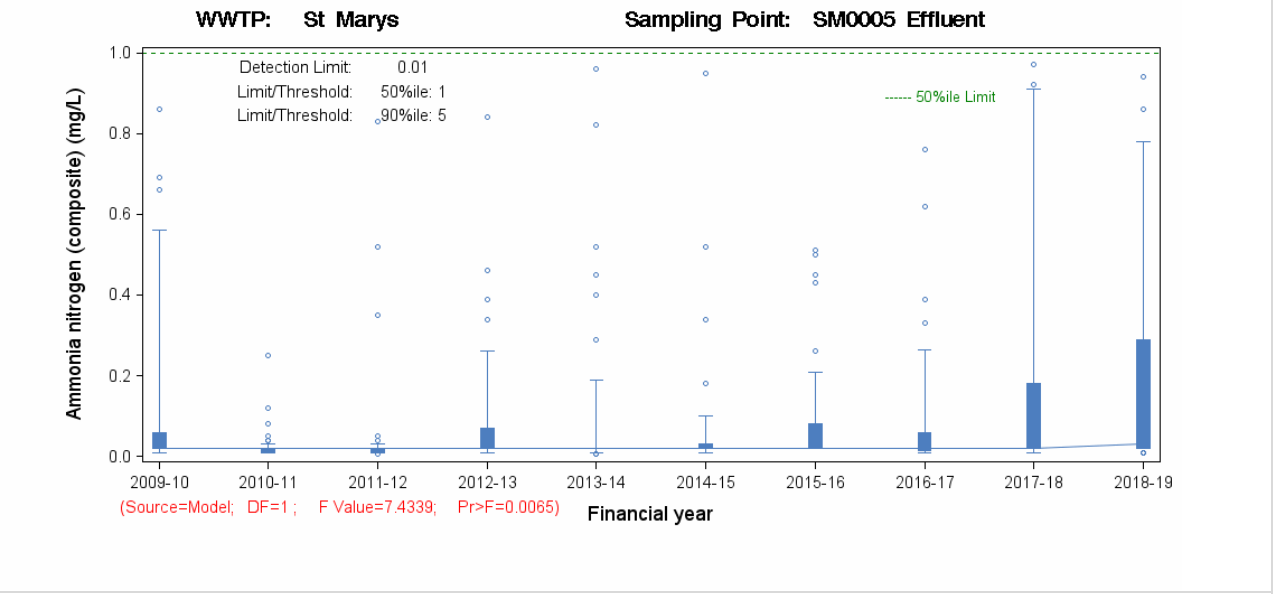
Discharge volume and rainfall

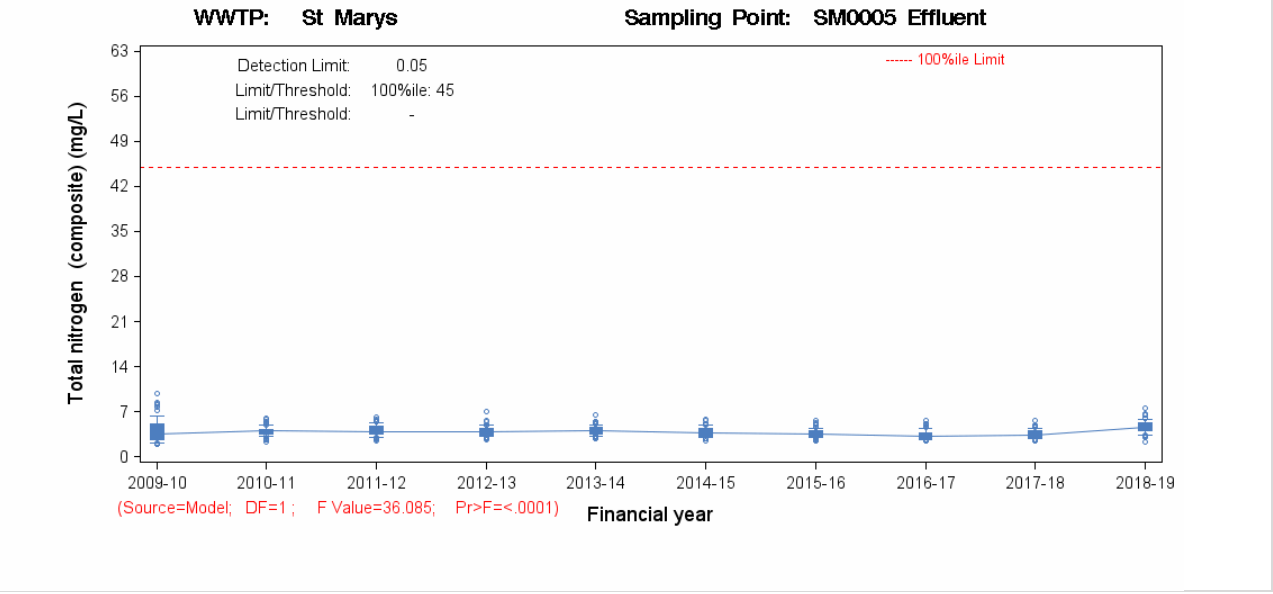


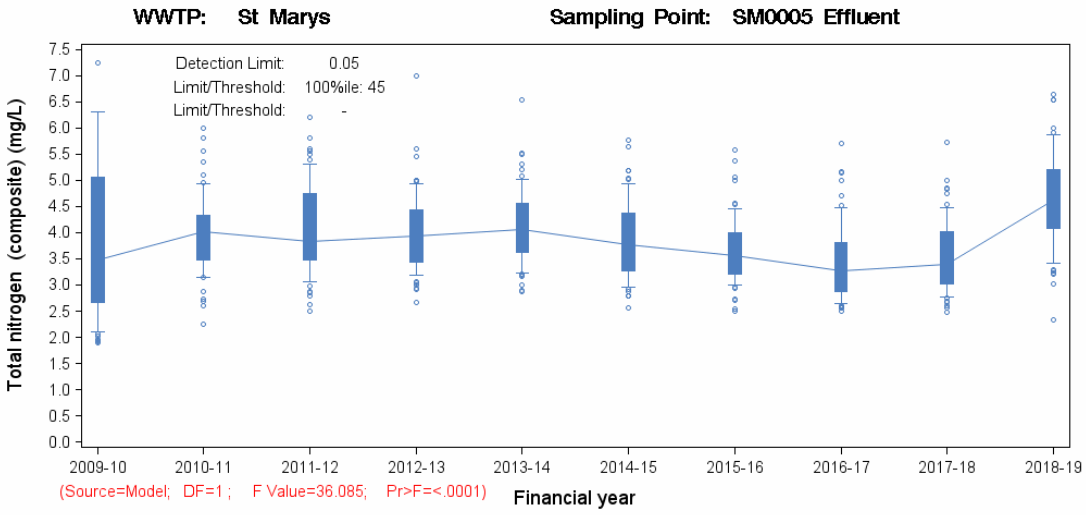


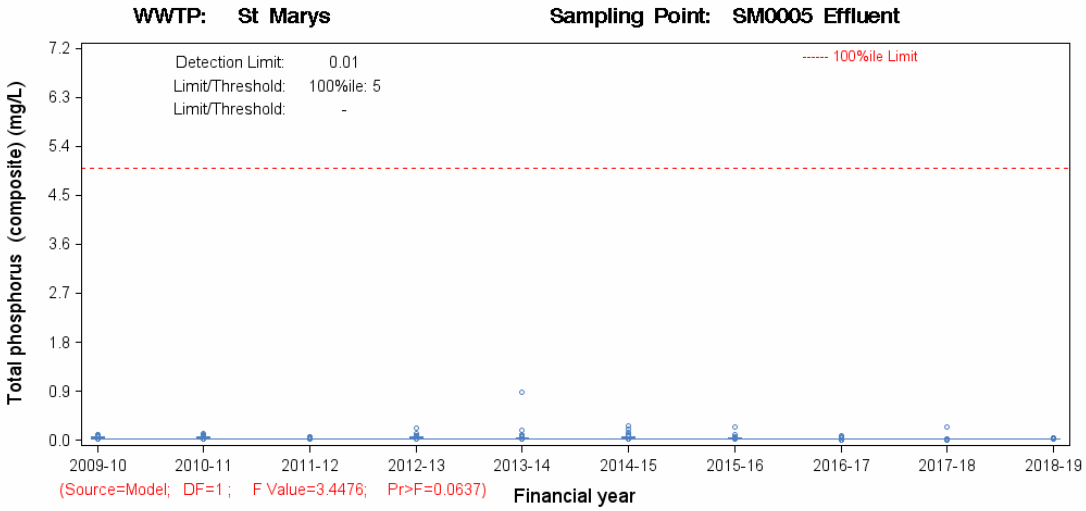
Discharge quality: Nutrients



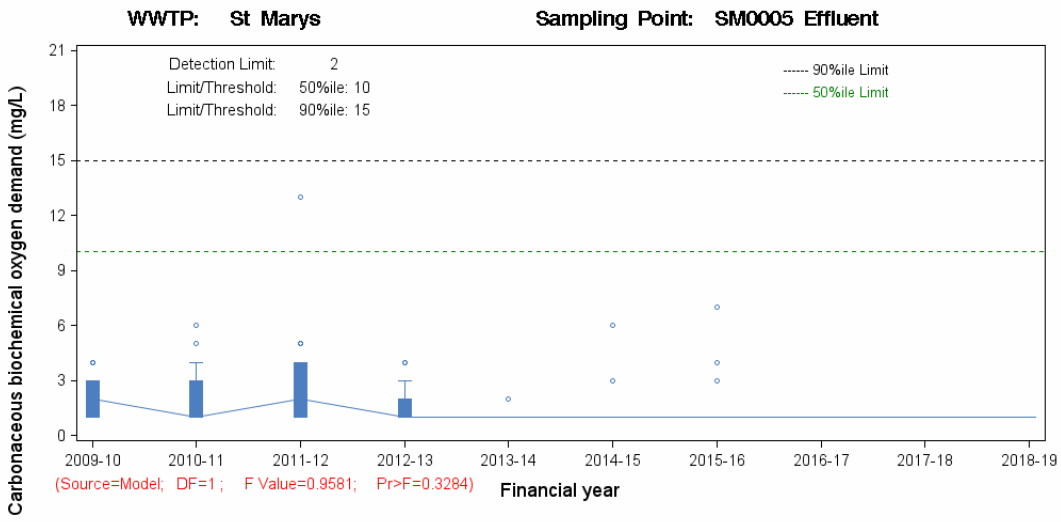




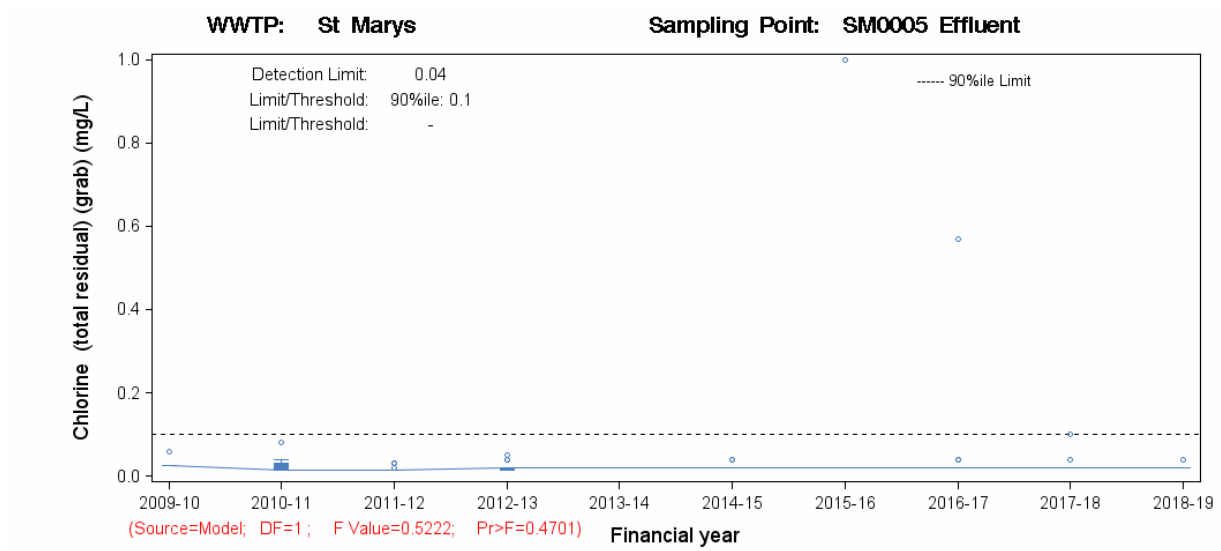


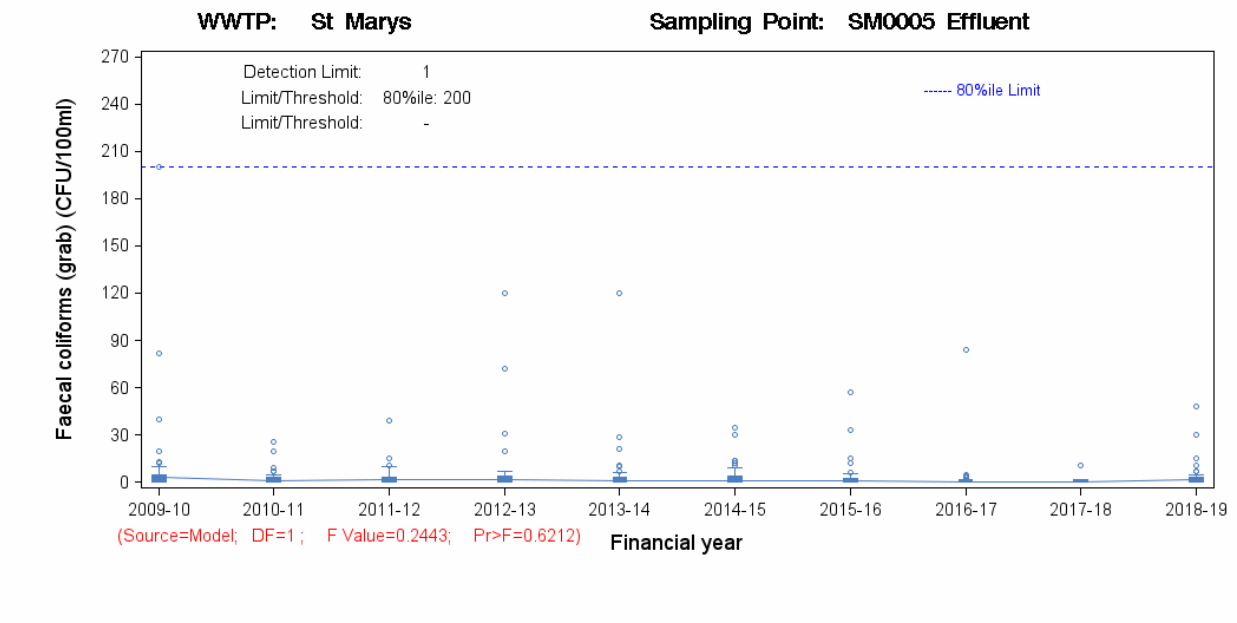


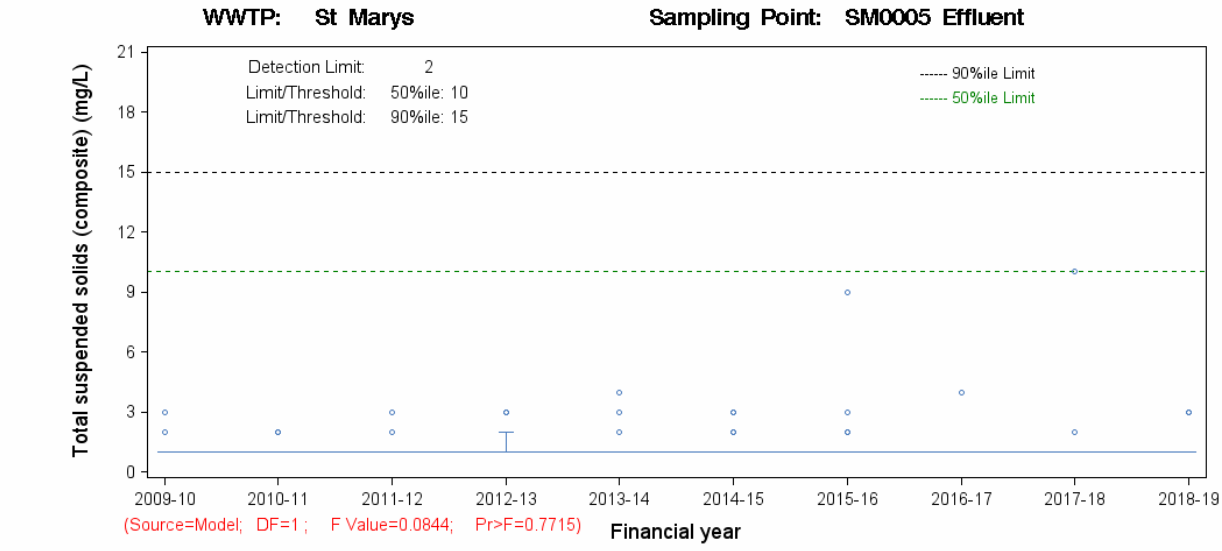
Discharge quality: Major conventional analytes



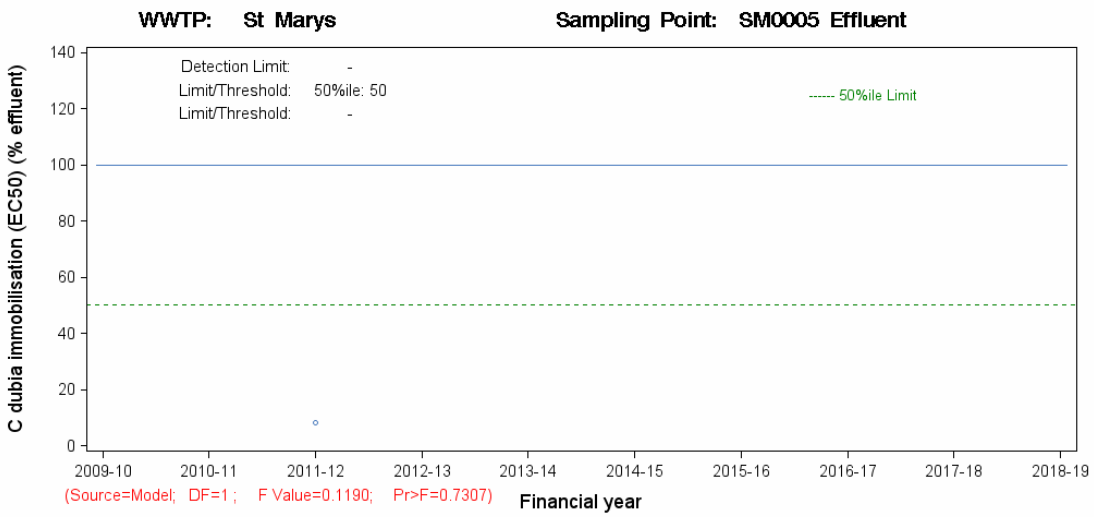
Note: 2018-19 data was compared with previous four years data (2014-2018) due to lab method change in 2014-15.


WWTP: St Marys
Sampling Point: SM0005 Effluent
Detection Limit: 0.04
Limit/Threshold: 90%ile: 0.1
Limit/Threshold: -
------ 90%ile Limit
Chlorine (total residual) (grab) (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5222; Pr>F=0.4701)
Financial year

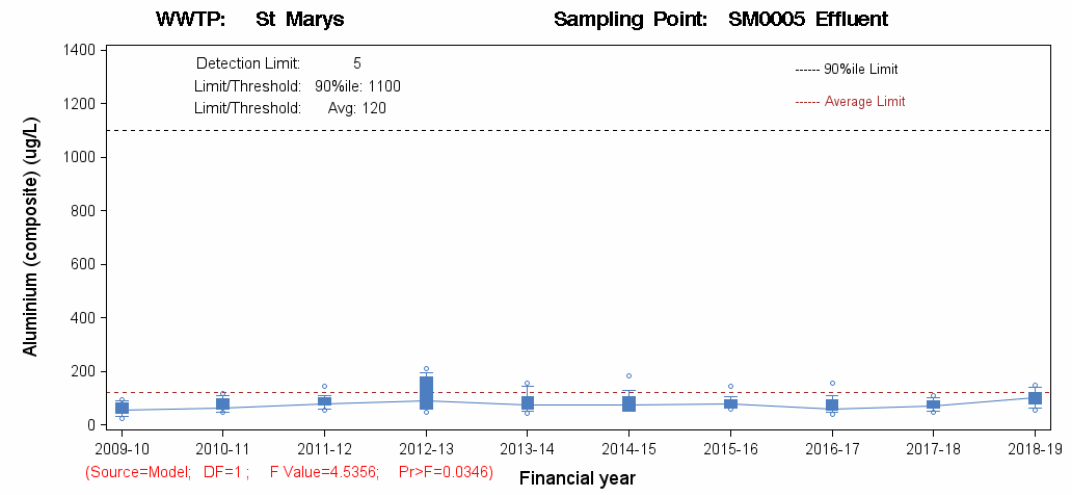

WWTP: St Marys
Sampling Point: SM0005 Effluent
Detection Limit: 1
Limit/Threshold: 80%ile: 200
Limit/Threshold: -
------ 80%ile Limit
Faecal coliforms (grab) (CFU/100ml)
270
240
210
180
150
120
90
60
30
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2443; Pr>F=0.6212)
Financial year

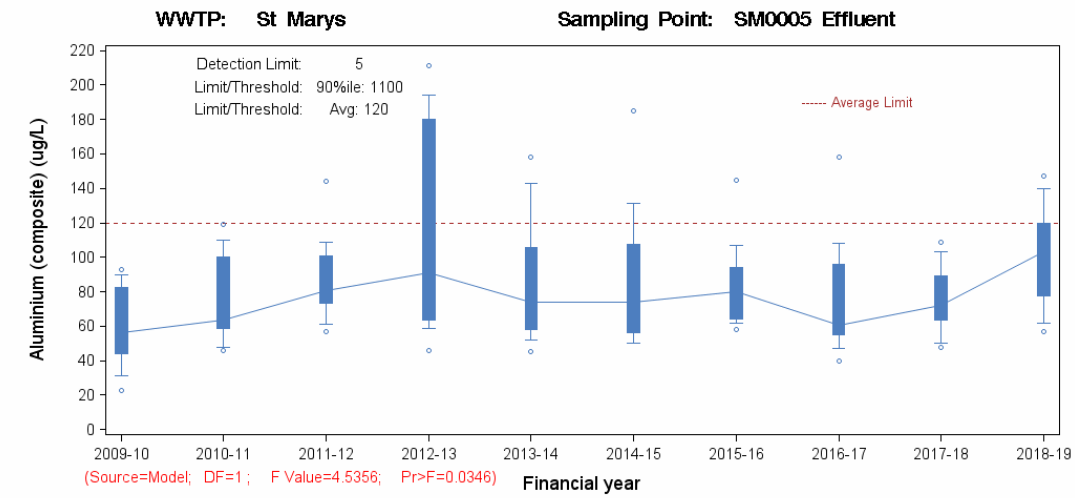

WWTP: St Marys
Sampling Point: SM0005 Effluent
Detection Limit: 2
Limit/Threshold: 50%ile: 10
Limit/Threshold: 90%ile: 15
------ 90%ile Limit
------ 50%ile Limit
Total suspended solids (composite) (mg/L)
21
18
15
12
9
6
3
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0844; Pr>F=0.7715)
Financial year

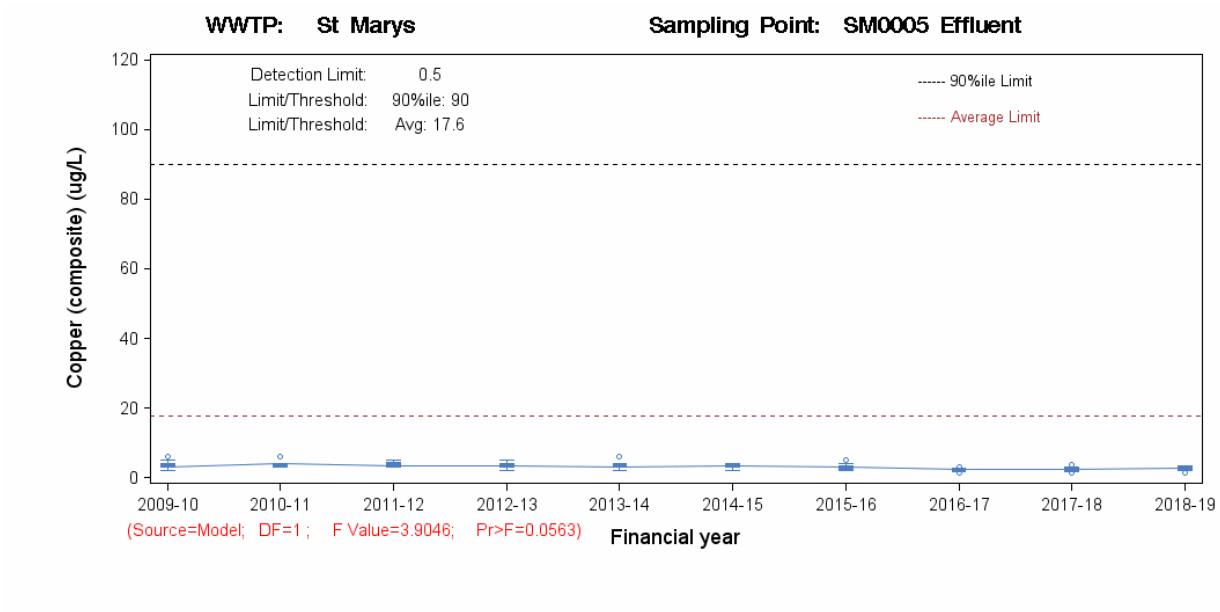
Discharge quality: Toxicity



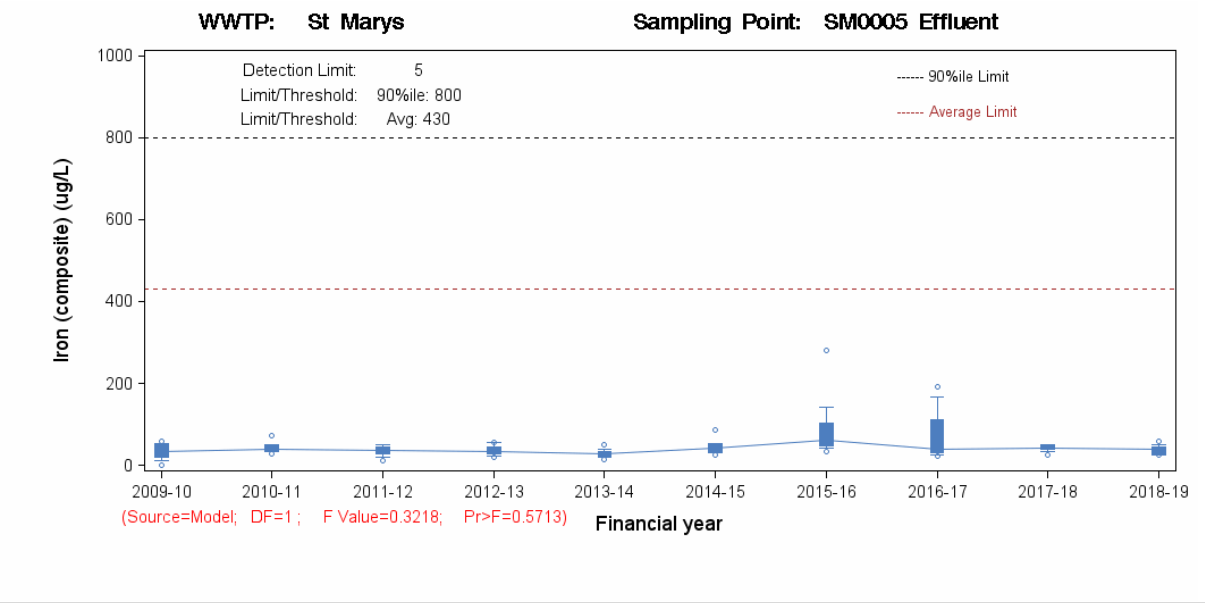
Discharge quality: Trace metals

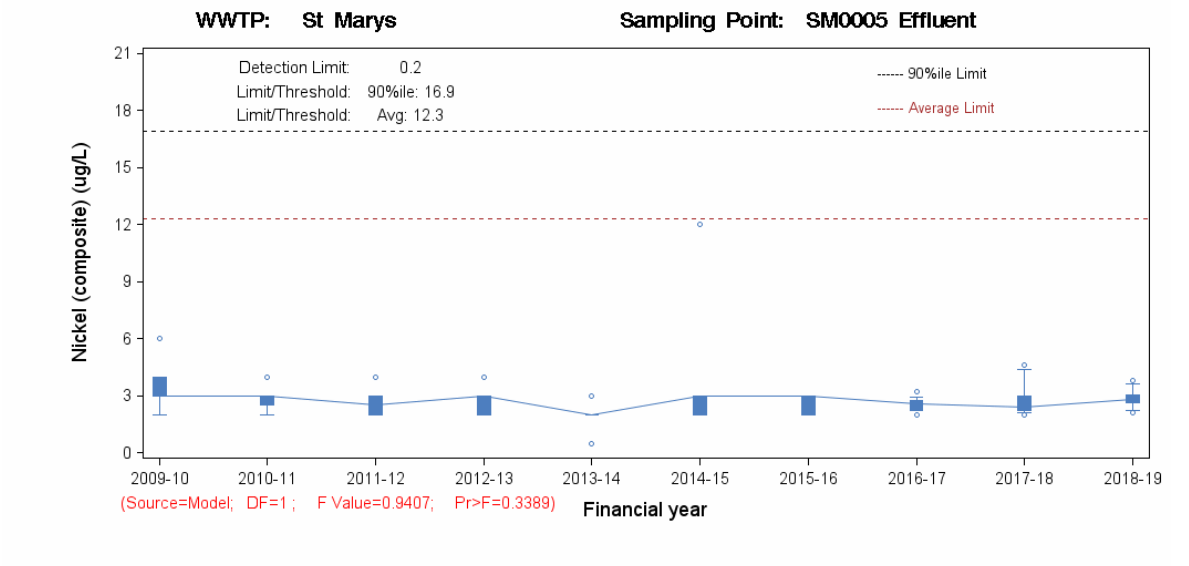




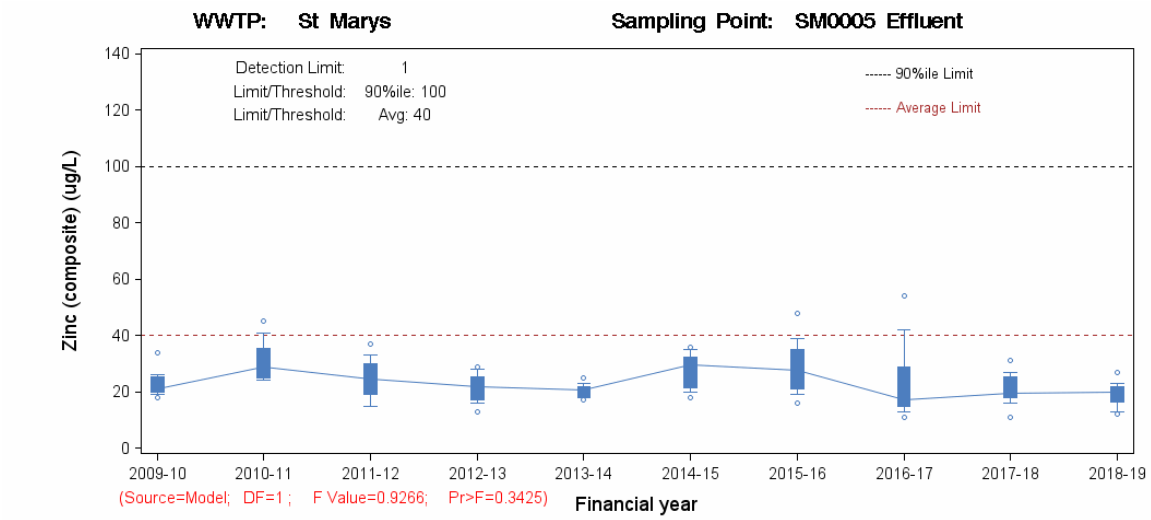


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



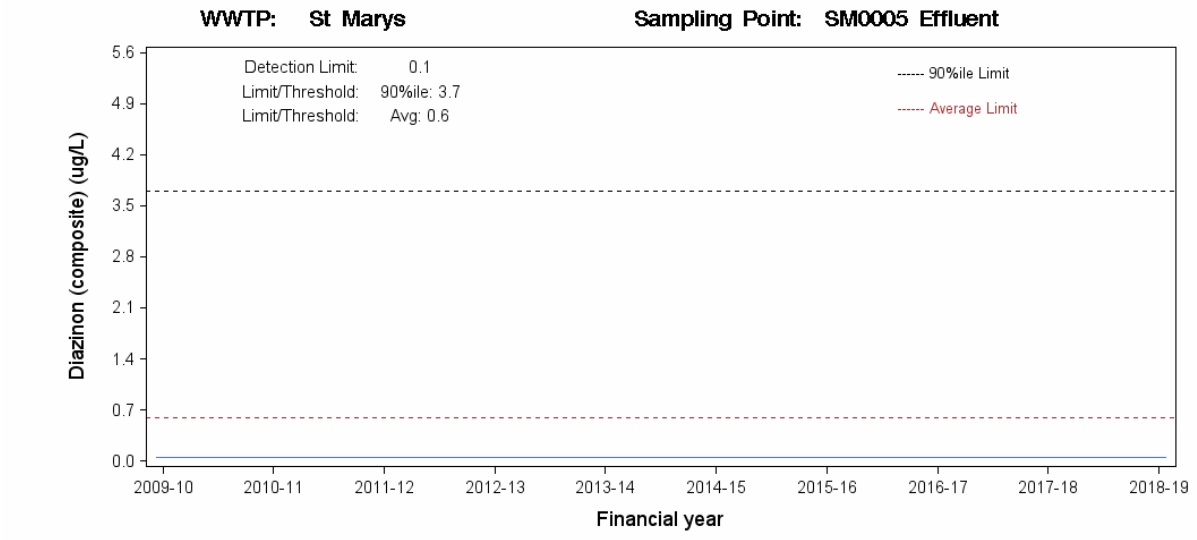


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

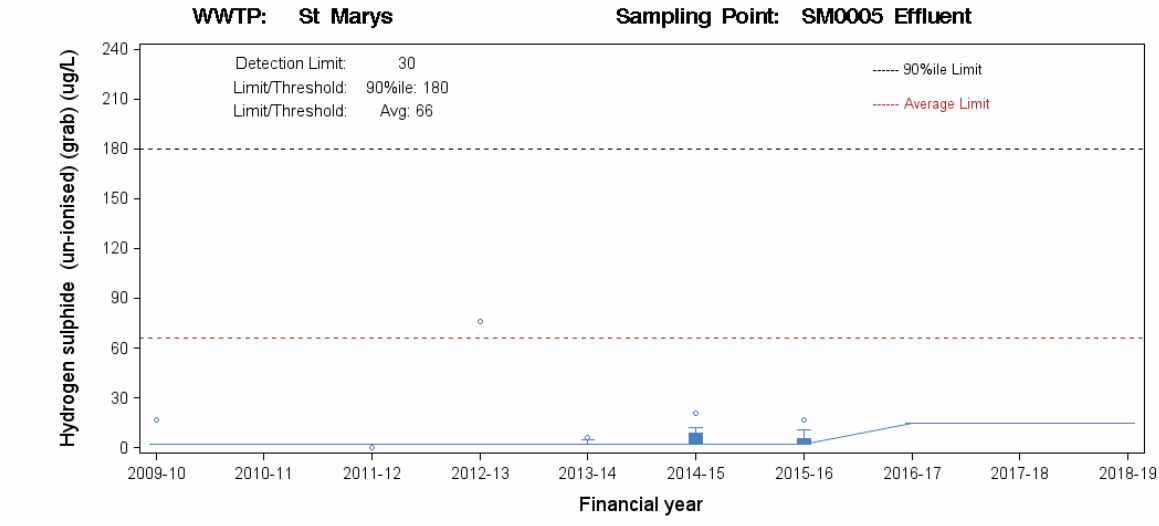


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

Discharge quality: Other chemicals and organics (including pesticides)

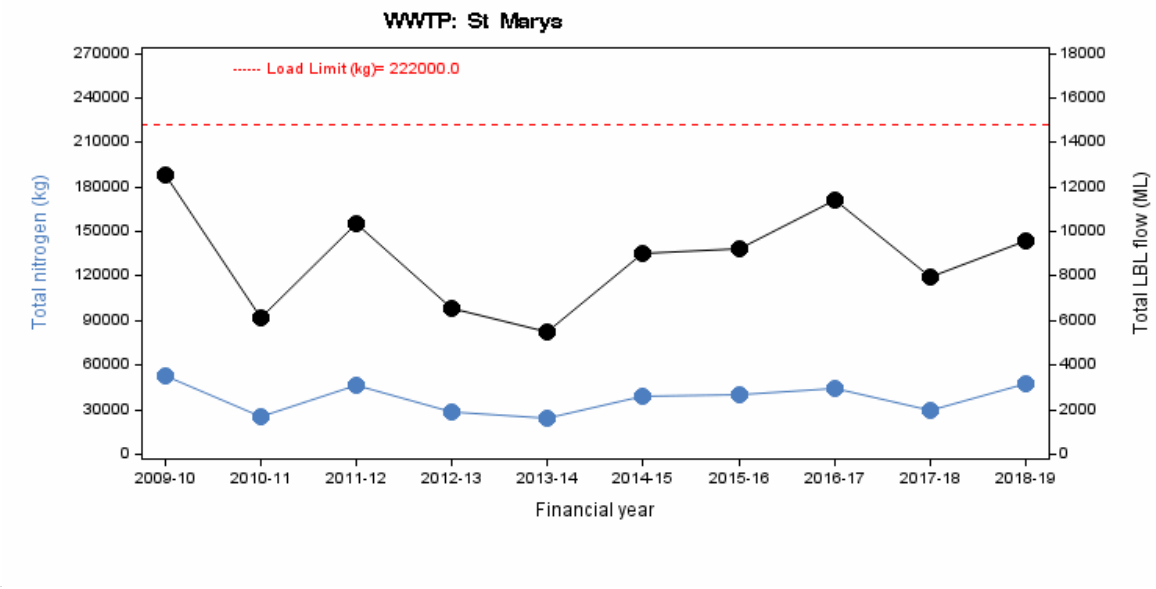


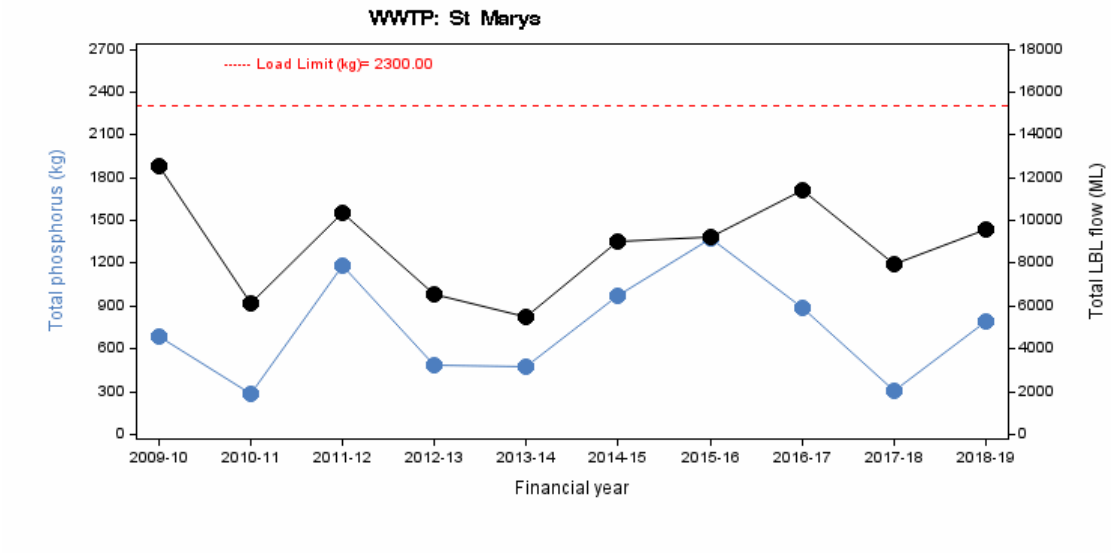
Note: Statistical test was not conducted because >90% of results were below the detection limit.



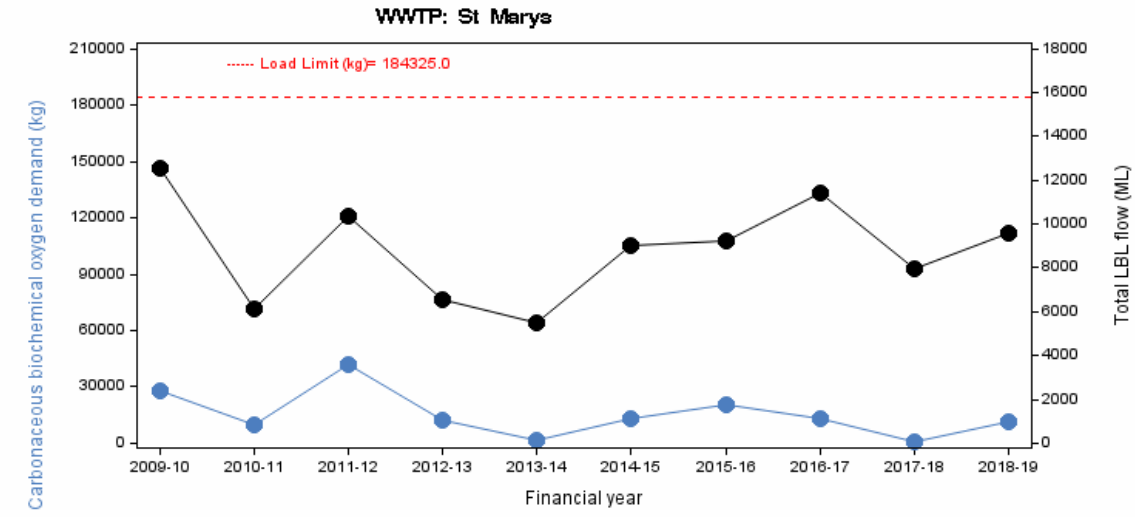
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

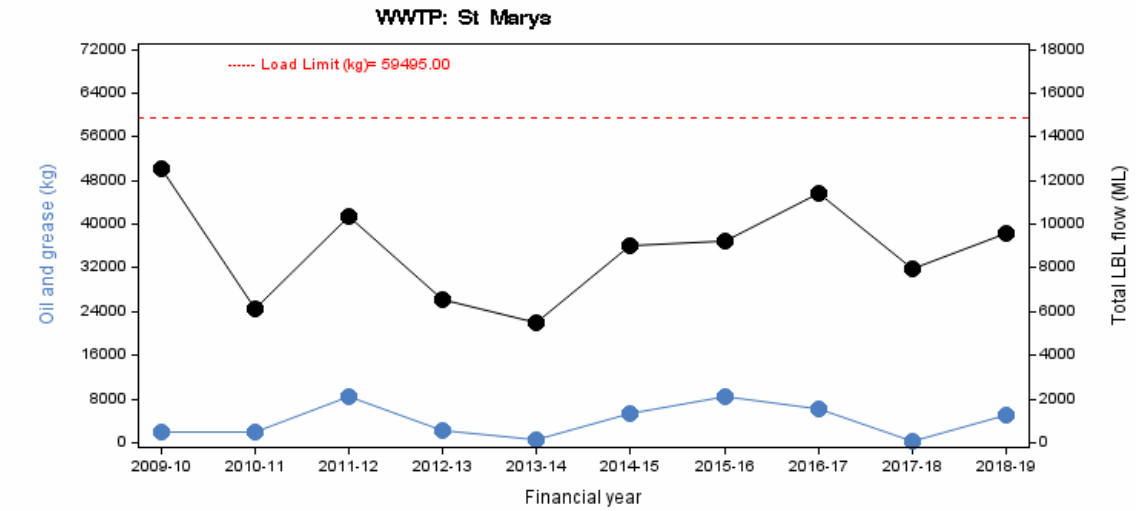
Discharge load: Nutrients

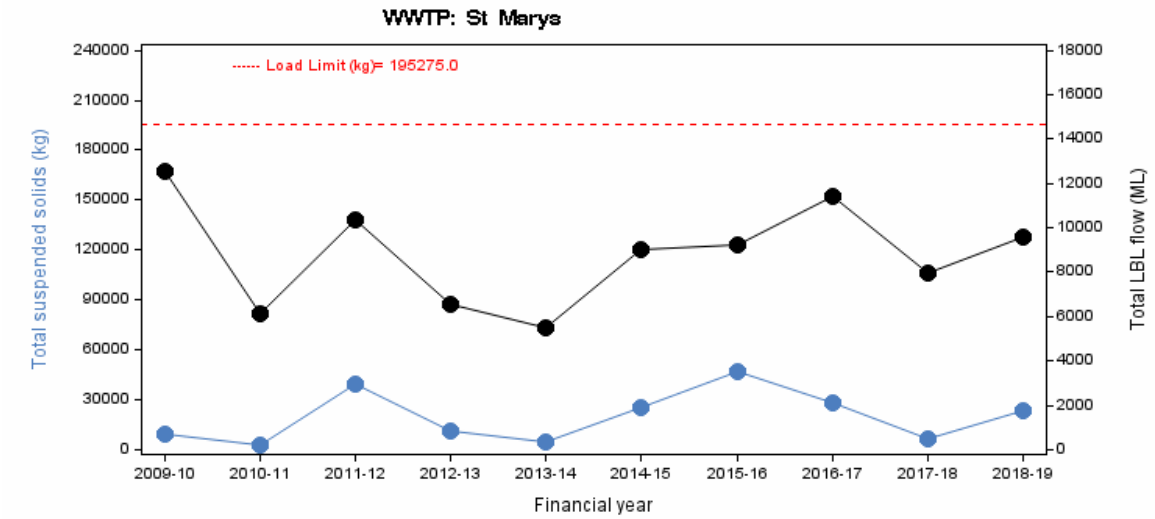




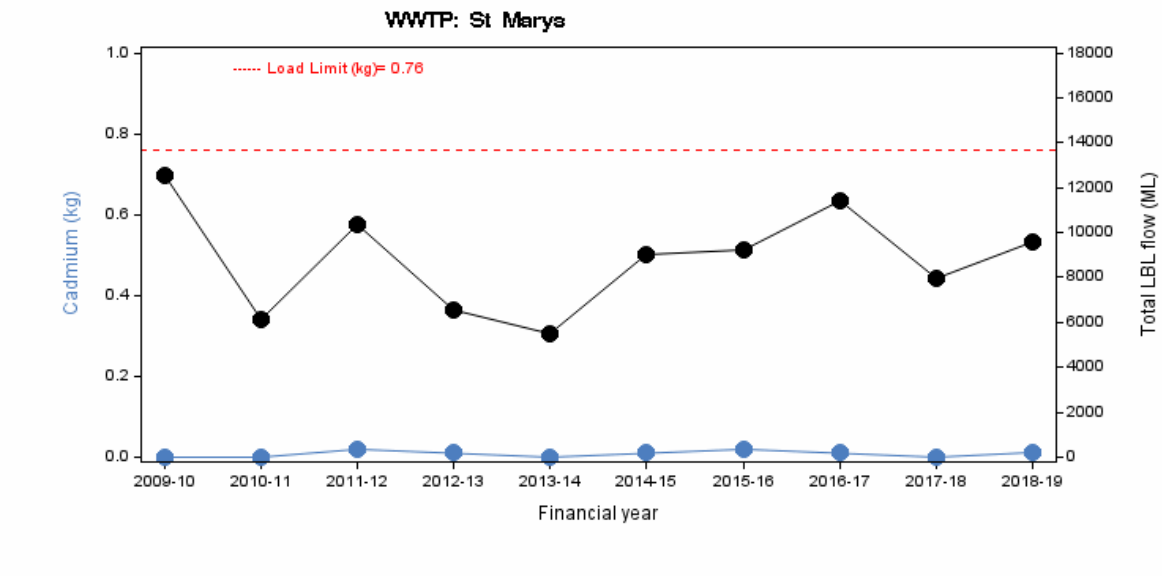
Discharge load: Major conventional analytes

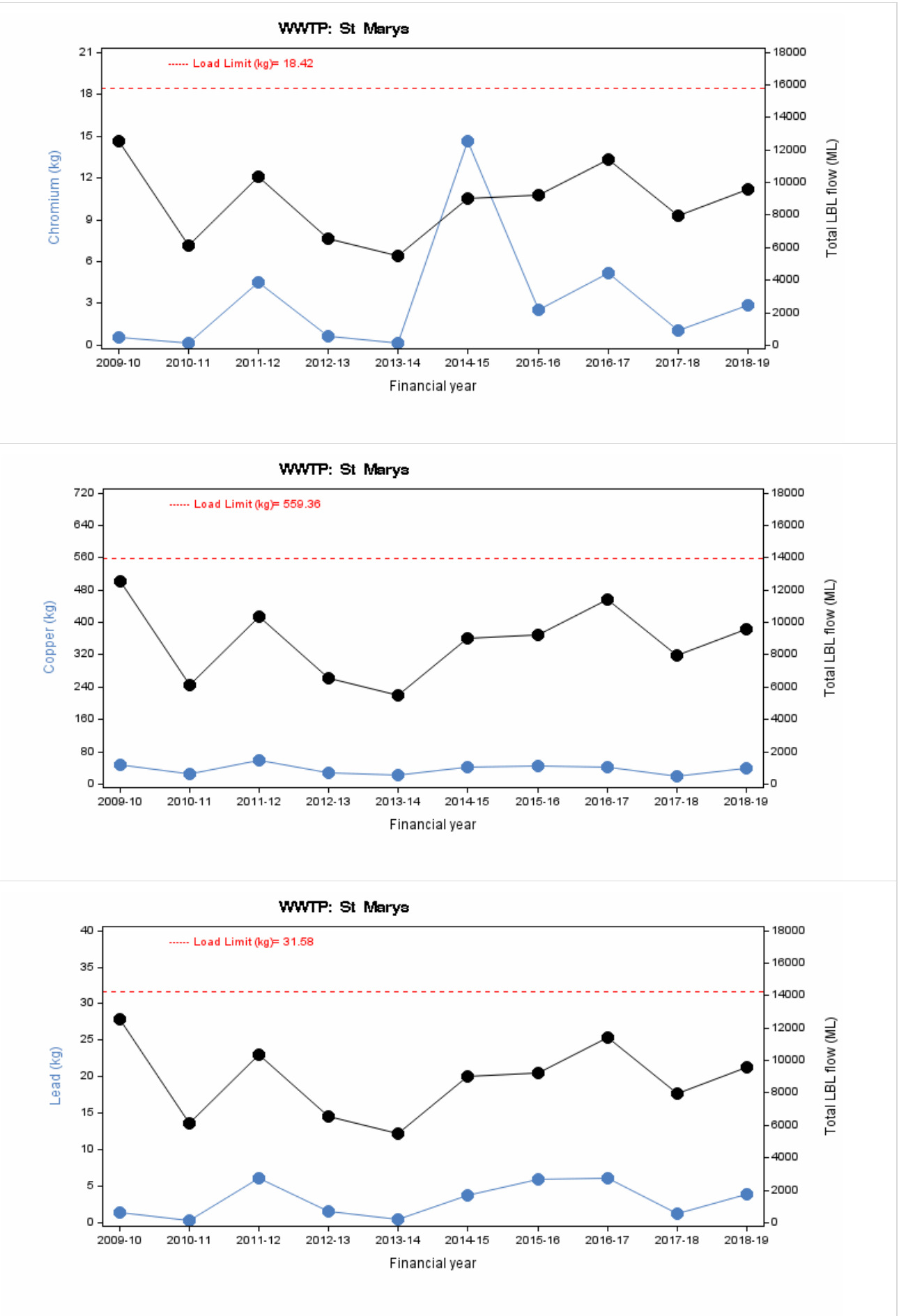


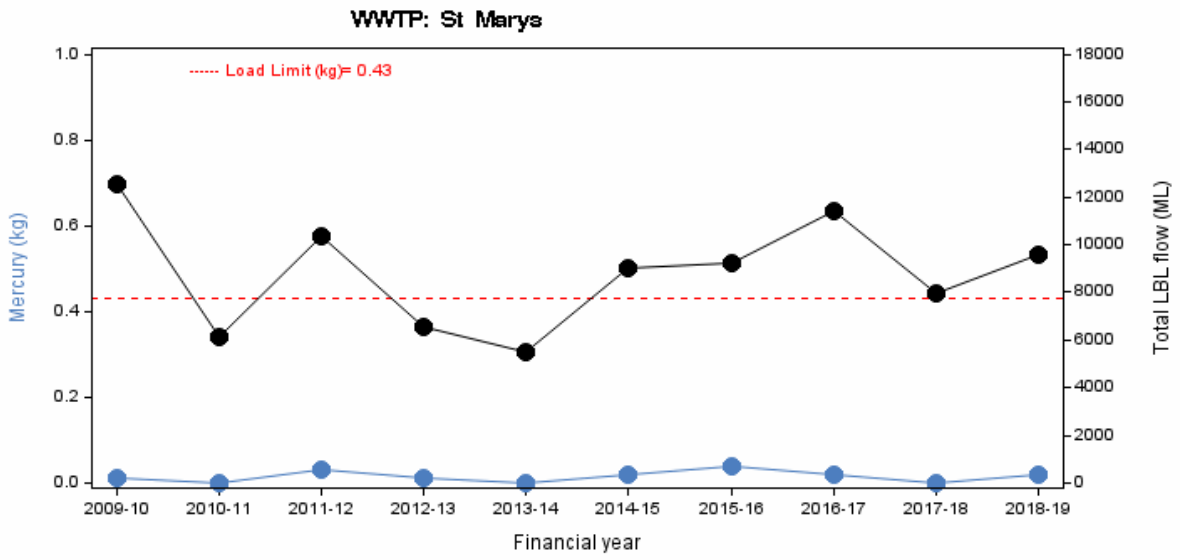


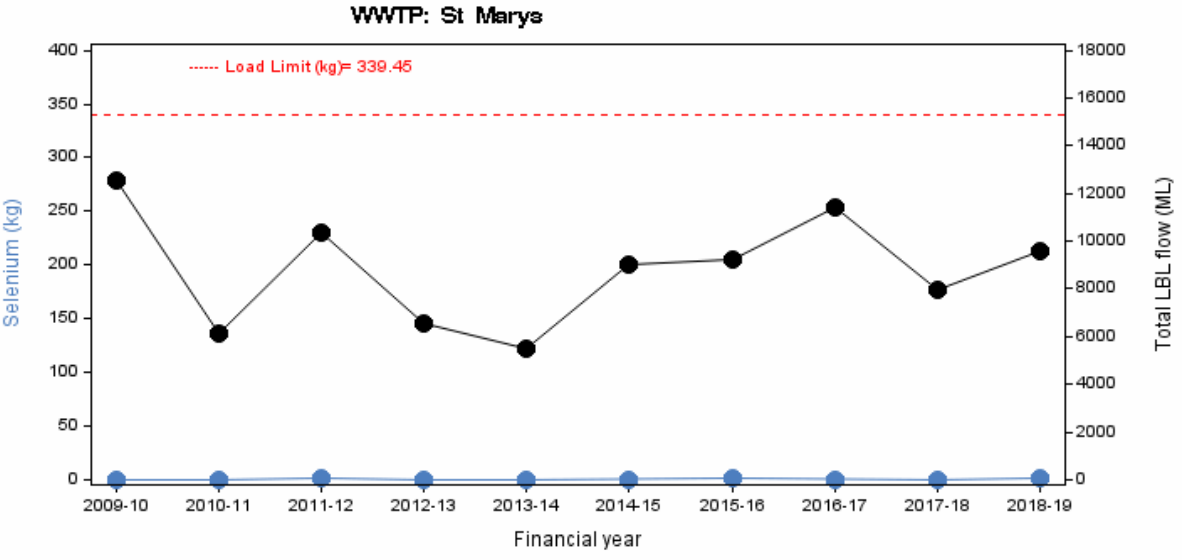


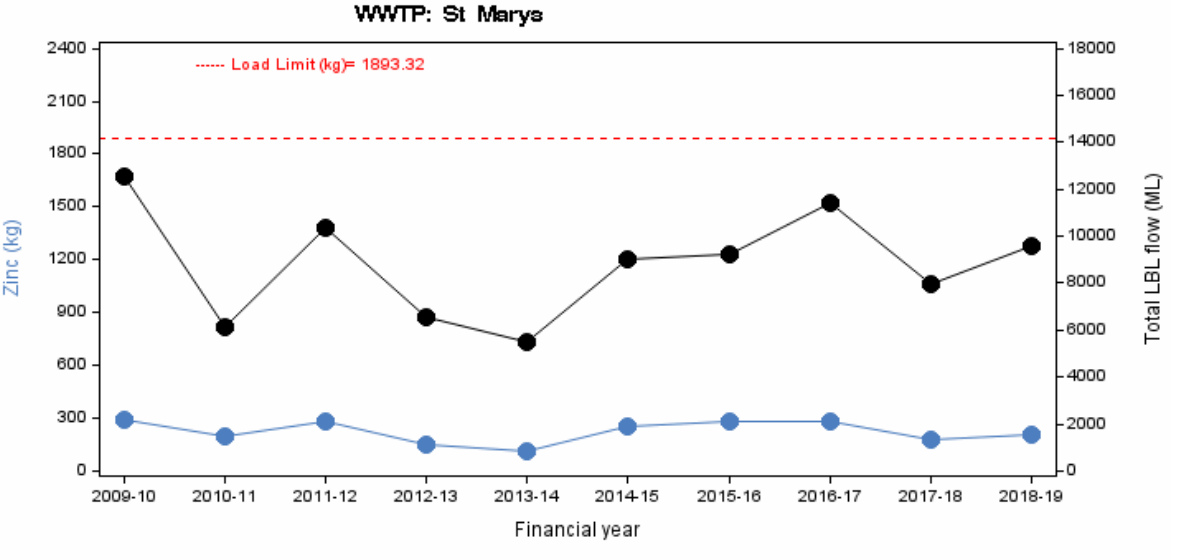
Discharge load: Trace metals



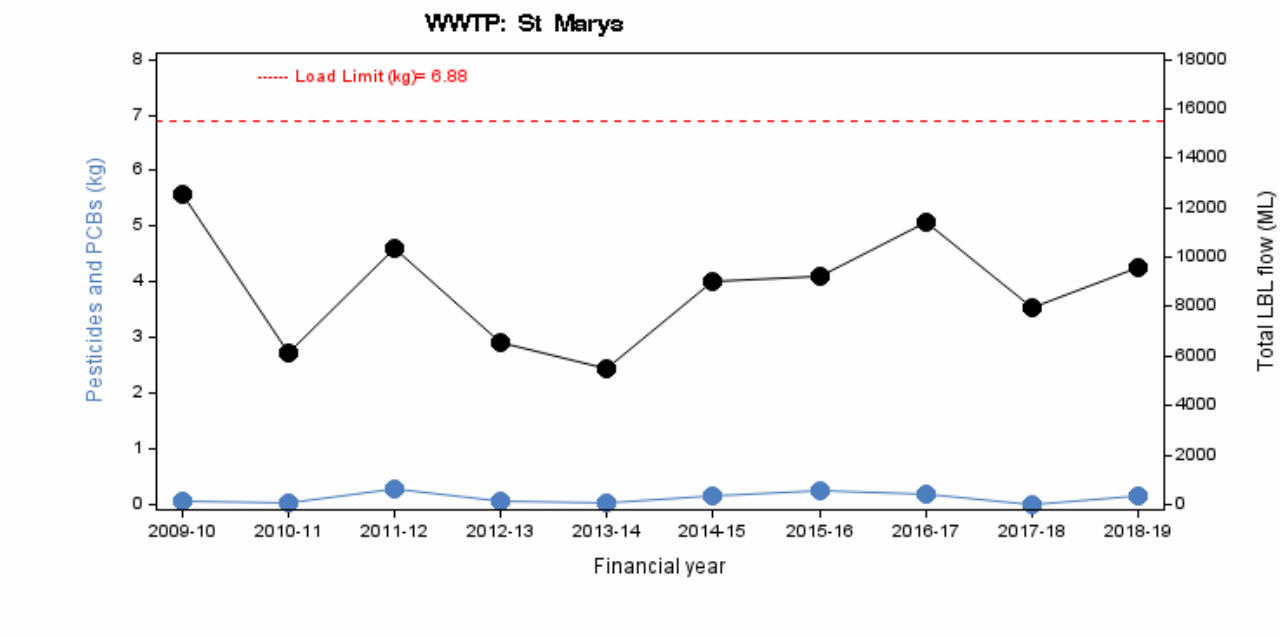

WWTP: St Marys
Load Limit (kg)= 18.42
Chromium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
WWTP: St Marys
Load Limit (kg)= 559.36
Copper (kg)
Total LBL flow (ML)
Financial year
WWTP: St Marys
Load Limit (kg)= 31.58
Lead (kg)
Total LBL flow (ML)
Financial year


WWTP: St Marys
Load Limit (kg)= 0.43
Mercury (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: St Marys
Load Limit (kg)= 339.45
Selenium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

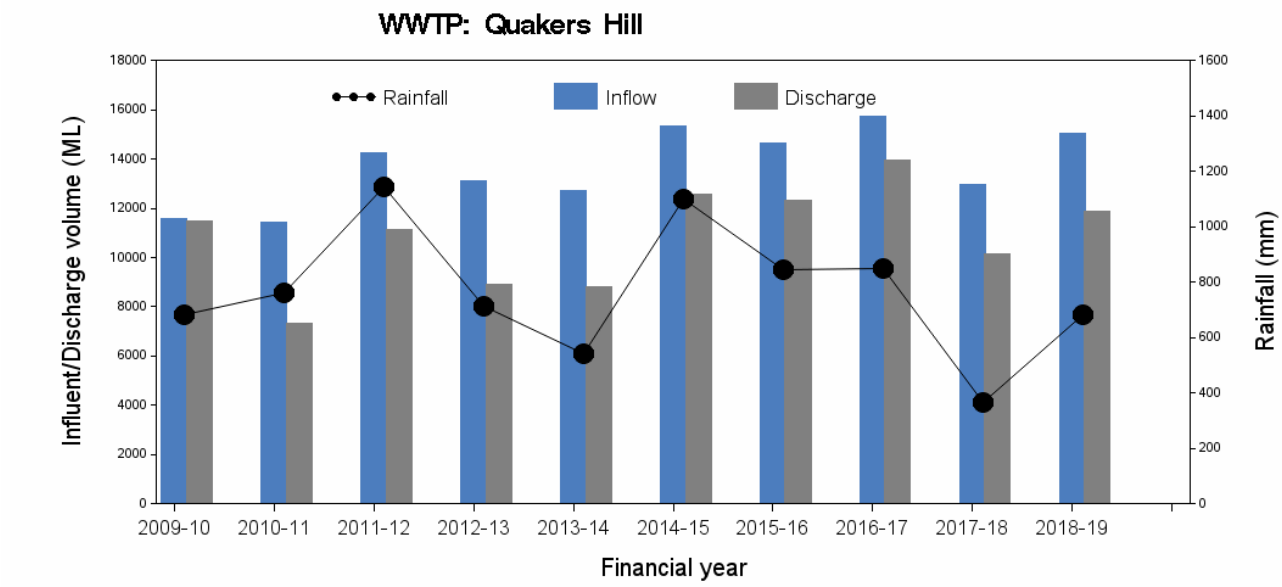

WWTP: St Marys
Load Limit (kg)= 1893.32
Zinc (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

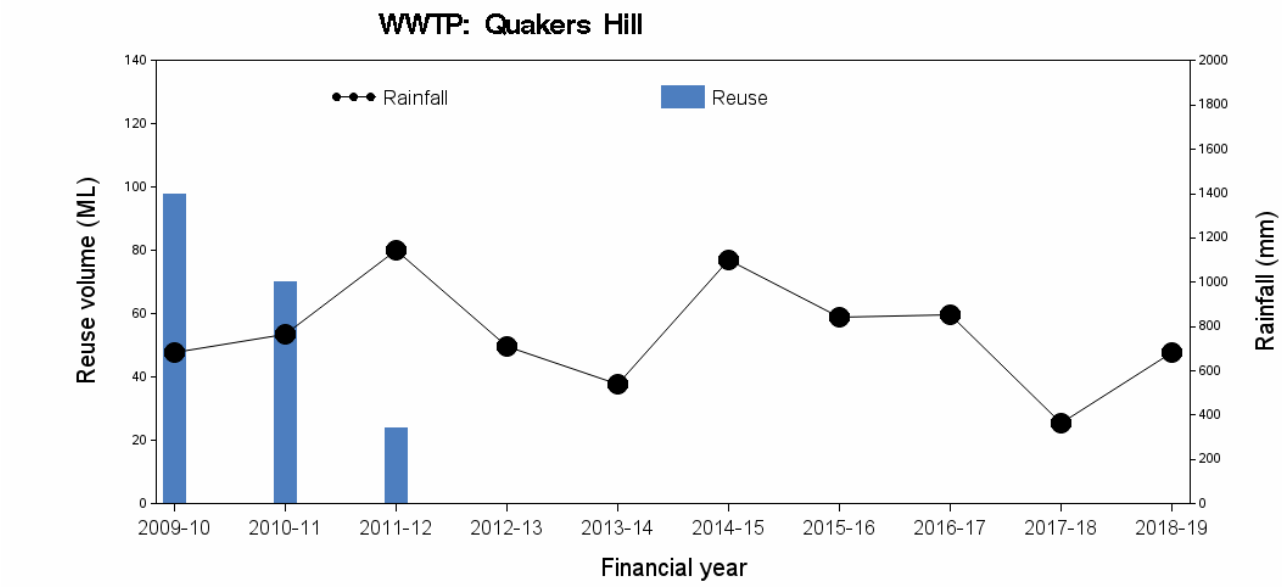
Discharge load: Other chemicals and organics (including pesticides)



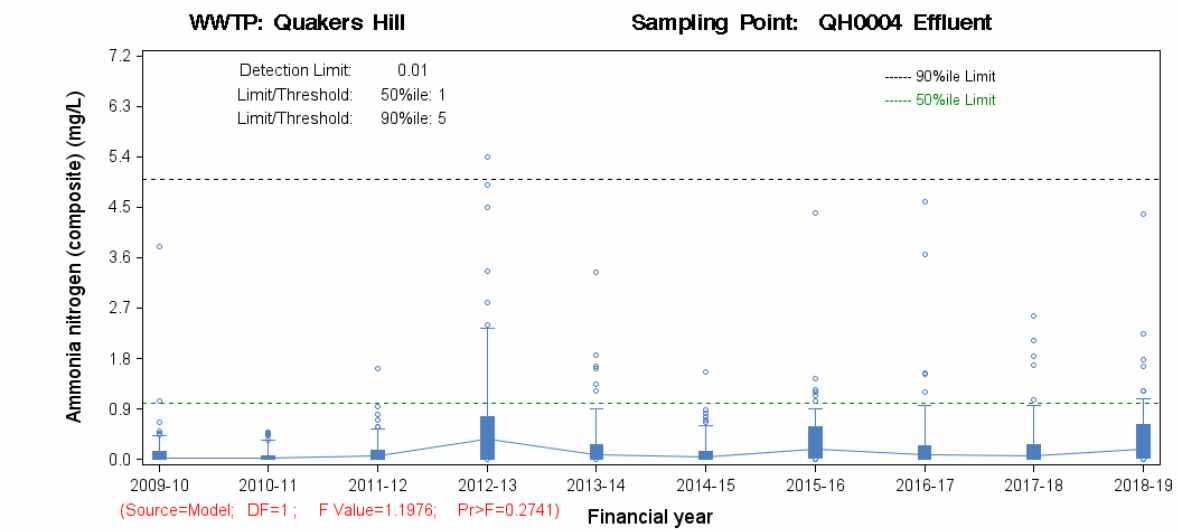
Quakers Hill WWTP

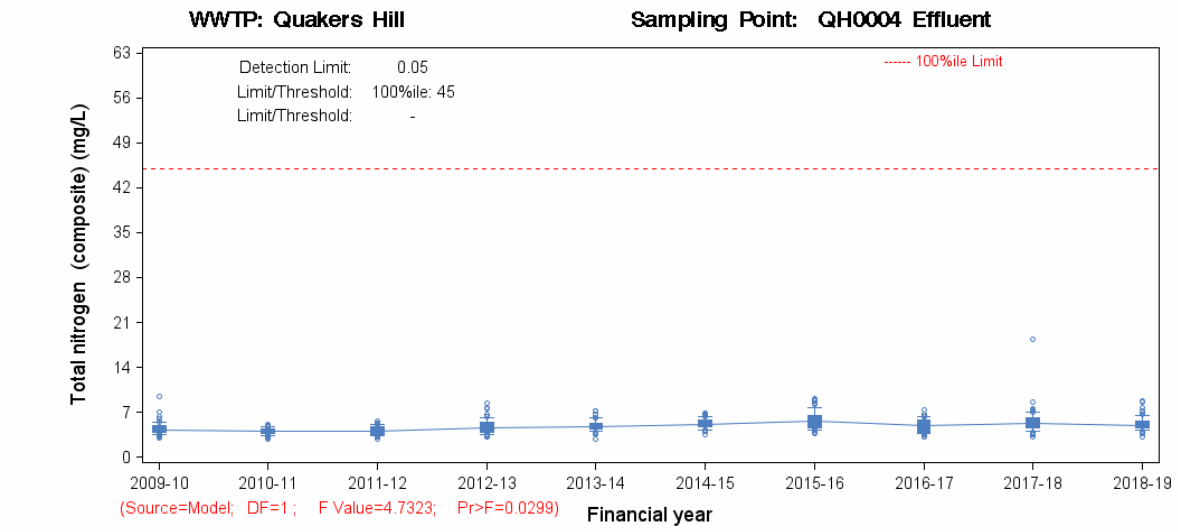
Discharge volume and rainfall

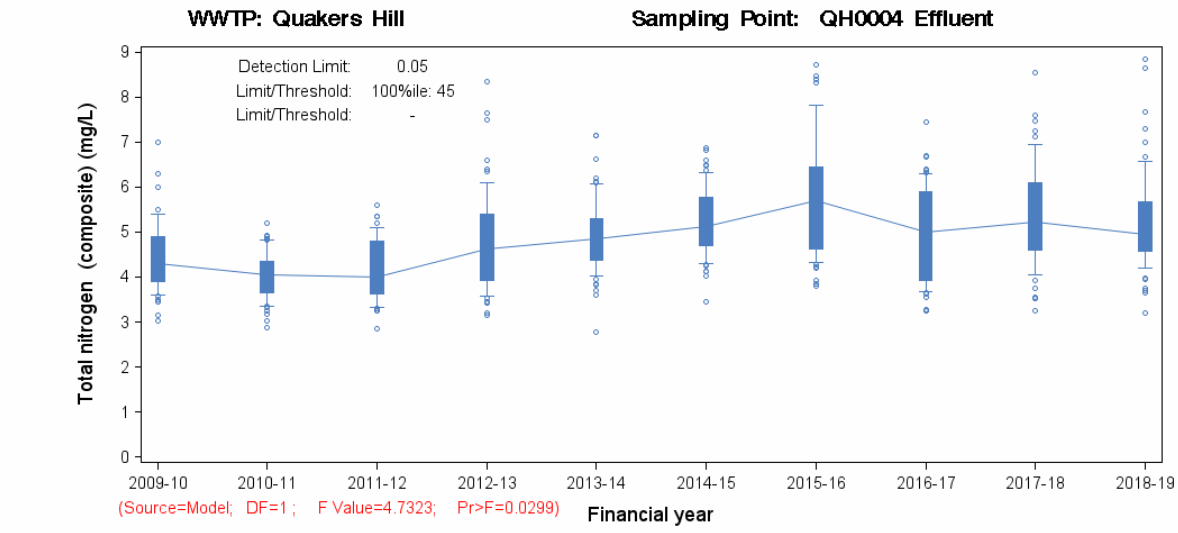


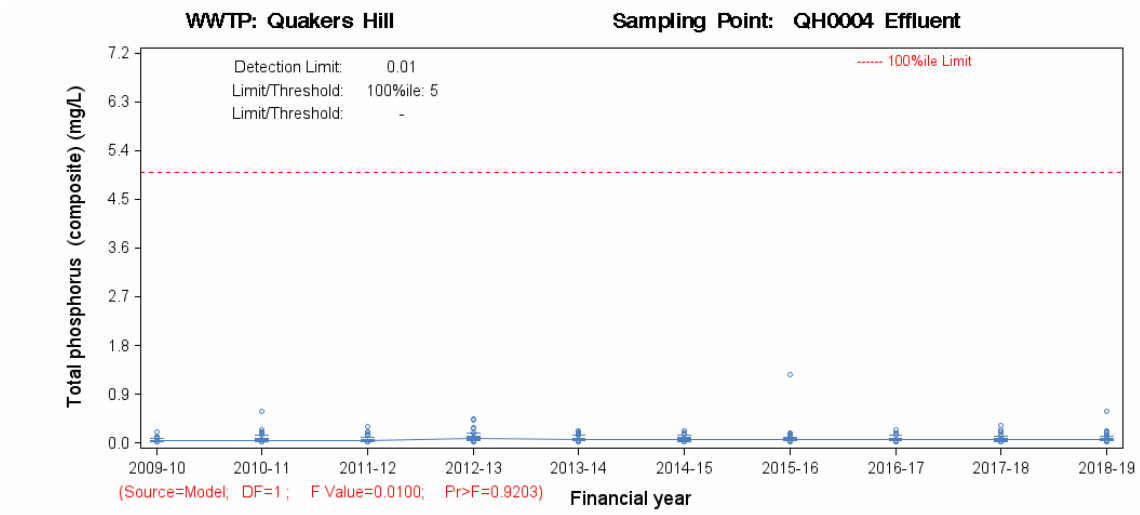


Discharge quality: Nutrients

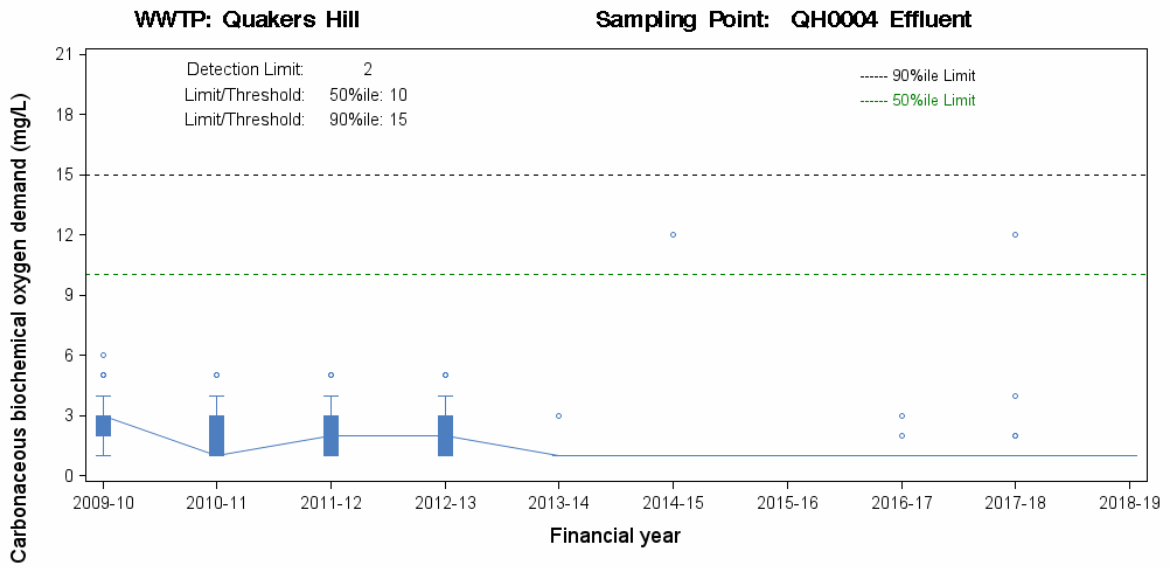




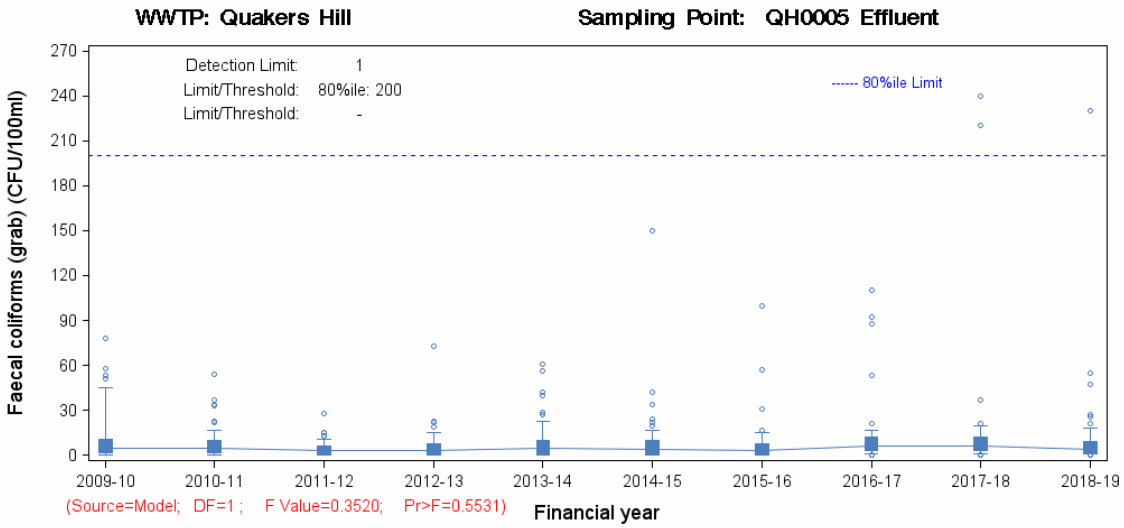


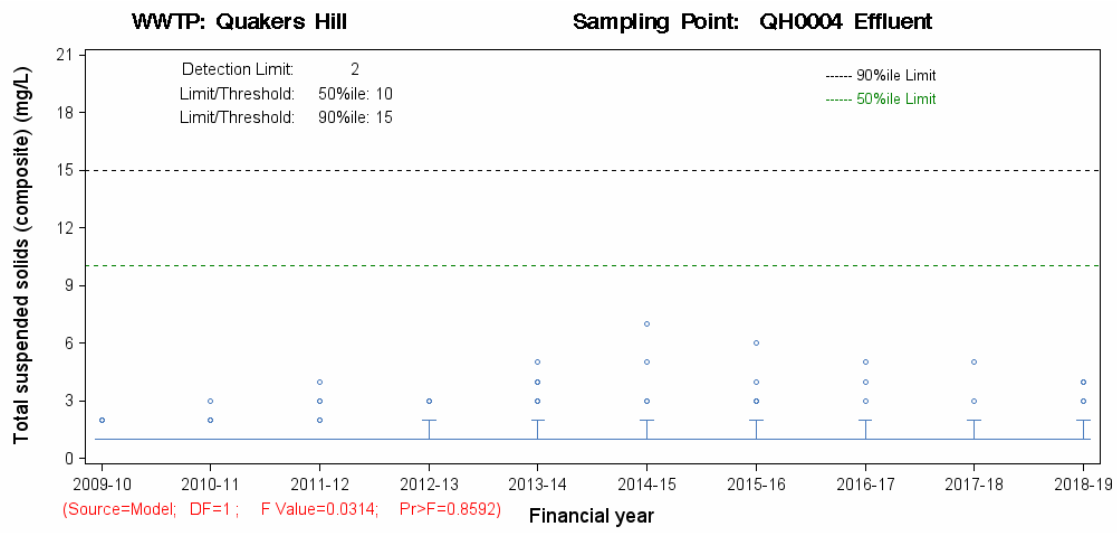


Discharge quality: Major conventional analytes

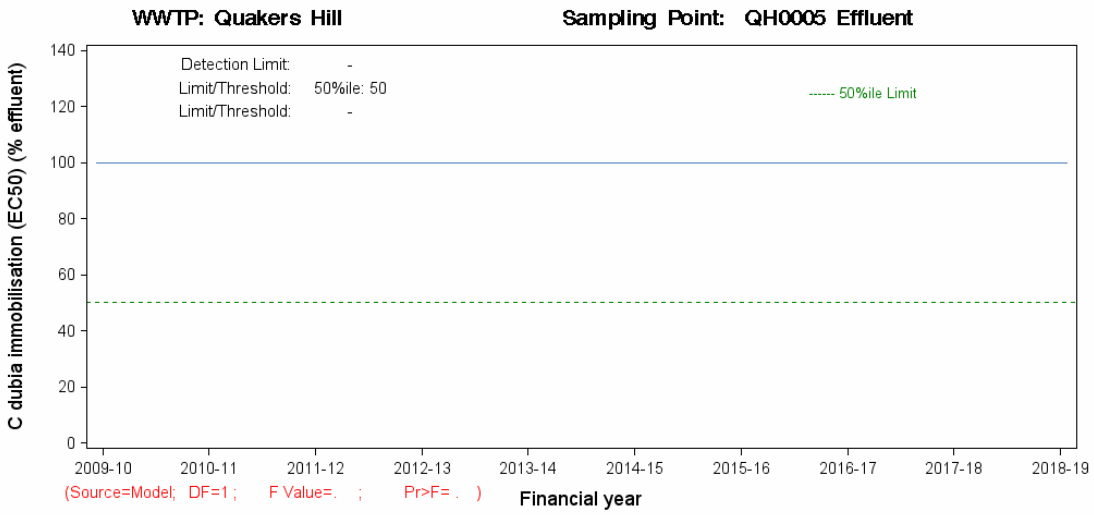


Note: 2018-19 data was compared with previous four years data (2014-2018) due to lab method change in 2014-15. Statistical test was not conducted because >90% of results were below the detection limit.

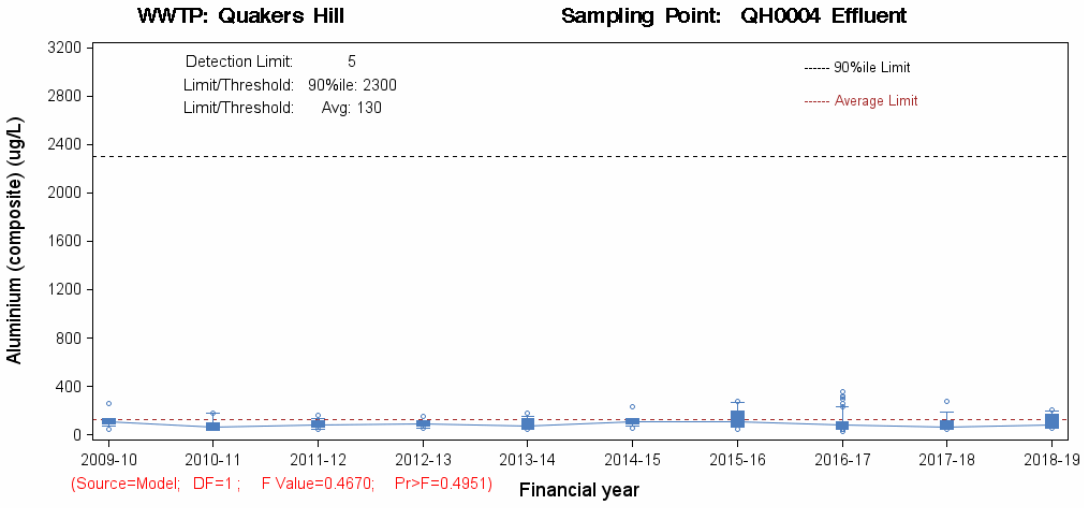


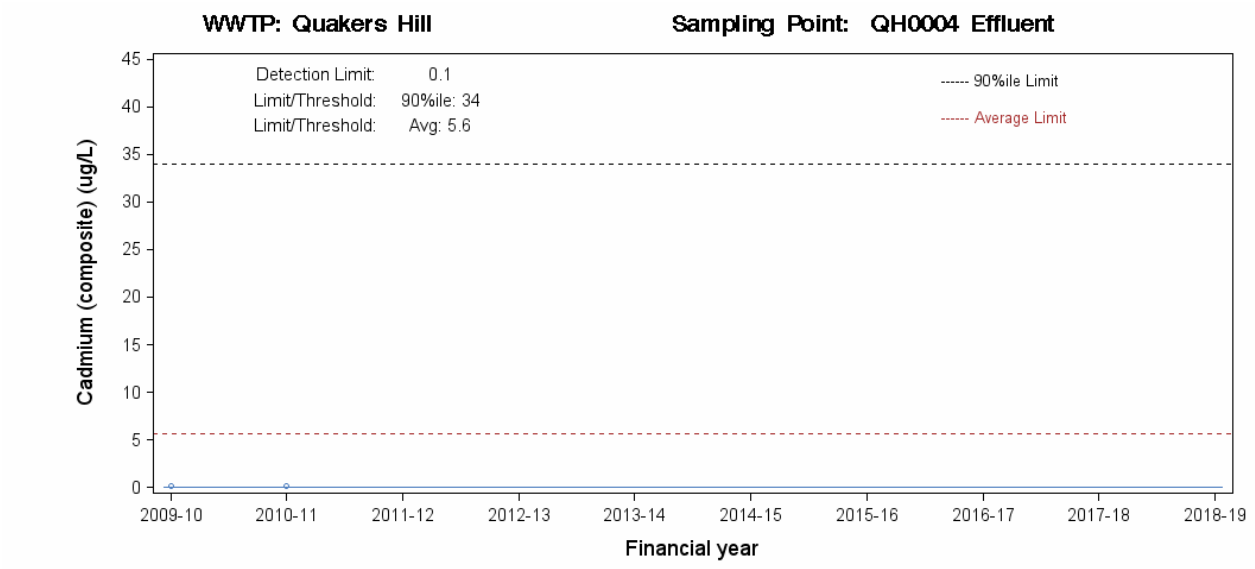


Discharge quality: Toxicity

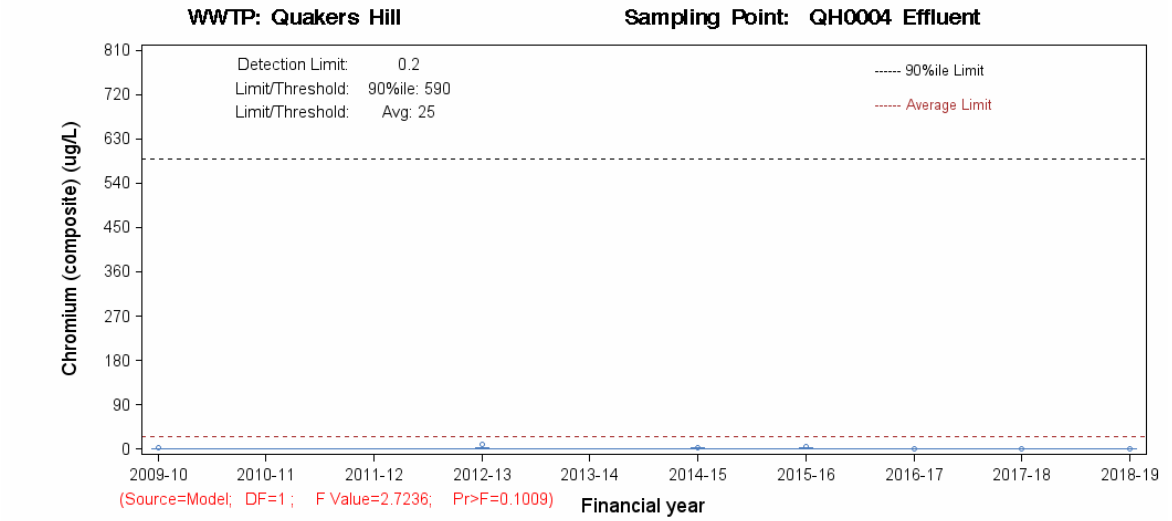


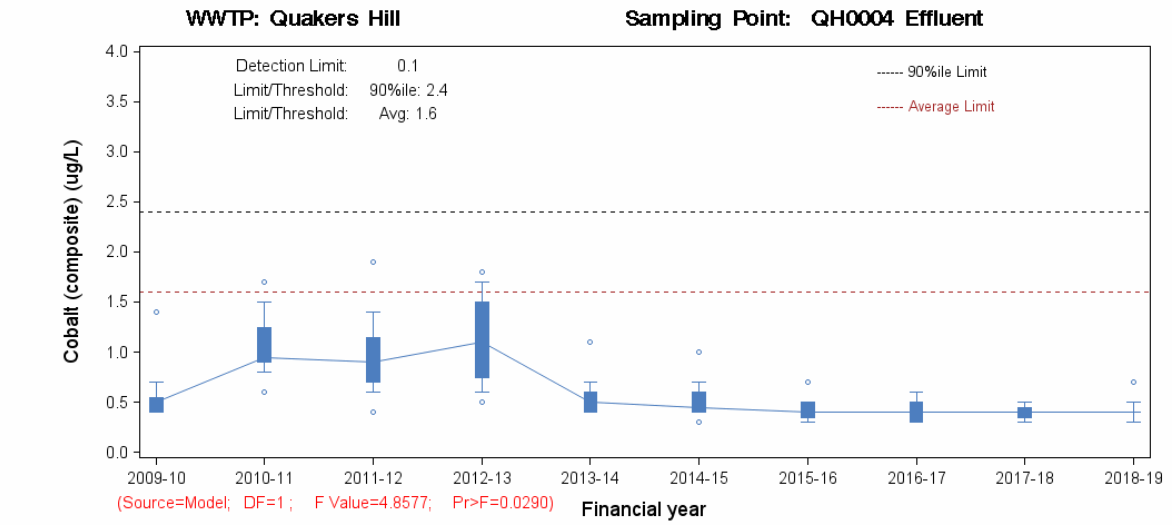
Discharge quality: Trace metals

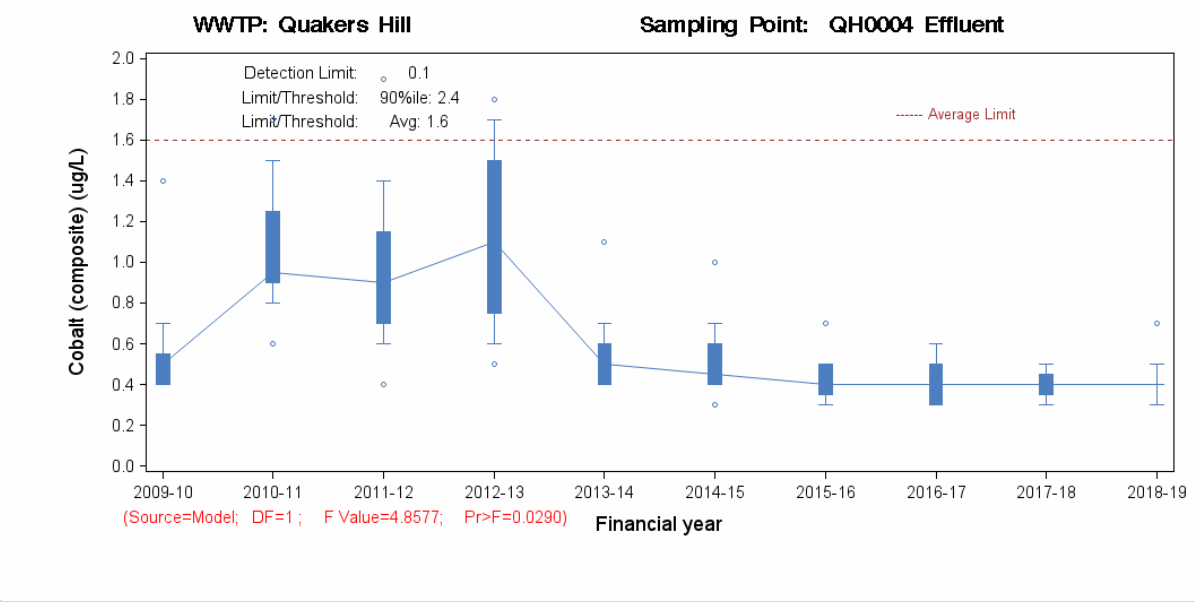


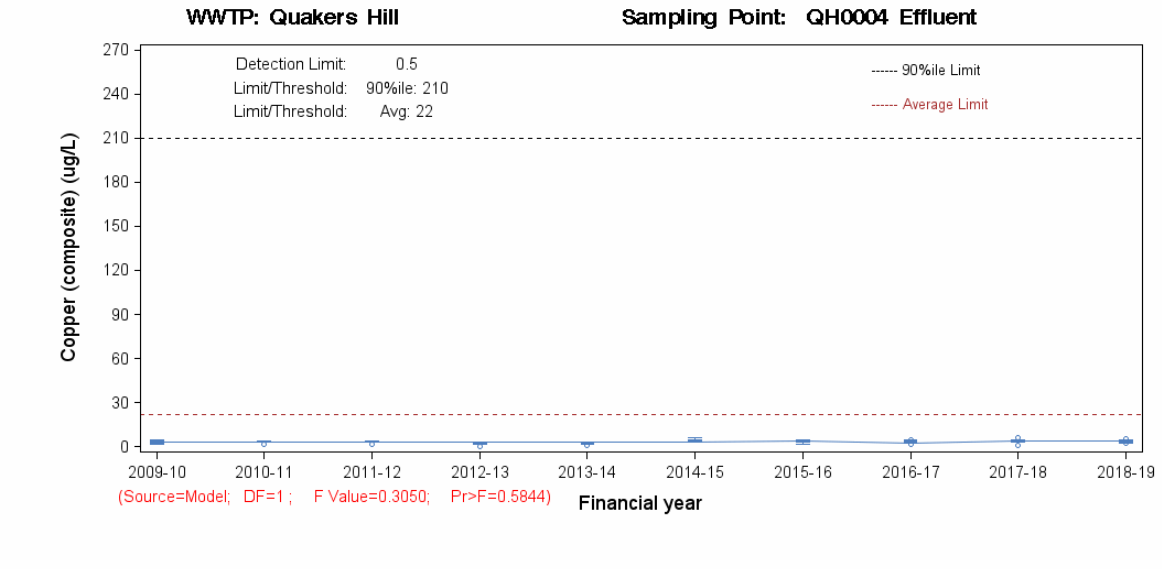


Note: Statistical test was not conducted because >90% of results were below the detection limit.

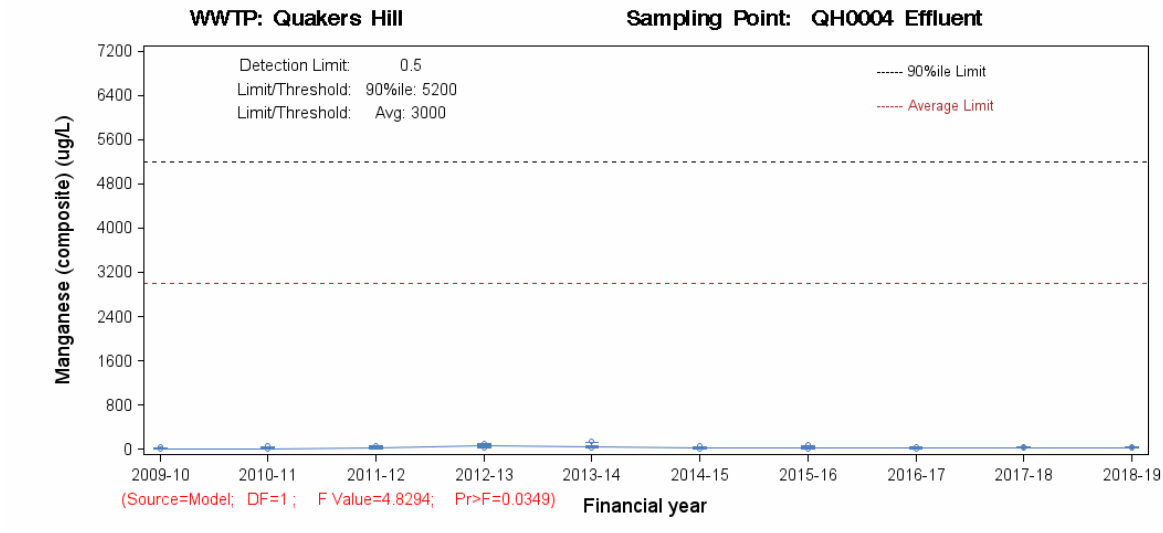




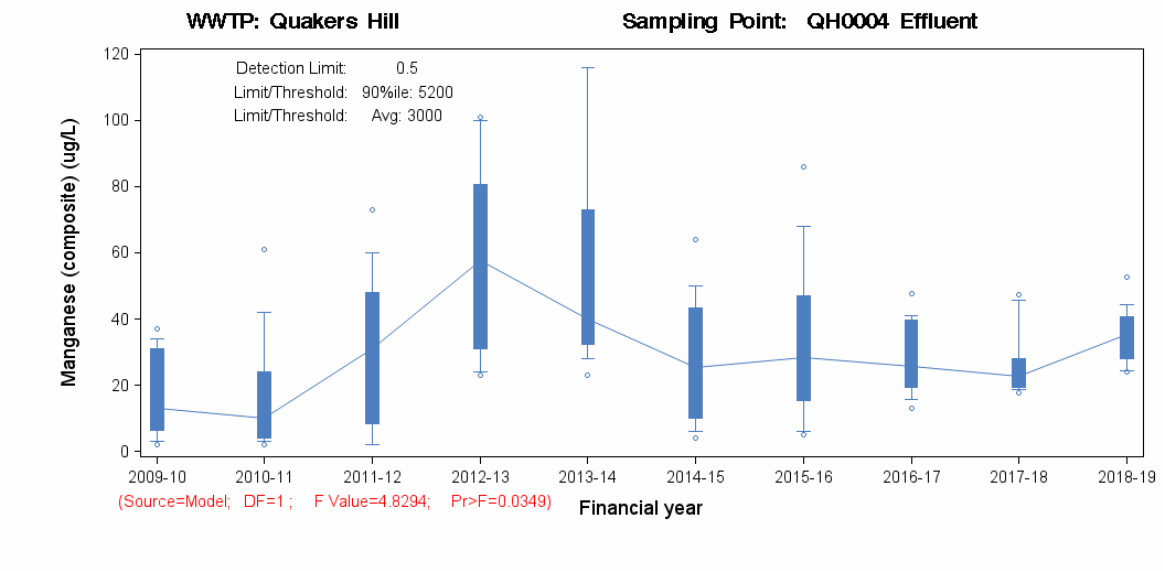




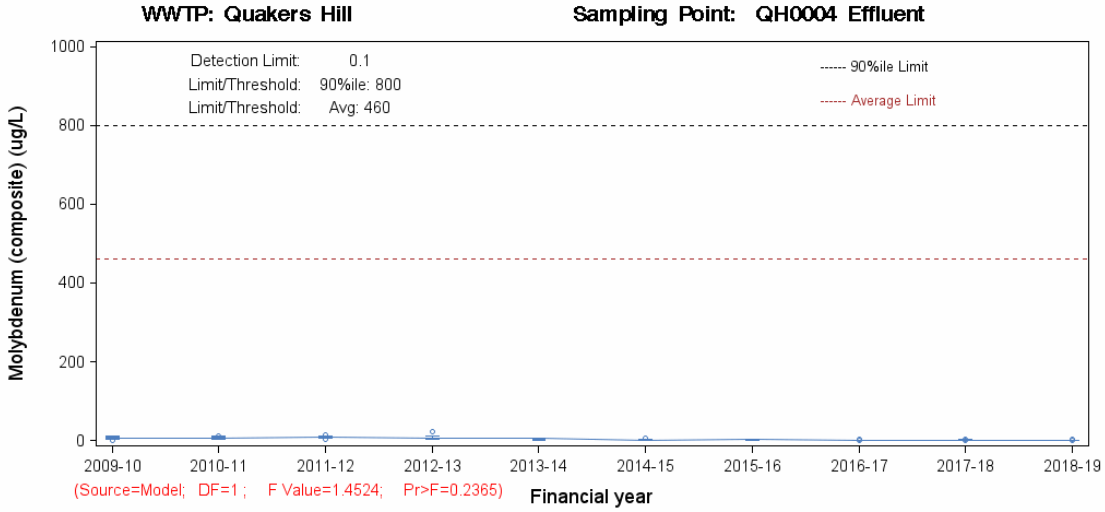
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



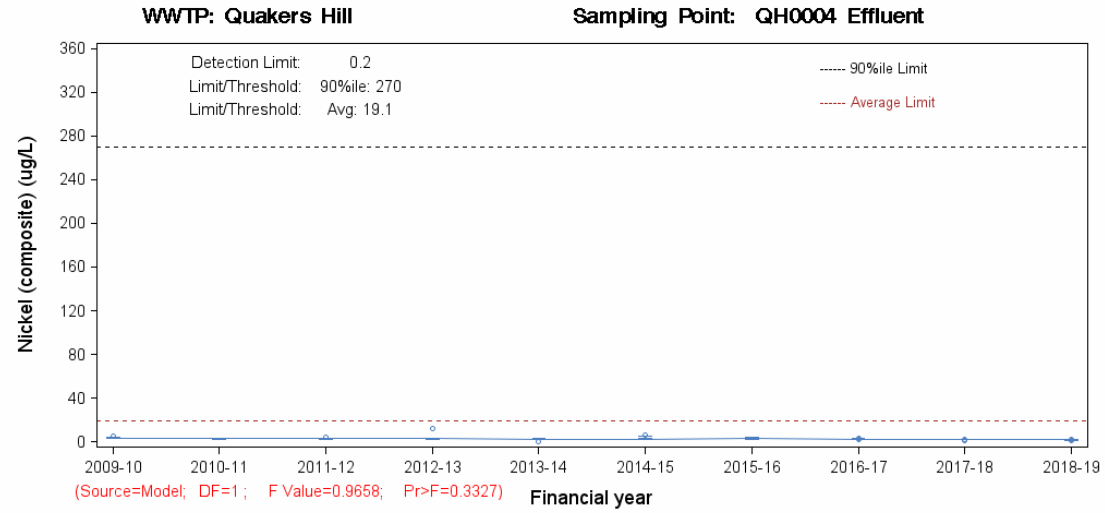
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



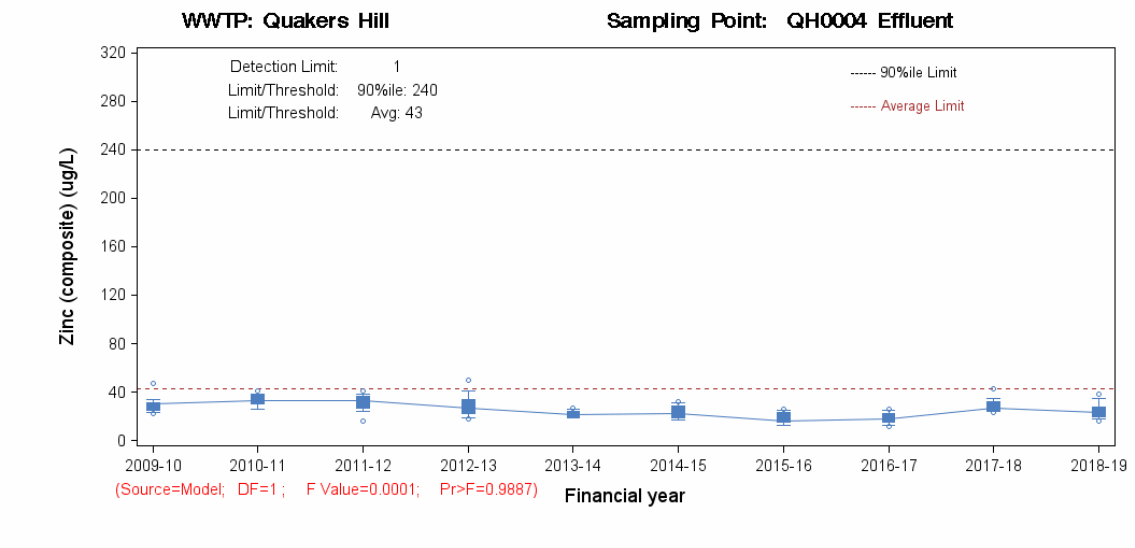
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

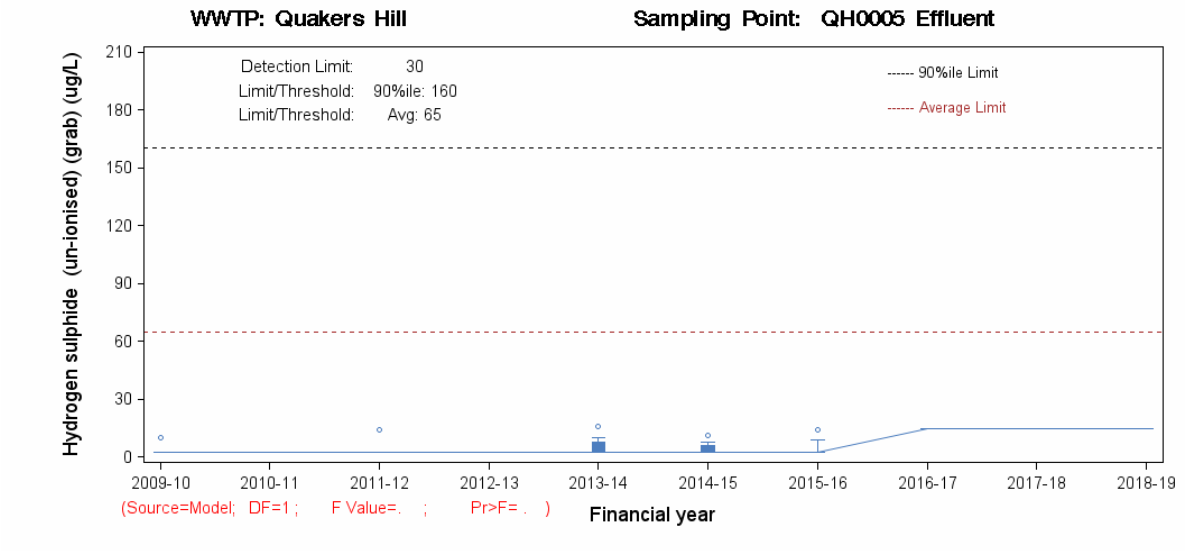


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



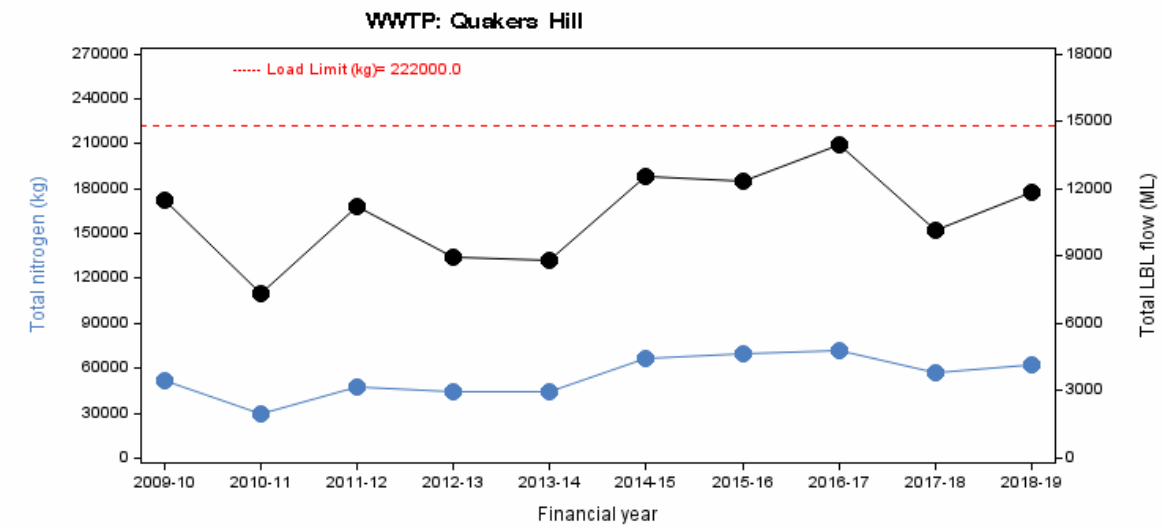
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

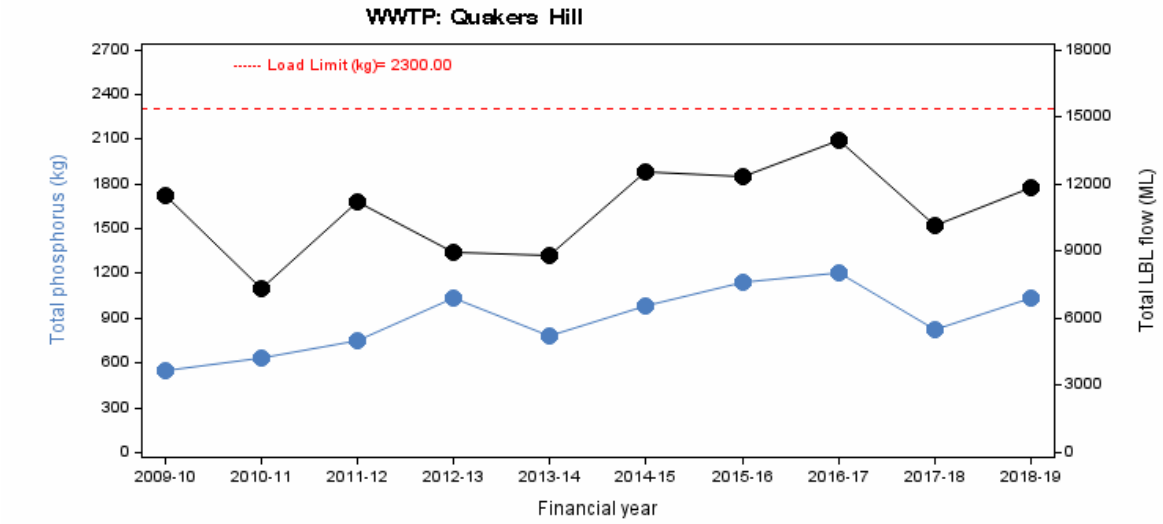
Discharge quality: Other chemicals and organics (including pesticides)



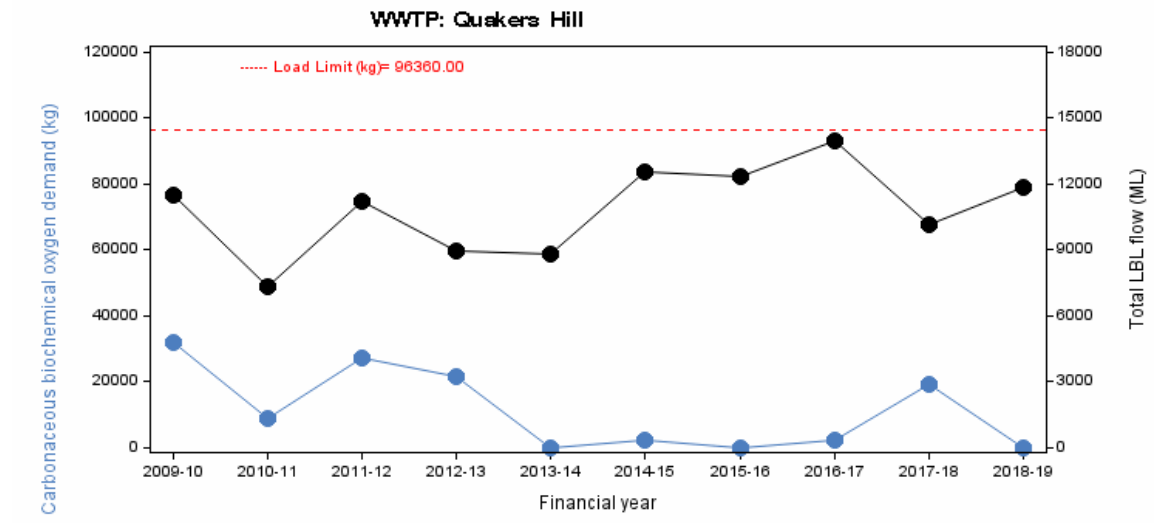
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

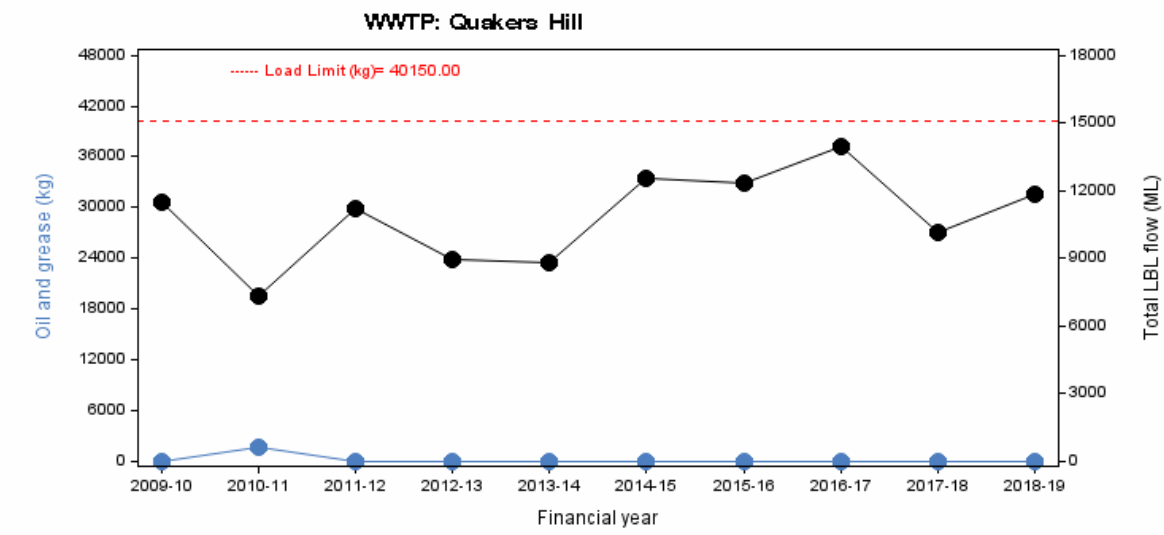
Discharge load: Nutrients

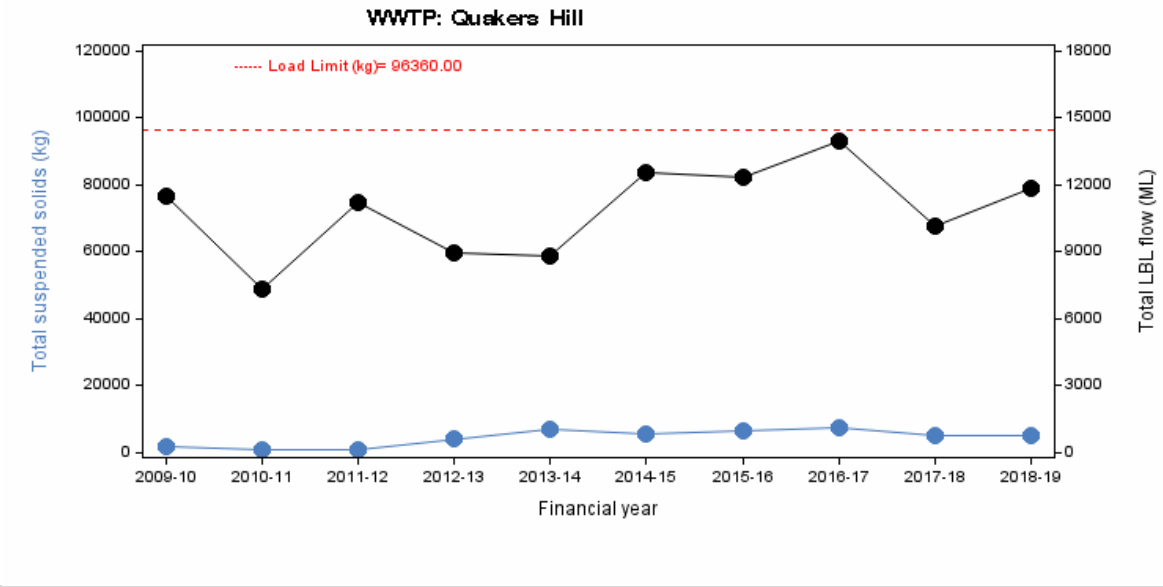




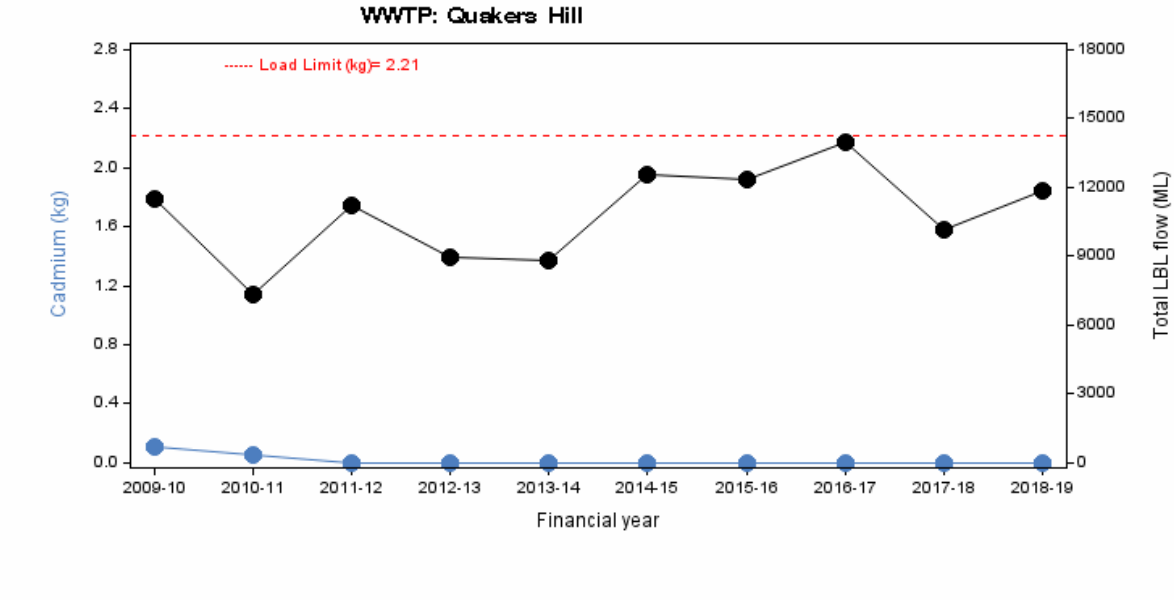
Discharge load: Major conventional analytes

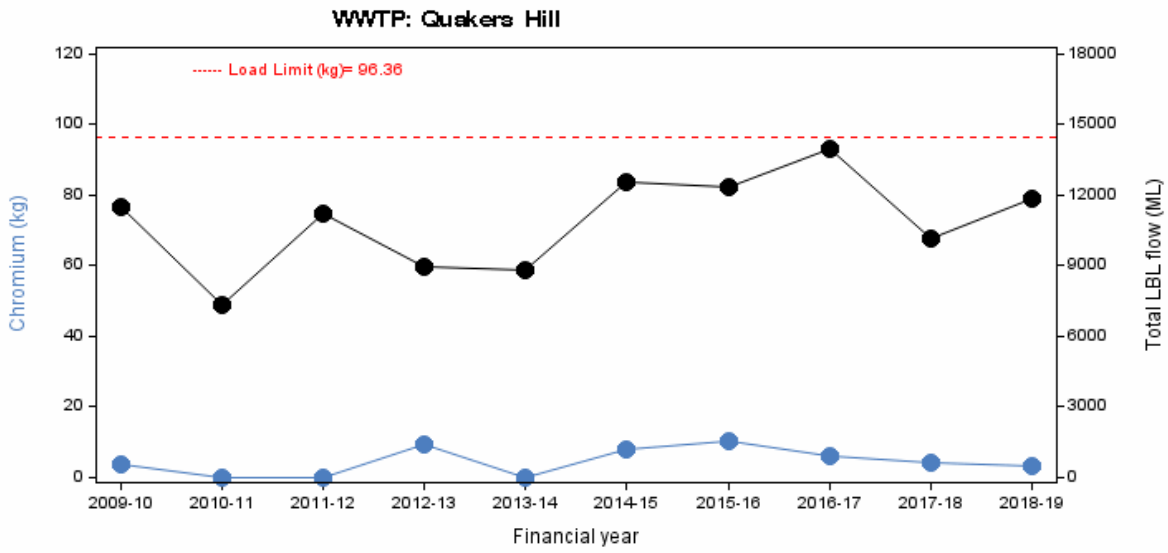


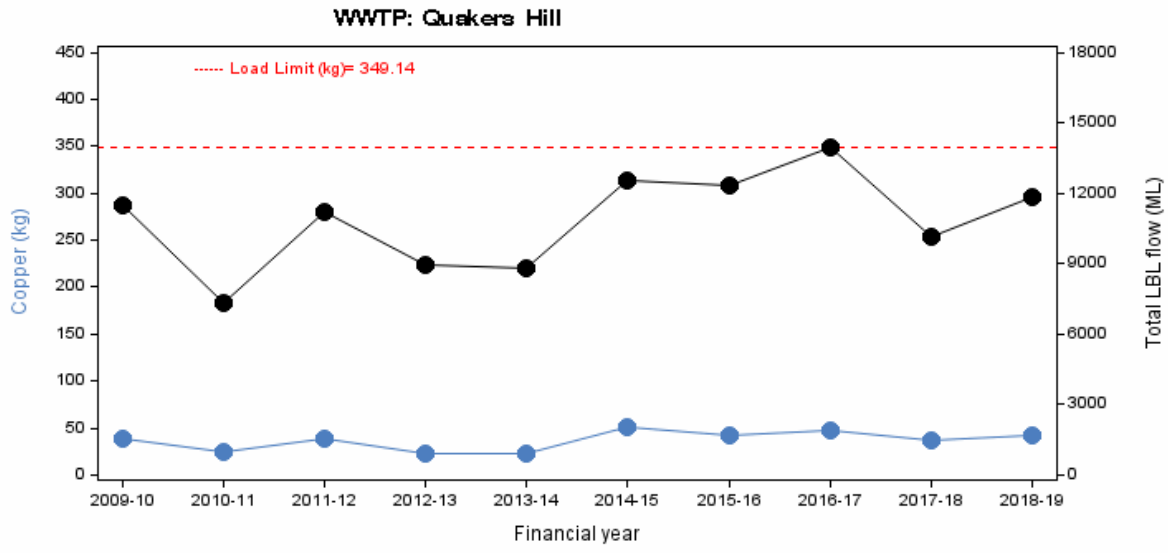


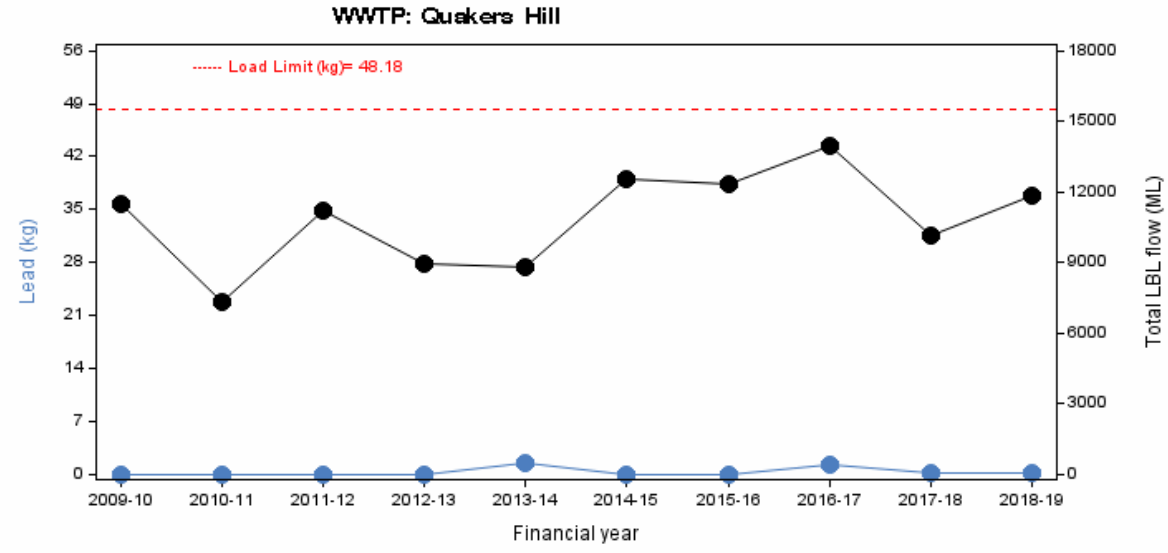


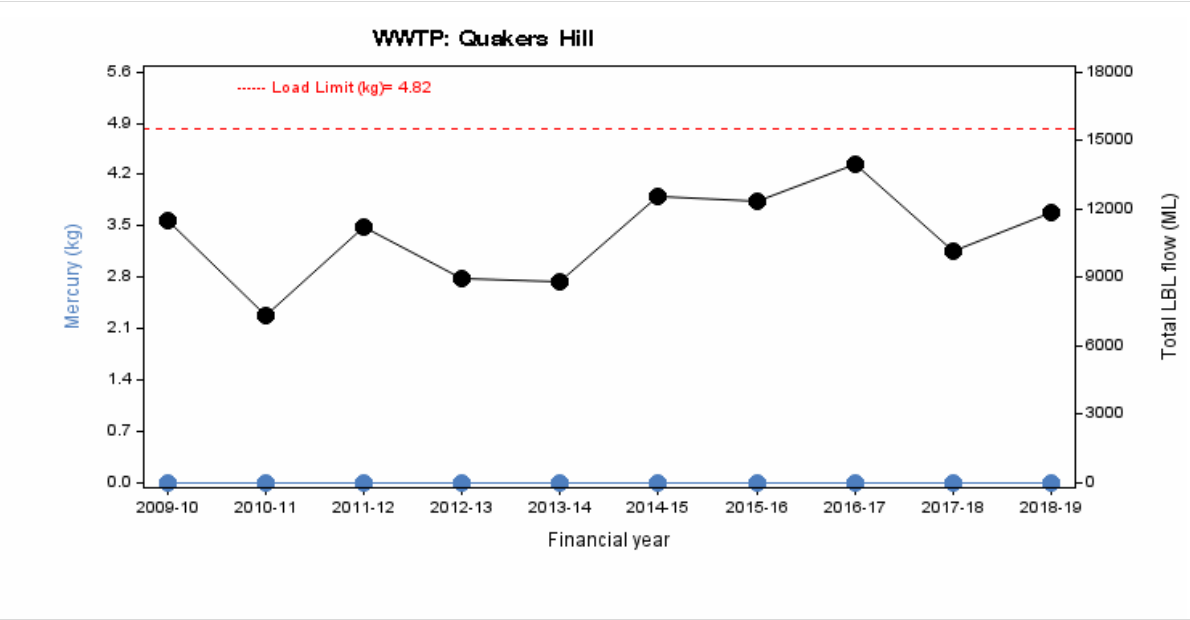
Discharge load: Trace metals

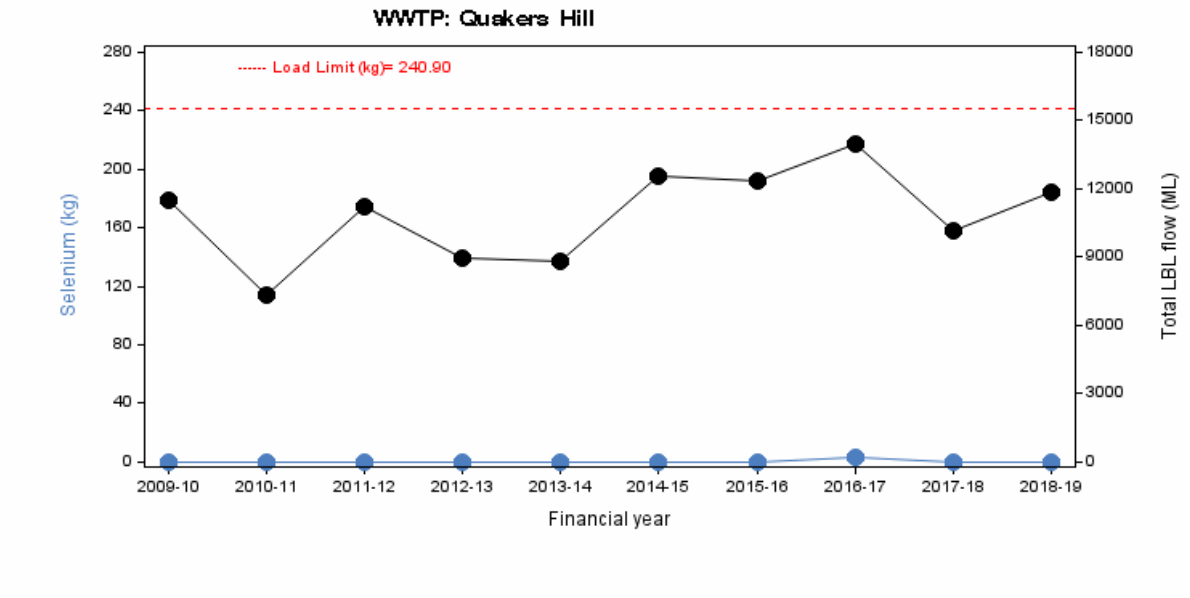


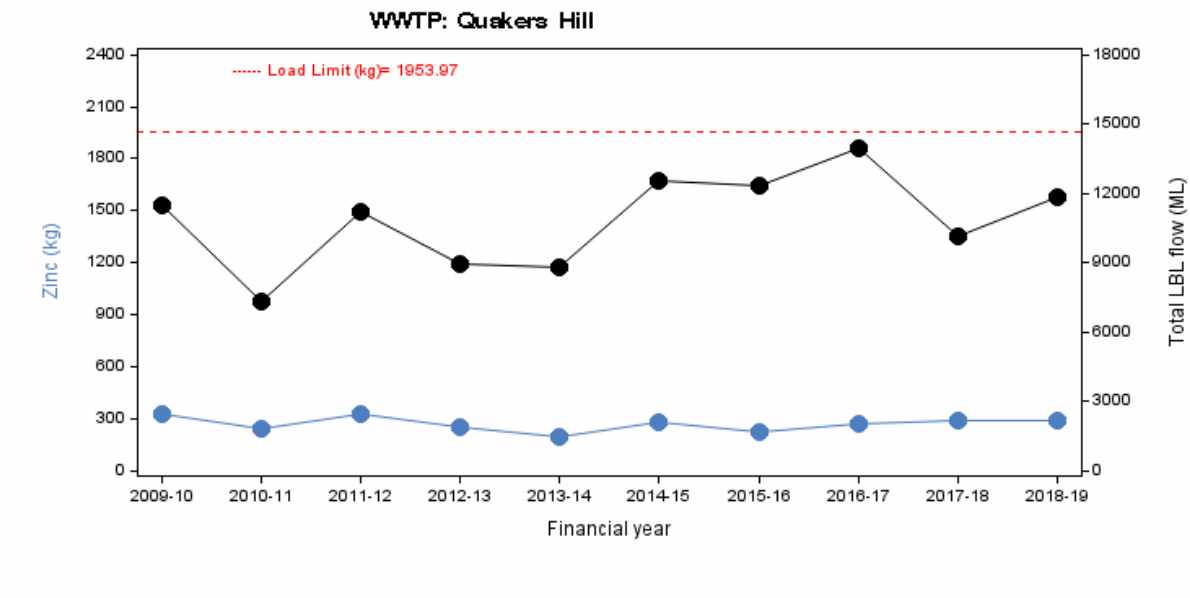

WWTP: Quakers Hill
Load Limit (kg)= 96.36
Chromium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Quakers Hill
Load Limit (kg)= 349.14
Copper (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

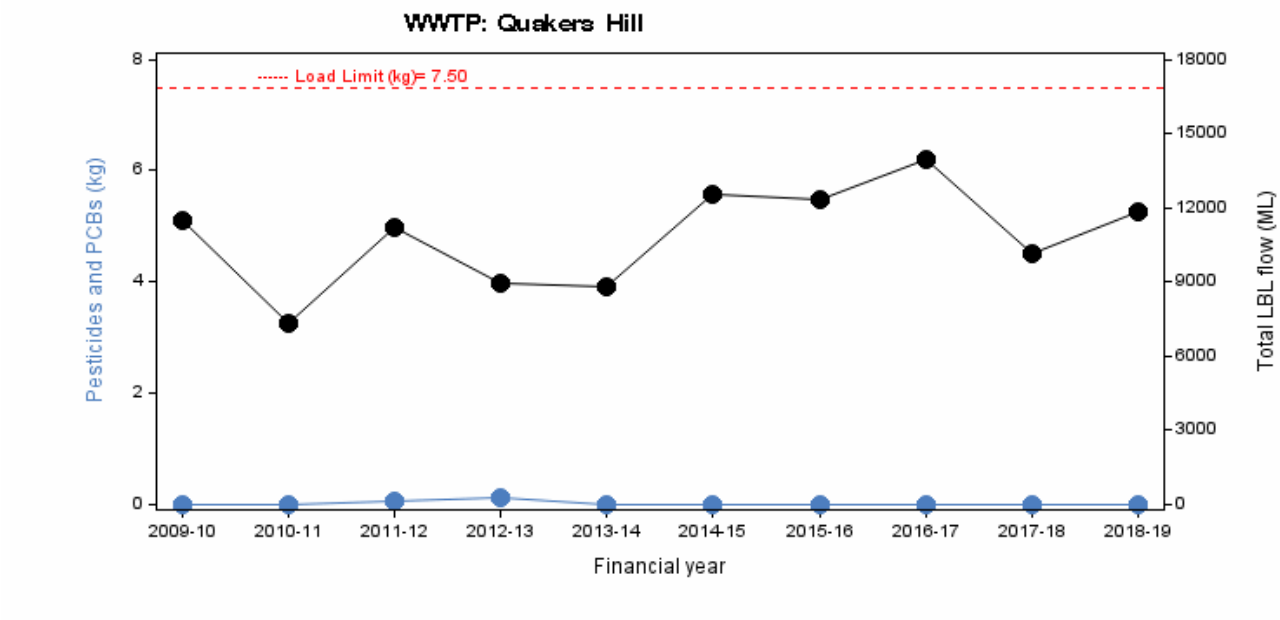

WWTP: Quakers Hill
Load Limit (kg)= 48.18
Lead (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Quakers Hill
Load Limit (kg)= 4.82
Mercury (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Quakers Hill
Load Limit (kg)= 240.90
Selenium (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

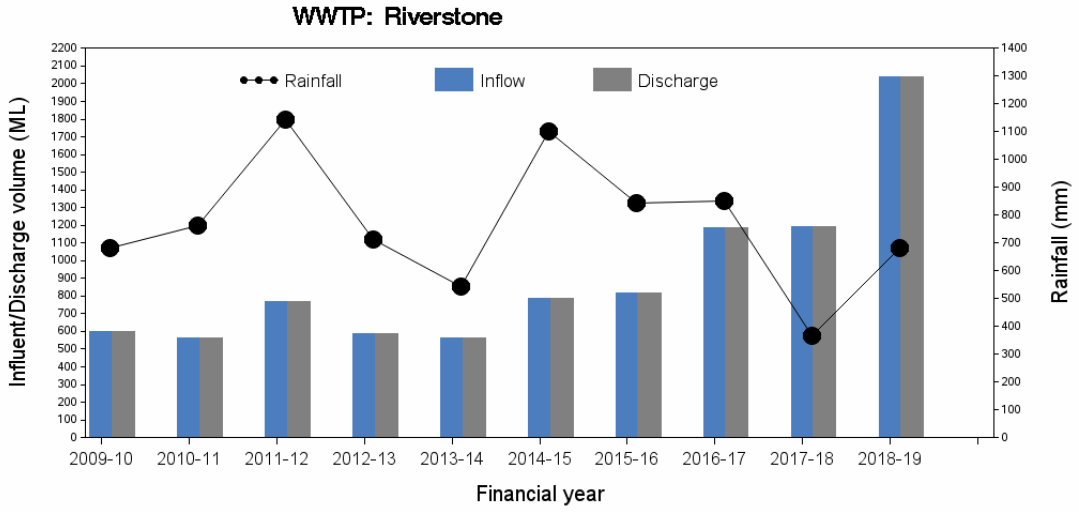

WWTP: Quakers Hill
Load Limit (kg)= 1953.97
Zinc (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

Discharge load: Other chemicals and organics (including pesticides)

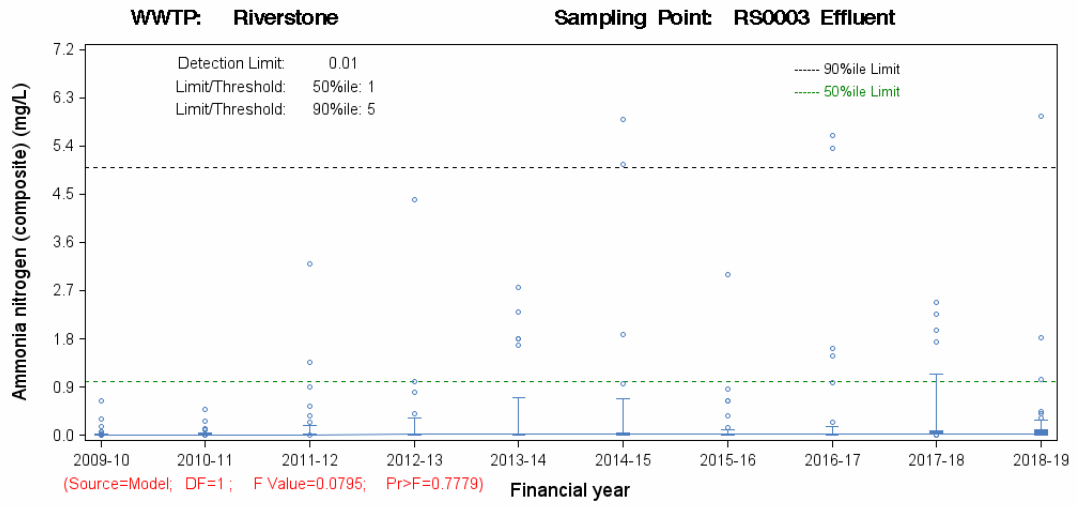


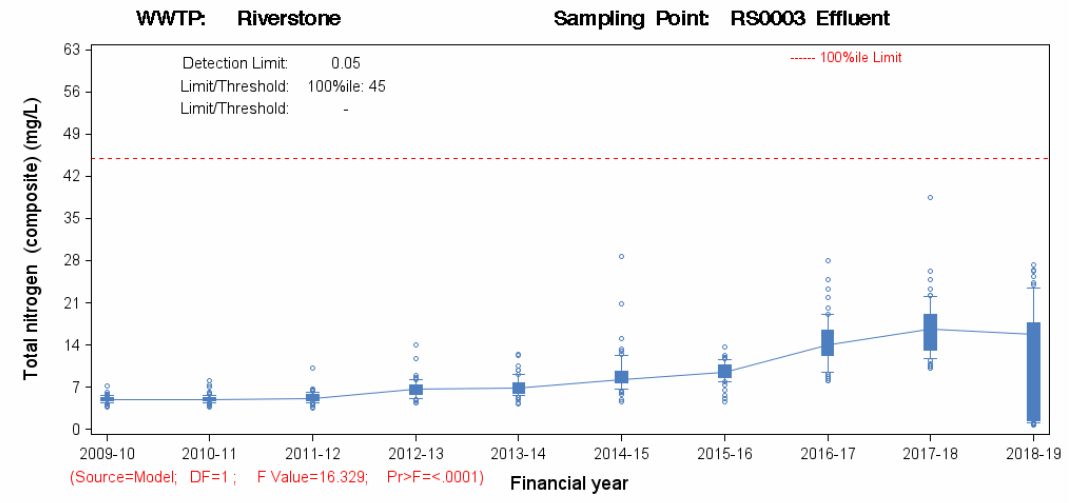
Riverstone WWTP

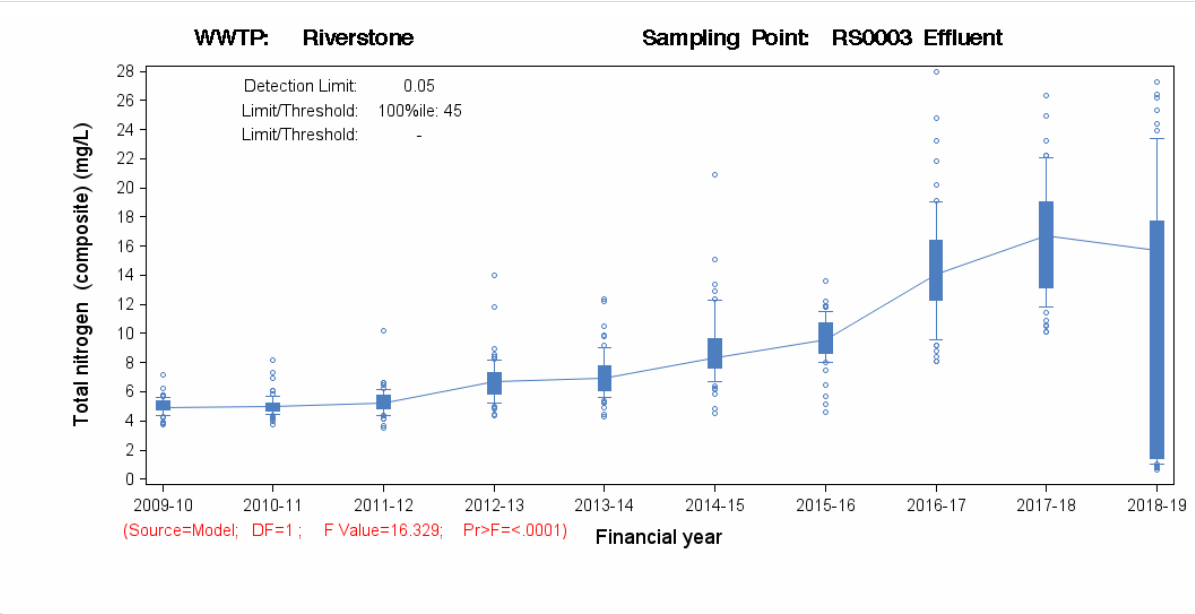
Discharge volume and rainfall

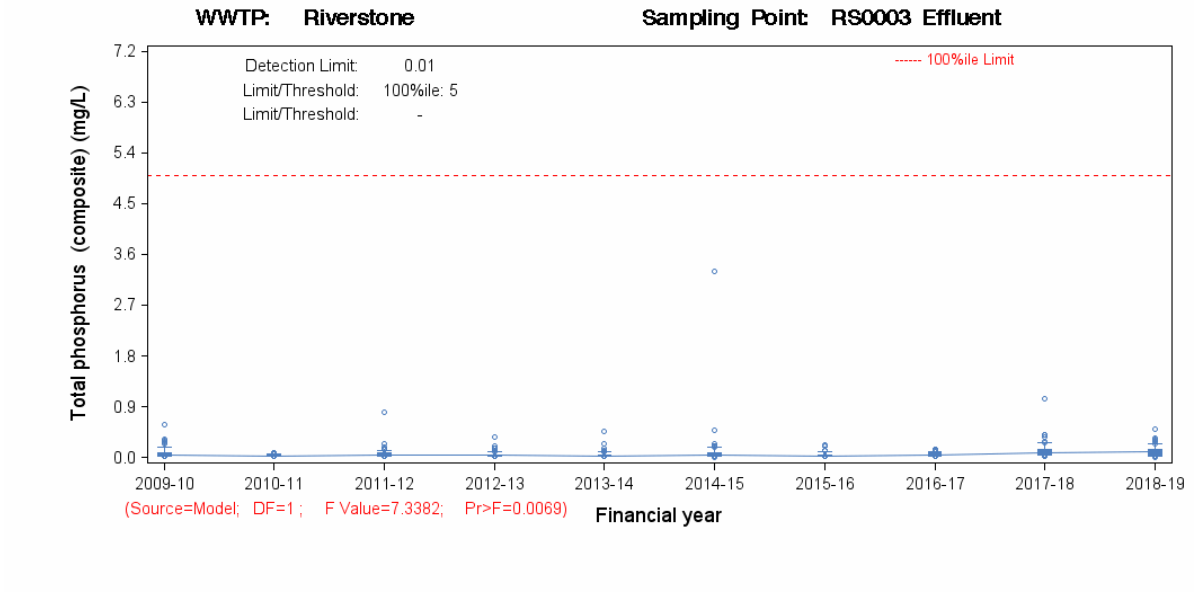


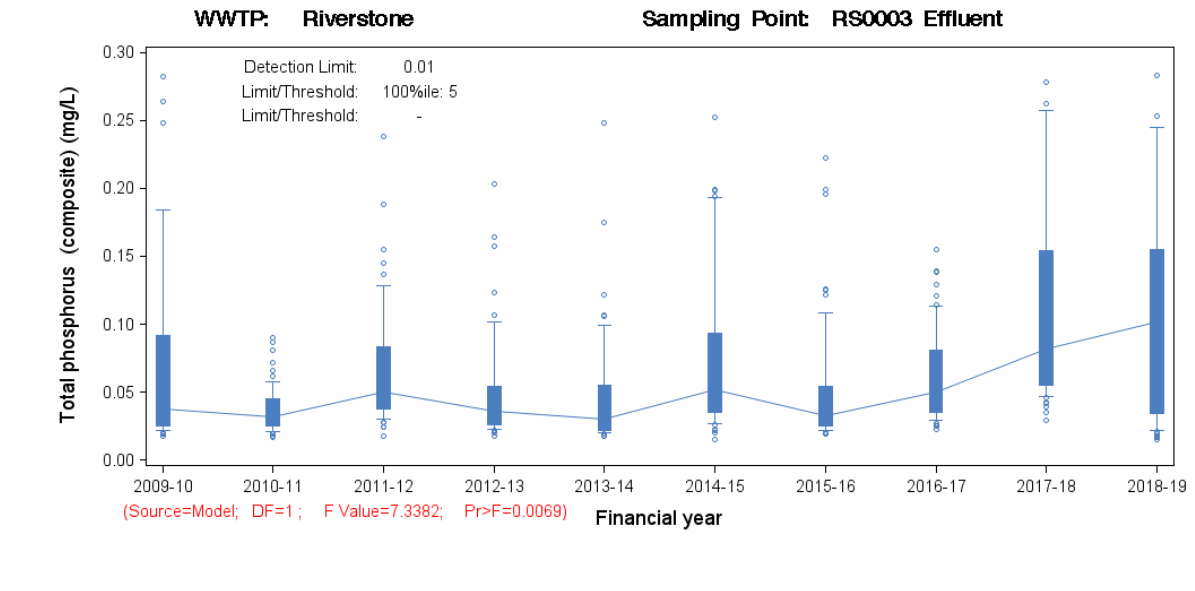
Discharge quality: Nutrients



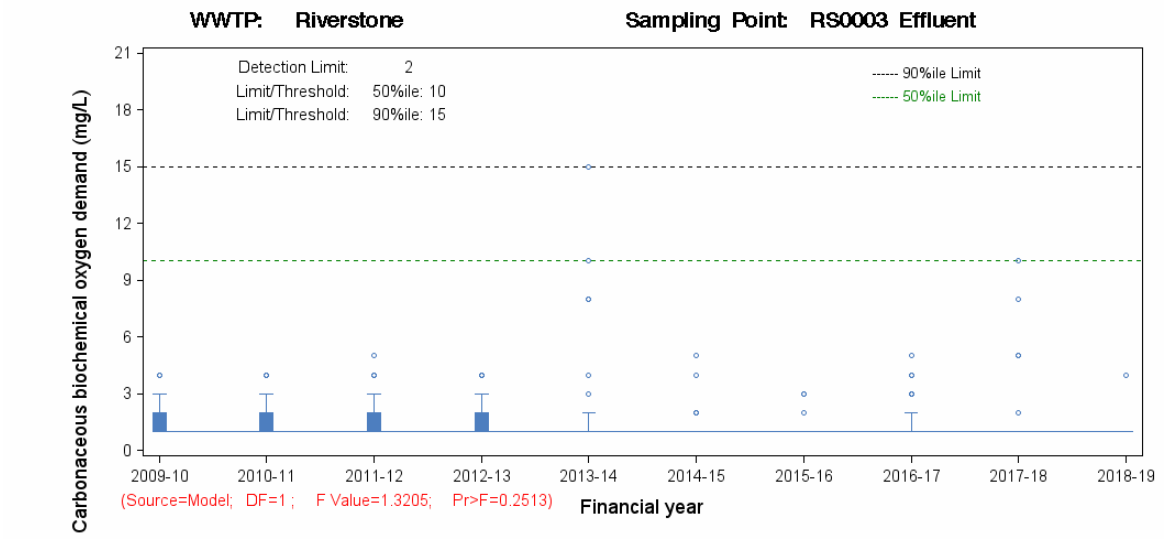



WWTP: Riverstone
Sampling Point: RS0003 Effluent
Detection Limit: 0.05
Limit/Threshold: 100%ile: 45
Limit/Threshold: -
Total nitrogen (composite) (mg/L)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
2009-10 2010-11 2011-12 2012-13 2013-14 2014-15 2015-16 2016-17 2017-18 2018-19
(Source=Model; DF=1 ; F Value=16.329; Pr>F=<.0001)
Financial year

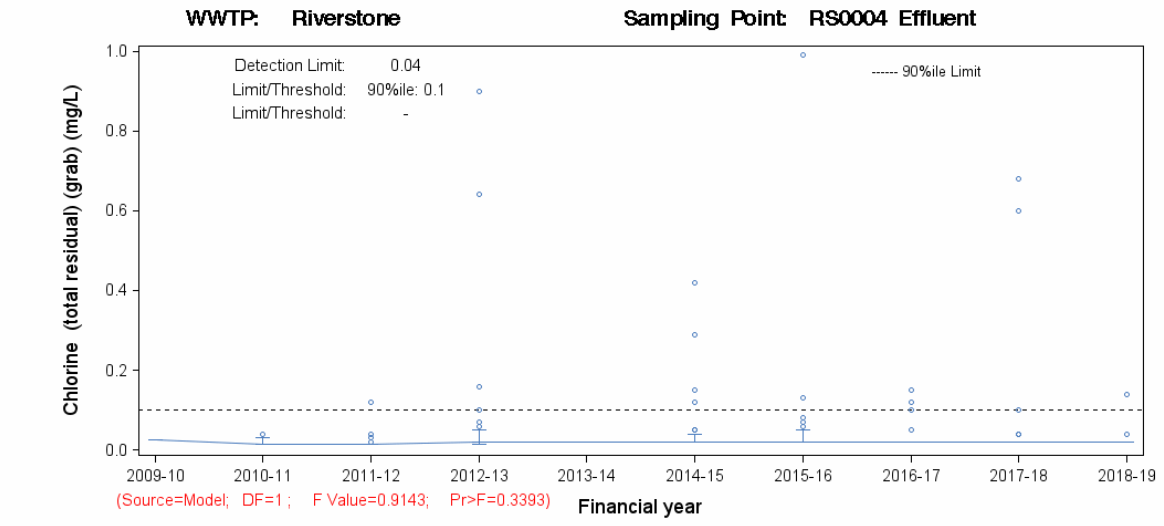

WWTP: Riverstone
Sampling Point: RS0003 Effluent
Detection Limit: 0.01
Limit/Threshold: 100%ile: 5
Limit/Threshold: -
----- 100%ile Limit
Total phosphorus (composite) (mg/L)
0.0 0.9 1.8 2.7 3.6 4.5 5.4 6.3 7.2
2009-10 2010-11 2011-12 2012-13 2013-14 2014-15 2015-16 2016-17 2017-18 2018-19
(Source=Model; DF=1 ; F Value=7.3382; Pr>F=0.0069)
Financial year

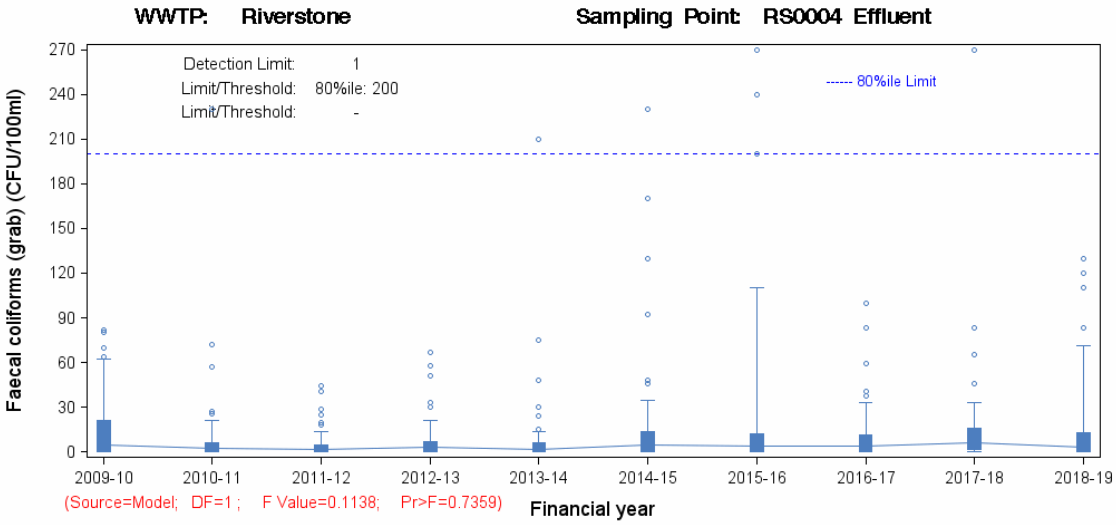

WWTP: Riverstone
Sampling Point: RS0003 Effluent
Detection Limit: 0.01
Limit/Threshold: 100%ile: 5
Limit/Threshold: -
Total phosphorus (composite) (mg/L)
0.00 0.05 0.10 0.15 0.20 0.25 0.30
2009-10 2010-11 2011-12 2012-13 2013-14 2014-15 2015-16 2016-17 2017-18 2018-19
(Source=Model; DF=1 ; F Value=7.3382; Pr>F=0.0069)
Financial year

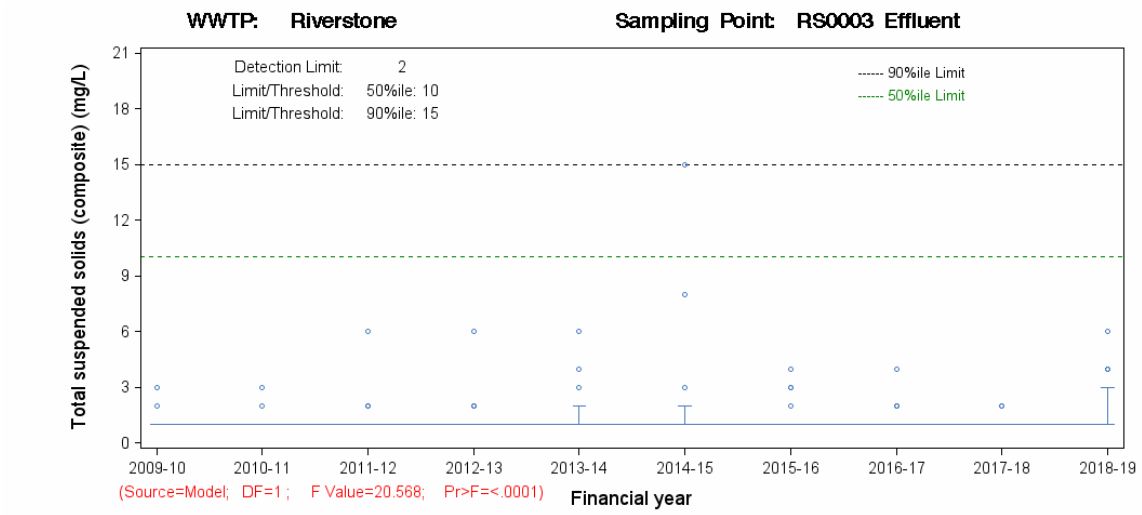
Discharge quality: Major conventional analytes

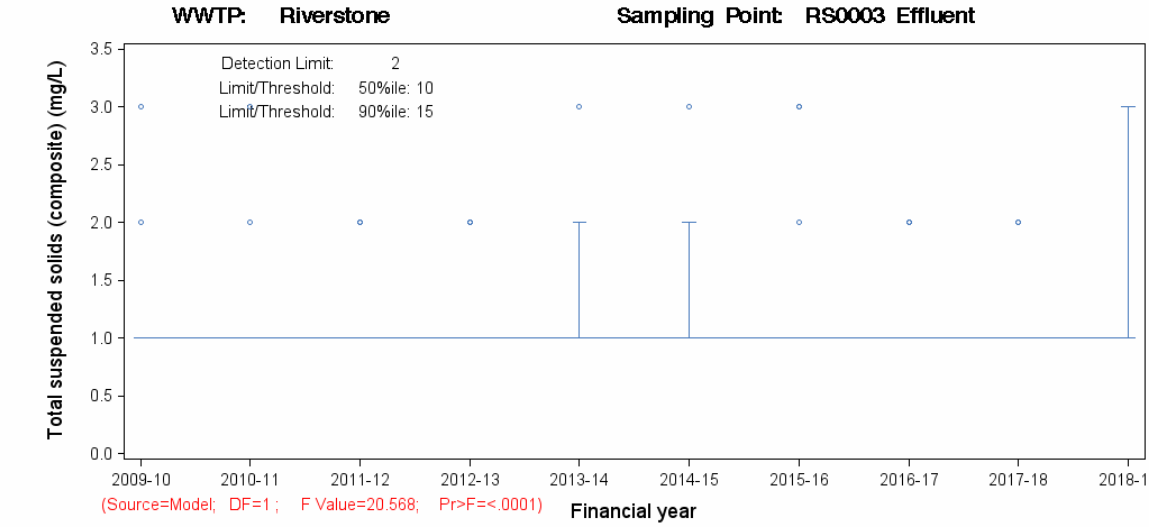


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

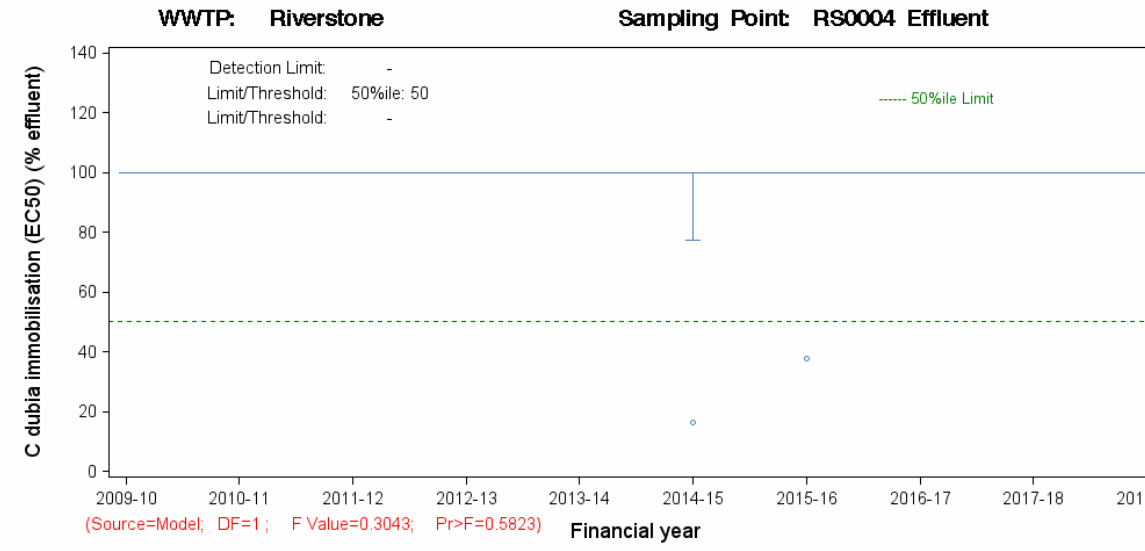




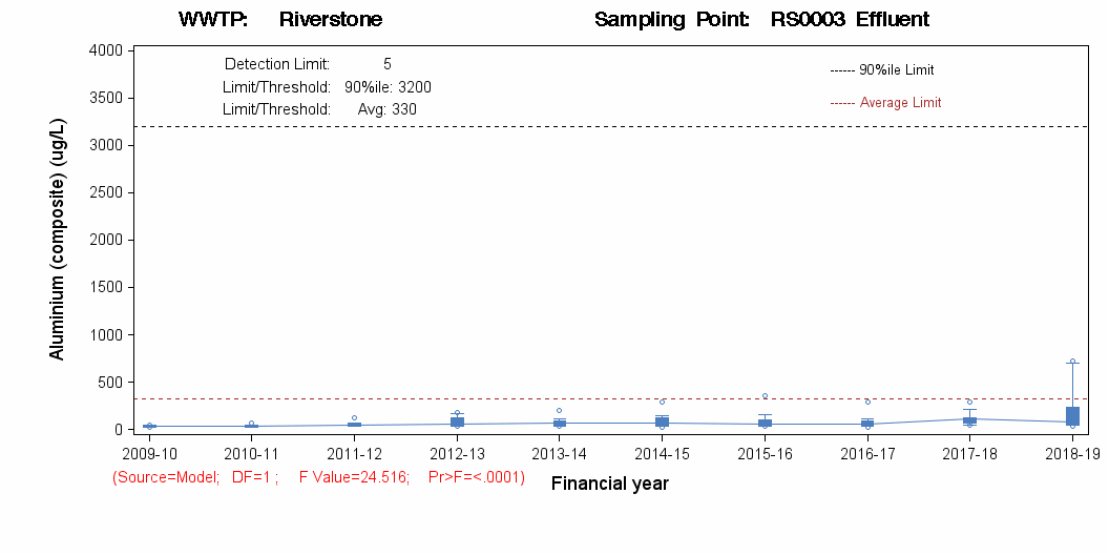


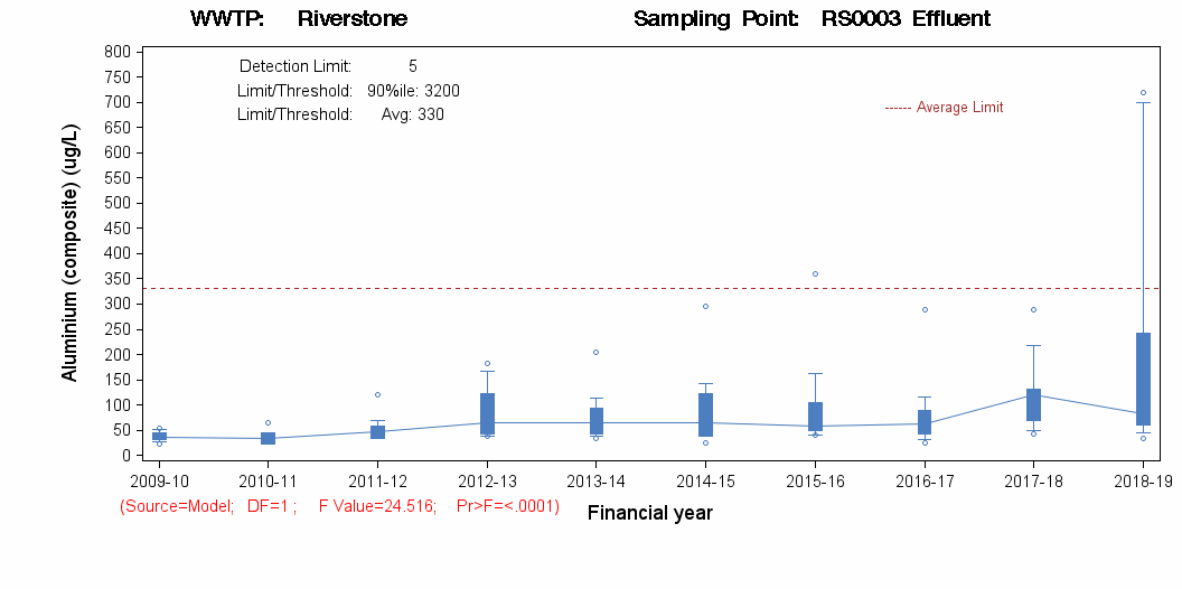


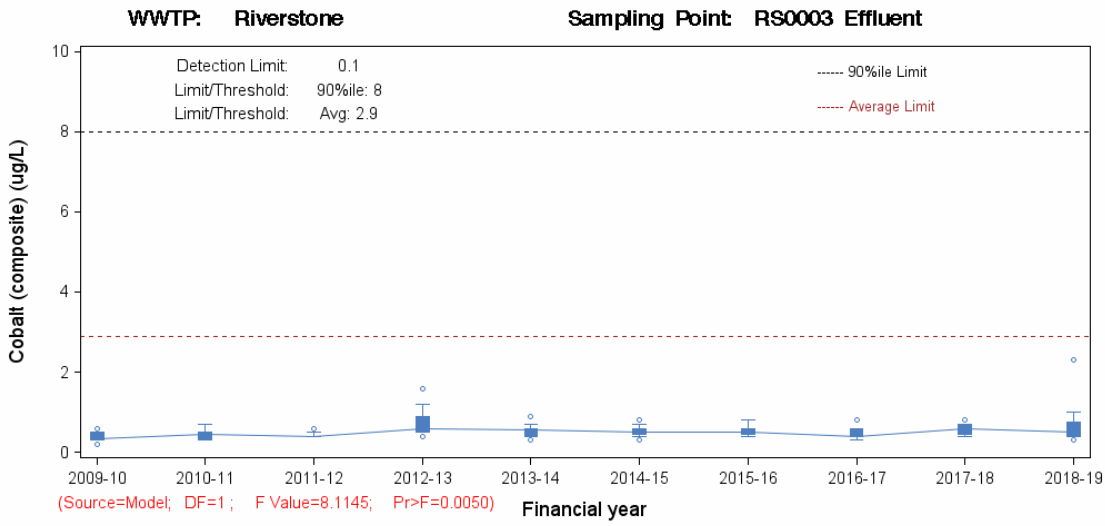
Discharge quality: Toxicity

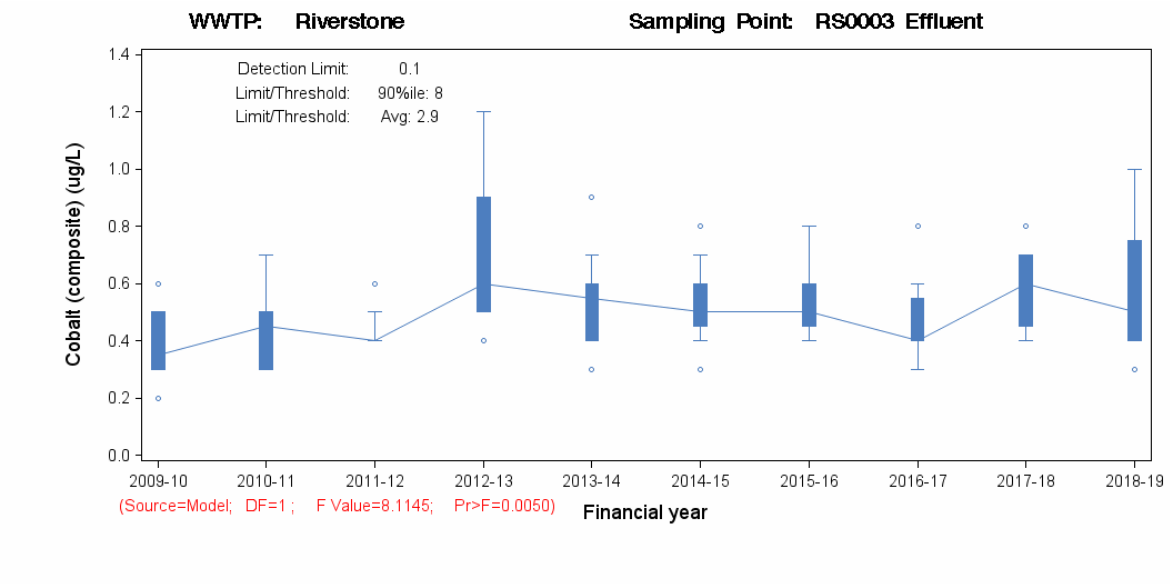


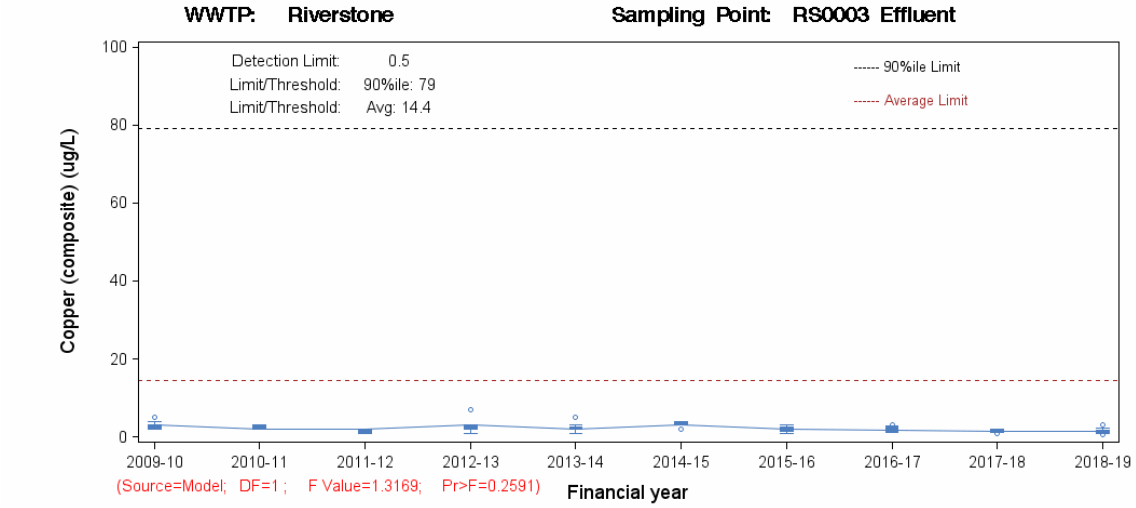
Discharge quality: Trace metals



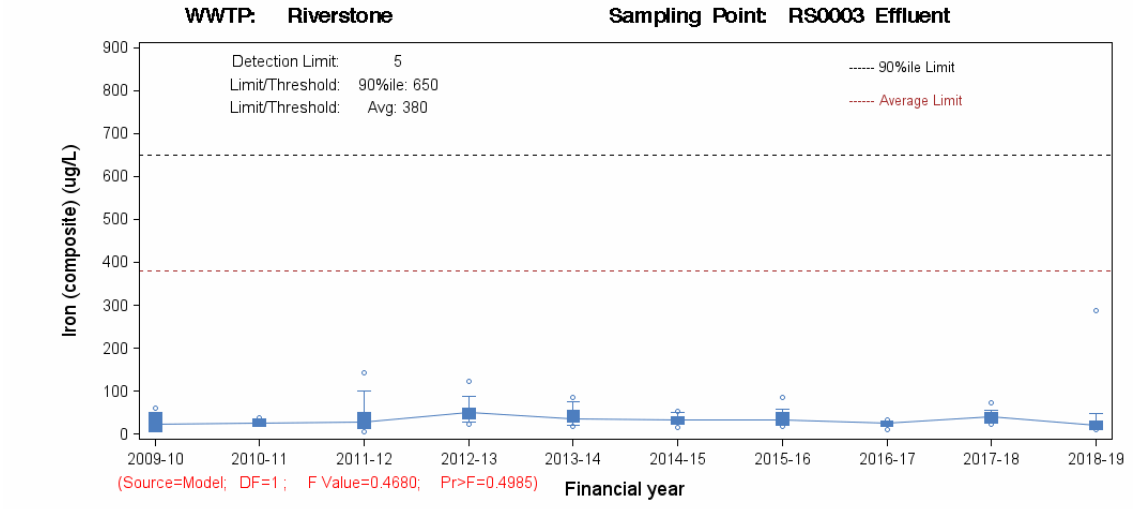




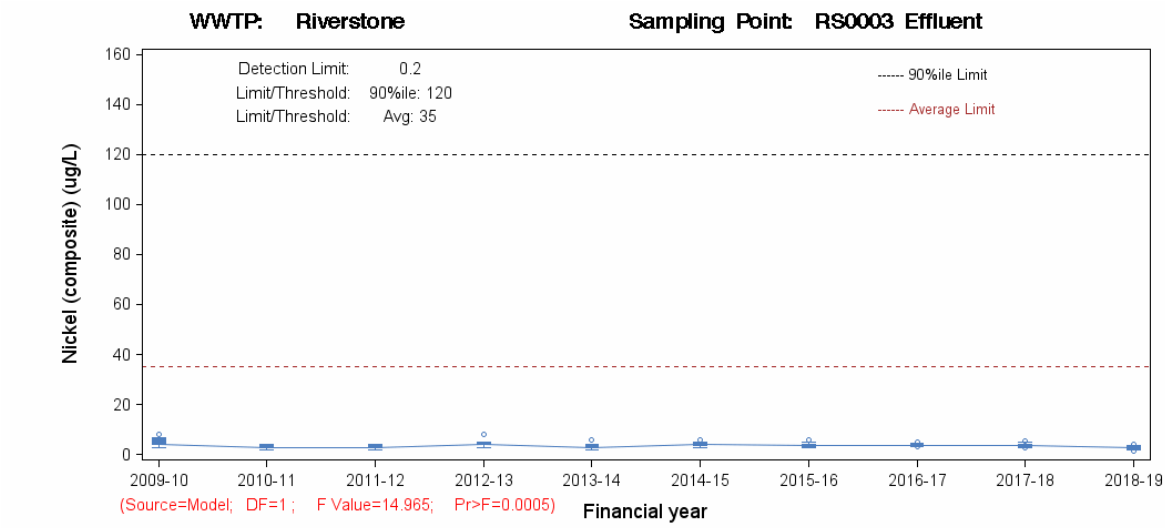




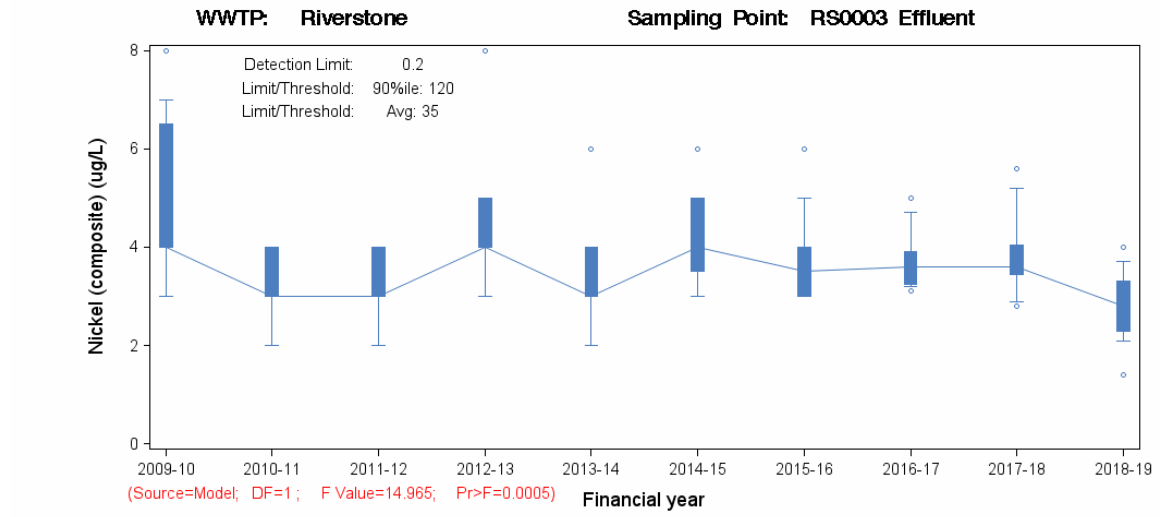
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



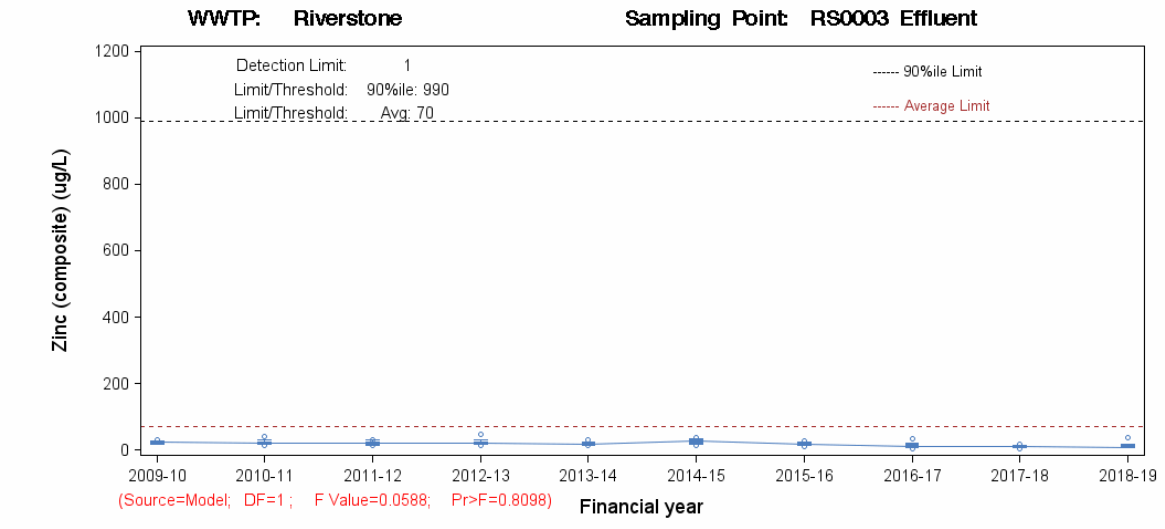
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

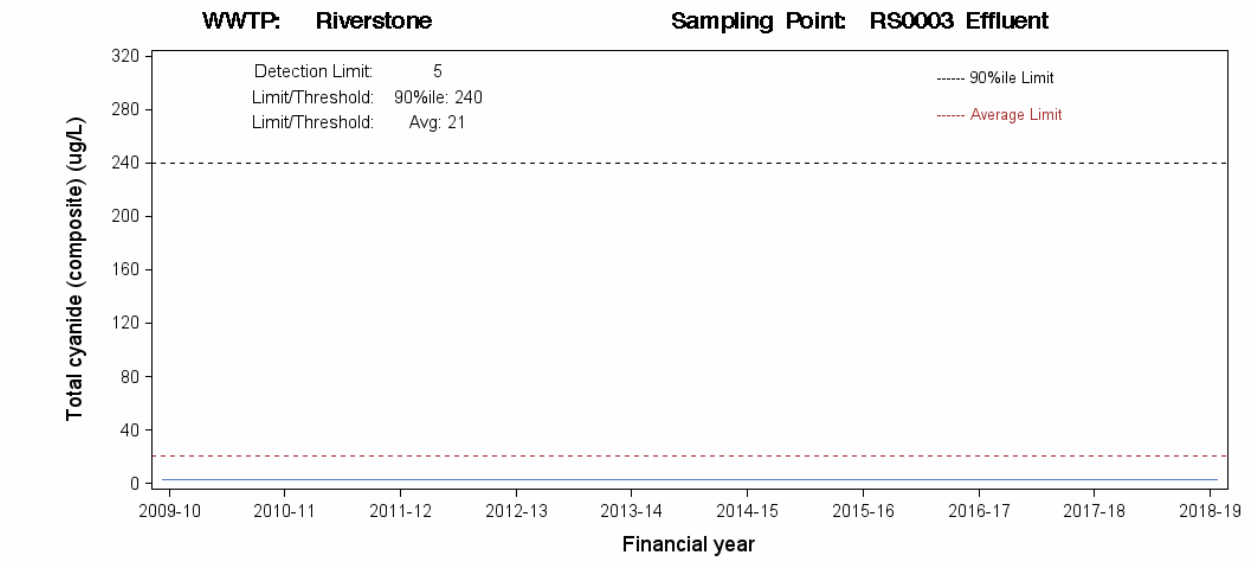


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

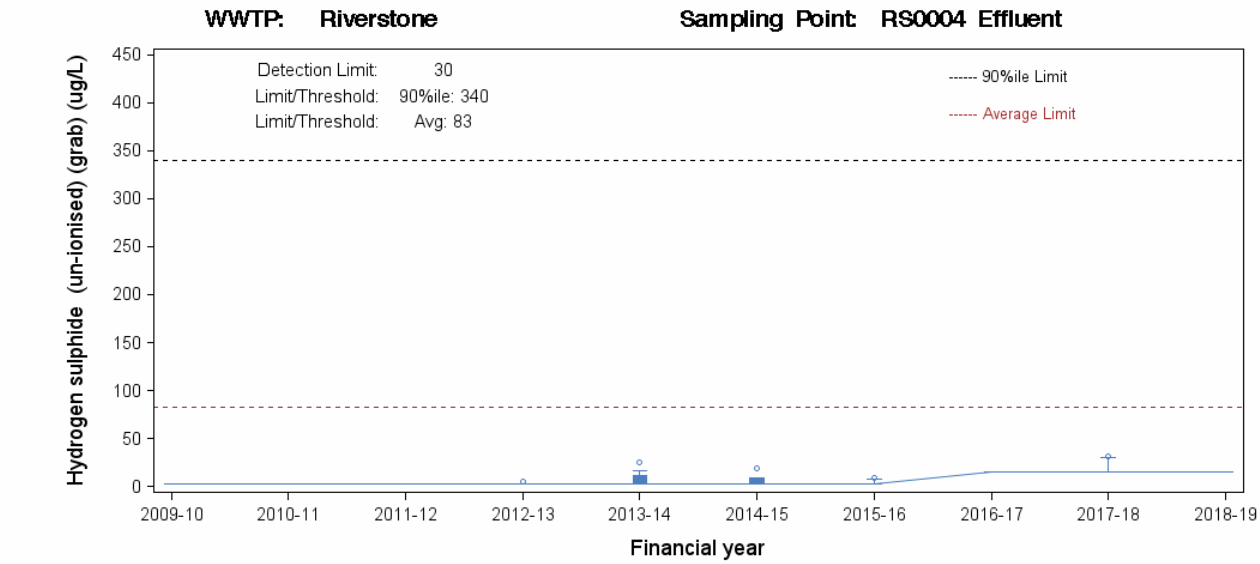


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

Discharge quality: Other chemicals and organics (including pesticides)

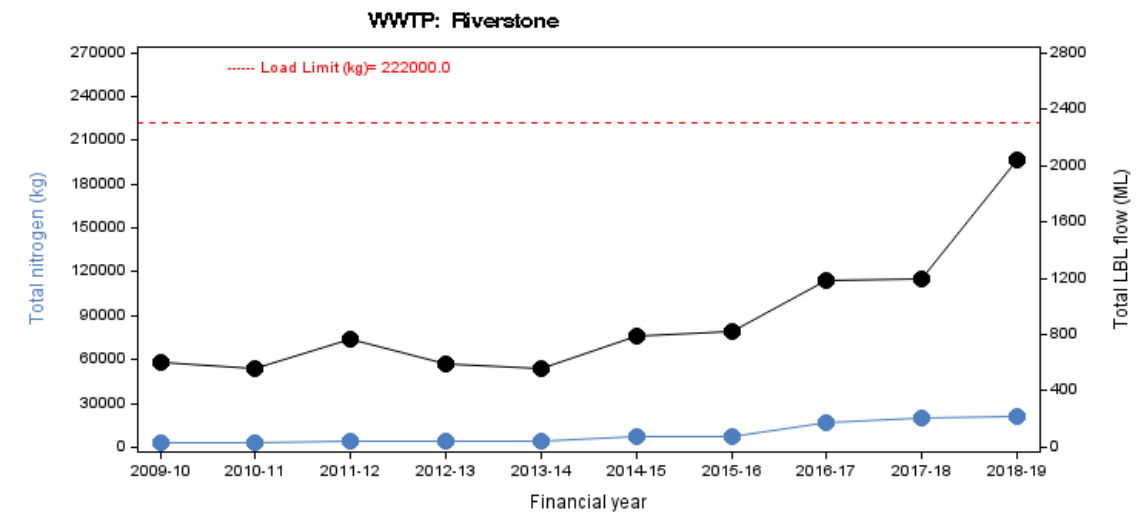


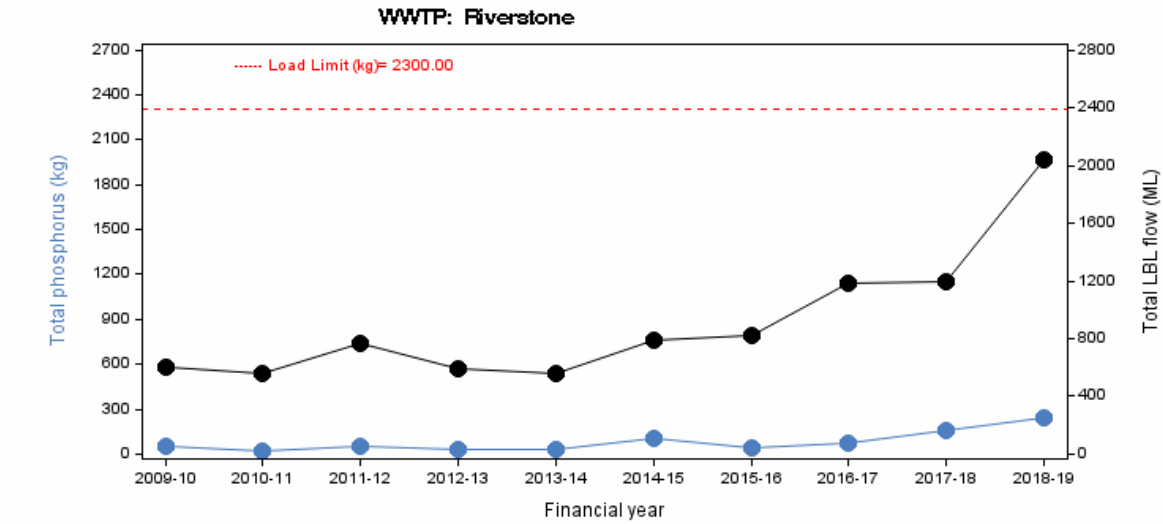
Note: Statistical test was not conducted because >90% of results were below the detection limit.



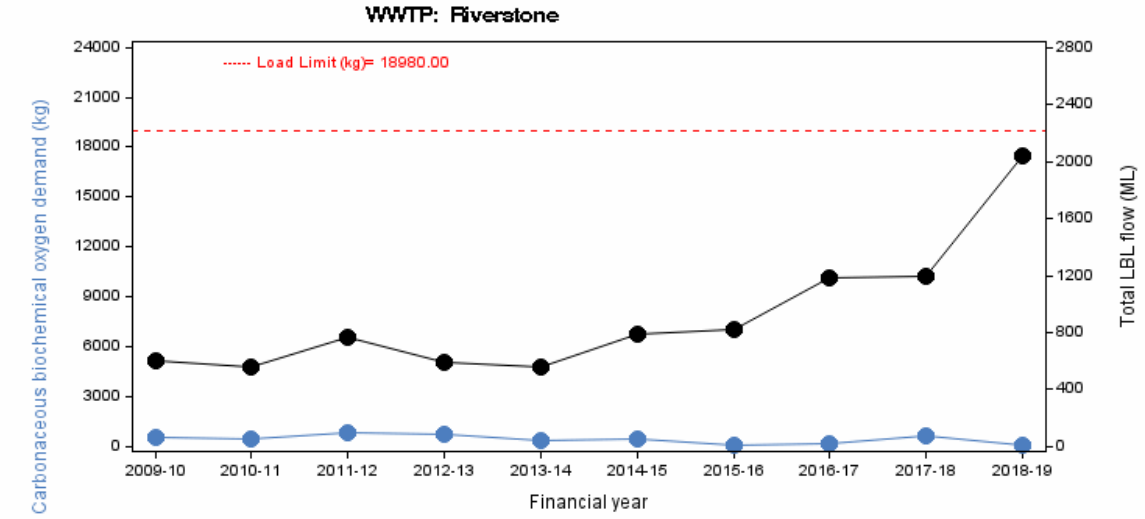
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

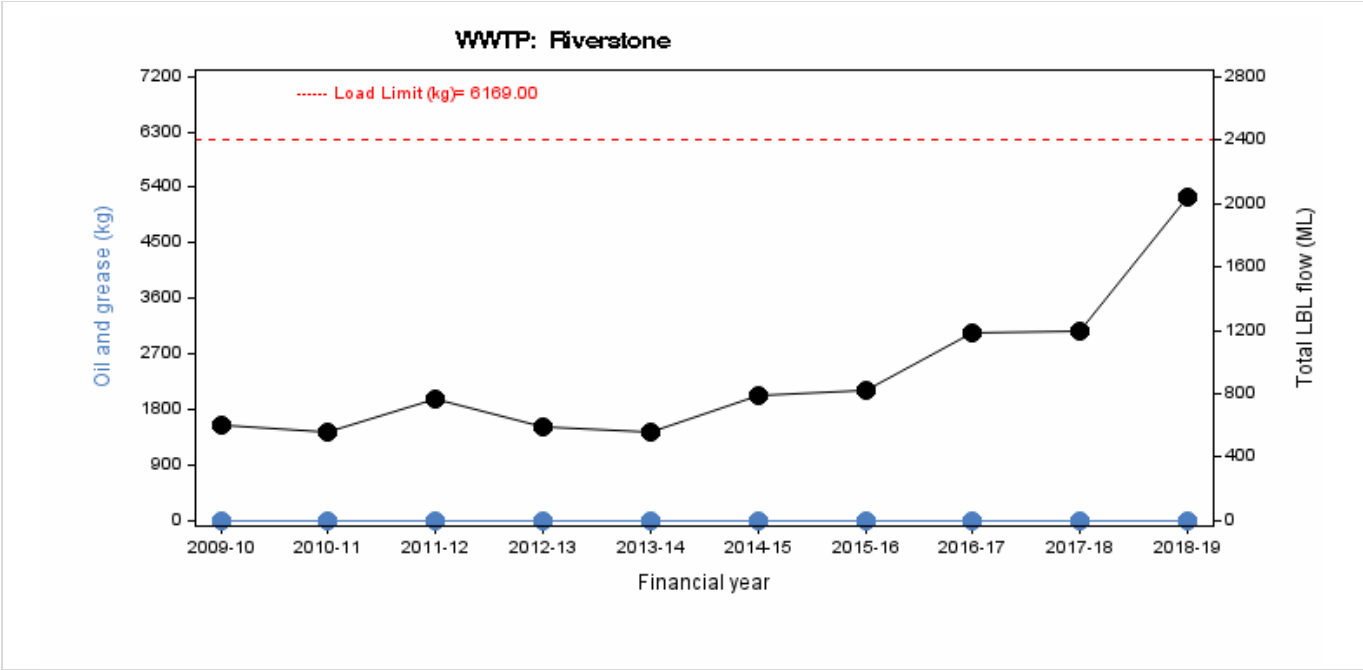
Discharge load: Nutrients

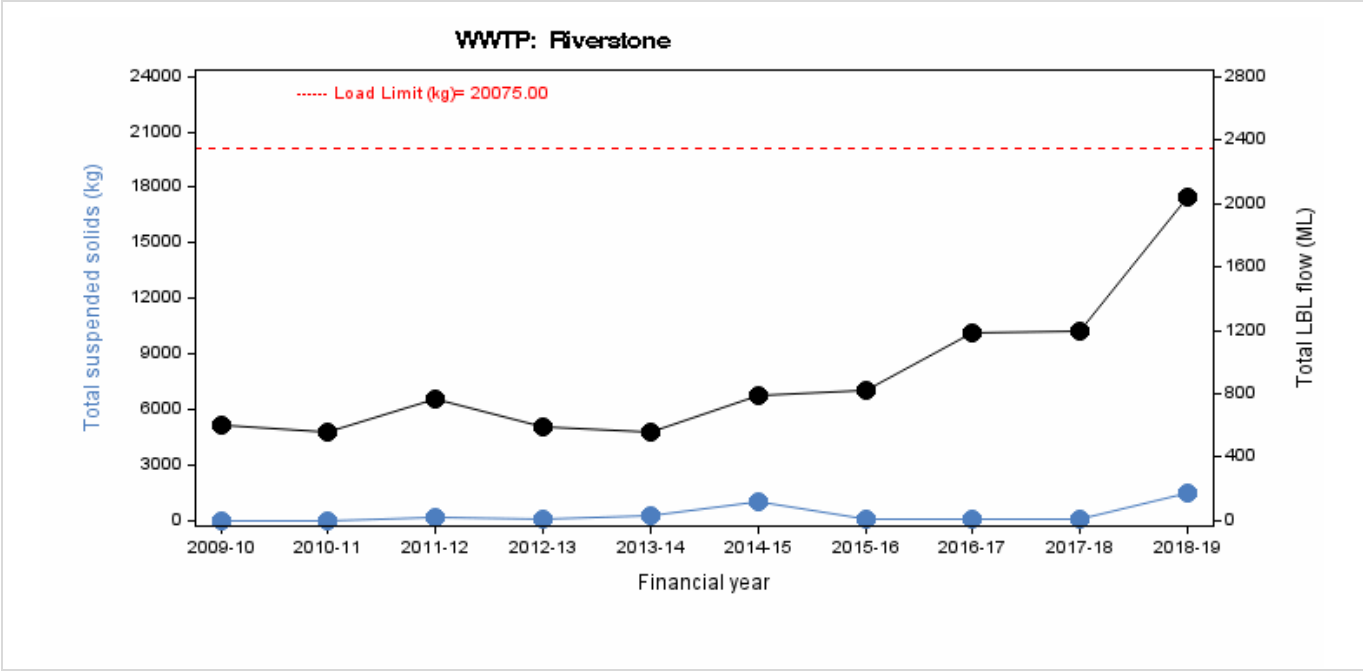




Discharge load: Major conventional analytes

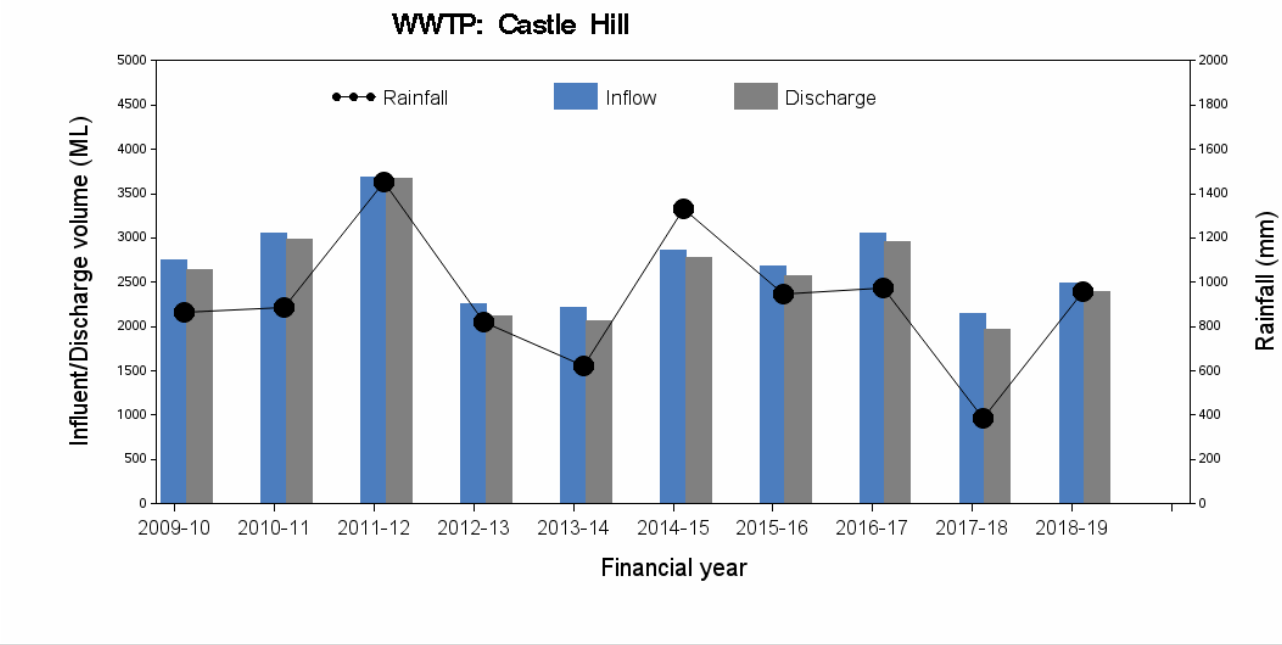


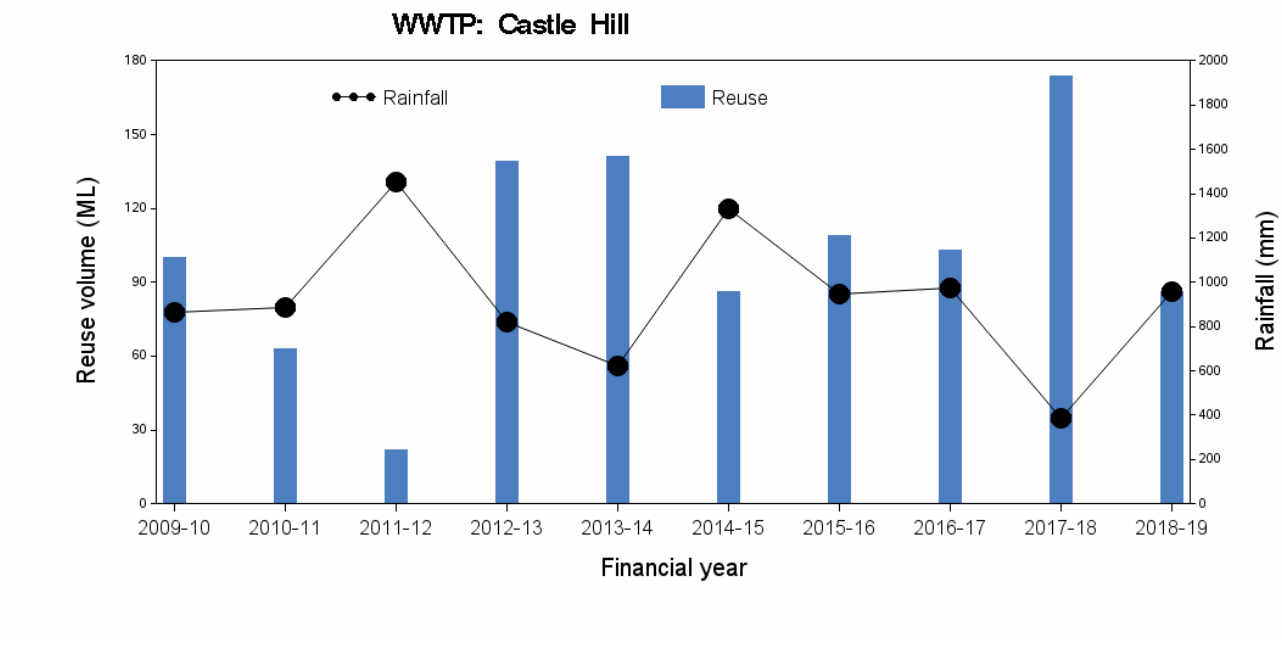

WWTP: Riverstone
Load Limit (kg)= 6169.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

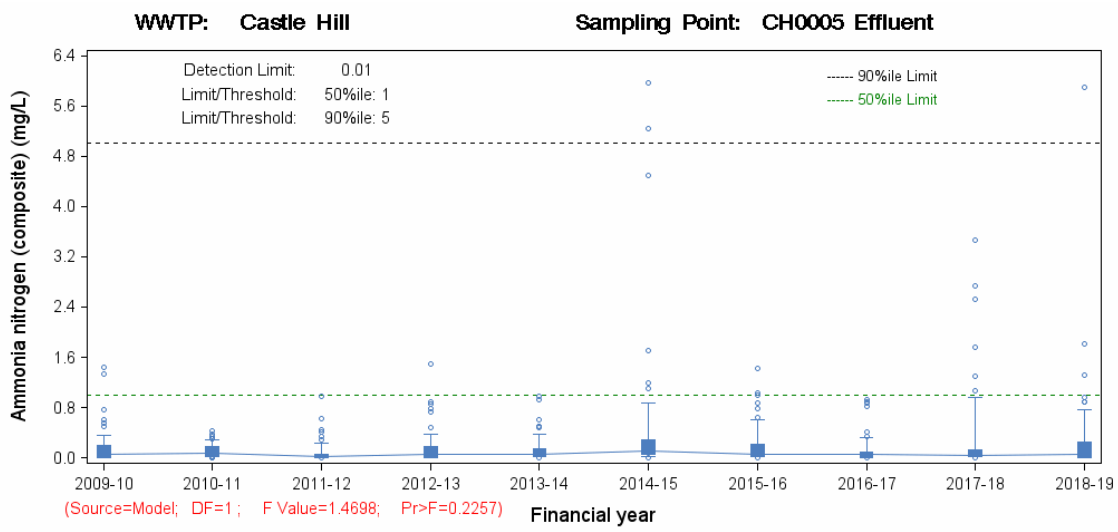

WWTP: Riverstone
Load Limit (kg)= 20075.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

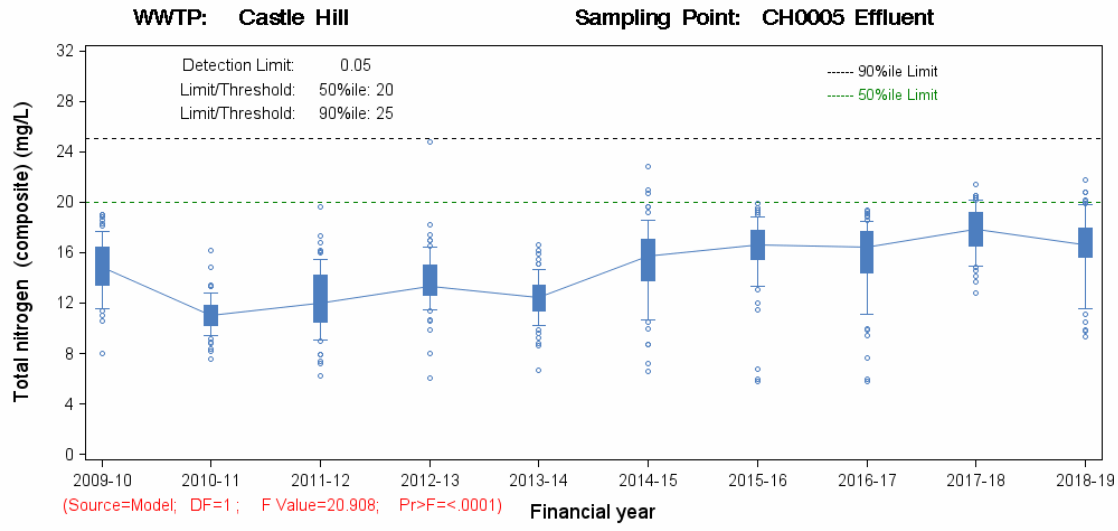
Castle Hill WWTP

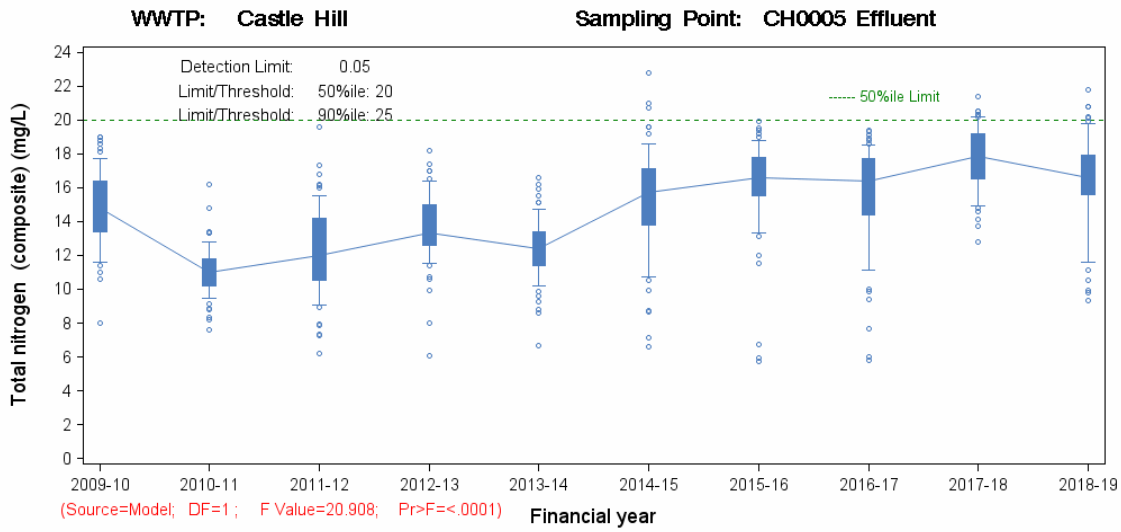
Discharge volume and rainfall

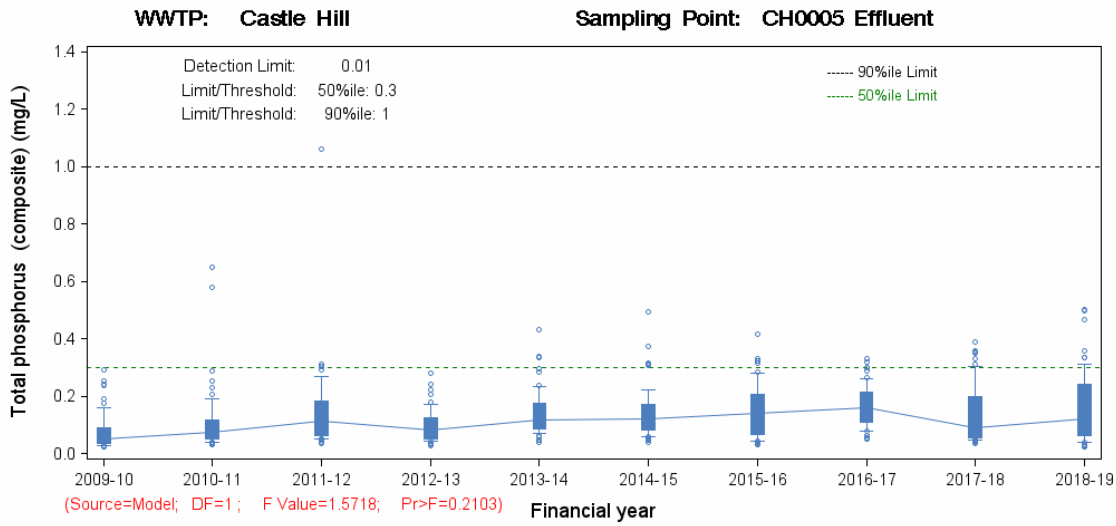




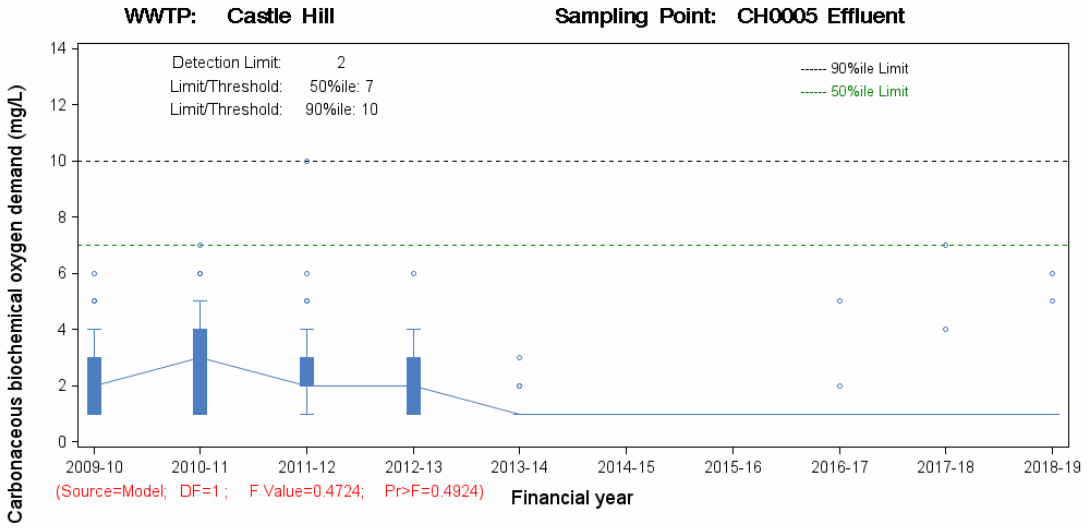

WWTP: Castle Hill
Sampling Point: CH0005 Effluent
Detection Limit: 0.01
Limit/Threshold: 50%ile: 1
Limit/Threshold: 90%ile: 5
----- 90%ile Limit
----- 50%ile Limit
Ammonia nitrogen (composite) (mg/L)
6.4
5.6
4.8
4.0
3.2
2.4
1.6
0.8
0.0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.4698; Pr>F=0.2257)
Financial year


WWTP: Castle Hill
Sampling Point: CH0005 Effluent
Detection Limit: 0.05
Limit/Threshold: 50%ile: 20
Limit/Threshold: 90%ile: 25
----- 90%ile Limit
----- 50%ile Limit
Total nitrogen (composite) (mg/L)
32
28
24
20
16
12
8
4
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=20.908; Pr>F=<.0001)
Financial year

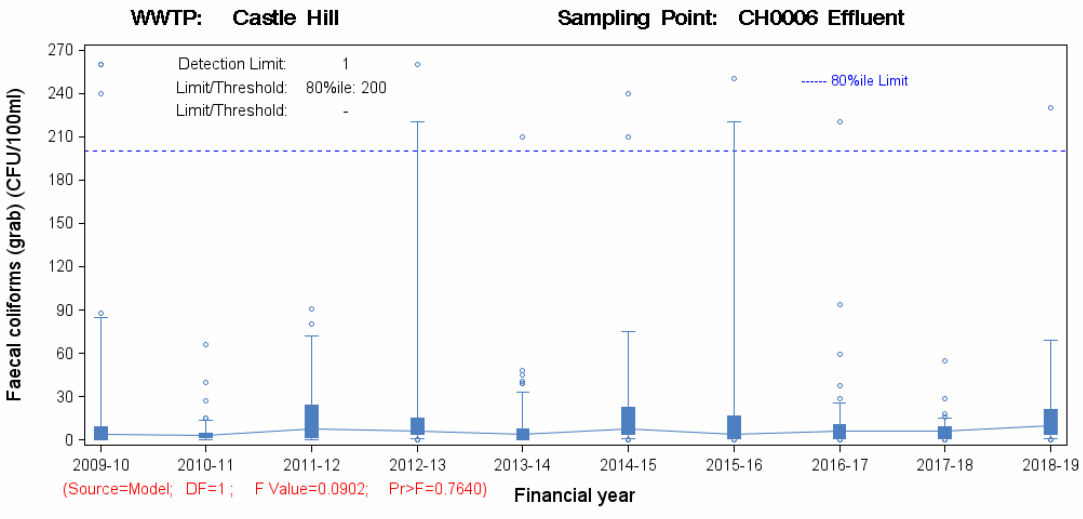

WWTP: Castle Hill
Sampling Point: CH0005 Effluent
Detection Limit: 0.05
Limit/Threshold: 50%ile: 20
Limit/Threshold: 90%ile: 25
----- 50%ile Limit
Total nitrogen (composite) (mg/L)
24
22
20
18
16
14
12
10
8
6
4
2
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=20.908; Pr>F=<.0001)
Financial year

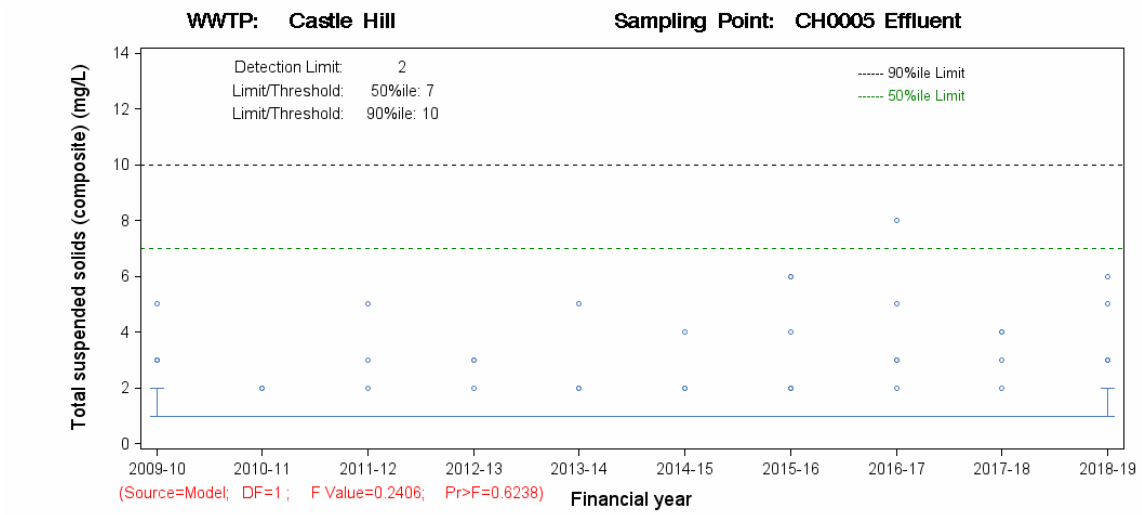


Discharge quality: Major conventional analytes

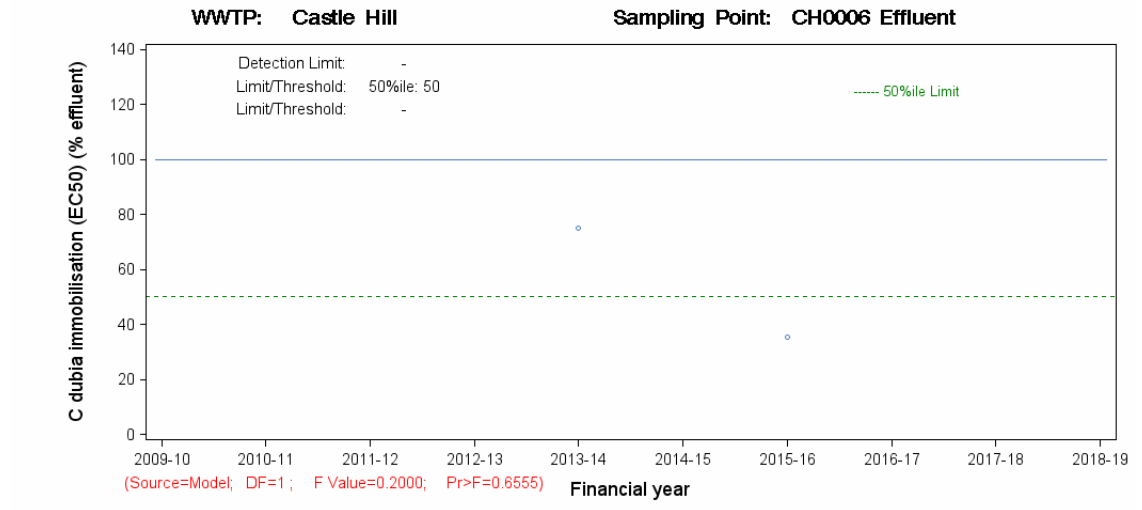


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

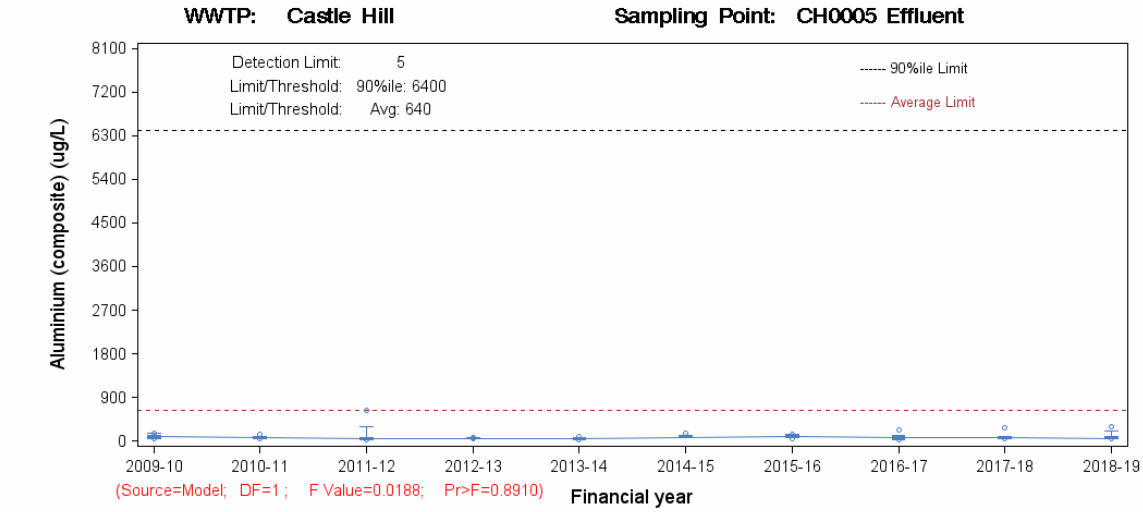


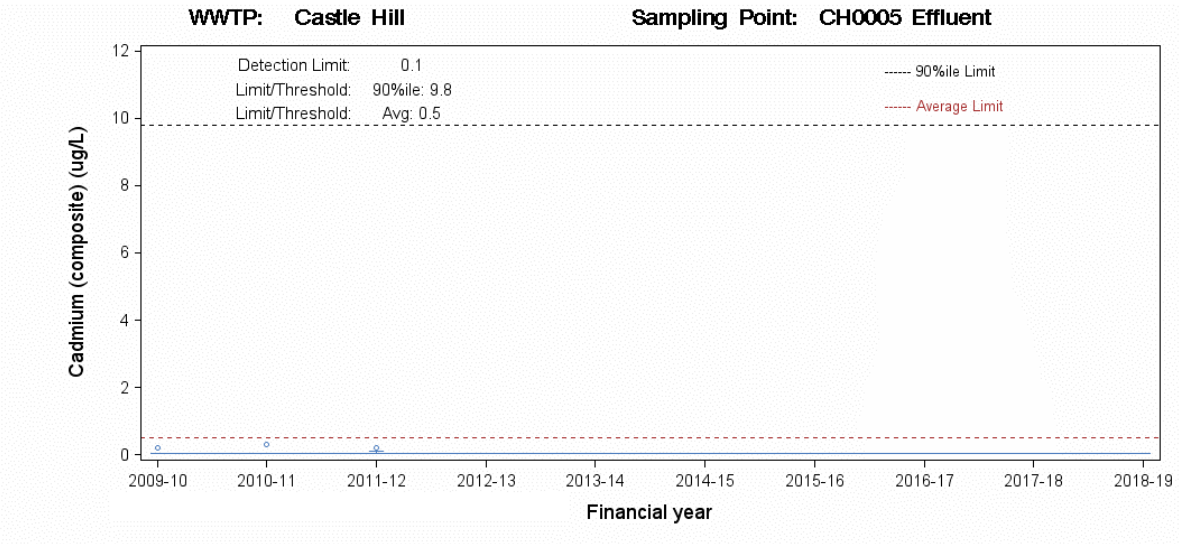


Discharge quality: Toxicity

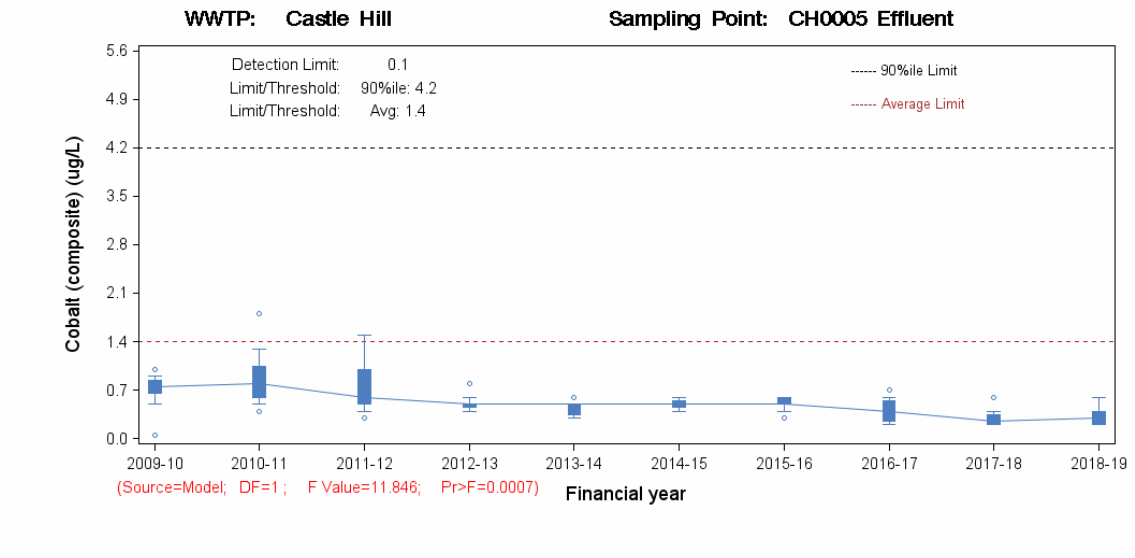


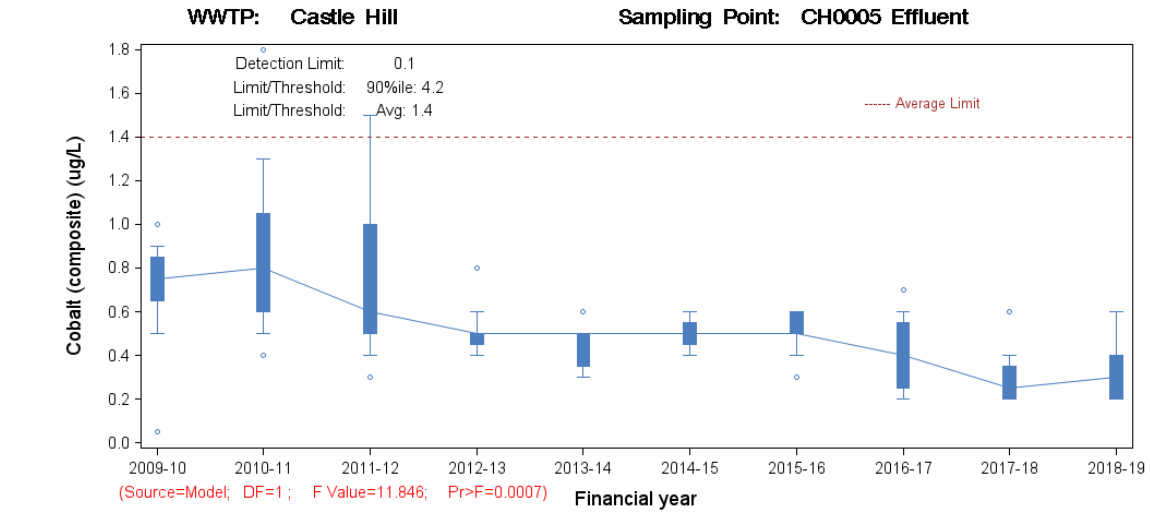
Discharge quality: Trace metals

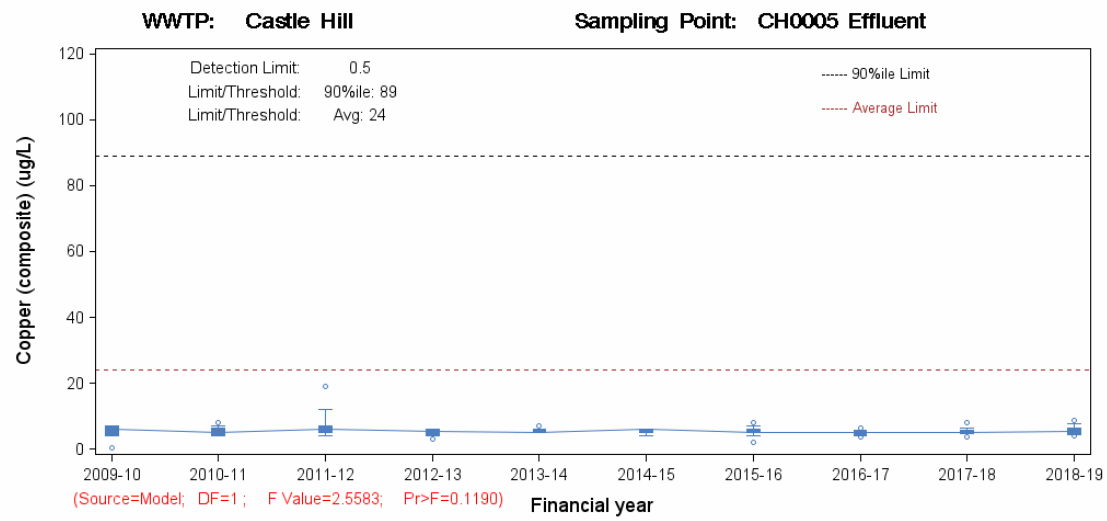




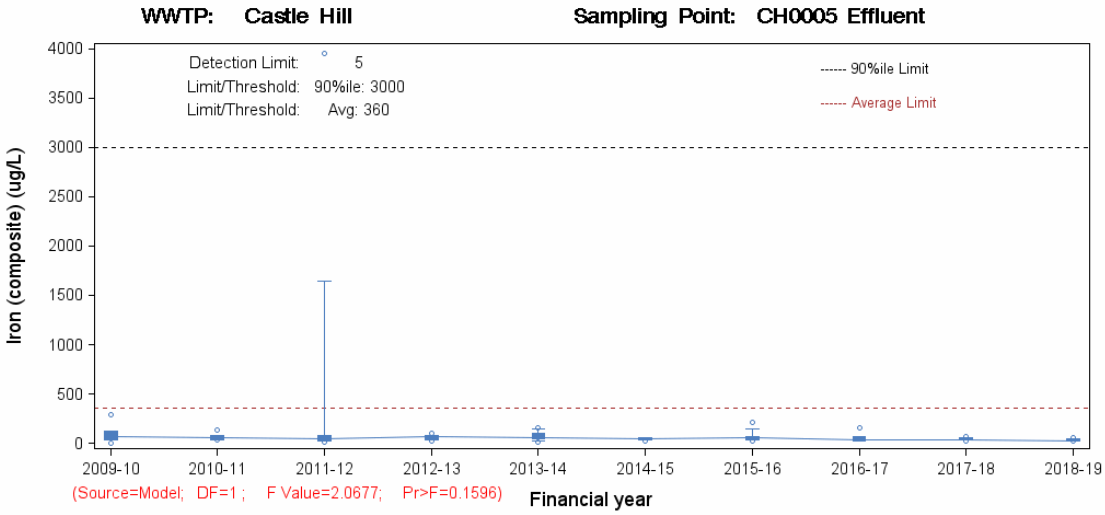
Note: Statistical test was not conducted because >90% of results were below the detection limit.



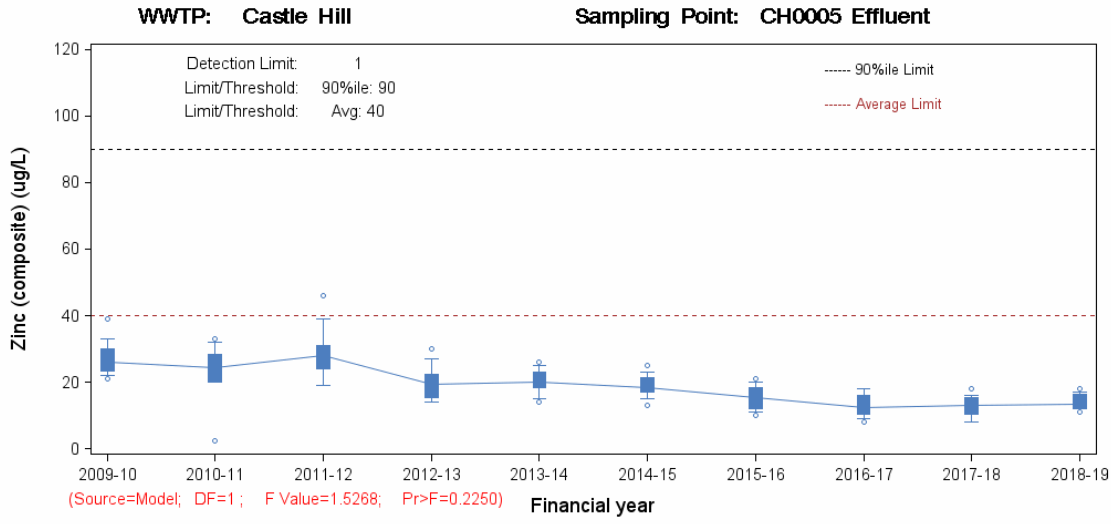




Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

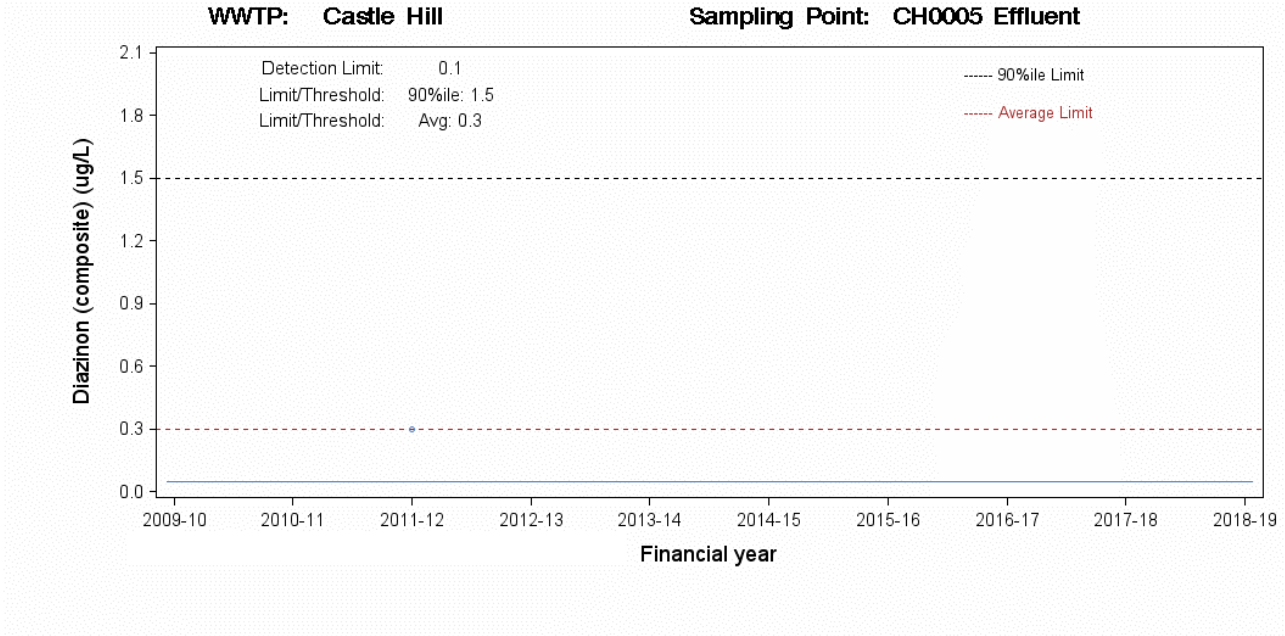


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

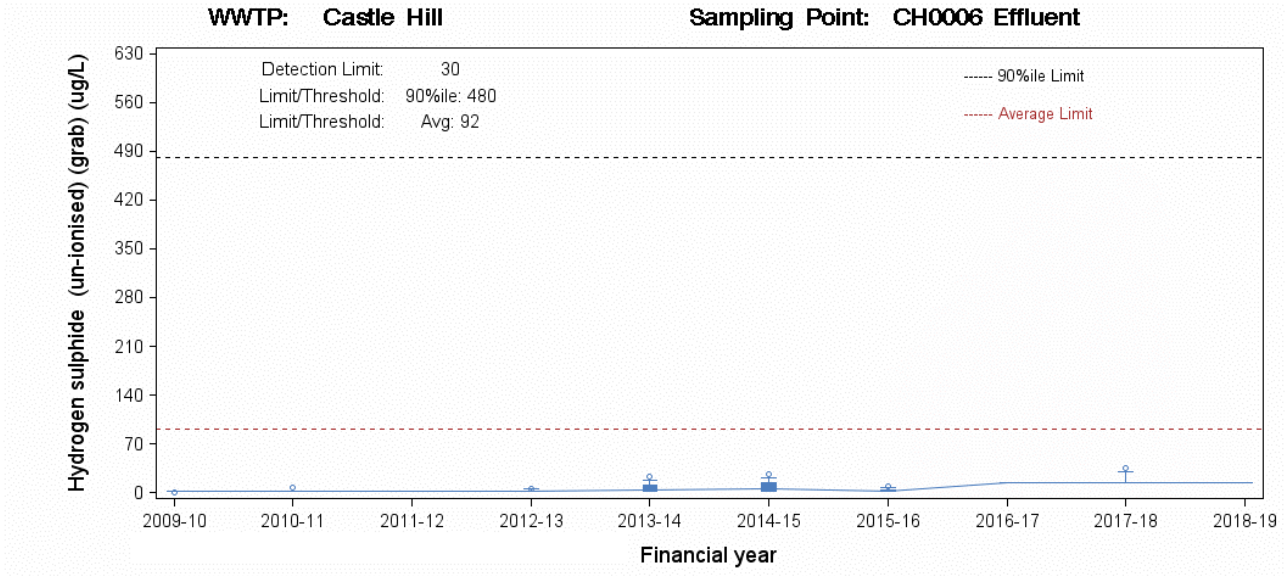


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

Discharge quality: Other chemicals and organics (including pesticides)

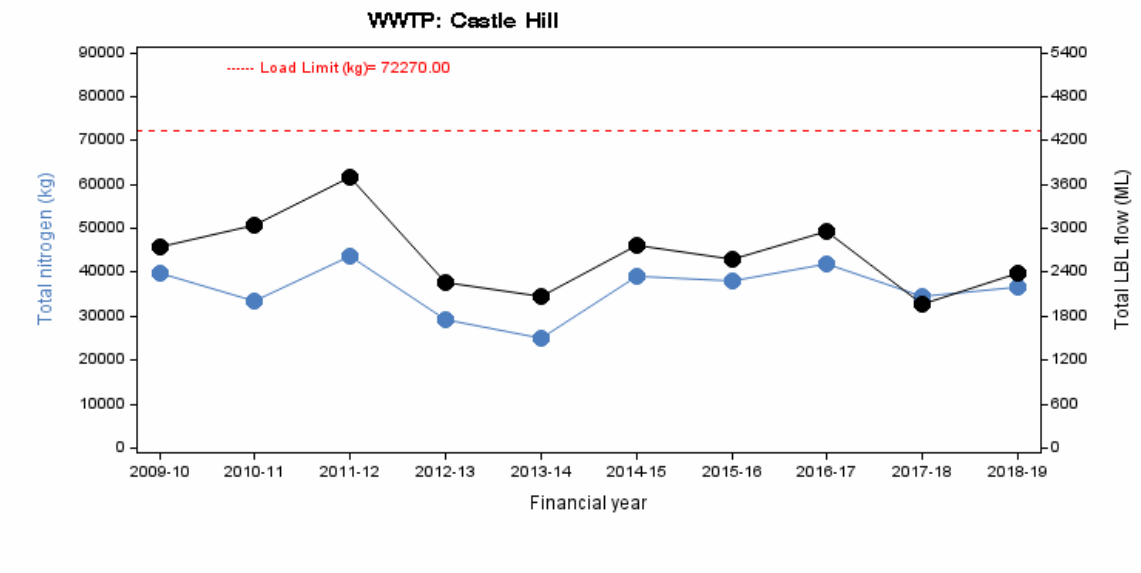


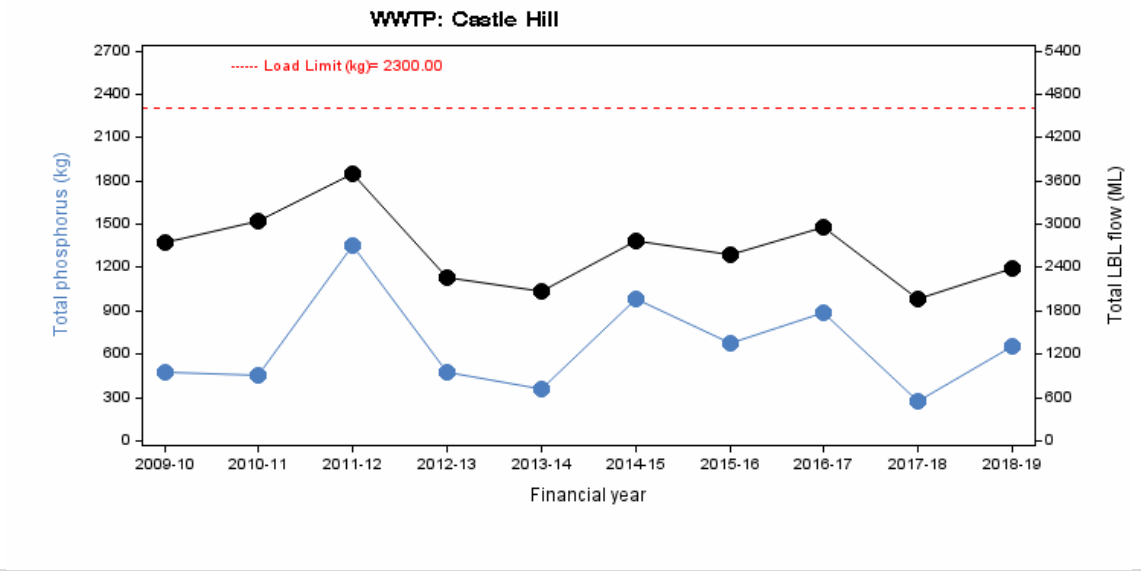
Note: Statistical test was not conducted because >90% of results were below the detection limit.



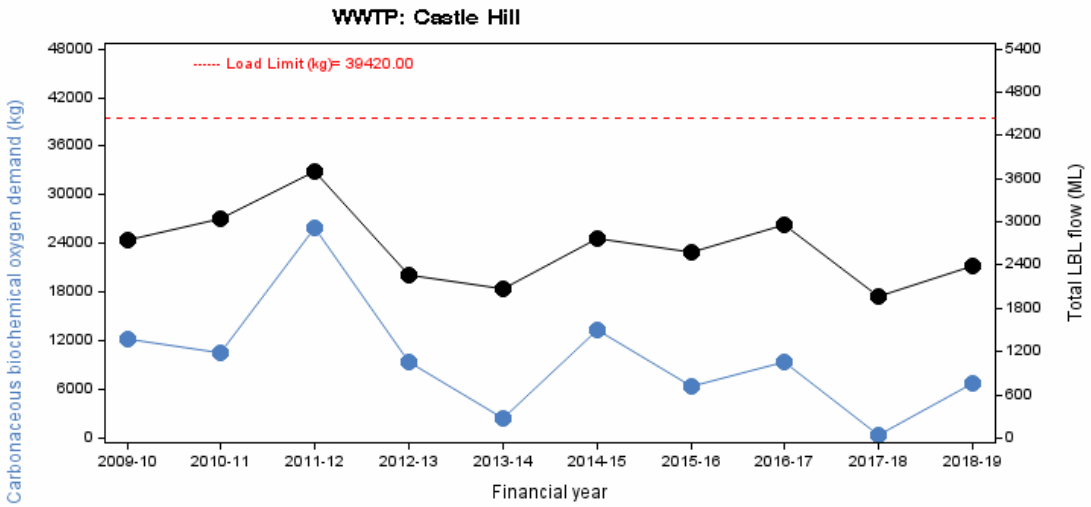
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

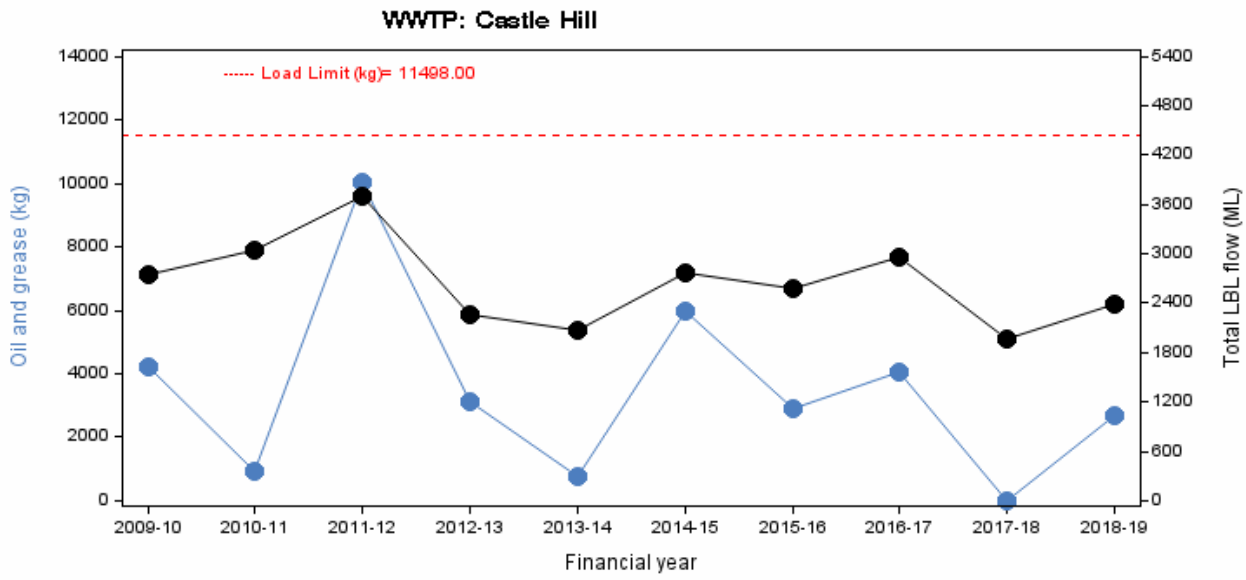
Discharge load: Nutrients

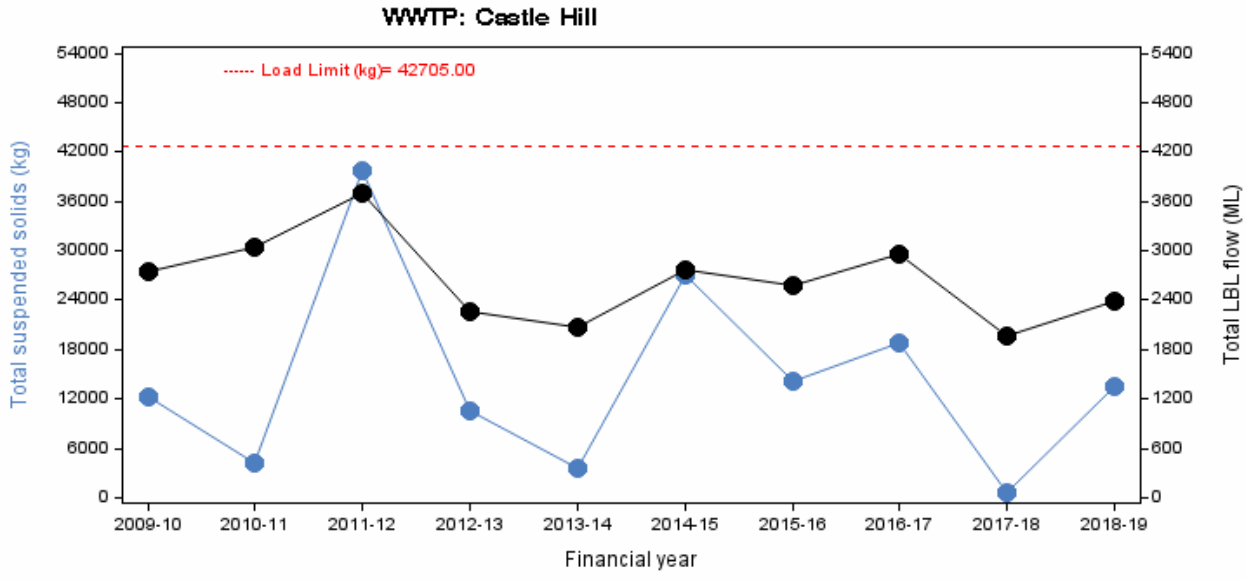




Discharge load: Major conventional analytes

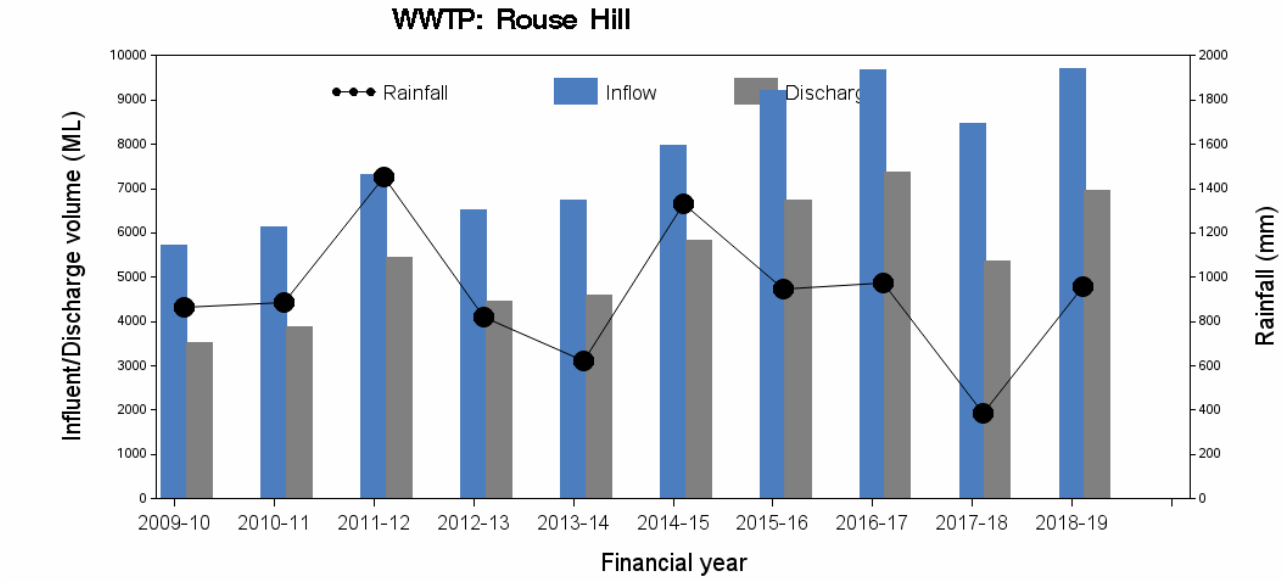


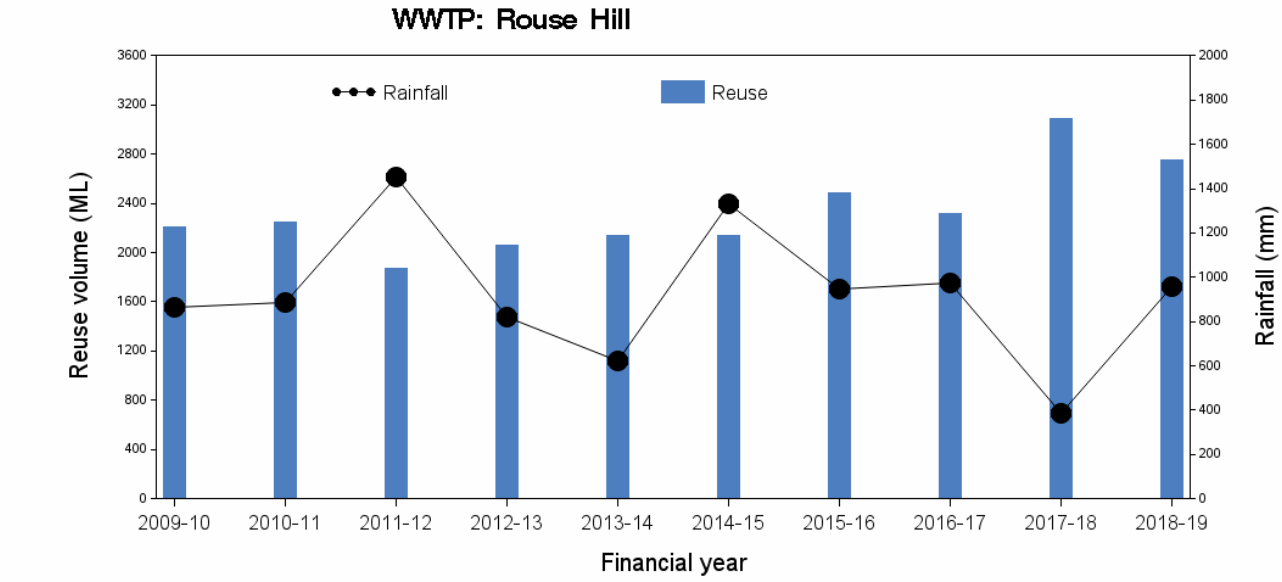

WWTP: Castle Hill
Load Limit (kg)= 11498.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19


WWTP: Castle Hill
Load Limit (kg)= 42705.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

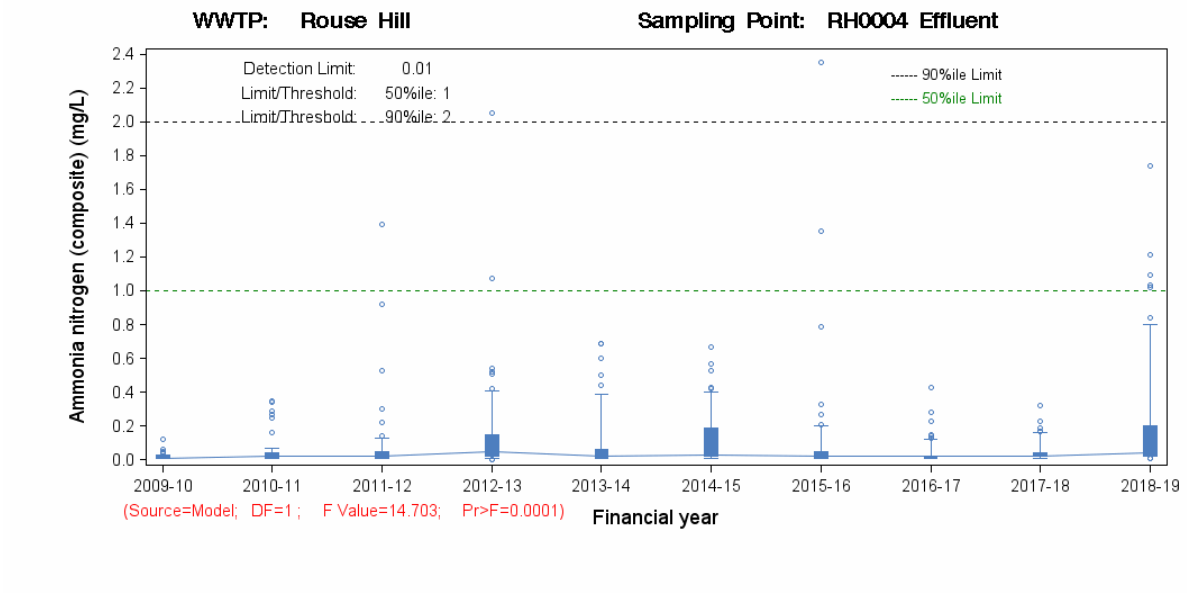
Rouse Hill WWTP

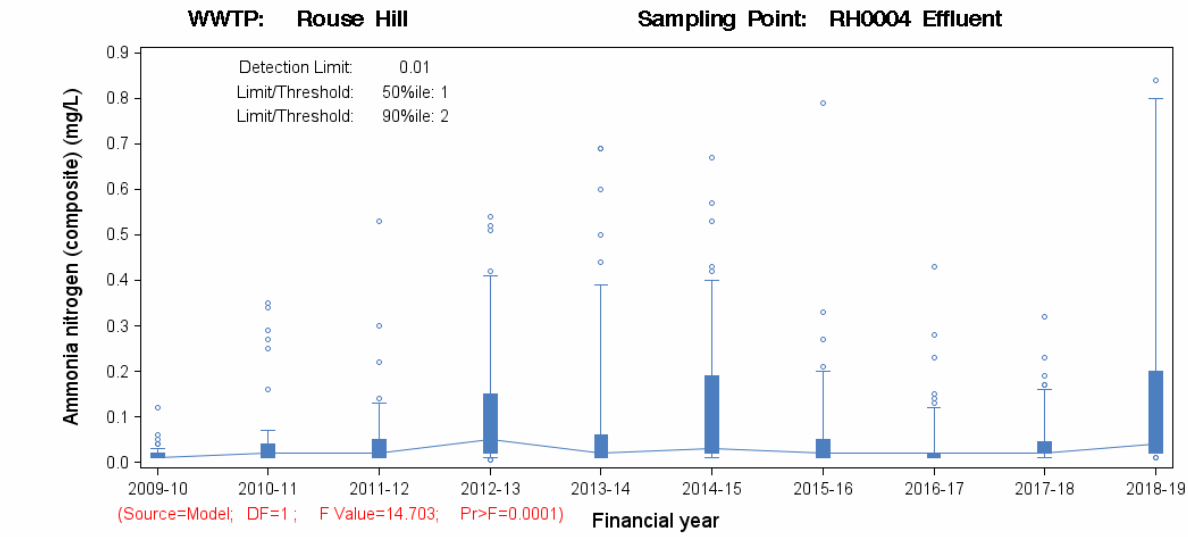
Discharge volume and rainfall

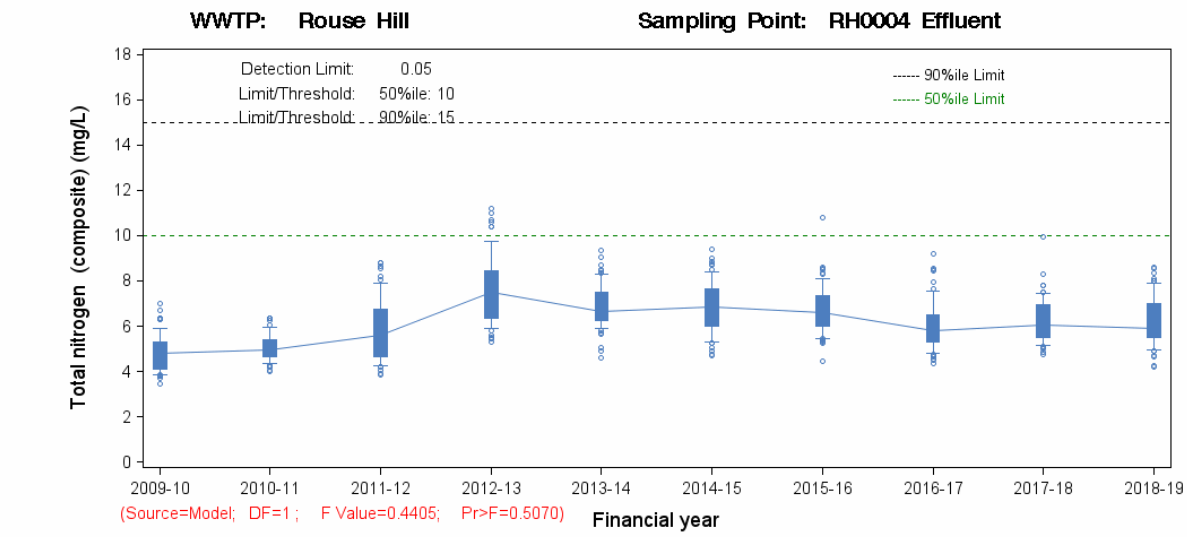


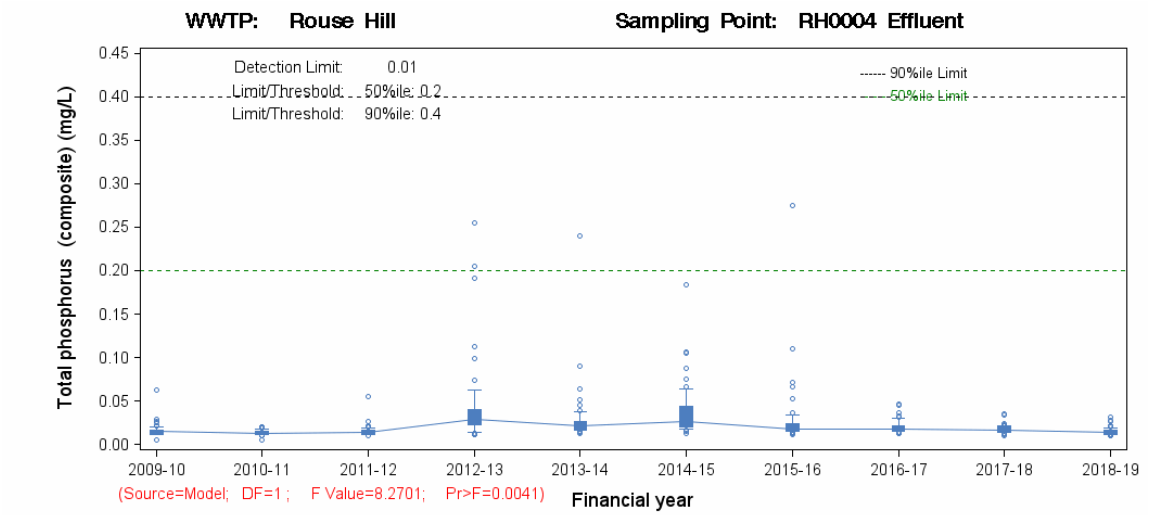


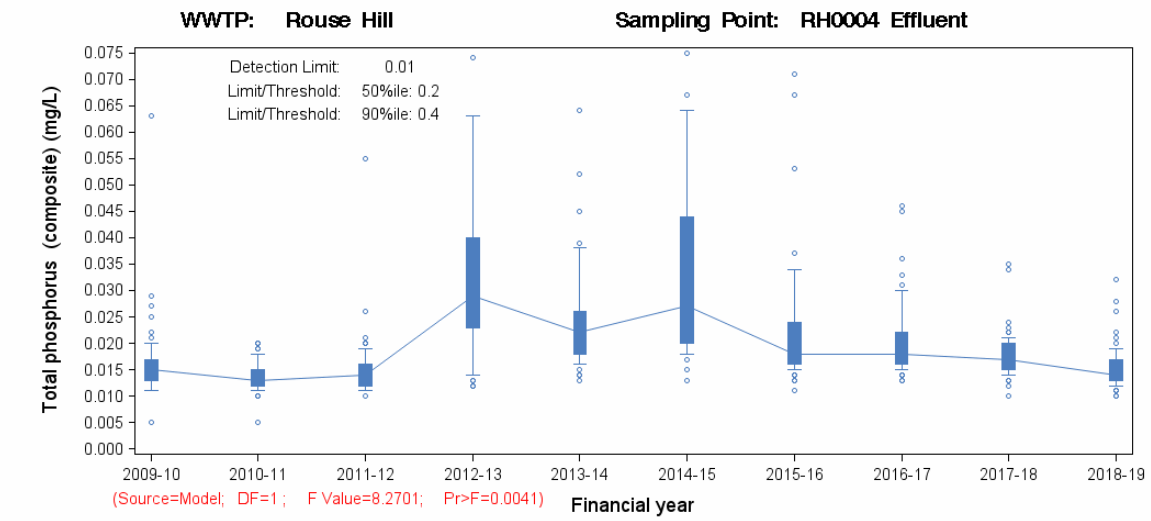
Discharge quality: Nutrients (RH0004 Effluent)



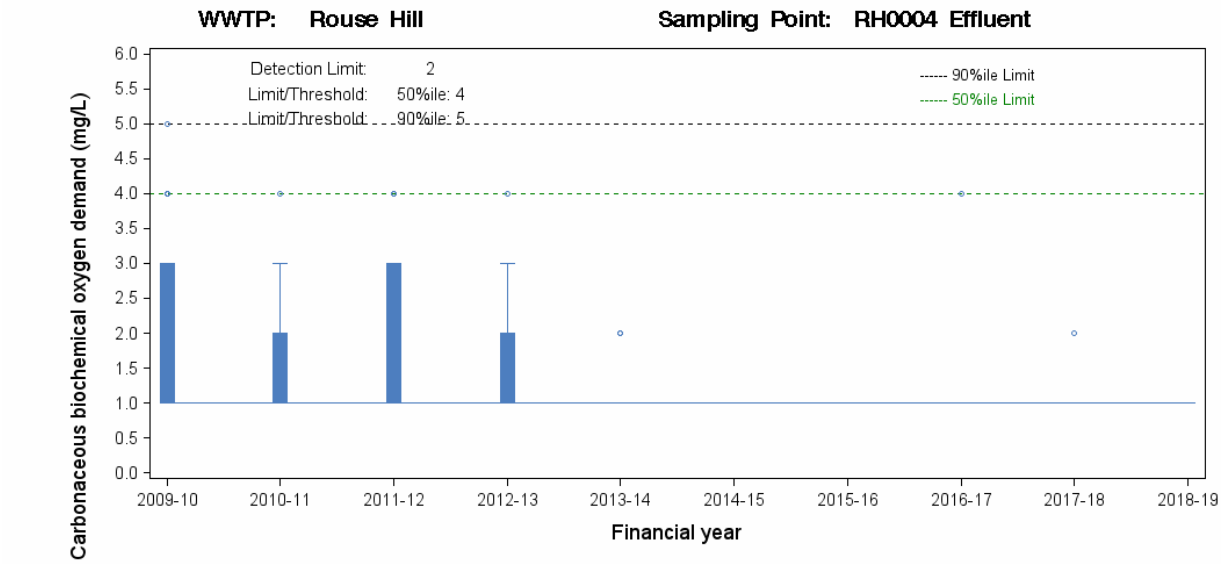




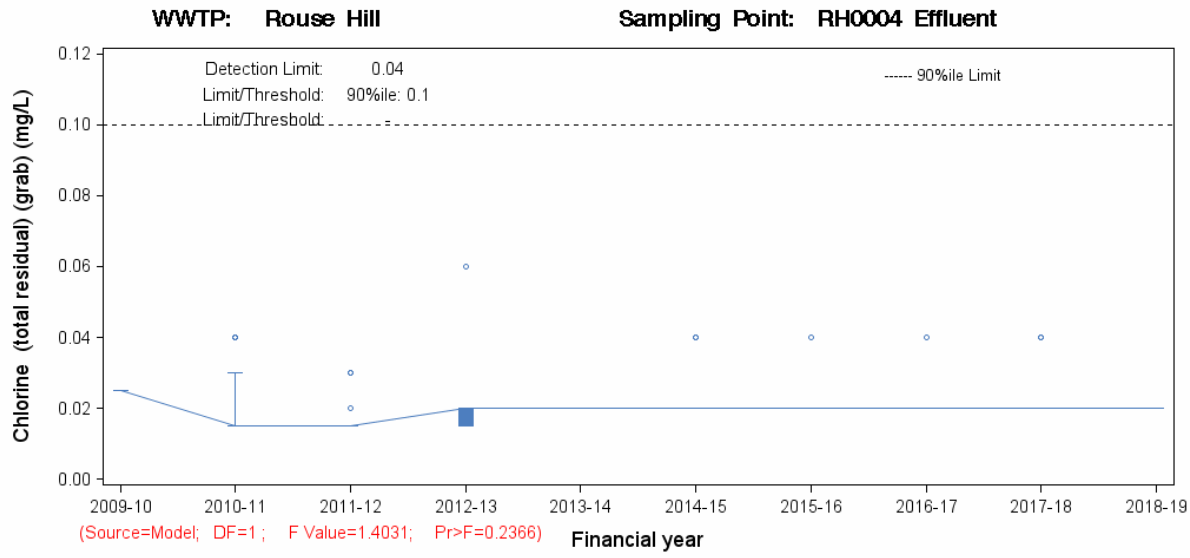


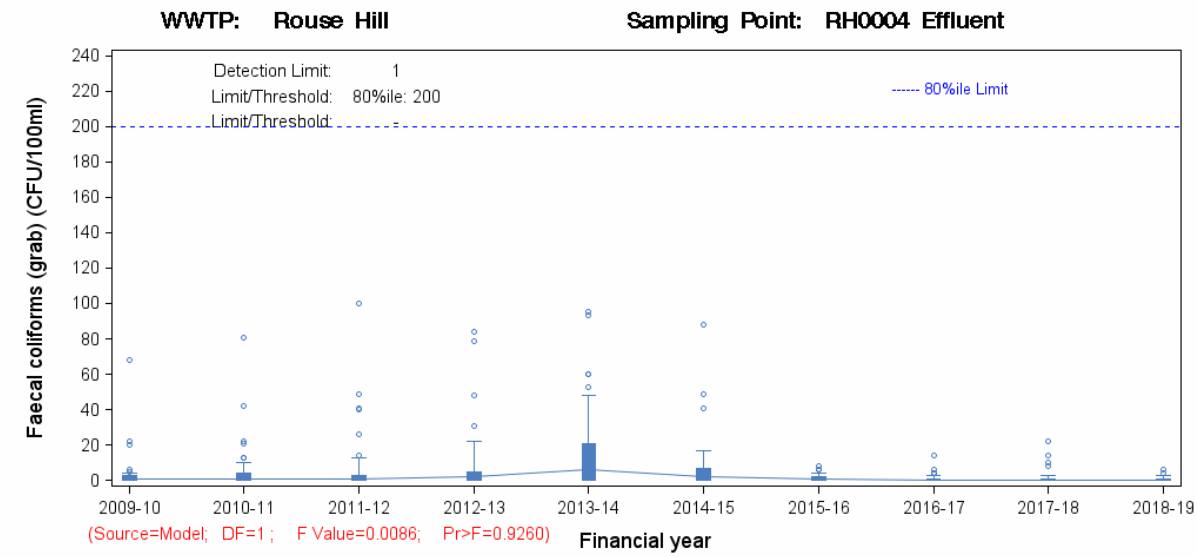


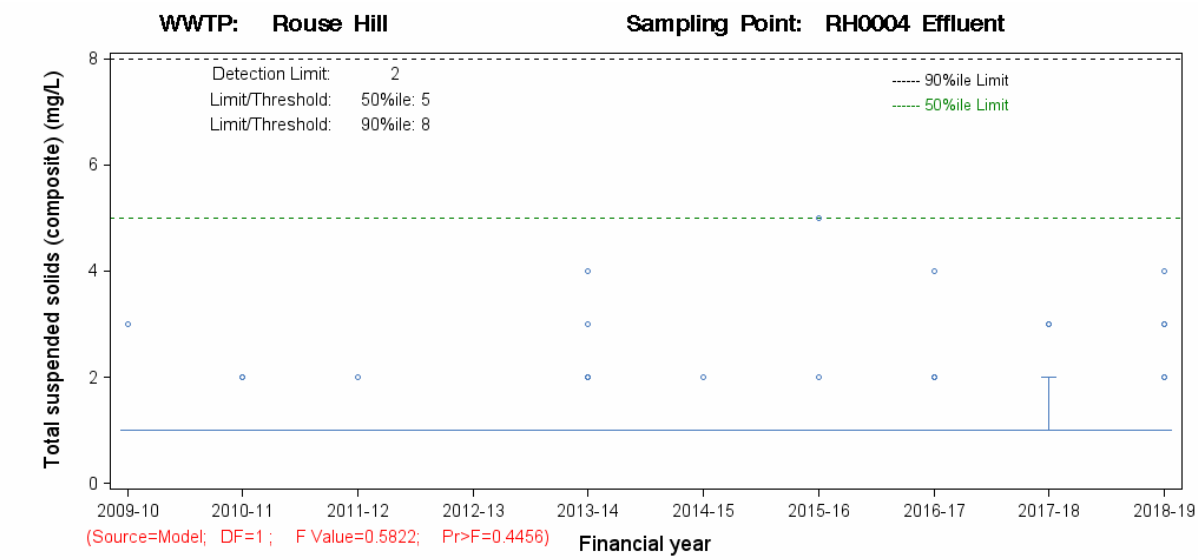
Discharge quality: Major conventional analytes (RH0004 Effluent)



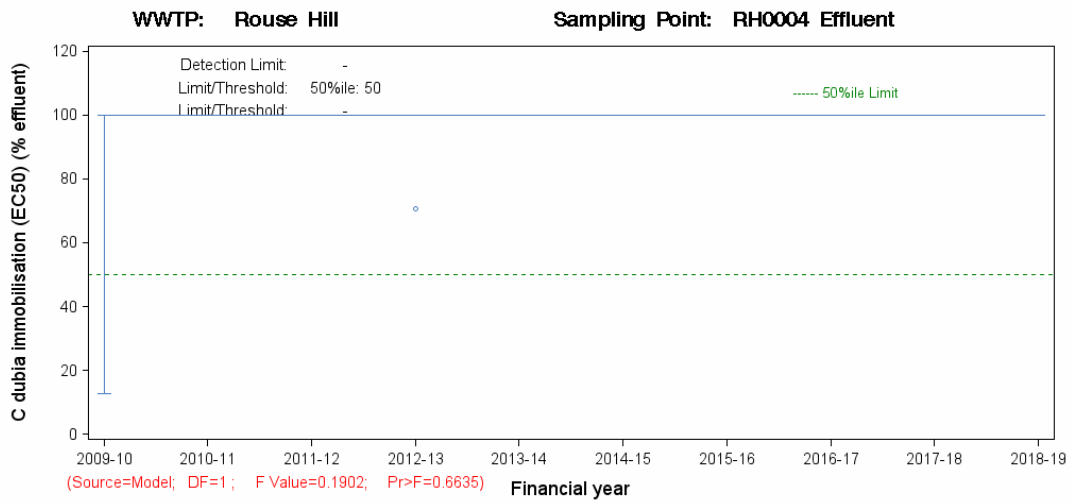
Note: 2018-19 data was compared with previous four years data (2014-2018) due to lab method change in 2014-15. Statistical test was not conducted because >90% of results were below the detection limit.


WWTP: Rouse Hill
Sampling Point: RH0004 Effluent
Detection Limit: 0.04
Limit/Threshold: 90%ile: 0.1
Limit/Threshold:
------ 90%ile Limit
Chlorine (total residual) (grab) (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.4031; Pr>F=0.2366)
Financial year

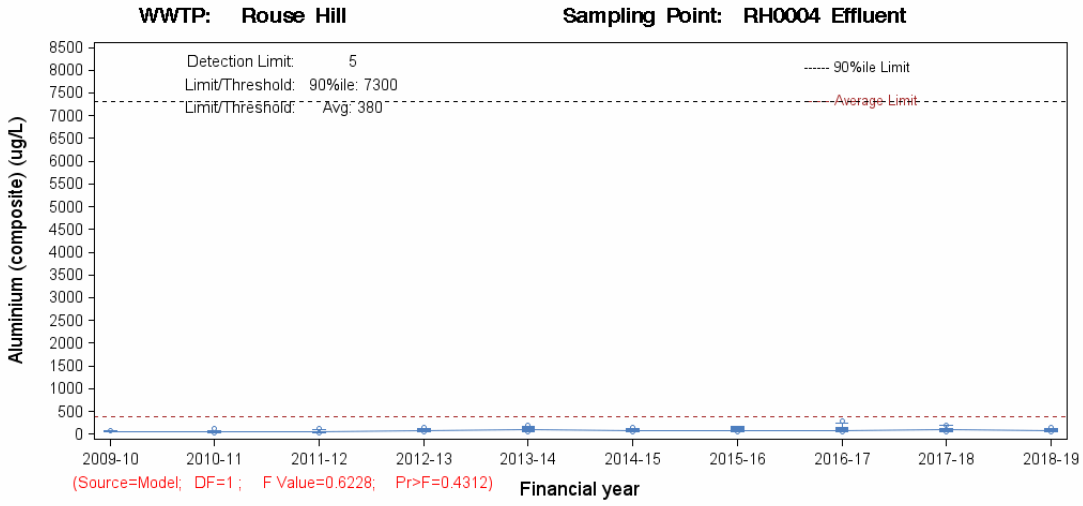

WWTP: Rouse Hill
Sampling Point: RH0004 Effluent
Detection Limit: 1
Limit/Threshold: 80%ile: 200
Limit/Threshold:
------ 80%ile Limit
Faecal coliforms (grab) (CFU/100ml)
240
220
200
180
160
140
120
100
80
60
40
20
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0086; Pr>F=0.9260)
Financial year

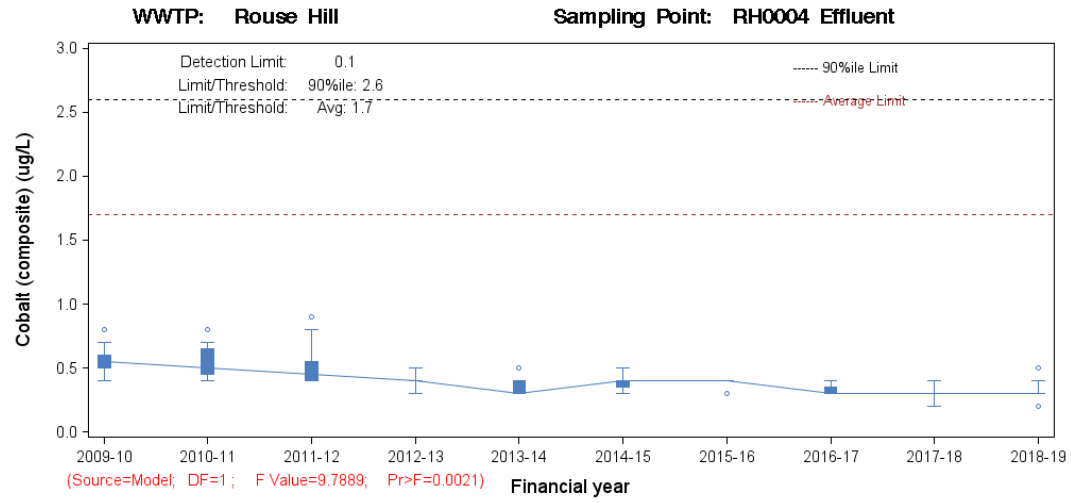

WWTP: Rouse Hill
Sampling Point: RH0004 Effluent
Detection Limit: 2
Limit/Threshold: 50%ile: 5
Limit/Threshold: 90%ile: 8
------ 90%ile Limit
------ 50%ile Limit
Total suspended solids (composite) (mg/L)
8
6
4
2
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5822; Pr>F=0.4456)
Financial year

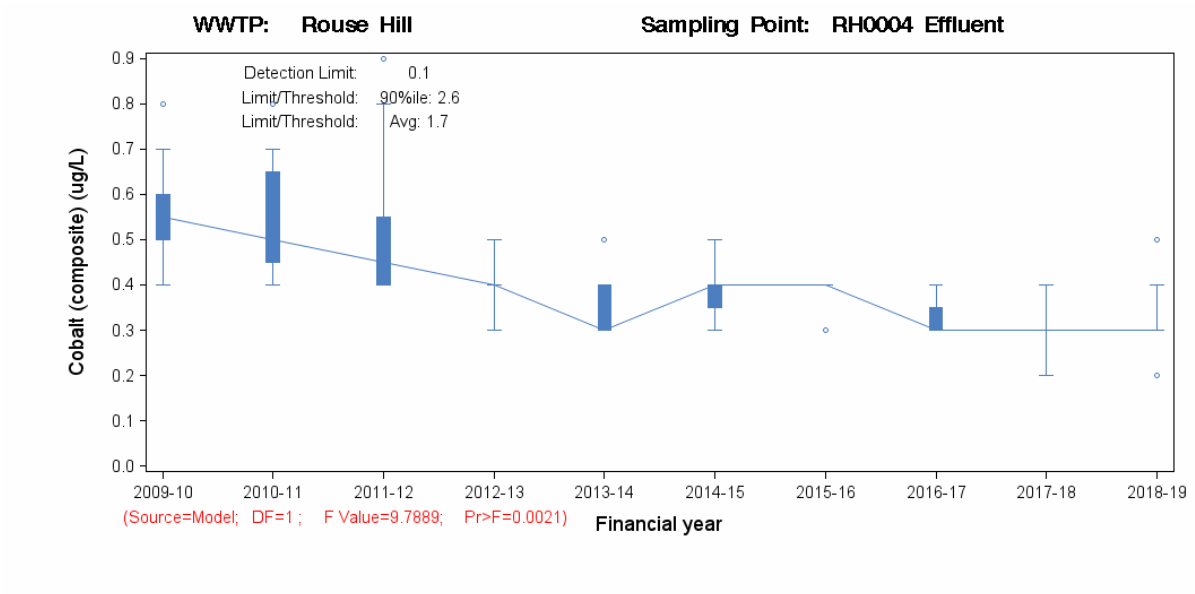
Discharge quality: Toxicity (RH0004 Effluent)

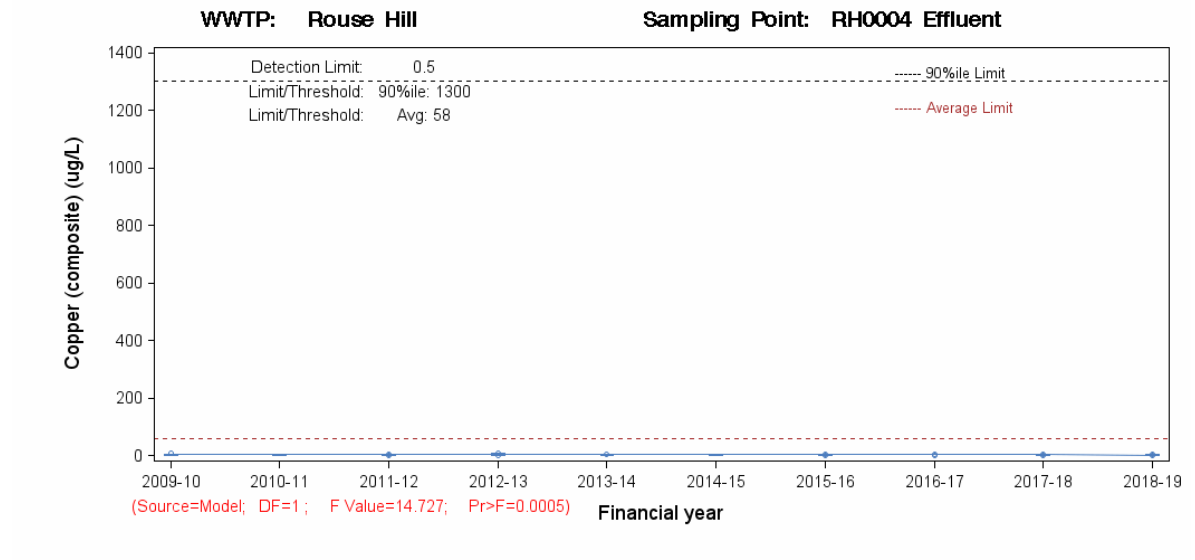


Discharge quality: Trace metals (RH0004 Effluent)

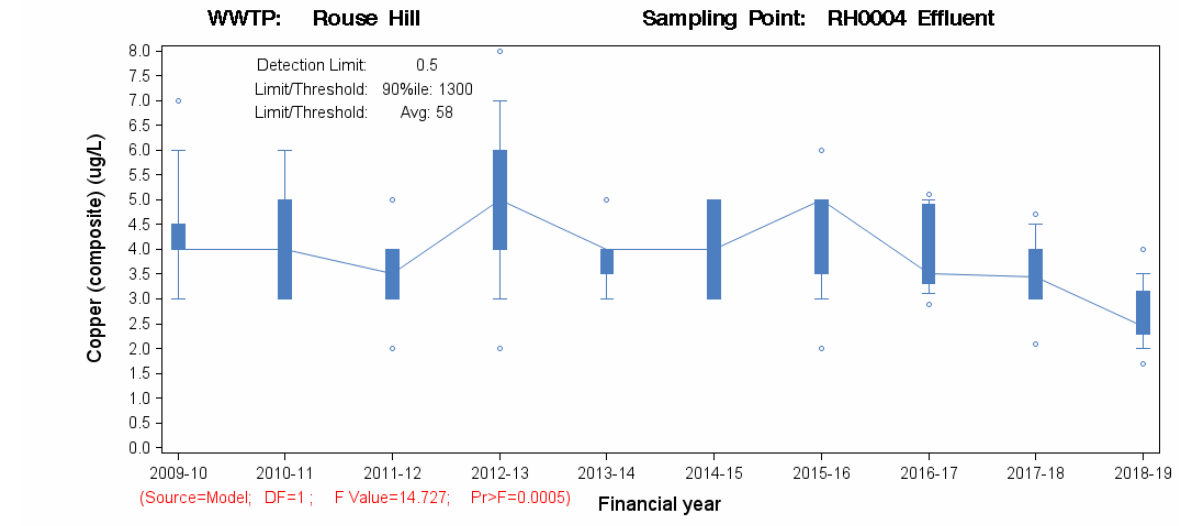




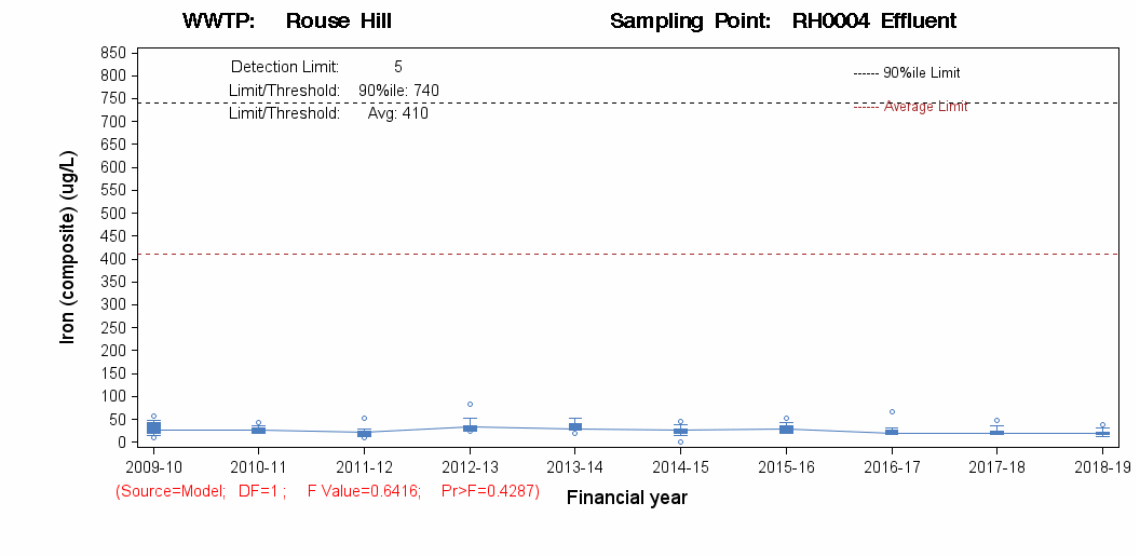




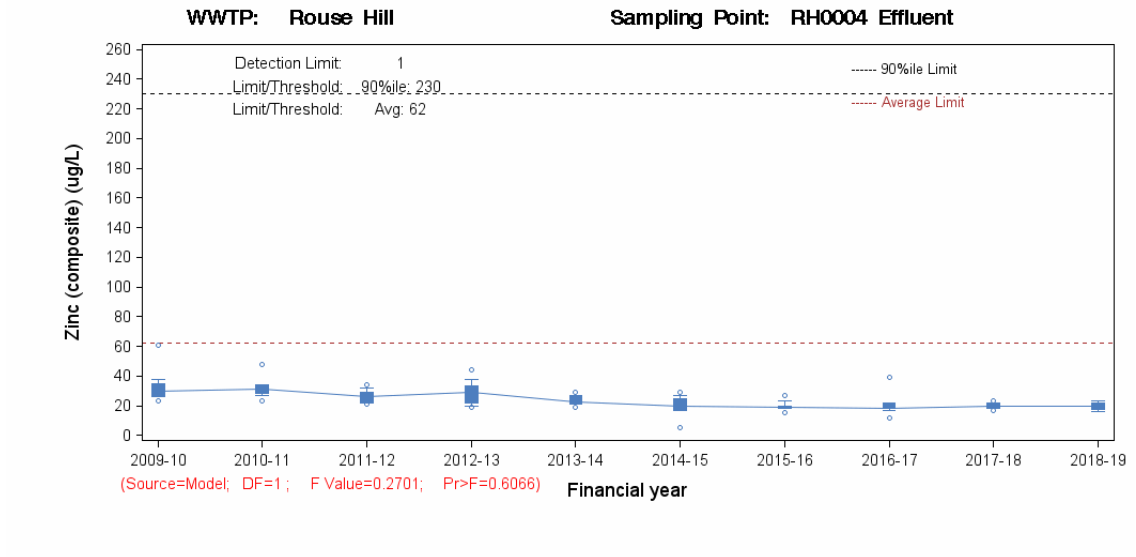
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

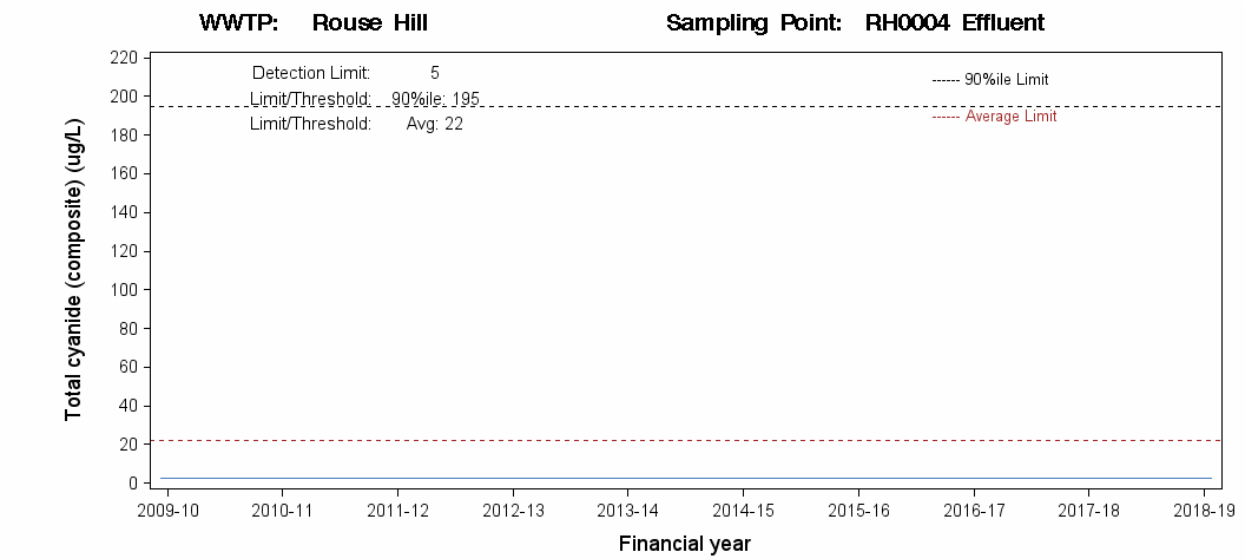


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



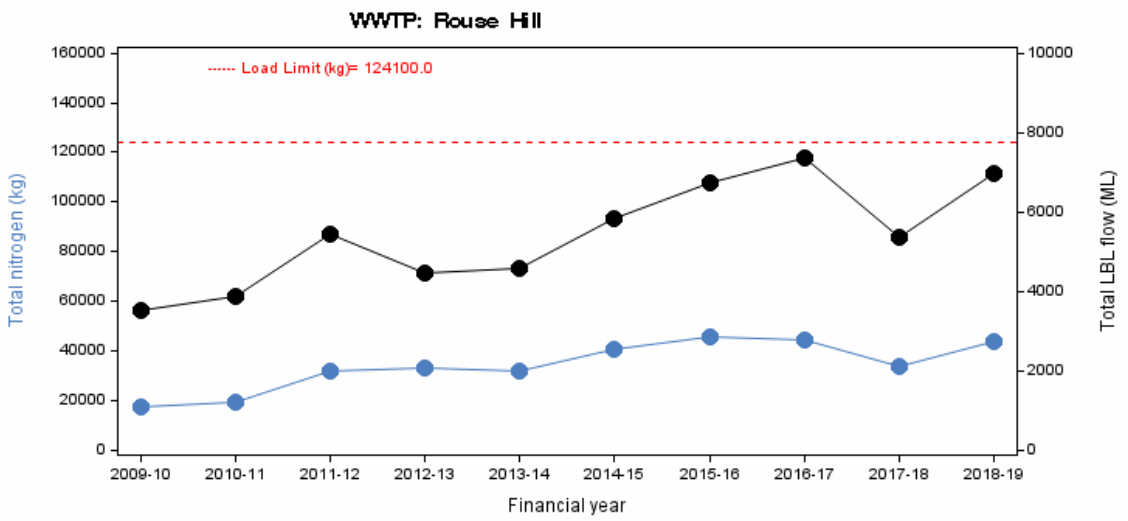
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

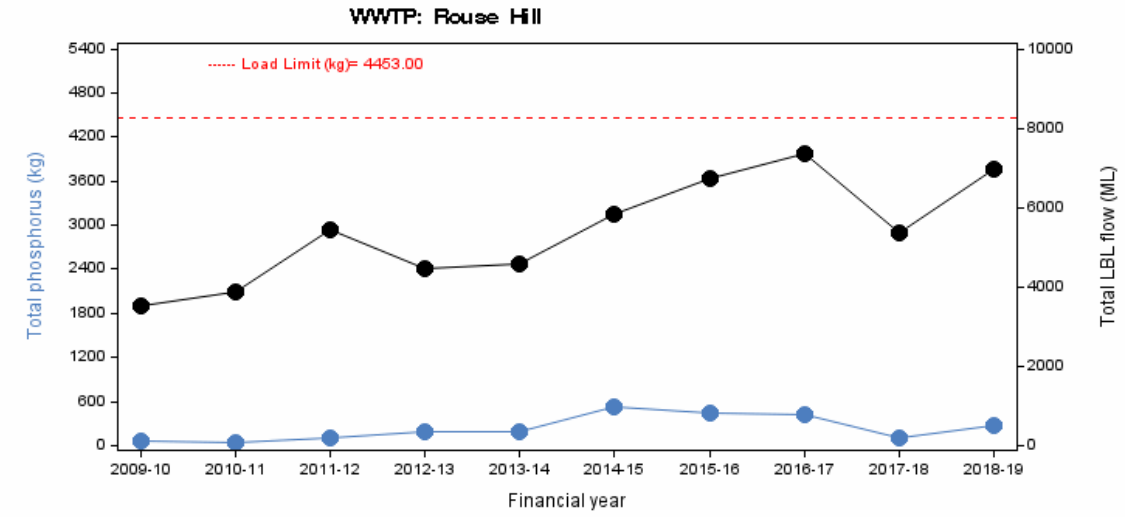
Discharge quality: Other chemicals and organics (including pesticides) (RH0004 Effluent)



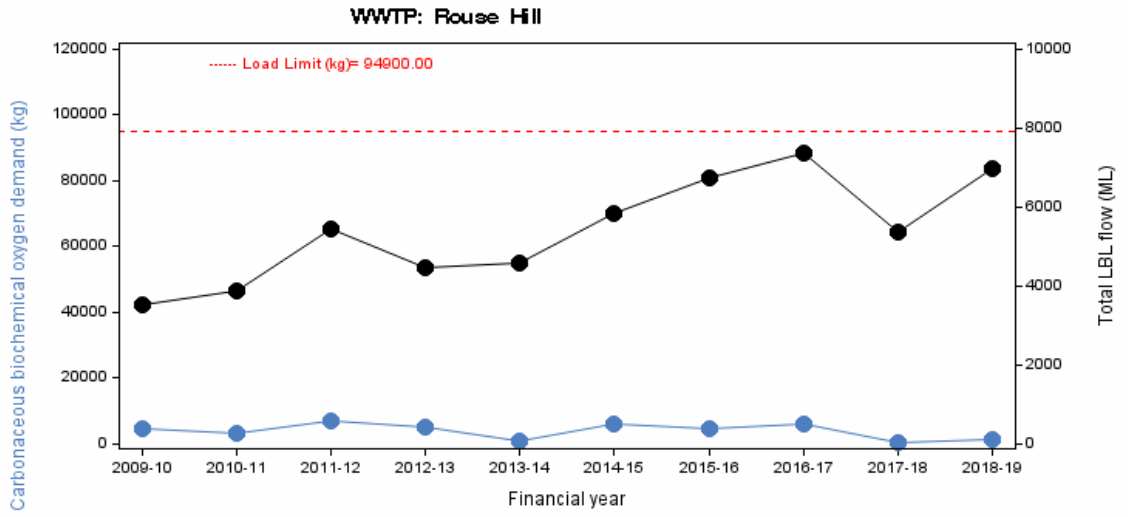
Note: Statistical test was not conducted because >90% of results were below the detection limit.

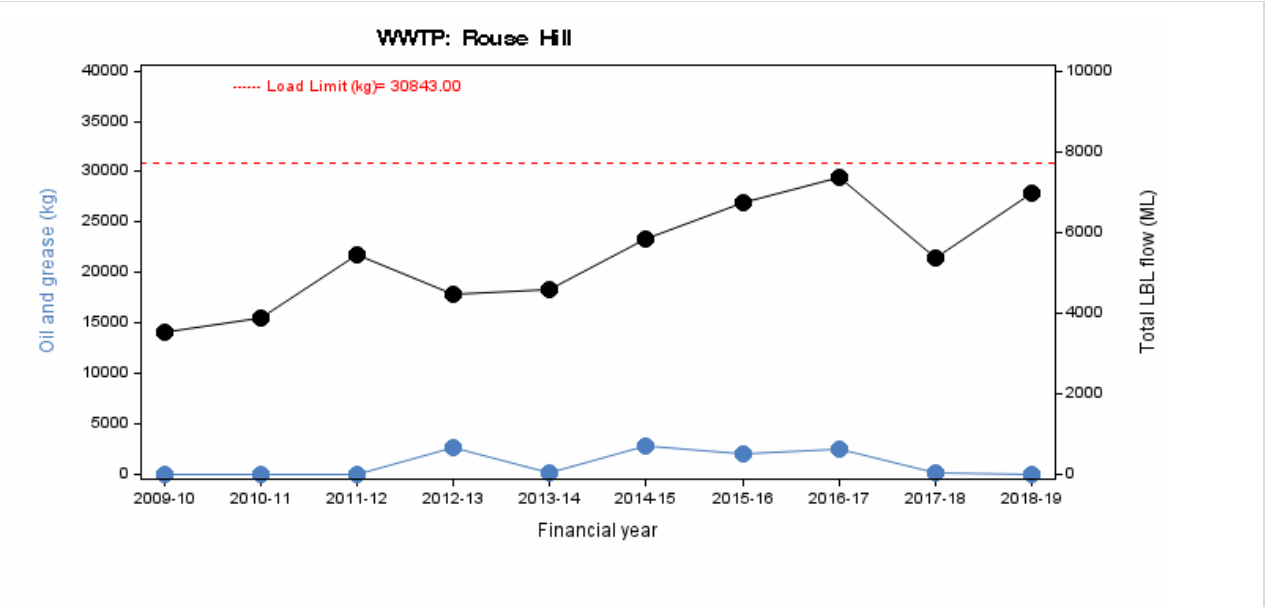
Discharge load: Nutrients

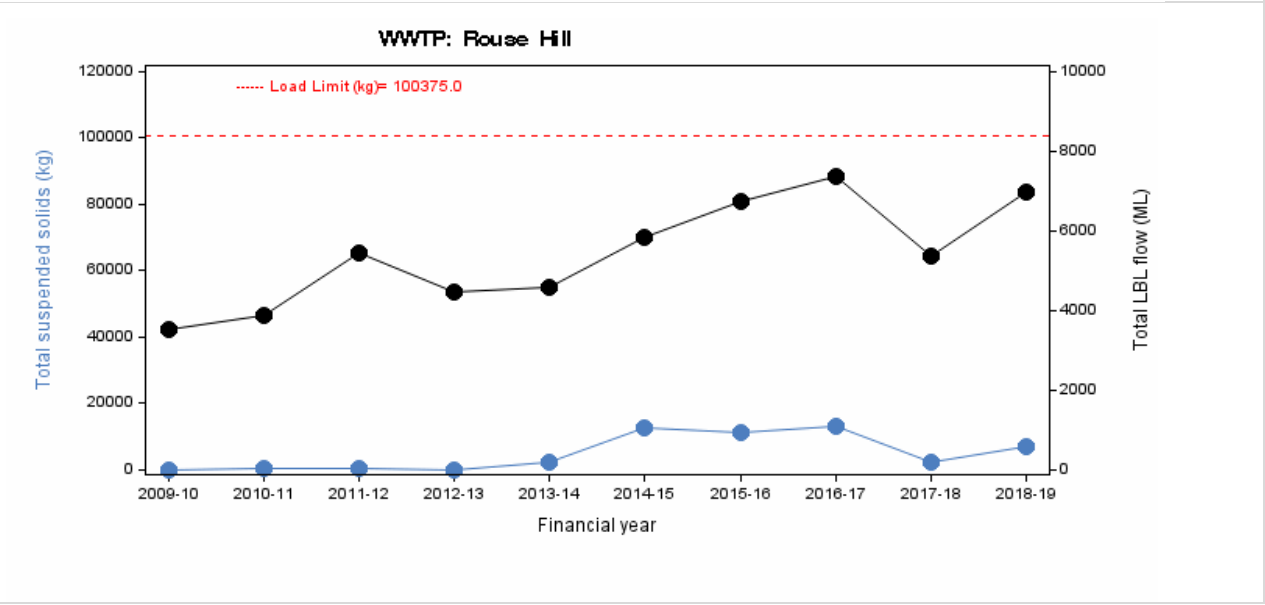




Discharge load: Major conventional analytes

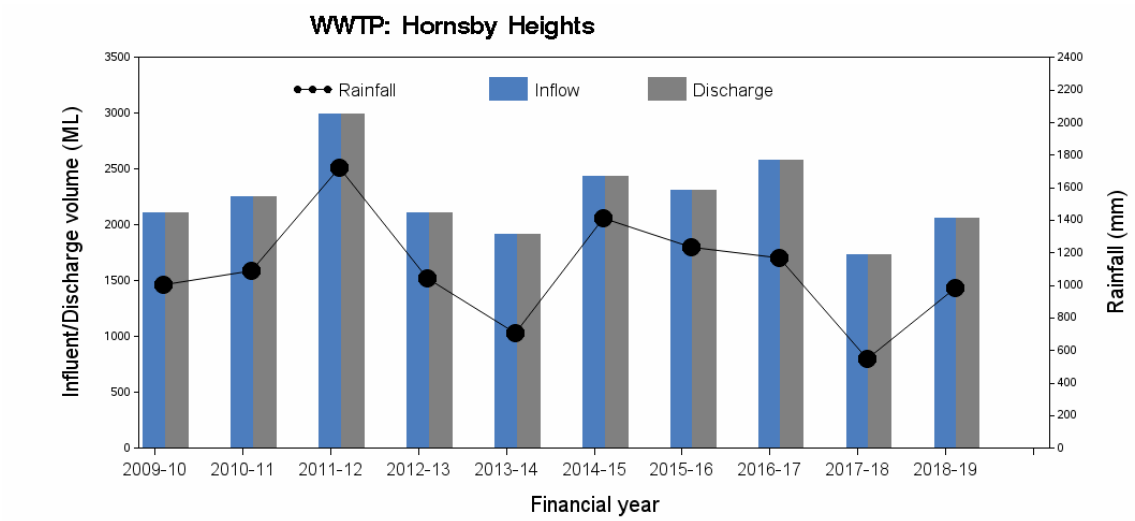



WWTP: Rouse Hill
Load Limit (kg)= 30843.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

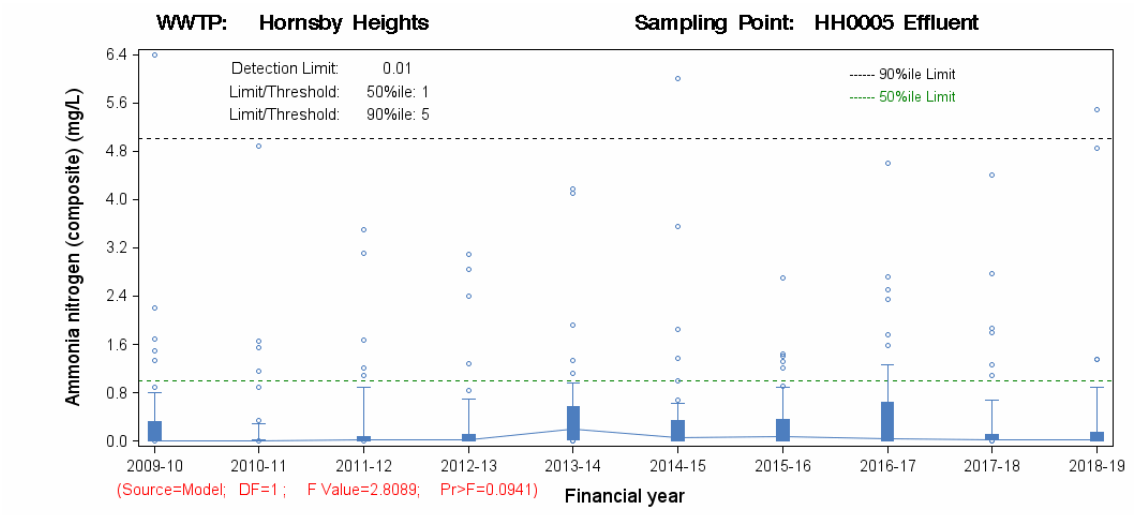

WWTP: Rouse Hill
Load Limit (kg)= 100375.0
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

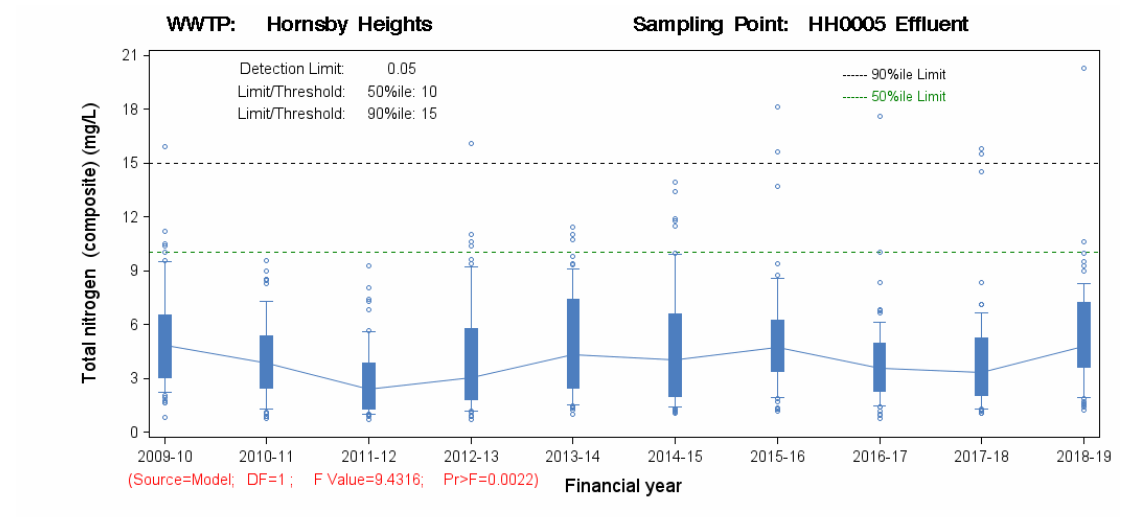
Hornsby Heights WWTP

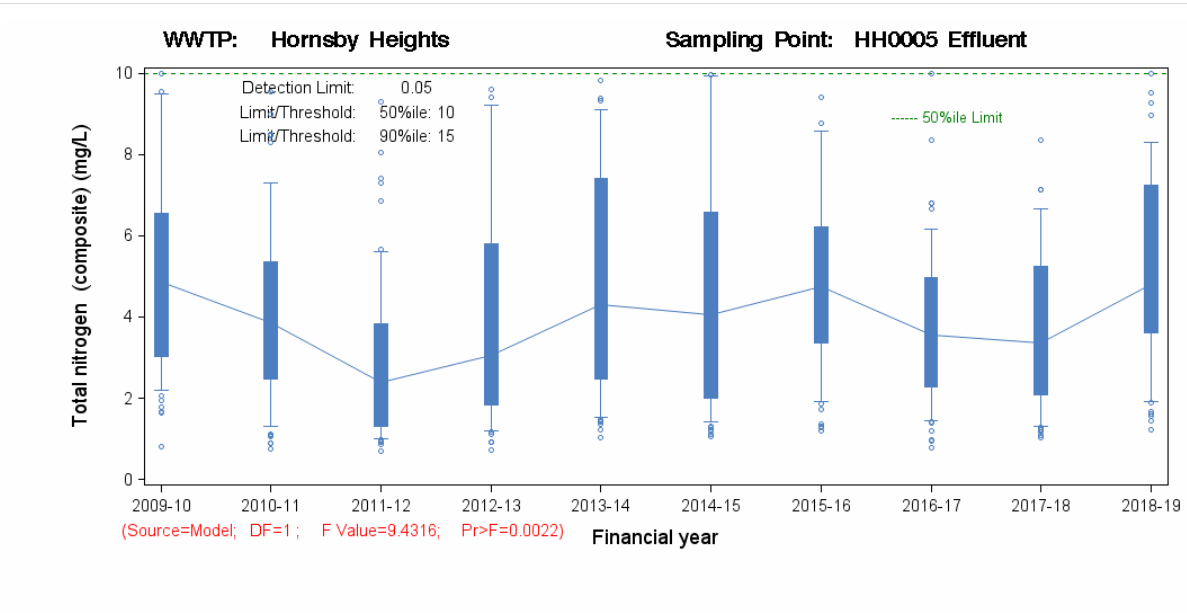
Discharge volume and rainfall

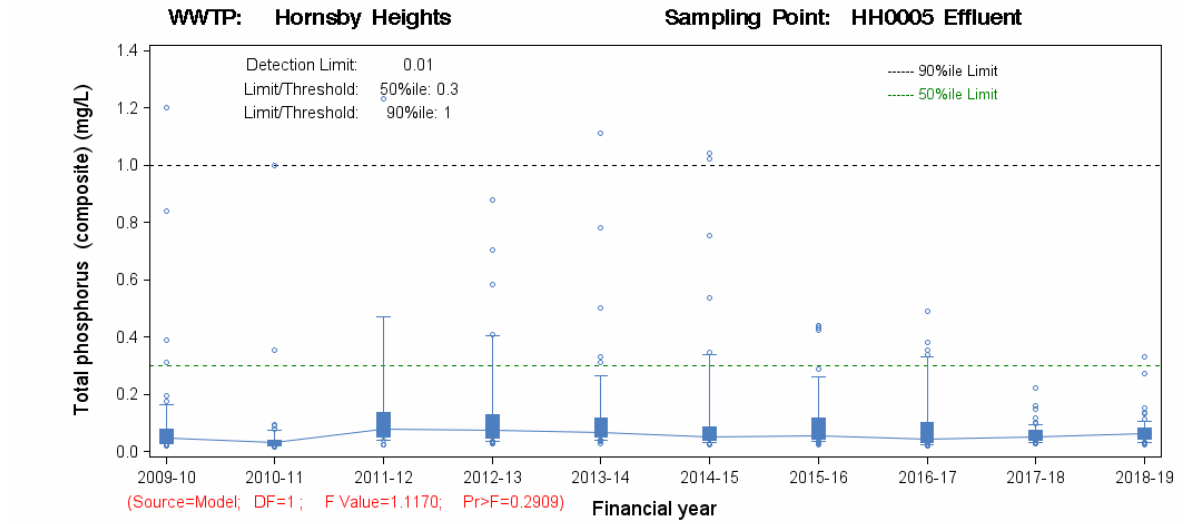


Discharge quality: Nutrients

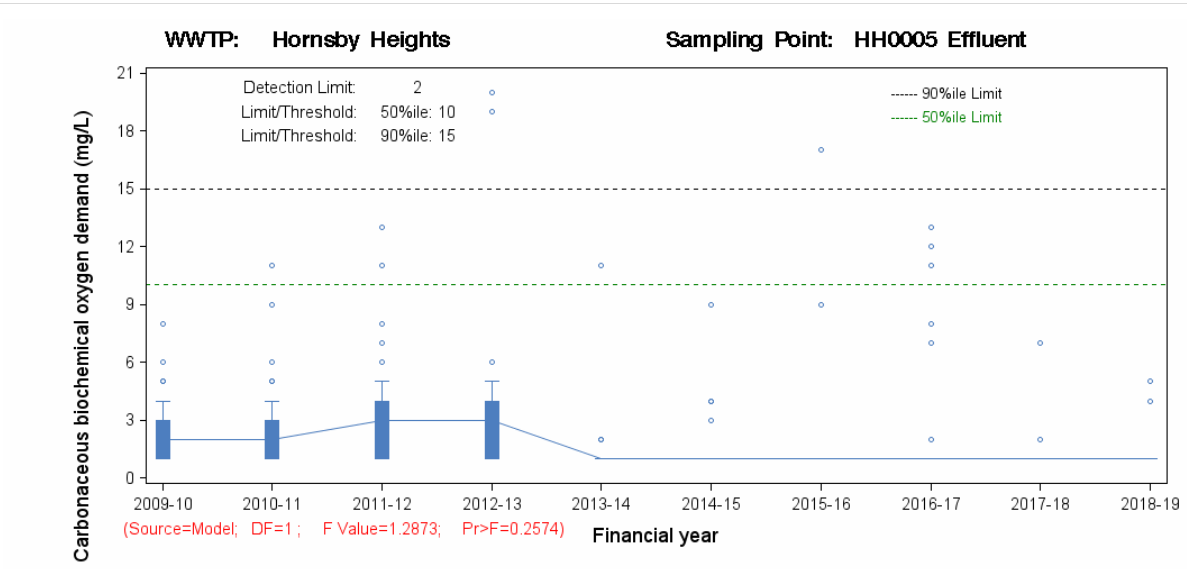




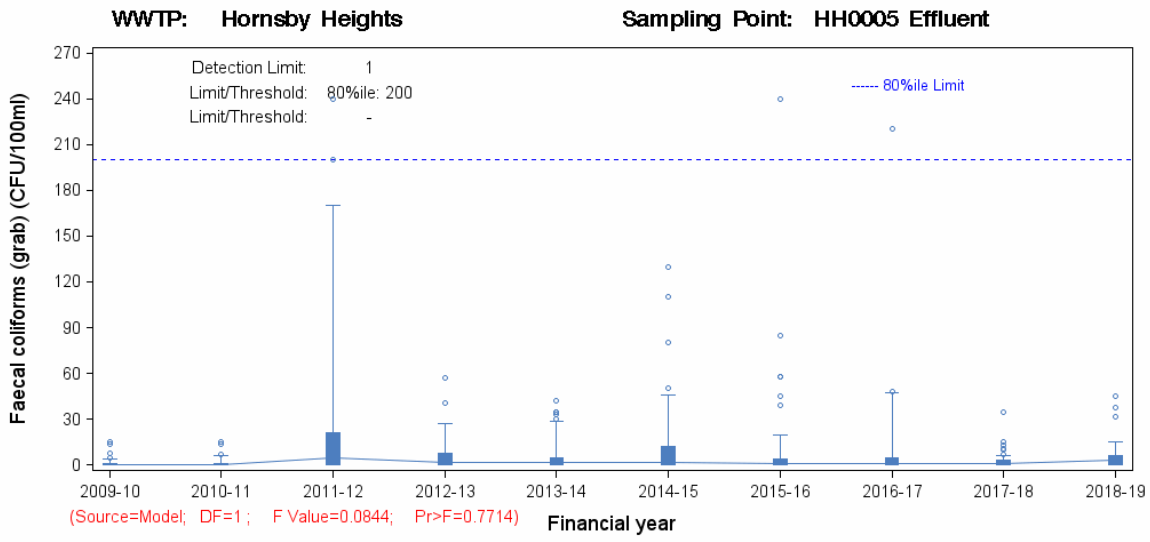


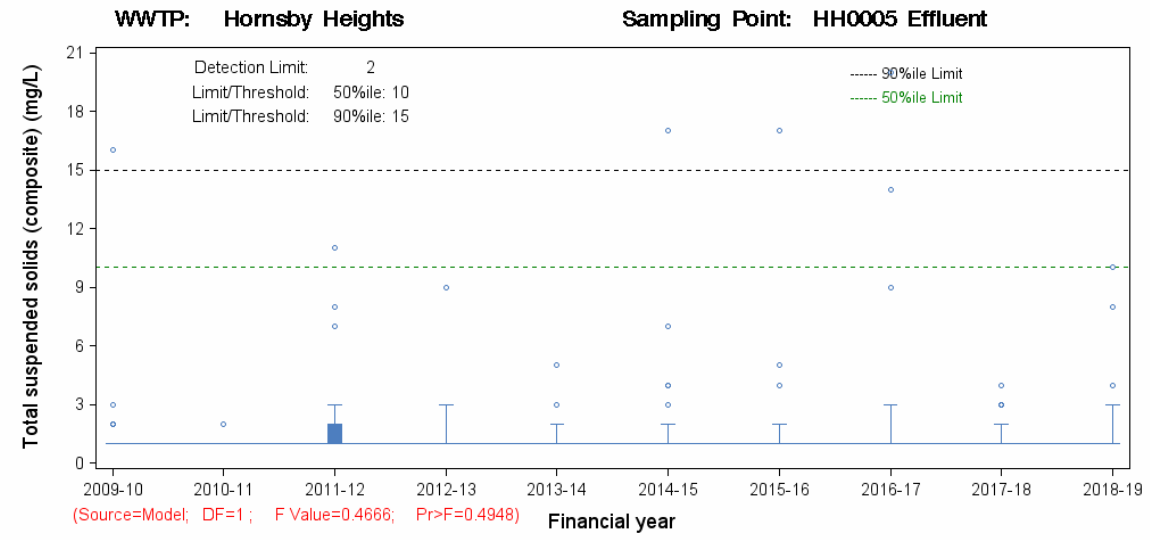


Discharge quality: Major conventional analytes

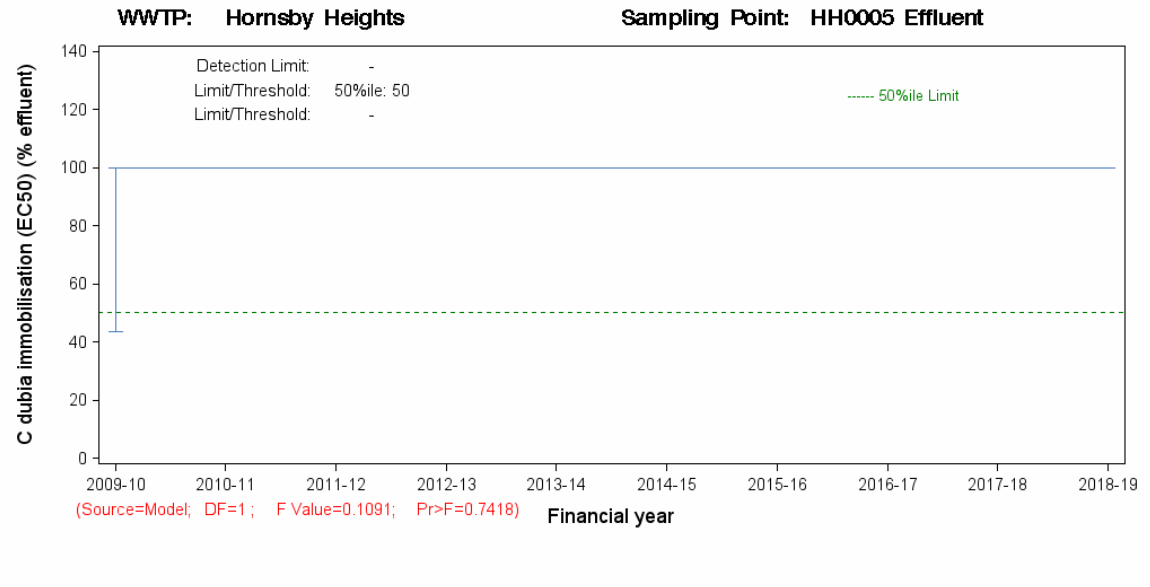


Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.

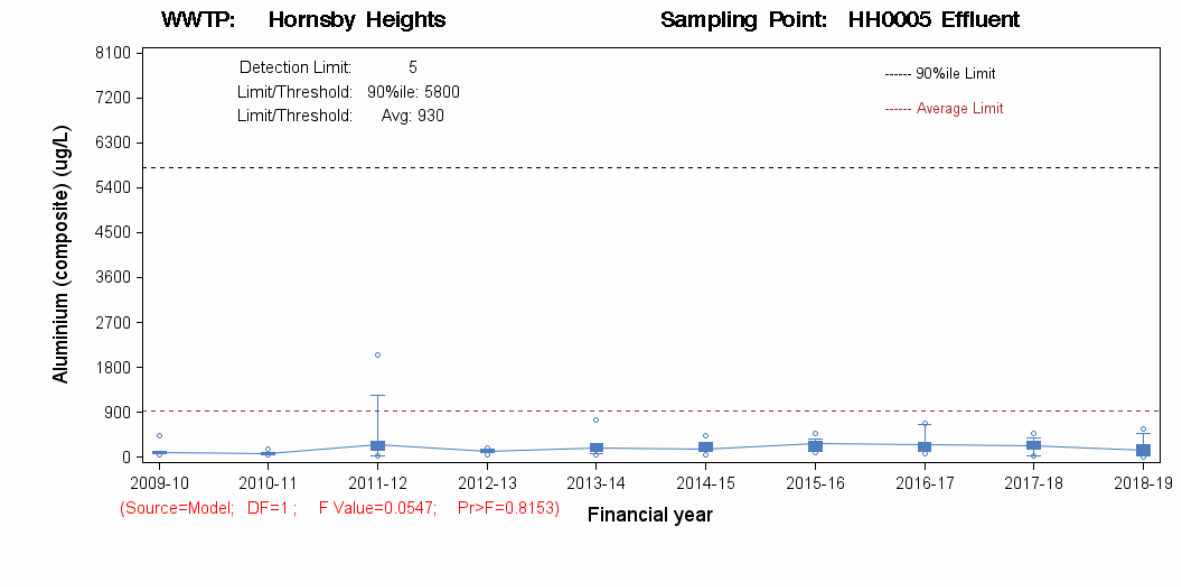


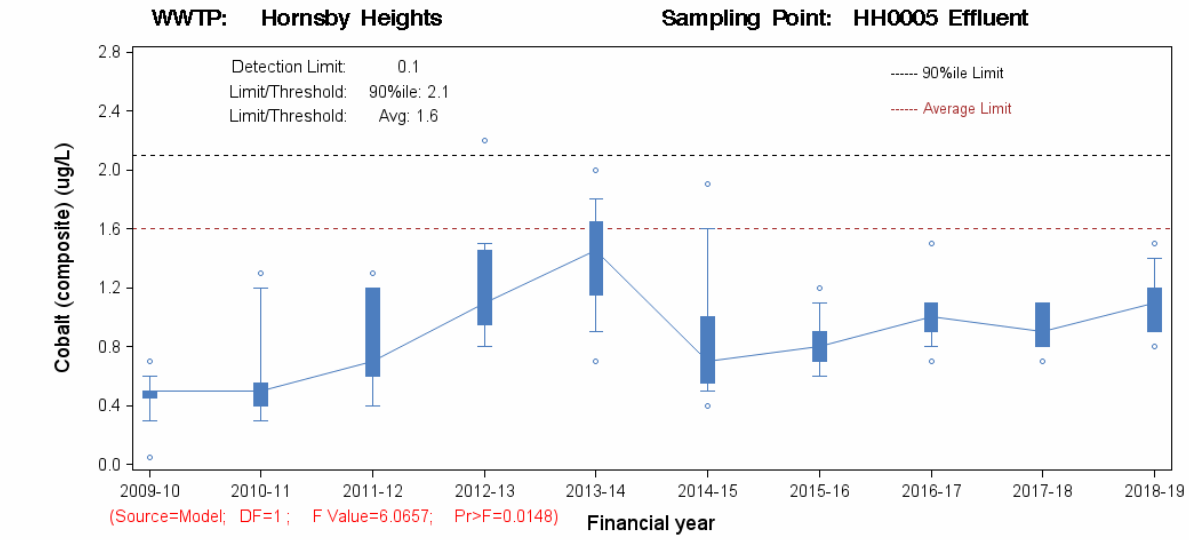


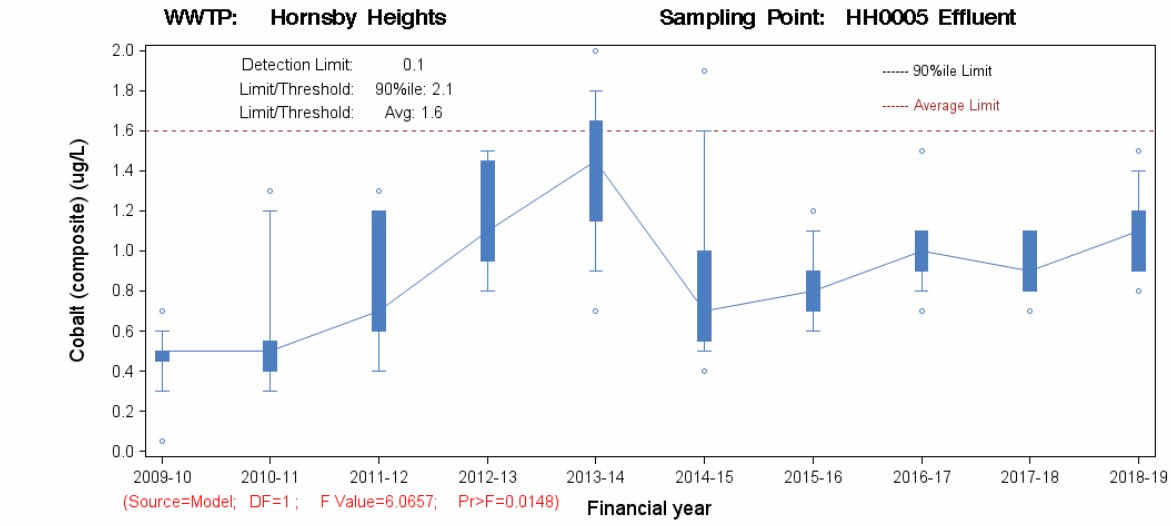
Discharge quality: Toxicity

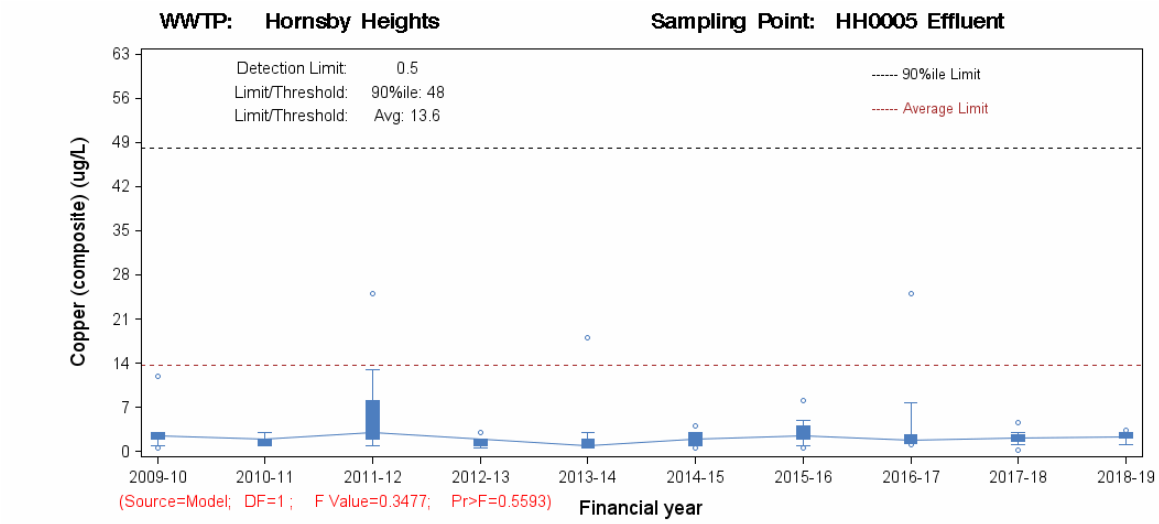


Discharge quality: Trace metals

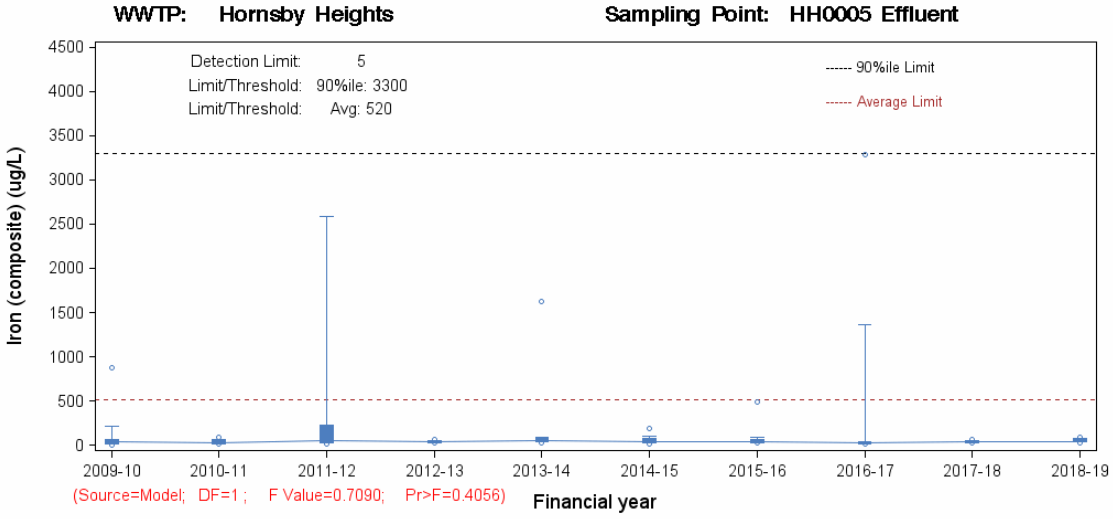




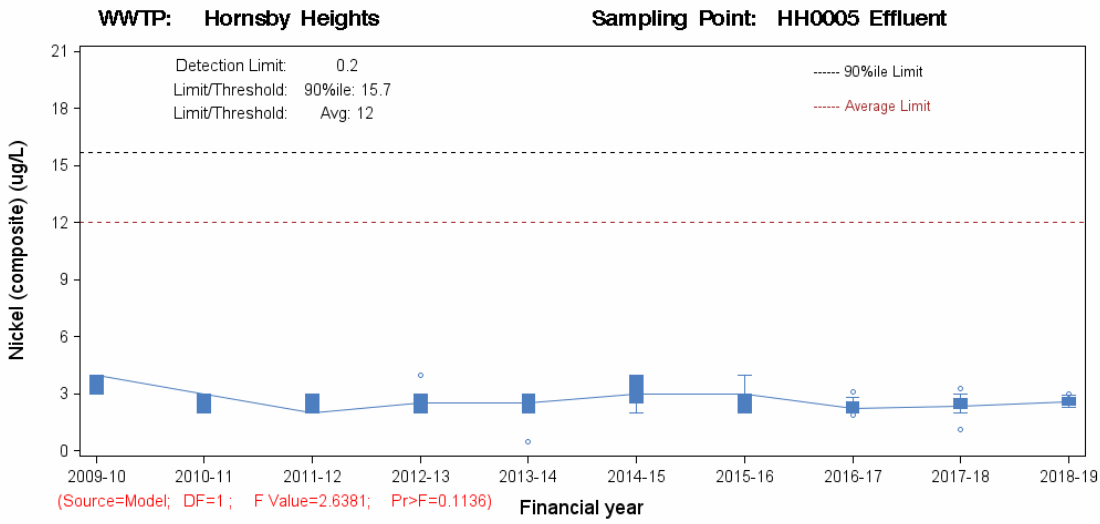




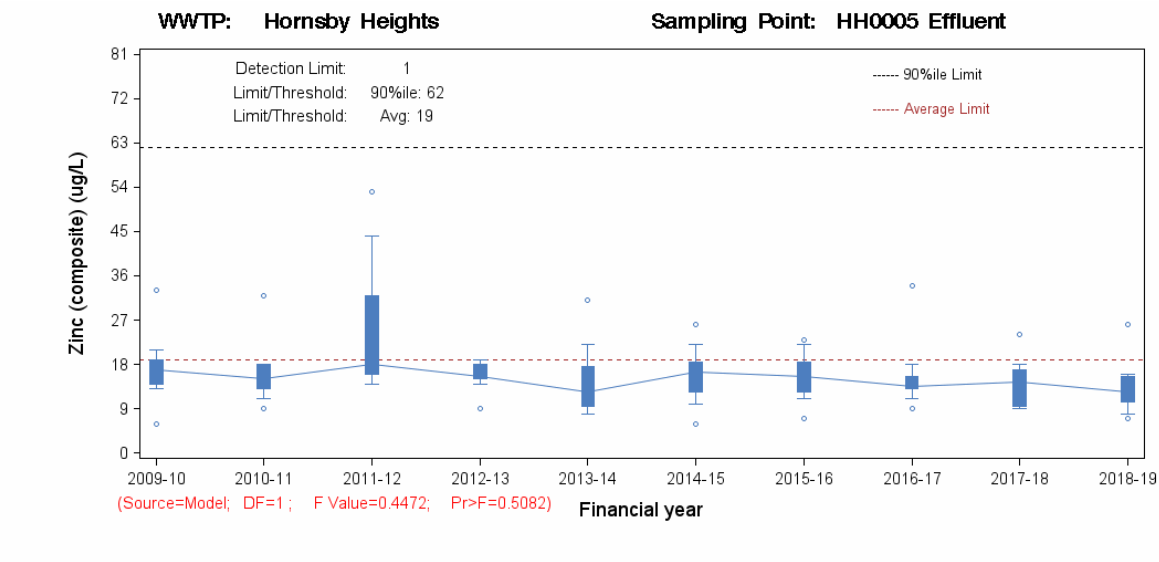
Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.



Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

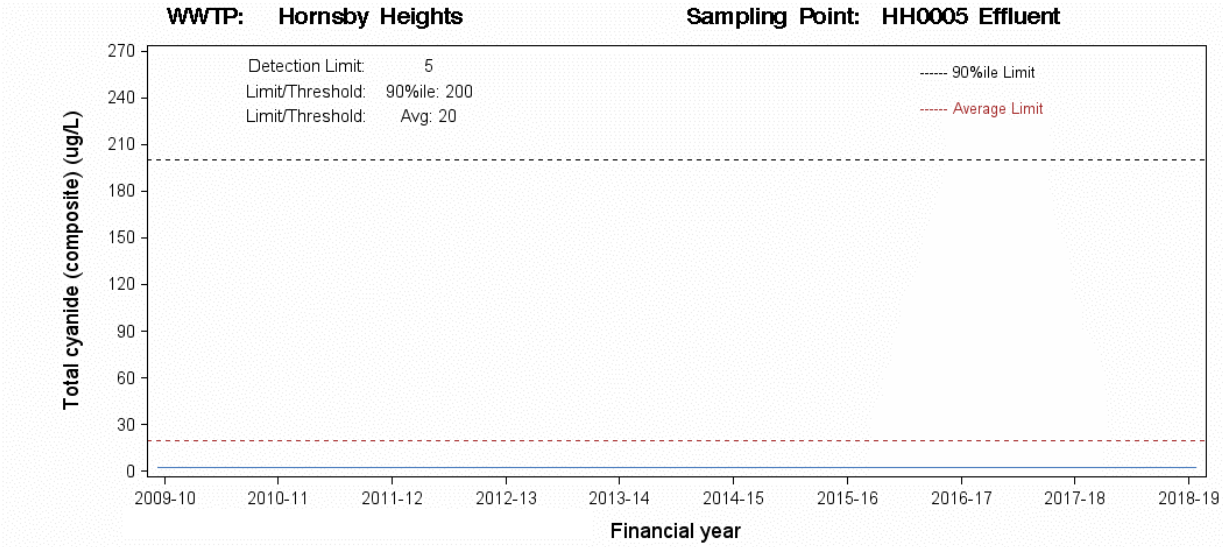


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

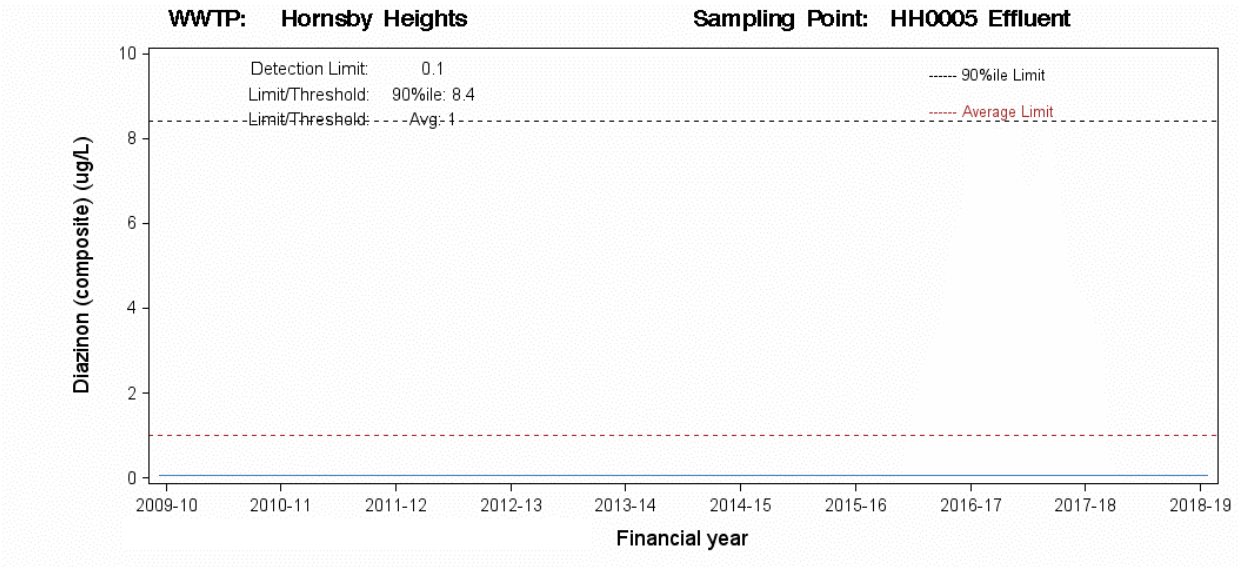


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

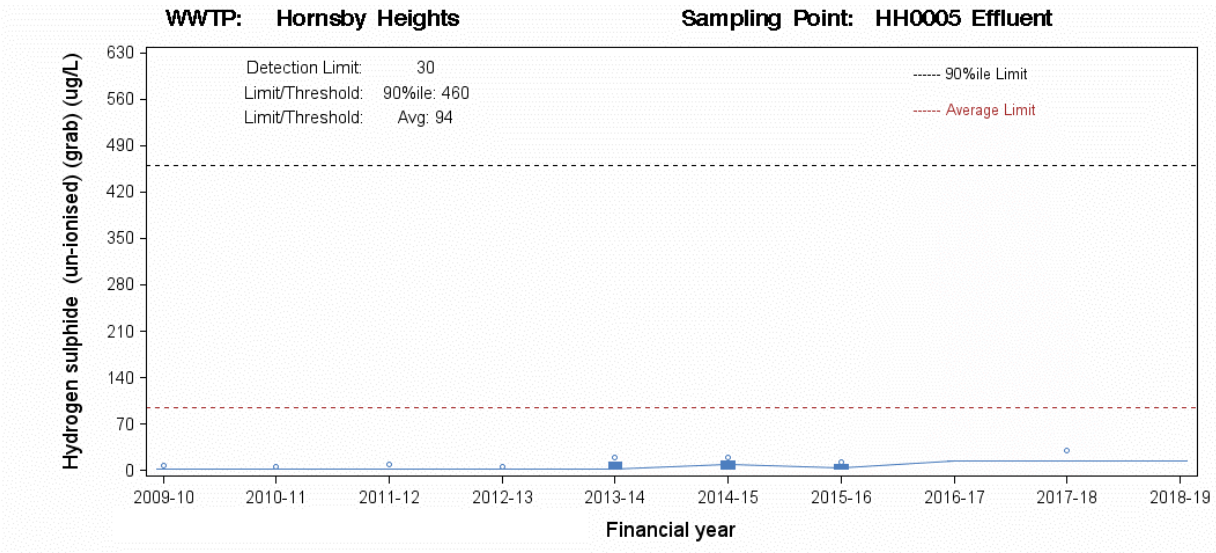
Discharge quality: Other chemicals and organics (including pesticides)



Note: Statistical test was not conducted because >90% of results were below the detection limit.

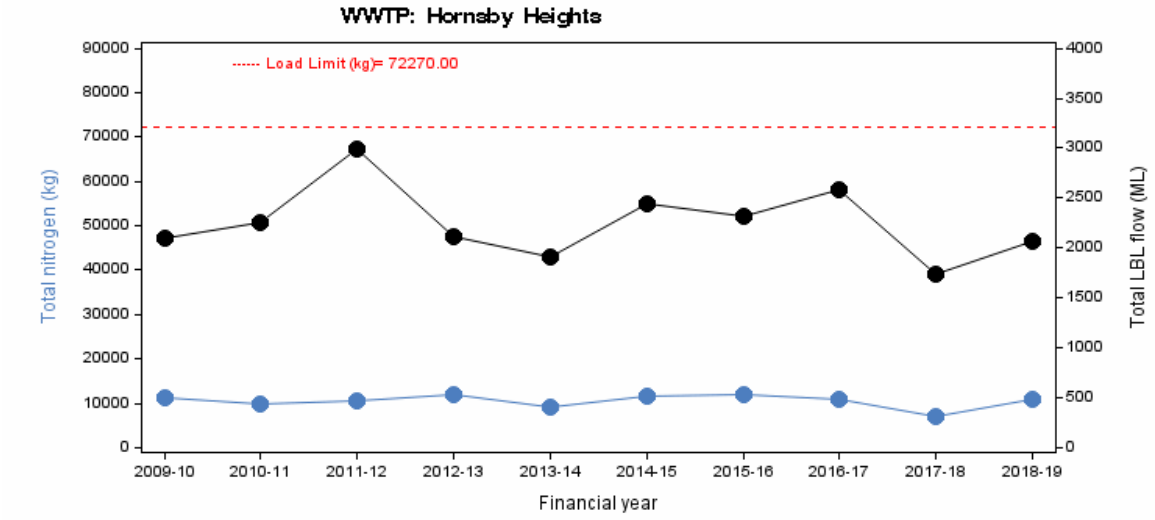


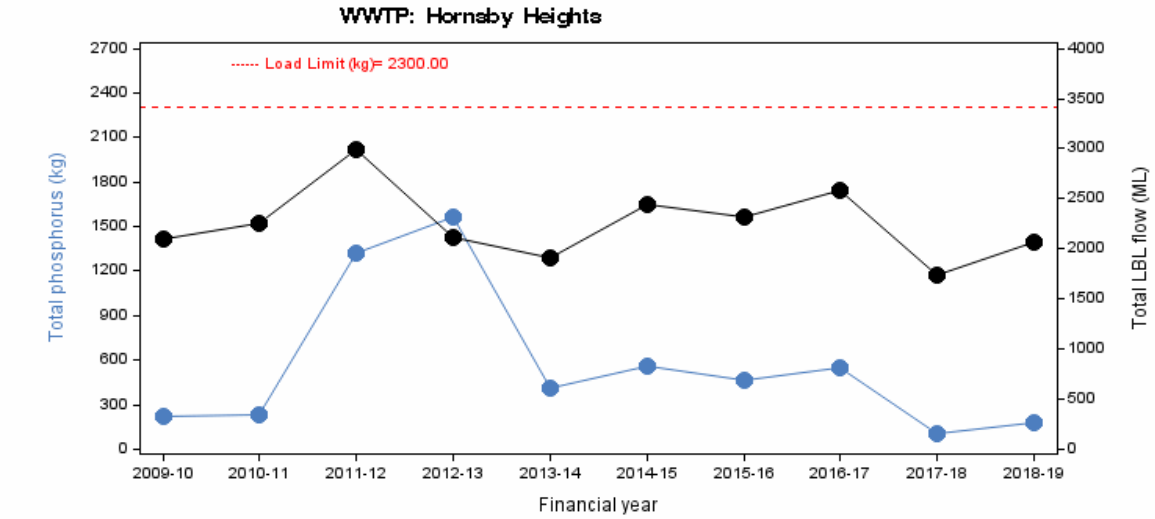
Note: Statistical test was not conducted because >90% of results were below the detection limit.



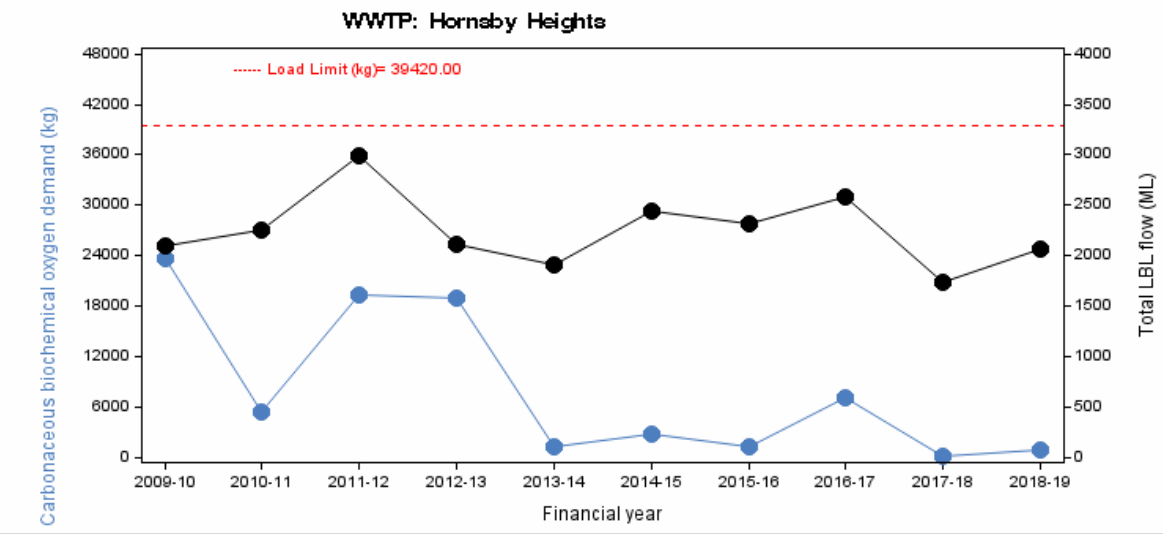
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

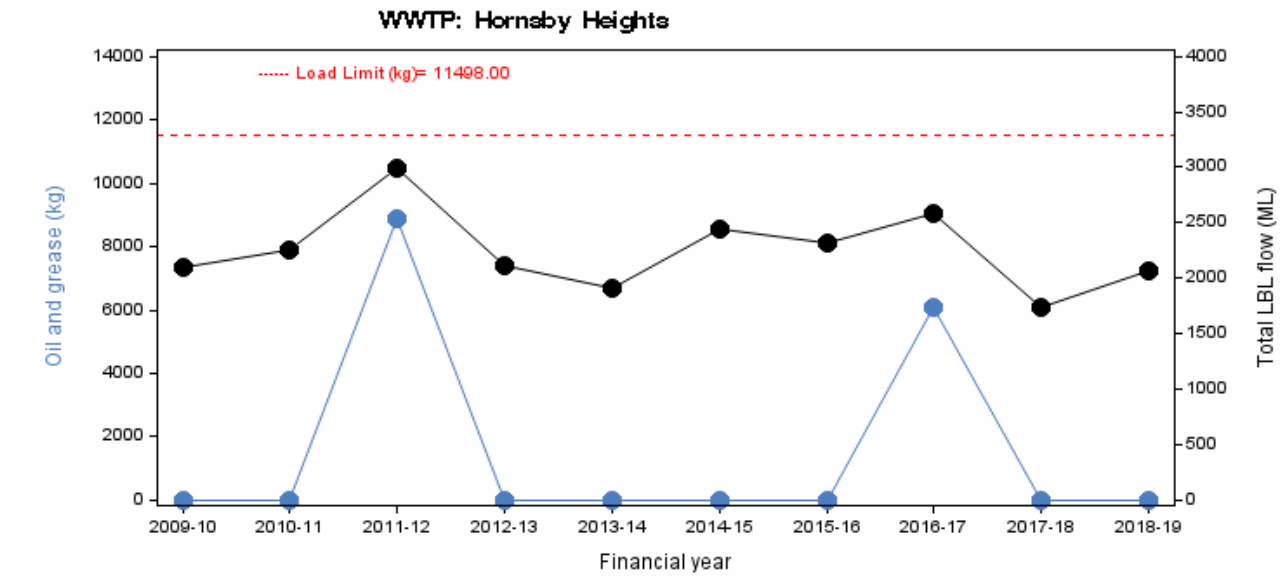
Discharge load: Nutrients

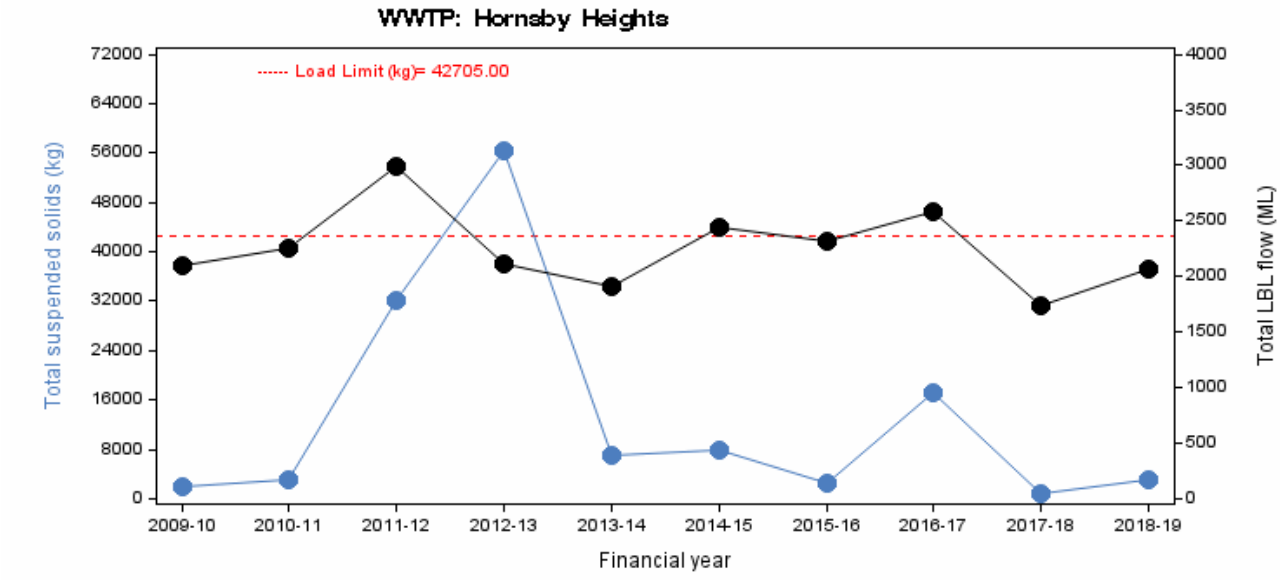




Discharge load: Major conventional analytes

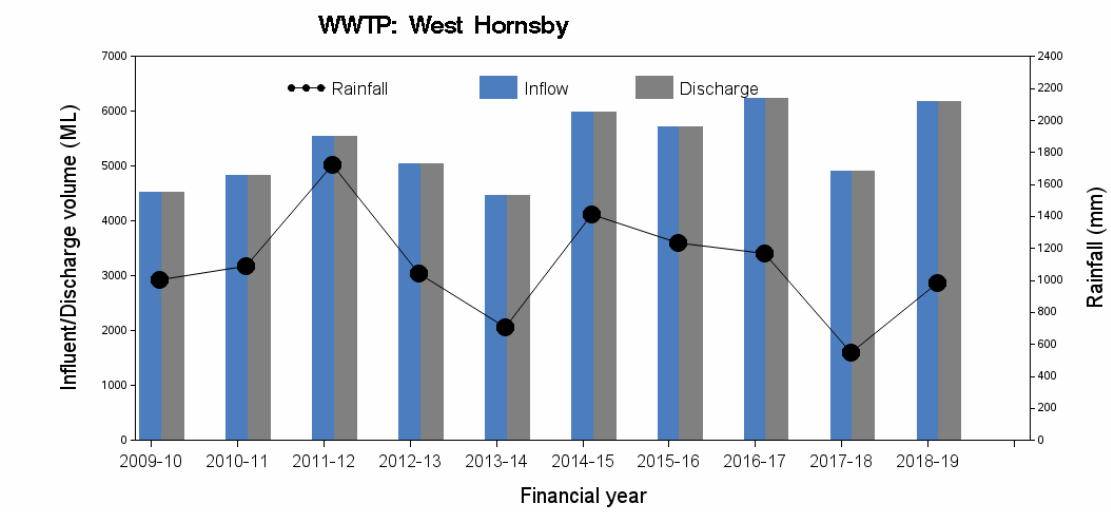




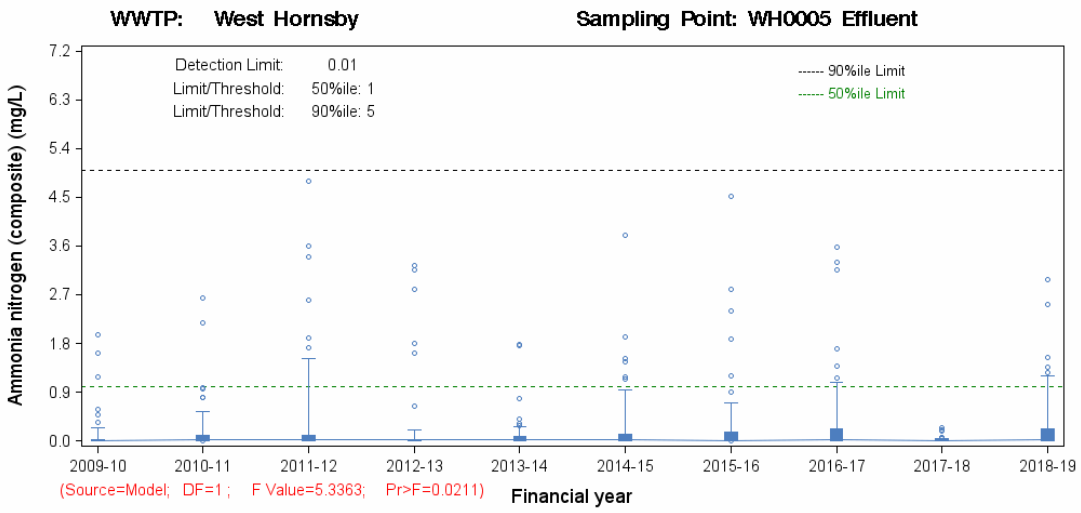


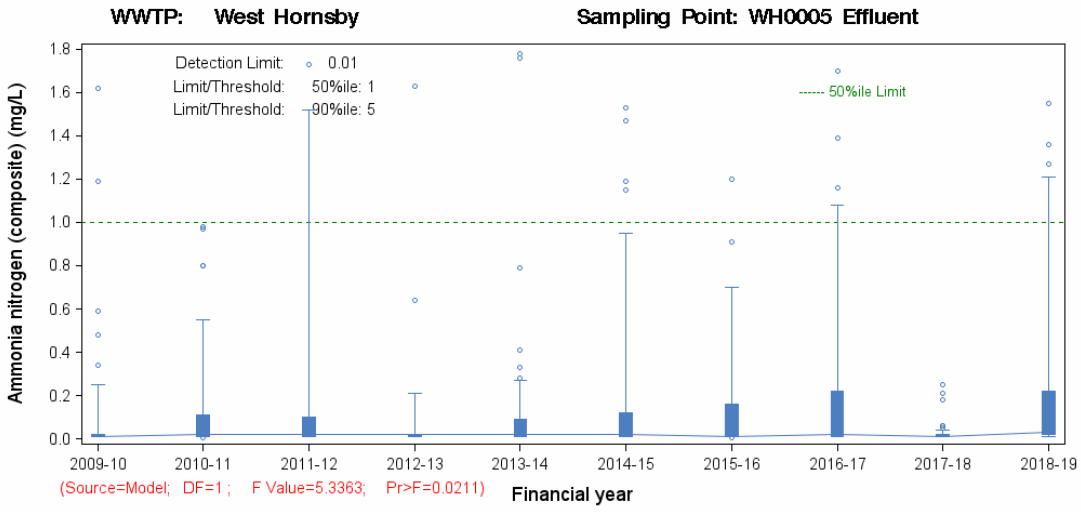
West Hornsby WWTP

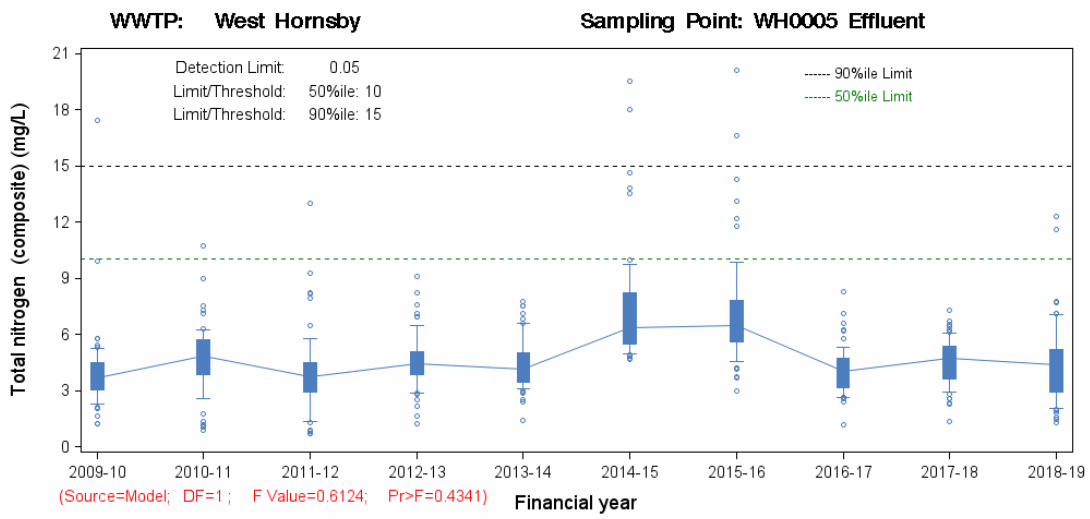
Discharge volume and rainfall

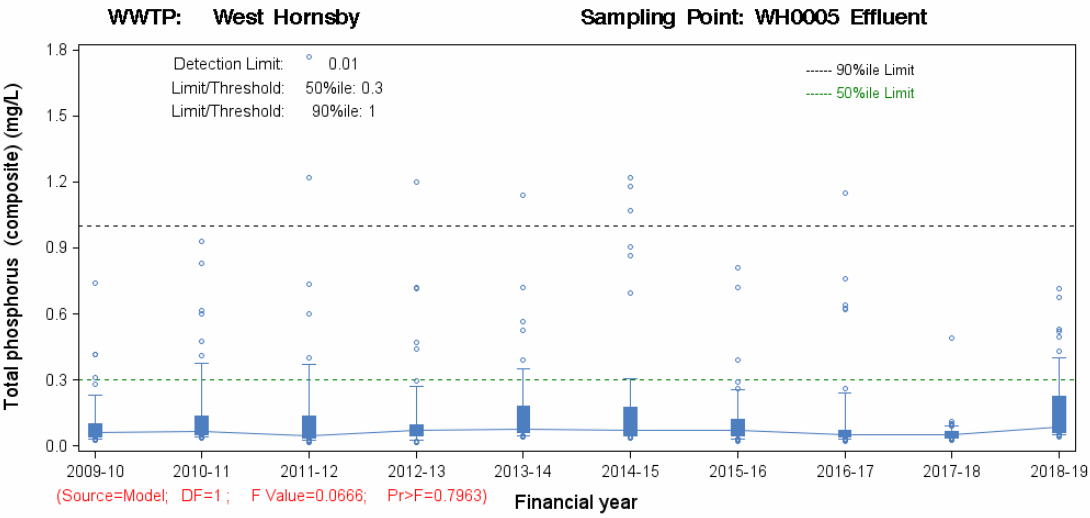


Discharge quality: Nutrients

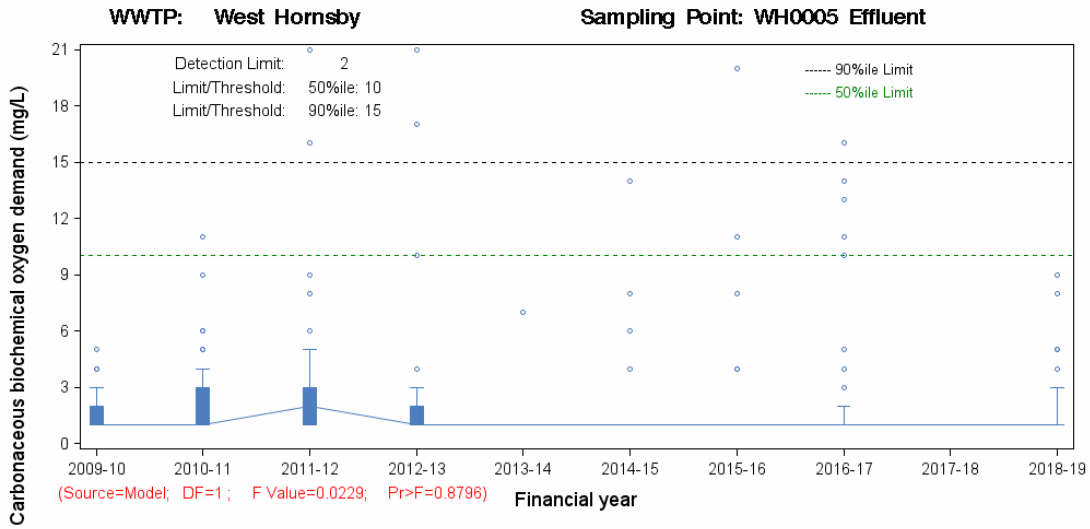




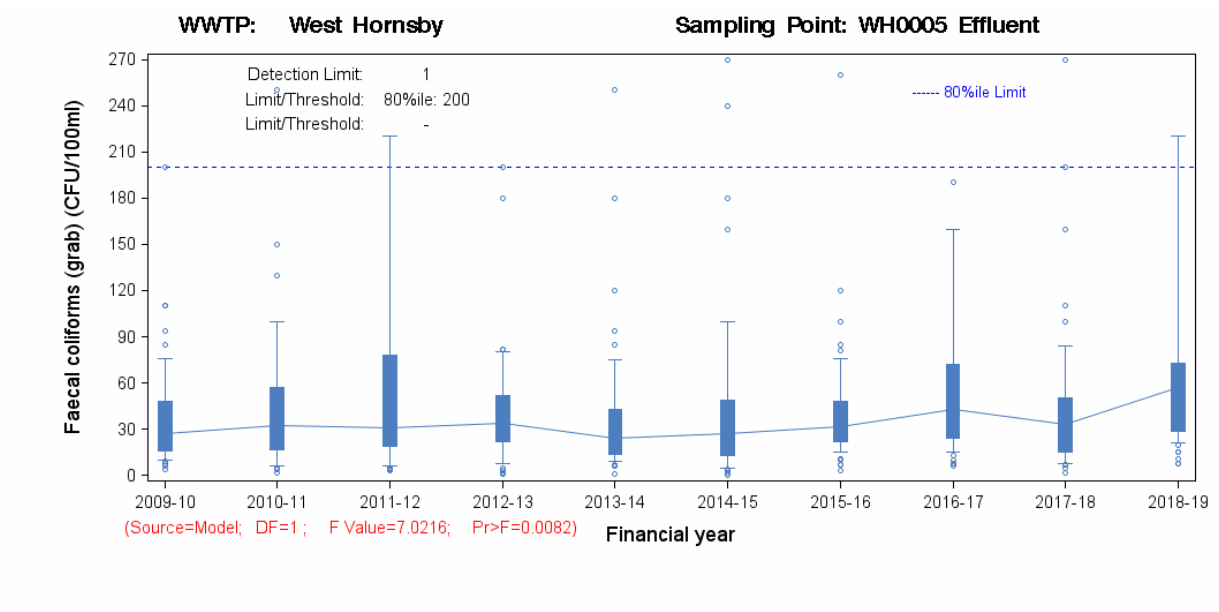


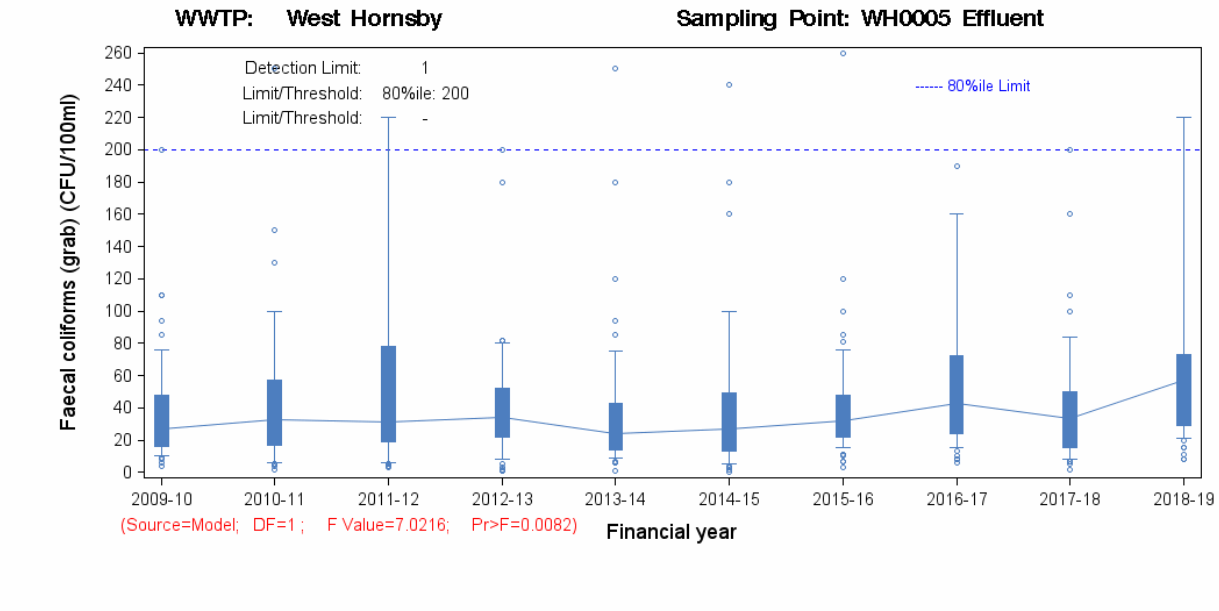


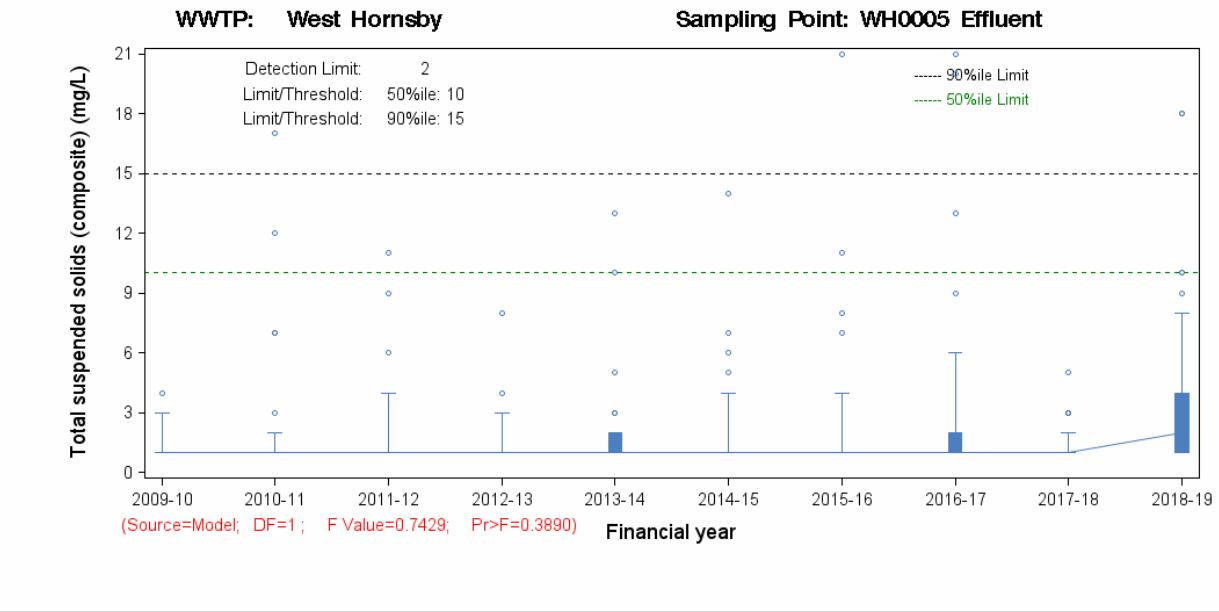
Discharge quality: Major conventional analytes



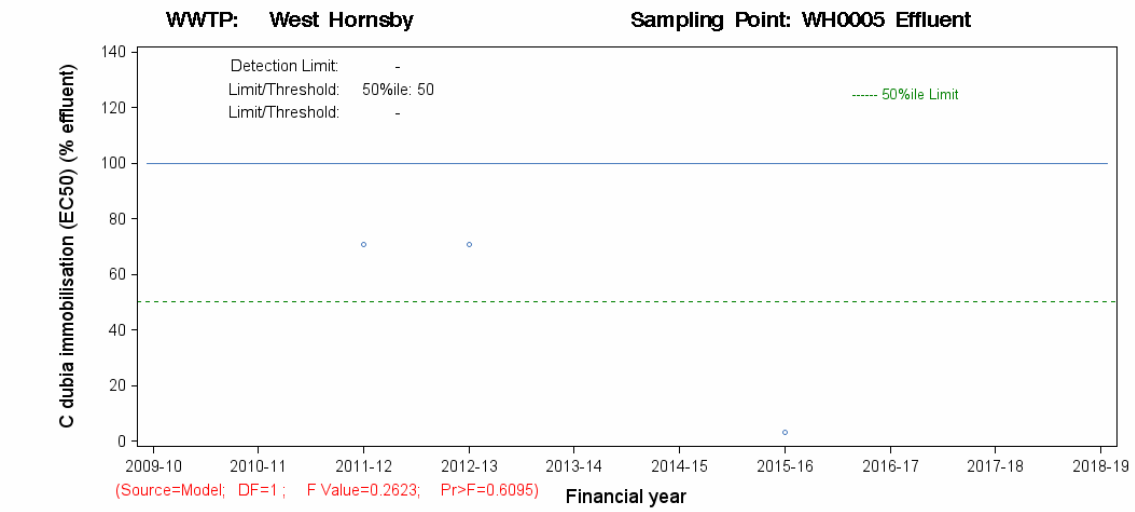
Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.


WWTP: West Hornsby
Sampling Point: WH0005 Effluent
Detection Limit: 1
Limit/Threshold: 80%ile: 200
Limit/Threshold: -
----- 80%ile Limit
Faecal coliforms (grab) (CFU/100ml)
270
240
210
180
150
120
90
60
30
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.0216; Pr>F=0.0082)
Financial year

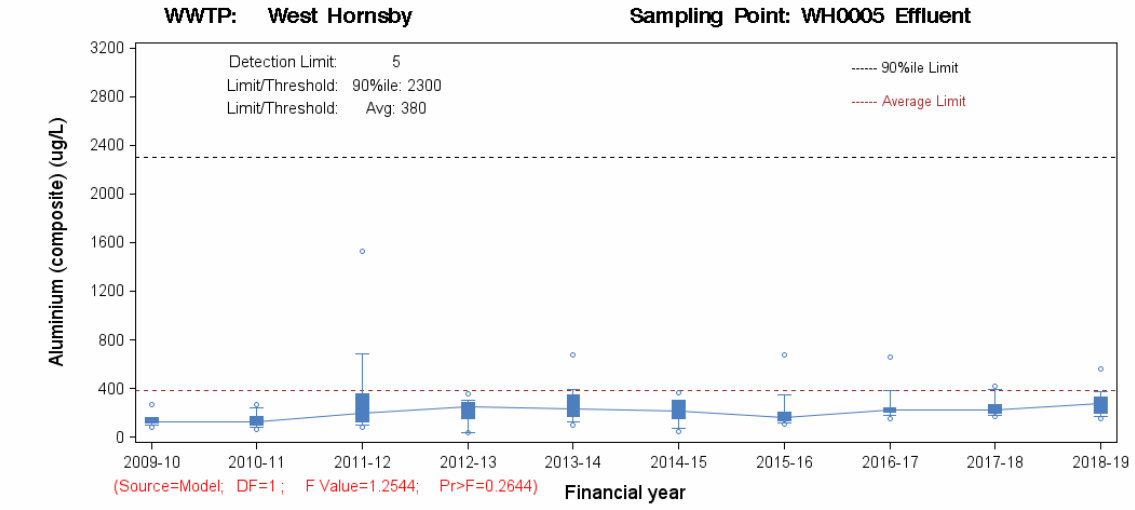

WWTP: West Hornsby
Sampling Point: WH0005 Effluent
Detection Limit: 1
Limit/Threshold: 80%ile: 200
Limit/Threshold: -
----- 80%ile Limit
Faecal coliforms (grab) (CFU/100ml)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.0216; Pr>F=0.0082)
Financial year

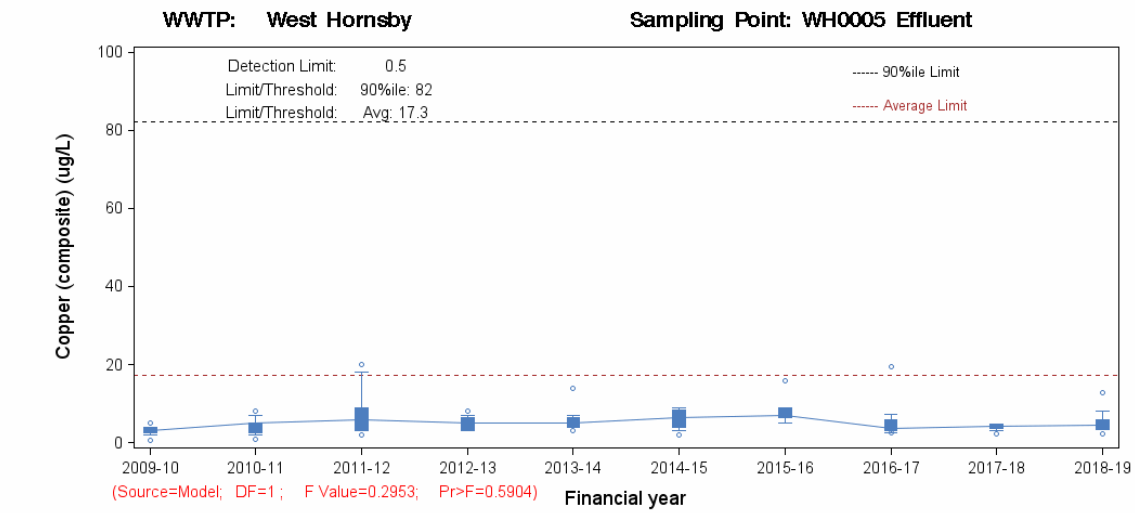

WWTP: West Hornsby
Sampling Point: WH0005 Effluent
Detection Limit: 2
Limit/Threshold: 50%ile: 10
Limit/Threshold: 90%ile: 15
----- 90%ile Limit
----- 50%ile Limit
Total suspended solids (composite) (mg/L)
21
18
15
12
9
6
3
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.7429; Pr>F=0.3890)
Financial year

Discharge quality: Toxicity

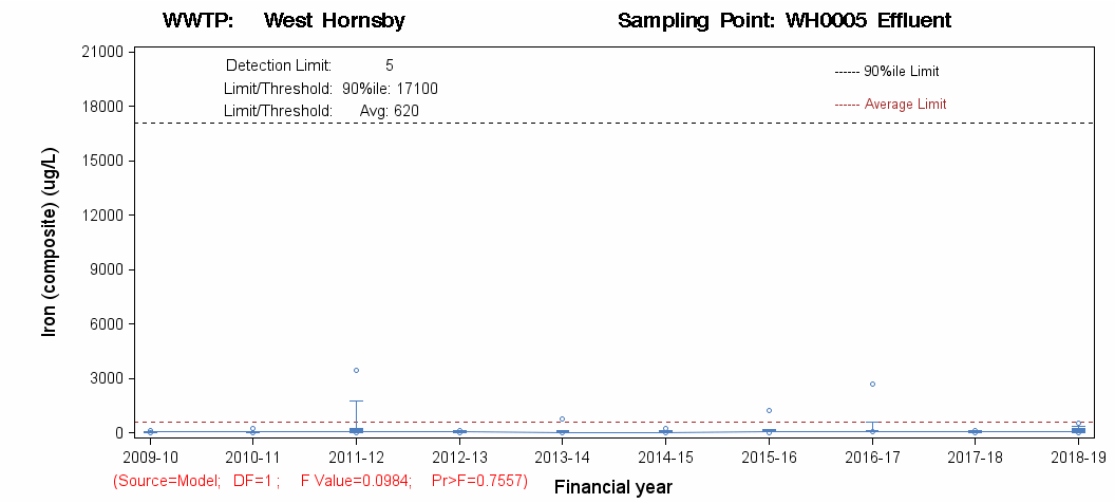


Discharge quality: Trace metals

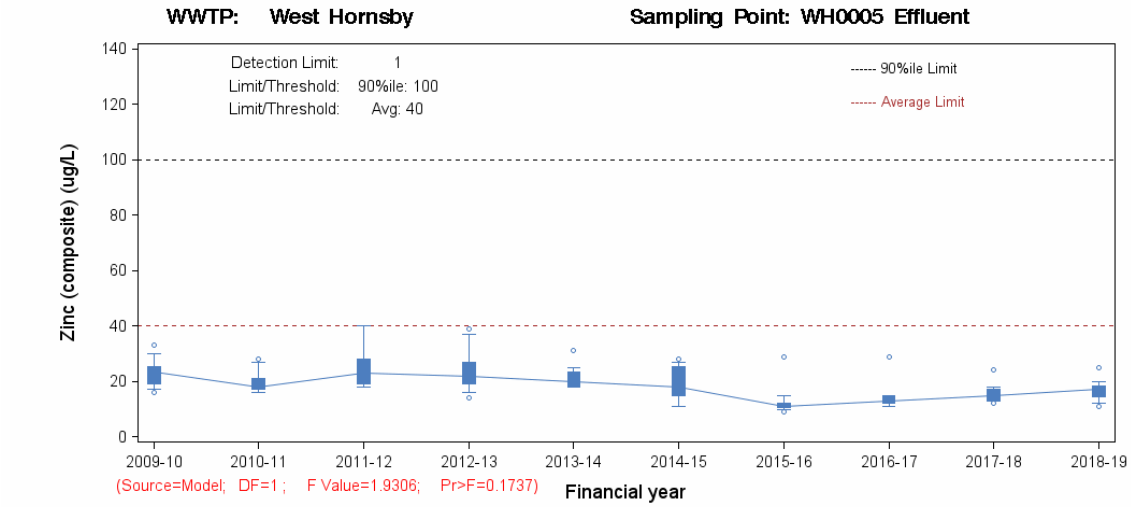




Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

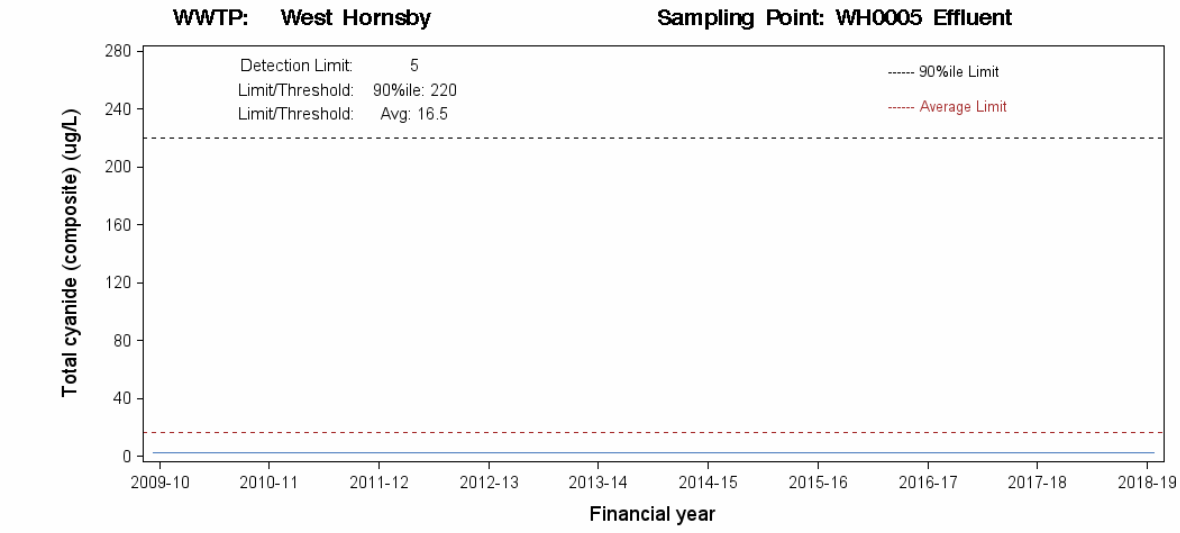


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

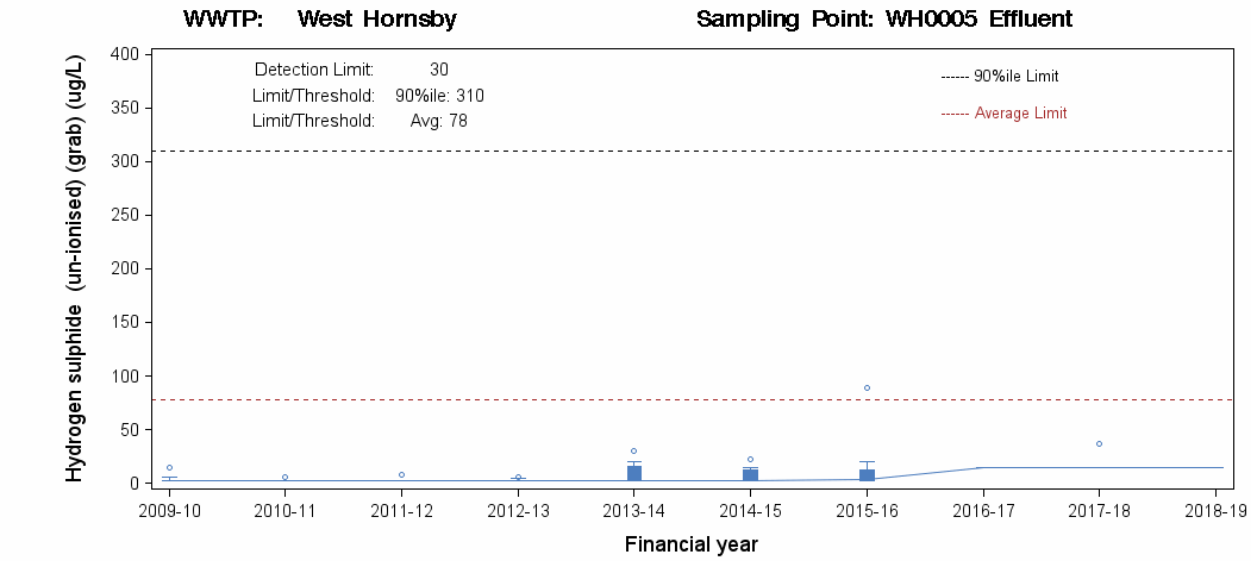


Note: Statistical test was based on 2018-19 data with previous two years data (2016-2018) due to detection limit change in 2016-17.

Discharge quality: Other chemicals and organics (including pesticides)

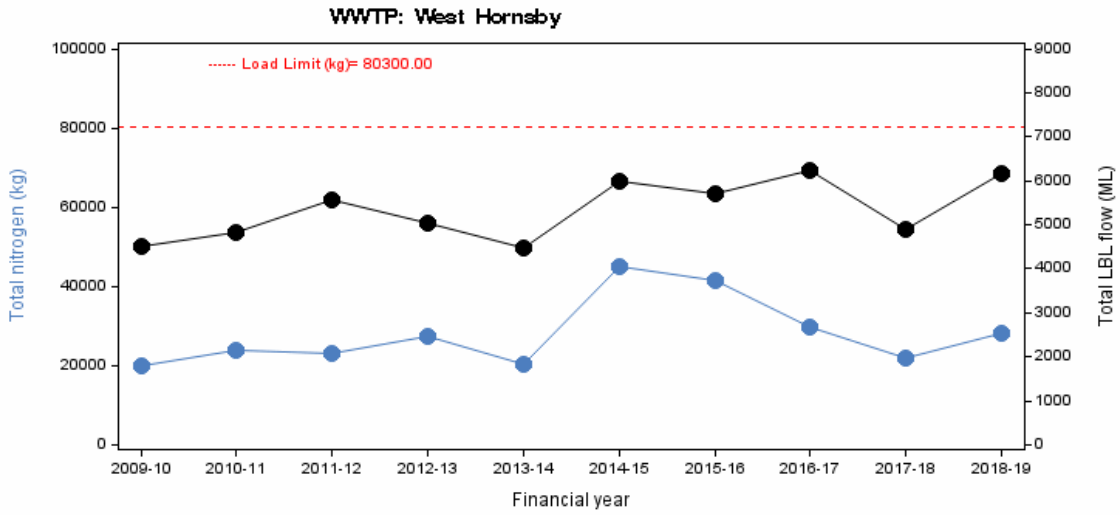


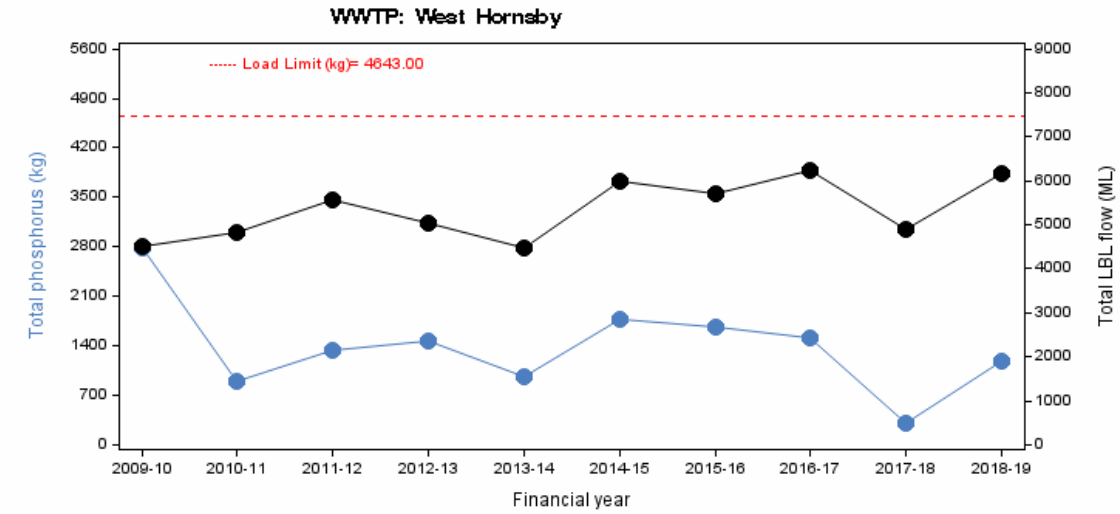
Note: Statistical test was not conducted because >90% of results were below the detection limit.



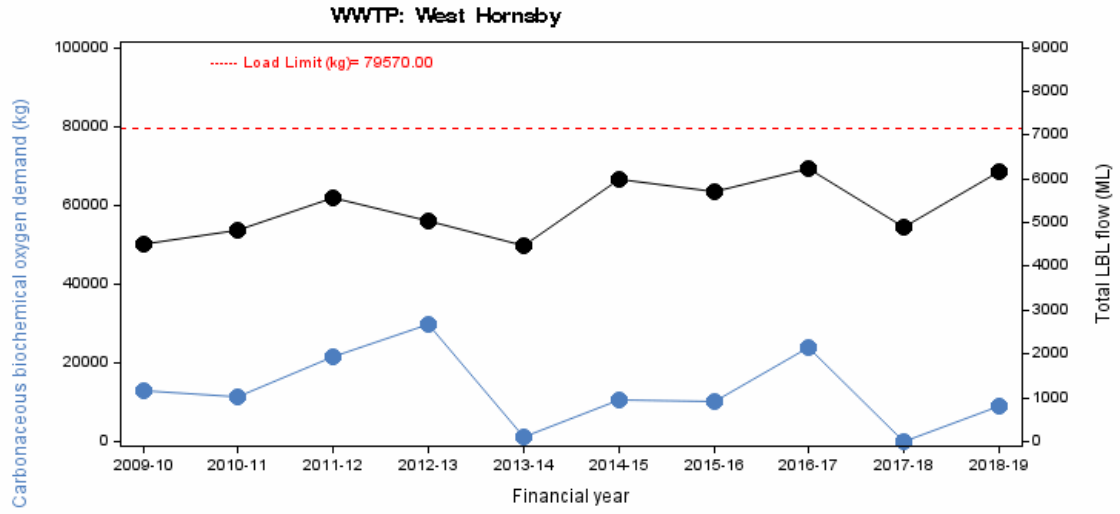
Note: 2018-19 data was compared with previous two years data (2016-2018) due to lab method change in 2016-17. Statistical test was not conducted because >90% of results were below the detection limit.

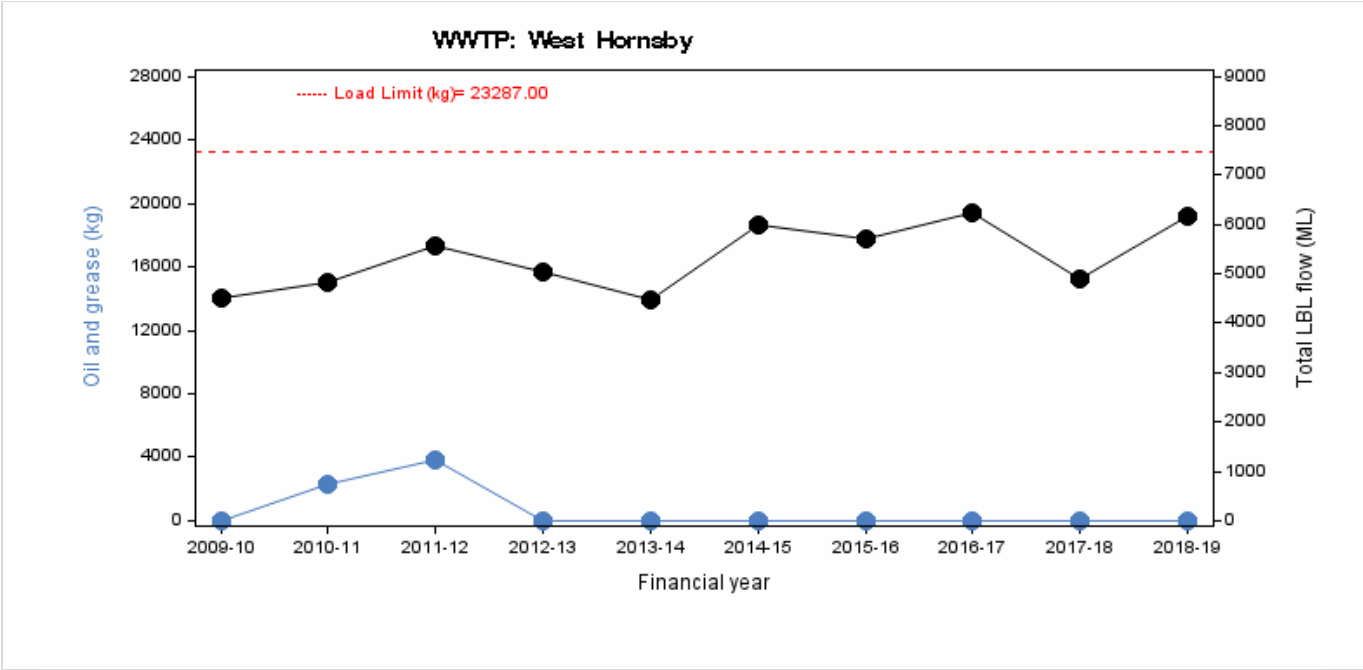
Discharge load: Nutrients

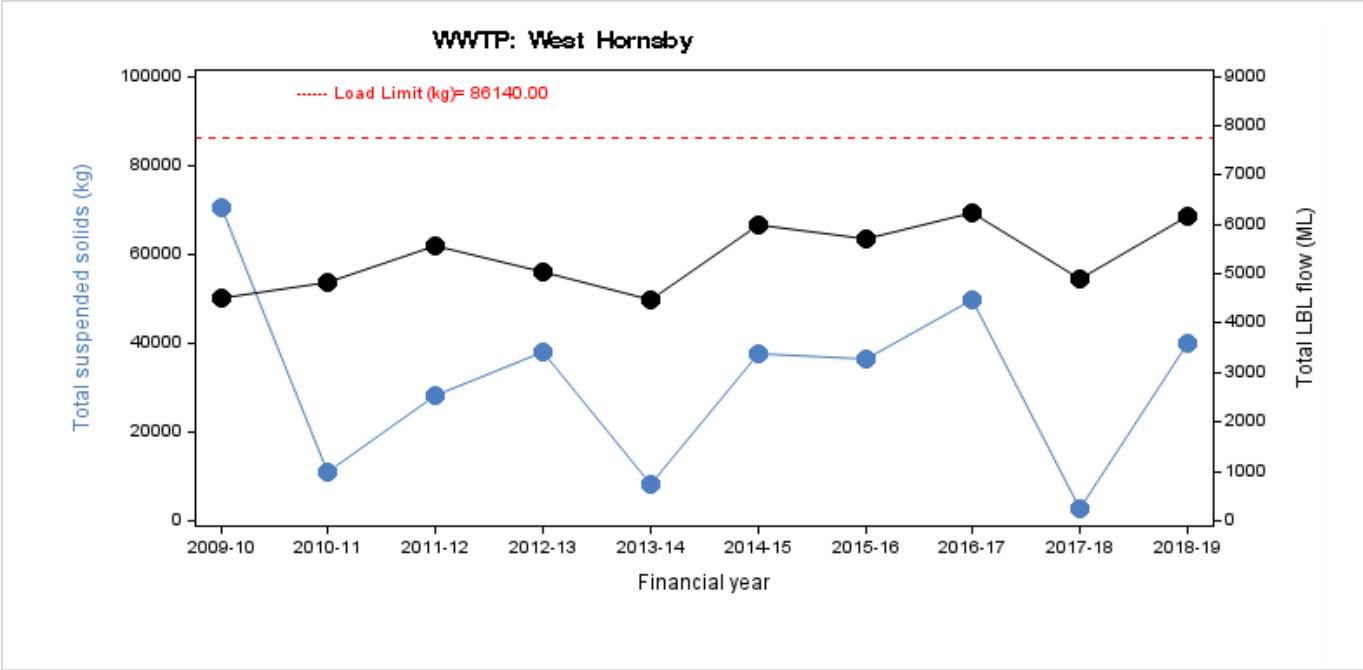




Discharge load Major conventional analytes

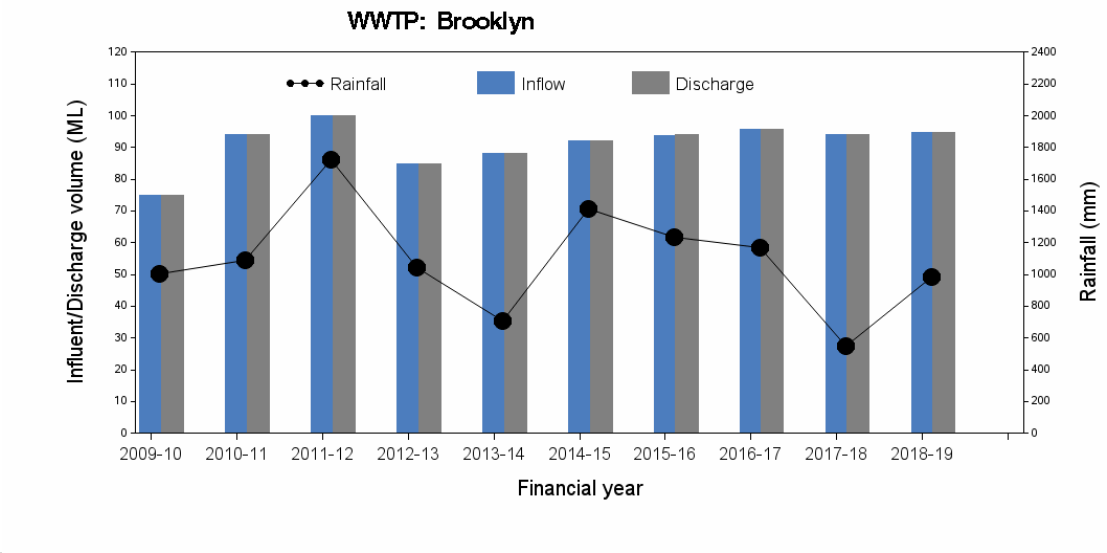



WWTP: West Hornsby
Load Limit (kg)= 23287.00
Oil and grease (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

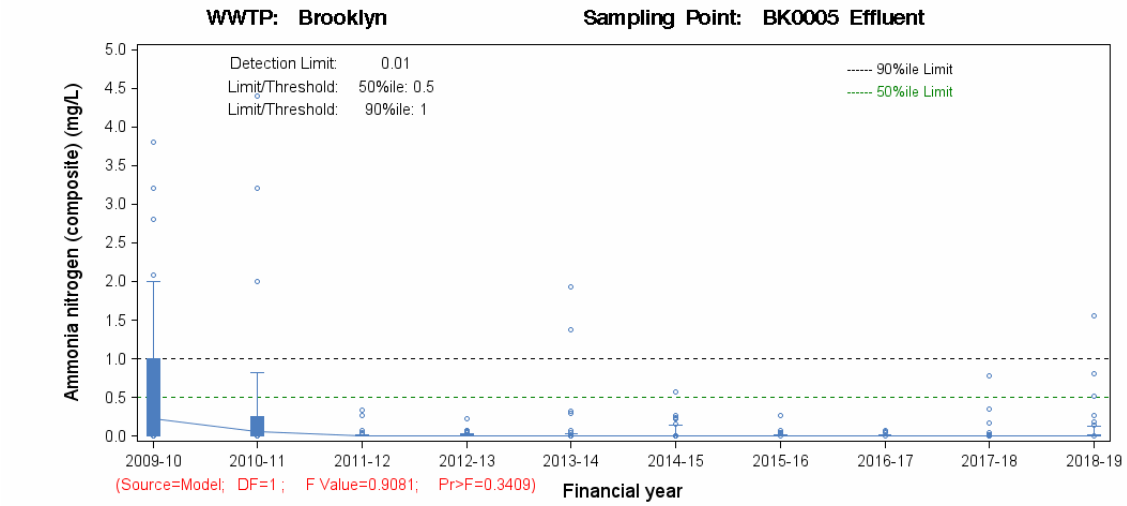

WWTP: West Hornsby
Load Limit (kg)= 86140.00
Total suspended solids (kg)
Total LBL flow (ML)
Financial year
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19

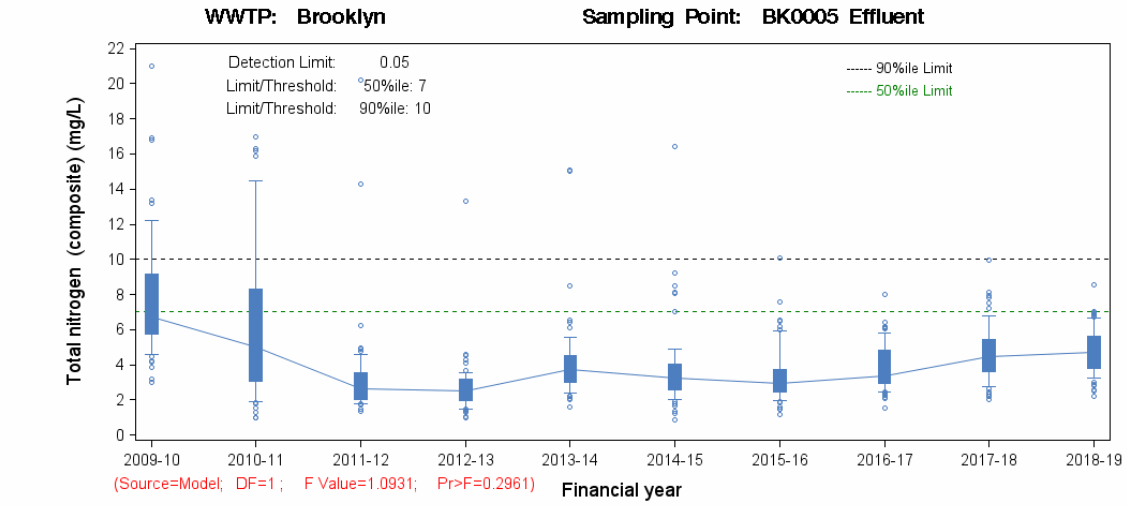
Brooklyn WWTP

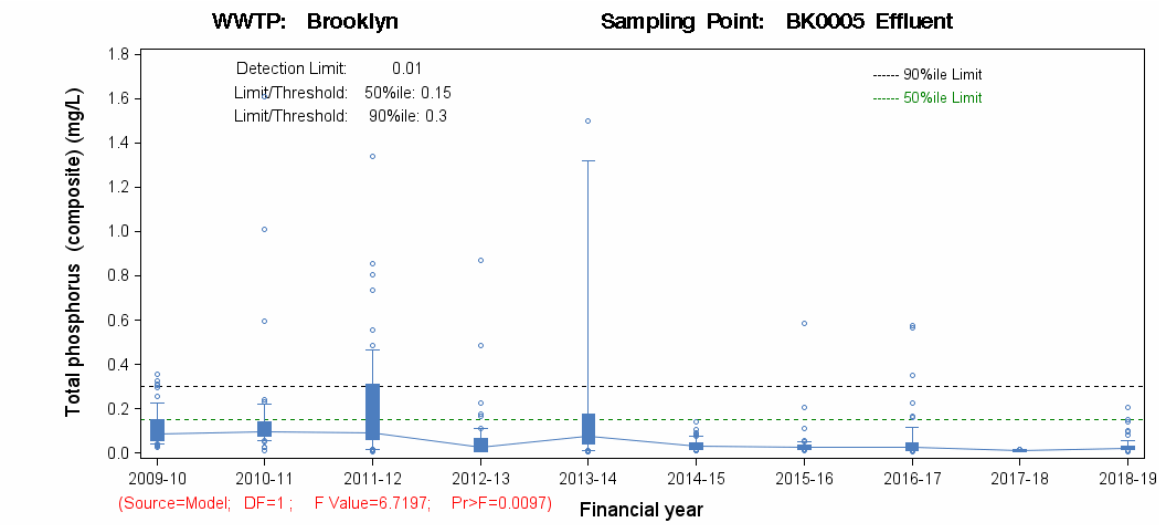
Discharge volume and rainfall

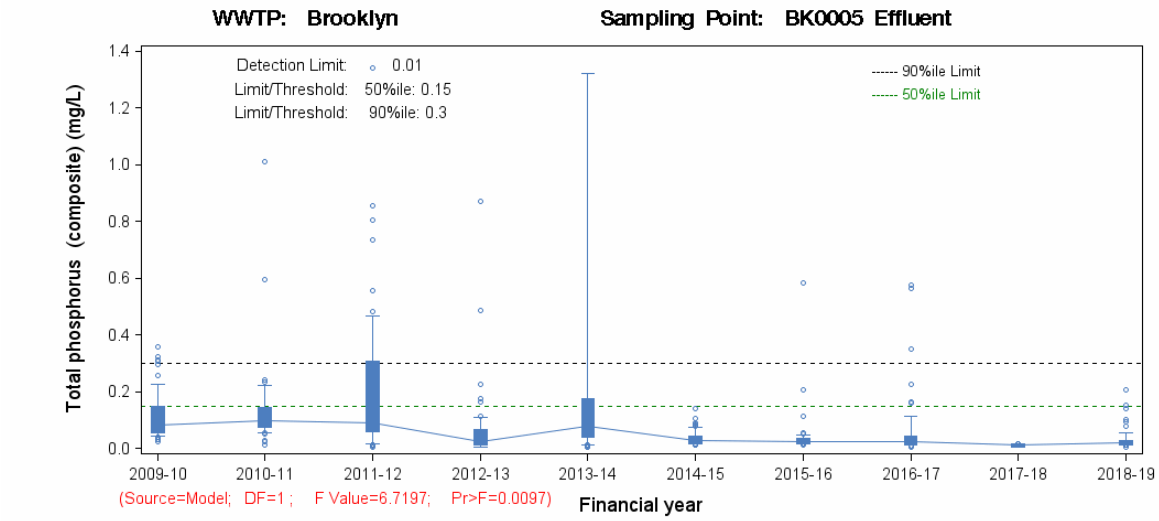


Discharge quality: Nutrients

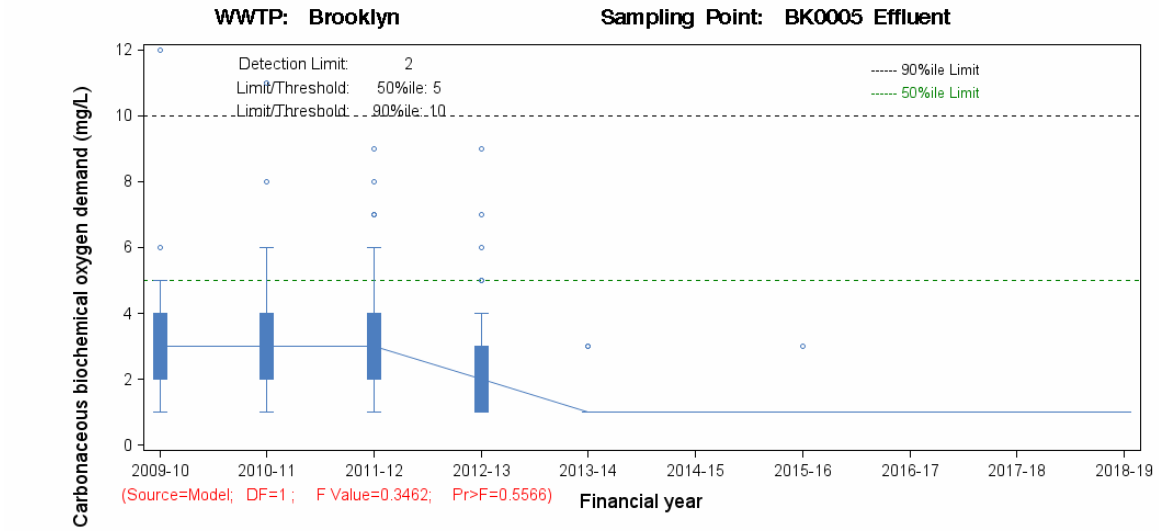




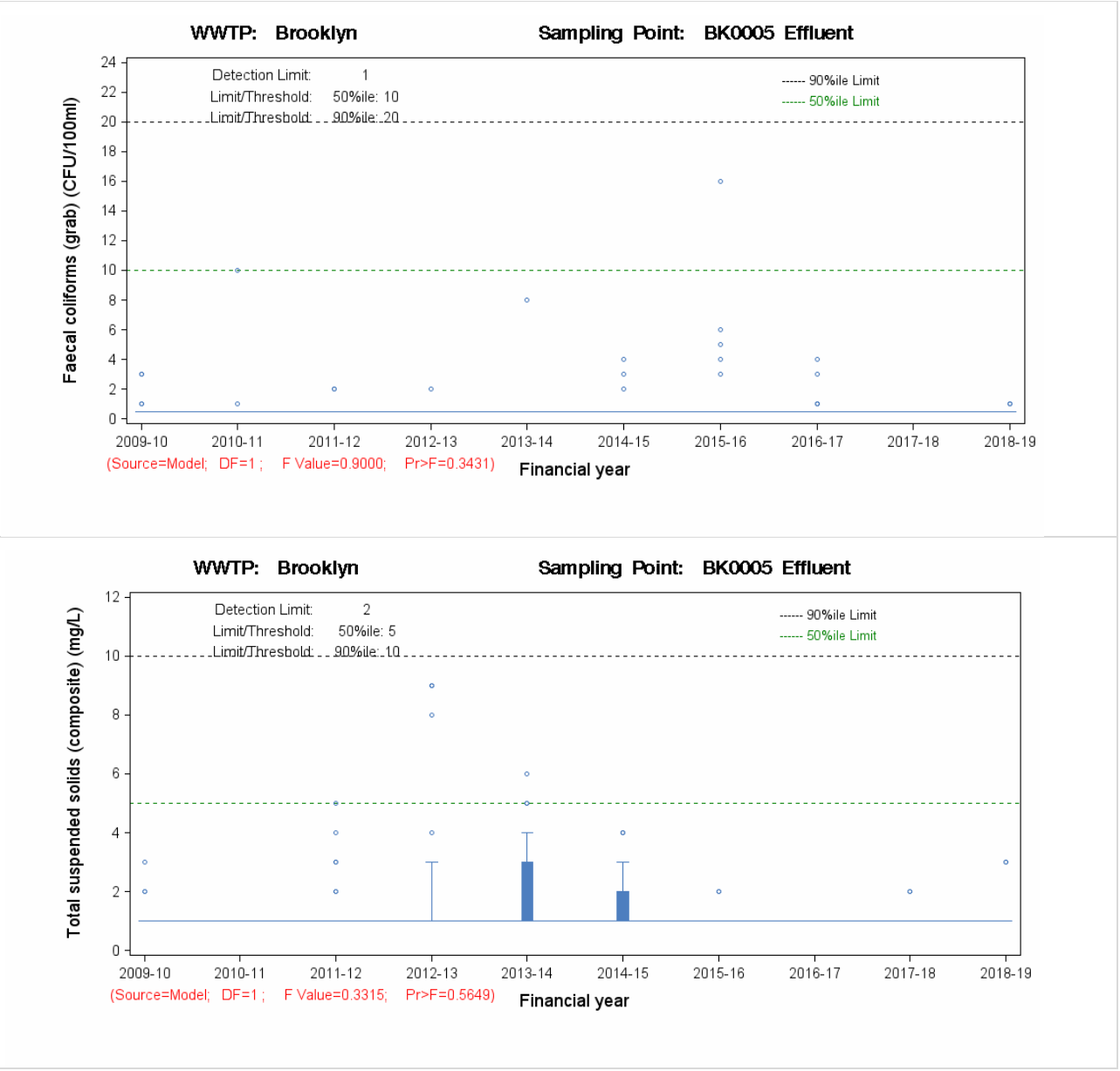




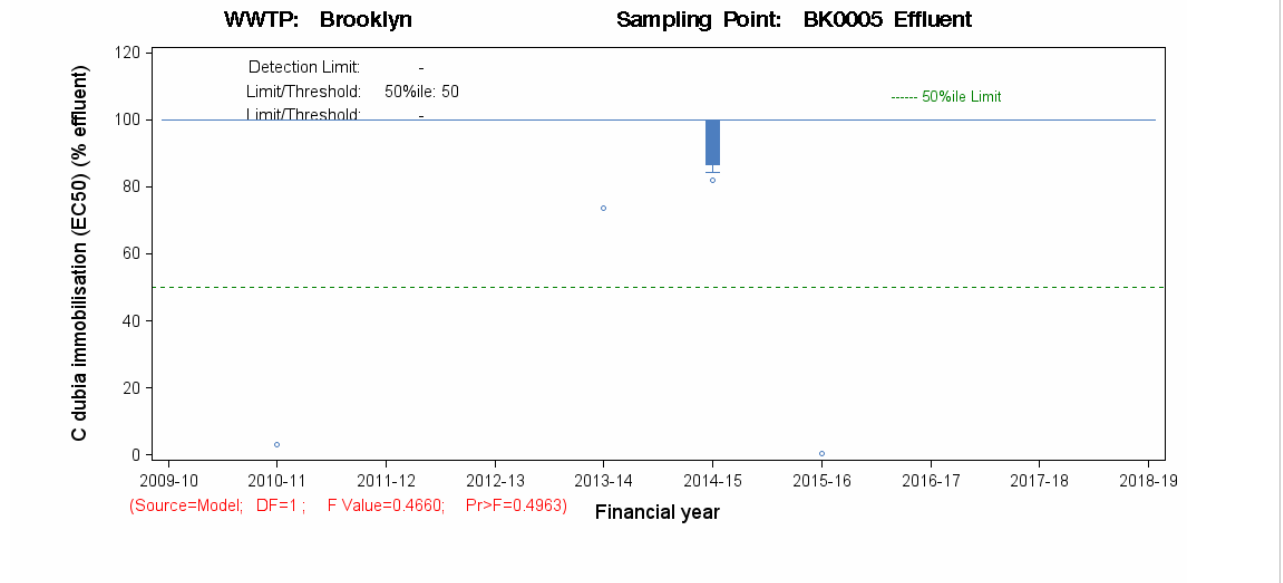
Discharge quality: Major conventional analytes



Note: Statistical test was based on 2018-19 data with previous four years data (2014-2018) due to lab method change in 2014-15.



Discharge quality: Toxicity



Appendix E Wastewater overflows

Dry weather overflows

Table E-1 Trend in dry weather wastewater overflow frequency and volumes for coastal WWTPs wastewater system (2013-14 to 2018-19)

Wastewater system	2013-14		2014-15		2015-16		2016-17		2017-18		2018-19	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
Warriewood	52	309	34	272	18	62	6	99	6	39	3	27
North Head / Northern suburbs	441	8,331	406	9,248	241	7,379	98	6,547	147	10,197	170	16,151
Bondi	18	2,154	12	1,208	12	448	24	1,017	16	960	30	1,424
Malabar / Southern suburbs	91	7,837	100	13,997	77	6,803	76	8,098	75	6,112	79	6,853
Cronulla	25	289	26	795	19	424	30	1,030	42	2,205	54	2,279
Wollongong	17	126	11	188	16	472	9	174	11	132	28	551
Shellharbour	3	8	1	50	4	75	2	75	3	387	3	42
Kiama/Bombo	2	25	2	13	1	2	1	142	1	7	2	34
All ocean systems	**649**	**19,080**	**592**	**25,771**	**388**	**15,664**	**246**	**17,182**	**301**	**20,039**	**369**	**27,361**

Table E-2 Trend in dry weather wastewater overflow frequency and volumes for inland wastewater systems (2013-14 to 2018-19)

Wastewater system	2013-14		2014-15		2015-16		2016-17		2017-18		2018-19	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
Picton	4	171	0	0	1	83	5	188	2	22	3	45
West Camden	5	18	2	16	2	43	4	35	7	1,079	1	7
Wallacia	0	0	0	0	1	24	2	3	1	13	1	9
Penrith	13	896	15	483	9	492	6	194	11	287	3	73
Winmalee	11	250	13	263	13	142	11	441	11	580	8	180
North Richmond	0	0	0	0	0	0	0	0	0	0	2	14
Richmond	0	0	0	0	1	0.3	0	0	0	0	0	0
St Marys	5	1,823	4	151	3	235	2	62	0	0	4	170
Quakers Hill	38	298	28	153	21	90	2	109	5	123	10	866
Riverstone	1	11	0	0.0	1	0.7	0	0	1	87	1	57
Castle Hill	12	394	9	253	10	342	2	312	4	74	8	213
Rouse Hill	14	162	10	55	6	32	6	72	1	10	9	318
Hornsby Heights	19	156	15	81	16	95	6	43	3	2	4	37
West Hornsby	37	1,186	32	688	13	185	8	123	6	27	9	391
Brooklyn-Danger Island	0	0	0	0	0	0	0	0	0	0	0	0
All inland systems	**159**	**5,365**	**128**	**2,144**	**97**	**1,764**	**54**	**1,582**	**52**	**2,304**	**63**	**2,380**

Wet weather overflows

Table E-3 Trend in wet weather wastewater overflow frequency and volumes for ocean WWTPs wastewater system (2013-14 to 2018-19)

Wastewater system	2013-14		2014-15		2015-16		2016-17		2017-18		2018-19	
	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)
Warriewood	1	0	2	3	3	159	3	0.5	1	3.5	2	4.8
North Head / Northern suburbs	11	666.7	23	11,181	26	9,076	23	4,000	16	279.9	23	3,801.0
Bondi	15	10.6	23	189	23	247	20	94	5	11.7	10	179.5
Malabar/Southern suburbs	14	1303.5	33	15,098	28	10,515	29	5,328	20	2,415.0	28	6,586.5
Cronulla	1	0	13	815	9	678	13	94	-	0.03	8	28.0
Wollongong	6	126.5	21	285	6	367	8	86	2	0.2	5	25.0
Bellambi	14	315.7	6	45	14	693	22	234	1	0.0	19	46.2
Port Kembla	6	143.1	7	78	4	503	8	159	2	0.7	4	6.7
Shellharbour	4	121.4	6	223	4	494	4	146	1	1.5	4	2.6
Kiama/Bombo	6	29.1	9	47	4	216	8	72	4	2.5	6	4.1
All ocean systems	**78**	**2,717**	**143**	**27,964**	**121**	**22,949**	**138**	**10,213.5**	**52**	**2,715.0**	**109**	**10,684.4**

MOF: Maximum overflow frequency
SOV: System overflow volume

Table E-4 Trend in wet weather wastewater overflow frequency and volumes for inland WWTPs wastewater system (2013-14 to 2018-19)

Wastewater system	2013-14		2014-15		2015-16		2016-17		2017-18		2018-19	
	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)
Picton	0	0	0	0	1	8	0	0	0	0	0	0
West Camden	1	0.4	3	32	3	211	3	3	0	0	2	1.0
Wallacia	0	0	3	14	5	11	5	11	0	0	3	2.2
Penrith	1	0	3	27	5	22	4	0.3	0	0	4	12.2
Winmalee	0	0	2	0.1	0	0	0	0	0	0	1	0.1
North Richmond	0	0	2	13	2	17	8	11	0	0	2	0.4
Richmond	0	0	2	1.2	0	0	0	0	0	0	0	0
St Marys	3	8.2	10	222	5	400	5	38	0	0	10	71.7
Quakers Hill	4	20.4	10	744	7	693	10	162	1	12.2	8	280.0
Riverstone	1	0.0	1	12	2	30	3	3.5	0	0	2	0.5
Castle Hill	1	0.4	2	49	2	32	2	1	0	0	4	4.6
Rouse Hill	0	0	1	140	3	94	3	0.3	0	0	2	8.1
Hornsby Heights	1	0	1	0.4	1	1	0	0	0	0	0	0
West Hornsby	1	0	5	125	5	162	2	11	0	0	8	42.9
Brooklyn-Danger Island	0	0	0	0	0	0	0	0	0	0	0	0
All inland systems	**13.0**	**29.5**	**45**	**1,380**	**41**	**1,680**	**45**	**241**	**1**	**12.2**	**46**	**423.7**

Appendix F Ocean receiving water

Summary of modelled chemical concentrations near deepwater ocean outfalls

Out of eight chemicals assessed in 2018-19, only modelled copper concentrations in the receiving waters in the initial dilution zones of all three deepwater ocean outfalls just exceeded the ANZG (2018) guidelines for protection of 95% of marine species (Table F-1, Table F-2 and Table F-3).

Table F-1 Comparison of modelled chemical concentrations near the deepwater ocean outfalls for the STSIMP (for the last ten financial years) to ANZG (2018) guideline values for North Head WWTP

North Head		Chemical concentration (µg/L)							
		Cadmium	Chromium	Copper	Mercury	Lead	Zinc	Endosulphan	Chlorpyrifos
Guideline 95th %ile for protection of marine species		5.5	4.4*	1.3	0.4	4.4	15	0.01	0.009
2018-19 undiluted wastewater average value		0.1	6.3	135	0.04	2.5	114	<0.01	<0.05
Dilution exceeded 98% of time	69:1	0.002	0.09	1.9	0.0006	0.04	1.6	0.0001	0.0007
Dilution exceeded 10% of time	685:1	0.0002	0.009	0.2	0.00006	0.004	0.2	0.00001	0.00007
2017-18 undiluted wastewater average value		0.1	7.4	123	0.05	3.0	115	<0.01	<0.05
Dilution exceeded 98% of time	92:1	0.001	0.08	1.3	0.0005	0.03	1.3	0.0001	0.0005
Dilution exceeded 10% of time	1245:1	0.00008	0.006	0.1	0.00004	0.002	0.1	0.00001	0.00004
2016-17 undiluted wastewater average value		0.1	5.3	111	0.05	2.8	109	<0.01	<0.05
Dilution exceeded 98% of time	68:1	0.002	0.1	1.6	0.0007	0.040	1.6	0.0001	0.0007
Dilution exceeded 10% of time	712:1	0.0002	0.007	0.2	0.00007	0.004	0.2	0.00001	0.00007
2015-16 undiluted wastewater average value		0.2	8.8	111	0.04	2.9	102	<0.01	<0.05
Dilution exceeded 98% of time	71:1	0.002	0.1	1.6	0.0006	0.04	1.4	0.0001	0.0007
Dilution exceeded 10% of time	421:1	0.0004	0.02	0.3	0.0001	0.007	0.2	0.00002	0.0001
2014-15 undiluted wastewater average value		0.2	6.3	138	0.1	3.5	127	<0.01	<0.05
Dilution exceeded 98% of time	85:1	0.002	0.07	1.6	0.001	0.04	1.5	0.0001	0.0006
Dilution exceeded 10% of time	873:1	0.0002	0.007	0.2	0.0001	0.004	0.15	0.00001	0.00006
2013-14 undiluted wastewater average value		0.2	3.8	104	0.2	2.6	109	<0.01	<0.05
Dilution exceeded 98% of time	72:1	0.003	0.05	1.4	0.003	0.04	1.5	0.0001	0.0007
Dilution exceeded 10% of time	690:1	0.0003	0.01	0.2	0.0004	0.004	0.16	0.00001	0.00007
2012-13 undiluted wastewater average value		0.2	6.3	101	0.08	3.7	115	<0.01	<0.05
Dilution exceeded 98% of time	84:1	0.002	0.08	1.2	0.001	0.04	1.4	0.0001	0.0006
Dilution exceeded 10% of time	713:1	0.0004	0.01	0.1	0.0001	0.005	0.2	0.00001	0.0001
2011-12 undiluted wastewater average value		0.4	4.1	79	0.09	3.6	109	<0.01	<0.05
Dilution exceeded 98% of time	81:1	0.005	0.05	1.0	0.001	0.04	1.3	0.0001	0.0006
Dilution exceeded 10% of time	818:1	0.0005	0.005	0.1	0.0001	0.004	0.1	0.00001	0.00006
2010-11 undiluted wastewater average value		0.4	5.3	96	0.2	3.6	130	<0.01	<0.05
Dilution exceeded 98% of time	73:1	0.006	0.07	1.3	0.003	0.05	1.8	0.0001	0.0007
Dilution exceeded 10% of time	595:1	0.0006	0.009	0.2	0.0003	0.006	0.2	0.00002	0.00008
2009-10 undiluted wastewater average value		0.4	6.2	99	0.2	4.6	122	<0.01	<0.05
Dilution exceeded 98% of time	68:1	0.006	0.09	1.4	0.003	0.07	1.8	0.0001	0.0007
Dilution exceeded 10% of time	798:1	0.0005	0.008	0.1	0.0003	0.006	0.2	0.00001	0.00006
2008-09 undiluted wastewater average value		0.4	5.8	96	0.1	4.9	121	<0.01	<0.05
Dilution exceeded 98% of time	82:1	0.005	0.07	1.2	0.001	0.06	1.5	0.0001	0.0006
Dilution exceeded 10% of time	774:1	0.0005	0.007	0.1	0.0001	0.006	0.2	0.00001	0.00006

* high reliability trigger value for chromium VI
Blue shading indicates value exceeds ANZG (2018) guideline value; Further context is detailed in Sydney Water (2016)

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Table F-2 Comparison of modelled chemical concentrations near the deepwater ocean outfalls for the STSIMP (for the last ten financial years) to ANZG (2018) guideline values for Bondi WWTP

Bondi WWTP		Chemical concentration (µg/L)							
		Cadmium	Chromium	Copper	Mercury	Lead	Zinc	Endosulphan	Chlorpyrifos
Guideline 95th %ile for protection of marine species		5.5	4.4*	1.3	0.4	4.4	15	0.01	0.009
2018-19 undiluted wastewater average value		0.1	1.58	152	0.03	3.0	113	<0.01	<0.05
Dilution exceeded 98% of time	93:1	0.001	0.02	1.6	0.0004	0.03	1.2	0.0001	0.0005
Dilution exceeded 10% of time	1007:1	0.0001	0.002	0.2	0.00003	0.003	0.1	0.00001	0.00005
2017-18 undiluted wastewater average value		0.1	1.83	148	0.05	3.98	109	<0.01	<0.05
Dilution exceeded 98% of time	114:1	0.0009	0.02	1.3	0.0004	0.03	1.0	0.0001	0.0004
Dilution exceeded 10% of time	1711:1	0.00006	0.001	0.1	0.00003	0.002	0.06	0.00001	0.00003
2016-17 undiluted wastewater average value		<0.1	2.4	130	0.04	3.1	105	<0.01	<0.05
Dilution exceeded 98% of time	89:1	0.001	0.03	1.5	0.0004	0.03	1.2	0.0001	0.001
Dilution exceeded 10% of time	1018:1	0.0001	0.002	0.1	0.00004	0.003	0.1	0.00001	0.00005
2015-16 undiluted wastewater average value		0.1	2.3	152	0.03	4.1	108	<0.01	<0.05
Dilution exceeded 98% of time	92:1	0.001	0.02	1.6	0.0004	0.04	1.2	0.0001	0.0005
Dilution exceeded 10% of time	623:1	0.0002	0.004	0.2	0.00005	0.007	0.2	0.00002	0.00008
2014-15 undiluted wastewater average value		0.2	1.5	121	0.1	3.6	108	<0.01	<0.05
Dilution exceeded 98% of time	111:1	0.001	0.01	1.1	0.001	0.03	1.0	0.00009	0.0005
Dilution exceeded 10% of time	1522:1	0.0001	0.001	0.08	0.00007	0.002	0.07	0.000007	0.00003
2013-14 undiluted wastewater average value		0.1	1.1	120	0.07	3.6	106	<0.01	<0.05
Dilution exceeded 98% of time	89:1	0.001	0.01	1.3	0.001	0.04	1.2	0.0001	0.0006
Dilution exceeded 10% of time	943:1	0.0001	0.001	0.1	0.0001	0.004	0.1	0.00001	0.00005
2012-13 undiluted wastewater average value		0.3	2.3	125	0.09	5.4	123	<0.01	<0.05
Dilution exceeded 98% of time	102:1	0.003	0.02	1.2	0.001	0.05	1.2	0.0001	0.0005
Dilution exceeded 10% of time	1033:1	0.0003	0.002	0.1	0.0001	0.005	0.1	0.00001	0.0001
2011-12 undiluted wastewater average value		0.2	1.6	110	0.06	5.1	102	<0.01	<0.05
Dilution exceeded 98% of time	104:1	0.002	0.02	1.1	0.001	0.05	1.0	0.0001	0.0005
Dilution exceeded 10% of time	1353:1	0.0001	0.001	0.08	0.00004	0.004	0.08	0.00001	0.00004
2010-11 undiluted wastewater average value		0.1	1.8	113	<0.1	3.5	104	<0.01	<0.05
Dilution exceeded 98% of time	93:1	0.001	0.02	1.2	0.001	0.04	1.1	0.0001	0.0005
Dilution exceeded 10% of time	917:1	0.0001	0.002	0.1	0.0001	0.004	0.1	0.00001	0.00005
2009-10 undiluted wastewater average value		0.2	1.8	110	<0.1	4.4	102	<0.01	<0.05
Dilution exceeded 98% of time	86:1	0.002	0.02	1.3	0.001	0.05	1.2	0.0001	0.0006
Dilution exceeded 10% of time	1233:1	0.0002	0.001	0.1	0.00008	0.004	0.08	0.000008	0.00004
2008-09 undiluted wastewater average value		0.1	2.3	118	<0.1	4.7	106	<0.01	<0.05
Dilution exceeded 98% of time	108:1	0.001	0.02	1.1	0.001	0.04	1.0	0.0001	0.0005
Dilution exceeded 10% of time	1271:1	0.00008	0.002	0.09	0.00008	0.004	0.08	0.000008	0.00004

* High reliability trigger value for chromium VI; Blue shading indicates value exceeds ANZG (2018) guideline value; Further context is detailed in Sydney Water (2016)

Table F-3 Comparison of modelled chemical concentrations near the deepwater ocean outfalls for the STSIMP (for the last ten financial years) to ANZG (2018) guideline values for Malabar WWTP

Malabar		Chemical concentration (µg/L)							
		Cadmium	Chromium	Copper	Mercury	Lead	Zinc	Endosulphan	Chlorpyrifos
Guideline 95th %ile for protection of marine species		5.5	4.4*	1.3	0.4	4.4	15	0.01	0.009
2018-19 undiluted wastewater average value		0.1	9.1	98	0.2	2.7	99	<0.01	<0.05
Dilution exceeded 98% of time	64:1	0.002	0.1	1.5	0.003	0.04	1.6	0.0002	0.0008
Dilution exceeded 10% of time	470:1	0.0002	0.02	0.2	0.0003	0.006	0.2	0.00002	0.0001
2017-18 undiluted wastewater average value		0.2	9.0	105	0.05	3.9	111	<0.01	<0.05
Dilution exceeded 98% of time	68:1	0.003	0.1	1.5	0.0007	0.06	1.6	0.0001	0.0007
Dilution exceeded 10% of time	824:1	0.0002	0.01	0.1	0.00006	0.005	0.1	0.00001	0.00006
2016-17 undiluted wastewater average value		0.3	8.1	103	0.04	4.0	118	<0.01	0.124
Dilution exceeded 98% of time	56:1	0.004	0.1	1.8	0.0008	0.07	2.1	0.0002	0.002
Dilution exceeded 10% of time	515:1	0.0005	0.02	0.2	0.0001	0.008	0.2	0.00002	0.0002
2015-16 undiluted wastewater average value		0.2	6.8	91	0.13	4.8	92	<0.01	<0.05
Dilution exceeded 98% of time	55:1	0.004	0.1	1.7	0.002	0.09	1.7	0.0002	0.0009
Dilution exceeded 10% of time	244:1	0.0009	0.03	0.4	0.0005	0.02	0.4	0.00004	0.0002
2014-15 undiluted wastewater average value		0.1	6.5	78	0.03	3.3	94	<0.01	<0.05
Dilution exceeded 98% of time	70:1	0.002	0.09	1.1	0.0004	0.05	1.3	0.0001	0.0007
Dilution exceeded 10% of time	665:1	0.0002	0.01	0.1	0.00005	0.005	0.1	0.00002	0.00008
2013-14 undiluted wastewater average value		0.2	9.3	80	0.05	3.3	102	<0.01	<0.05
Dilution exceeded 98% of time	56:1	0.004	0.17	1.4	0.001	0.06	1.8	0.0002	0.0009
Dilution exceeded 10% of time	478:1	0.0004	0.02	0.2	0.0001	0.01	0.2	0.00002	0.0001
2012-13 undiluted wastewater average value		0.2	6.0	74	0.07	4.3	97	<0.01	<0.05
Dilution exceeded 98% of time	65:1	0.003	0.09	1.1	0.001	0.07	1.5	0.0002	0.0008
Dilution exceeded 10% of time	507:1	0.0003	0.01	0.1	0.0001	0.01	0.2	0.00002	0.0001
2011-12 undiluted wastewater average value		0.2	7.8	74	0.06	4.2	107	<0.01	<0.05
Dilution exceeded 98% of time	68:1	0.003	0.11	1.1	0.001	0.06	1.6	0.0001	0.0007
Dilution exceeded 10% of time	578:1	0.0003	0.01	0.1	0.0001	0.007	0.2	0.00002	0.00009
2010-11 undiluted wastewater average value		0.1	7.8	59	<0.1	2.7	86	<0.01	<0.05
Dilution exceeded 98% of time	55:1	0.002	0.14	1.1	0.002	0.05	1.6	0.0002	0.0009
Dilution exceeded 10% of time	448:1	0.0002	0.02	0.1	0.0002	0.006	0.2	0.00002	0.0001
2009-10 undiluted wastewater average value		0.3	10.2	67	<0.1	13.3	86	<0.01	<0.05
Dilution exceeded 98% of time	55:1	0.005	0.19	1.2	0.002	0.24	1.6	0.0002	0.0009
Dilution exceeded 10% of time	551:1	0.0005	0.02	0.1	0.0002	0.02	0.2	0.00002	0.00009
2008-09 undiluted wastewater average value		0.2	7.0	68	<0.1	4.1	90	<0.01	<0.05
Dilution exceeded 98% of time	67:1	0.003	0.10	1.0	0.001	0.06	1.3	0.0001	0.0007
Dilution exceeded 10% of time	550:1	0.0004	0.01	0.1	0.0002	0.007	0.2	0.00002	0.00009

* High reliability trigger value for chromium VI

Blue shading indicates value exceeds ANZG (2018) guideline value; Further context is detailed in Sydney Water (2016)

Appendix G Ocean sediment program

Ocean sediment program - surveillance year 2019

Approximately 80% of Sydney's wastewater is treated at the North Head, Bondi and Malabar WWTPs and discharged through three deepwater ocean outfalls located between 2 and 4 km off shore, in waters between 65-80 m deep. As a general description, these deepwater ocean outfalls discharge wastewater through multiple diffusers that spread it over 500 to 750 m, which achieves rapid dilution that approximately ranges from design targets of 300:1 to 500:1, depending on oceanographic conditions and the diffuser field. The purpose of the diffusers is to release wastewater into the ocean at concentrations that are unlikely to be toxic once mixing has occurred. The distance from the discharge point to the boundary of the initial dilution zone varies considerably, depending on ocean and discharge conditions. It is defined to occur when the vertical momentum and buoyancy of the wastewater are the same as that of the surrounding water. The initial dilution zone is also referred to as the initial mixing zone or the end of the near-field.

TOC and sediment grain size results

For the 2019 'surveillance' year, results were obtained from the analytes measured at both sites (1 and 2) of the three locations listed in Figure G-1.

Table G-1 Locations and analytes measured in 2018-19

Sites 1 and 2 of locations	Analytes measured
Malabar 0 km	Total Organic Carbon Sediment Grain Size Benthic macrofauna
Bondi and North Head	Total Organic Carbon Sediment Grain Size

Coordinates for the grid centres for each site of the nine locations of the study are provided in Table G-8. Actual geographical coordinates of each sample collected in the 2019 surveillance year from sites 1 and 2 for each of the three locations are listed in Table G-9.

Sediment grain size analyses were undertaken on sediment samples from all sites. Results for sediment granulometry size classes were calculated for <0.063 mm (%), >0.063 mm (%) and >2.0 mm (%) categories. Summary statistics including mean and standard deviation are presented in Table G-2 with all raw data presented in Table G-3. Levels were similar to those seen in past years (Figure G-1).

Table G-2 Summary statistics of TOC and sediment grain size measured in 2018-19

Sites	TOC %		<0.063mm		>0.063mm		>2.0mm	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
North Head 1	0.5	0.3	3.3	1.3	93.5	3.0	3.2	2.8
North Head 2	0.4	0.2	4.2	1.8	88.7	5.2	7.1	4.1
Bondi 1	0.3	0.1	5.5	1.2	93.5	1.0	1.0	0.2
Bondi 2	0.5	0.3	3.6	2.2	95.1	2.3	1.3	0.7
Malabar 0km 1	0.5	0.1	2.1	1.1	96.1	2.0	1.8	1.0
Malabar 0km 2	0.3	0.2	2.8	1.1	95.0	1.0	2.2	0.6

Table G-3 TOC and sediment grain size for each sample measured in 2018-19

		TOC	<0.063 mm	>0.063 mm	>2.0 mm
Site description	Replicate	%	%	%	%
North Head 1	1	0.57	3.87	95.2	0.96
North Head 1	2	0.88	3.78	88.3	7.92
North Head 1	3	0.18	1.54	94.9	3.57
North Head 1	4	0.53	2.52	95.3	2.17
North Head 1	5	0.44	4.84	93.8	1.34
North Head 2	1	0.39	4.85	83	12.2
North Head 2	2	0.22	2.92	88.3	8.79
North Head 2	3	0.2	2.83	93.5	3.64
North Head 2	4	0.62	3.27	94.4	2.32
North Head 2	5	0.38	6.96	84.4	8.59
Bondi 1	1	0.34	5.65	93.3	1.07
Bondi 1	2	0.11	6.37	92.9	0.75
Bondi 1	3	0.33	6.95	92.2	0.86
Bondi 1	4	0.41	4.08	94.6	1.29
Bondi 1	5	0.4	4.68	94.3	1.01
Bondi 2	1	1.08	7.13	92	0.82
Bondi 2	2	0.55	3.68	93.8	2.52
Bondi 2	3	0.31	2.48	96.5	0.99
Bondi 2	4	0.48	3.52	95.2	1.28
Bondi 2	5	0.27	1.05	97.9	1.01
Malabar 0 km 1	1	0.44	2.49	96.2	1.31
Malabar 0 km 1	2	0.48	0.98	97.8	1.17
Malabar 0 km 1	3	0.39	1.86	96.2	1.99
Malabar 0 km 1	4	0.45	1.53	97.4	1.11
Malabar 0 km 1	5	0.52	3.79	92.7	3.52
Malabar 0 km 2	1	0.2	2.6	95.5	1.88
Malabar 0 km 2	2	0.33	4.15	93.3	2.56
Malabar 0 km 2	3	0.14	1.22	95.8	2.98
Malabar 0 km 2	4	0.56	3.44	95.2	1.41
Malabar 0 km 2	5	0.41	2.64	95.2	2.15

In 2019, the TOC % content for all ten samples collected from the Malabar 0 km location were less than the NSW EPA specified 99th percentile trigger value of 1.2%. No specific trigger value has been set for either Bondi or North Head.

TOC % content was also less than 1.2% for all ten samples collected from North Head and for 9 of the 10 samples collected from Bondi. Over the 2001 to 2019 period, 23 TOC values were recorded from a total of 1350 samples to exceed 1.2% across a number of the nine locations (Table G-4). This suggests the recent values recorded from North Head in previous years may be examples of the higher variability seen from time to time, rather than an indication of TOC build up and subsequent anoxic conditions around this deepwater outfall. High anoxia conditions would be more likely to impact benthic community structure.

These TOC results suggest the prevailing currents that induce sediment movement and also move effluent plumes away from the diffuser arrays, have contributed to the low anoxia conditions in the benthic sediments around the diffuser arrays.

Table G-4 TOC replicate values above 1.2% content from 2001 to 2019

Year	Location	TOC %
2002	North Head	1.46
2002	North Head	1.88
2002	North Head	1.2
2002	Long Reef	4.4
2003	North Head	1.26
2003	Long Reef	1.53
2003	Long Reef	1.34
2004	Marley	1.2
2005	Long Reef	1.92
2005	Long Reef	1.65
2005	Long Reef	1.84
2006	North Head	1.2
2006	Bondi	1.52
2006	Malabar 7 km	1.77
2007	North Head	1.41
2009	Malabar 7 km	3.46
2011	North Head	3.49
2015	Bondi	2
2016	Malabar 0 km	1.25
2017	North Head	1.60
2017	North Head	1.68
2018	North Head	1.21
2018	North Head	1.40

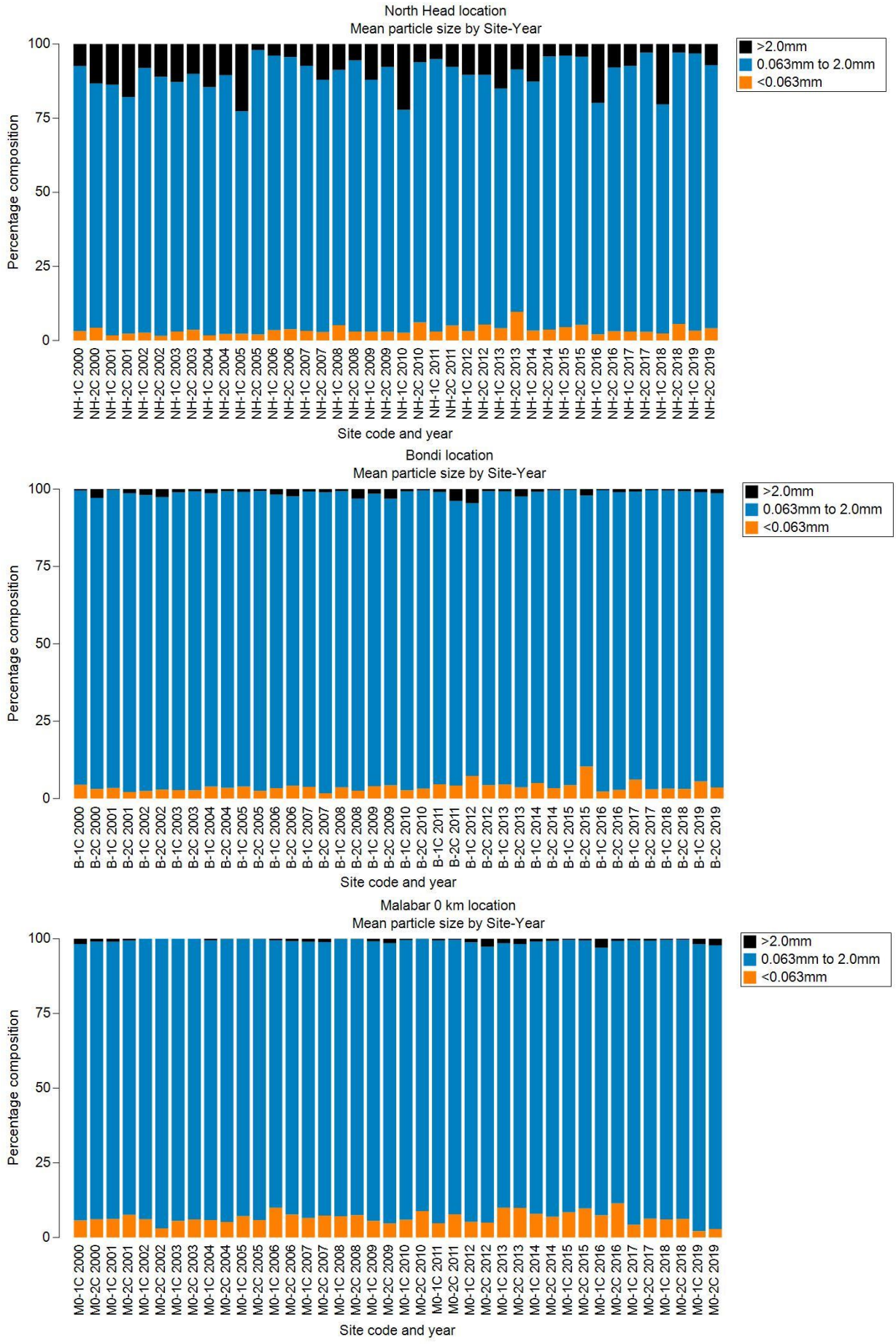


Figure G-1 Cumulative sediment particle size composition by three size classes for: top North Head; middle Bondi; and bottom Malabar 0 km 2000 to 2018-19

The average levels of fine sediments observed in 2018 were similar to those seen in past years, with no apparent build-up of fine particles (<0.063 mm) (Figure G-1). This suggests that metal concentrations in the sediment were unlikely to have increased at the North Head, Bondi and Malabar 0 km deepwater outfall locations.

With high levels of anoxia unlikely, together with the probable lack of build-up in chemical concentrations in the fine sediments, the benthic community structure of the Malabar location was unlikely to have changed beyond the levels recorded in past assessment years. A check of the 2019 benthic community structure was made next to see if it was similar to past assessment years (Figure G-4).

Benthic macrofauna results

A summary of the benthic macrofauna data from the Malabar 0 km location is presented in Table G-5 and visually in Figure G-2. In 2019, the most common fauna types (taxa) were Crustaceans, however these formed approximately one fifth of the number of individuals collected compared to the Polychaete worms. Other taxa groups had less animal types and lower abundances (Figure G-2). While abundances and the exact number of taxa varied between years, this year's taxonomic structure was typical of other years except for 2012 where Crustacean individuals outnumbered Polychaete worm individuals (Figure G-3).

The detailed benthic community dataset collected in 2019 is provided in Table G-10. The Polychaete worm of the family Maldanidae was the most abundant taxon, which was collected in 18 of the 19 samples representing 44% of the total Polychaete worms collected in 2019 (Table G-5 and Table G-10). Maldanidae is described as an indicator of low organic input conditions, as was the next most dominant Polychaeta taxon, Oweniidae (Dean, 2008) that was also collected in 18 of the 19 samples and contributing 26% of total polychaete abundance (Table G-10). Although only contributing approximately 14% of all polychaete worms collected, Spionidae was found in all Malabar 0 km samples collected during 2019.

Table G-5 Summary of benthic macrofauna at Malabar 0 km location in 2019

Summary statistics based on taxa	Sum	% Contribution
Total number of taxa	106	100
Number of Polychaete taxa	29	27.4
Number of Crustacean taxa	44	41.5
Number of Mollusc taxa	21	19.8
Number of Echinoderm taxa	4	3.8
Number of other worm phyla taxa	5	4.7
Number of other phyla taxa	3	2.8
Summary statistics based on abundance	**Sum**	**% Contribution**
Total number of individuals	7822	100
Number of Polychaetes	5700	72.9
Number of Crustaceans	1086	13.9
Number of Molluscs	111	1.4
Number of Echinoderms	865	11.1
Number of other worm phyla	51	0.7
Number of other phyla	9	0.1

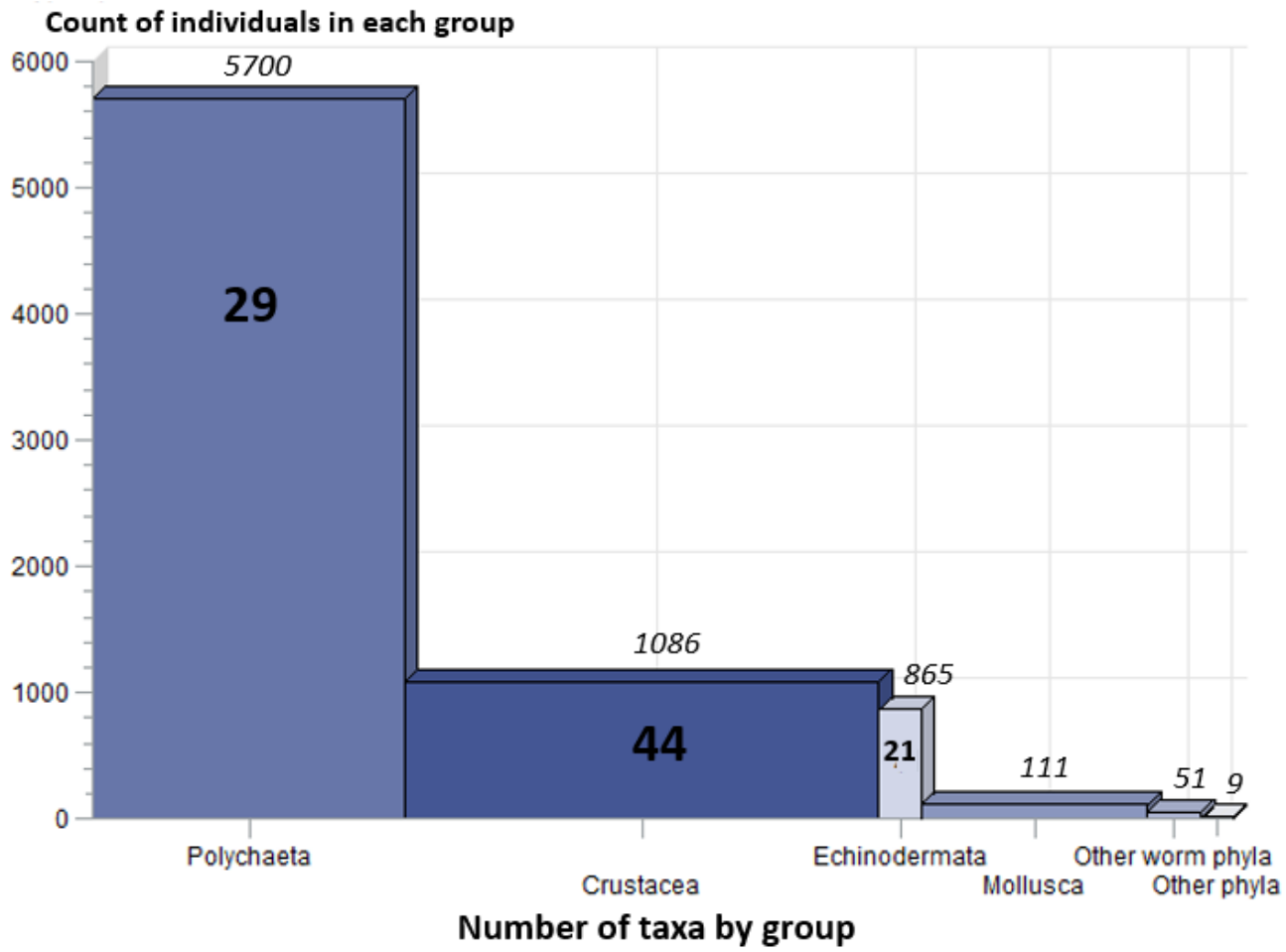


Figure G-2 Benthic macrofauna at Malabar 0 km location in 2019

The composition of the Polychaeta, Crustacea, Mollusca and Echinodermata has been observed to vary up and down in both number of taxa and in number of individuals over the 2000 to 2019 period (Figure G-3). This summary also indicates there has not been a sustained decline or increase in any of these four taxonomic groups over the 20 years of monitoring.

In addition to the above coarse check of the taxonomic structure, a finer comparison of the taxonomic structure at the Malabar 0 km location was made against that from past 'assessment' years to see if it was typical of that seen in the past. This was done by placing the 2019 samples from the Malabar outfall location onto the canonical axes of the existing Canonical Analysis of Principal coordinates (CAP) model of interpretive-year data (2002, 2005, 2008, 2011, 2014, 2016) with the outputted sample allocations inspected for fit of 2019 samples to past samples.

A first pass of the CAP routine was run and after viewing diagnostic statistics an 'm' value of 15 was chosen to make the second pass. The second pass indicated a 62% allocation success and the first squared canonical correlation was reasonably large ($\delta 12 = 0.86$). The Pillar's trace statistic was significant (2.55123 p = 0.0001) and indicated there was more than one group of samples in multivariate space. The Cross Validation Leave-one-out Allocation of Observations to Groups statistic reflected a number of overlapped and mixed groups of samples with no one location having all of its samples being allocated solely to it. Rather, miss-classified samples were mostly assigned to locations immediately north or south of that location or nearby locations (Table G-7).

The allocation based on taxonomic structure of the 19 samples collected in 2019 from the Malabar 0 km location was to either the Malabar 0 km location or to other nearby locations with a similar allocation as seen in the base six-year assessment data analysis. The resultant CAP plot is shown in Figure G-4.

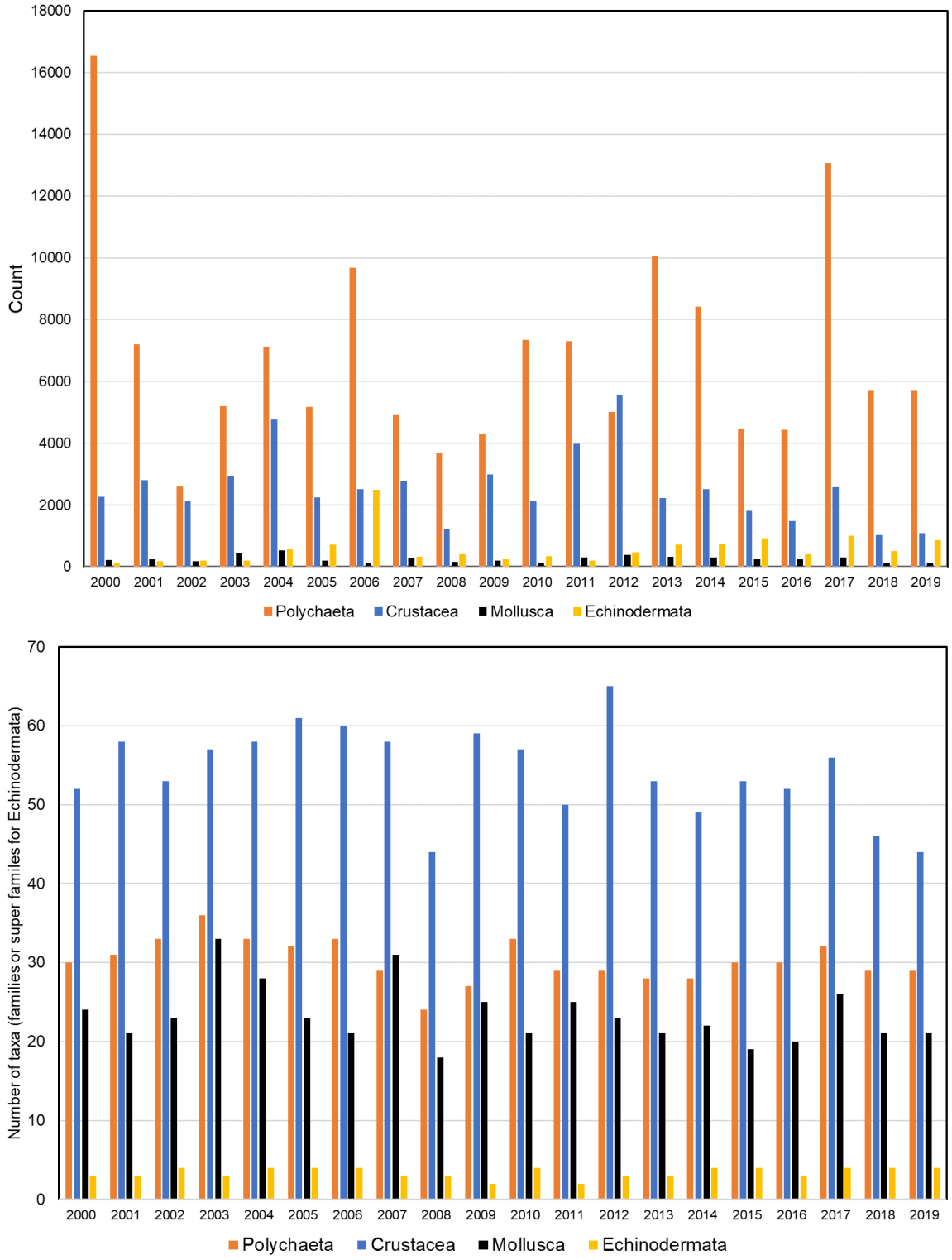


Figure G-3 Counts and number of taxa at Malabar 0 km location each year from 2000 to 2019

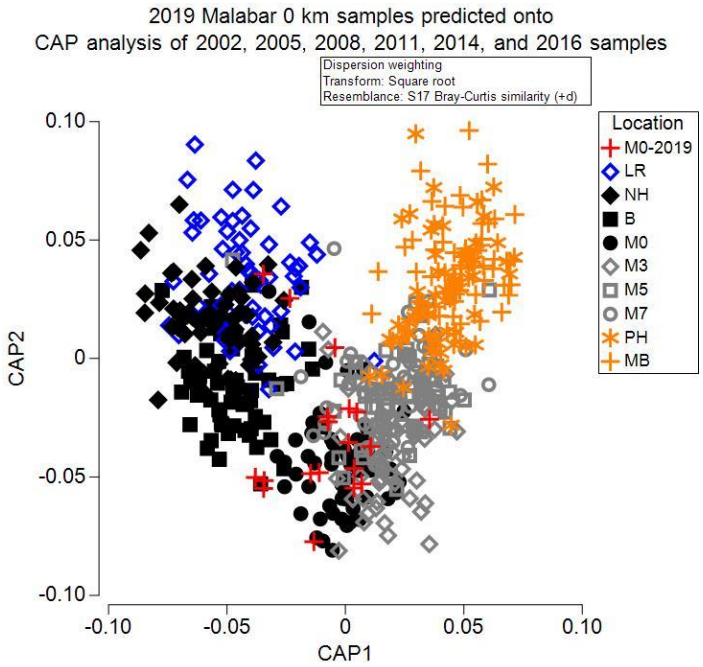


Figure G-4 CAP plot with Malabar 0 km location 2018 sample prediction compared to past assessment years

OSP Summary for 2019

TOC % content results suggested elevated levels of anoxia were unlikely to have built-up in benthic sediment in 2019. There also appeared to be a lack of build-up of fine sediment particles, which in turn suggests sedimentary metal concentrations have not increased in 2019. Without changes in those sediment characteristics, the benthic community structure at the Malabar deepwater ocean outfall location was unlikely to have changed beyond the levels recorded in past 'assessment' years. The check of the 2019 benthic community structure to past 'assessment' years also suggested community structure was within ranges seen in the past 'assessment' years.

Table G-6 Allocated location group for Malabar 0 km samples of 2019 which were predicted onto the base CAP analysis of samples collected from all nine locations in 2002, 2005, 2008, 2011, 2014 and 2016 assessment years

2019 Malabar 0 km site and replicate sample number	Allocated location group
M01C-1	M0
M01C-2	M0
M01C-3	M0
M01C-4	M0
M01C-5	M0
M01C-6	M0
M01C-7	M0
M01C-8	M0
M01C-9	M0
M01C-10	M0
M02C-1	NH
M02C-2	M0
M02C-3	NH
M02C-4	M7
M02C-5	M0
M02C-6	M0
M02C-7	M0
M02C-8	M0
M02C-9	M0

Table G-7 Statistics from the cross validation leave-one-out allocation of samples to location groups of 2002, 2005, 2008, 2011, 2014 and 2016 from base CAP analysis

Original group	LR	NH	B	M0	M3	M5	M7	PH	MB	Total samples	%correct
LR	45	12	2	0	0	0	1	0	0	60	75
NH	8	46	6	0	0	0	0	0	0	60	77
B	2	5	52	0	0	1	0	0	0	60	87
M0	2	2	1	41	8	1	5	0	0	60	68
M3	1	0	0	10	32	13	3	1	0	60	53
M5	1	1	0	4	13	25	12	2	2	60	42
M7	1	0	2	4	6	14	28	4	1	60	47
PH	0	0	0	0	1	2	10	28	19	60	47
MB	0	0	0	0	0	0	3	18	39	60	65

Table G-8 EPA sampling site coordinate grid centres

Sites of location	Easting (grid centre)	Northing (grid centre)	Latitude (S)	Longitude (E)	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)
Long Reef 1	349791.41	6266903.05	33º43.630'	151º22.720'	349666.41	6266778.05
Long Reef 2	349315.23	6264892.5	33º44.707'	151º22.393'	349190.23	6264767.5
North Head 1	347436.95	6257934.94	33º48.460'	151º21.100'	347311.95	6257809.94
North Head 2	347463.41	6256056.66	33º49.470'	151º21.100'	347338.41	6255931.66
Bondi 1	343415.85	6248226.1	33º53.670'	151º18.400'	343290.85	6248101.1
Bondi 2	344024.31	6250792.2	33º52.300'	151º18.820'	343899.31	6250667.2
Malabar 0 km 1	342807.4	6238966.99	33º58.680'	151º17.900'	342682.4	6238841.99
Malabar 0 km 2	343468.76	6239125.72	33º58.600'	151º18.325'	343343.76	6239000.72
Malabar 3 km 1	341378.85	6236506.71	34º00.000'	151º16.950'	341253.85	6236381.71
Malabar 3 km 2	341590.48	6236612.53	33º59.945'	151º17.085'	341465.48	6236487.53
Malabar 5 km 1	340638.12	6234628.44	34º01.000'	151º16.450'	340513.12	6234503.44
Malabar 5 km 2	340902.67	6234469.71	34º01.100'	151º16.615'	340777.67	6234344.71
Malabar 7 km 1	339527.03	6233041.16	34º01.860'	151º15.705'	339402.03	6232916.16
Malabar 7 km 2	339394.75	6232723.7	34º02.030'	151º15.615'	339269.75	6232598.7
Port Hacking 1	336749.29	6228649.7	34º04.200'	151º13.850'	336624.29	6228524.7
Port Hacking 2	336749.29	6228411.6	34º04.334'	151º13.845'	336624.29	6228286.6
Marley 1	331643.55	6221348.22	34º08.105'	151º10.450'	331518.55	6221223.22
Marley 2	331722.92	6221163.04	34º08.205'	151º10.500'	331597.92	6221038.04

Table G-9 Actual sub-sampling coordinates from collection of 2019 samples from sites 1 and 2 of three locations with replicate samples numbers

Location	Easting (grid centre)	Northing (grid centre	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)	Random number - x co-ord (0-5)	Random number - y co-ord (0-5)	Grid Easting	Grid Northing
North Head site 1								
Replicate 1	347437	6257935	347311.95	6257809.94	5	2	347540.0	6257908.9
Replicate 2	347437	6257935	347311.95	6257809.94	3	2	347453.0	6257890.5
Replicate 3	347437	6257935	347311.95	6257809.94	1	2	347350.2	6257909.6
Replicate 4	347437	6257935	347311.95	6257809.94	3	3	347476.1	6257975.3
Replicate 5	347437	6257935	347311.95	6257809.94	4	3	347528.7	6257946.1
North Head site 2								
Replicate 1	347463	6256057	347338.41	6255931.66	1	4	347403.2	6256135.6
Replicate 2	347463	6256057	347338.41	6255931.66	0	4	347344.8	6256115.6
Replicate 3	347463	6256057	347338.41	6255931.66	1	4	347371.4	6256124.8
Replicate 4	347463	6256057	347338.41	6255931.66	3	0	347508.6	6255951.6
Replicate 5	347463	6256057	347338.41	6255931.66	2	4	347418.5	6256109.4
Bondi site 1								
Replicate 1	343416	6248226	343290.85	6248101.1	3	0	343459.7	6248103.9
Replicate 2	343416	6248226	343290.85	6248101.1	1	3	343349.2	6248259.6
Replicate 3	343416	6248226	343290.85	6248101.1	1	3	343364.9	6248273.0
Replicate 4	343416	6248226	343290.85	6248101.1	4	2	343481.4	6248201.6
Replicate 5	343416	6248226	343290.85	6248101.1	4	4	343512.4	6248289.7
Bondi site 2								
Replicate 1	344024	6250792	343899.31	6250667.2	3	5	344037.2	6250892.6
Replicate 2	344024	6250792	343899.31	6250667.2	3	4	344027.2	6250849.3
Replicate 3	344024	6250792	343899.31	6250667.2	2	2	344003.0	6250788.8

Location	Easting (grid centre)	Northing (grid centre	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)	Random number - x co-ord (0-5)	Random number - y co-ord (0-5)	Grid Easting	Grid Northing
Replicate 4	344024	6250792	343899.31	6250667.2	3	2	344040.6	6250757.8
Replicate 5	344024	6250792	343899.31	6250667.2	2	2	343998.4	6250778.4
Malabar 0km site 1								
Replicate 1	342807	6238967	342682.4	6238841.99	4	1	342893.4	6238886.0
Replicate 2	342807	6238967	342682.4	6238841.99	2	4	342794.6	6239037.7
Replicate 3	342807	6238967	342682.4	6238841.99	2	2	342767.0	6238925.4
Replicate 4	342807	6238967	342682.4	6238841.99	5	3	342918.9	6238992.0
Replicate 5	342807	6238967	342682.4	6238841.99	4	5	342869.1	6239070.3
Replicate 6	342807	6238967	342682.4	6238841.99	0	2	342700.5	6238920.4
Replicate 7	342807	6238967	342682.4	6238841.99	2	4	342792.3	6239052.3
Replicate 8	342807	6238967	342682.4	6238841.99	3	2	342819.5	6238949.7
Replicate 9	342807	6238967	342682.4	6238841.99	5	2	342925.2	6238936.2
Replicate 10	342807	6238967	342682.4	6238841.99	2	2	342795.6	6238961.6
Malabar 0km site 2								
Replicate 1	343469	6239126	343343.76	6239000.72	3	2	343492.0	6239088.4
Replicate 2	343469	6239126	343343.76	6239000.72	4	3	343548.6	6239165.0
Replicate 3	343469	6239126	343343.76	6239000.72	0	1	343345.0	6239075.3
Replicate 4	343469	6239126	343343.76	6239000.72	5	5	343593.5	6239237.2
Replicate 5	343469	6239126	343343.76	6239000.72	5	2	343572.5	6239076.2
Replicate 6	343469	6239126	343343.76	6239000.72	4	4	343525.3	6239202.6
Replicate 7	343469	6239126	343343.76	6239000.72	1	5	343402.8	6239245.4
Replicate 8	343469	6239126	343343.76	6239000.72	5	0	343578.3	6239005.6
Replicate 9	343469	6239126	343343.76	6239000.72	1	0	343385.2	6239015.0

Table G-10 Invertebrate data from the Malabar 0 km location in 2019 from sites 1 and 2

				M01	M01	M01	M01	M01	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02	M02	M02	M02	M02
			Replicate	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9
Phylum	**Class**	**Order**	**Family**																			
Annelida	Clitellata	Oligochaeta	Indeterminate			1			2		3		2									
Annelida	Polychaeta	Amphinomida	Amphinomidae			1		3							3							
Annelida	Polychaeta	Eunicida	Lumbrineridae	8	17	6	6	6	3	5	12	11	10				2	1	1	1	4	5
Annelida	Polychaeta	Eunicida	Oenonidae	1		1	1	1			1	1	1		2	1	2				1	2
Annelida	Polychaeta	Eunicida	Onuphidae	1		1		1	2					4	9	32	1	7	2	6	11	12
Annelida	Polychaeta	Phyllodocida	Acoetidae																			1
Annelida	Polychaeta	Phyllodocida	Glyceridae																1			
Annelida	Polychaeta	Phyllodocida	Nephtyidae		1	2			1									1	1	1	1	
Annelida	Polychaeta	Phyllodocida	Nereididae			1		1	1		2	2	1	1						1		
Annelida	Polychaeta	Phyllodocida	Phyllodocidae	1	2						2	1	1	1	3	1	1			2	2	2
Annelida	Polychaeta	Phyllodocida	Polynoidae	2	2									3						2		
Annelida	Polychaeta	Phyllodocida	Sigalionidae										1				1					
Annelida	Polychaeta	Phyllodocida	Sphaerodoridae		1					1												
Annelida	Polychaeta	Phyllodocida	Goniadidae	1		2	1	1	2	4	2	1		1	1		3	3				3
Annelida	Polychaeta	Phyllodocida	Syllidae	13	17	13	5	14	10	11	20	13	14		2	1		3	3	5	7	5
Annelida	Polychaeta	Sabellida	Sabellidae	18	7	5	8	31	8	5	13	4	8	1	12		14	7	30	34	20	9
Annelida	Polychaeta	Sabellida	Oweniidae	56	132	23	11	445	117	98	173	50	30		160	2	18	9	99	34	3	7
Annelida	Polychaeta	Scolecida	Capitellidae	1									1	1				1				
Annelida	Polychaeta	Scolecida	Maldanidae	159	169	105	118	312	106	191	194	139	102		170	18	53	88	167	136	184	84
Annelida	Polychaeta	Scolecida	Paraonidae	8	5	11	1	6	12	3	15	9	15			3		2		3	1	5
Annelida	Polychaeta	Scolecida	Scalibregmatidae	1	1			1	1		1	1	2									
Annelida	Polychaeta	Scolecida	Opheliidae	1	4		1			3	8							1			2	2
Annelida	Polychaeta	Scolecida	Orbiniidae	2	5	4	4	2	3	4	12	1	4	1	1						4	
Annelida	Polychaeta	Spionida	Magelonidae											1								
Annelida	Polychaeta	Spionida	Spionidae	58	56	68	27	41	61	45	128	62	62	1	13	2	16	26	47	18	29	24
Annelida	Polychaeta	Spionida	Chaetopteridae		3	2	1			1								2	2	1		2
Annelida	Polychaeta	Terebellida	Ampharetidae	1	2	5		1	22		5		6				1		1	1		
Annelida	Polychaeta	Terebellida	Cirratulidae		2	3	1	2	1		2		1	1		1		1	1	2	2	1
Annelida	Polychaeta	Terebellida	Pectinariidae			1		1		1				1							1	
Annelida	Polychaeta	Terebellida	Trichobranchidae	7	2		1				1									1		
Annelida	Polycheata	Terebellida	Trichobranchidae/Terebellidae	5	1	1		19	1	2	7	3	3						1			1
Arthropoda	Malacostraca	Amphipoda	Amaryllididae							1					1							
Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	1	4	7	1	1	5	2	10	2	5					4	3		6	1
Arthropoda	Malacostraca	Amphipoda	Aoridae/Isaeidae/Photidae/Unciolidae	4	9	1	2	15	10	9	3		4	3	14	12	3	4	13	10	20	4
Arthropoda	Malacostraca	Amphipoda	Atylidae							2	1									1		
Arthropoda	Malacostraca	Amphipoda	Caprellidae	2		1	3			1			1		1			1			1	

				M01	M01	M01	M01	M01	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02	M02	M02	M02	M02
				1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9
Arthropoda	Malacostraca	Amphipoda	Corophiidae													3						
Arthropoda	Malacostraca	Amphipoda	Eusiridae							1								1				
Arthropoda	Malacostraca	Amphipoda	Iciliidae				1															
Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	3	3		1			1			1	1	10	5		9	5	3	4	1
Arthropoda	Malacostraca	Amphipoda	Leucothoidae													1		1				
Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae					1	1		1	1	1		1			1	1		2	1
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	3	14	1	4	7	4	8	7	1	2	2	3			2	4	3	2	2
Arthropoda	Malacostraca	Amphipoda	Melitidae														2					
Arthropoda	Malacostraca	Amphipoda	Oedicerotidae			1										1				1		1
Arthropoda	Malacostraca	Amphipoda	Pachynid Group																		1	1
Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	15	9	4	2	14	4	9	12	5	2	1	3			3	3	4	9	6
Arthropoda	Malacostraca	Amphipoda	Podoceridae				2	1													2	
Arthropoda	Malacostraca	Amphipoda	Urothoidae											1								
Arthropoda	Malacostraca	Cumacea	Bodotriidae									1										
Arthropoda	Malacostraca	Cumacea	Bodotriidae/Nannastacidae										1									
Arthropoda	Malacostraca	Cumacea	Diastylidae/Gynodiastylidae								1											
Arthropoda	Malacostraca	Decapoda	Callianassidae	2	1	1	2		1		3	1	4	1			2	4	5	3	2	2
Arthropoda	Malacostraca	Decapoda	Goneplacidae				1															
Arthropoda	Malacostraca	Decapoda	Hexapodidae	1	3				1		2				1		1		1			
Arthropoda	Malacostraca	Decapoda	Leucosiidae																		1	
Arthropoda	Malacostraca	Decapoda	Paguridae							1								4				
Arthropoda	Malacostraca	Decapoda	Paguroidea	1	2							1	1		3	2			1	1	2	
Arthropoda	Malacostraca	Decapoda	Pasiphaeidae	1	2		1					1	1					2				
Arthropoda	Malacostraca	Decapoda	Raninidae				1						1				1		2			
Arthropoda	Malacostraca	Decapoda	Indeterminate					1														
Arthropoda	Malacostraca	Isopoda	Antarcturidae	5	5		17	1		5	1											
Arthropoda	Malacostraca	Isopoda	Anthuridae	2	8	12	5	1	12	1	13	2	7		2		1	1	1	3	2	2
Arthropoda	Malacostraca	Isopoda	Arcturidae		1		1	2		2		1	1		1						5	
Arthropoda	Malacostraca	Isopoda	Cirolanidae		2	2		1	1	3	5	2	1		1			3		3	4	1
Arthropoda	Malacostraca	Isopoda	Gnathiidae												1							
Arthropoda	Malacostraca	Isopoda	Leptanthuridae	3						2	2		2							1		2
Arthropoda	Malacostraca	Isopoda	Paramunnidae					2														
Arthropoda	Malacostraca	Isopoda	Paranthuridae	3	3	2		6	2		4	4	2	3	1	1		1		2	6	4
Arthropoda	Malacostraca	Isopoda	Rectarcturidae									1										
Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	3	3			1		1									2	2	6	
Arthropoda	Malacostraca	Nebaliacea	Nebaliidae			2					2		1									
Arthropoda	Malacostraca	Tanaidacea	Apseudidae	5	5		2	9	3	7	7	1	3	1								1
Arthropoda	Malacostraca	Tanaidacea	Leptocheliidae	15	11	3	6	49	10	21	3	3	3		35	1	2	2	15	14	10	10

				M01	M01	M01	M01	M01	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02	M02	M02	M02	M02
				1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9
Arthropoda	Malacostraca	Tanaidacea	Neotanaidae/Leptocheliidae						1						1					3		
Arthropoda	Malacostraca	Tanaidacea	Paratanaidae	4	2	2	1	10		7	1				2		1		2		3	2
Arthropoda	Malacostraca	Tanaidacea	Whiteleggiidae												2	1						
Arthropoda	Maxillopoda	Calanoida	Calanoida													1						
Arthropoda	Maxillopoda	Indeterminate	Indeterminate					1	1		1											
Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae		2			1		1			2	1	2			1	1	1		1
Arthropoda	Ostracoda	Myodocopida	Cypridinidae/Rutidermatidae		1			1	2	1	1			1		2						
Arthropoda	Ostracoda	Myodocopida	Sarsiellidae							1	2									1	1	
Arthropoda	Pycnogonida	Indeterminate	Indeterminate					4							2					1		
Bryozoa	Indeterminate	Indeterminate	Indeterminate					1						1			1					
Cnidaria	Anthozoa	Actinaria	Indeterminate		1			1					2				1					
Echinodermata	Asteroidea	Indeterminate	Indeterminate								1											
Echinodermata	Echinoidea	Indeterminate	Indeterminate	2	4			7	1	2	2				3		1	2	6	2	1	3
Echinodermata	Holothuroidea	Indeterminate	Indeterminate											1		1					3	
Echinodermata	Ophiuroidea	Indeterminate	Indeterminate	88	95	33	35	78	72	85	65	18	40	11	65	4	26	2	87	12	3	4
Mollusca	Aplacophora	Indeterminate	Indeterminate		1	3		1		2	4	2					1			2	3	2
Mollusca	Bivalva	Lucinoida	Lucinidae	4	5	2	2	1	1				1	1	1				2	1	1	1
Mollusca	Bivalva	Mytiloida	Mytilidae	6		1	1	2			1			1					2	3	1	
Mollusca	Bivalva	Nuculida	Nuculanidae	1																		
Mollusca	Bivalva	Nuculida	Nuculidae		1		1						2	1			1					
Mollusca	Bivalva	Pectinoida	Propeamussiidae							1										2		
Mollusca	Bivalva	Solemyoida	Solemyidae			1			1						1				1		1	
Mollusca	Bivalva	Indeterminate	Indeterminate					1														
Mollusca	Bivalva	Veneroida	Cardiidae										1									
Mollusca	Bivalva	Veneroida	Galeommatidae					1		1												
Mollusca	Bivalva	Veneroida	Trapeziidae						1													
Mollusca	Bivalvia	Veneroida	Kelliidae					1														
Mollusca	Gastropoda	Cephalaspidea	Cylichnidae											1								
Mollusca	Gastropoda	Littorinimorpha	Anabathridae					5	1	6									1		1	
Mollusca	Gastropoda	Littorinimorpha	Rissoidae		1			2												1		
Mollusca	Gastropoda	Indeterminate	Skeneidae											1						1		
Mollusca	Gastropoda	Neogastropoda	Marginellidae											1								
Mollusca	Gastropoda	Neogastropoda	Nassariidae		1																	
Mollusca	Gastropoda	Neogastropoda	Volutomitridae								1											
Mollusca	Gastropoda	(unassigned) Heterobranchia	Acteonidae															1		1		
Mollusca	Gastropoda	(unassigned) Heterobranchia	Pyramidellidae			1								1								
Mollusca	Gastropoda	Indeterminate	Indeterminate	1																		

				M01	M01	M01	M01	M01	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02	M02	M02	M02	M02
				1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9
Mollusca	Scaphopoda	Dentaliida	Laevidentaliidae															1				
Nematoda	Indeterminate	Indeterminate	Indeterminate					1			1		1						1			1
Nemertea	Indeterminate	Indeterminate	Indeterminate	2	2	14		5	1	1	3		2		1			1			1	1
Platyhelminthes	Indeterminate	Indeterminate	Indeterminate											3								
Porifera	Indeterminate	Indeterminate	Indeterminate																	1		
Sipuncula	Indeterminate	Indeterminate	Indeterminate																		1	

Appendix H Harbour and beaches

The analysis of the Beachwatch data has been designed to identify potential wastewater overflows or leakage **under dry weather conditions**. Overflows or leakage reaching the waterways during dry weather conditions pose a greater risk to public health. The wet weather public health risk for recreational activities in waterways (harbour and beaches) are a known fact and people are generally well aware of this.

Assumptions behind the data for Beachwatch analysis:

- *Enterococci* results without a respective conductivity value were excluded. Conductivity results for many sites were not available prior to 2013. Conductivity data is required to separate dry weather data from wet weather data.
- Only dry weather results were included in these plots. *Enterococci* results below 30,000 μS/cm conductivity level were considered extreme wet weather and not included in these plots
- Data labels are shown in plots for all values ≥ 230 cfu/100mL, which is the secondary contact recreation guideline (ANZECC 2000).

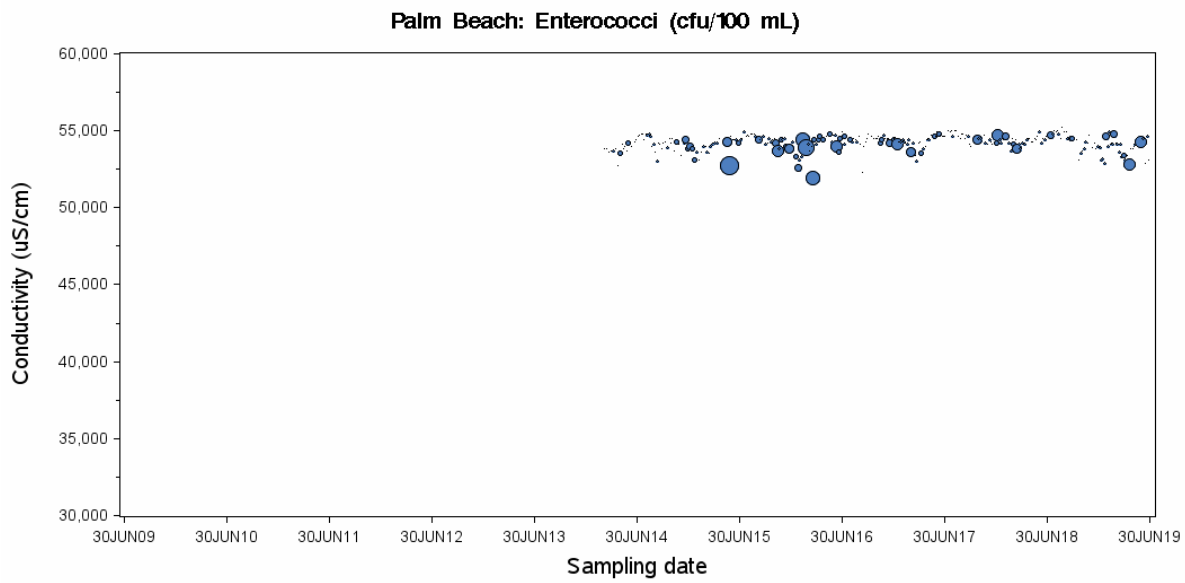
The Beachwatch results are presented in the following order similar to monitoring programs and sub-catchments as stated in the method section of Volume 1:

- Sydney Beaches
  - Northern Sydney
  - Central Sydney
  - Southern Sydney
- Illawarra Beaches
  - Wollongong
  - Shellharbour
  - Bombo
- Harbours
  - Botany Bay and Georges River
  - Port Hackings
  - Port Jackson
  - Middle Harbour
  - Pittwater

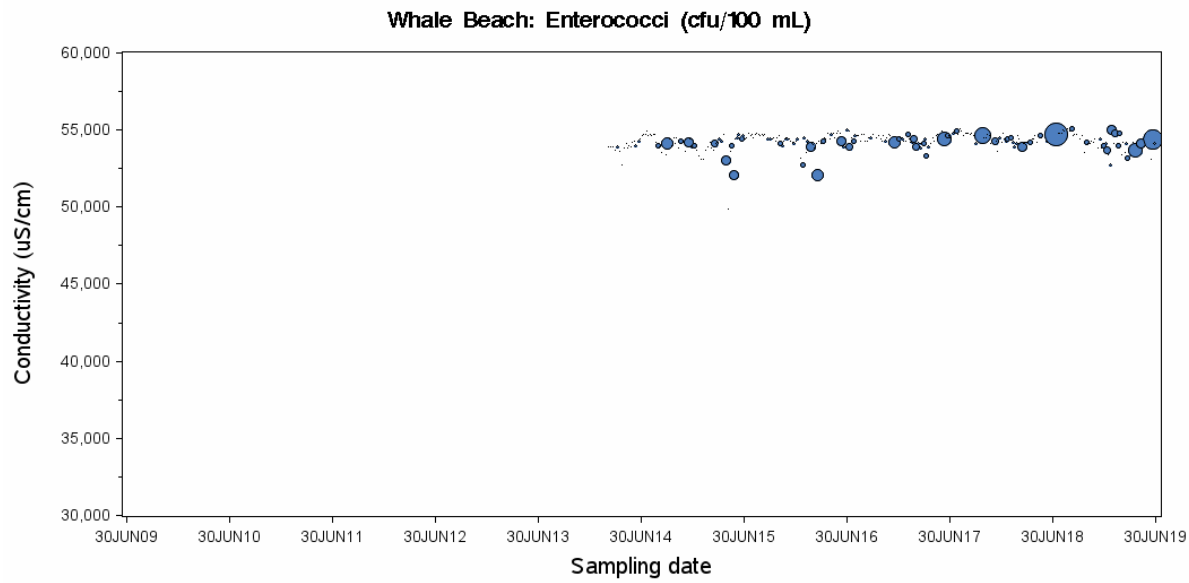
The sites under each sub-catchment are presented in the order from north coast to south coast. When the sub-catchment is a harbour with sites on both coasts then sites on south coasts were stated first and then following clockwise direction to the north coast.

Note: The size of the bubble can not be compared between plots precisely due to software limitation. Bubble size for each site varied based on maximum value for that site using following ranges:

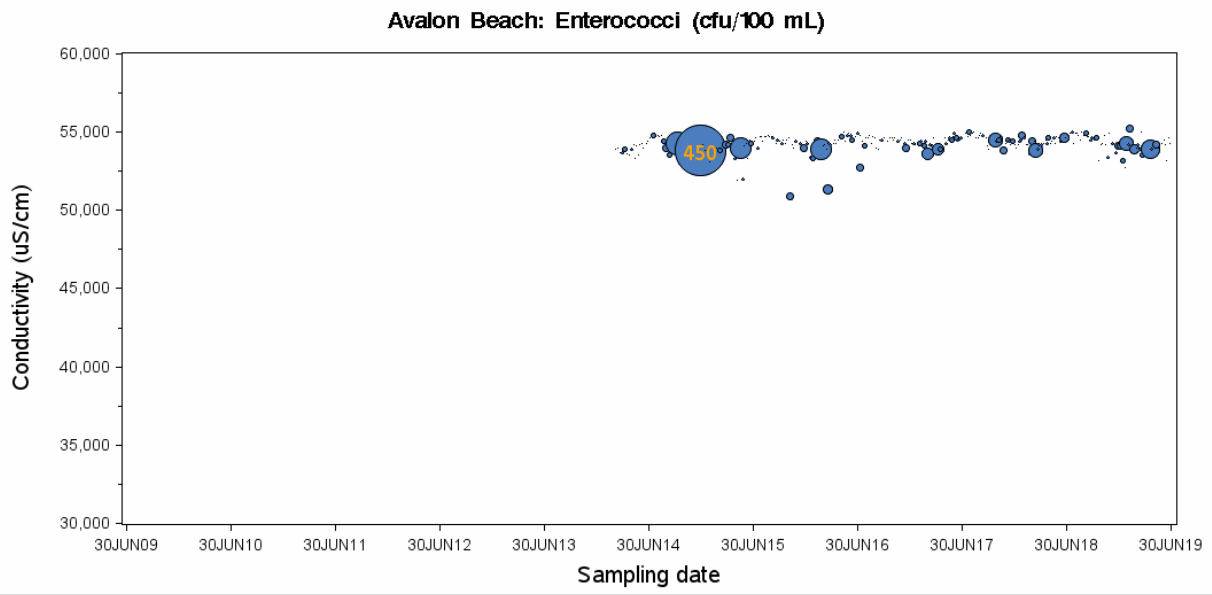
Bubble size	Range of maximum Enterococci value (cfu/100mL)
5	<200
6	200 to 399
7	400 to 599
8	600 to 799
9	800 to 999
10	1,000 to 2,999
11	3,000 to 5,999
12	6,000 to 9999
15	10,000 or more

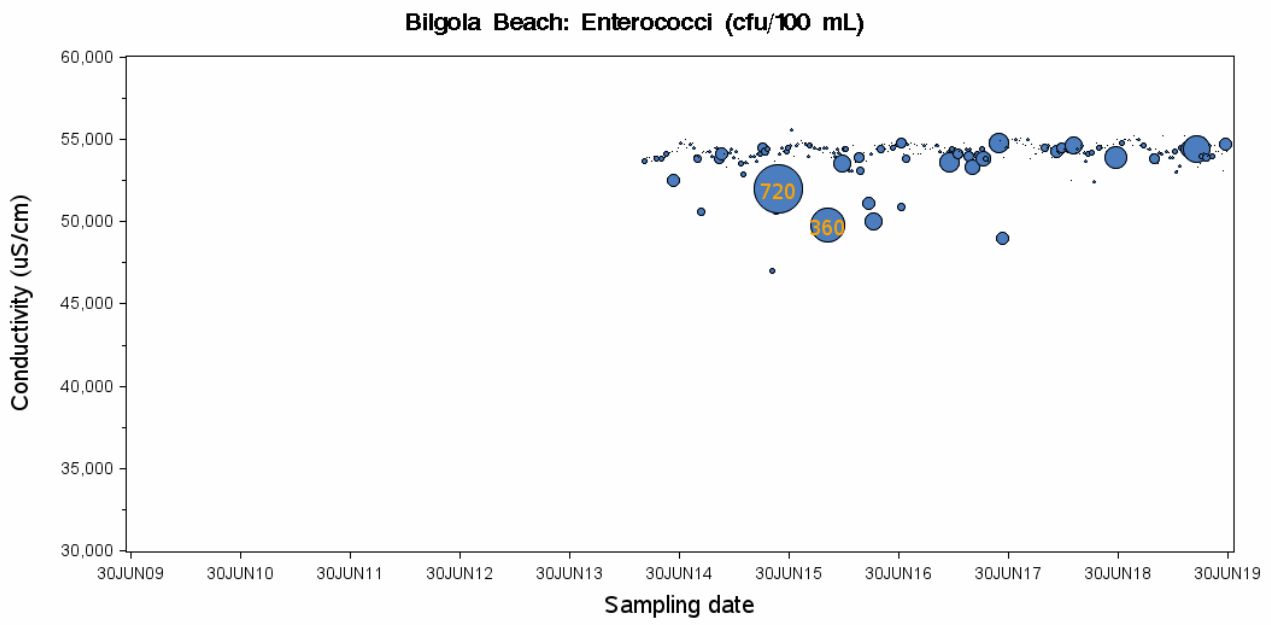


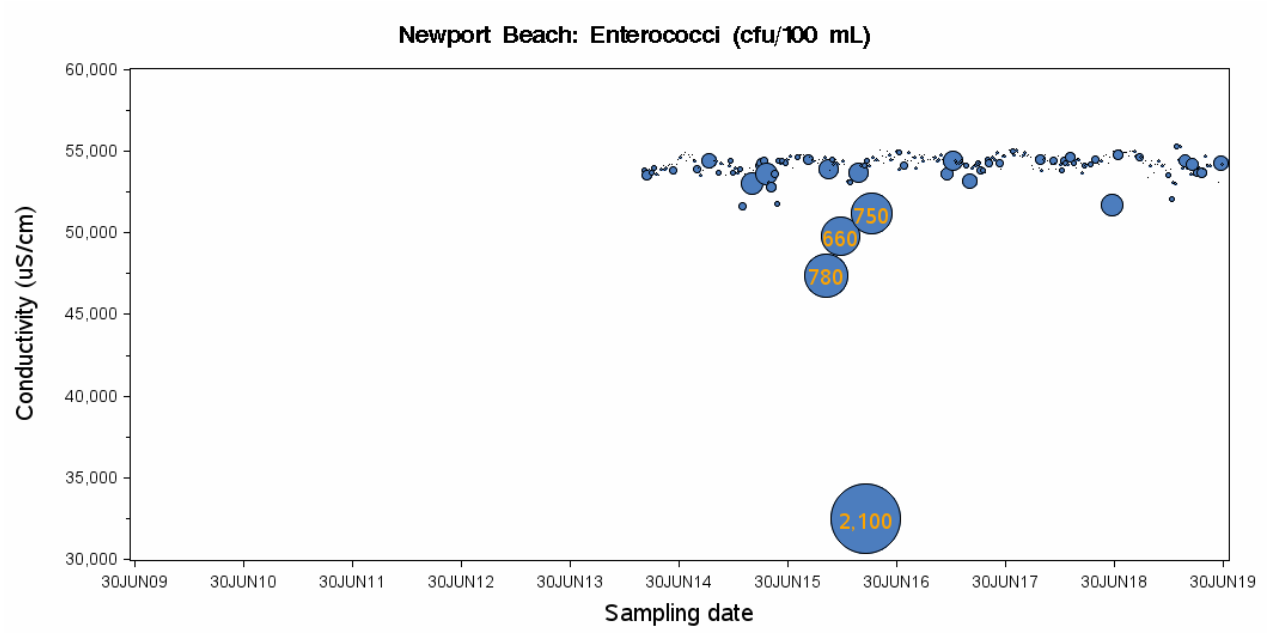
Note: No extreme values found (≥230 cfu/100mL) to mark using data labels

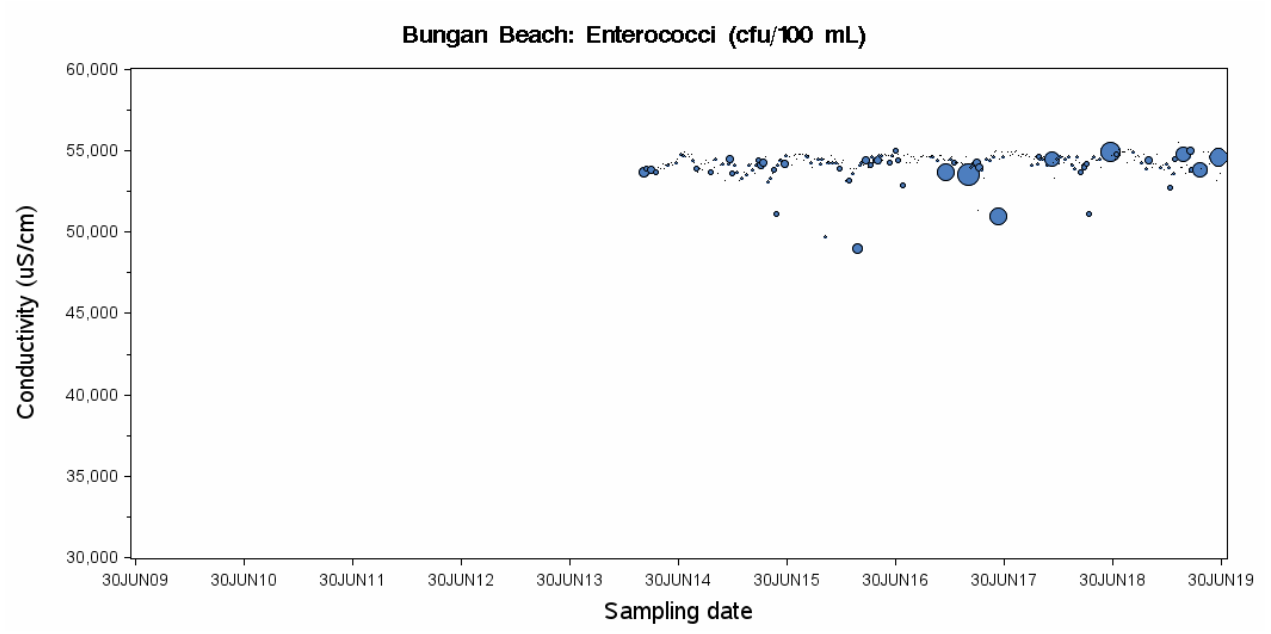


Note: No extreme values found (≥230 cfu/100mL) to mark using data labels

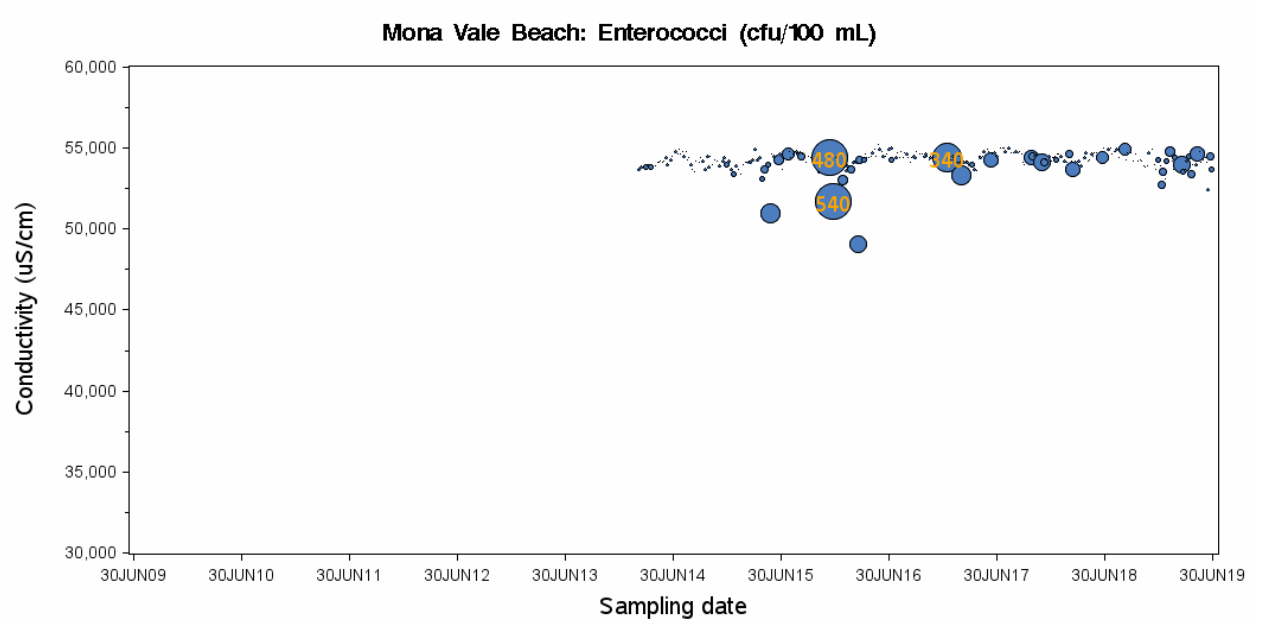


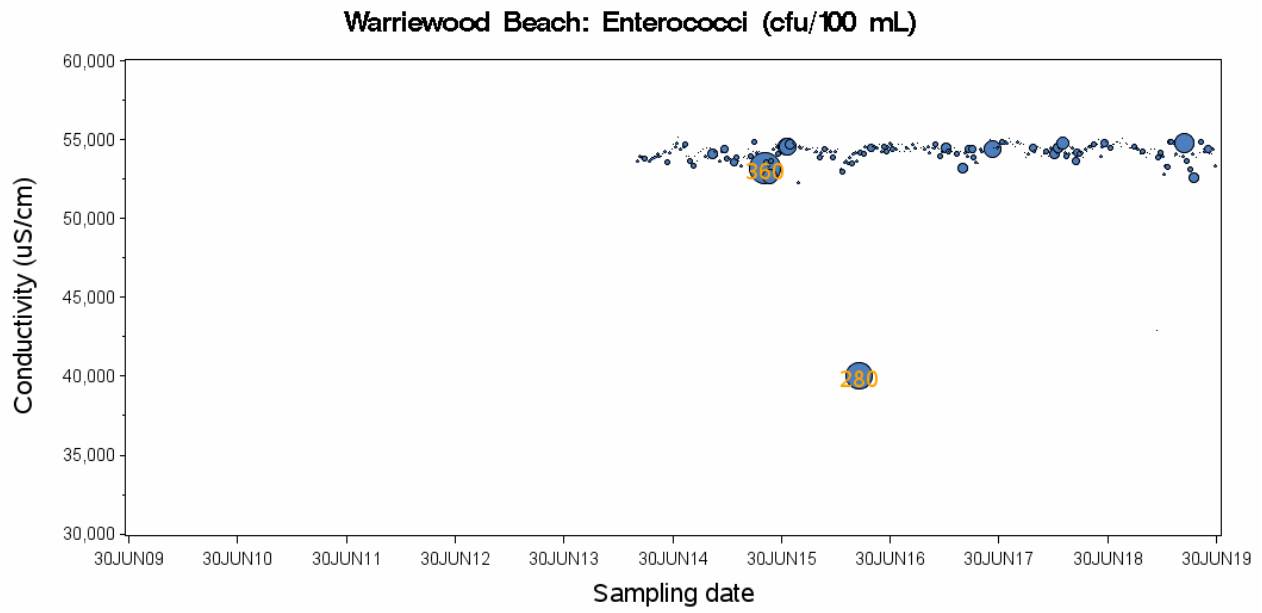


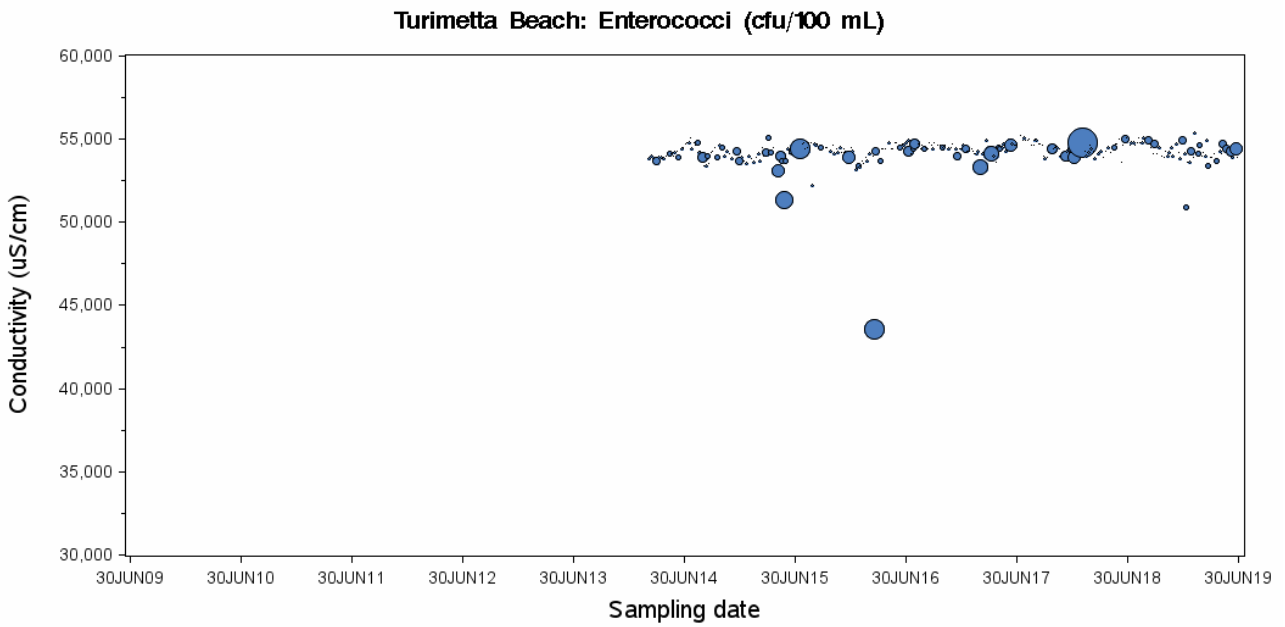




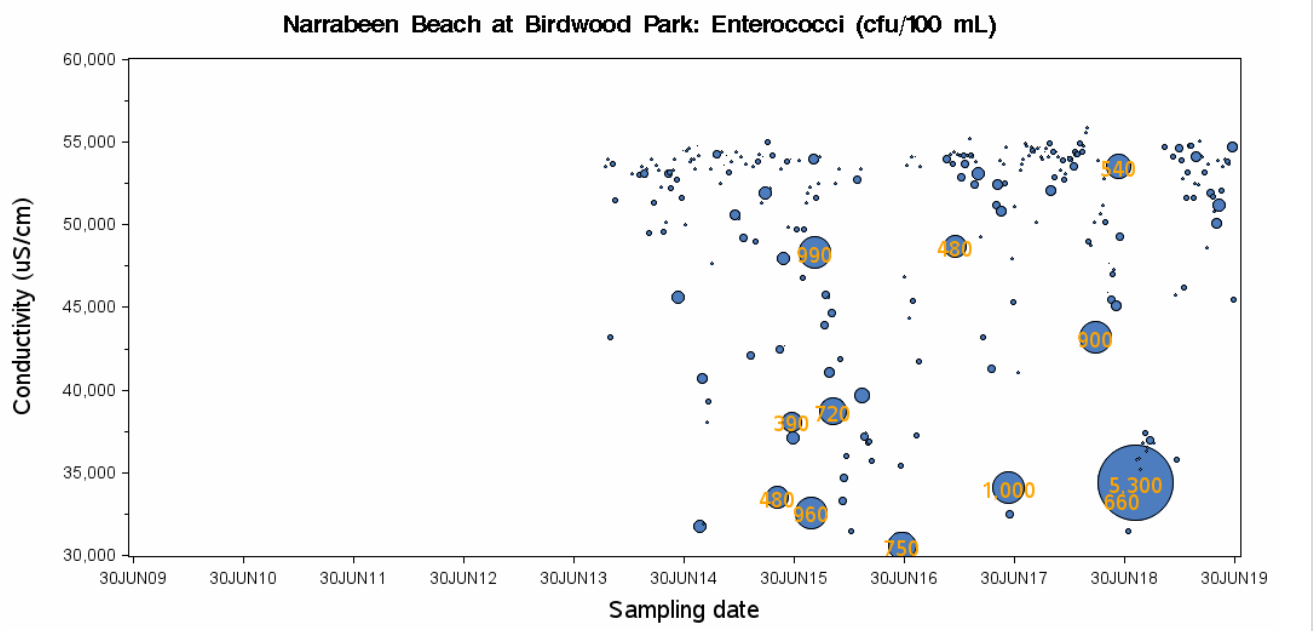
Note: No extreme values found (≥230 cfu/100mL) to mark using data labels

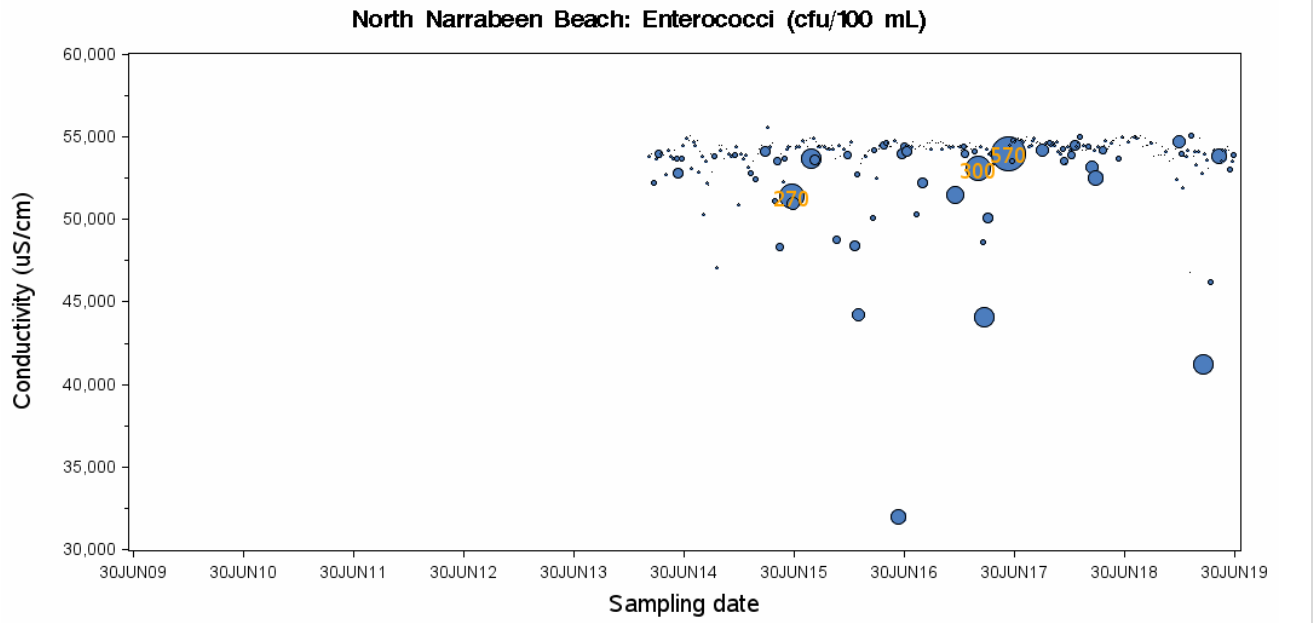


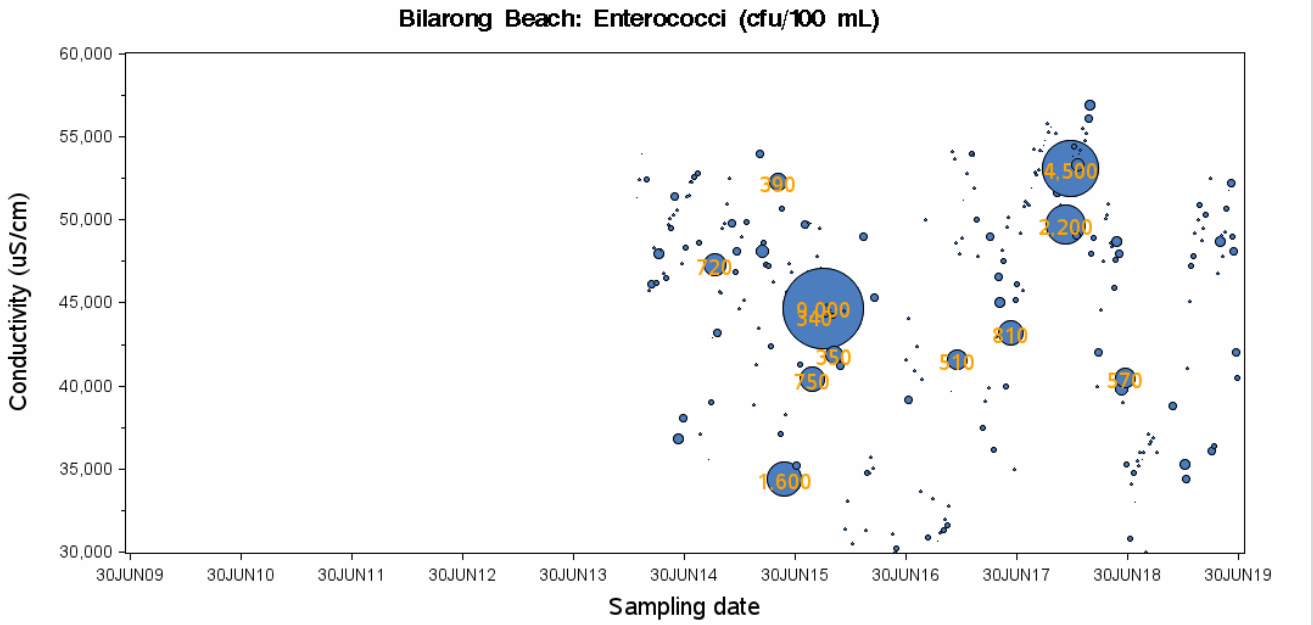


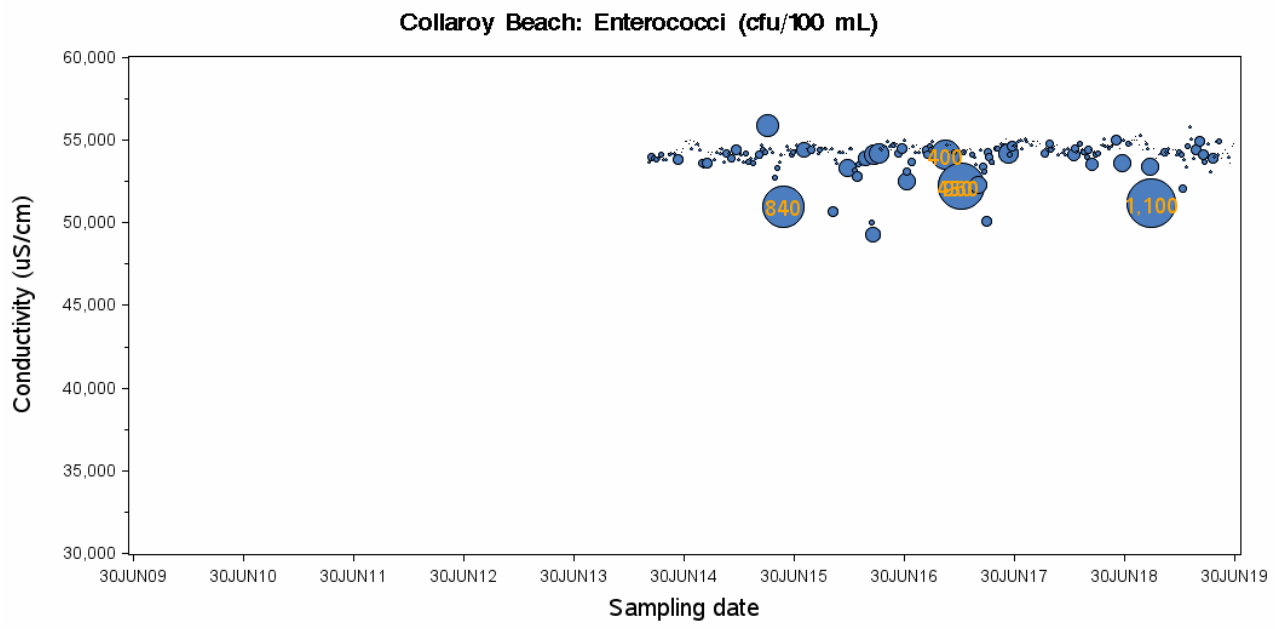


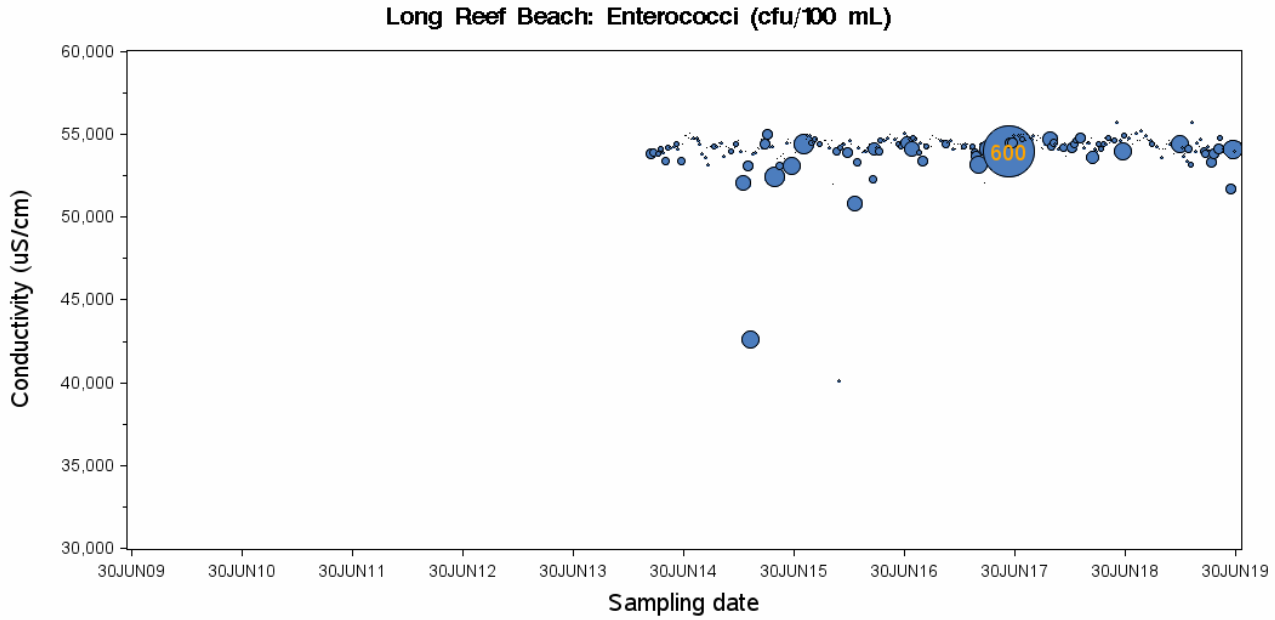
Note: No extreme values found (≥230 cfu/100mL) to mark using data labels

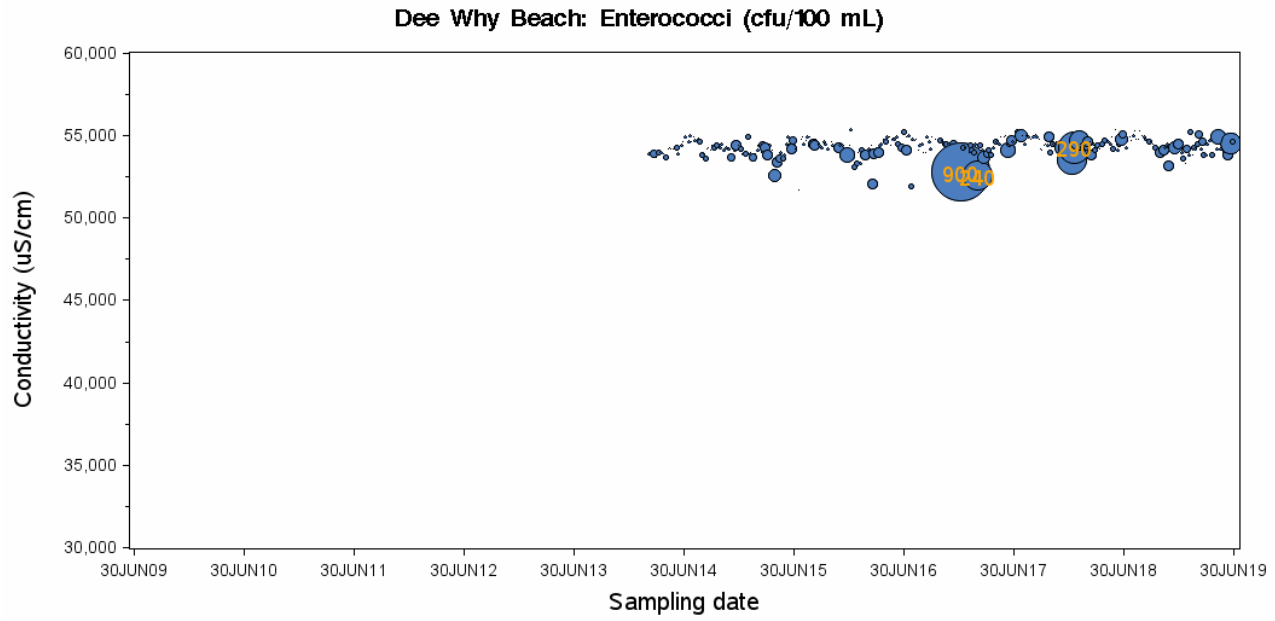

Narrabeen Beach at Birdwood Park: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
540
990
480
900
390
720
480
960
1,000
5,300
660
750

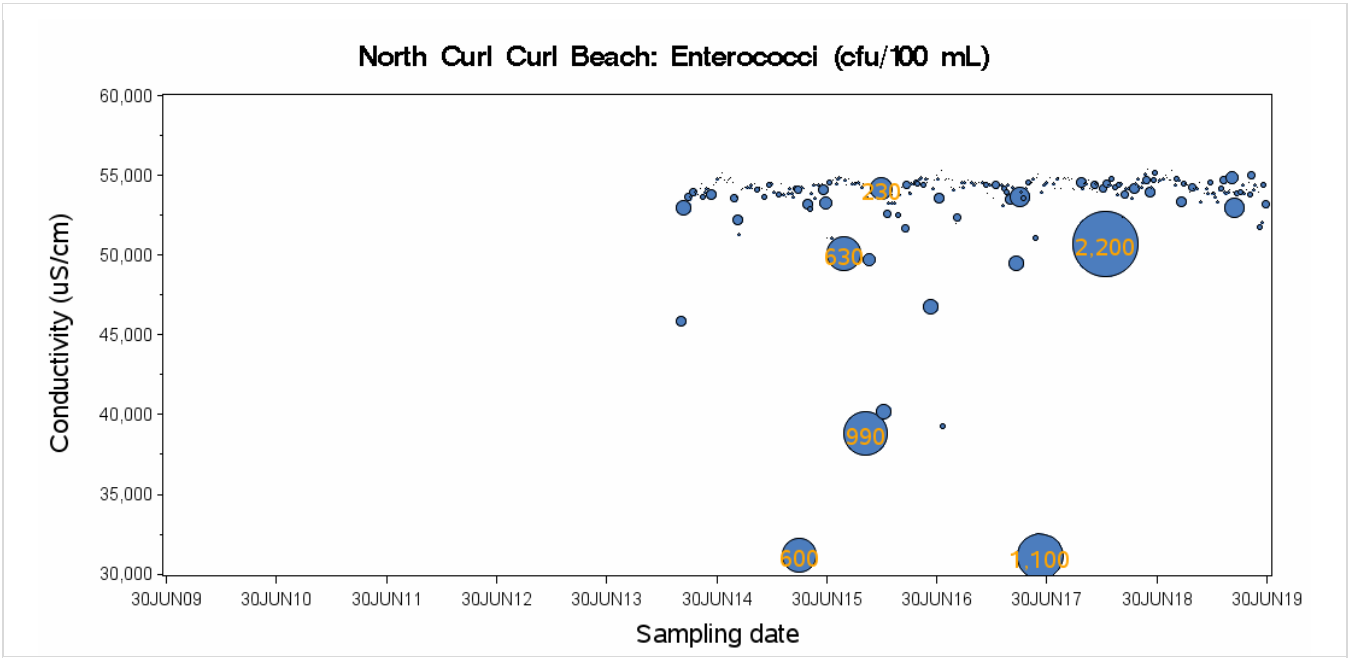

North Narrabeen Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
570
300
570

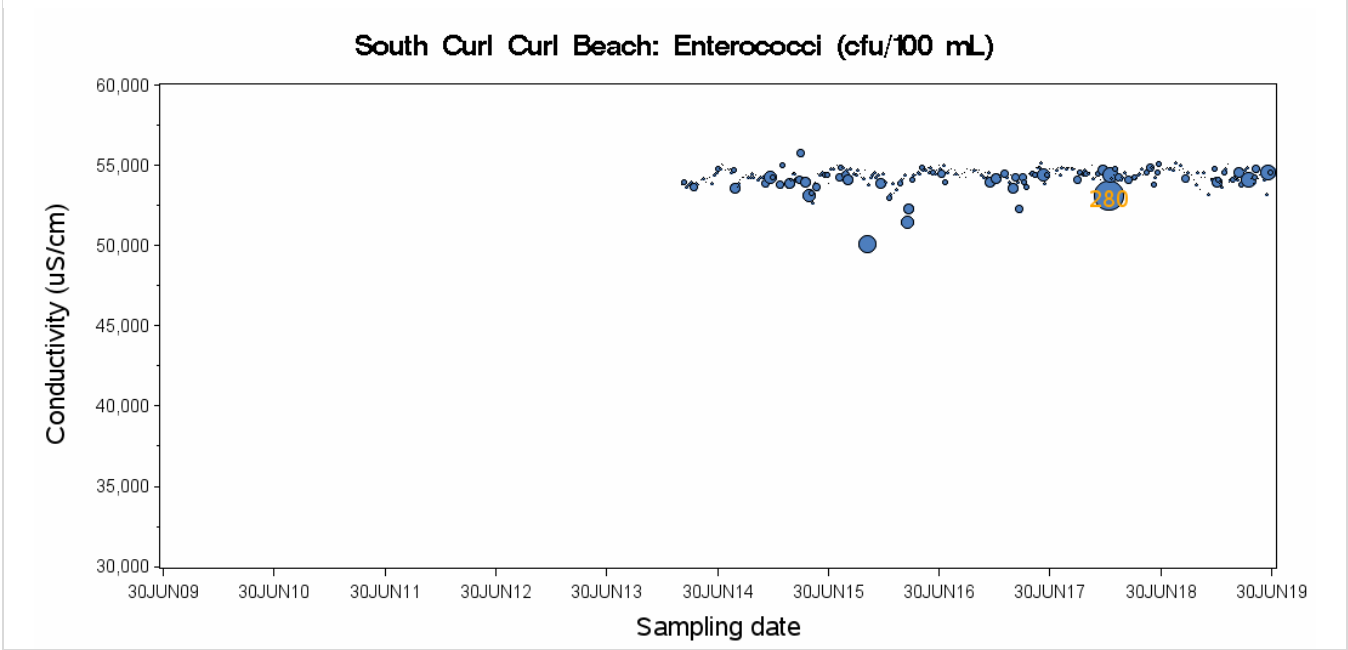

Bilarong Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
390
4,500
2,200
720
9,400
340
810
350
510
750
570
1,600

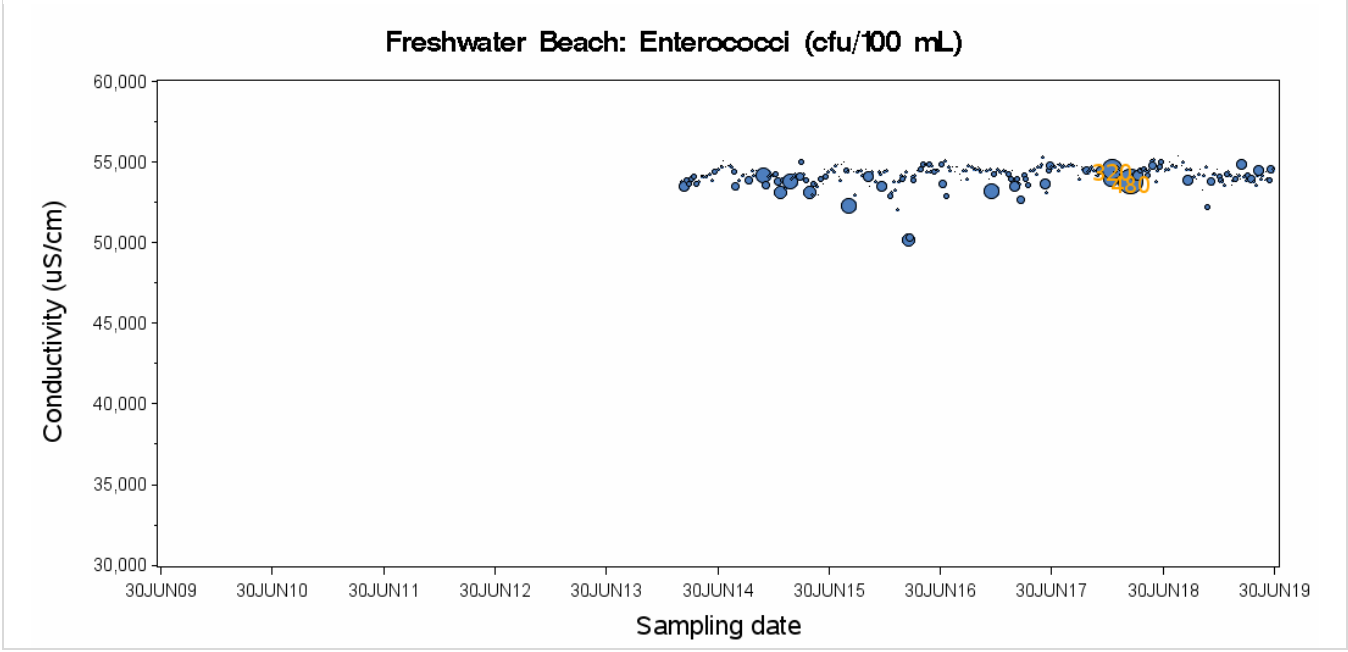

Collaroy Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
840
400
1,100
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

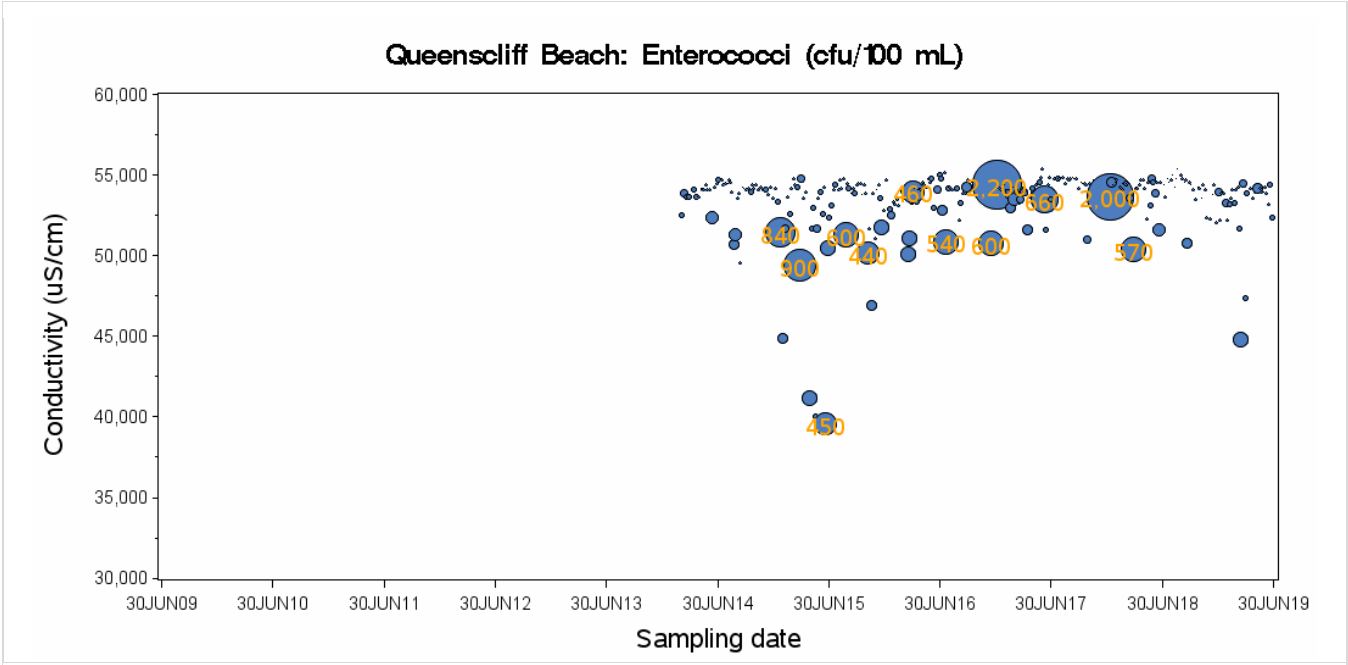

Long Reef Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
600
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

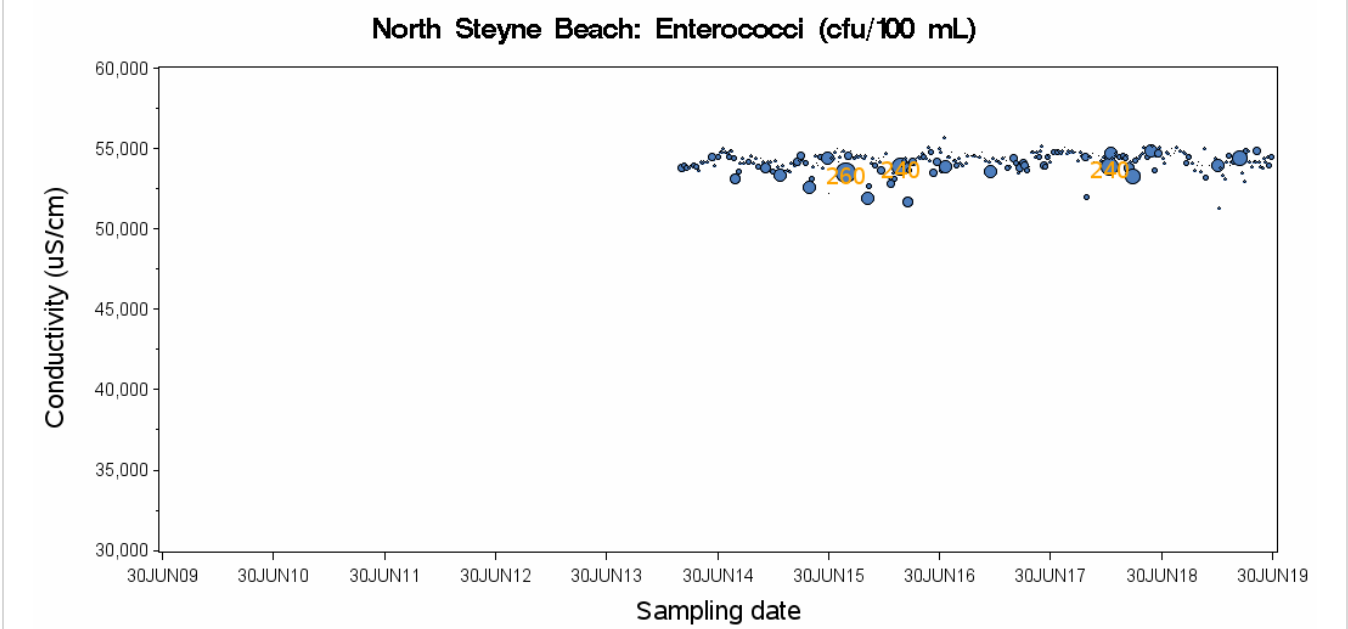

Dee Why Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
296
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

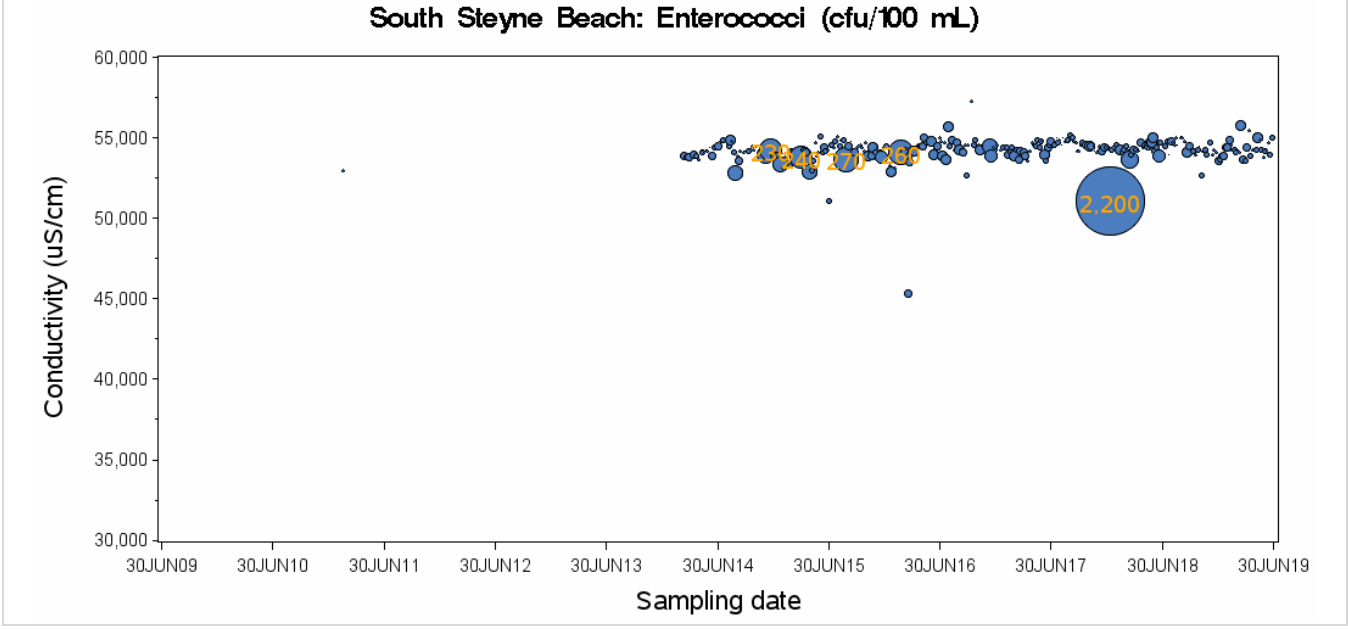

North Curl Curl Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
230
630
2,200
990
600
1,100
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

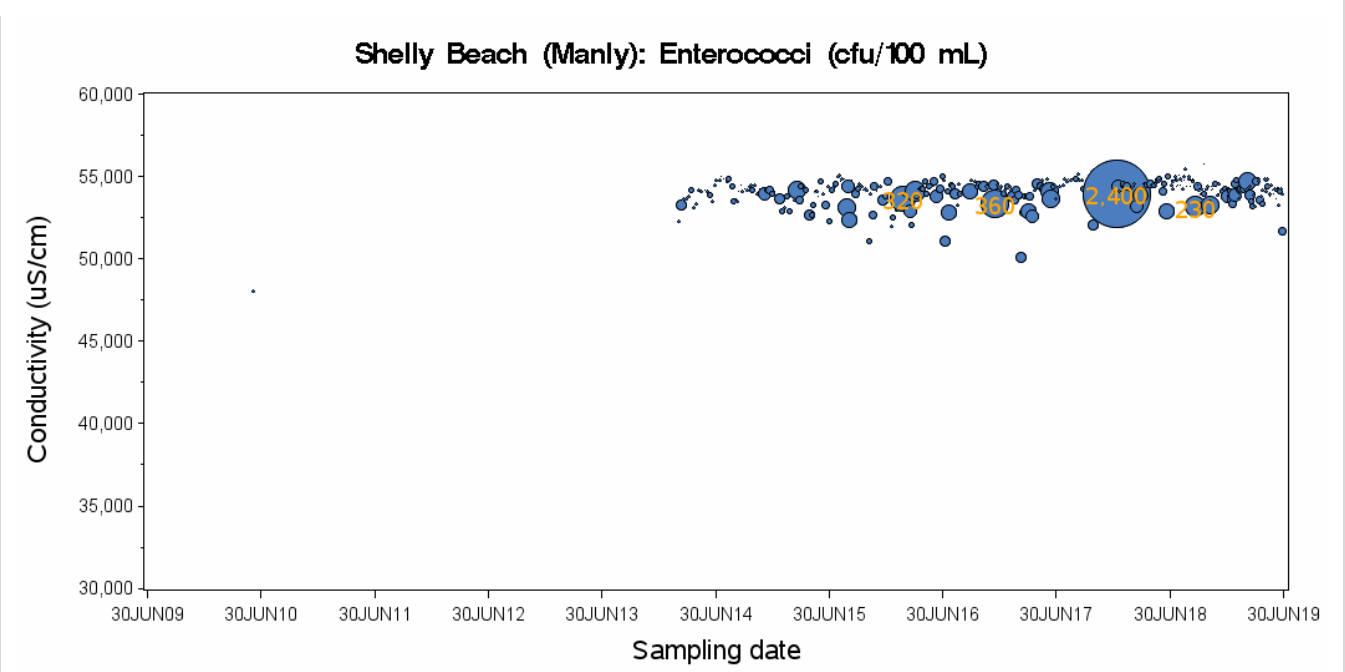

South Curl Curl Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
280
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date


Freshwater Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

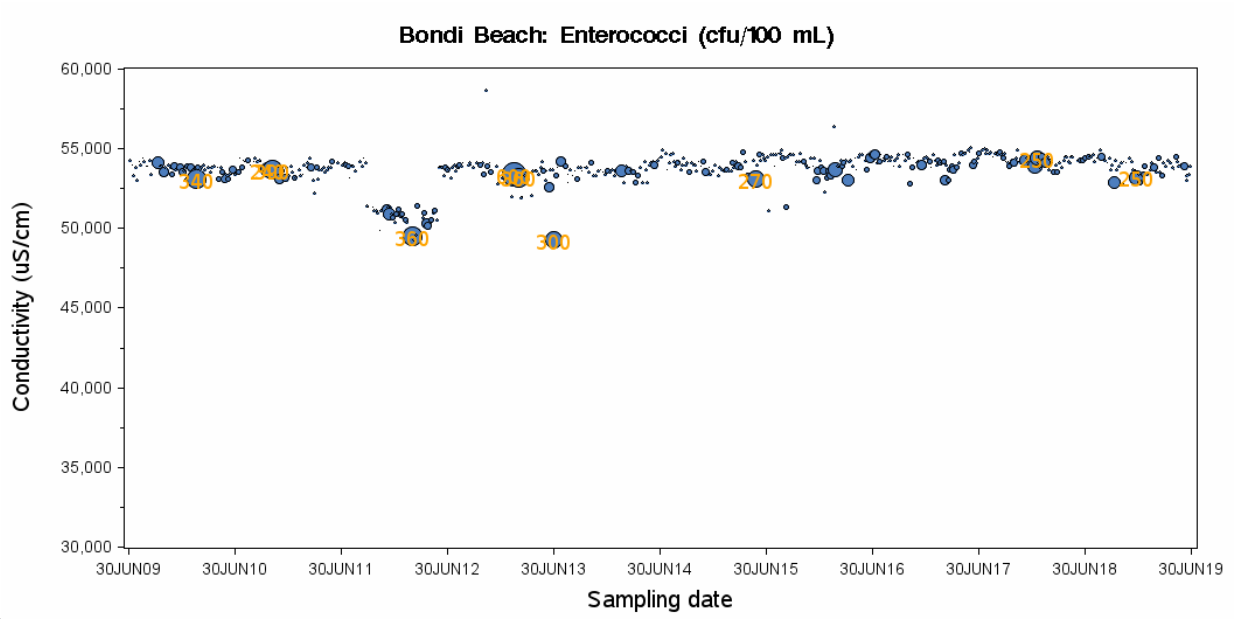

Queenscliff Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
460
2,200
660
2,000
840
800
540
600
400
570
900
450

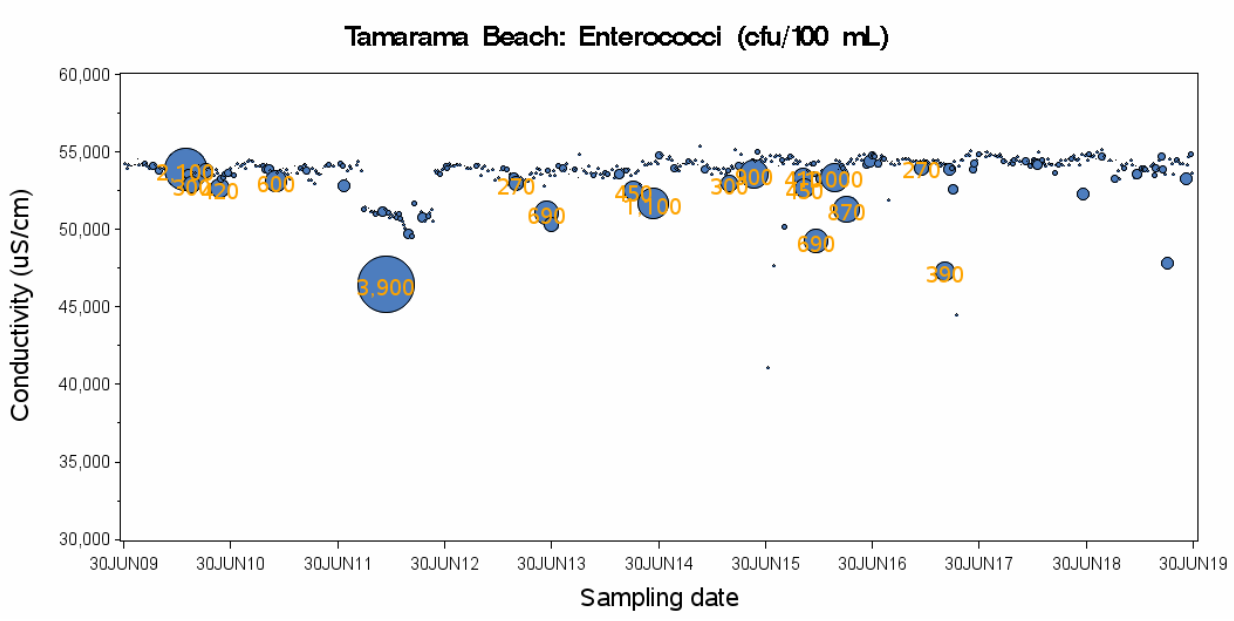

North Steyne Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
260
240

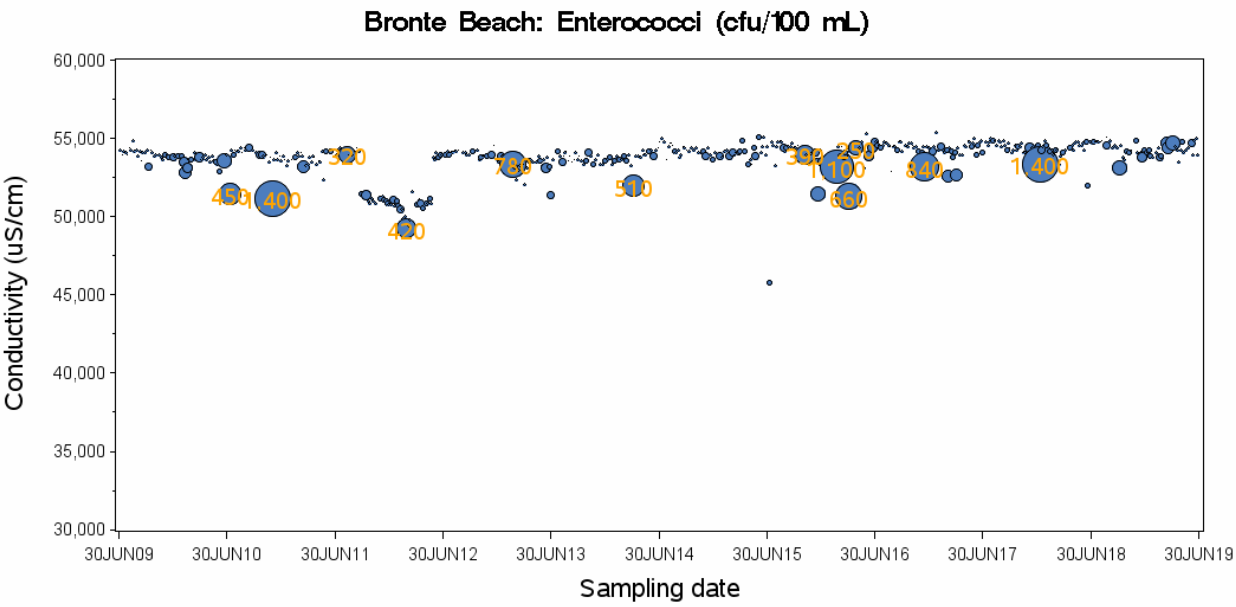

South Steyne Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
2,200

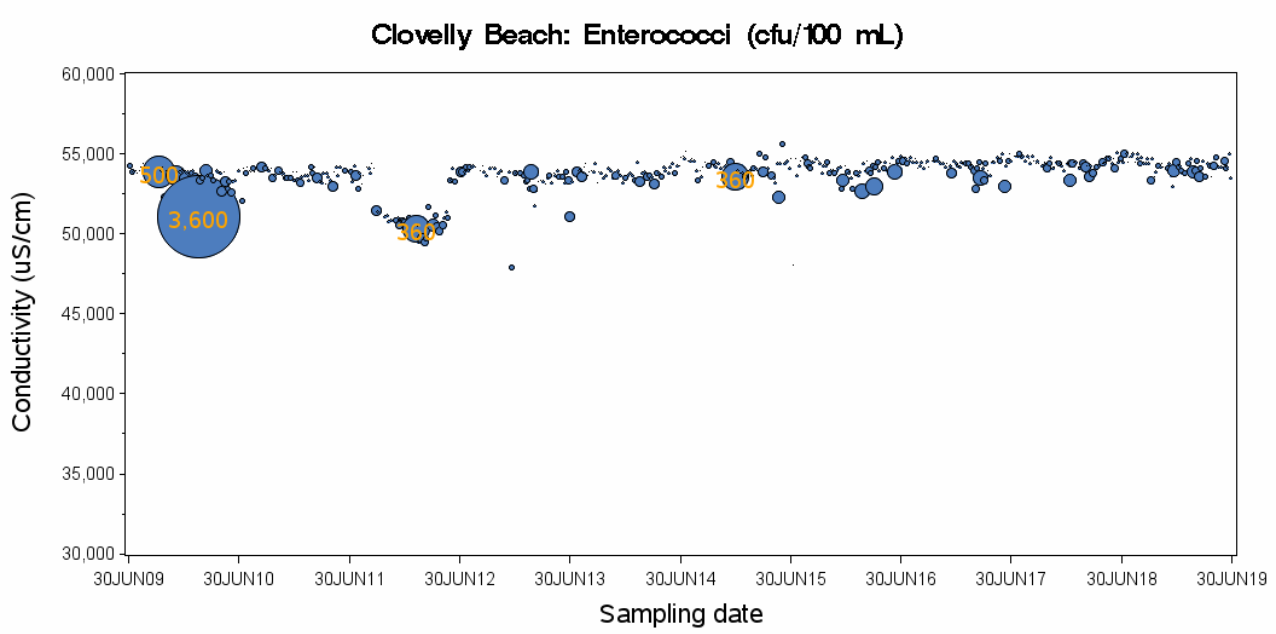

Shelly Beach (Manly): Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
420
360
2,400
230
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

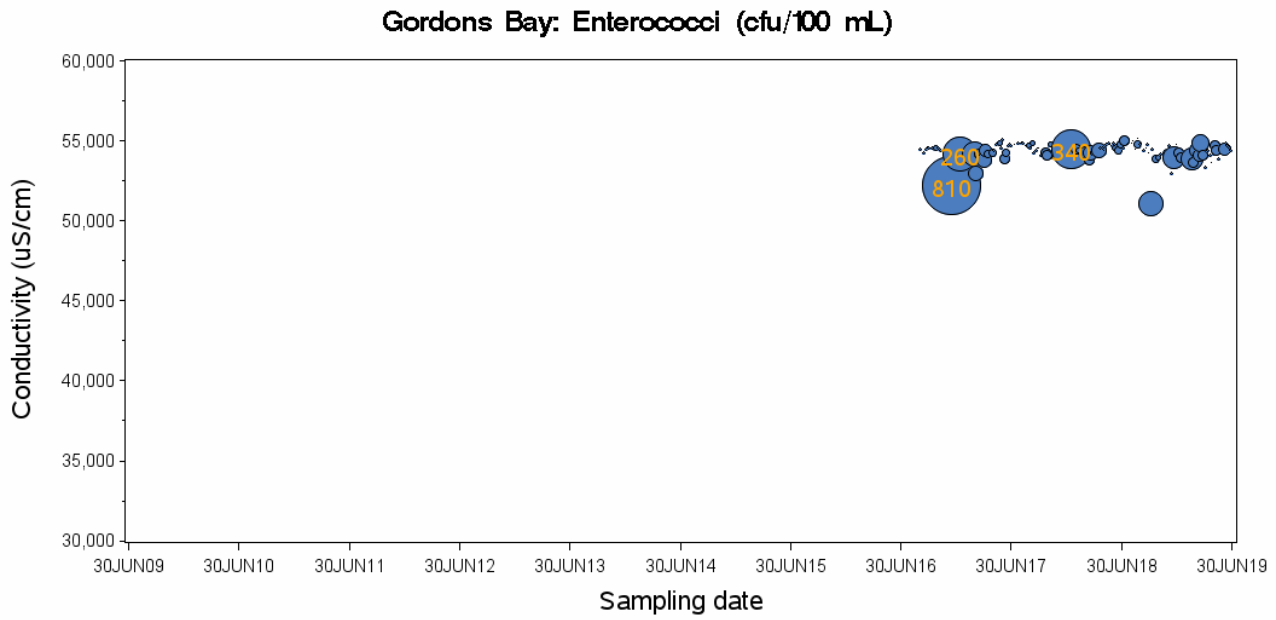
Sydney Beaches: Central Sydney

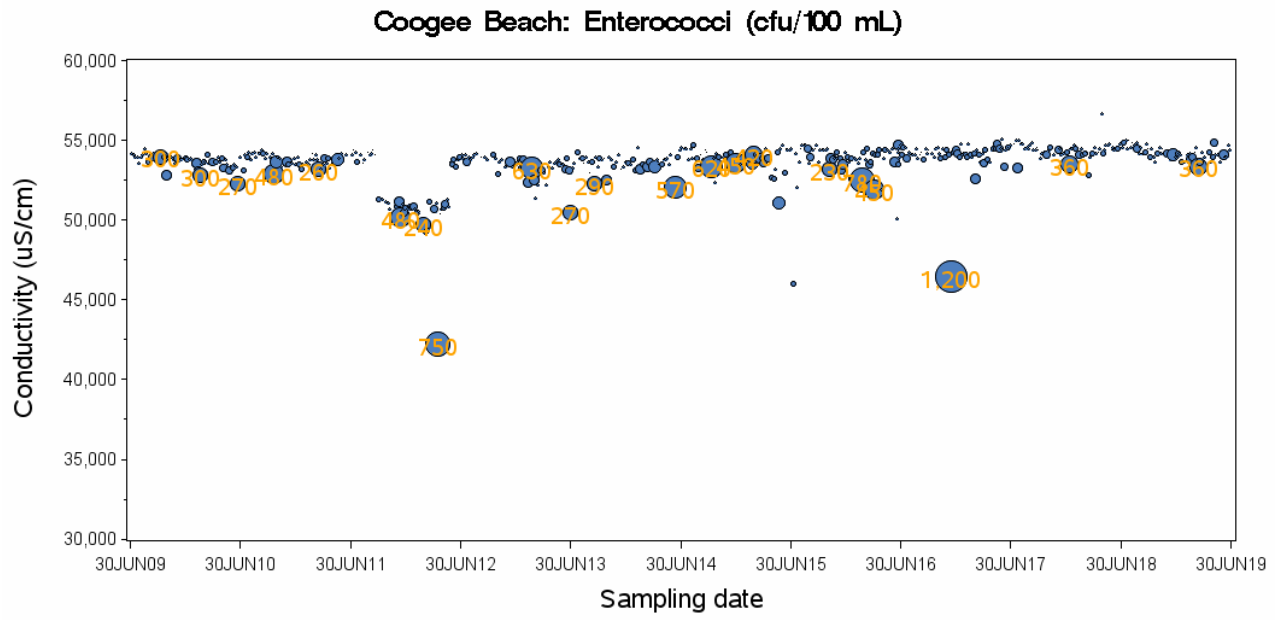


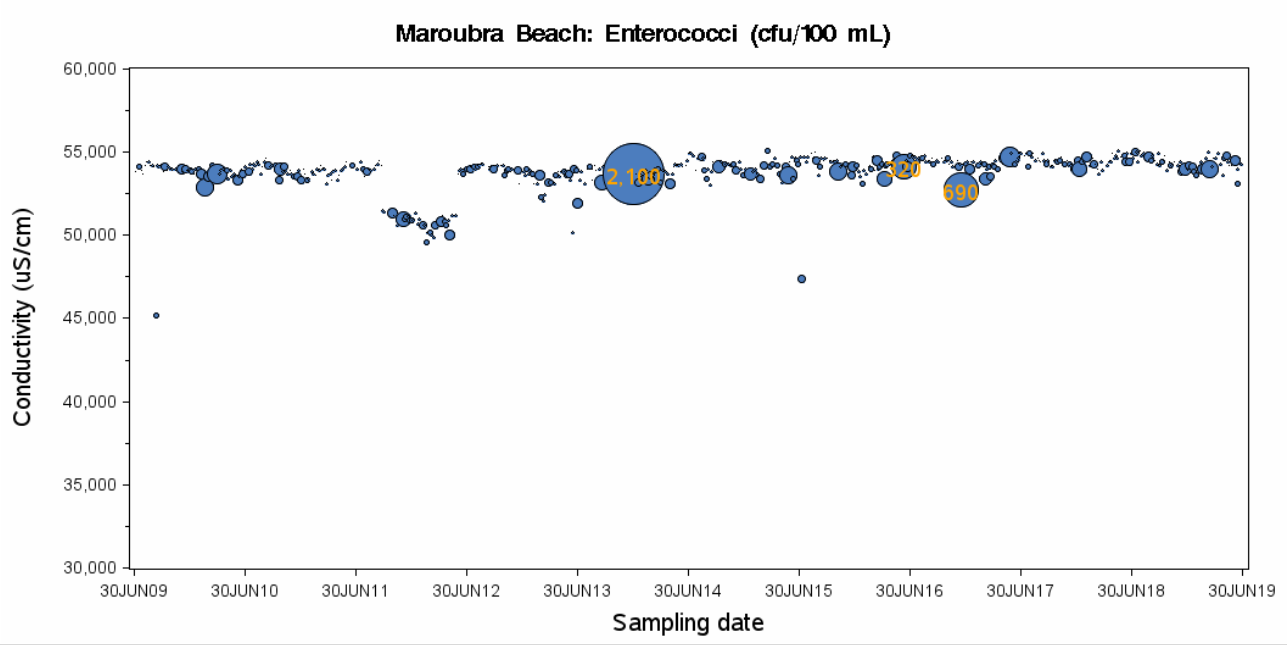


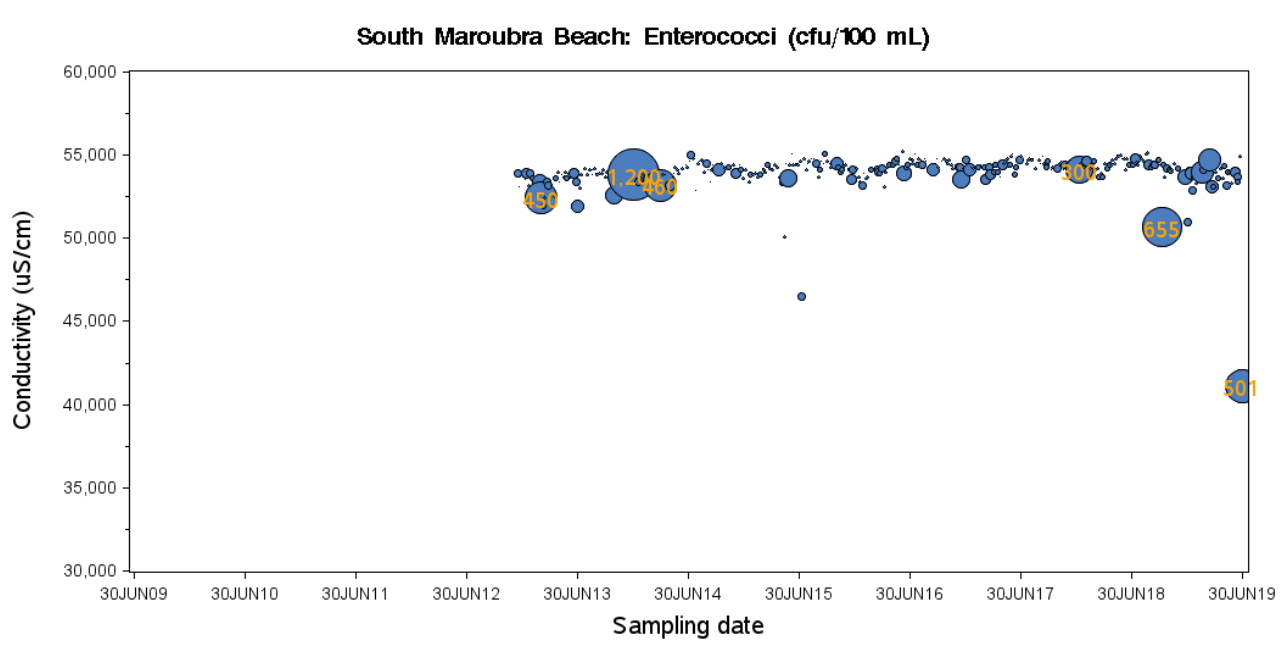


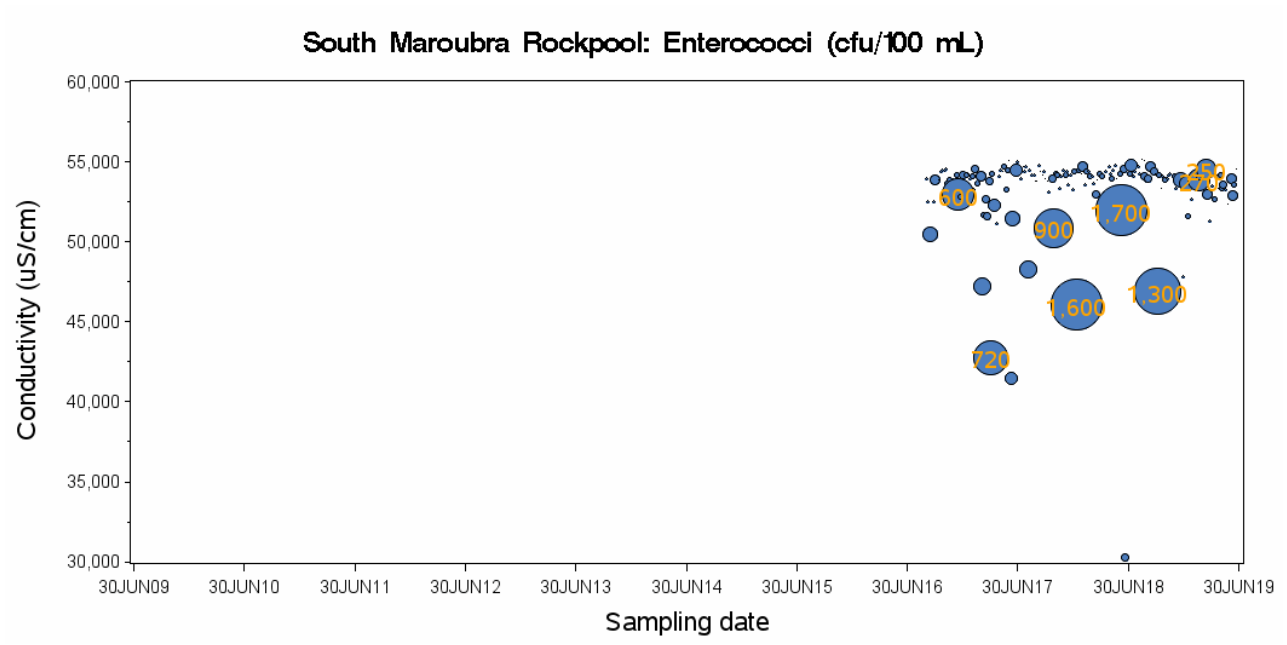

Clovelly Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
500
3,600
360
360
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

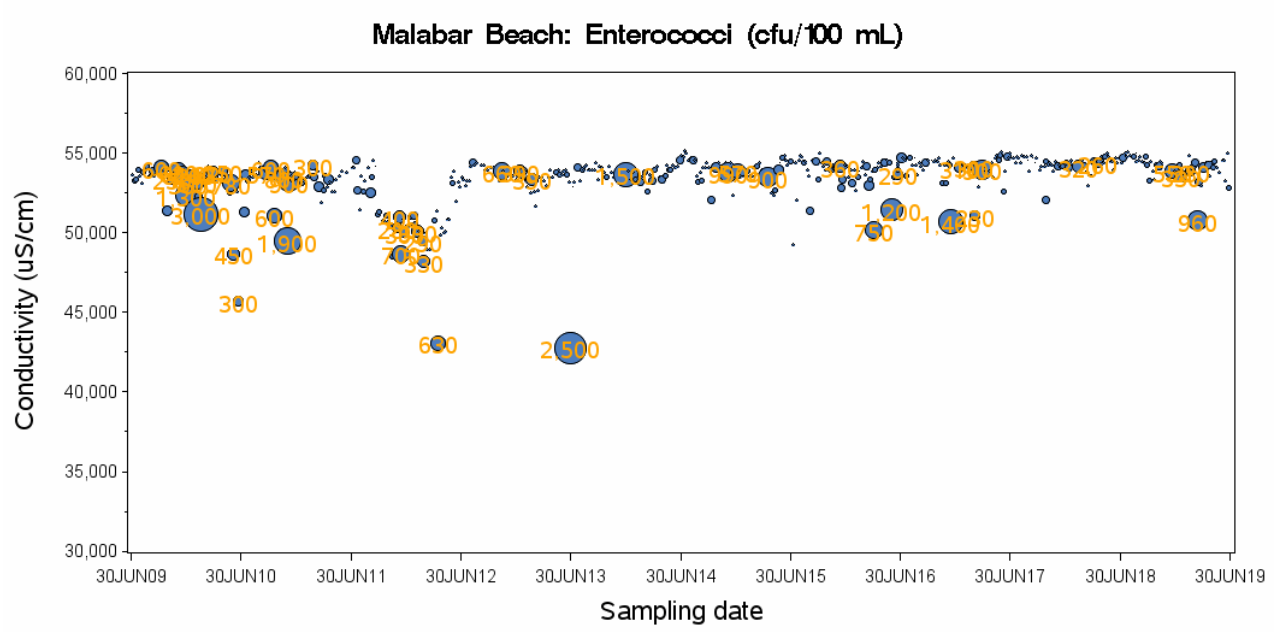

Gordons Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
260
810
340
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

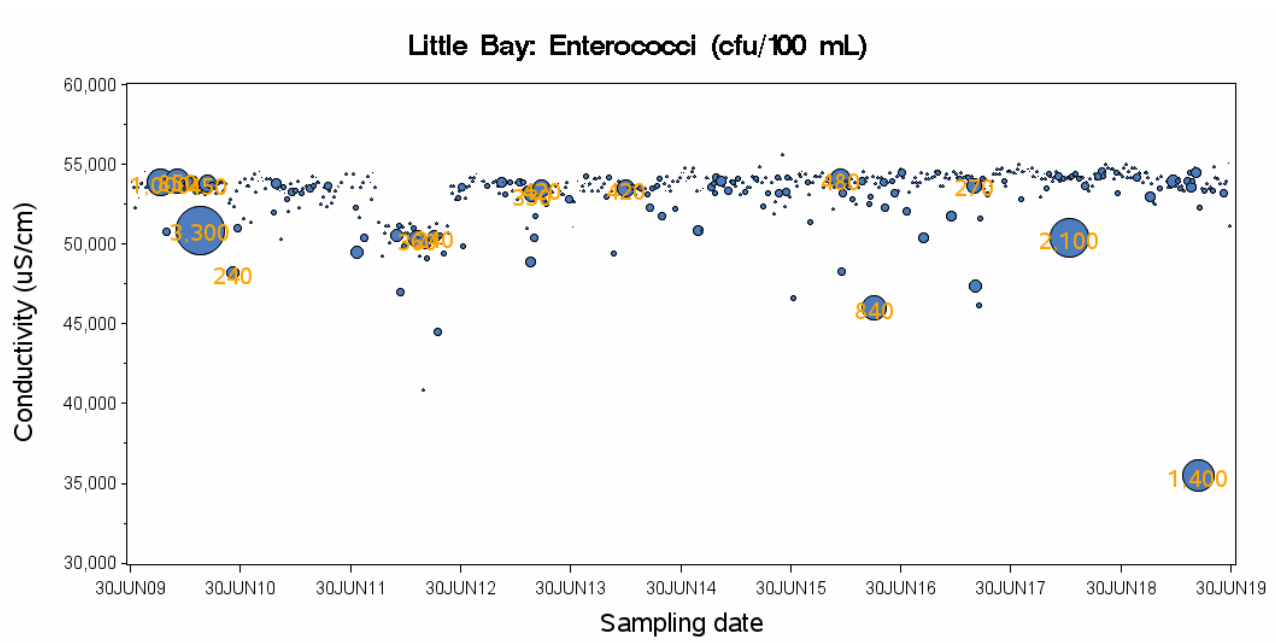

Coogee Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
300
300
270
480
260
630
290
290
570
360
360
1,200
750
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

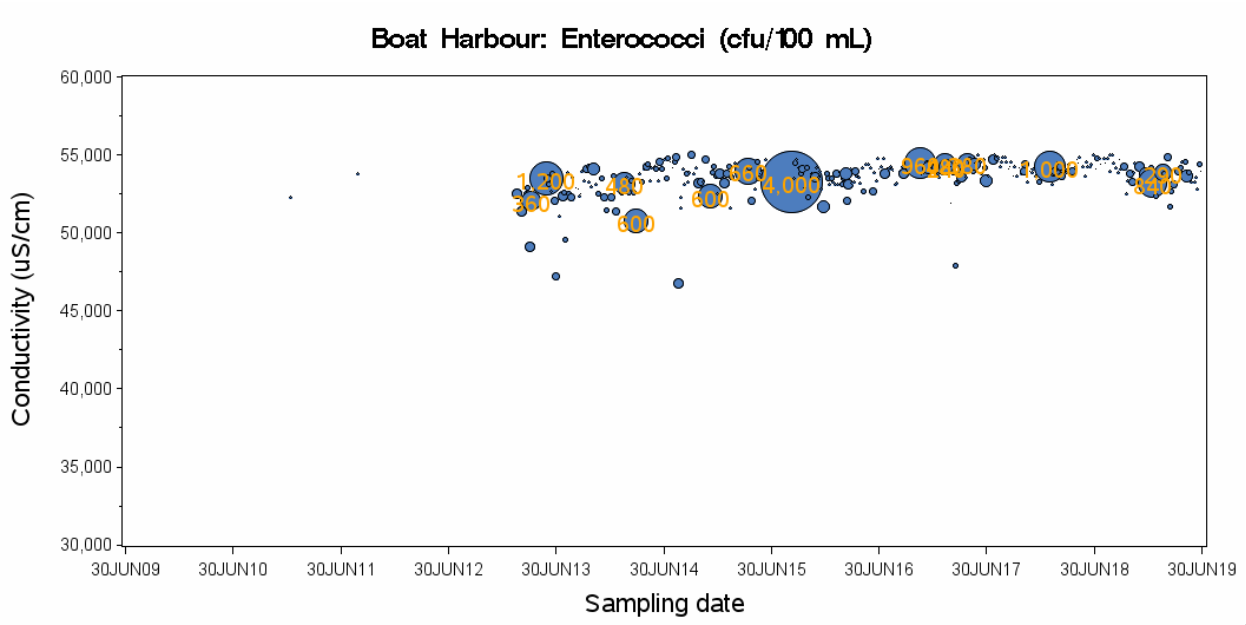

Maroubra Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
2,100
690
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

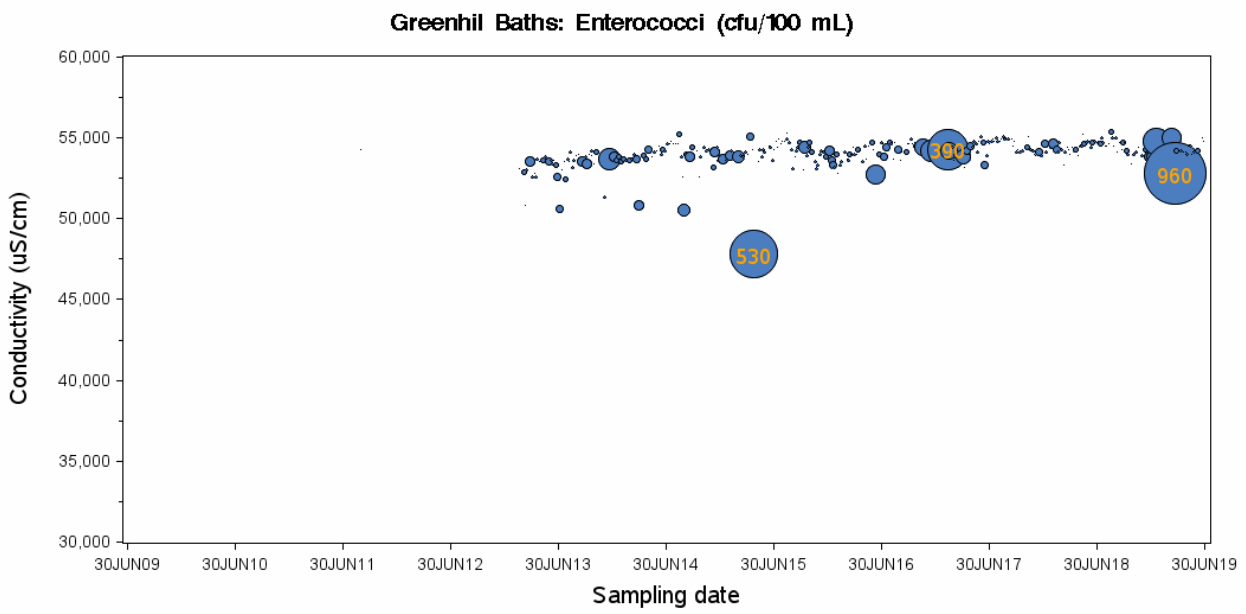

South Maroubra Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
1,200
450
450
655
501
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

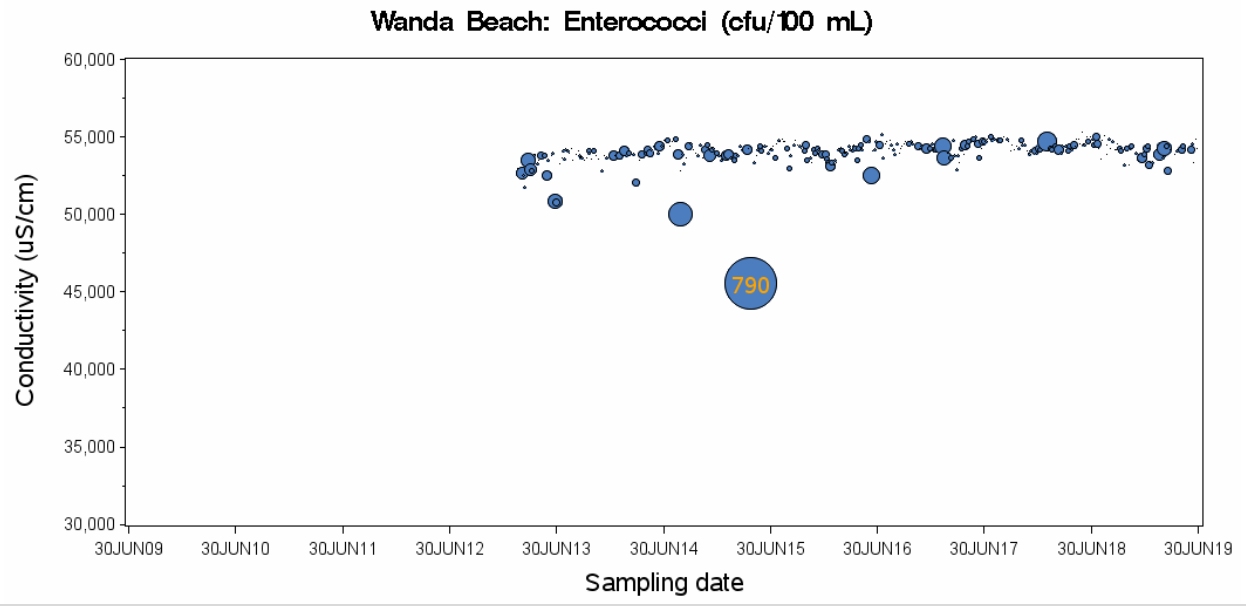

South Maroubra Rockpool: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
660
900
1,700
1,600
1,300
720
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

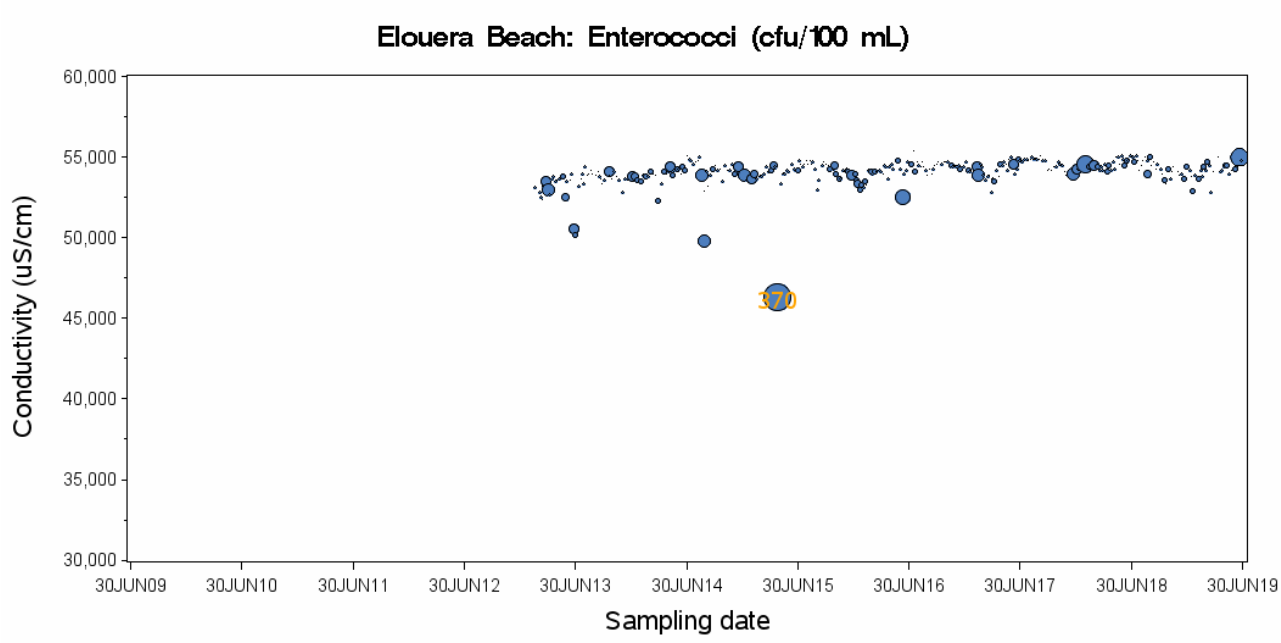

Malabar Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

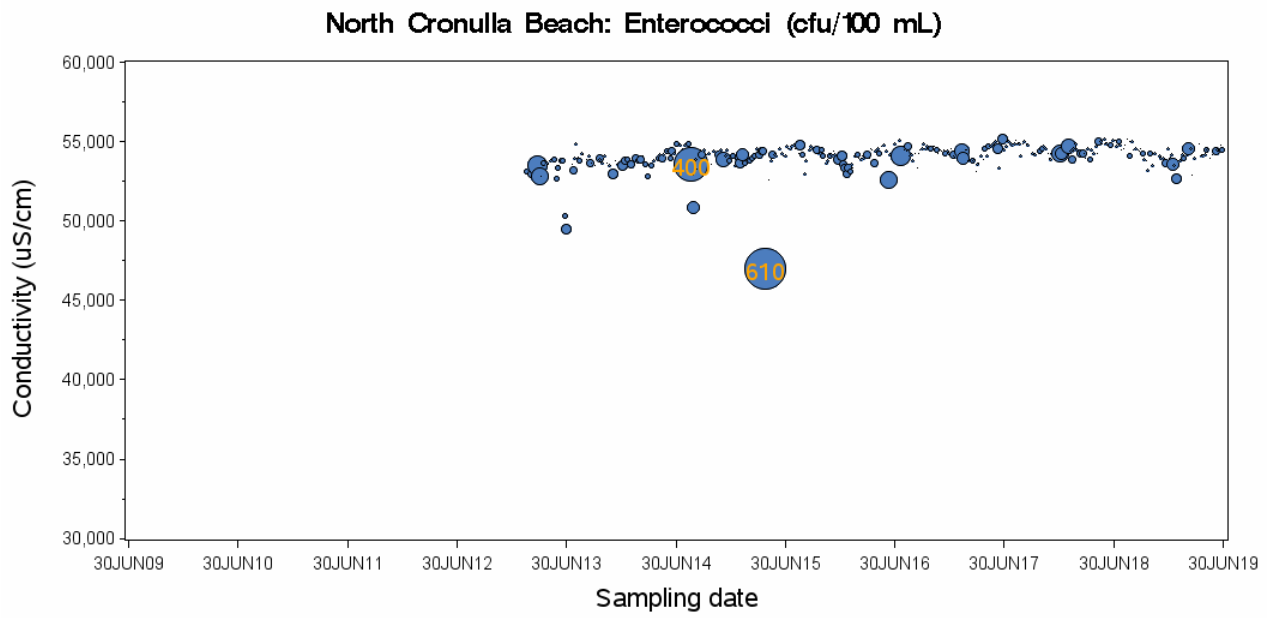

Little Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

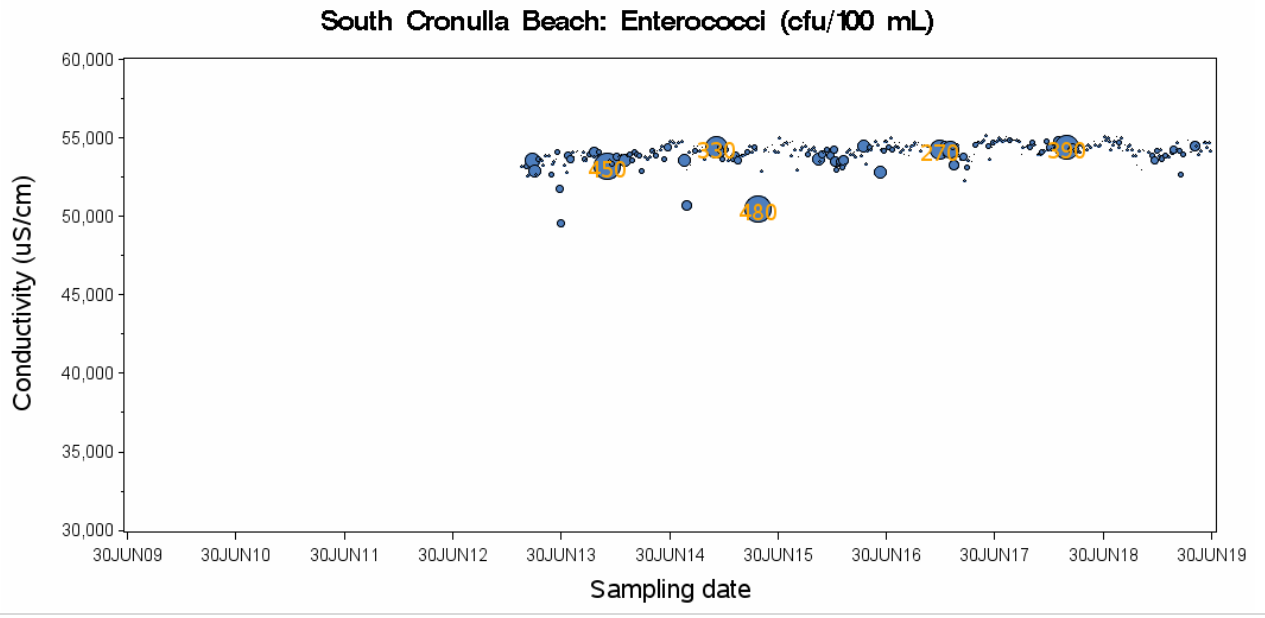

Boat Harbour: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
1,200
360
480
800
800
4,000
1,050

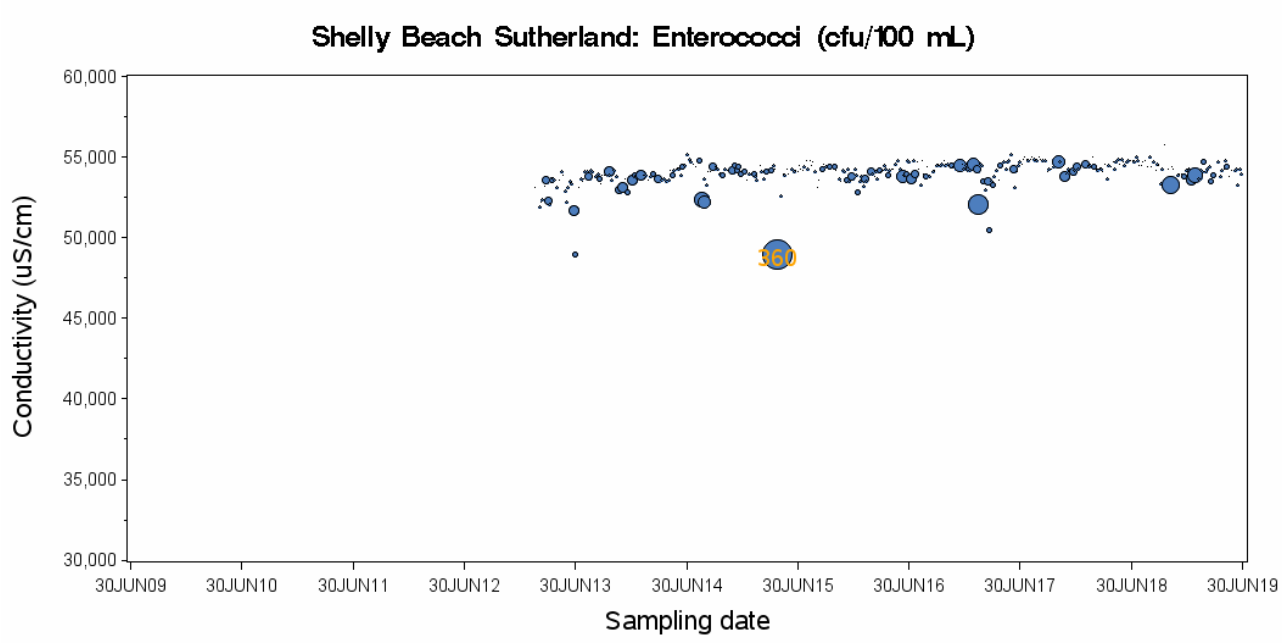

Greenhil Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
530
960

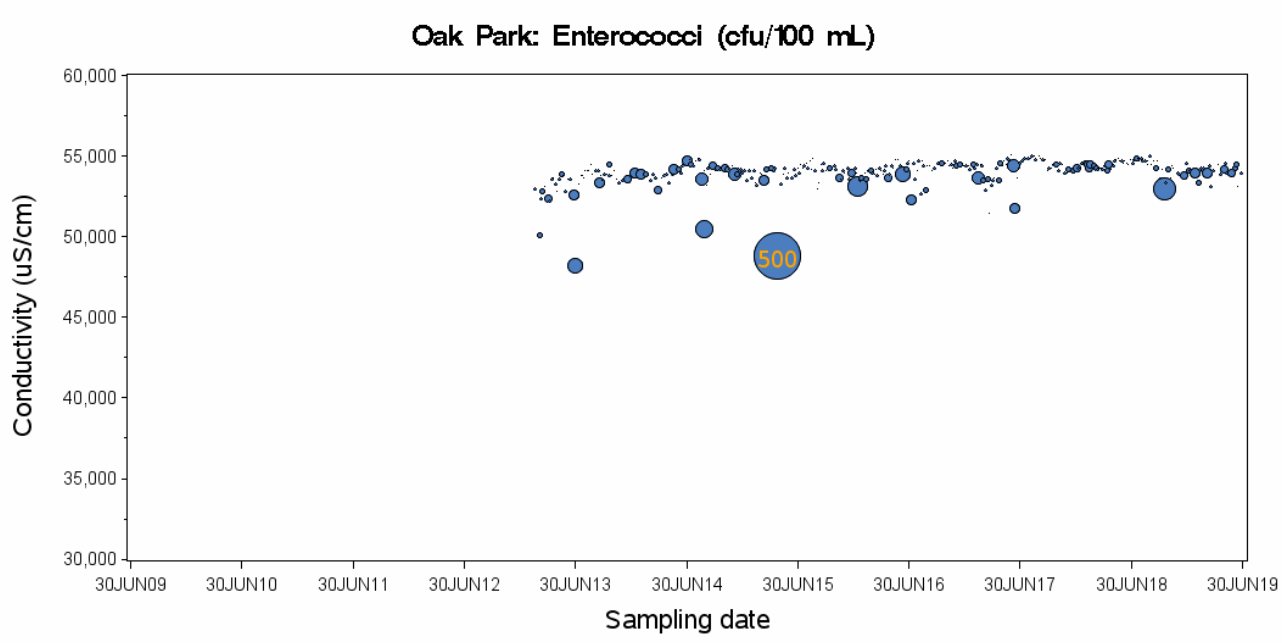

Wanda Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
790

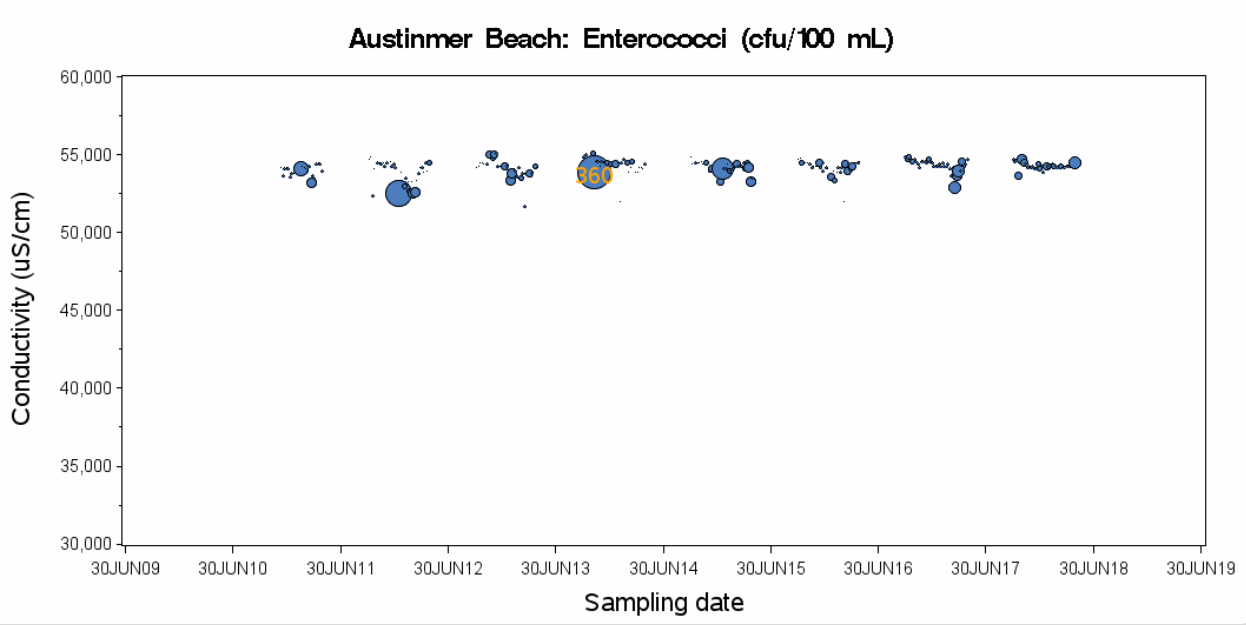

Elouera Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
370
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

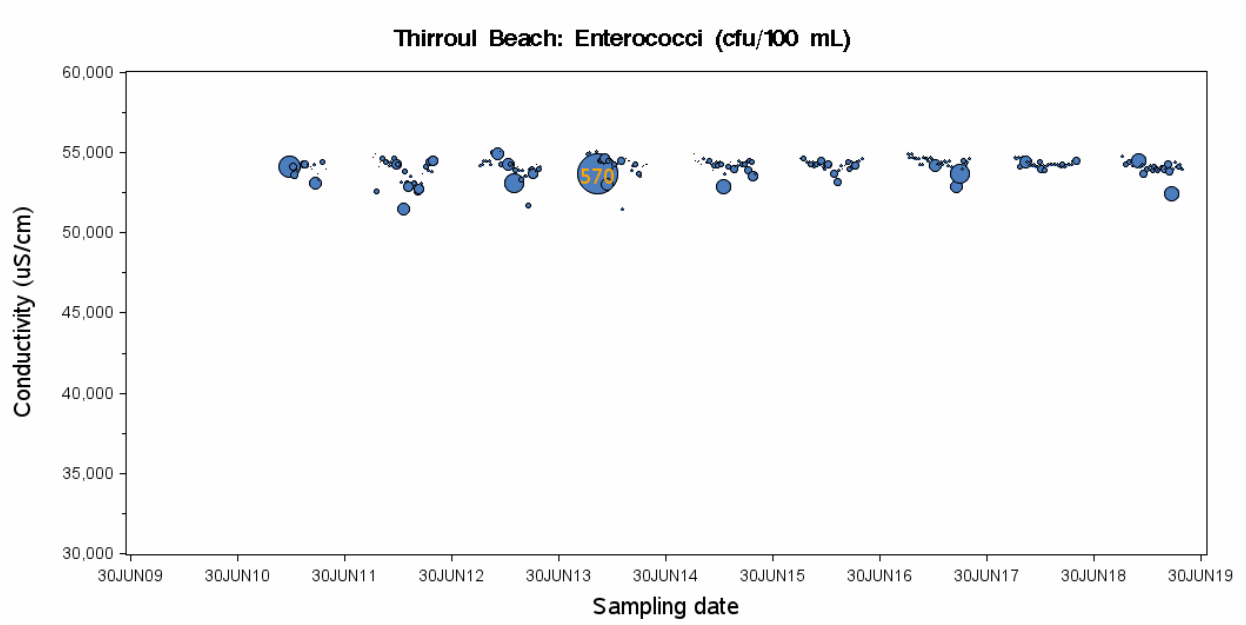

North Cronulla Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
400
610
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

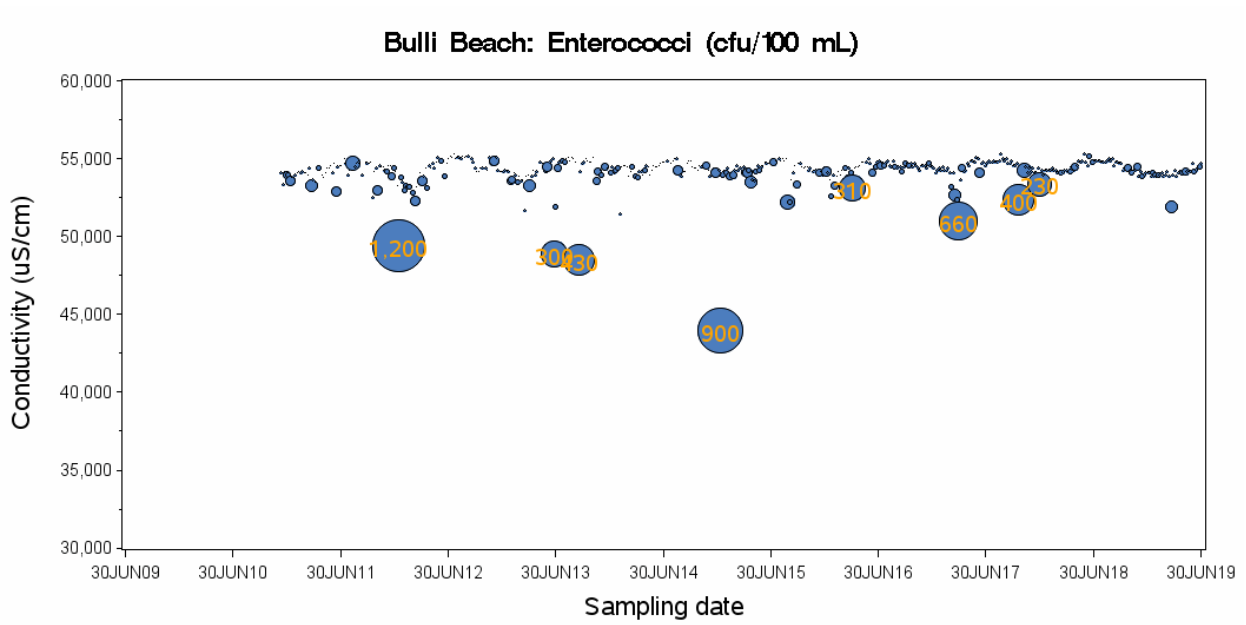

South Cronulla Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
450
480
270
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

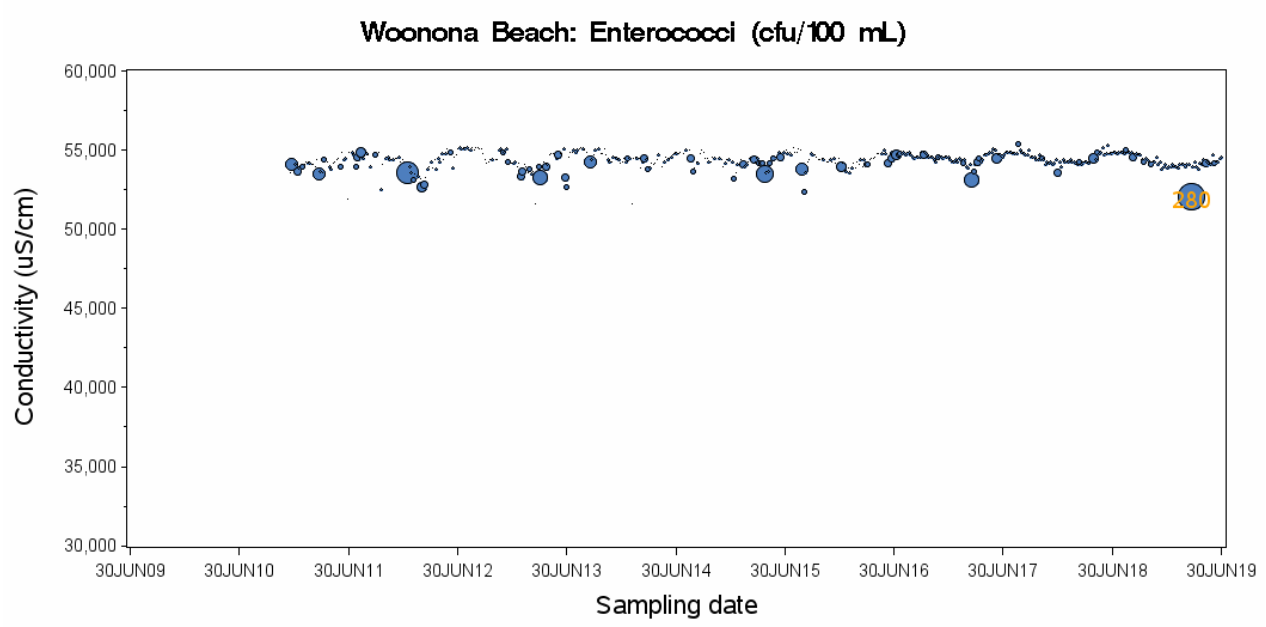

Shelly Beach Sutherland: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
360
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

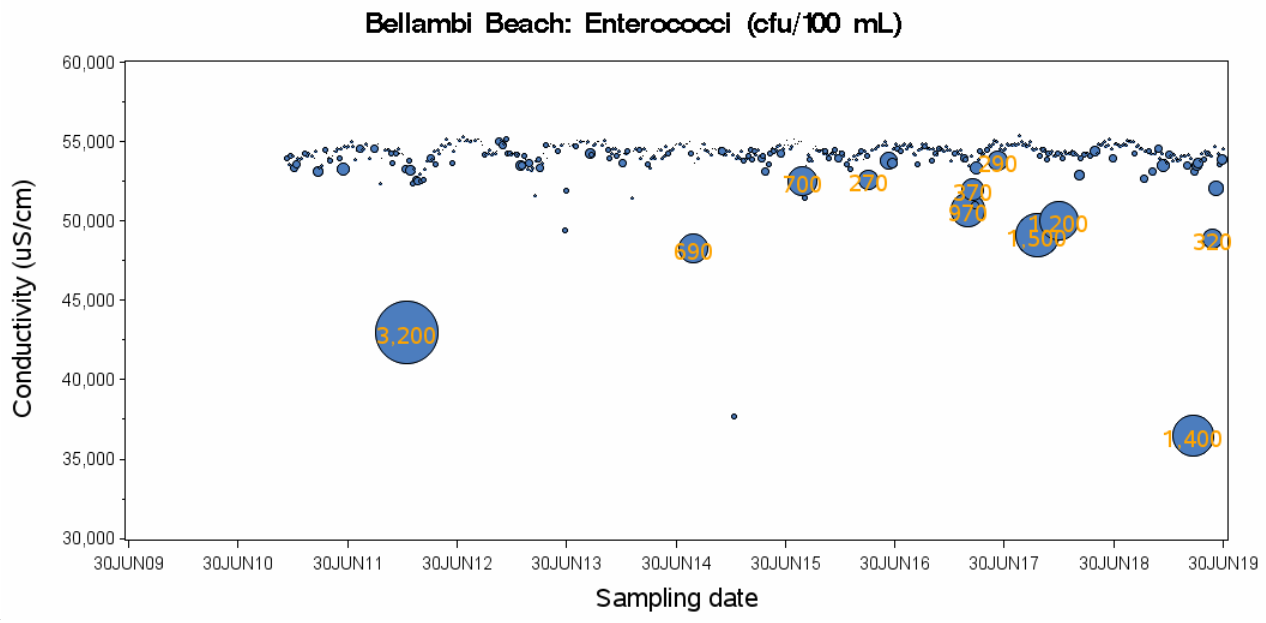

Oak Park: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
500
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

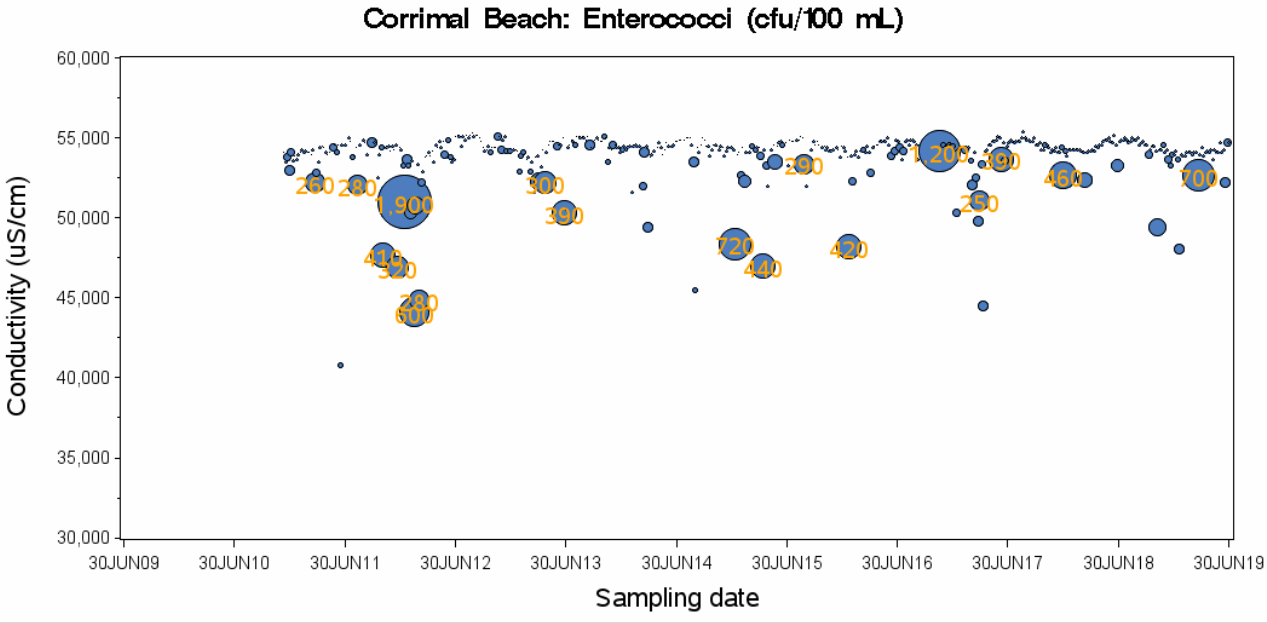

Austinmer Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
360
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

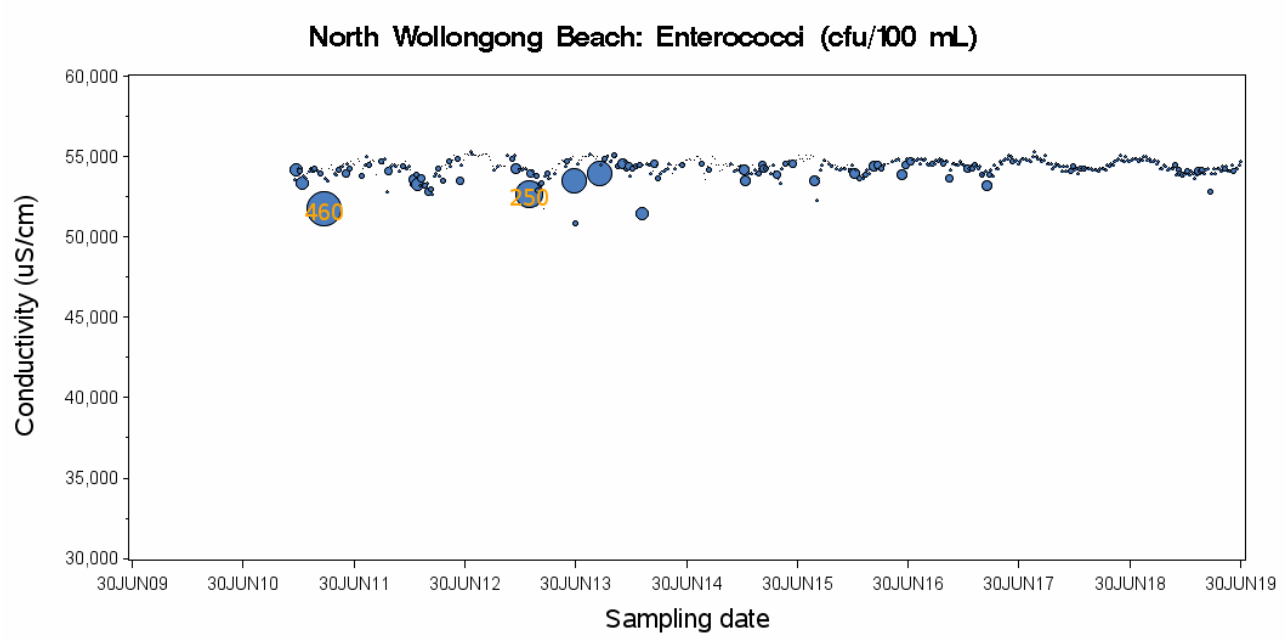

Thirroul Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
579
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

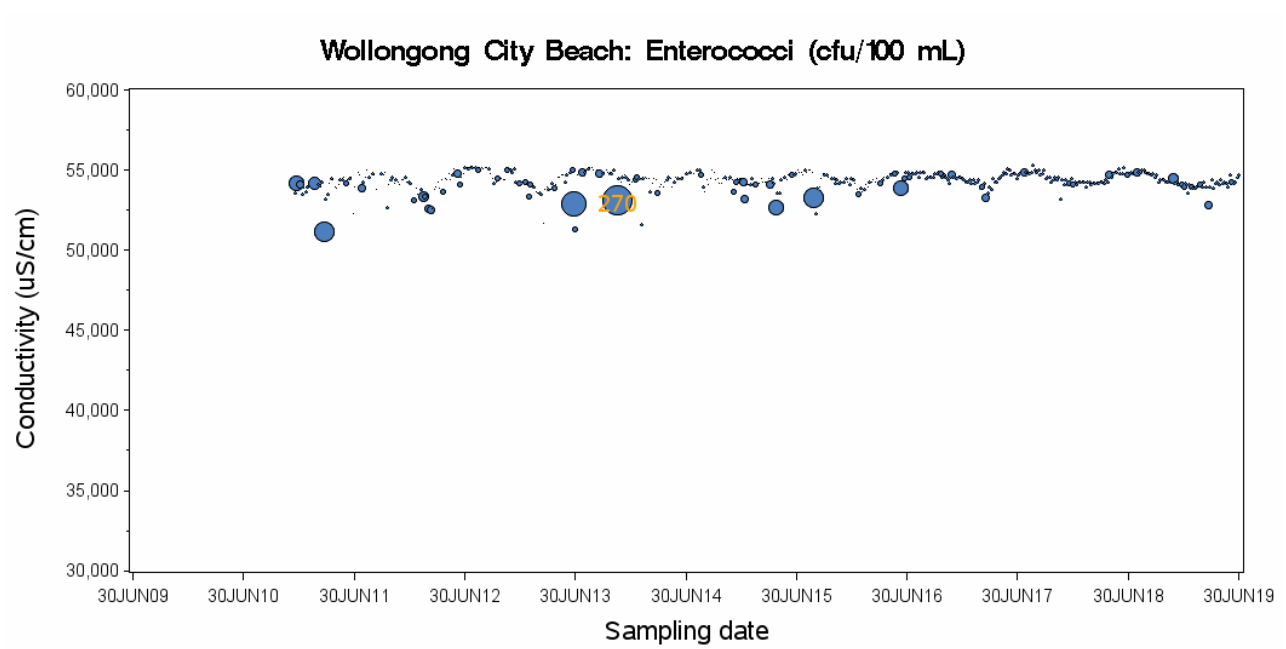

Bulli Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
1,200
900
660
400
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

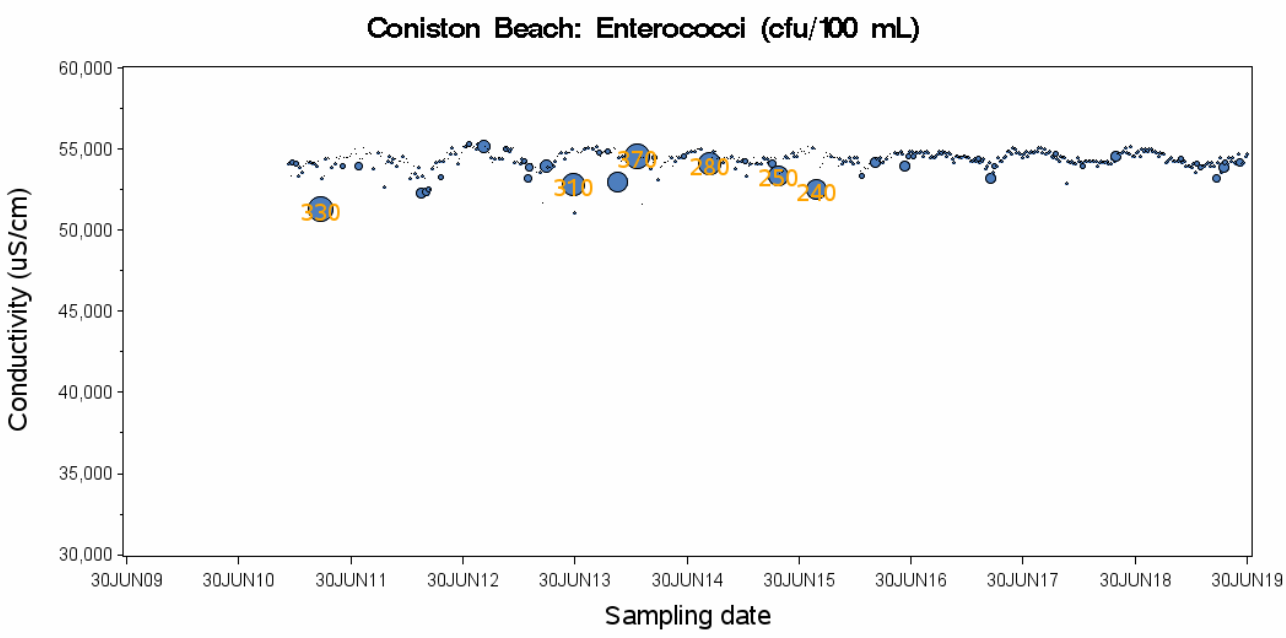

Woonona Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
280
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

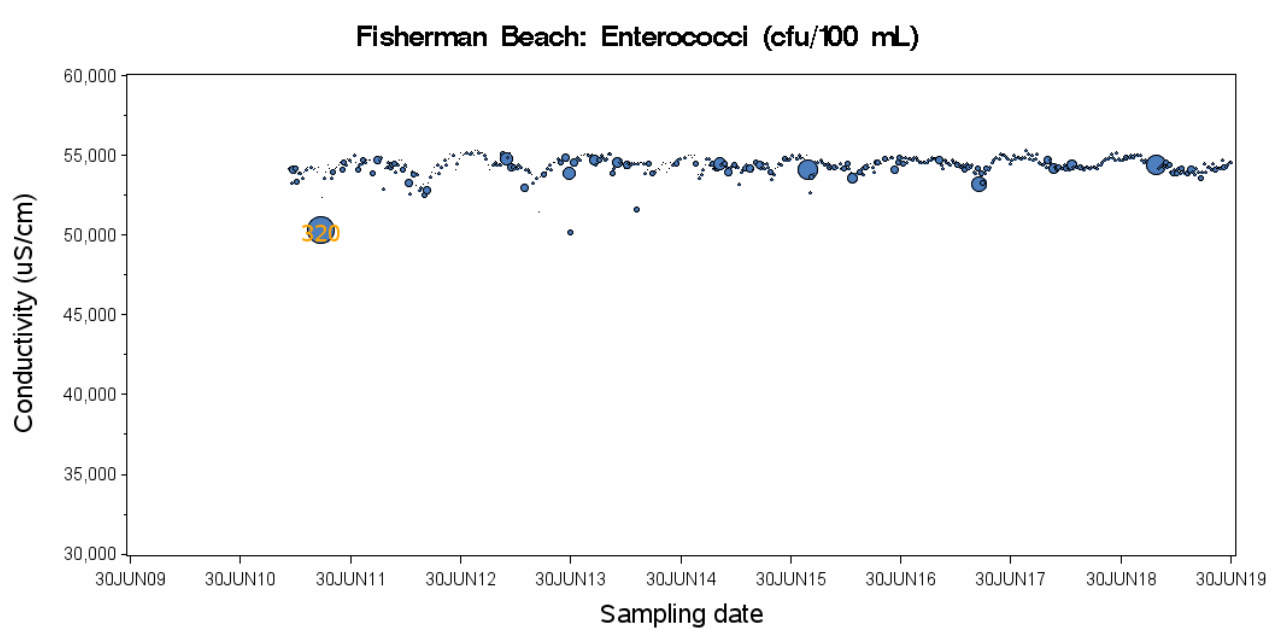

Bellambi Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
700
270
290
970
1,200
690
3,200
1,400
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

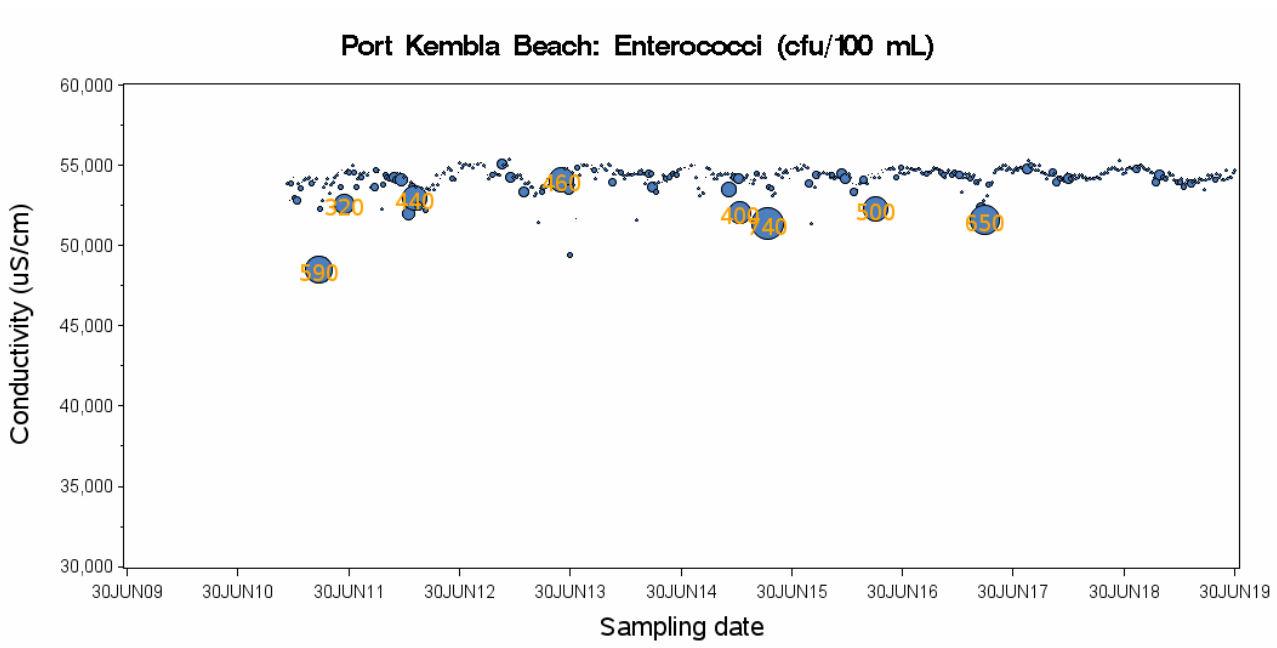

Corrimal Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
260
280
1,900
300
390
720
440
420
1,200
390
460
700
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

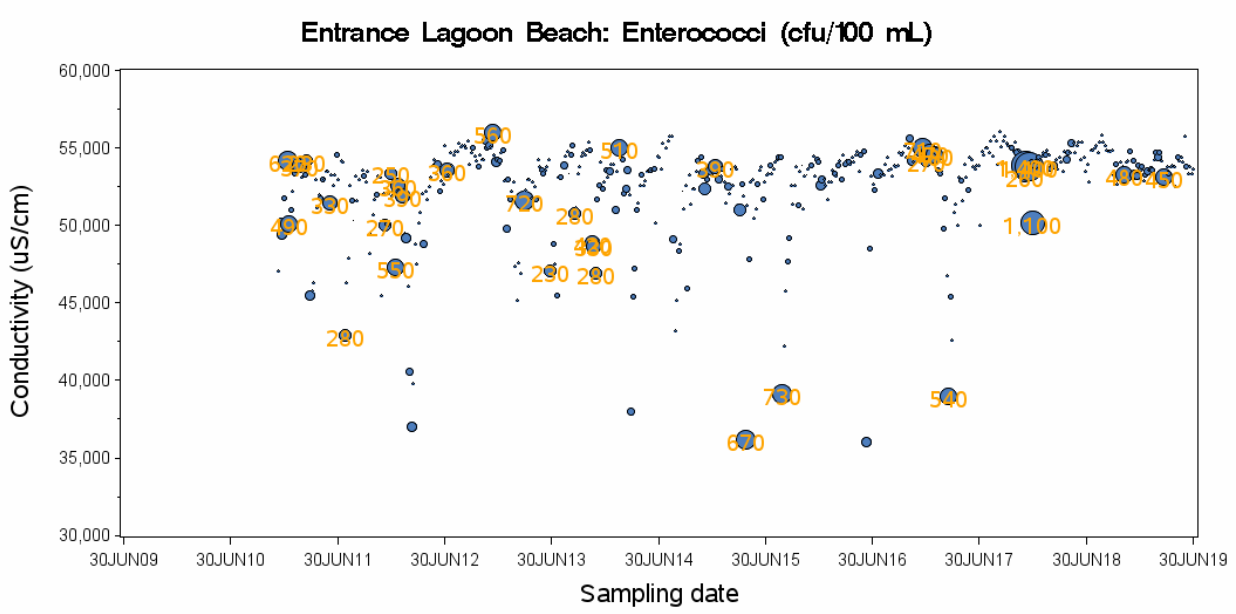

North Wollongong Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
460
250
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

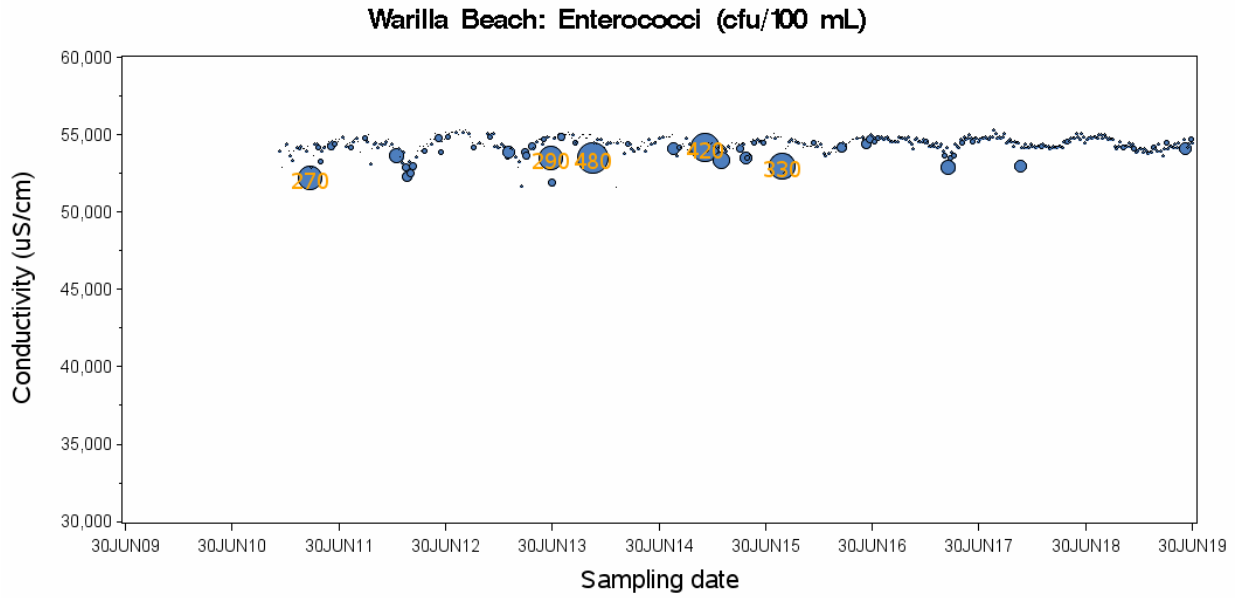

Wollongong City Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
270
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

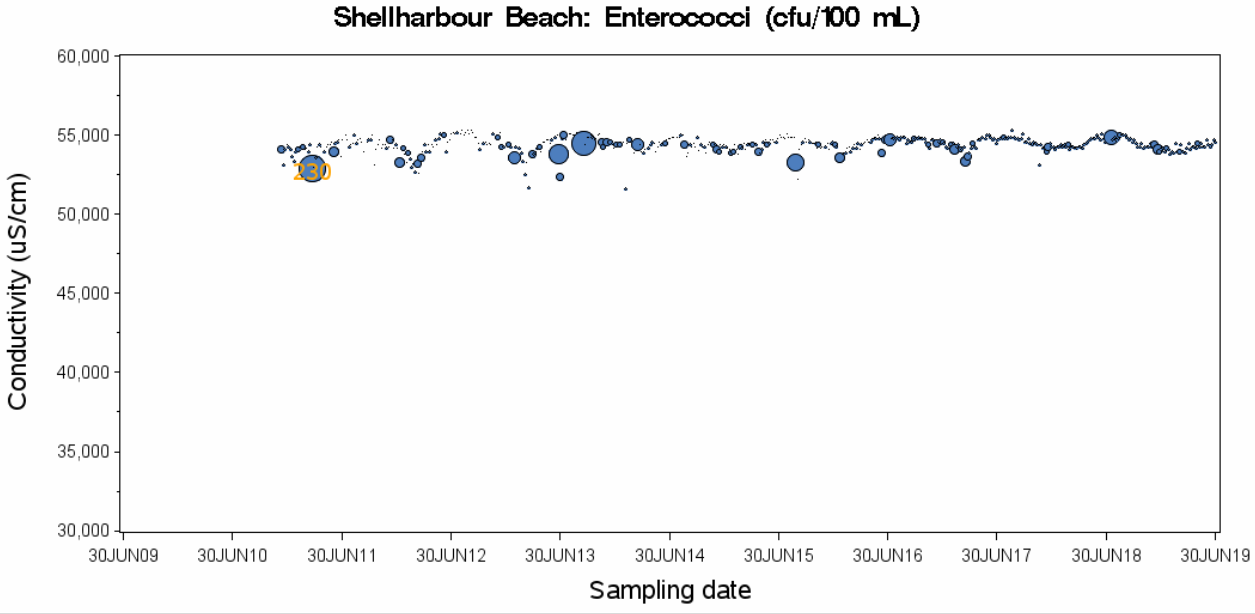

Coniston Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
330
310
370
280
230
240
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

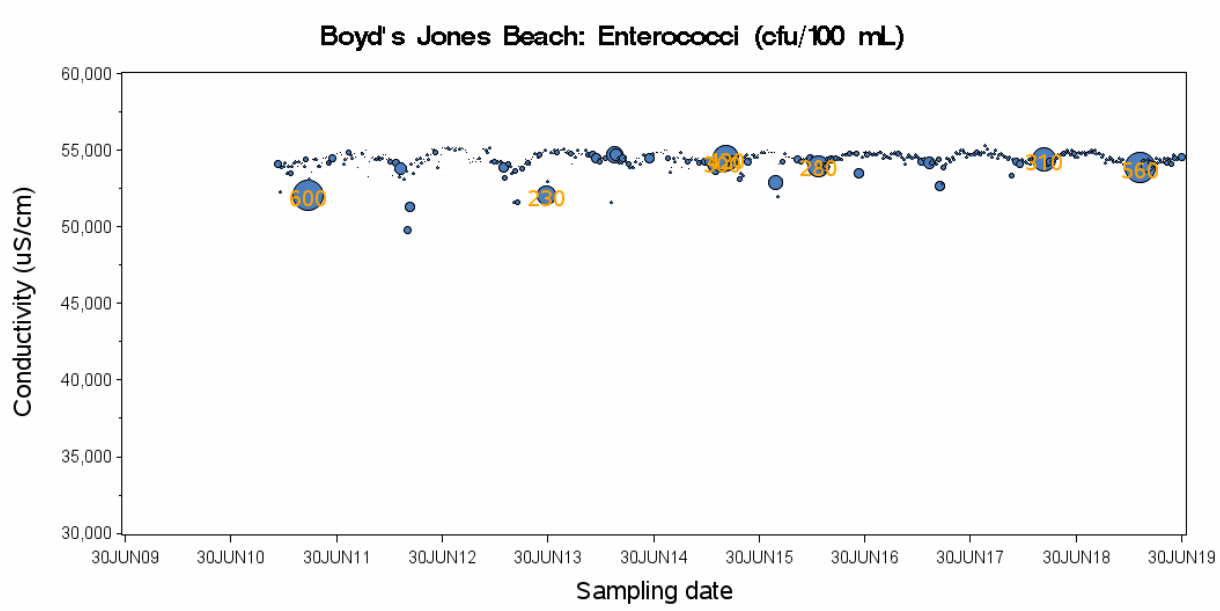

Fisherman Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
320
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

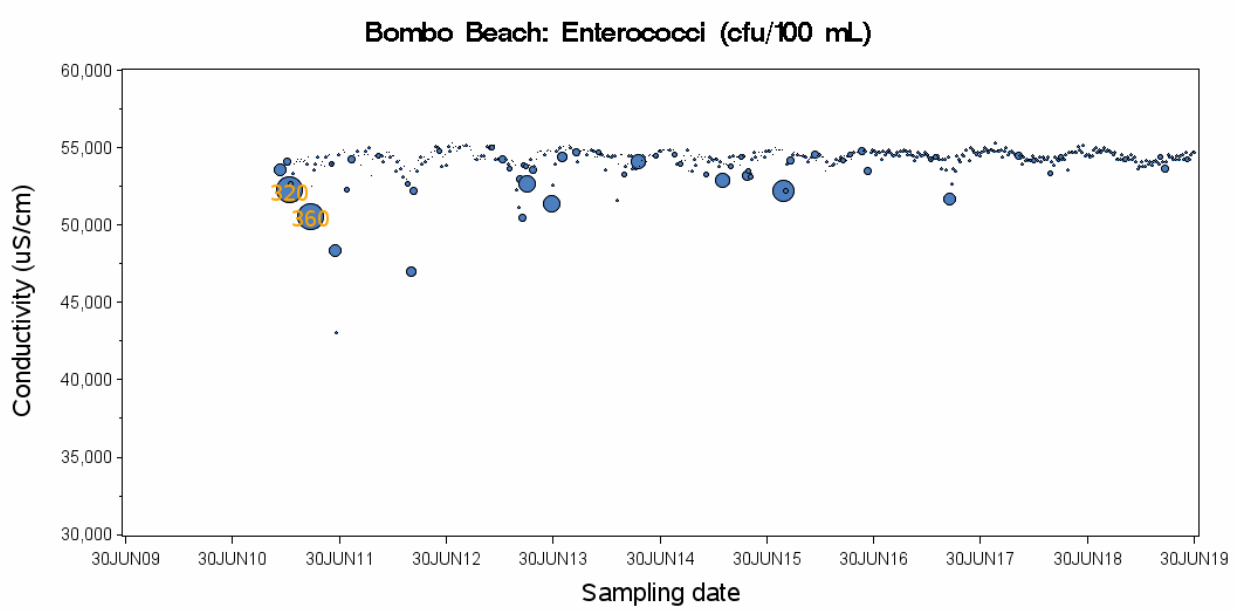

Port Kembla Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
590
440
460
404
740
500
650
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

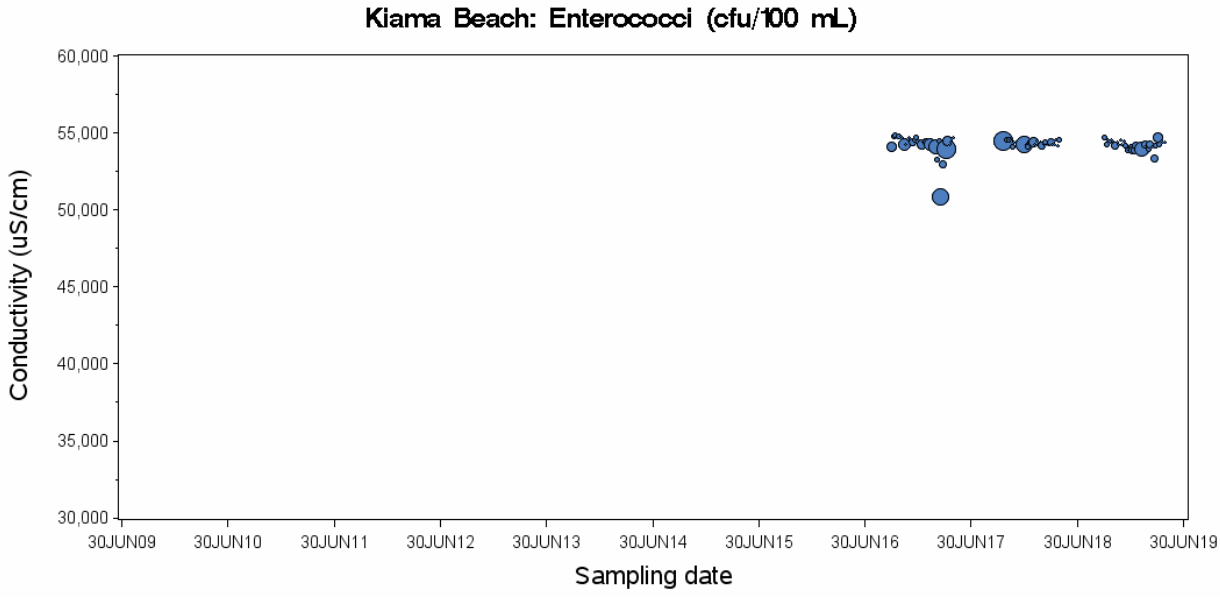

Entrance Lagoon Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date


Warilla Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

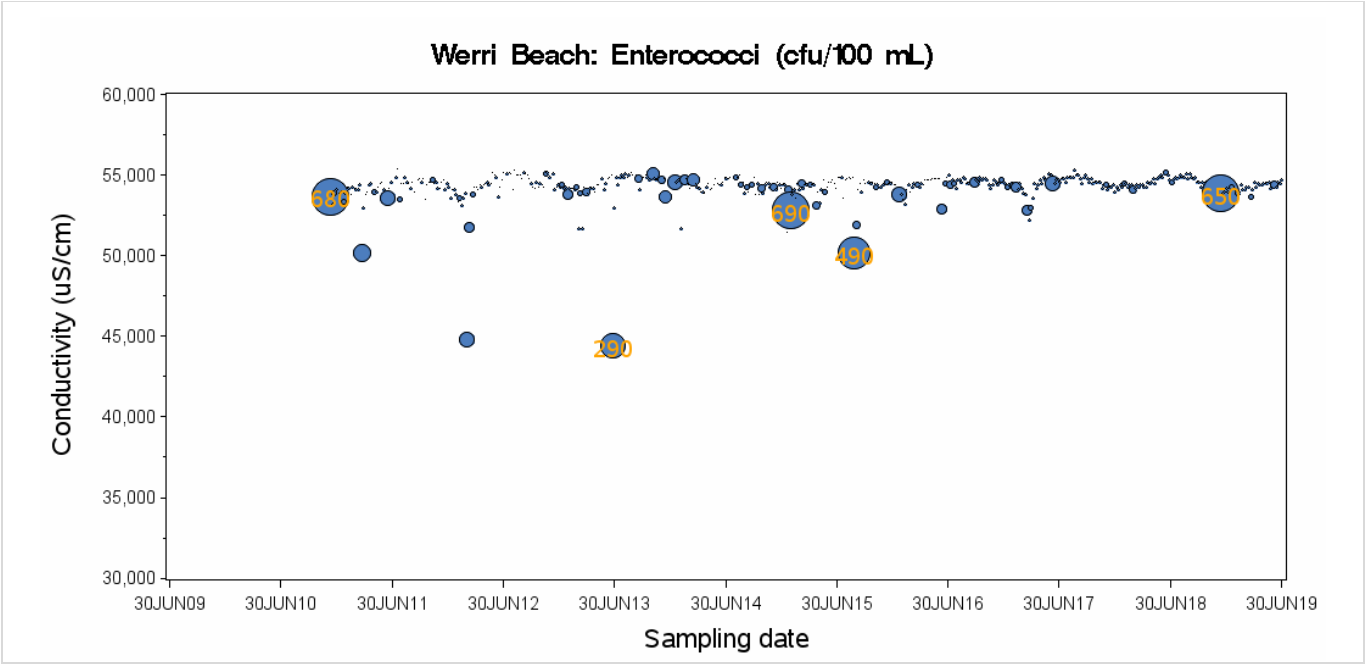

Shellharbour Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

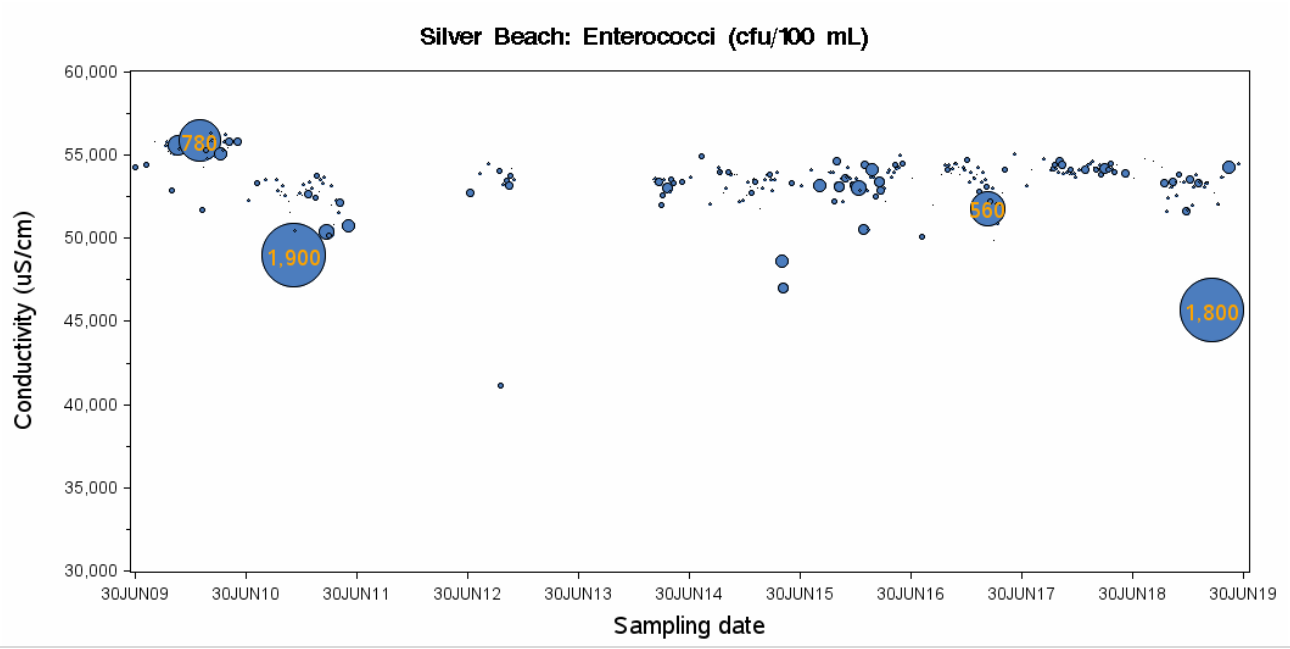


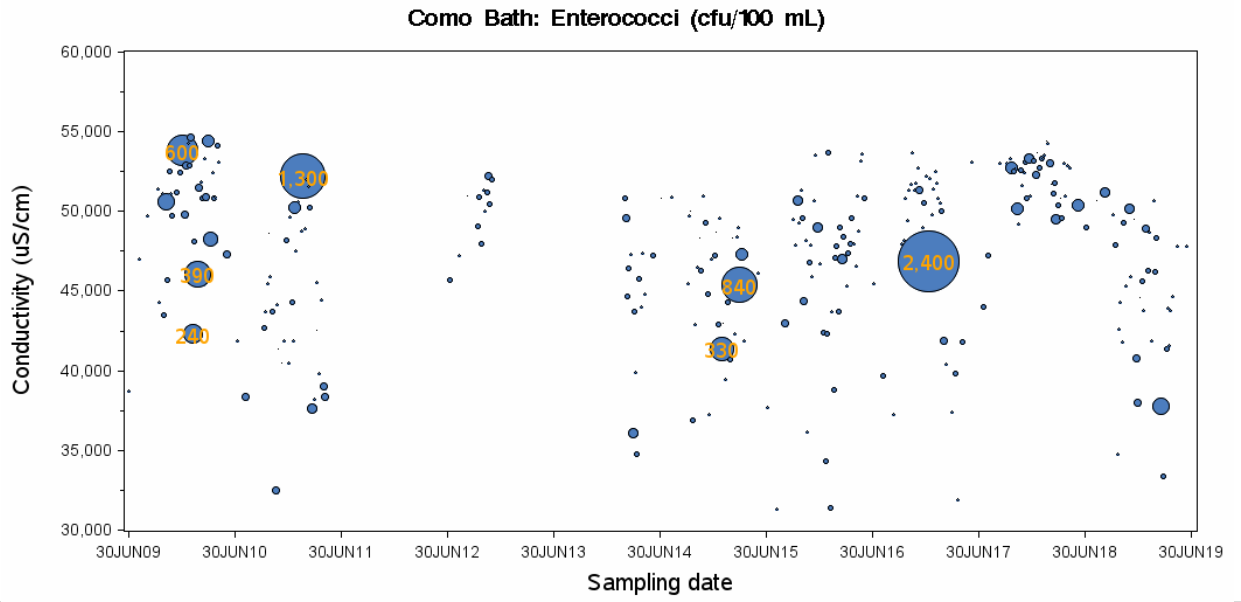


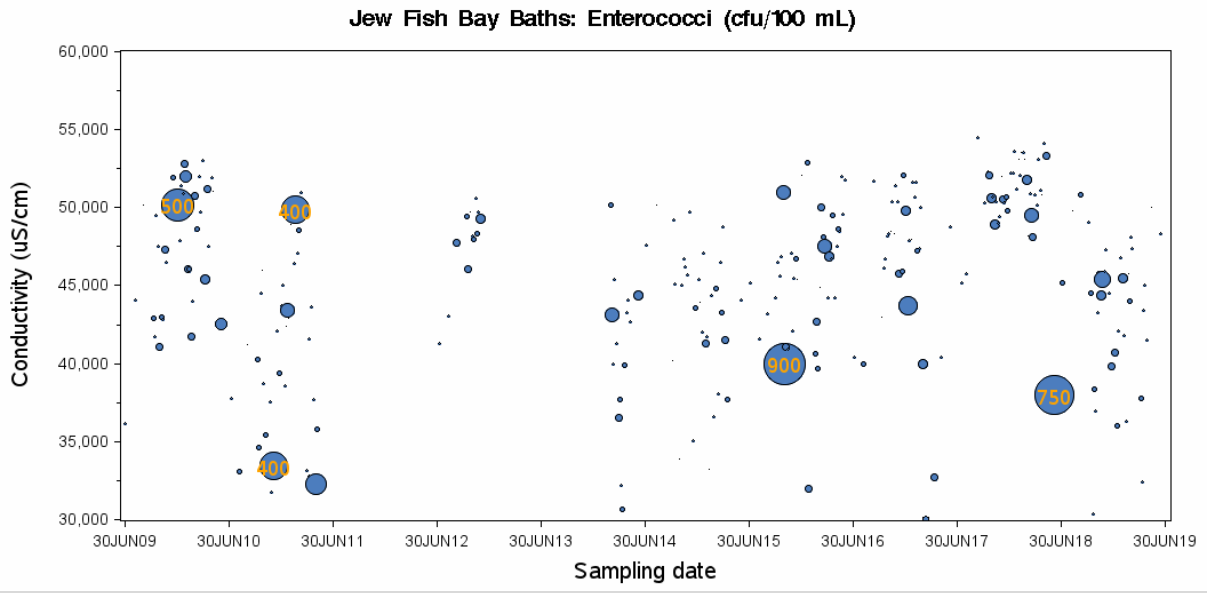


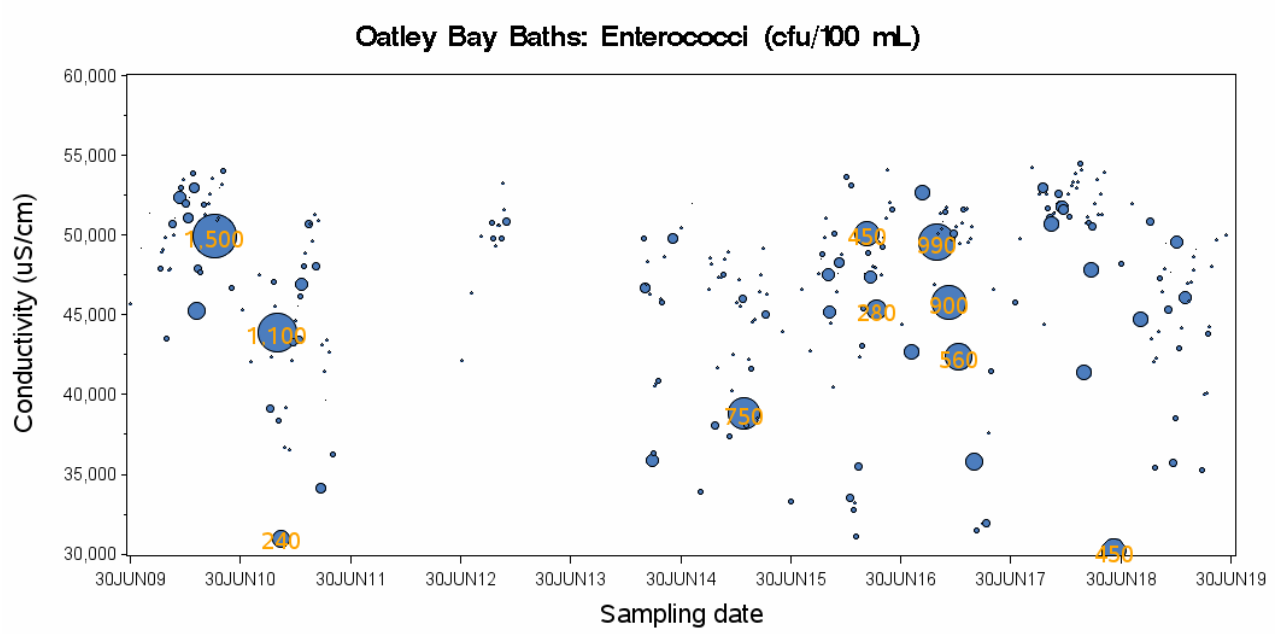
Note: No extreme values found (≥230 cfu/100mL) to mark using data labels

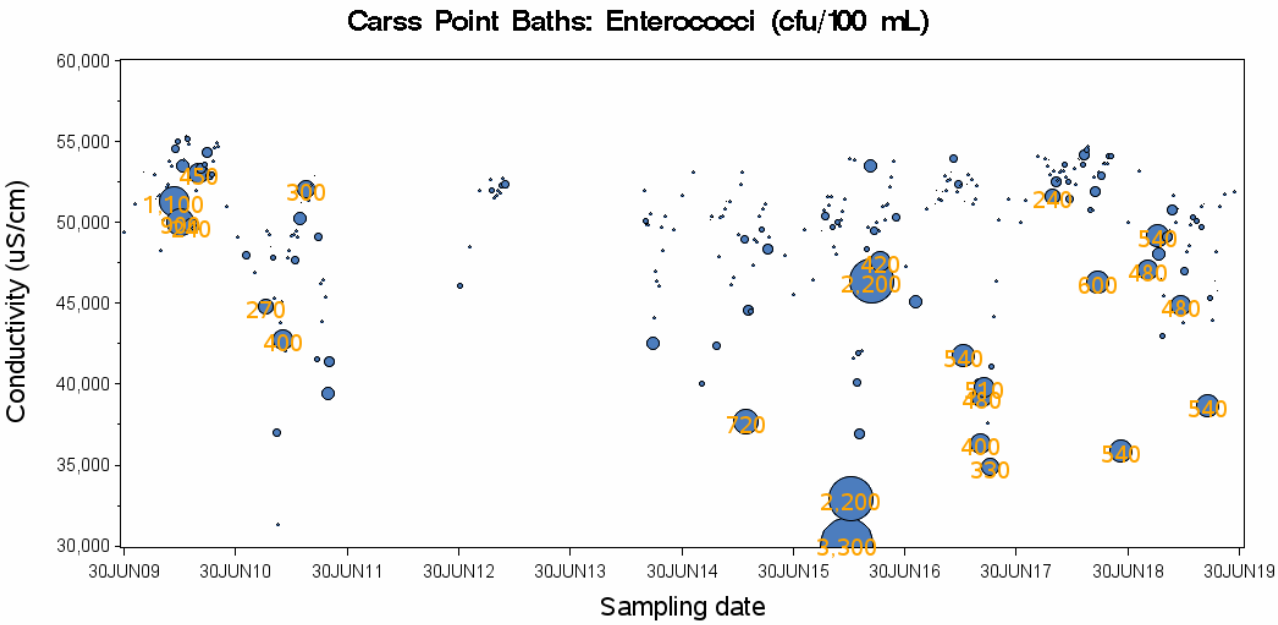

Werri Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
686
690
490
290
650
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

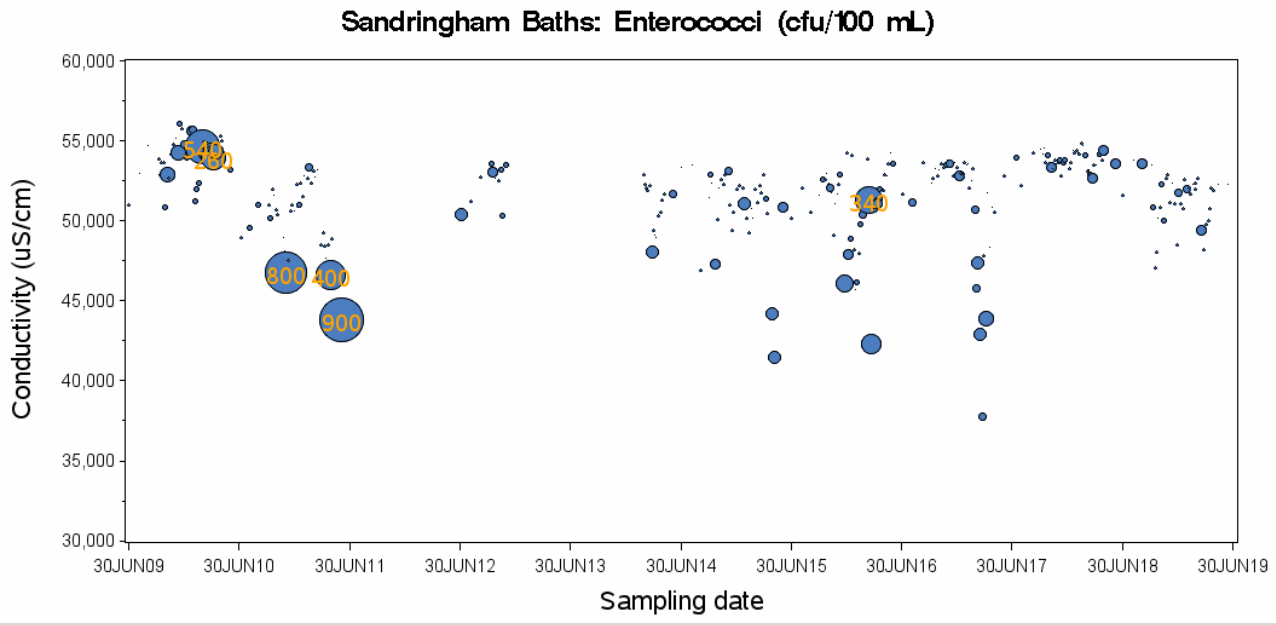

Silver Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
780
1,900
560
1,800
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

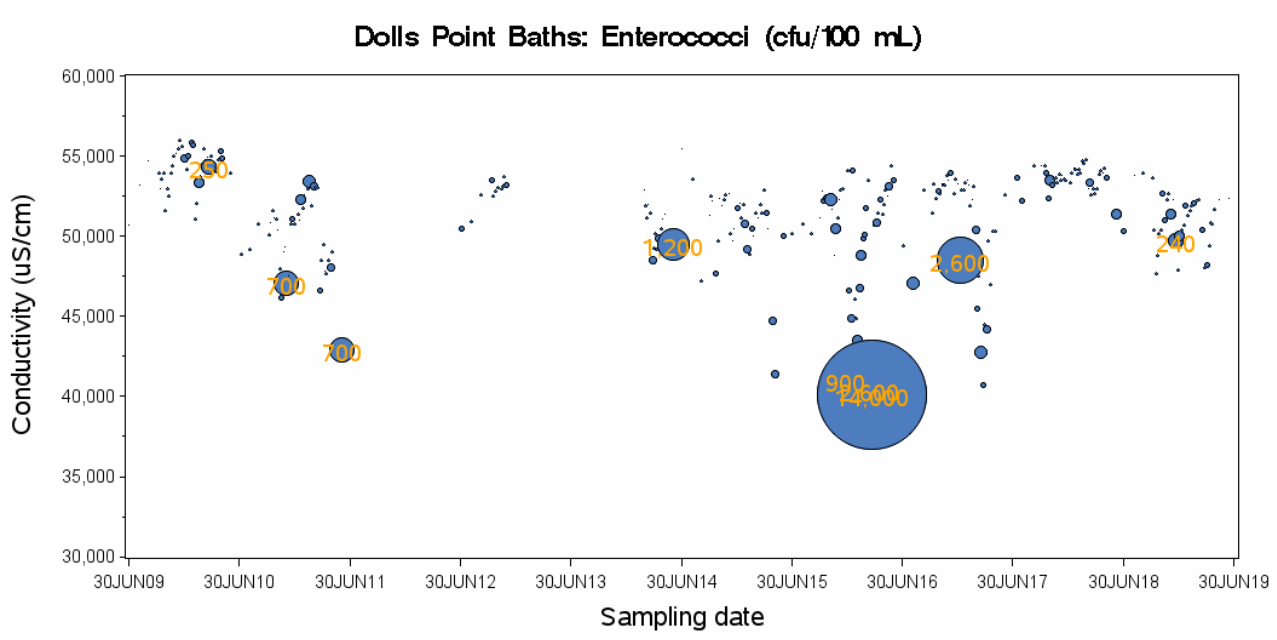

Como Bath: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
600
1,300
390
240
340
330
2,400
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

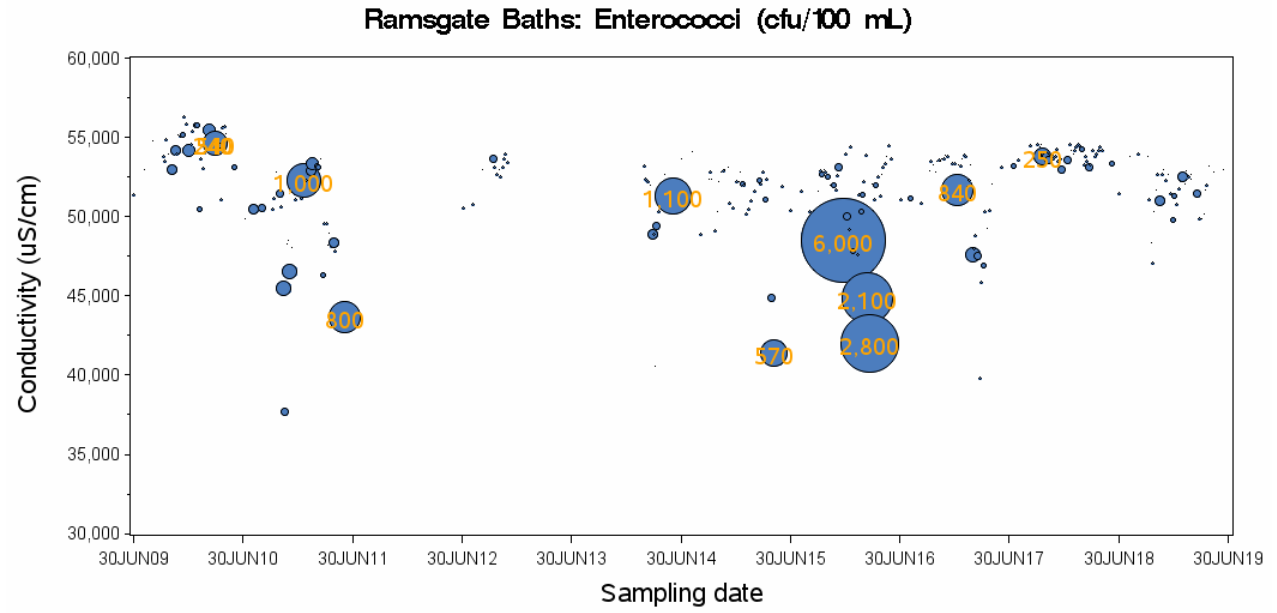

Jew Fish Bay Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
500
400
400
900
750
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

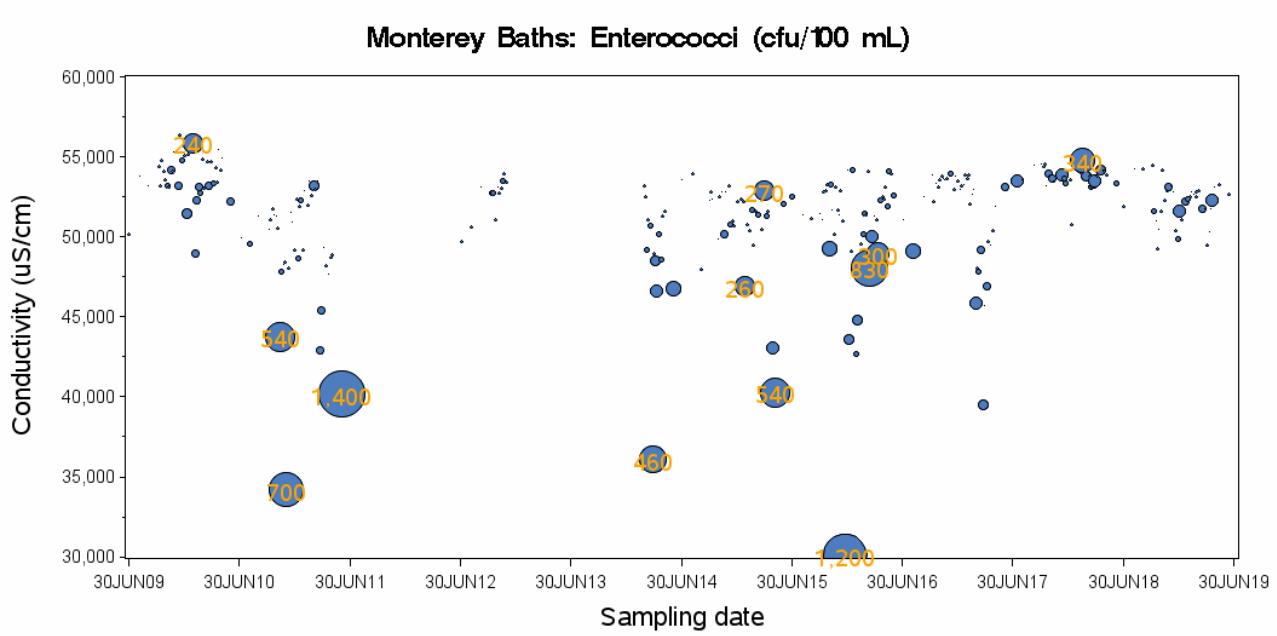

Oatley Bay Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

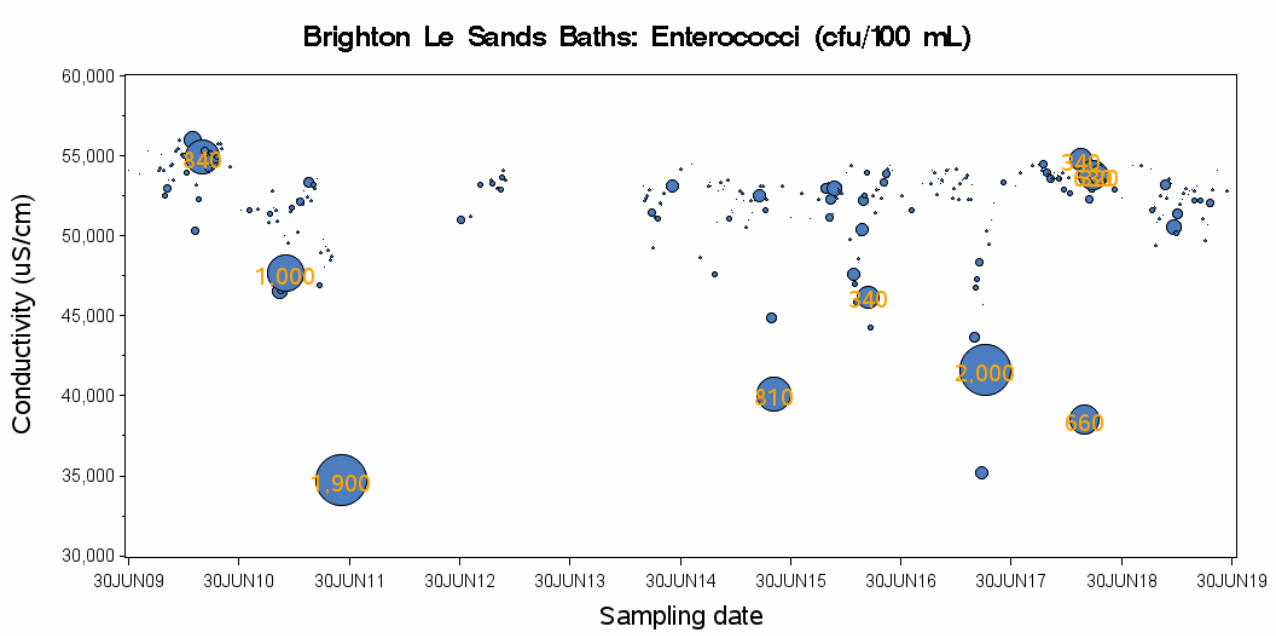

Carss Point Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

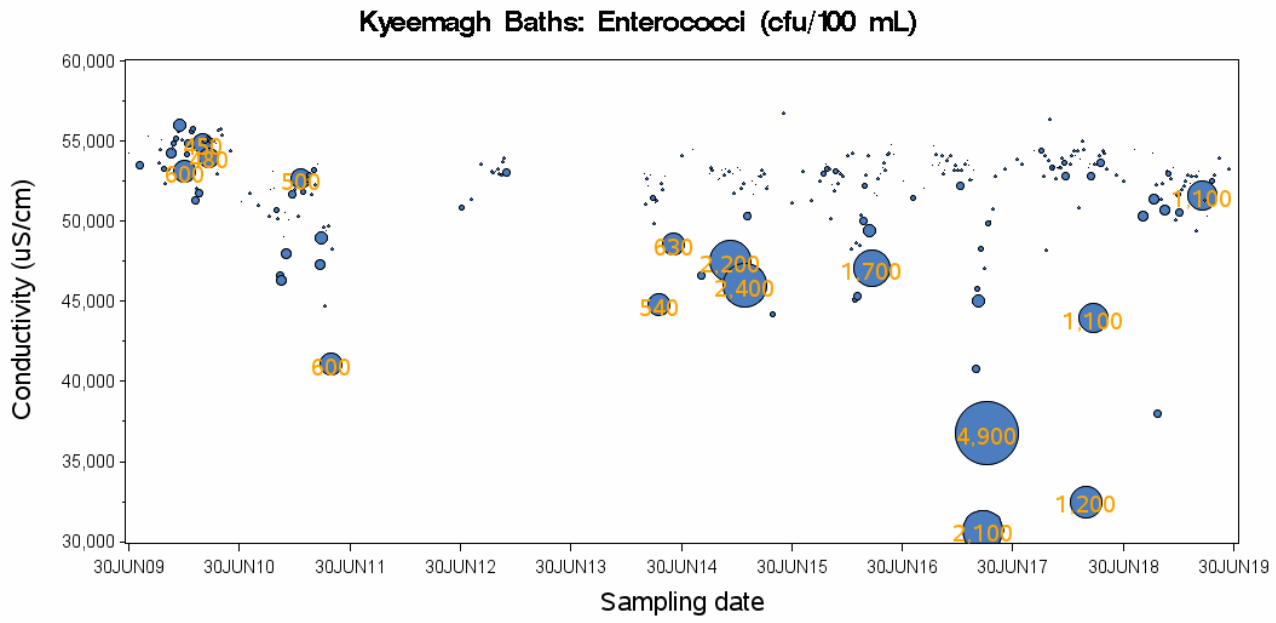

Sandringham Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

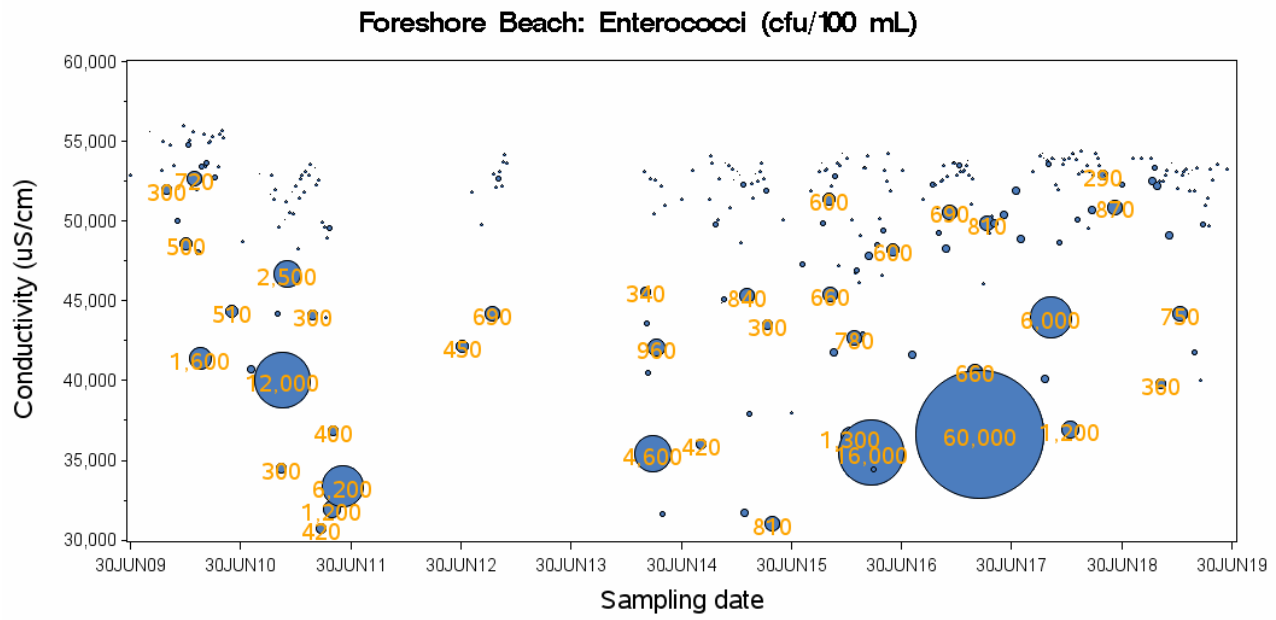

Dolls Point Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
700
700
1,200
2,600
240
990
14,000

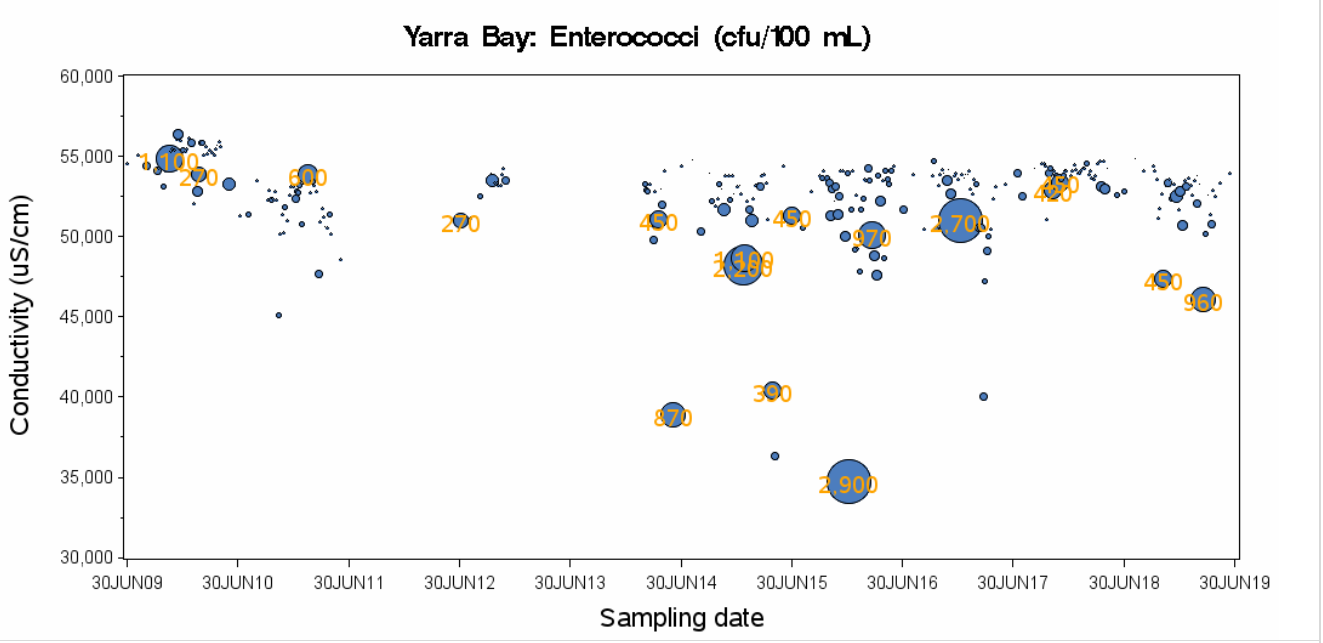

Ramsgate Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
1,000
800
1,100
6,000
2,100
2,800
570
840

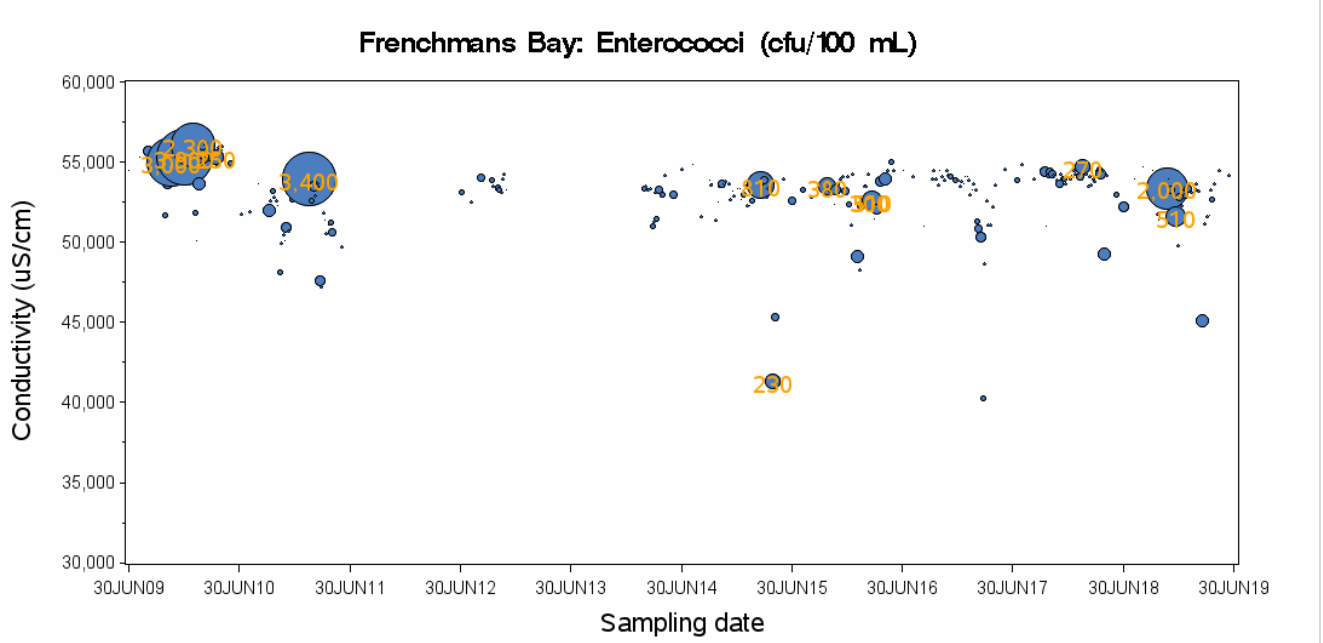

Monterey Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
540
1,400
700
270
280
530
540
460
1,200

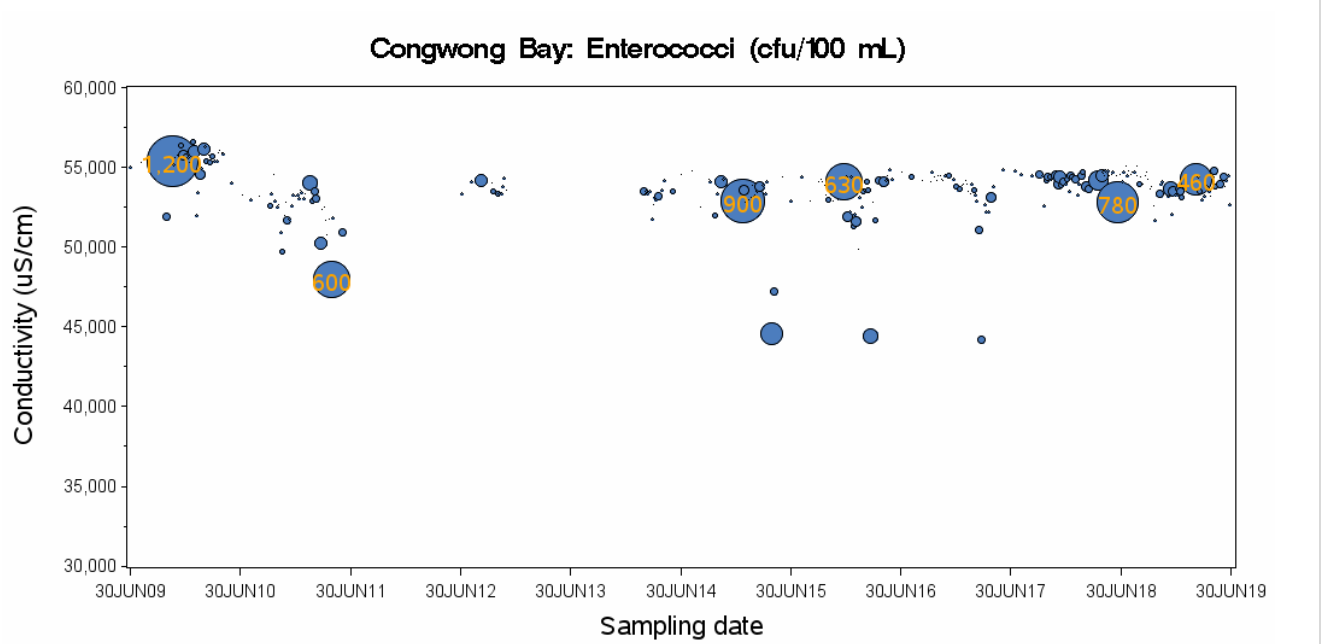

Brighton Le Sands Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

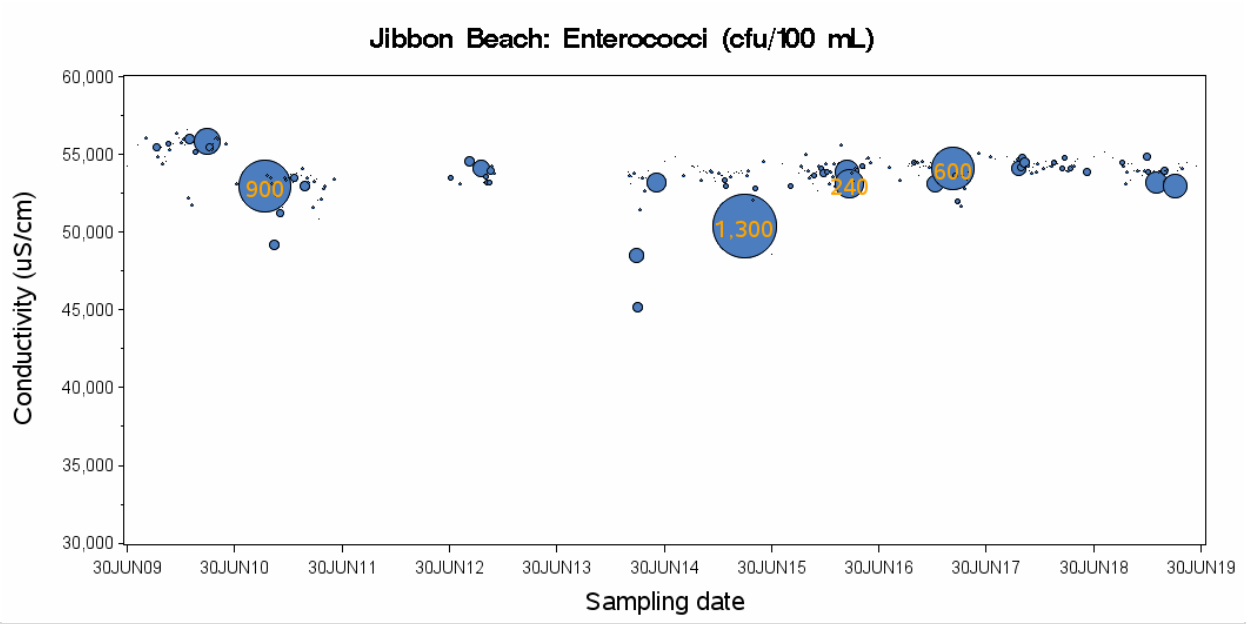

Kyeemagh Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

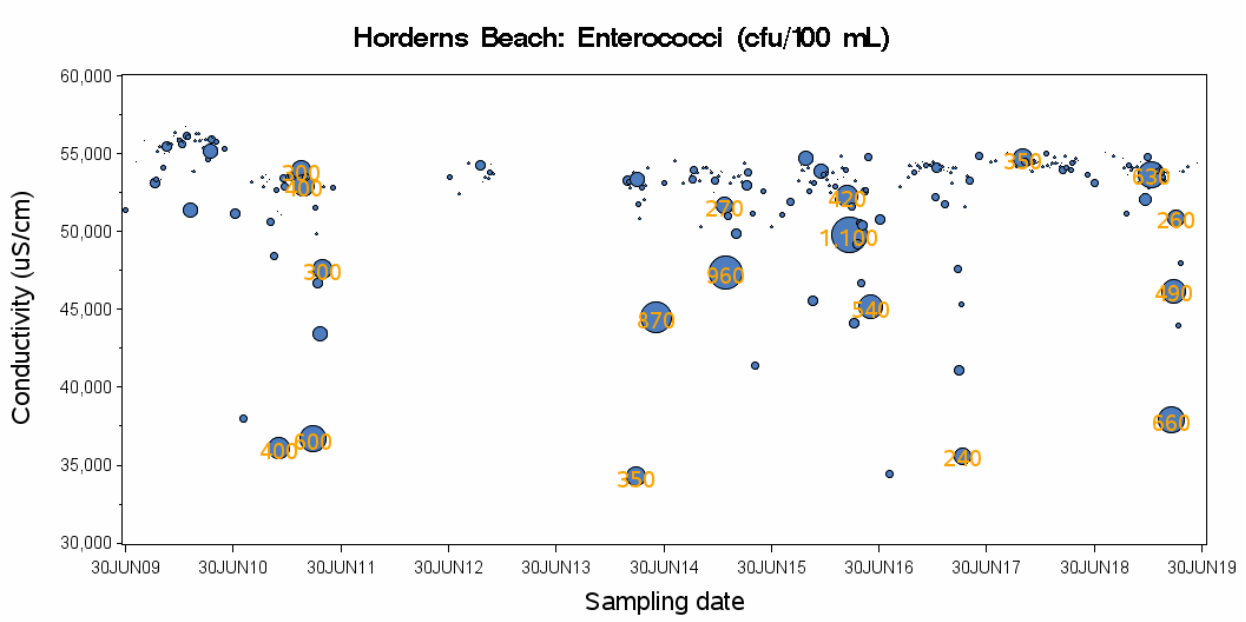

Foreshore Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

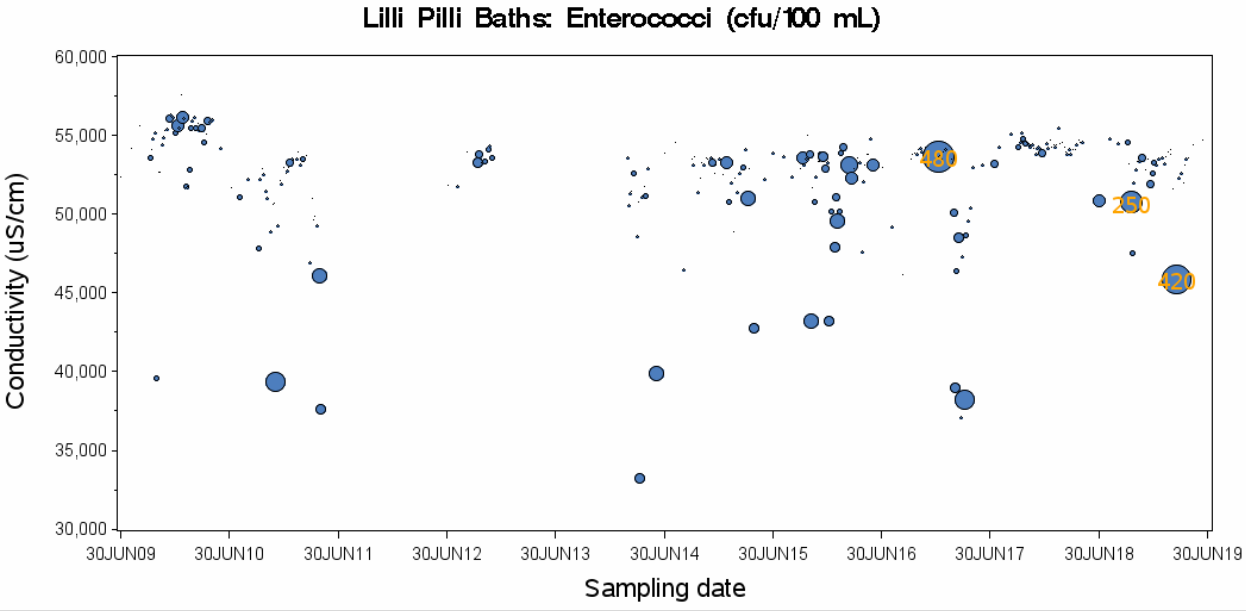

Yarra Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

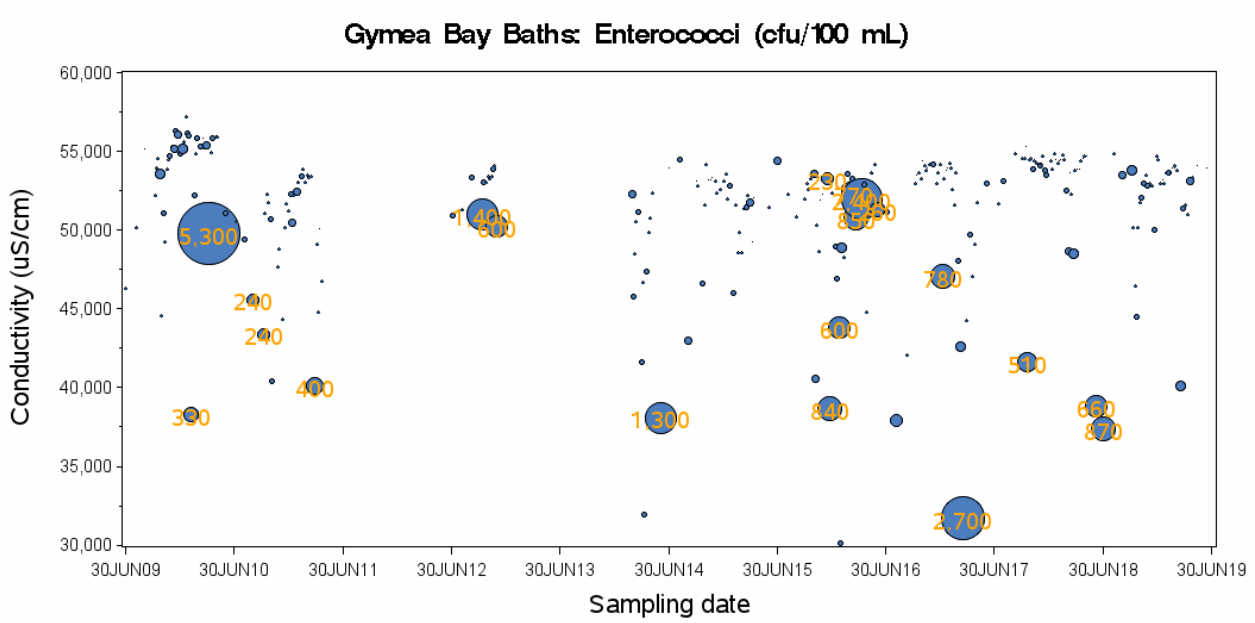

Frenchmans Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

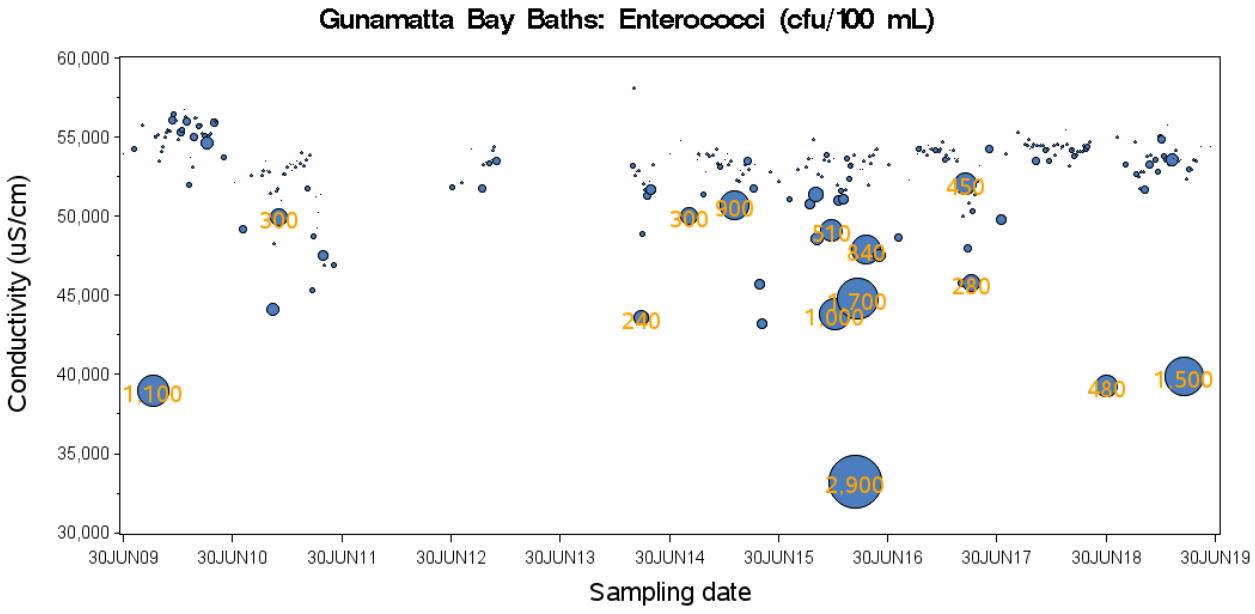

Congwong Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

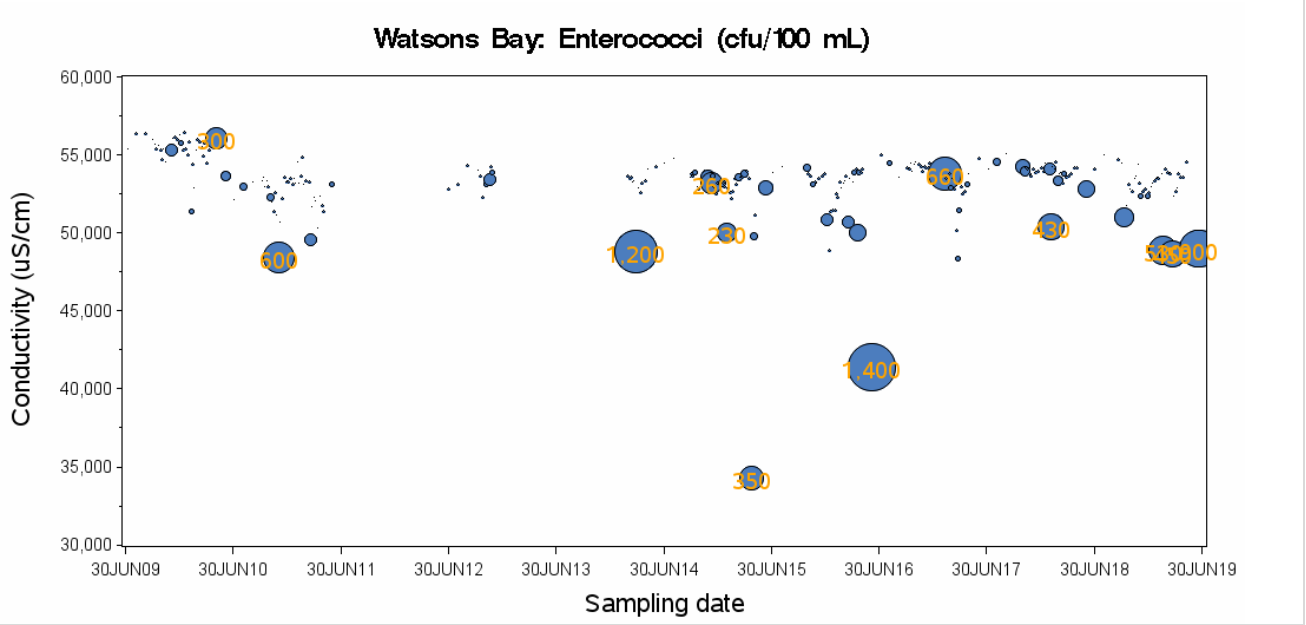

Jibbon Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
900
1,300
240
600
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

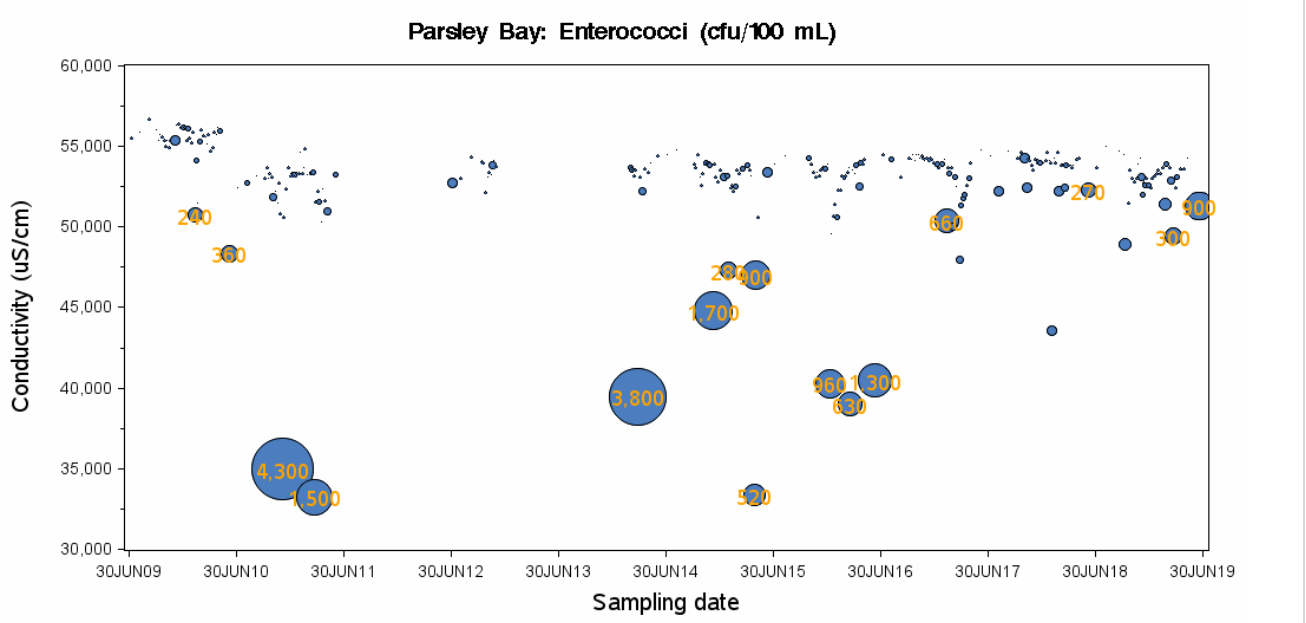

Horderns Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
300
960
870
540
660
490
260
240
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

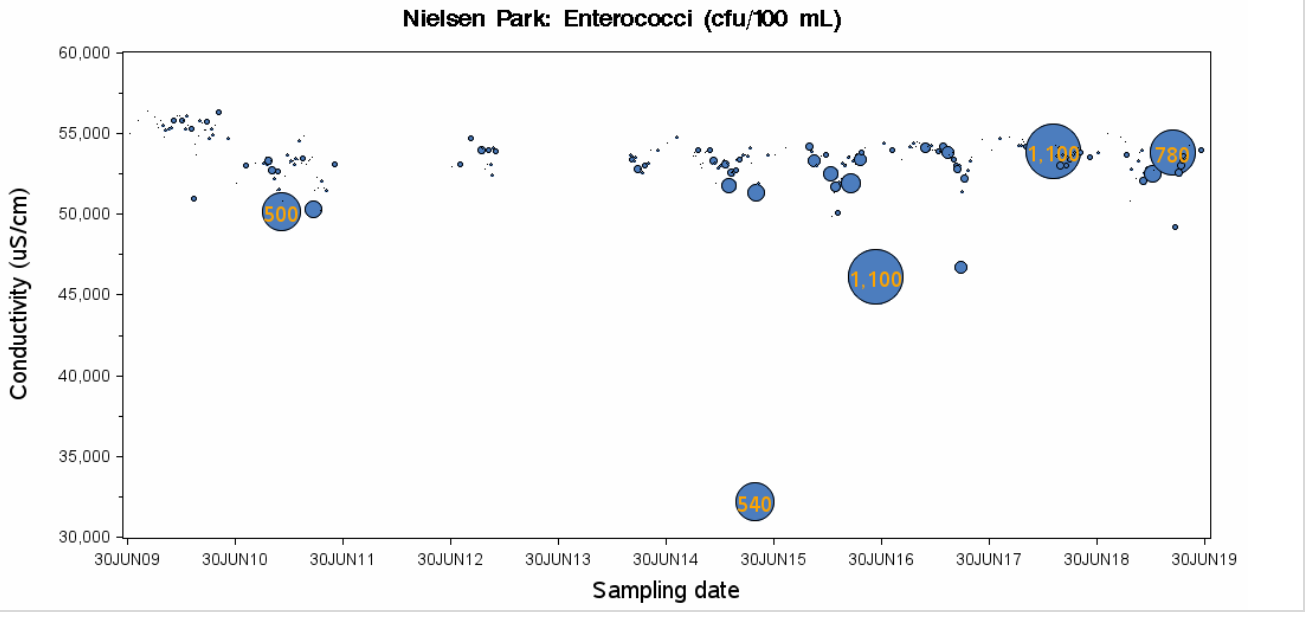

Lilli Pilli Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
480
250
420
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

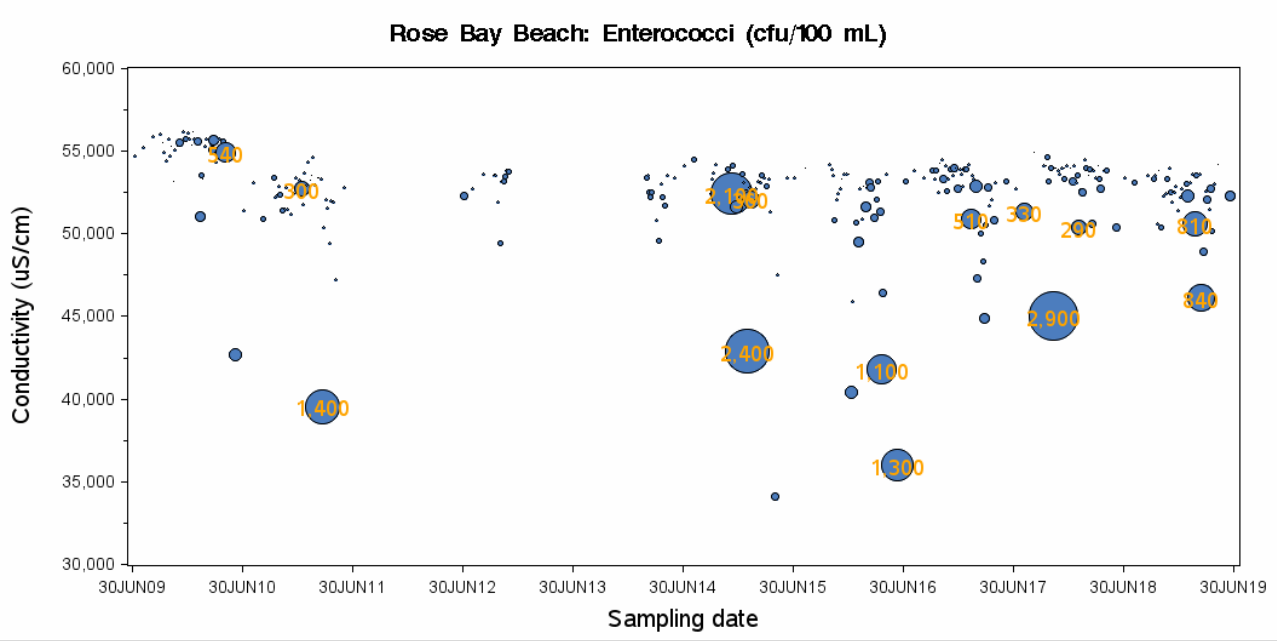

Gymea Bay Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
5,300
240
240
400
300
1,300
1,400
800
290
780
600
840
510
660
870
2,700
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

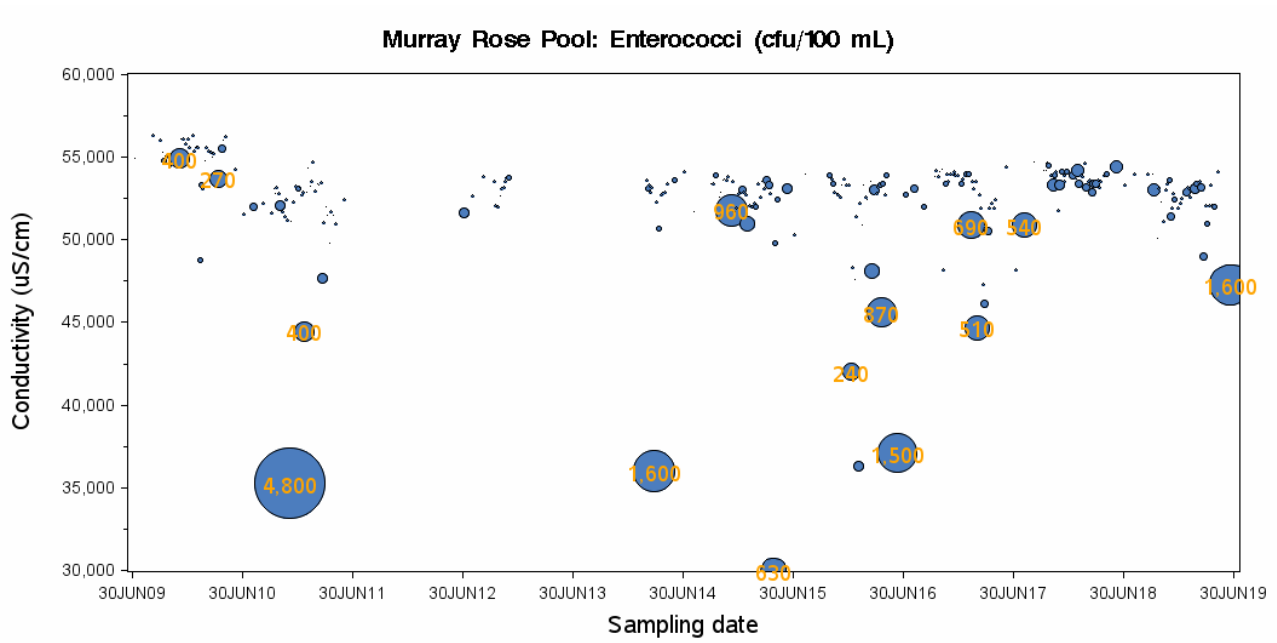

Gunamatta Bay Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
300
1,100
300
900
510
840
450
290
240
1,700
1,000
480
1,500
2,900
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

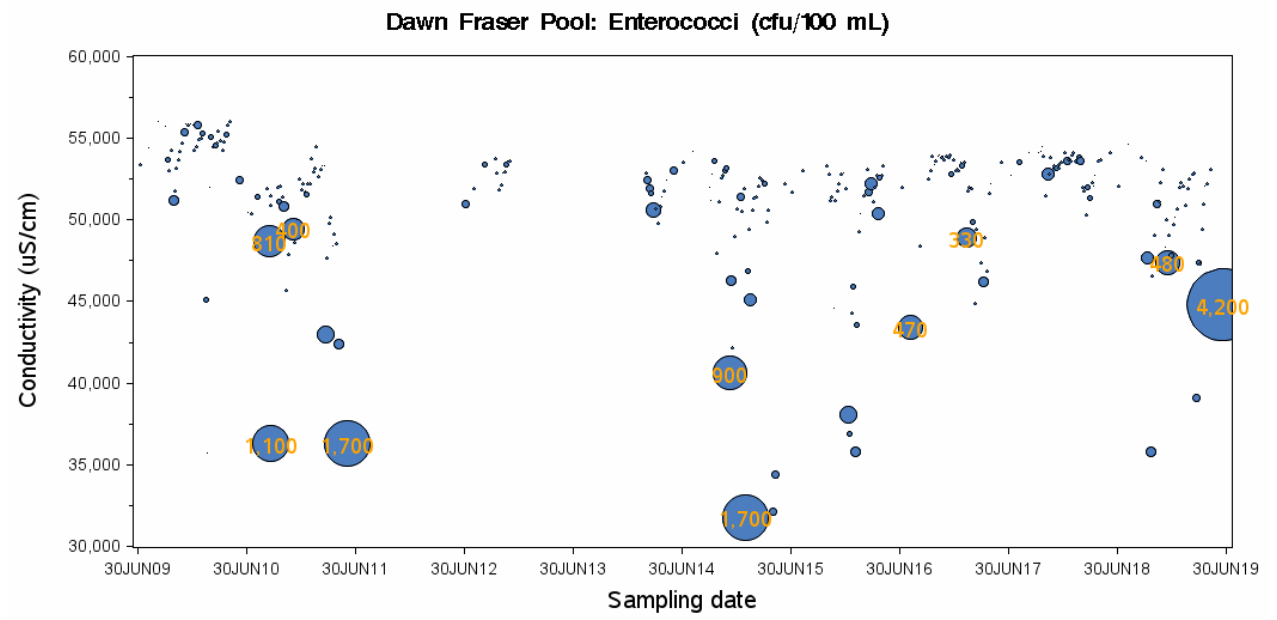

Watsons Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
600
1,200
660
430
1,400
350

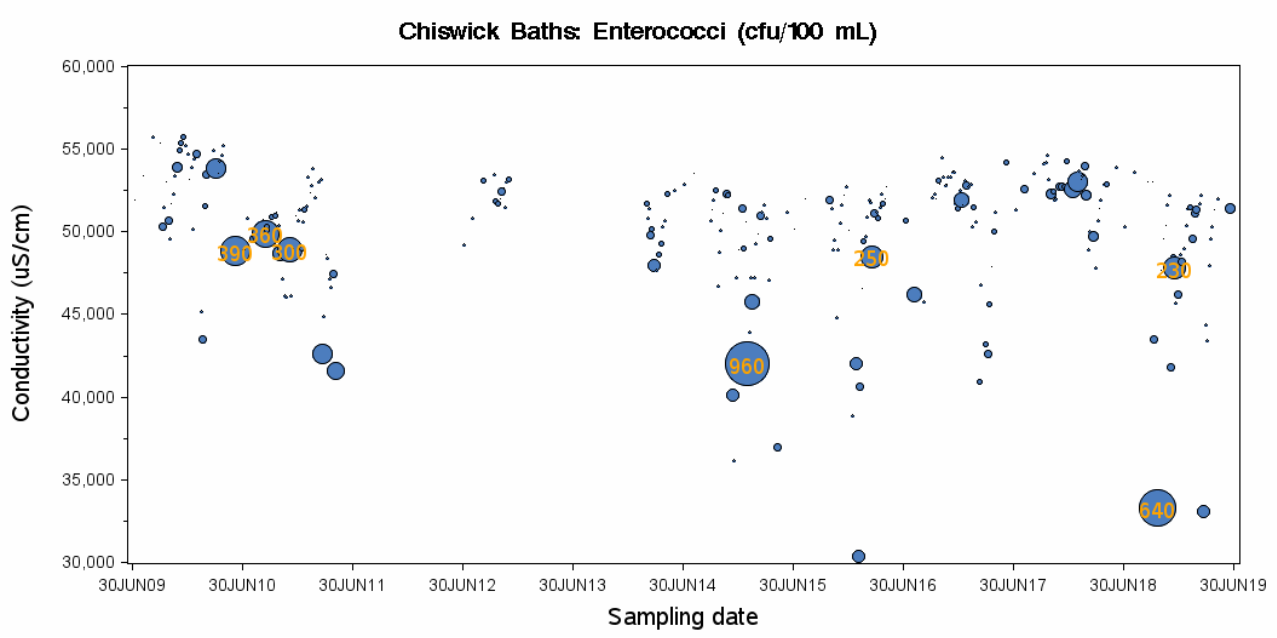

Parsley Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
660
1,700
3,800
4,300
1,500
520

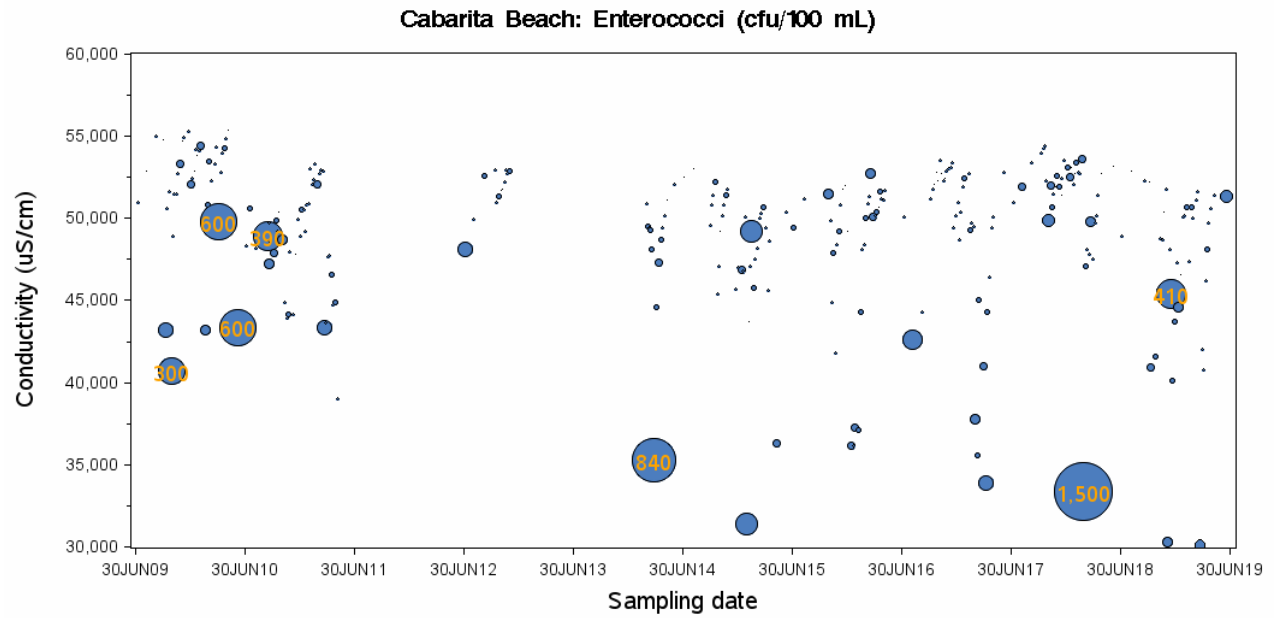

Nielsen Park: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
500
1,100
780
1,100
540

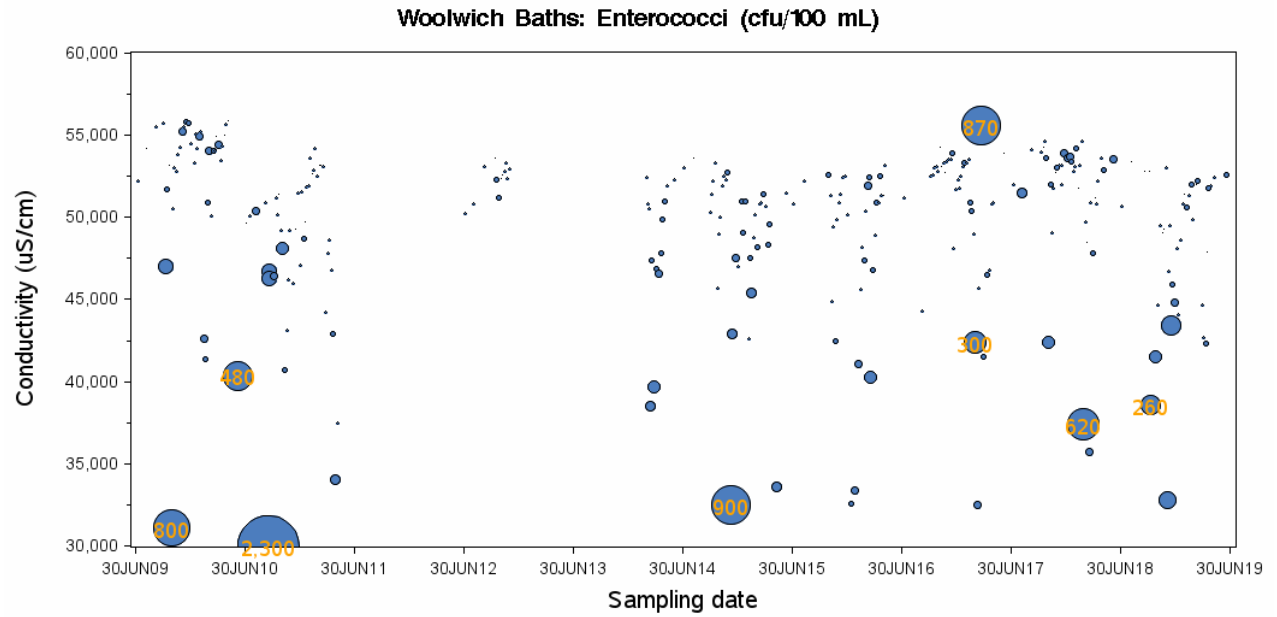

Rose Bay Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
540
900
2,100
510
330
200
810
840
2,900
2,400
1,100
1,400
1,300

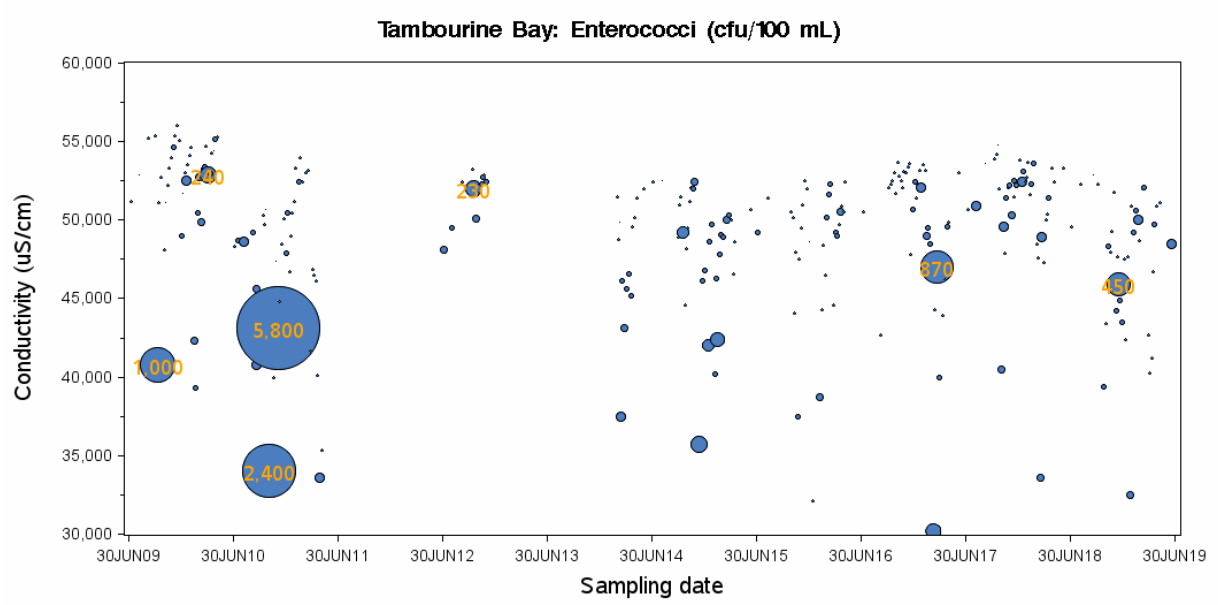

Murray Rose Pool: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
400
270
960
690
540
1,600
570
510
400
240
4,800
1,600
1,500
630

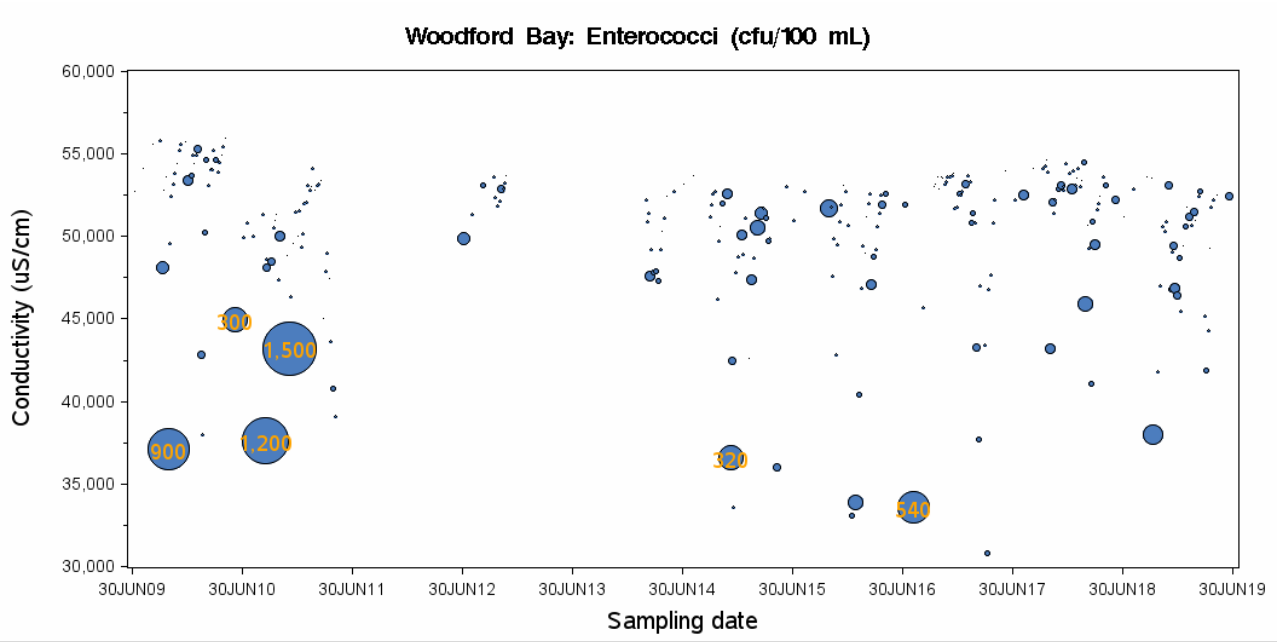

Dawn Fraser Pool: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
810
900
330
430
4,200
470
900
1,100
1,700
1,700

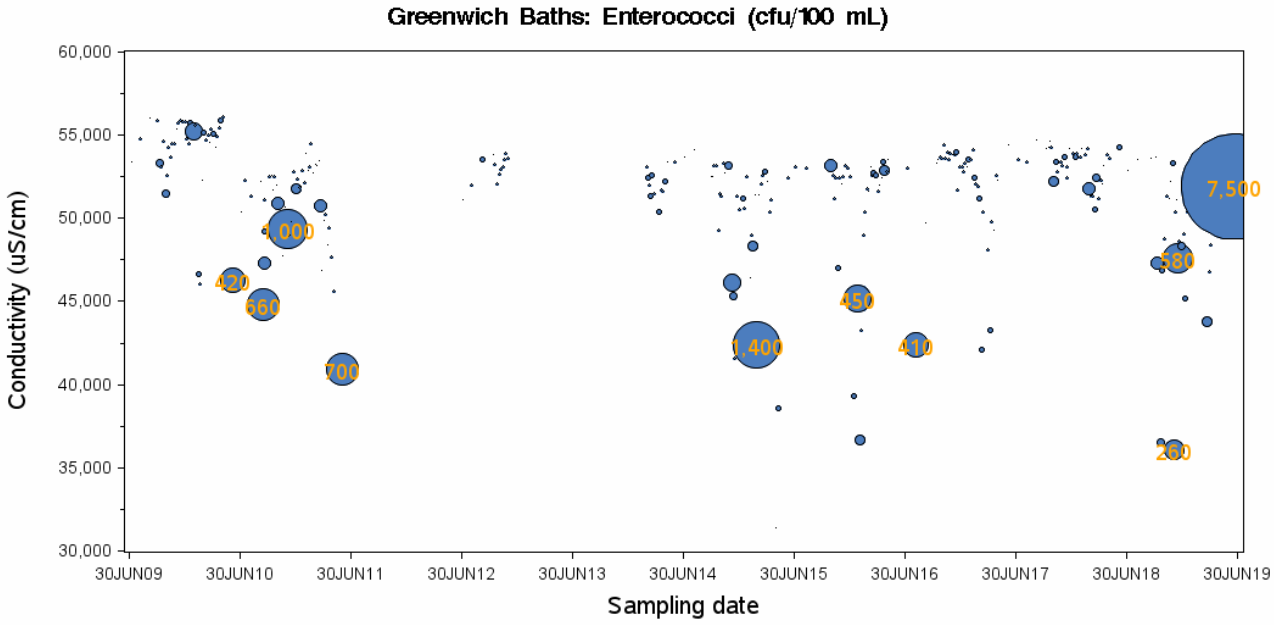

Chiswick Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
390
380
400
960
250
230
640
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

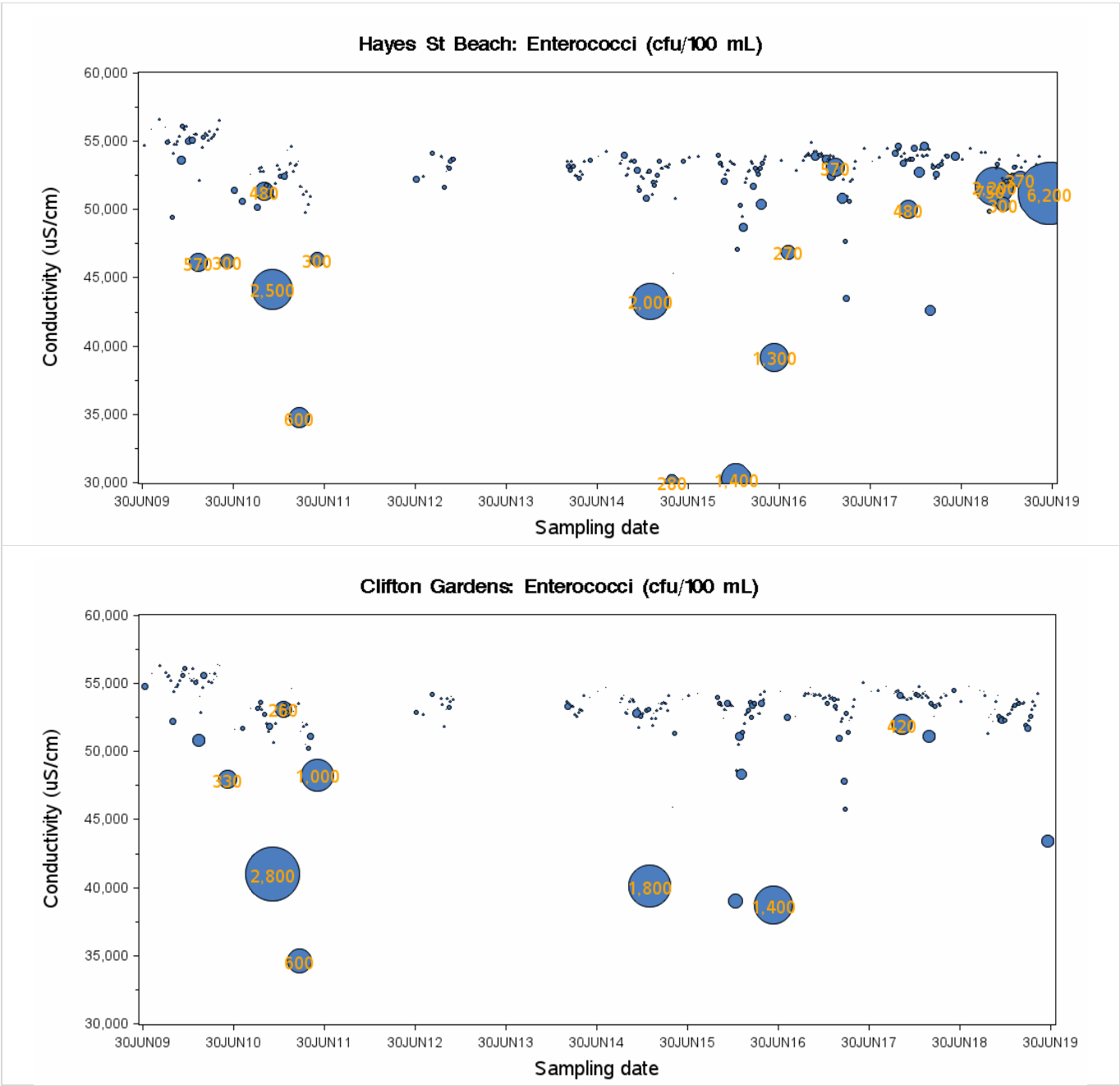

Cabarita Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
600
590
600
300
840
1,500
410
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

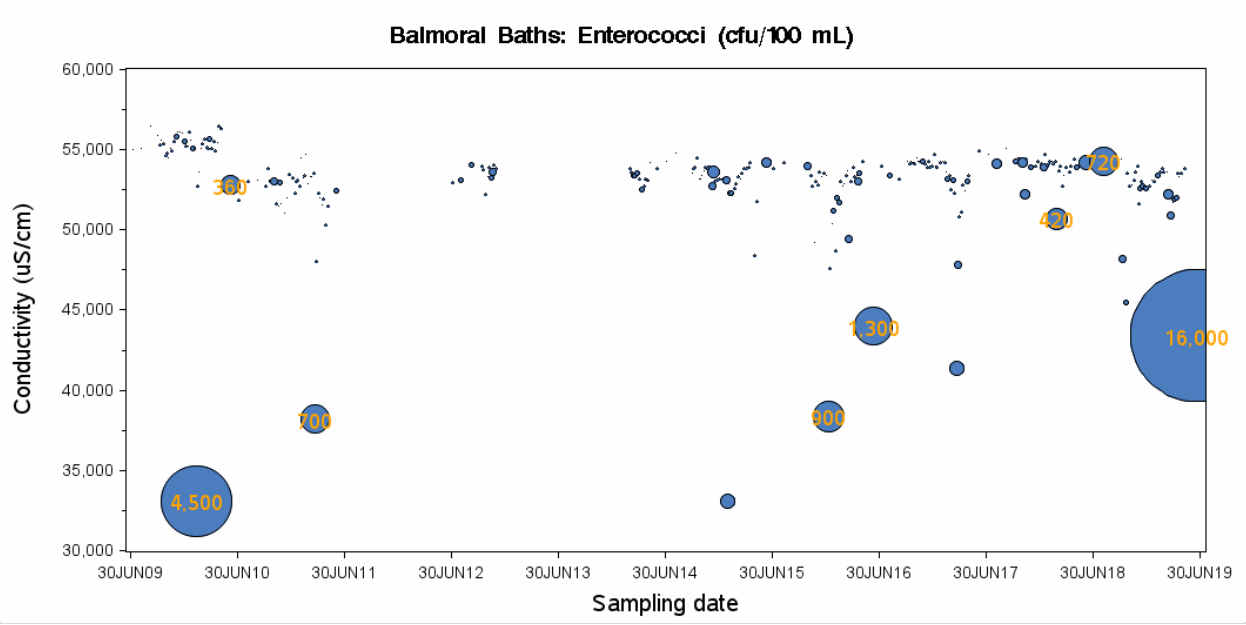

Woolwich Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
480
800
2,300
900
870
300
620
260
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

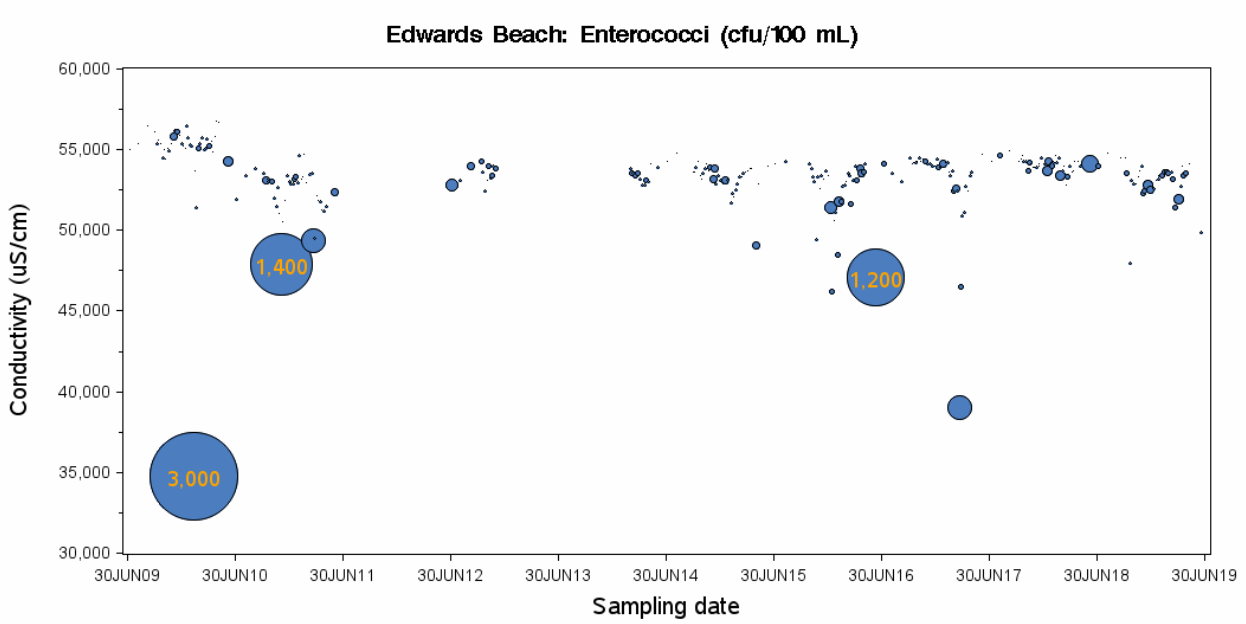

Tambourine Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
5,800
2,400
870
450
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

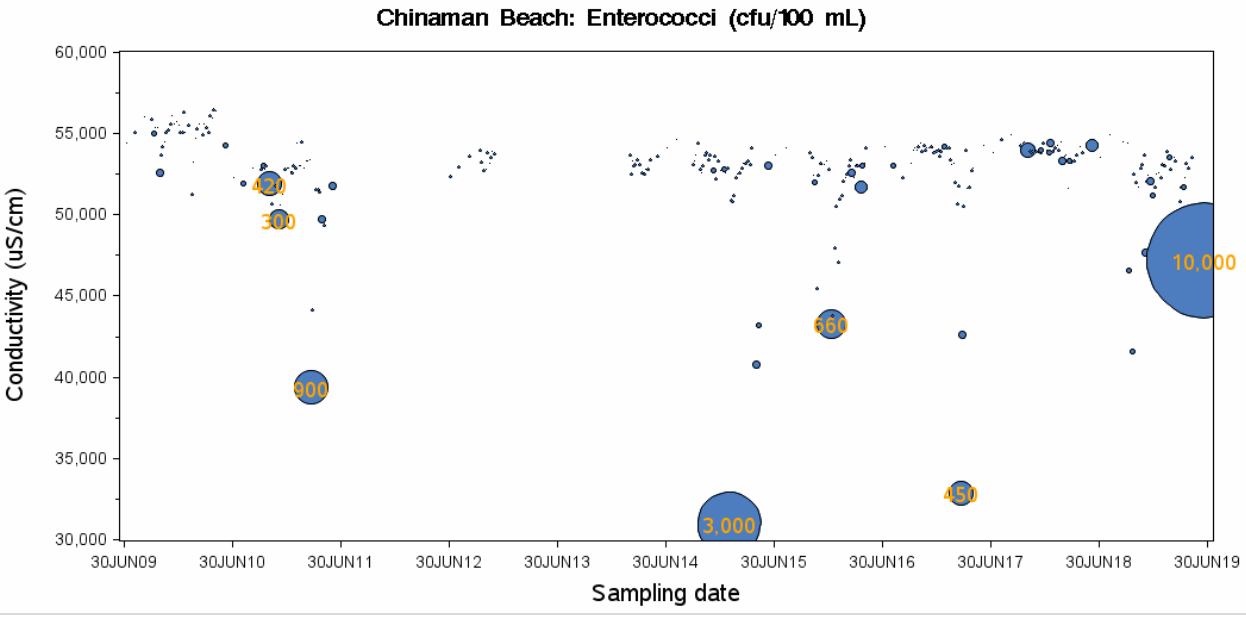

Woodford Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
1,500
1,200
900
320
540
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

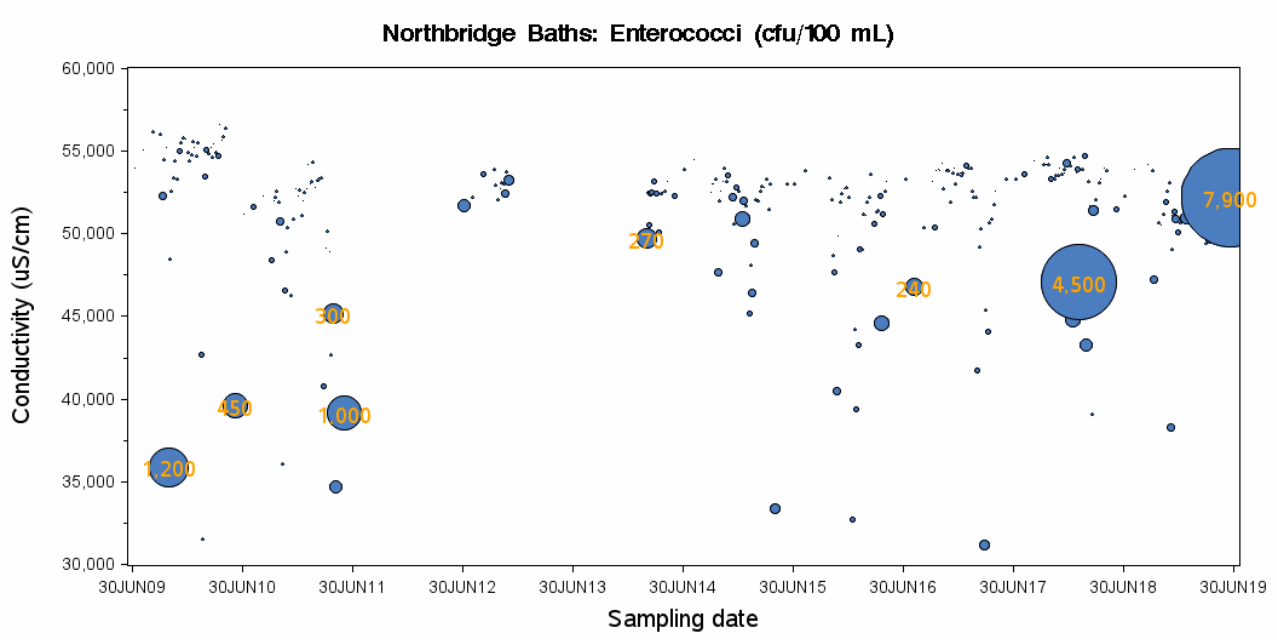

Greenwich Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
7,500
660
1,400
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

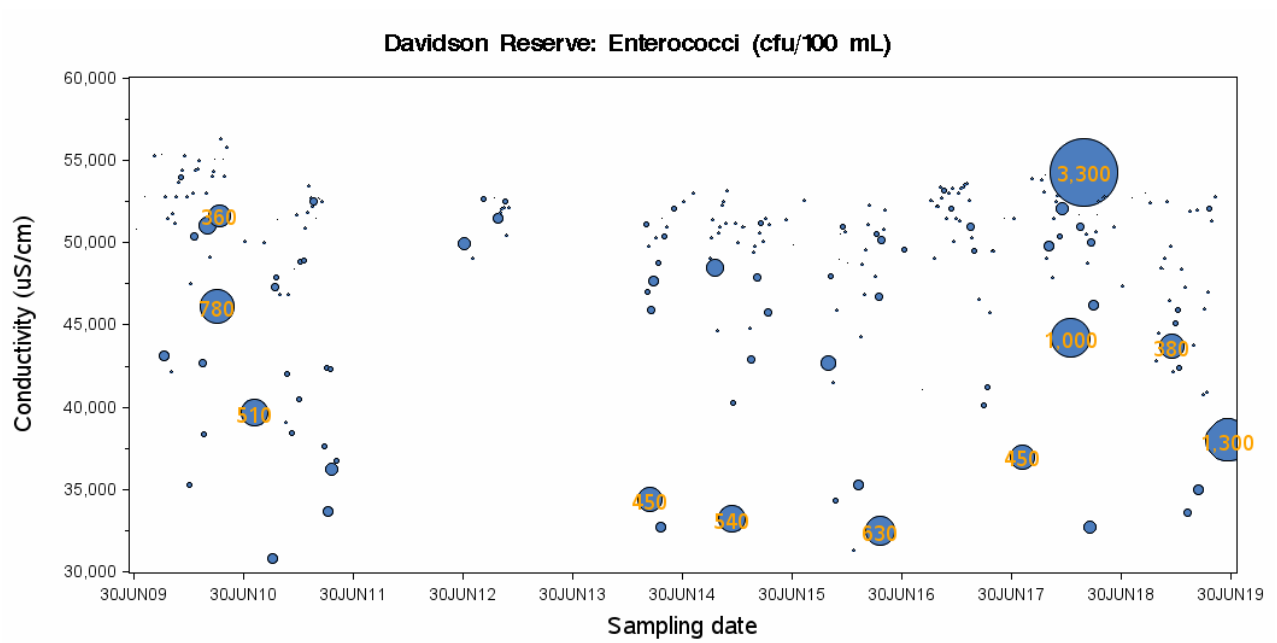

Hayes St Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
480
570
300
300
2,500
600
2,000
1,300
200
1,400
570
480
270
6,200
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
Clifton Gardens: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
380
1,000
2,800
600
1,800
1,400
420
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

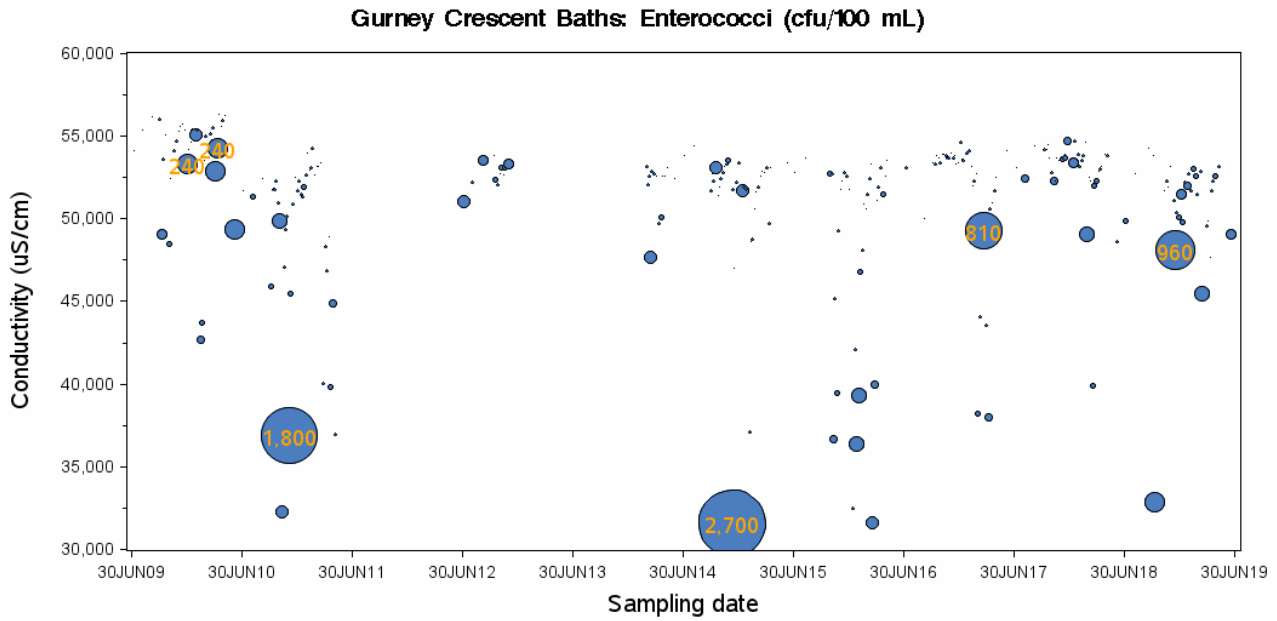

Balmoral Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
360
720
420
1,300
16,000
700
900
4,500
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

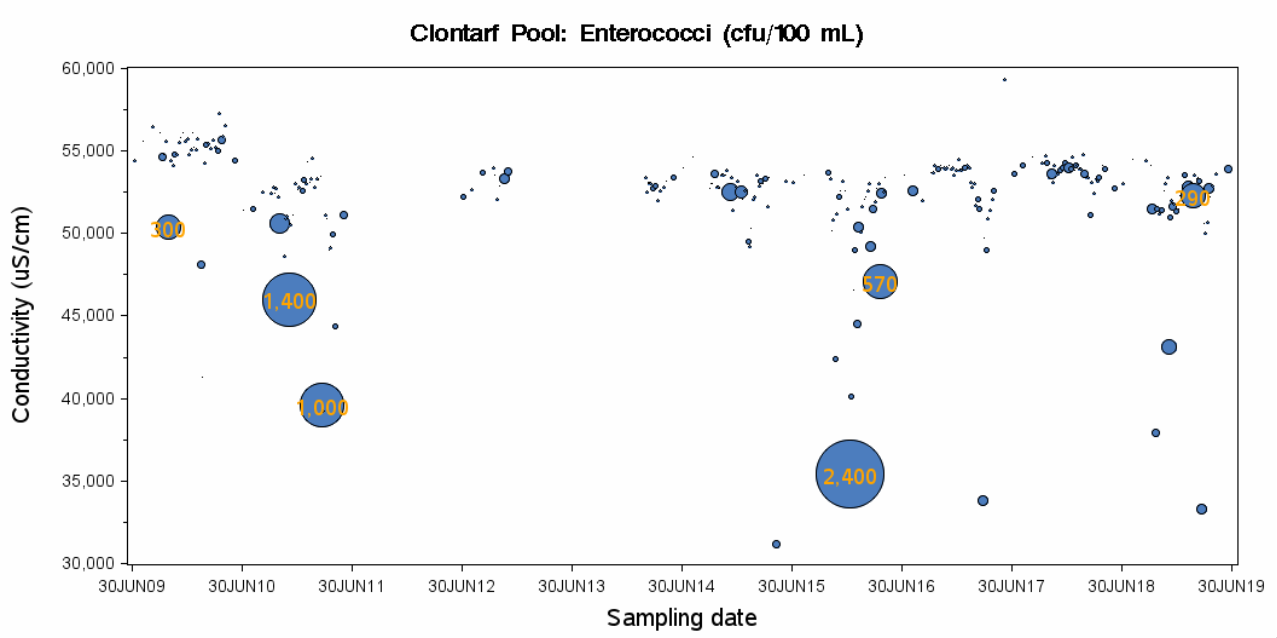

Edwards Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
1,400
1,200
3,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

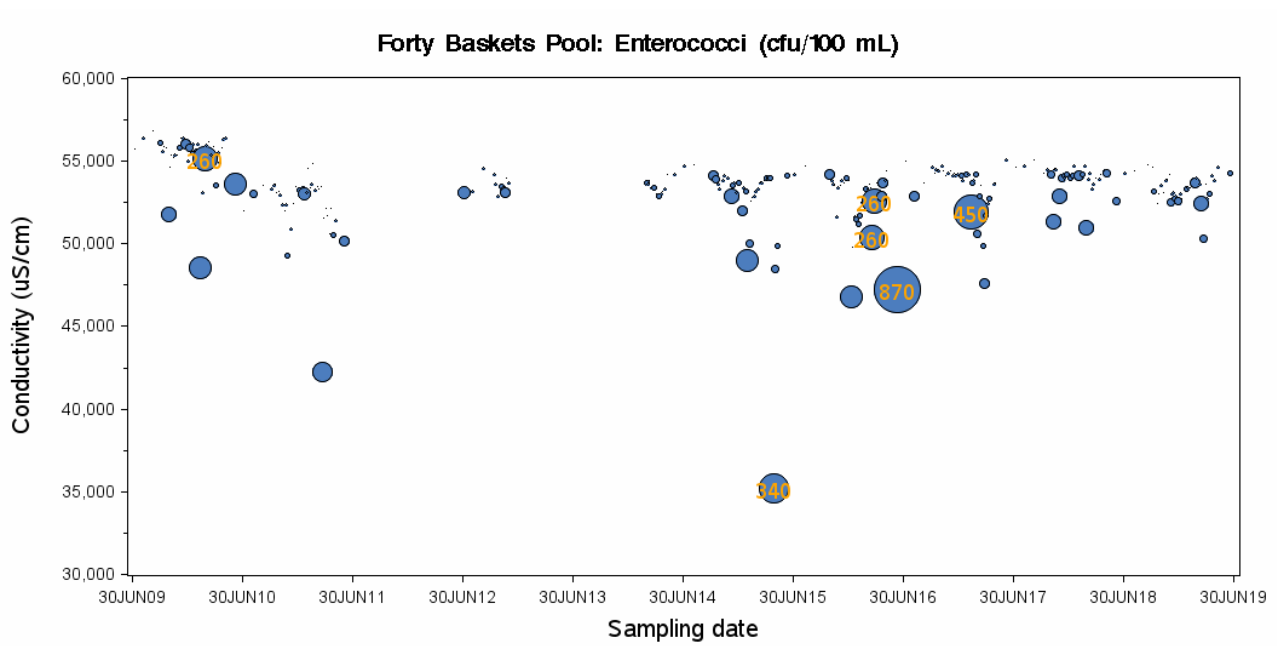

Chinaman Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
420
300
10,000
660
900
450
3,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

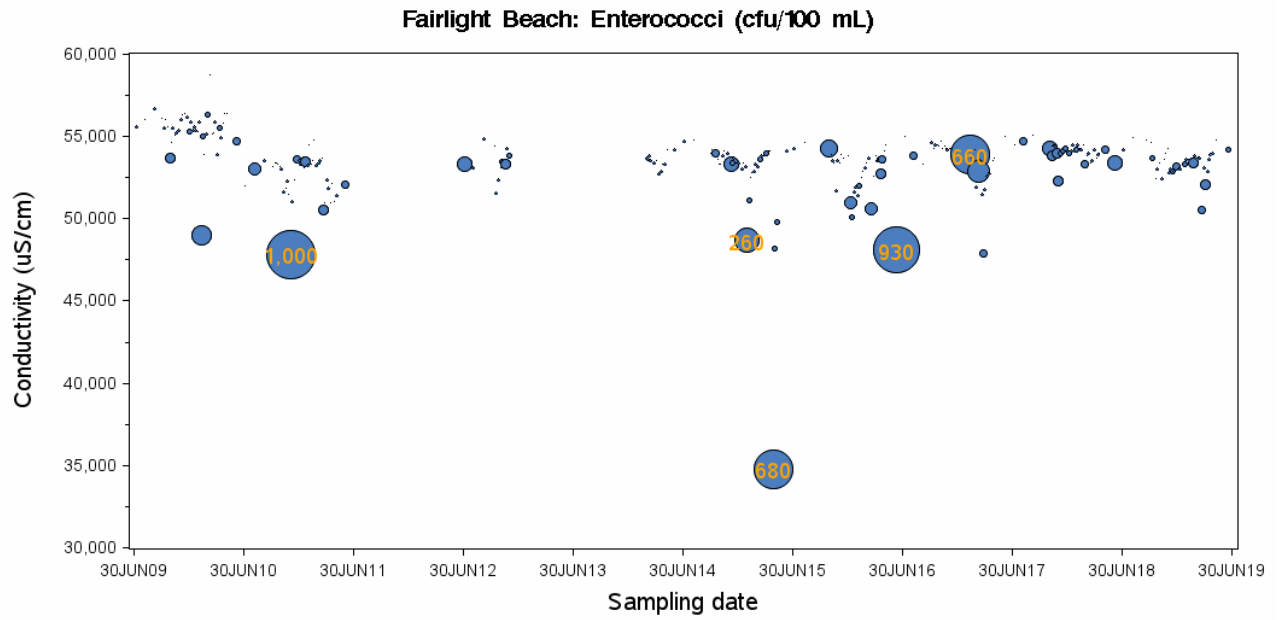

Northbridge Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
7,900
4,500
1,200
1,000
450
300
270
240
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

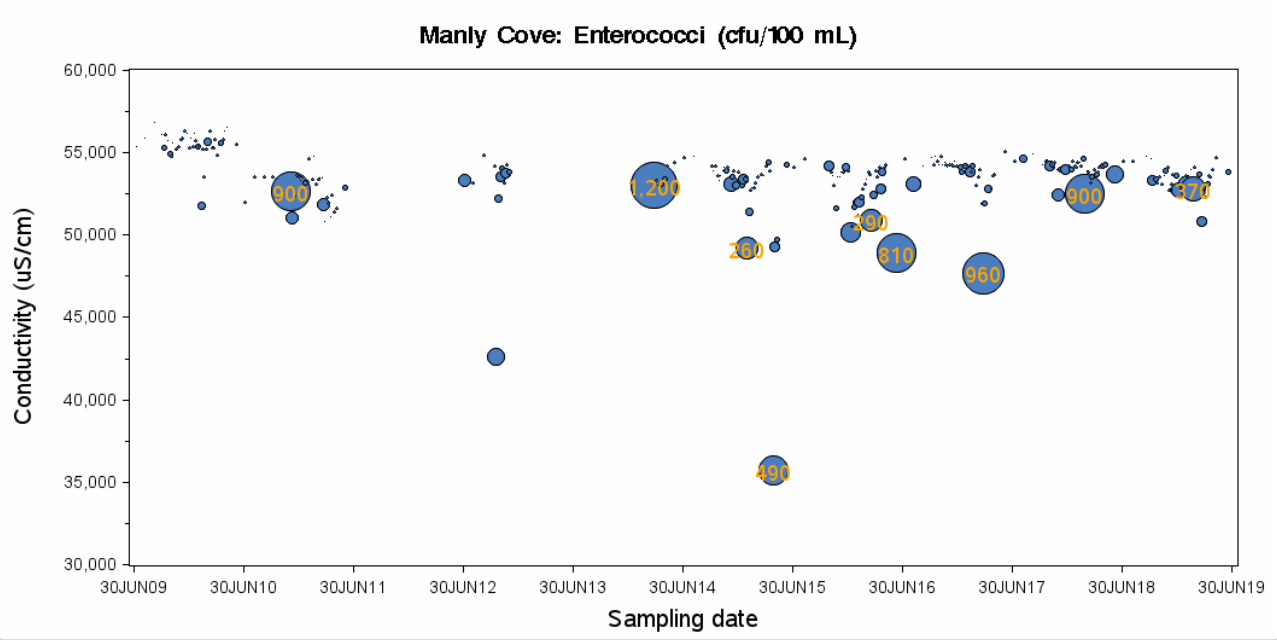

Davidson Reserve: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
3,300
1,300
1,000
780
630
540
450
380
360
310
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

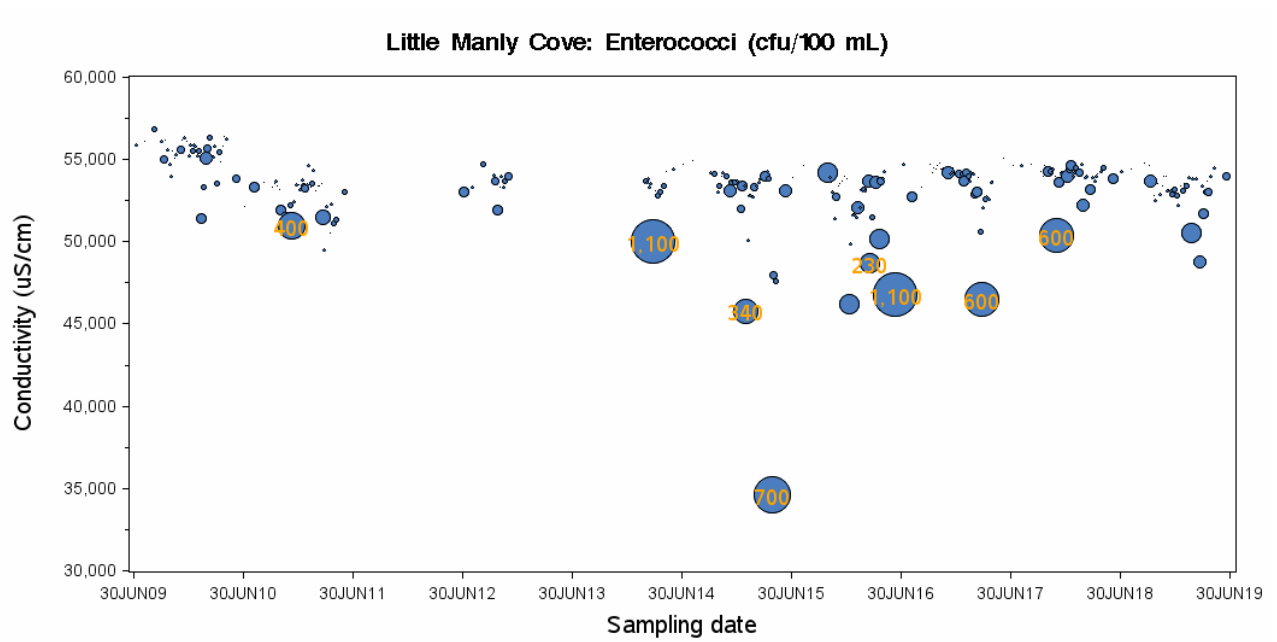

Gurney Crescent Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
2,700
1,800
960
810
240
200
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

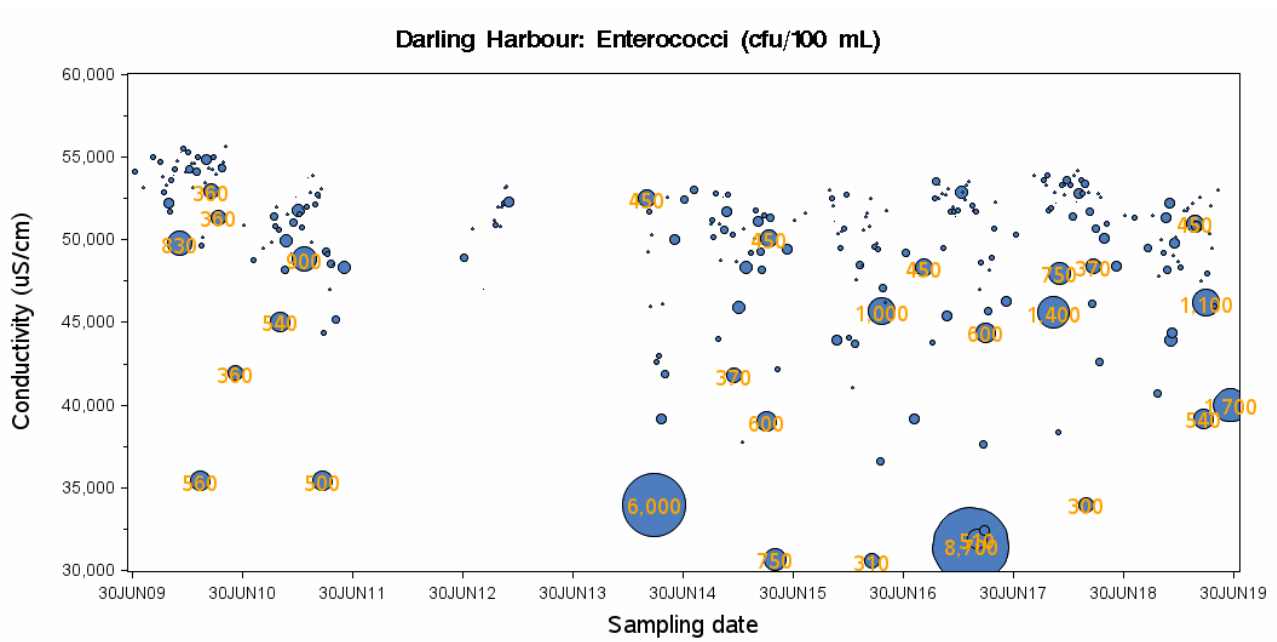

Clontarf Pool: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
300
1,400
1,000
570
190
2,400
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

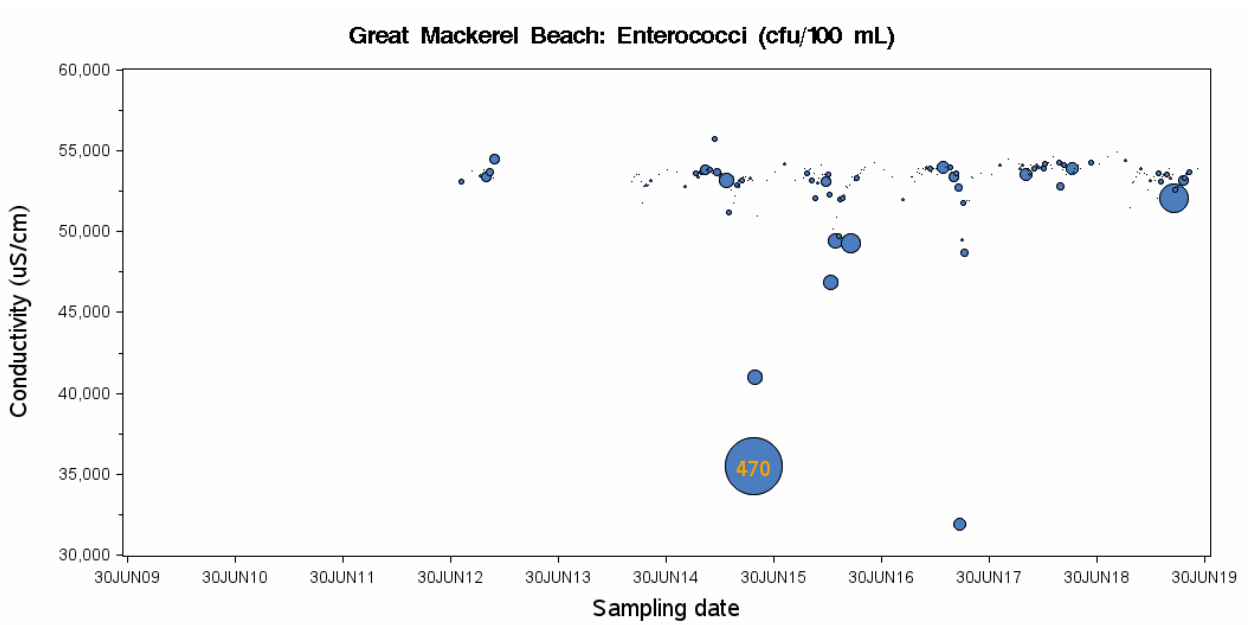

Forty Baskets Pool: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
160
260
160
450
870
240
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

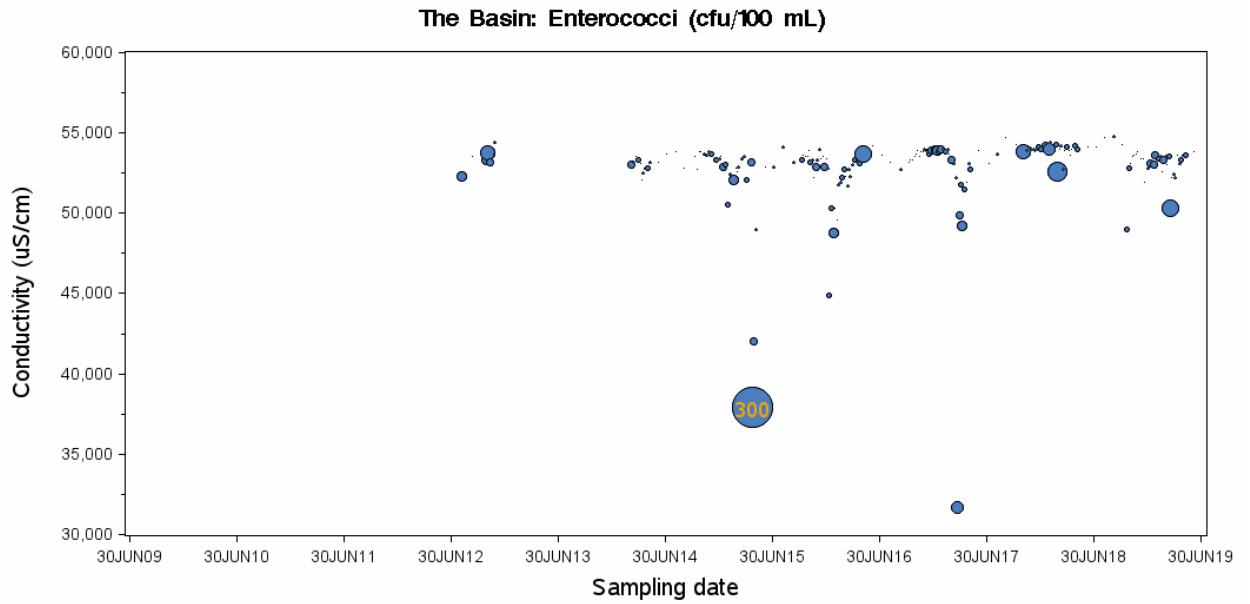

Fairlight Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
1,000
660
260
930
680
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

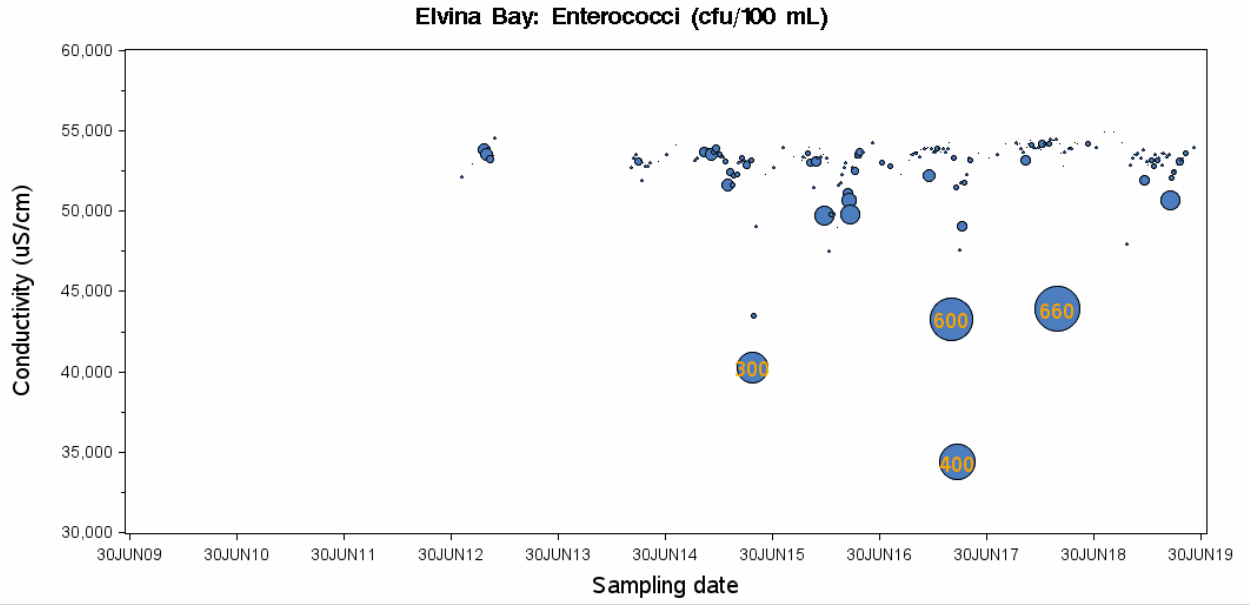

Manly Cove: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
900
1,200
900
370
190
260
610
960
490

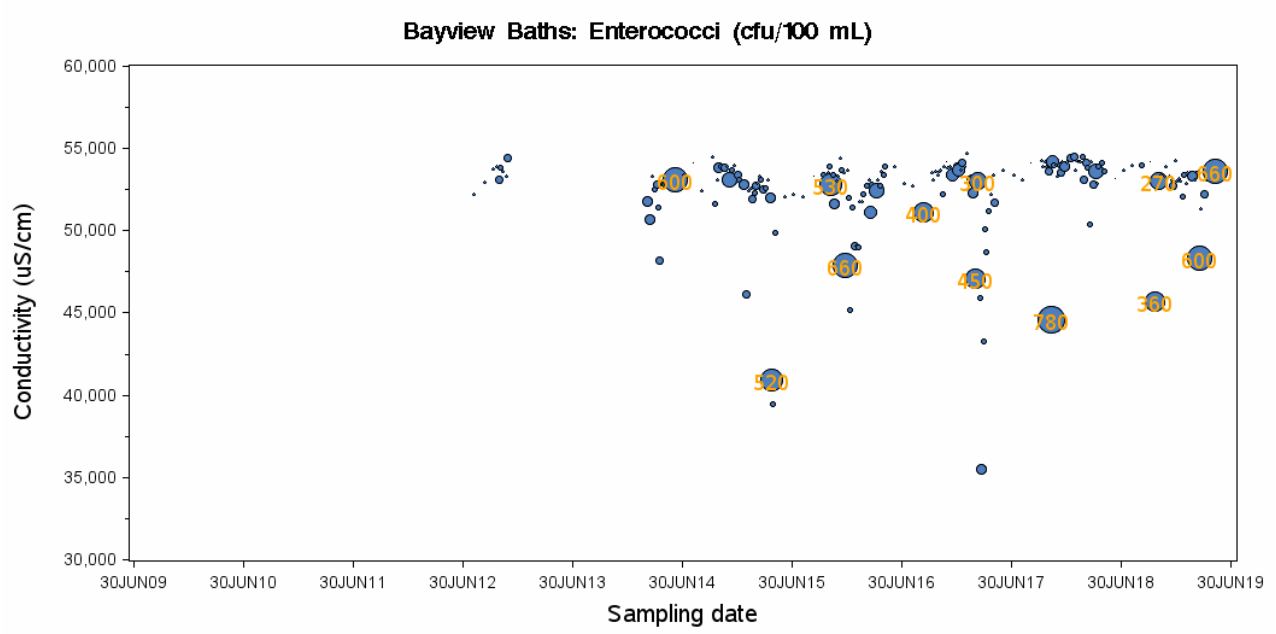

Little Manly Cove: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
400
1,100
600
230
1,100
340
600
700

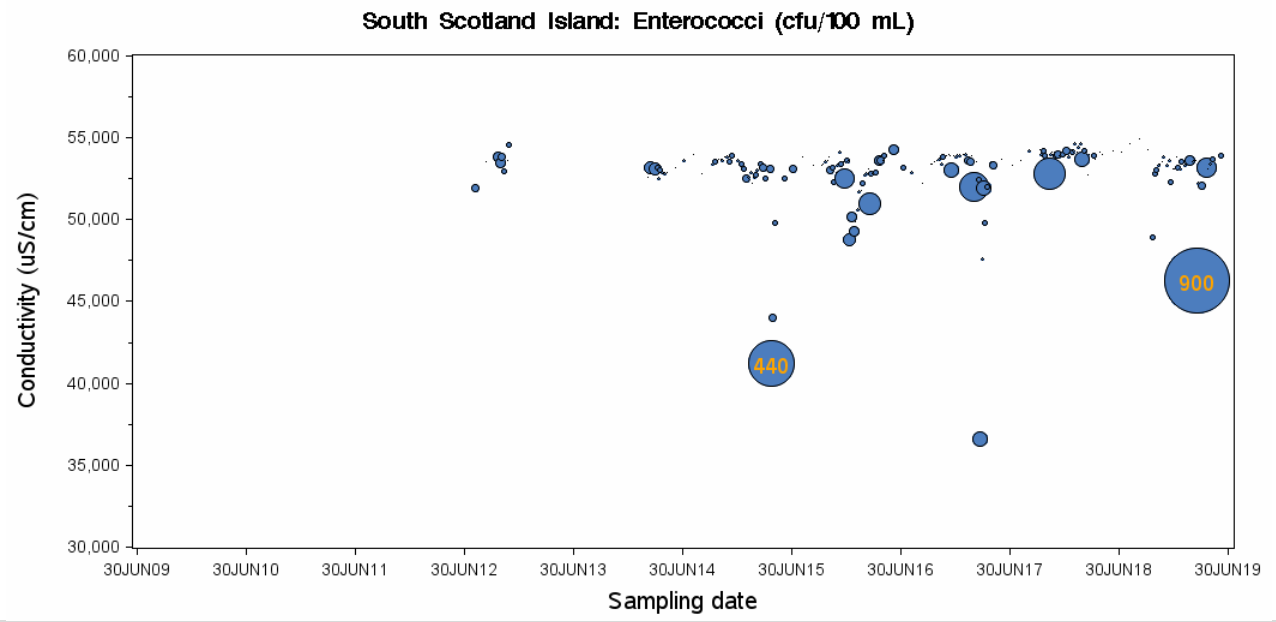

Darling Harbour: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date
300
300
330
900
540
360
560
500
450
450
450
450
750
370
1,000
1,400
600
370
600
6,000
750
310
8,700
300
540

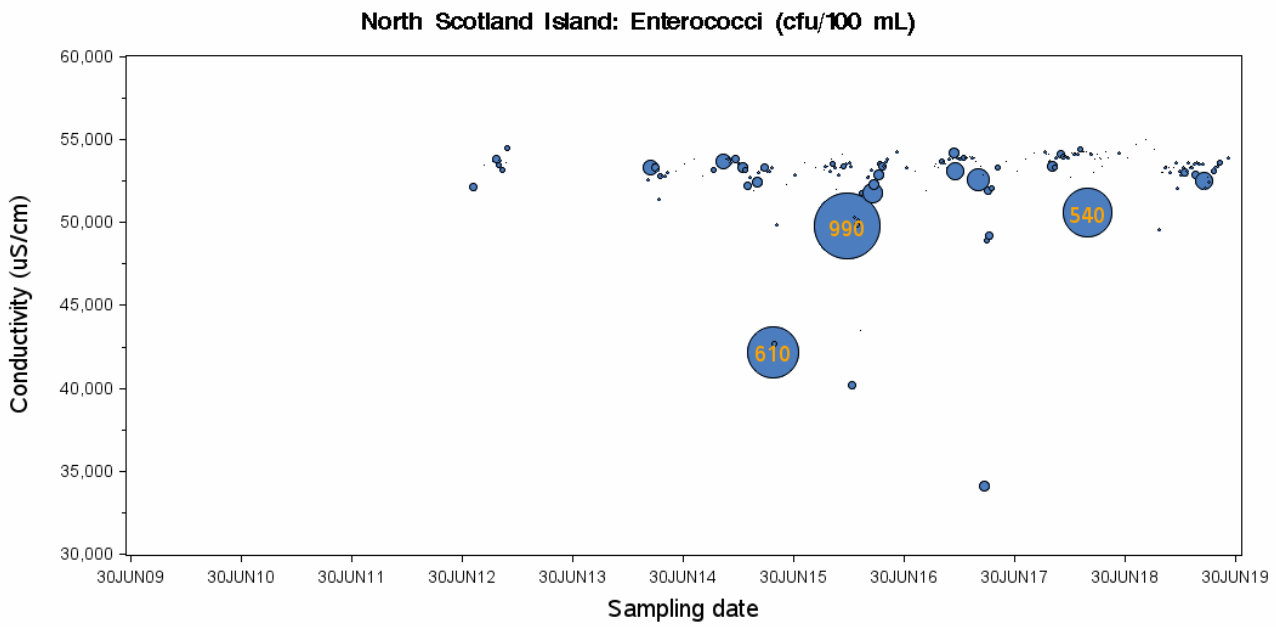

Great Mackerel Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
470
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

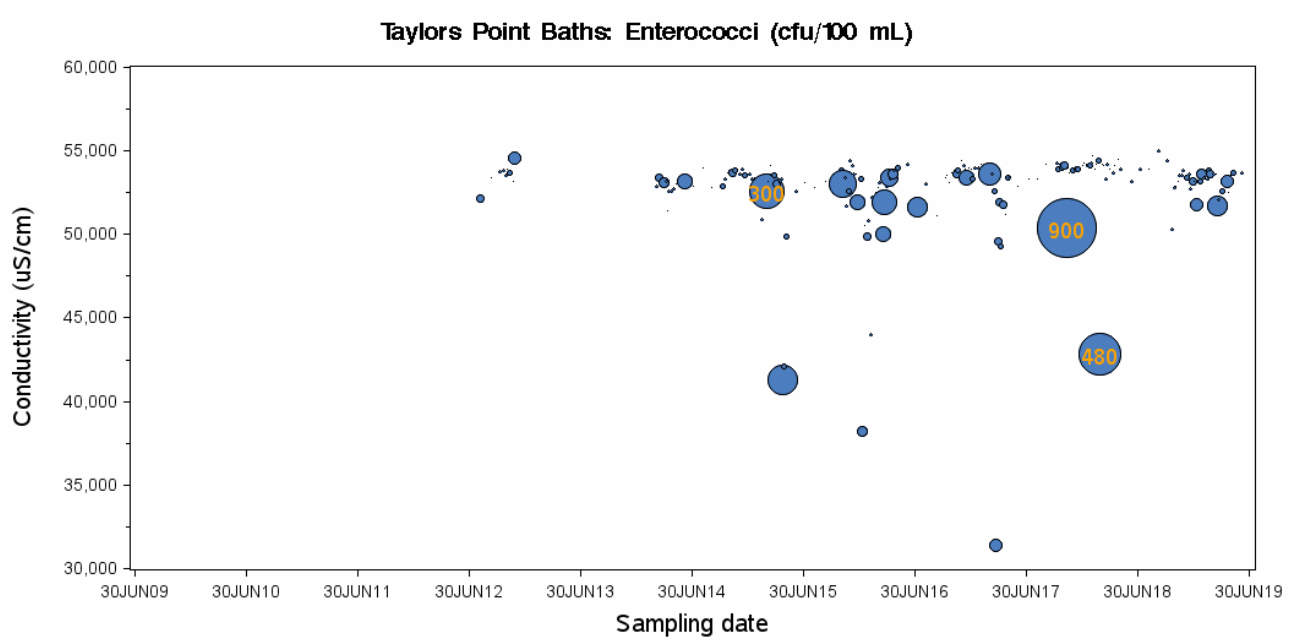

The Basin: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
300
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

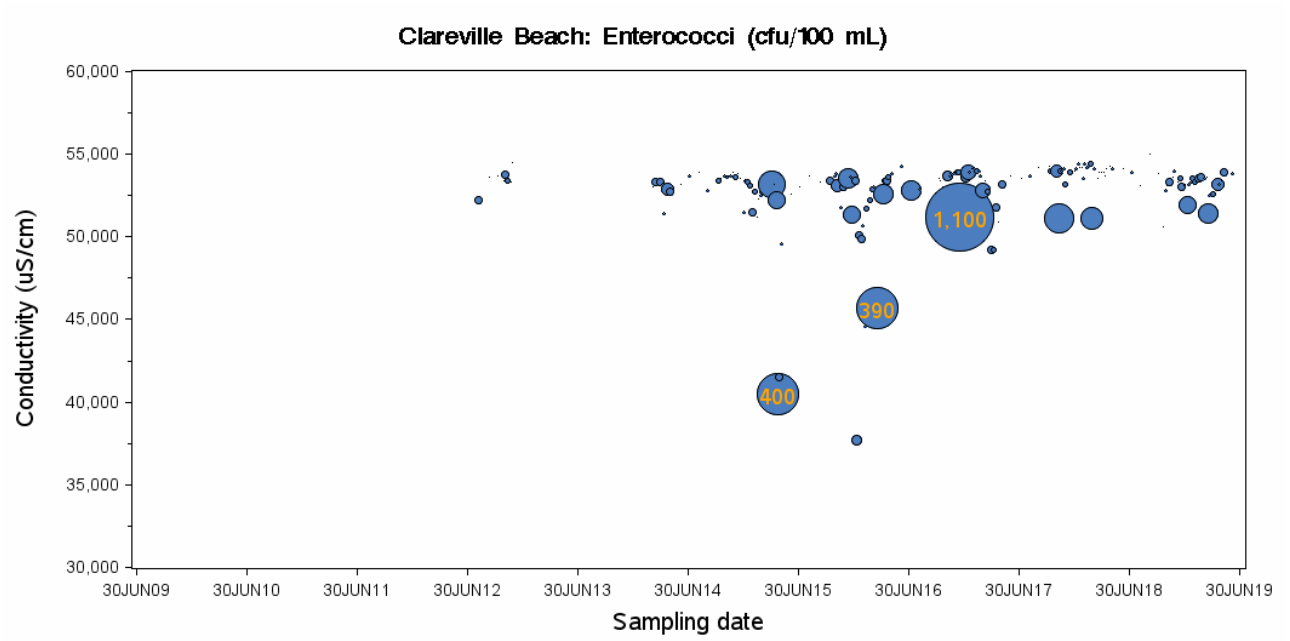

Elvina Bay: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
600
660
400
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

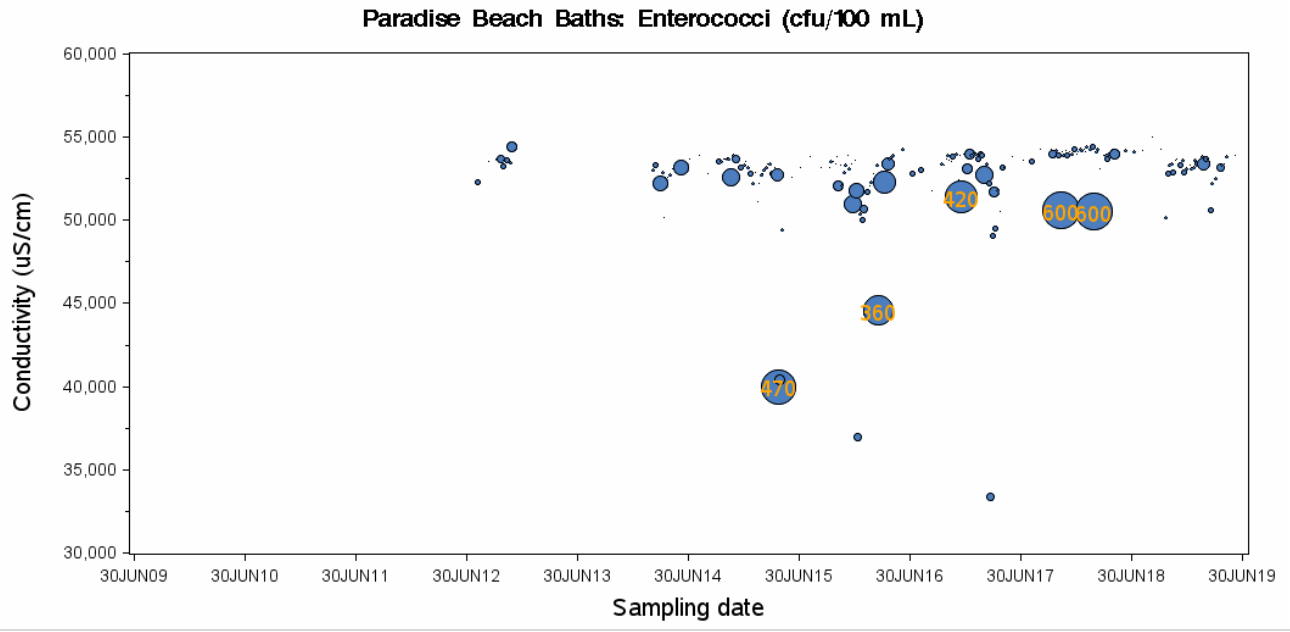

Bayview Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
400
530
300
400
660
450
780
520
360
600
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date


South Scotland Island: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
900
440
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date


North Scotland Island: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
990
540
610
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date


Taylors Point Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
600
900
480
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date


Clareville Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
1,100
390
400
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date


Paradise Beach Baths: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
420
600
600
360
470
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

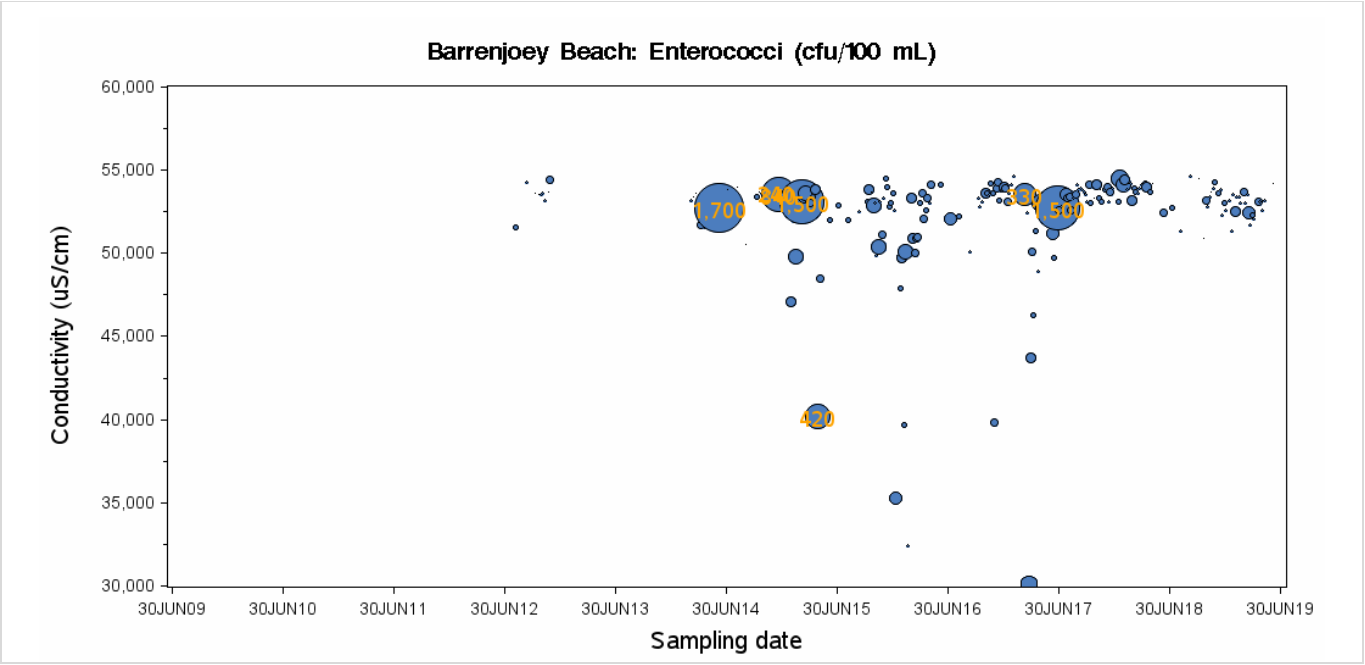

Barrenjoey Beach: Enterococci (cfu/100 mL)
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
1,700
240
1,500
530
1,500
420
30JUN09
30JUN10
30JUN11
30JUN12
30JUN13
30JUN14
30JUN15
30JUN16
30JUN17
30JUN18
30JUN19
Sampling date

Table H-1 Short-listed dry weather *Enterococci* exceptions data (>35 cfu/100mL) based on catchment rainfall condition

Sampling site	Date	*Enterococci (cfu/100mL)*	Conductivity (uS/cm)	72 hours rain ≤2 mm	Station no	Station name
Austinmer Beach	26-Nov-18	53	54500	1.6	68108	Woonona
Avalon Beach	16-Apr-19	60	53900	0.0	66079	Avalon Beach
Balmoral Baths	2-Aug-18	720	54300	0.0	66006	Sydney Botanic Garden
Barrenjoey Beach	25-Oct-18	50	53200	1.6	66128	Palm Beach
	31-Jan-19	58	52500	0.0		
	27-Feb-19	54	53700	0,8		
	16-Apr-19	40	53100	0.0		
Bayview Baths	31-Oct-18	270	53000	0.0	66141	Mona Vale Golf Club
	9-May-19	660	53600	0.0		
Bellambi Beach	25-May-19	320	48900	0.0	68228	Bellambi
Bilarong Reserve	5-Jul-18	38	30800	0.0	66126	Collaroy (Long Reef Golf Club)
	17-Jul-18	46	34800	0.0		
	23-Nov-18	54	38800	0.0		
	3-Jan-19	130	35300	2.0		
	24-Jan-19	40	47200	0.0		
	11-Mar-19	39	50300	0.8		
	10-Apr-19	37	36400	0.4		
	29-Apr-19	130	48700	0.0		
	3-Jun-19	51	52200	0.0		
	13-Jun-19	84	48100	0.0		
Boat Harbour	21-Dec-18	150	53800	0.0	66058	San Souci
	28-Dec-18	150	53000	0.0		
	11-Apr-19	45	54000	1.0		
	10-May-19	130	53700	0.0		
Brighton Le Sands Baths	21-Nov-18	58	53200	0.0	66037	Sydney airport
	18-Apr-19	52	52100	0.4		
Bronte Beach	18-Feb-19	41	53800	0.0	66098	Rose Bay
Bungan Beach	16-Apr-19	60	53800	0.0	66079	Avalon Beach
Carss Point Baths	21-Nov-18	97	50800	0.0	66058	San Souci
	20-Dec-18	480	44900	0.0		
Clareville Beach	16-Apr-19	35	53200	0.0	66079	Avalon Beach
Clontarf Pool	12-Apr-19	56	52700	0.0	66080	Castle Cove
Collaroy Beach	5-Mar-19	51	54900	2.0	66126	Collaroy (Long Reef Golf Club)
	16-Apr-19	44	53900	0.0		
Como Baths	27-Nov-18	49	50200	0.0	66058	San Souci
	27-Dec-18	38	38000	0.0		
Congwong Bay	11-Dec-18	85	53700	0.0	66037	Sydney airport
Coniston Beach	13-Apr-19	54	53900	0.0	68131	Port Kembla
Coogee Beach	18-Feb-19	110	53800	0.0	66098	Rose Bay
Corrimal Beach	19-Jan-19	53	48100	0.0	68228	Bellambi
Darling Harbour	2-Aug-18	46	51300	0.0	66006	Sydney Botanic Garden
	18-Sep-18	92	49500	0.0		
	6-Nov-18	46	49200	0.3		

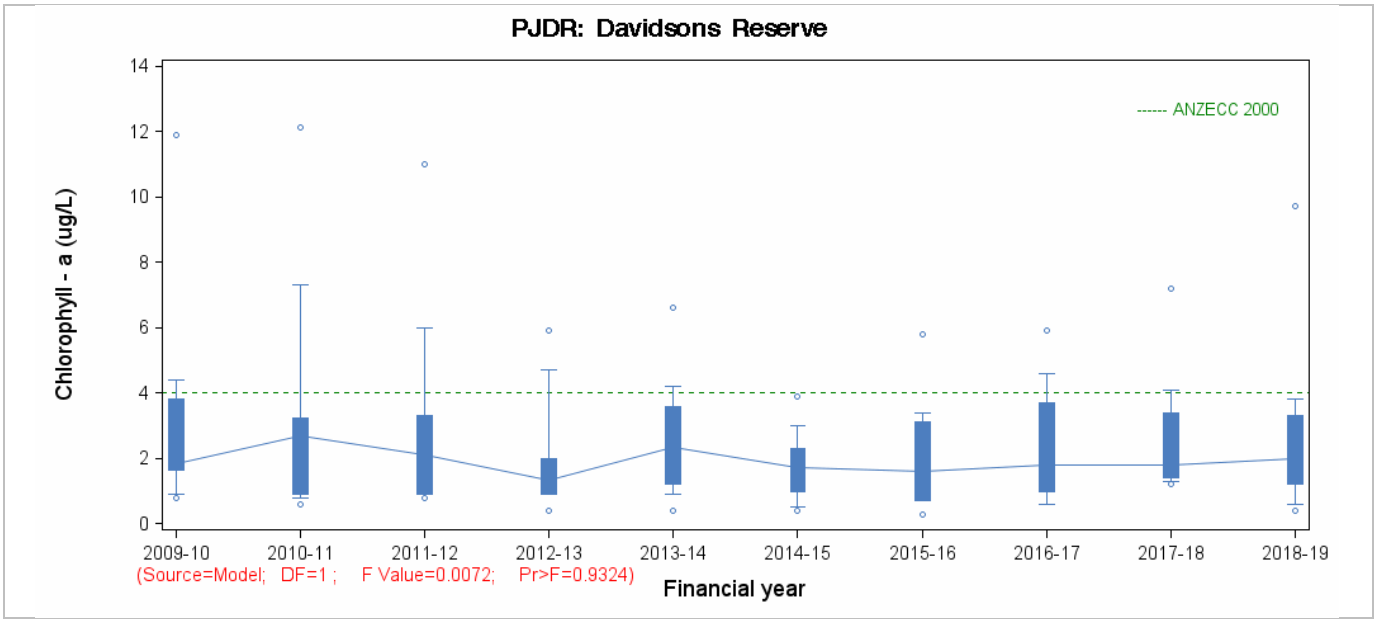
Sampling site	Date	*Enterococci (cfu/100mL)*	Conductivity (uS/cm)	72 hours rain ≤2 mm	Station no	Station name
	14-Nov-18	160	51300	0.0		
	20-Nov-18	72	48200	0.0		
	26-Nov-18	130	52200	0.3		
Dawn Fraser Pool	6-Nov-18	40	51000	0.0	66064	Sydney Observatory Hill
Dee Why Beach	12-Dec-18	48	54300	0.0	66126	Collaroy (Long Reef Golf Club)
	9-May-19	60	54900	0.0		
Dolls Point Baths	3-Dec-18	110	51400	0.0	66058	San Souci
	20-Dec-18	240	49700	0.0		
Fishermans Beach	27-Oct-18	170	54400	0.0	68131	Port Kembla
Foreshores Beach	26-Oct-18	150	52200	0.0	66037	Sydney airport
	3-Dec-18	190	49100	0.0		
	28-Feb-19	98	41800	0.0		
Frenchmans Bay	21-Nov-18	2000	53400	0.0	66037	Sydney airport
	3-Dec-18	46	53300	0.0		
Freshwater Beach	16-Apr-19	52	54000	0.0	66126	Collaroy (Long Reef Golf Club)
	9-May-19	80	54500	0.0		
Gordons Bay (East)	18-Feb-19	120	53900	0.0	66098	Rose Bay
	7-Mar-19	52	54400	2.0		
Greenwich Baths	12-Apr-19	36	51000	0.0	66034	Abbotsford
Gymea Bay Baths	15-Nov-18	37	53000	1.0	66204	Oyster Bay
	27-Nov-18	40	52800	0.0		
	18-Apr-19	50	53100	0.0		
Hayes Street Beach	24-Oct-18	750	51400	0.1	66006	Sydney Botanic Garden
	6-Nov-18	2200	51700	0.3		
	27-Dec-18	38	52100	0.0		
Horderns Beach	27-Dec-18	44	54800	0.0	66204	Oyster Bay
Jew Fish Bay Baths	15-Nov-18	37	44400	0.0	66058	San Souci
	21-Nov-18	140	45400	0.0		
Kyeemagh Baths	15-Nov-18	130	50700	0.2	66037	Sydney airport
	27-Nov-18	39	53000	0.0		
Lake Illawarra Entrance Lagoon Beach	8-Dec-18	52	54200	0.0	68246	Blackbutt
	26-Dec-18	47	53900	0.0		
	1-Jan-19	43	53700	0.4		
	24-Feb-19	35	54700	1.8		
Little Bay Beach	15-Jan-19	44	53500	0.0	66052	Randwick
	7-Feb-19	53	54000	0.4		
	13-Feb-19	42	54500	0.0		
	18-Feb-19	100	53600	0.0		
Malabar Beach	10-Jul-18	160	54700	0.0	66052	Randwick
	14-Aug-18	42	54800	0.0		
	24-Sep-18	40	54800	0.4		
	29-Oct-18	43	54300	0.8		
	15-Jan-19	55	54300	0.0		
	18-Jan-19	330	53600	0.0		
	18-Feb-19	280	53900	0.0		

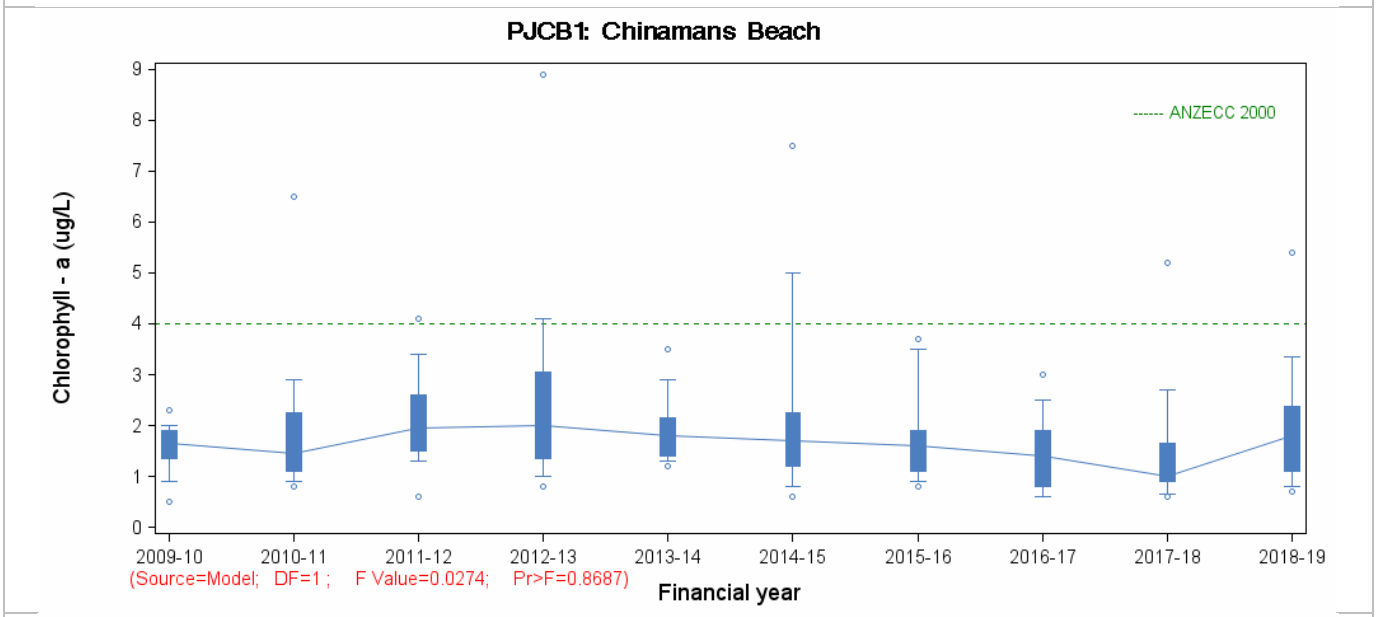
Sampling site	Date	*Enterococci (cfu/100mL)*	Conductivity (uS/cm)	72 hours rain ≤2 mm	Station no	Station name
	1-Mar-19	71	54200	0.4		
	17-Apr-19	140	54300	0.0		
	10-May-19	36	54500	0.0		
Manly Cove	19-Dec-18	35	52700	0.0	66126	Collaroy (Long Reef Golf Club)
	2-Jan-19	130	52700	2.0		
Maroubra Beach	18-Feb-19	67	54000	0.0	66053	Randwick
Mona Vale Beach	6-Feb-19	35	54800	0.8	66141	Mona Vale Golf Club
	9-May-19	70	54600	0.0		
Monterey Baths	18-Apr-19	82	52300	0.0	66058	San Souci
Murray Rose Pool	21-Jan-19	50	52900	1.0	66034	Abbotsford
Narrabeen Lagoon (Birdwood Park)	3-Aug-18	5300	34400	0.2	66141	Mona Vale Golf Club
	10-Apr-19	65	51900	0.2		
	29-Apr-19	84	50100	0.2		
	9-May-19	170	51200	0.0		
Newport Beach	11-Jul-18	49	54800	0.0	66079	Avalon Beach
	16-Apr-19	42	53700	0.0		
North Curl Curl Beach	25-Oct-18	35	54300	0.4	66126	Collaroy (Long Reef Golf Club)
	5-Mar-19	82	54900	2.0		
North Narrabeen Beach	9-May-19	110	53800	0.0	66141	Mona Vale Golf Club
North Steyne Beach	3-Jan-19	120	54000	0.2	66126	Collaroy (Long Reef Golf Club)
Palm Beach	16-Apr-19	55	52800	0.0	66128	Palm Beach
	27-May-19	52	54300	0.0		
Port Kembla Beach	10-Aug-18	35	54800	0.0	68131	Port Kembla
	27-Oct-18	71	54400	0.0		
Queenscliff Beach	3-Jan-19	35	54000	0.2	66126	Collaroy (Long Reef Golf Club)
	24-Jan-19	36	53300	0.0		
	9-May-19	70	54200	0.0		
Ramsgate Baths	15-Nov-18	94	51000	0.0	66058	San Souci
Rose Bay Beach	21-Jan-19	46	53000	0.2	66098	Rose Bay
	12-Apr-19	50	52700	1.0		
Shellharbour Beach	17-Jul-18	69	.	0.0	68246	Blackbutt
Shelly Beach (Manly)	3-Jan-19	70	53800	0.2	66126	Collaroy (Long Reef Golf Club)
	5-Mar-19	180	54700	2.0		
Shelly Beach (Sutherland)	25-Jan-19	80	53900	0.0	66058	San Souci
Silver Beach	13-May-19	74	54300	0.0	66058	San Souci
South Curl Curl Beach	3-Jan-19	40	54000	0.2	66126	Collaroy (Long Reef Golf Club)
	16-Apr-19	70	54100	0.0		
South Maroubra Beach	28-Dec-18	42	54100	0.0	66052	Randwick
	18-Feb-19	180	54100	0.0		
	10-Jul-18	76	54800	0.0		
	12-Sep-18	50	54700	0.0		
	18-Feb-19	270	53900	0.0		
South Scotland Island	16-Apr-19	90	53200	0.0	66079	Avalon Beach
South Steyne Beach	9-May-19	40	55000	0.0	66126	Collaroy (Long Reef Golf Club)

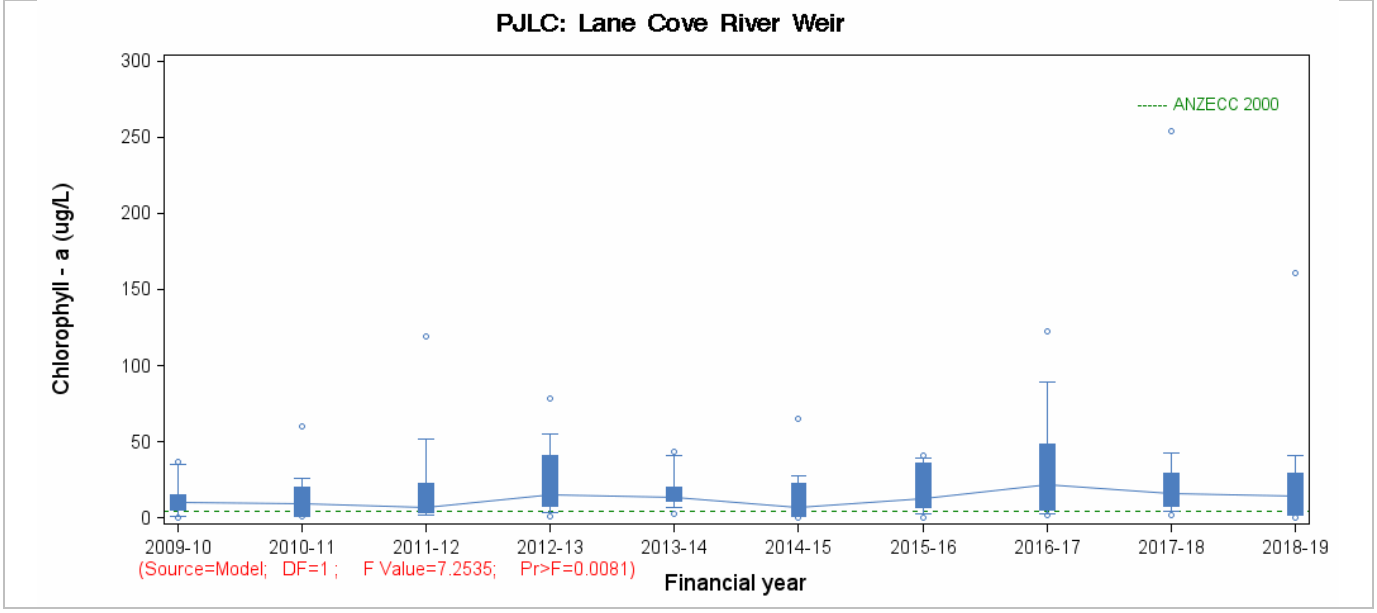
Sampling site	Date	*Enterococci (cfu/100mL)*	Conductivity (uS/cm)	72 hours rain ≤2 mm	Station no	Station name
Tamarama Beach	10-Jul-18	40	54900	0.0	66098	Rose Bay
Tambourine Bay	21-Jan-19	50	32500	1.0	66034	Abbotsford
Taylors Point Baths	16-Apr-19	40	53200	0.0	66079	Avalon Beach
Thirroul Beach	26-Nov-18	70	54500	1.6	68108	Woonona
Wanda Beach	18-Feb-19	42	53900	0.0	66058	San Souci
Warriewood Beach	16-Apr-19	42	52600	0.2	66141	Mona Vale Golf Club
Whale Beach	11-Jul-18	110	54700	0.0	66128	Palm Beach
	16-Apr-19	42	53700	0.0		
Woodford Bay	19-Dec-18	63	46900	0.0	66034	Abbotsford
	27-Dec-18	36	46400	0.0		
Woolwich Baths	24-Oct-18	84	41500	0.0		
Yarra Bay	21-Nov-18	56	53400	0.0	66037	Sydney airport
	3-Dec-18	47	52400	0.0		
	28-Feb-19	62	52100	0.0		
	15-Apr-19	64	50800	0.0		

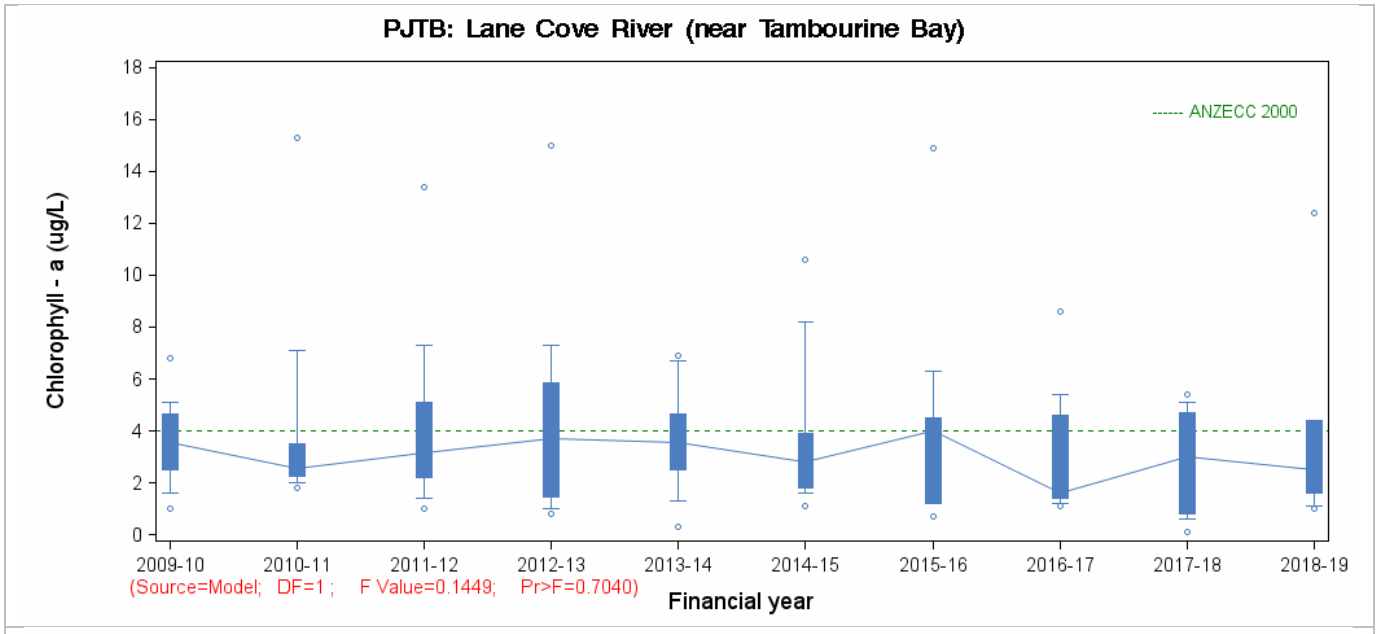
Appendix I Chlorophyll-*a* trends at estuarine sites

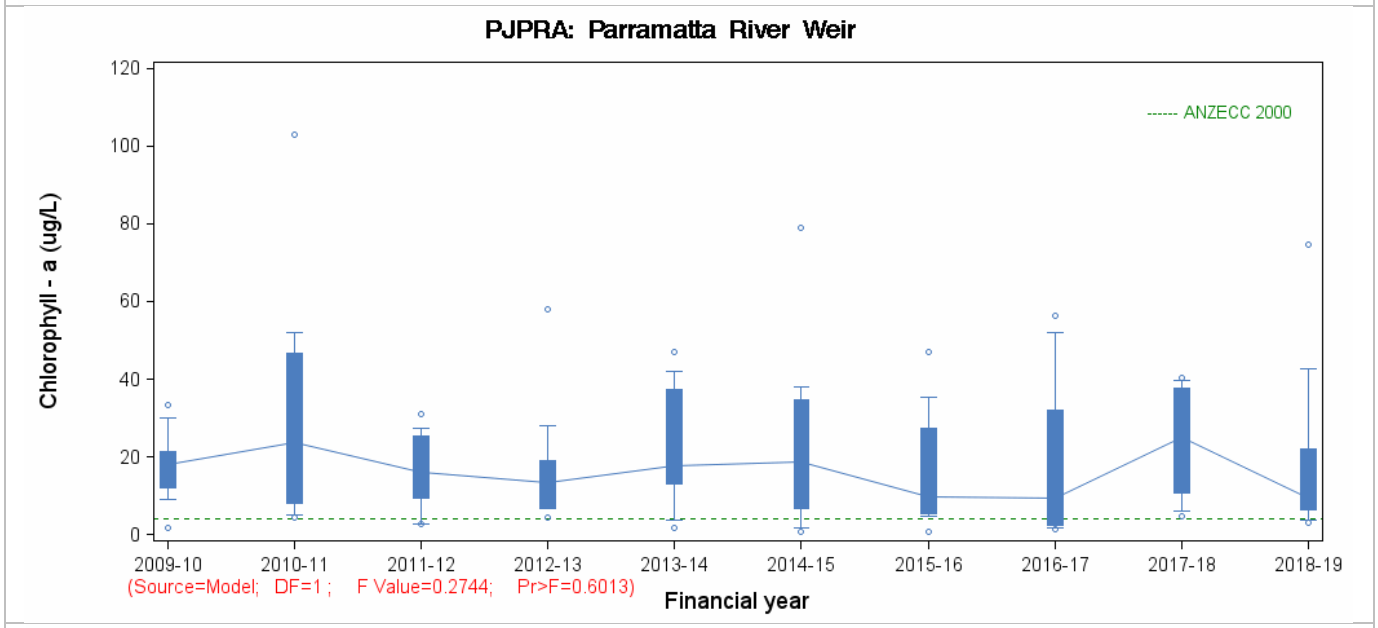
Port Jackson

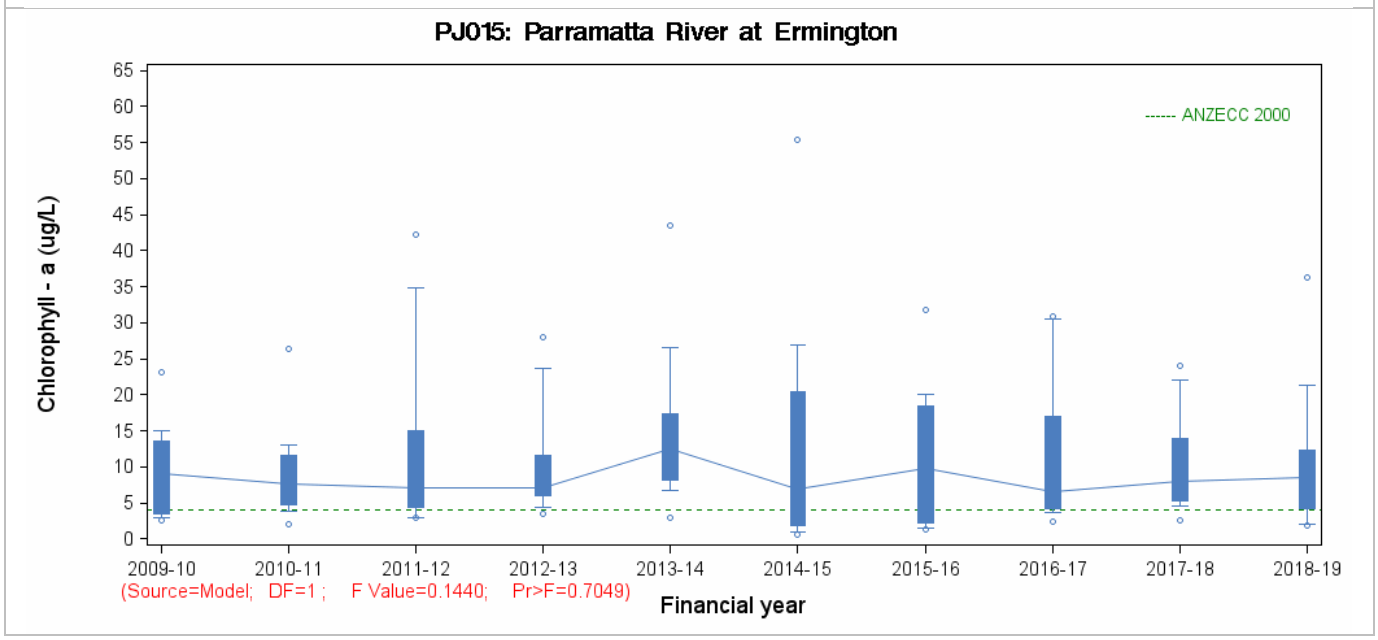


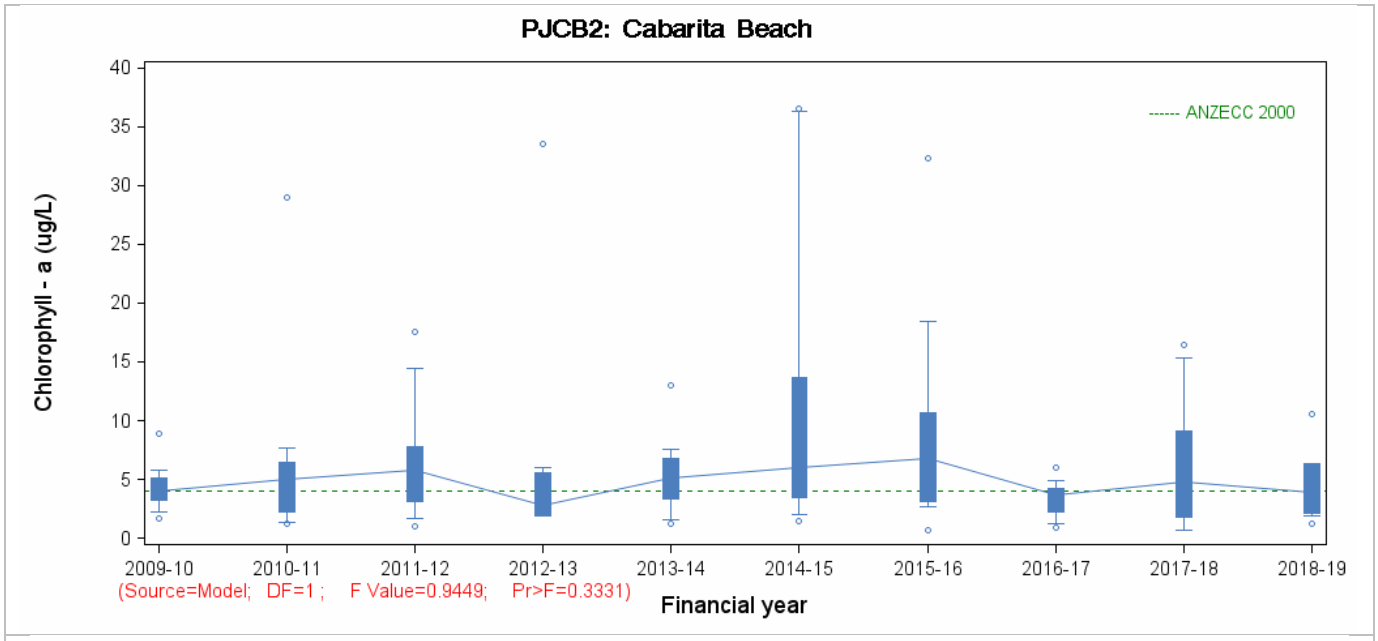


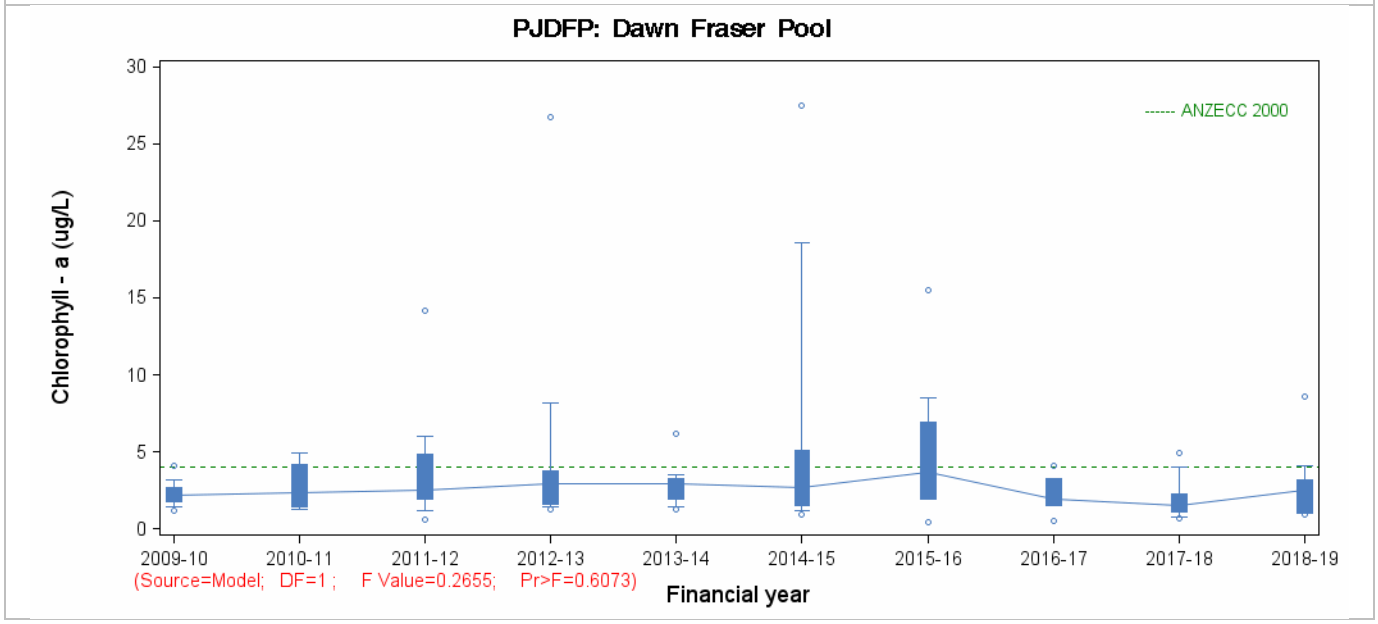



PJTB: Lane Cove River (near Tambourine Bay)
Chlorophyll - a (ug/L)
0
2
4
6
8
10
12
14
16
18
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1449; Pr>F=0.7040)
Financial year

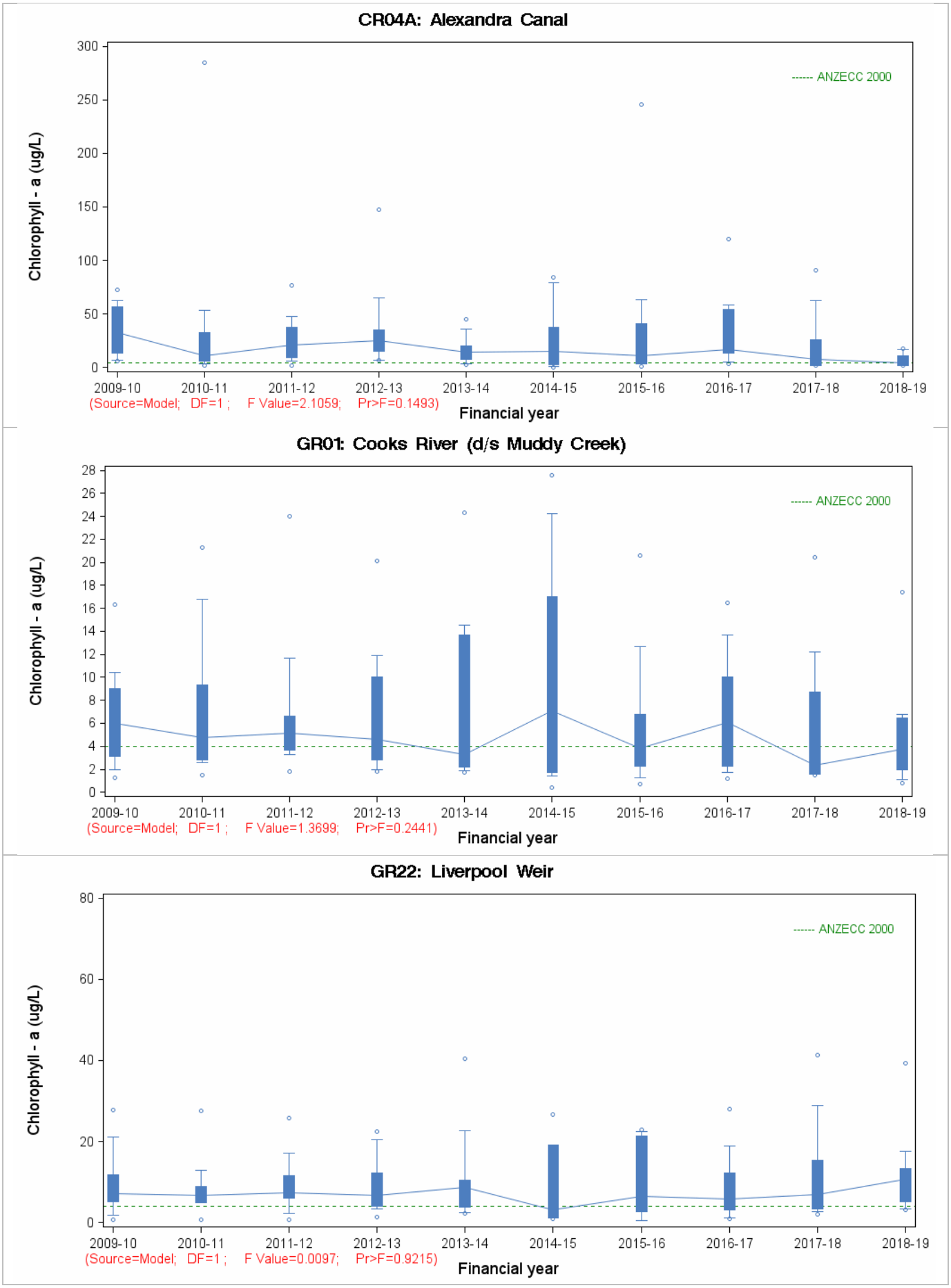

PJPRA: Parramatta River Weir
Chlorophyll - a (ug/L)
0
20
40
60
80
100
120
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2744; Pr>F=0.6013)
Financial year

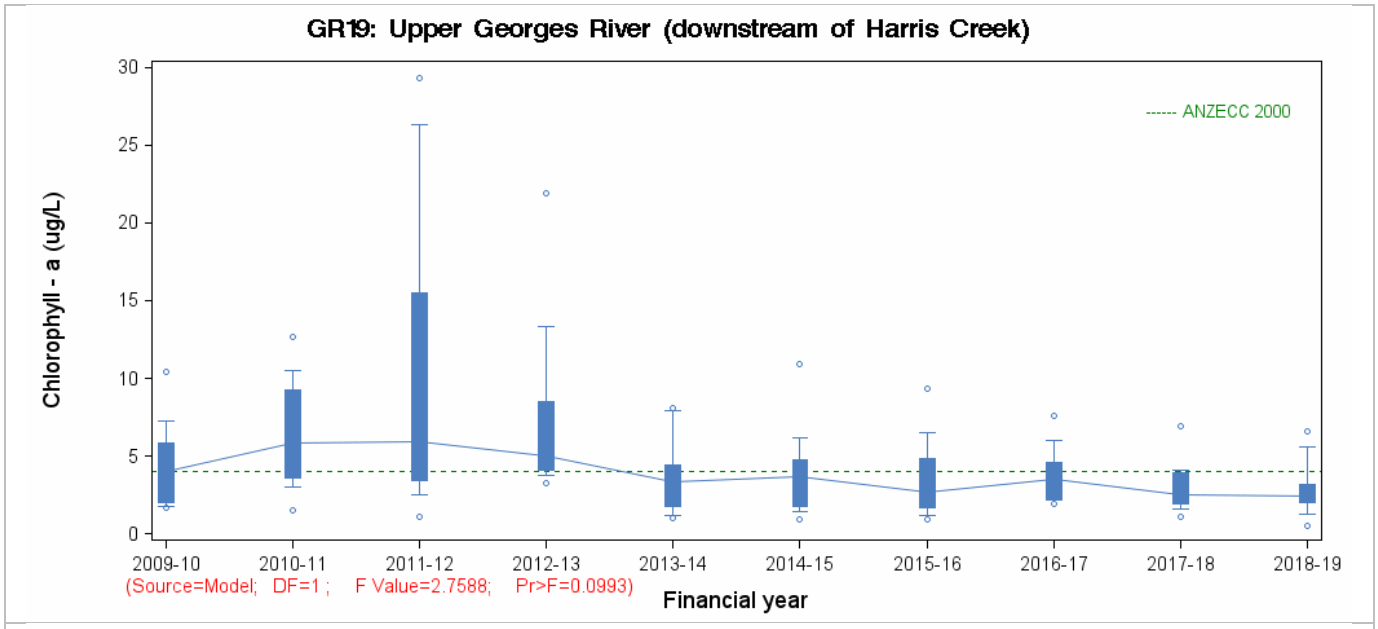

PJ015: Parramatta River at Ermington
Chlorophyll - a (ug/L)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1440; Pr>F=0.7049)
Financial year

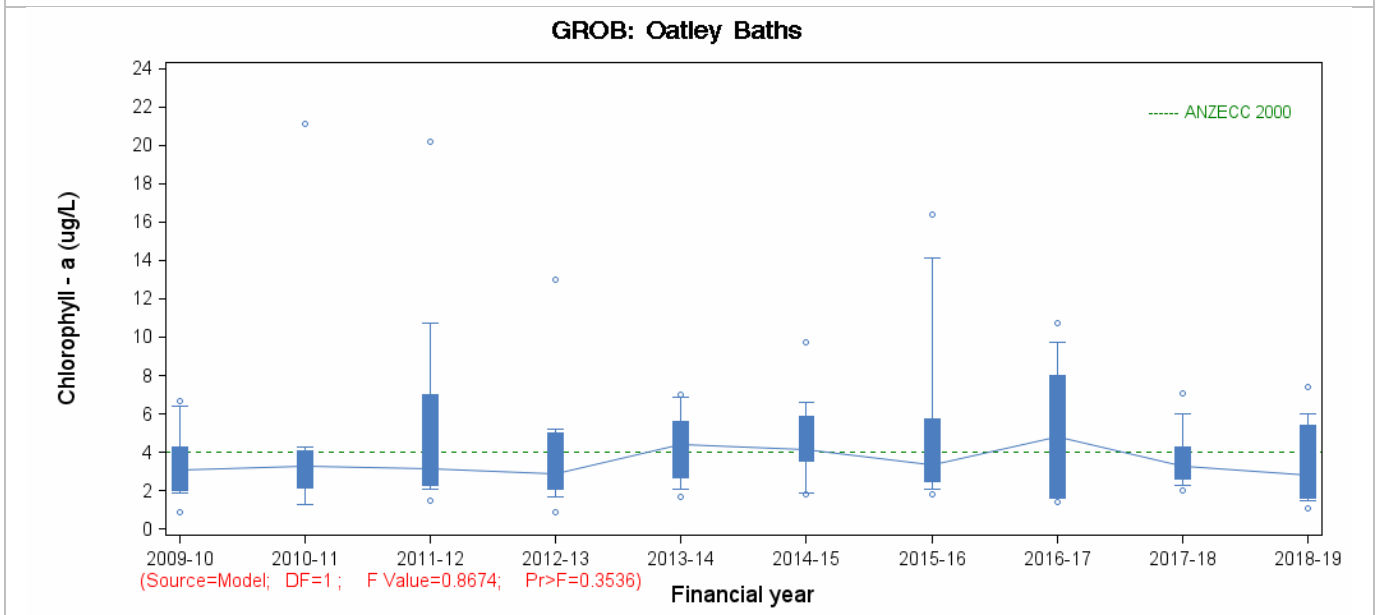

PJCB2: Cabarita Beach
Chlorophyll - a (ug/L)
40
35
30
25
20
15
10
5
0
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.9449; Pr>F=0.3331)
Financial year

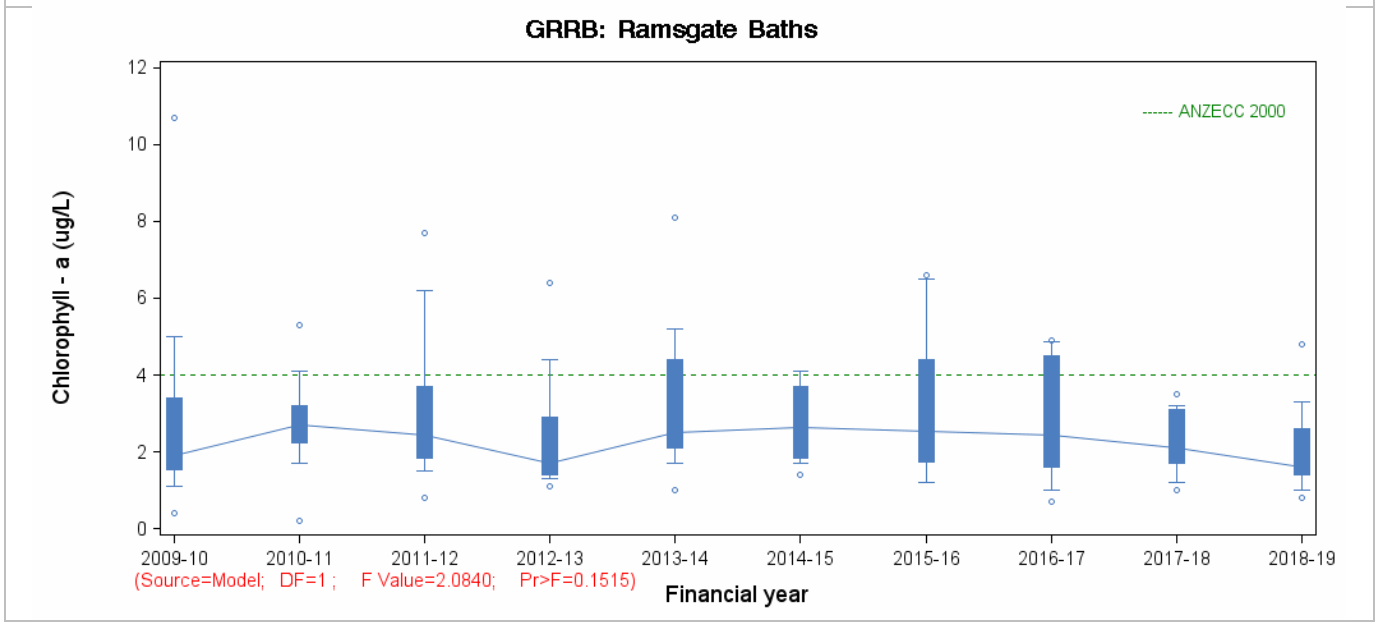

PJDFP: Dawn Fraser Pool
Chlorophyll - a (ug/L)
30
25
20
15
10
5
0
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2655; Pr>F=0.6073)
Financial year

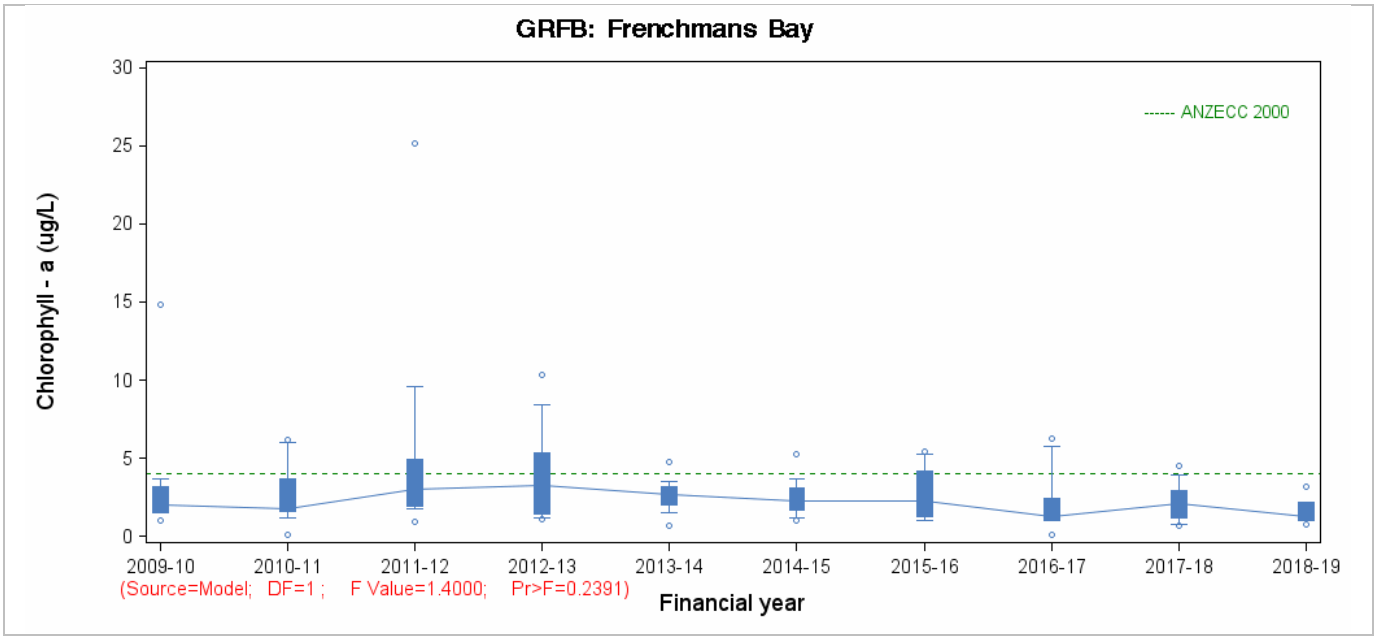
Botany Bay


CR04A: Alexandra Canal
Chlorophyll - a (ug/L)
300
250
200
150
100
50
0
------ ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.1059; Pr>F=0.1493)
Financial year
GR01: Cooks River (d/s Muddy Creek)
Chlorophyll - a (ug/L)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
------ ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.3699; Pr>F=0.2441)
Financial year
GR22: Liverpool Weir
Chlorophyll - a (ug/L)
80
60
40
20
0
------ ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0097; Pr>F=0.9215)
Financial year

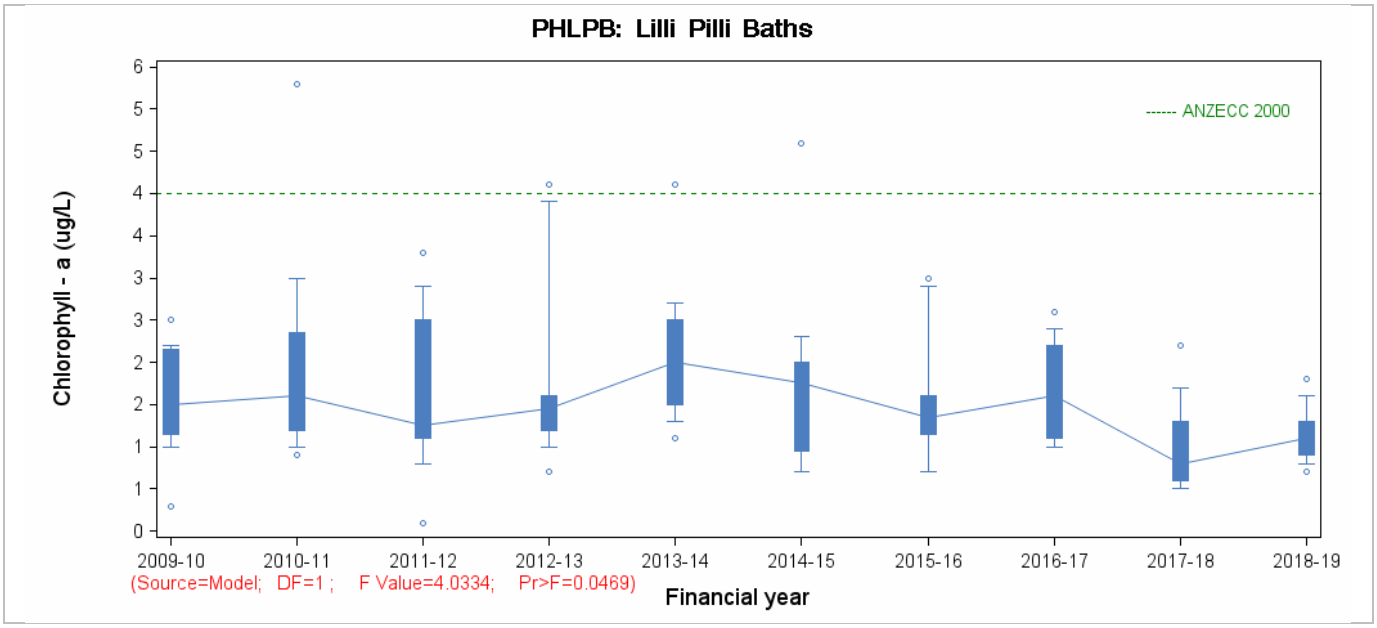

GR19: Upper Georges River (downstream of Harris Creek)
Chlorophyll - a (ug/L)
30
25
20
15
10
5
0
------ ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.7588; Pr>F=0.0993)
Financial year


GROB: Oatley Baths
Chlorophyll - a (ug/L)
24
22
20
18
16
14
12
10
8
6
4
2
0
------ ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.8674; Pr>F=0.3536)
Financial year

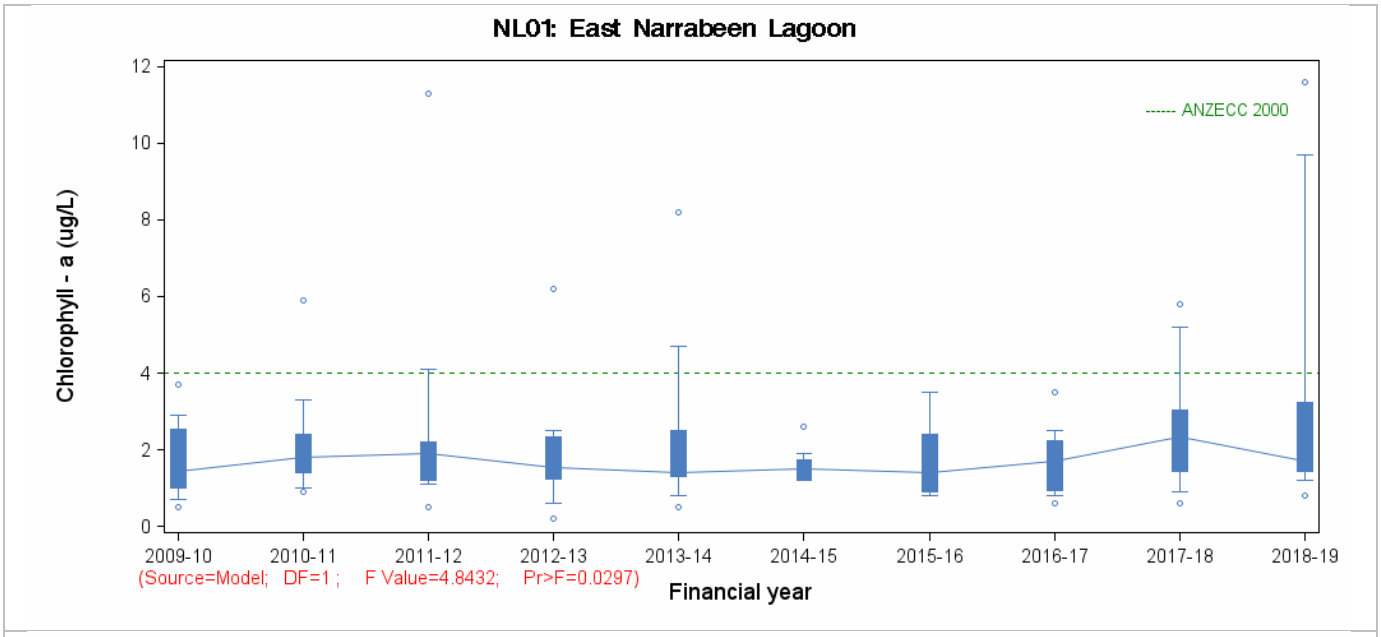

GRRB: Ramsgate Baths
Chlorophyll - a (ug/L)
12
10
8
6
4
2
0
------ ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.0840; Pr>F=0.1515)
Financial year

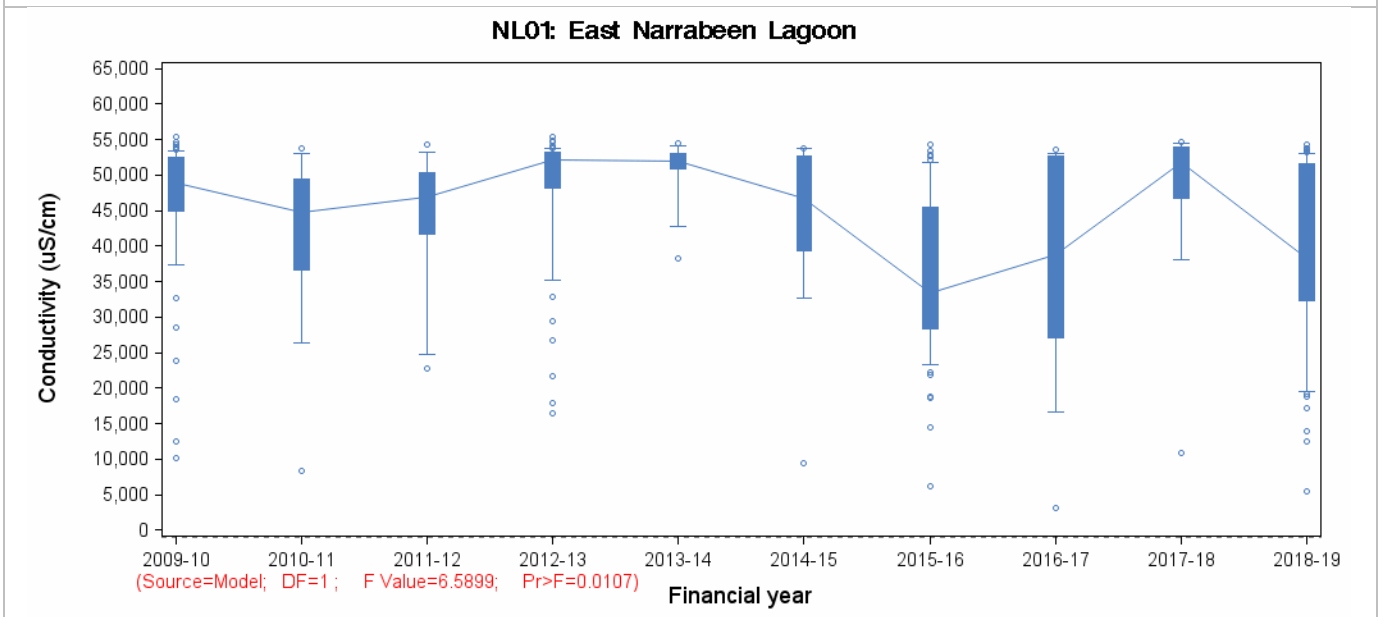


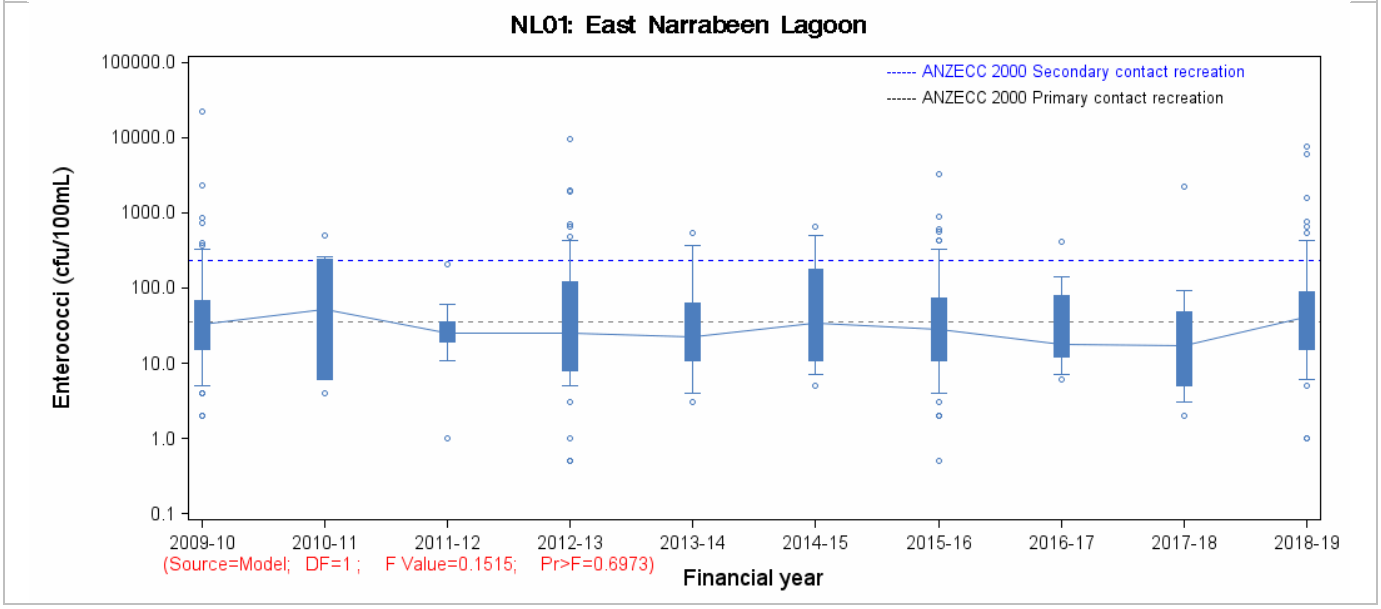
Port Hacking

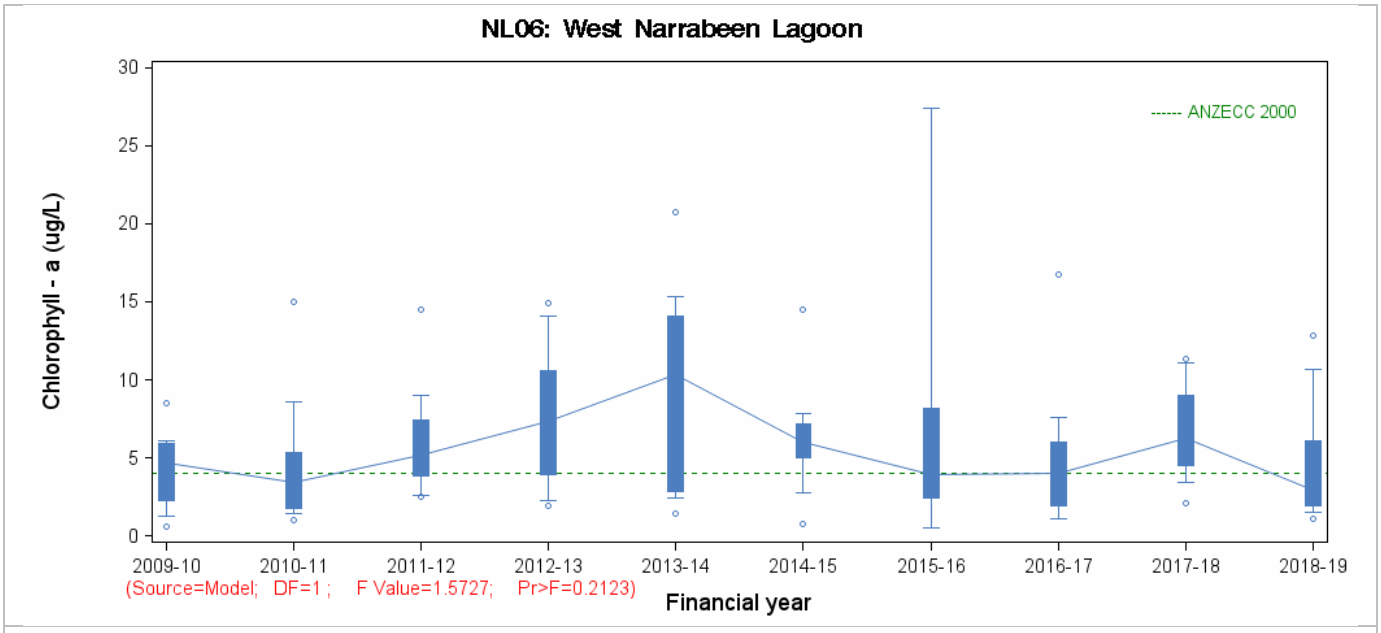


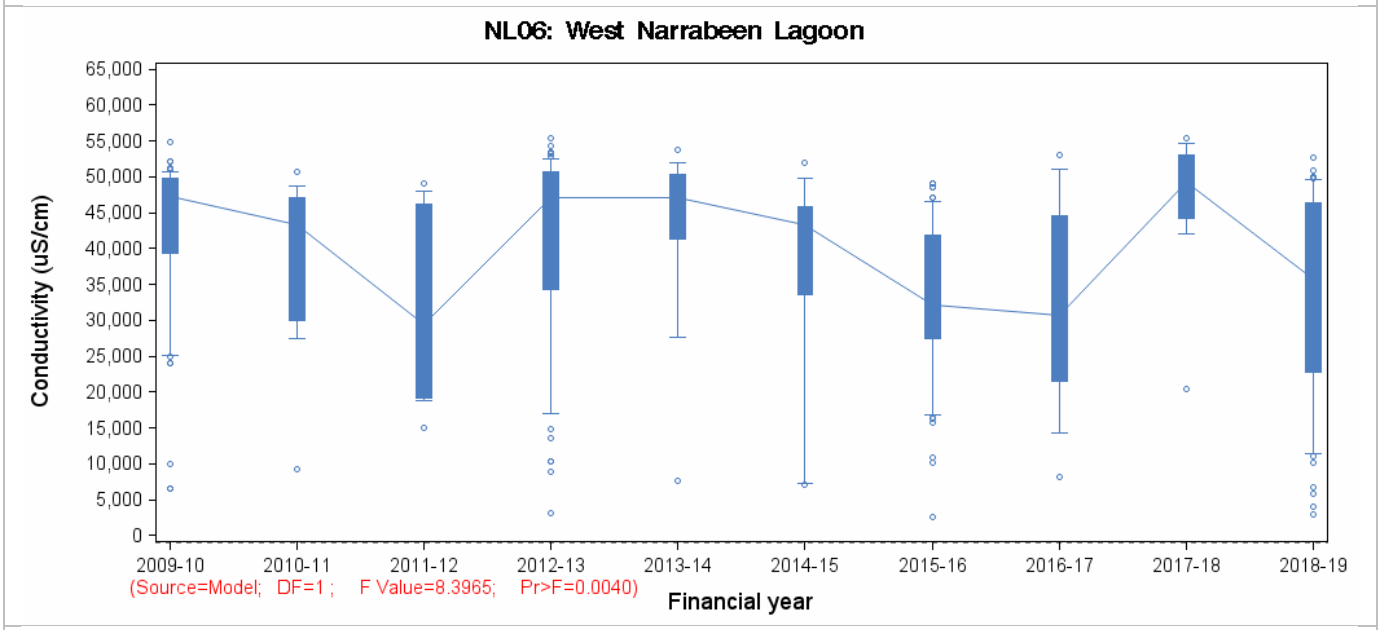
Appendix J Water quality trends in lagoons

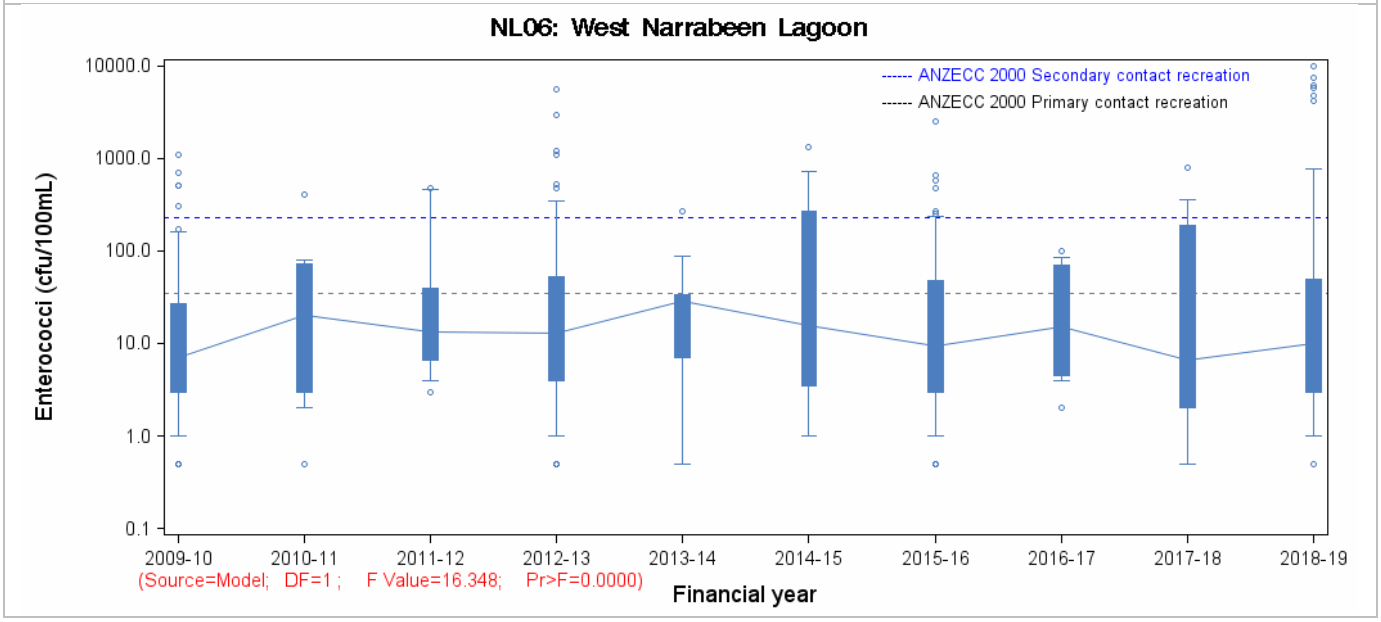


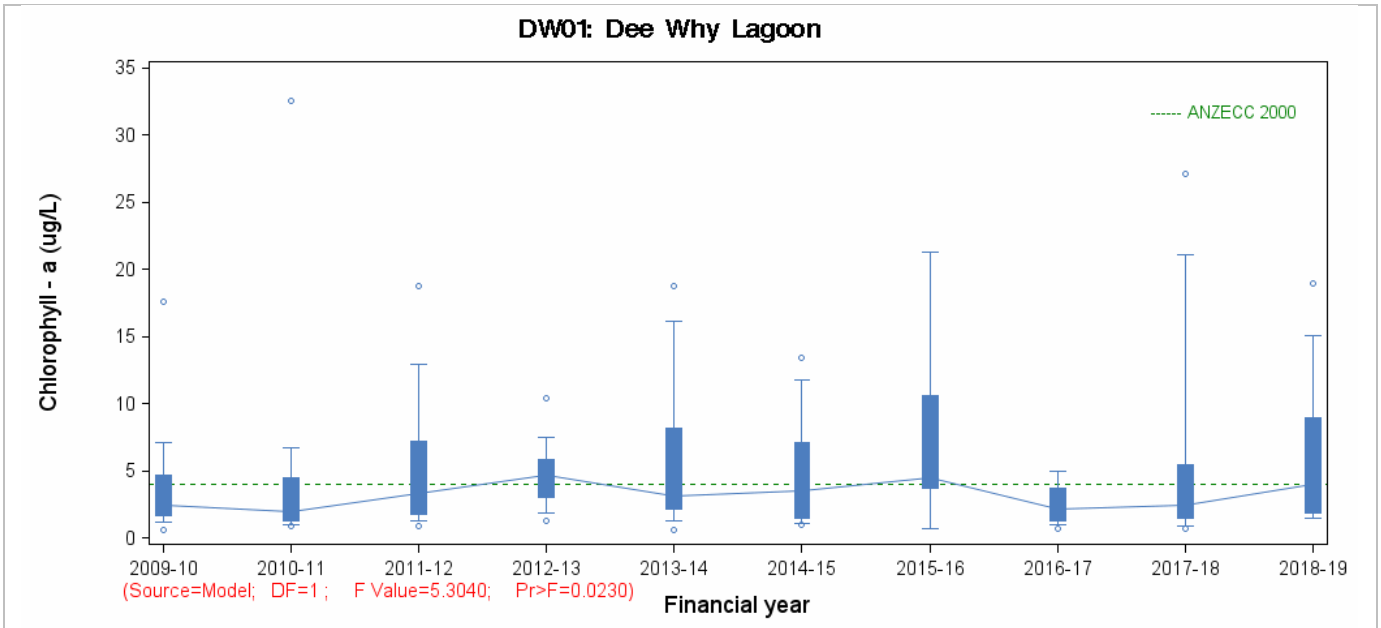


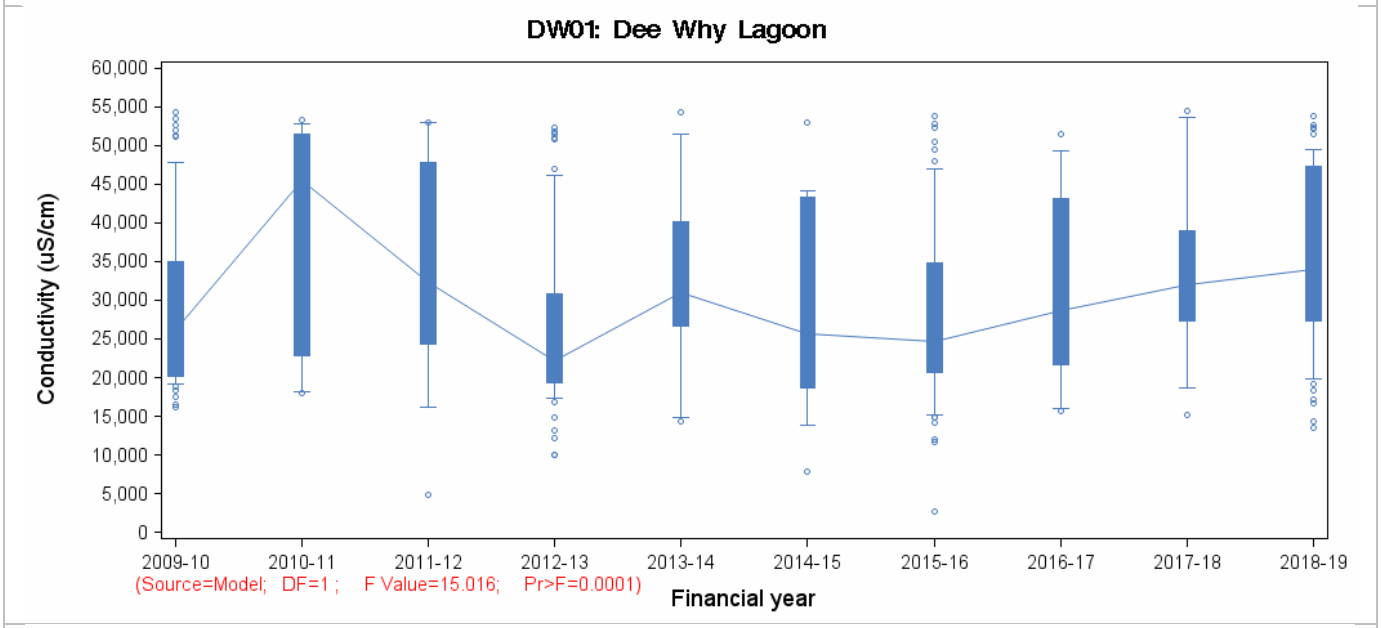


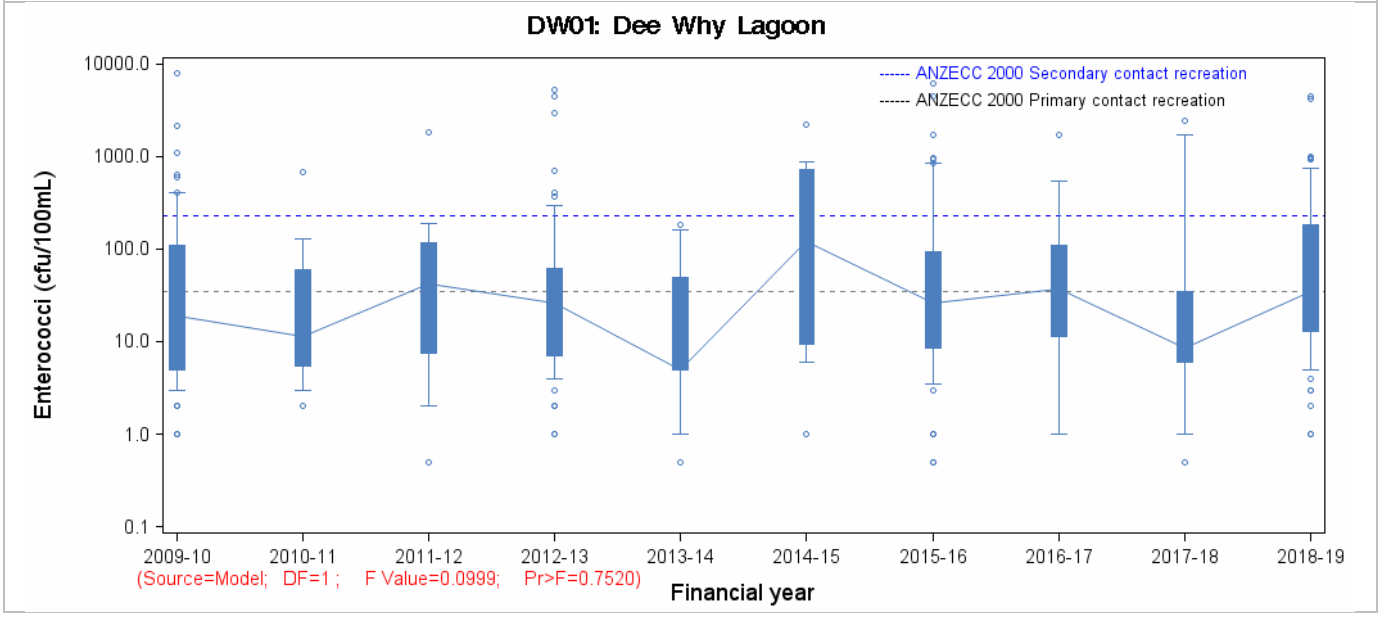

NL06: West Narrabeen Lagoon
Chlorophyll - a (ug/L)
30
25
20
15
10
5
0
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.5727; Pr>F=0.2123)
Financial year

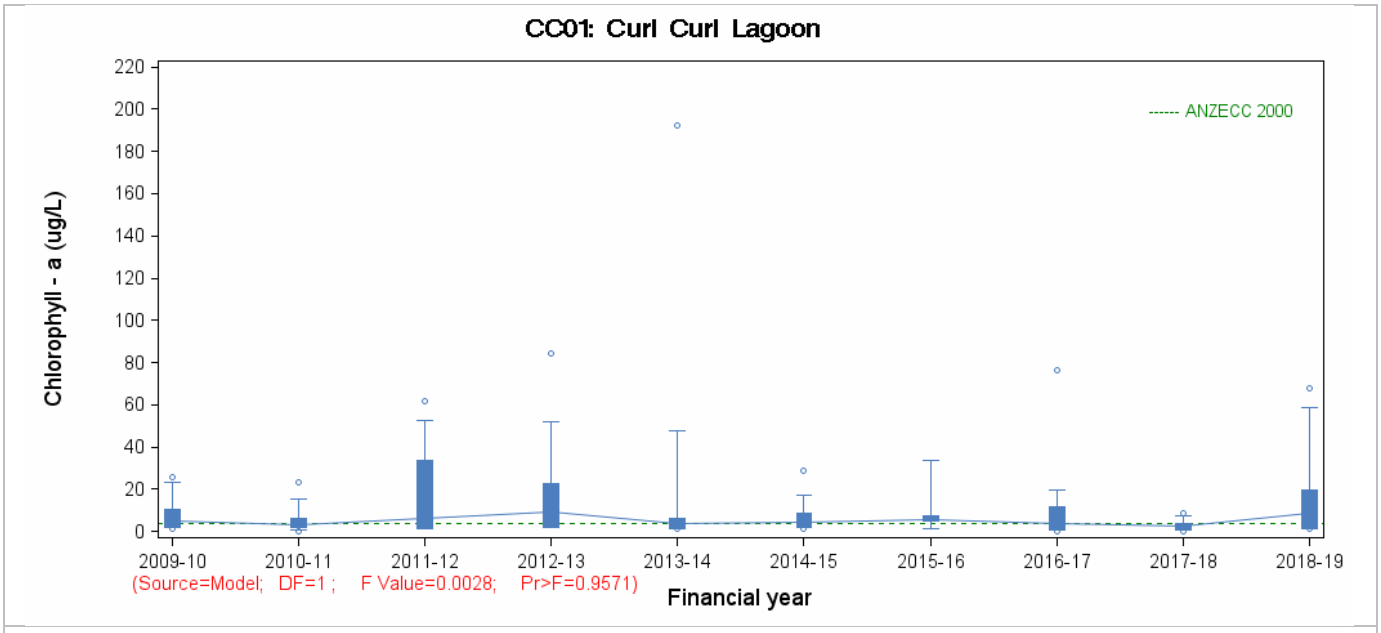

NL06: West Narrabeen Lagoon
Conductivity (uS/cm)
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=8.3965; Pr>F=0.0040)
Financial year

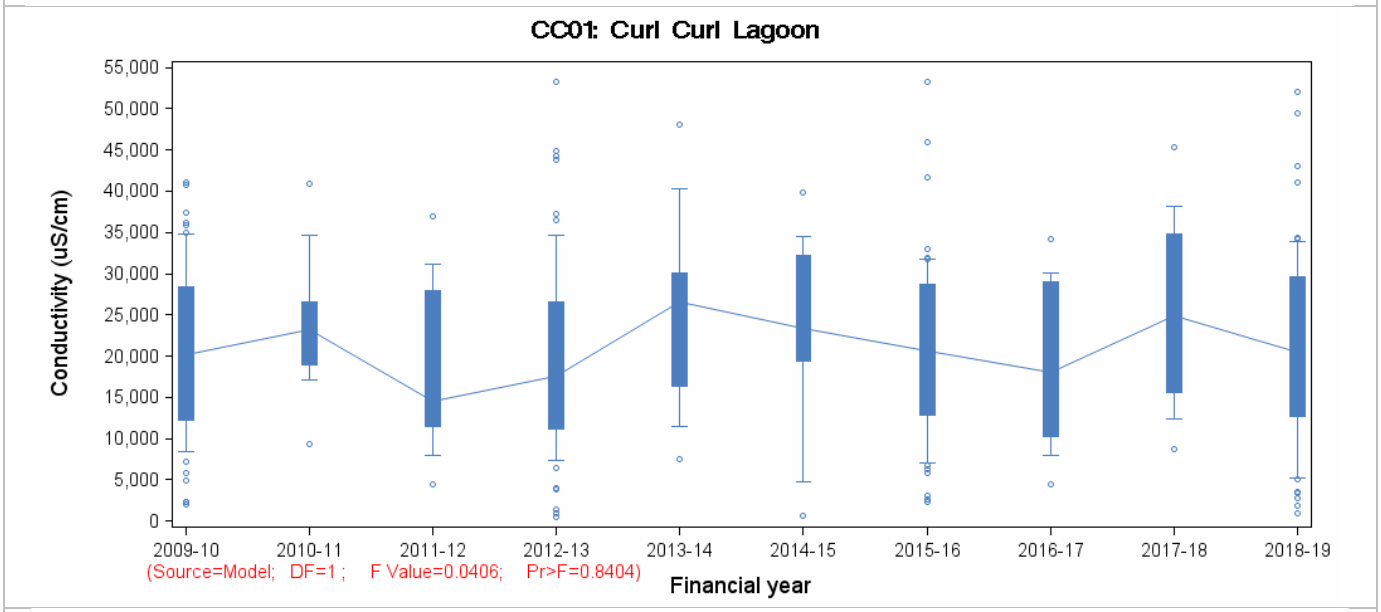

NL06: West Narrabeen Lagoon
Enterococci (cfu/100mL)
10000.0
1000.0
100.0
10.0
1.0
0.1
----- ANZECC 2000 Secondary contact recreation
----- ANZECC 2000 Primary contact recreation
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=16.348; Pr>F=0.0000)
Financial year

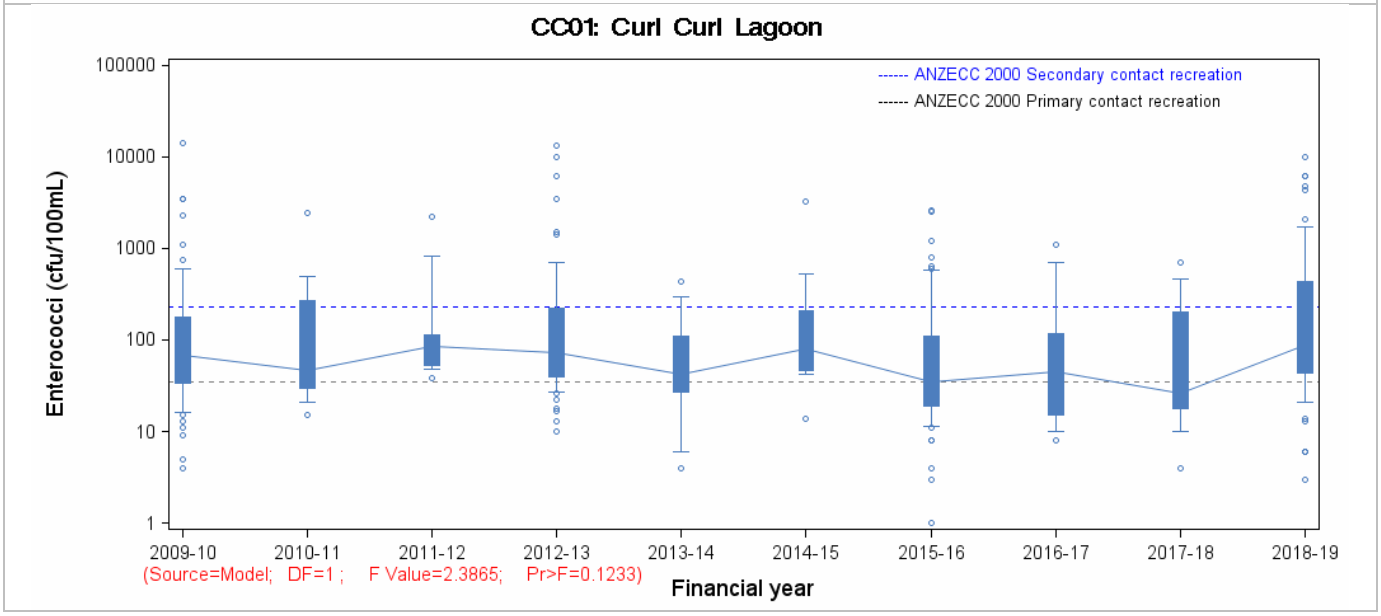

DW01: Dee Why Lagoon
Chlorophyll - a (ug/L)
35
30
25
20
15
10
5
0
------ ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.3040; Pr>F=0.0230)
Financial year

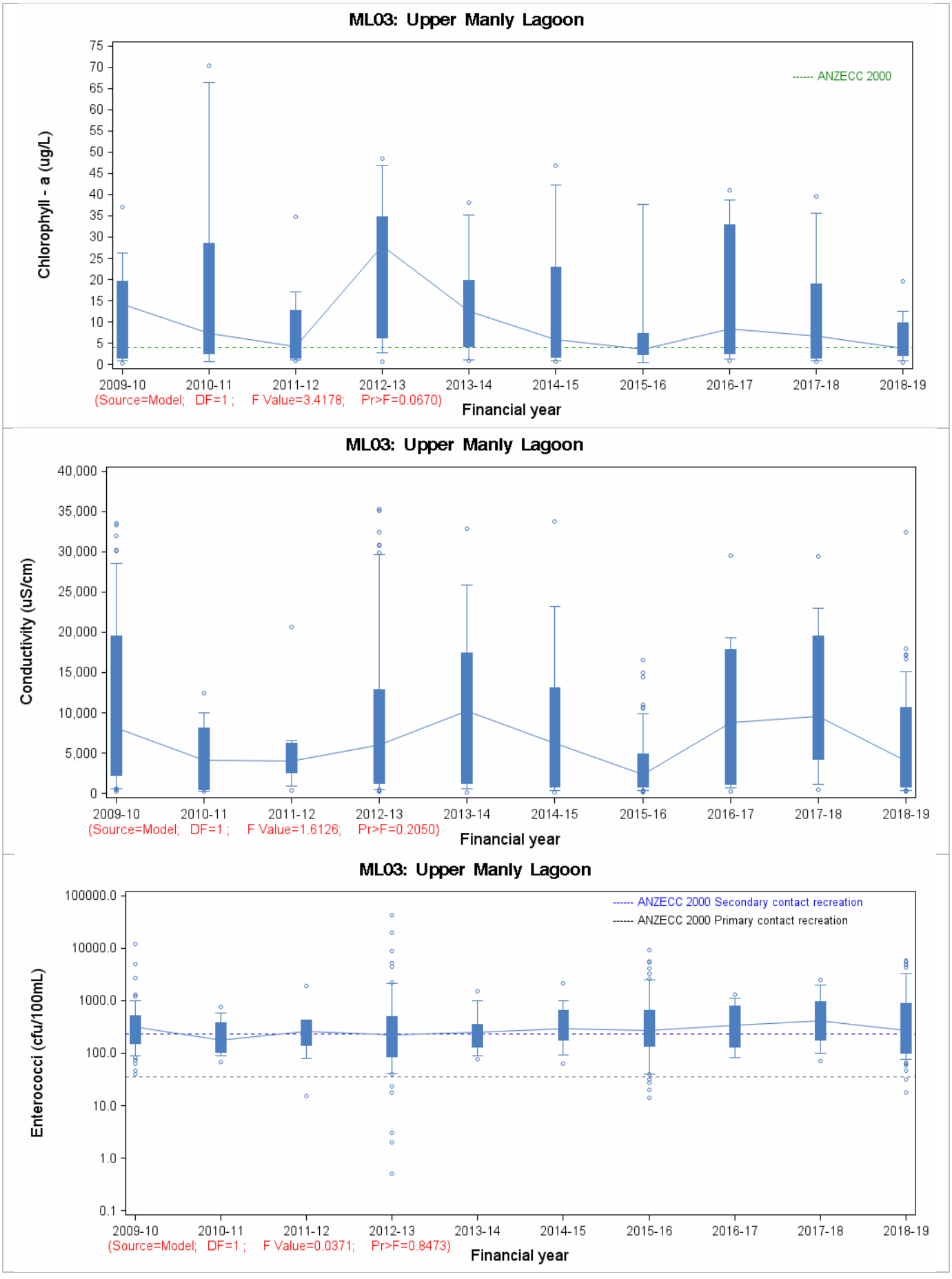

DW01: Dee Why Lagoon
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=15.016; Pr>F=0.0001)
Financial year

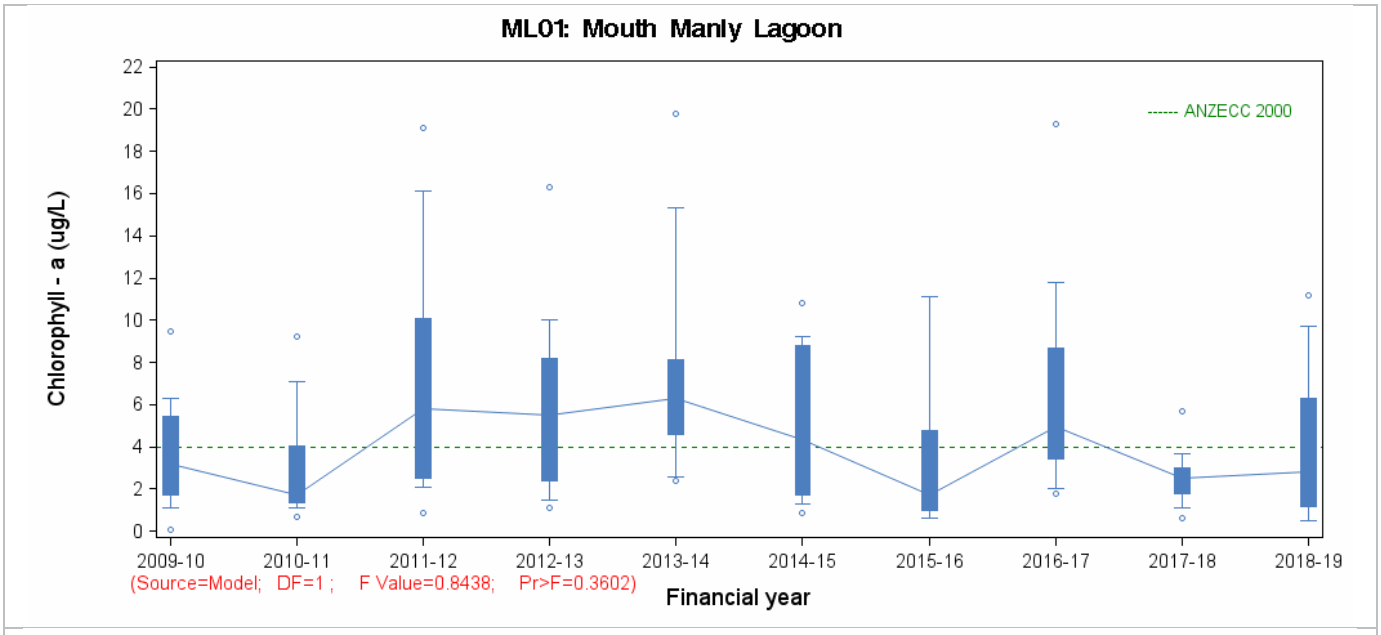

DW01: Dee Why Lagoon
Enterococci (cfu/100mL)
10000.0
1000.0
100.0
10.0
1.0
0.1
------ ANZECC 2000 Secondary contact recreation
------ ANZECC 2000 Primary contact recreation
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0999; Pr>F=0.7520)
Financial year

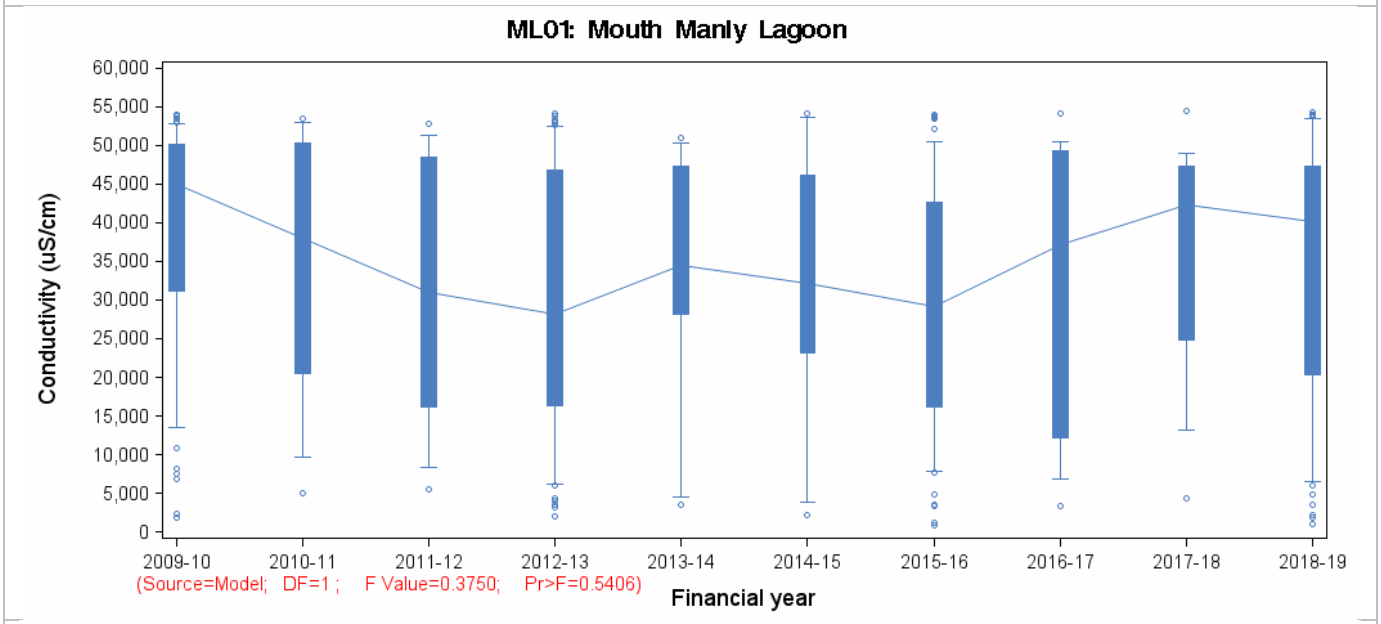

CC01: Curl Curl Lagoon
Chlorophyll - a (ug/L)
220
200
180
160
140
120
100
80
60
40
20
0
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0028; Pr>F=0.9571)
Financial year

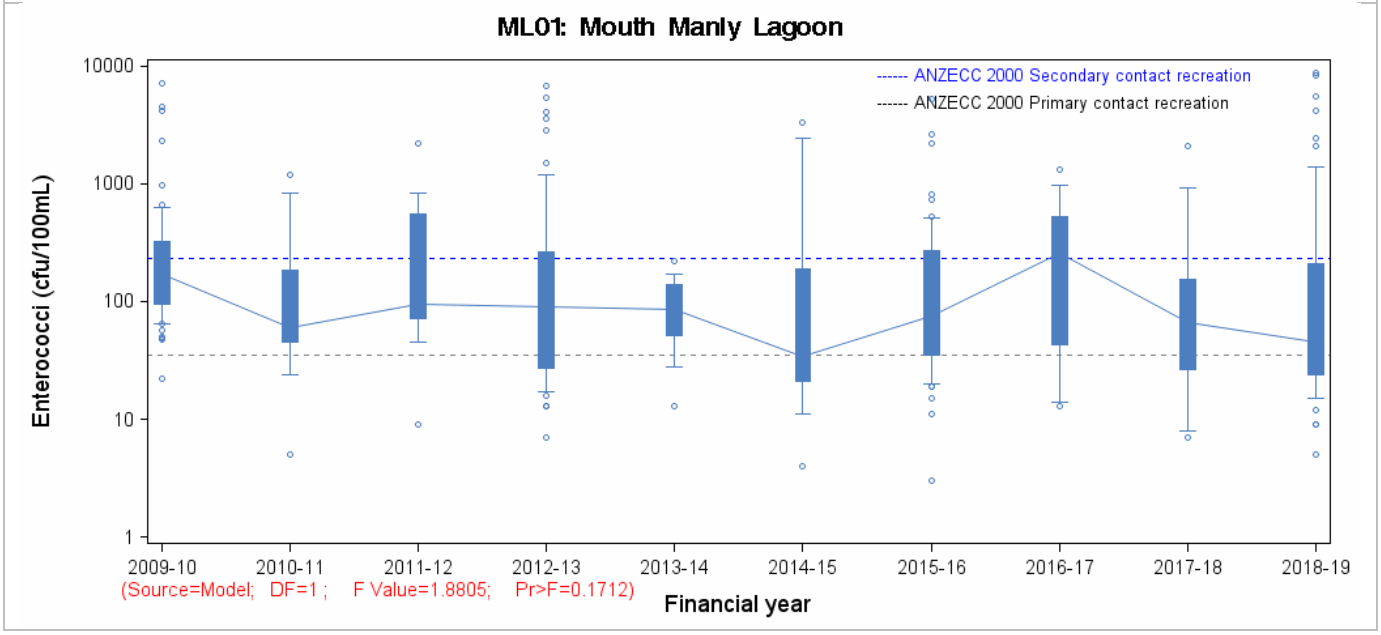

CC01: Curl Curl Lagoon
Conductivity (uS/cm)
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0406; Pr>F=0.8404)
Financial year

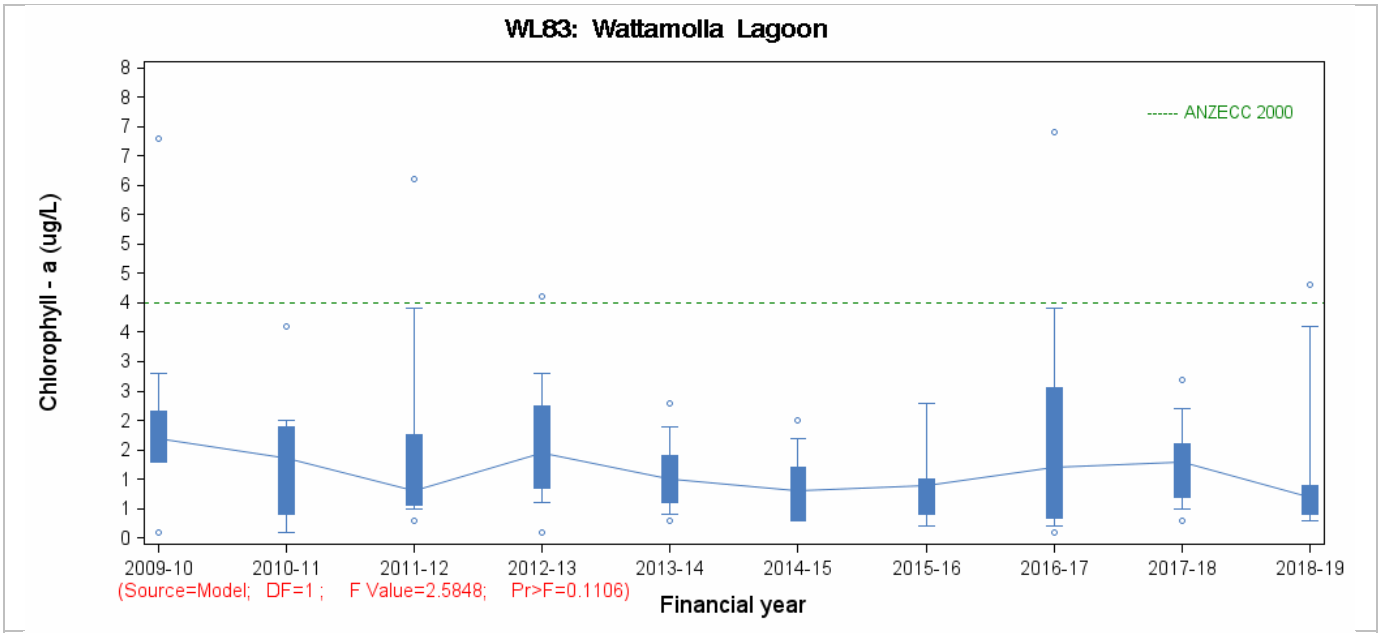

CC01: Curl Curl Lagoon
Enterococci (cfu/100mL)
100000
10000
1000
100
10
1
----- ANZECC 2000 Secondary contact recreation
----- ANZECC 2000 Primary contact recreation
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.3865; Pr>F=0.1233)
Financial year

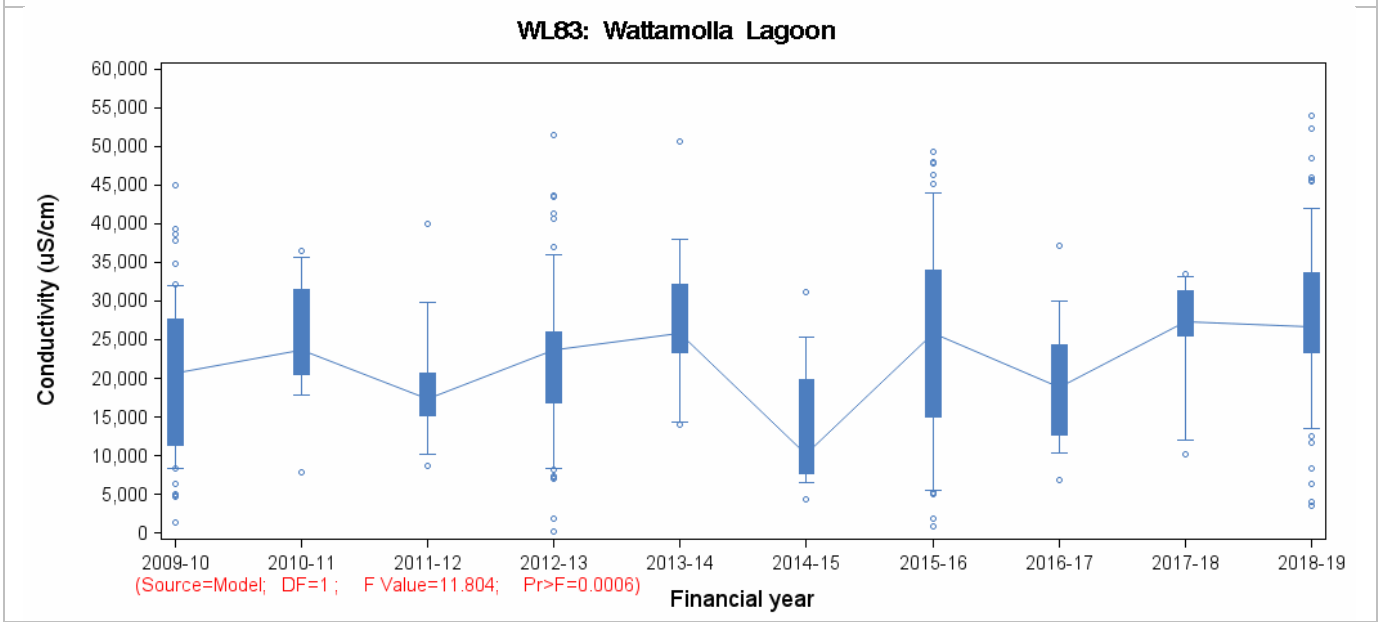

ML03: Upper Manly Lagoon
Chlorophyll - a (ug/L)
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.4178; Pr>F=0.0670)
Financial year
ML03: Upper Manly Lagoon
Conductivity (uS/cm)
(Source=Model; DF=1 ; F Value=1.6126; Pr>F=0.2050)
Financial year
ML03: Upper Manly Lagoon
Enterococci (cfu/100mL)
----- ANZECC 2000 Secondary contact recreation
----- ANZECC 2000 Primary contact recreation
(Source=Model; DF=1 ; F Value=0.0371; Pr>F=0.8473)
Financial year

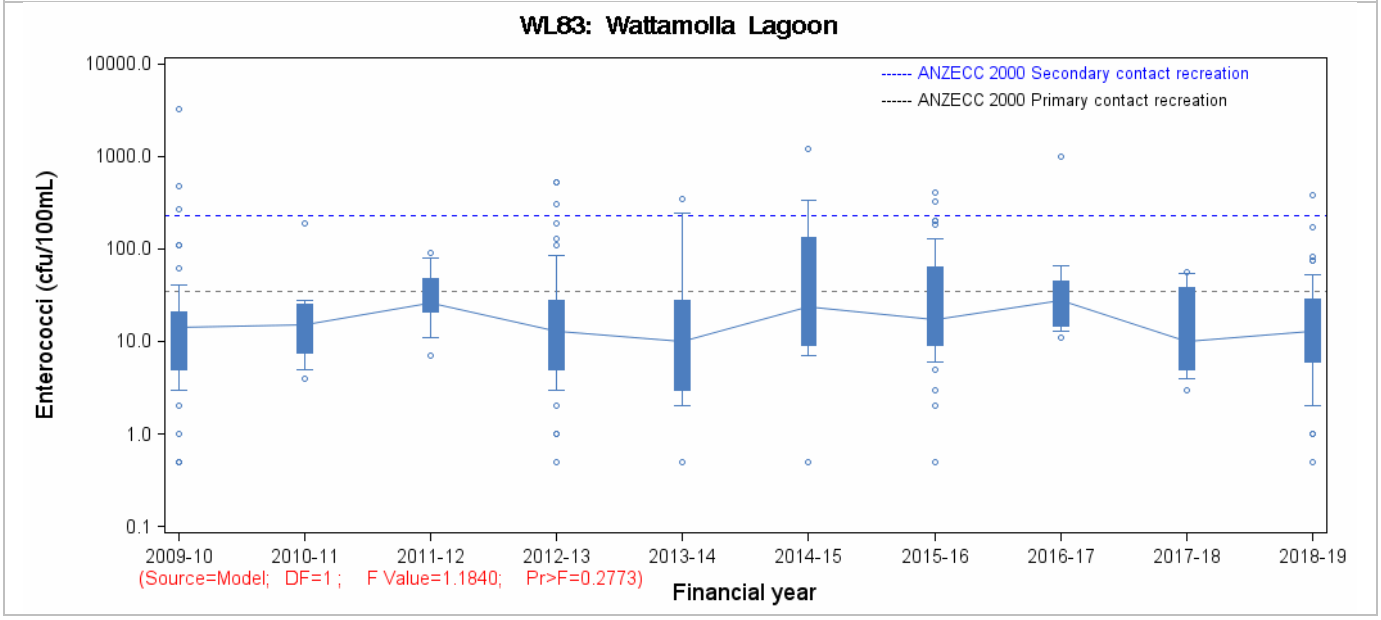

ML01: Mouth Manly Lagoon
Chlorophyll - a (ug/L)
22
20
18
16
14
12
10
8
6
4
2
0
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.8438; Pr>F=0.3602)
Financial year


ML01: Mouth Manly Lagoon
Conductivity (uS/cm)
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3750; Pr>F=0.5406)
Financial year


ML01: Mouth Manly Lagoon
Enterococci (cfu/100mL)
10000
1000
100
10
1
----- ANZECC 2000 Secondary contact recreation
----- ANZECC 2000 Primary contact recreation
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.8805; Pr>F=0.1712)
Financial year


WL83: Wattamolla Lagoon
Chlorophyll - a (ug/L)
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.5848; Pr>F=0.1106)
Financial year


WL83: Wattamolla Lagoon
Conductivity (uS/cm)
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=11.804; Pr>F=0.0006)
Financial year


WL83: Wattamolla Lagoon
Enterococci (cfu/100mL)
----- ANZECC 2000 Secondary contact recreation
----- ANZECC 2000 Primary contact recreation
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.1840; Pr>F=0.2773)
Financial year

Appendix K Intertidal communities – Shoreline outfalls

Monitoring of rocky-intertidal communities under the shoreline outfall program assesses the potential ecological impact from the Shellharbour WWTP which discharges to the nearshore ocean environment. The structures of natural communities (without anthropogenic impacts) from two control sites were used in assessment of the Shellharbour outfall (impact) site (Volume 1 Figure 2-16). The Shellharbour outfall site is situated about 2 km north of the two control sites. The control sites were situated about 400 m apart. Shellharbour was the only WWTP that was measured under this program, as health and safety risks precluded access to intertidal rock platforms near the four other nearshore ocean outfall locations.

Rocky-intertidal communities are comprised of macro algae and macro invertebrate animals. These organisms will also colonise a variety of man-made structures such as breakwaters, jetties, docks, groynes, dykes and seawalls (Crowe et al. 2000). Wave exposure is known to influence distribution and abundance of rocky-intertidal communities between exposed headlands and sheltered bays or inlets (Crowe et al. 2000). To control this natural influence, sites were selected that had similar levels of wave exposure. Rocky-intertidal community structure was monitored from wave-exposed ocean headland locations on naturally occurring rock platforms that could be safely accessed at low tide.

At each site, community composition and enumeration were recorded yearly during the period of late winter to late spring. Monitoring in this period reduces the influence of annual recruitment of most species of settling larvae that mainly happens in summer to autumn. Photographs of a 0.25 m^2 quadrat were taken within two hours either side of low tide. To help encapsulate variation between sites and across years, 14 randomly selected 0.25 m^2 quadrats were photographed between the low and high tide marks in the mid-littoral zone at each site visit. Using these photographs, counts were recorded for macro invertebrate taxa and estimates of percentage cover were made for macro algae. The taxonomic level recorded was based on morphological characteristics that could be seen with the naked eye and the level recorded is shown in the SIMPER 2018 output (Table K-2). Identification of macro invertebrate taxa and macro algae was checked against taxonomic works of Edgar (1997) and Dakin (1987).

Shoreline outfall discharges with documented measurable impacts on intertidal community structure are typically limited in spatial extent from 100 to 300 m (Fairweather 1990 and AWT 1998). These intertidal community structures were dominated by extensive covers of green macro algae. A pictorial example of a localised spatial impact of about 50 m^2 (Figure K-1) was formerly seen at Barrack Point outfall in 2001. At that time, an extensive cover of green macro algae occurred with few invertebrates (EP Consulting 2003). This was prior to upgrade works conducted at the Shellharbour WWTP in the early to mid-2000's.

The Bray-Curtis resemblance measure is focused on compositional changes in taxa identities (Anderson and Walsh 2013). As such, this is an appropriate choice since we understand the former measurable impact from near shore wastewater discharge at Shellharbour did cause a change in the composition of the intertidal rock platform community.

The PERMANOVA routine is designed to test whether it is reasonable to consider the existence of pre-defined groups given overall variability (Anderson et al. 2008).

An asymmetrical permutational multivariate analysis of variance test (PERMANOVA) was conducted with 'Control and Impact' locations treated as a fixed factor. 'Sites' were nested within 'Control and Impact', with 'Sites' treated as a random factor. The outfall site was the only site under the Impact location and the two sites were under the Control locations. A fourth root transformation was applied to the data prior to a Bray-Curtis dissimilarity matrix being constructed. This matrix was the basis for PERMANOVA testing with 9999 permutations run under a reduced model, with conservative Type III sums of squares inspected to base hypothesis decisions upon.

Asymmetrical PERMANOVA indicated there was no significant difference between 'Control and Impact' locations for the 2018 survey (Table K-3).

SIMPER analysis reflected a community structure dominated by invertebrates with a lesser contribution of macro algae at all three locations including the outfall location (Table K-4). The picture of the outfall site in 2018 (Figure K-1) reflects invertebrate dominance seen in SIMPER results, which is different to the green algal dominance recorded in 2001 prior to WWTP upgrade works (Figure K-2).

In summary the multivariate analyses of community structure of 2018 morphologically based intertidal rock platform community data suggested there was no measurable impact in the intertidal rock platform community near the outfall at Barrack Point from wastewater discharges from the Shellharbour WWTP. This outcome was supported by the differences apparent in the pictorial comparisons of 2001 and 2018. Context of 2018 data to the broader data collected back to 2008 is provided under the 2008 to 2018 data analysis below.

Table K-1 Asymmetrical PERMANOVA of 2018 intertidal assemblages

Permutational MANOVA
Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Control / Impact	Fixed	2
Site	Random	3

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms	P(MC)
Control / Impact	1	6204.5	6204.5	0.64137	1	3	0.6523
Site (Control / Impact)	1	9673.9	9673.9	16.06	0.0001	9946	0.0001
Res	39	23493	602.37				
Total	41	39371					

Estimates of components of variation

Source		Estimate	Sq.root
S(Control / Impact)		-185.86	-13.633
V(Site(Control / Impact))	647.97	25.455	
V(Res)	602.37	24.543	

Table K-2 SIMPER 2018 - intertidal assemblages by site

Control site-1 – 2018 Average sample similarity: 61%

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	3.26	25.90	2.97	42.66	42.66
False limpets and rock limpets (Patellogastropoda)	1.60	11.47	1.46	18.89	61.55
Conniwinks (Lottorinidae *Bembicium*)	1.35	9.55	1.44	15.72	77.27
Periwinkles (Littorinidae *Nodilitorina*)	1.57	8.24	0.77	13.57	90.85
Zebra top shell (Trochidae *Austrocochlea*)	0.74	3.07	0.65	5.06	95.90
Nerite (Nertidae *Nerita*)	0.50	1.58	0.44	2.61	98.51
Brown algae (Phaeophyta)	0.56	0.77	0.18	1.27	99.78
Oyster Borer (Muricidae *Morula marginalba*)	0.21	0.13	0.10	0.22	100.00

Control site-2 – 2018 Average sample similarity: 69%

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	8.48	32.11	2.71	46.70	46.70
Brown algae (Phaeophyta)	2.79	9.71	1.38	14.12	60.82
False limpets and rock limpets (Patellogastropoda)	2.08	8.32	4.34	12.10	72.92
Conniwinks (Lottorinidae *Bembicium*)	1.90	7.82	5.16	11.37	84.28
Red Algae (Rhodophyta)	1.42	3.10	0.76	4.51	88.80
Oyster Borer (Muricidae *Morula marginalba*)	1.10	3.01	0.95	4.38	93.17
Zebra top shell (Trochidae *Austrocochlea*)	0.87	2.00	0.79	2.91	96.08
Encrusting tube worm (Serpilidae *Galeolaria caespitose*)	0.80	1.31	0.44	1.91	97.99
Green Algae (Chlorophyta)	0.69	0.88	0.34	1.28	99.27
Periwinkles (Littorinidae *Nodilitorina*)	0.59	0.44	0.25	0.64	99.91
Nerite (Nertidae *Nerita*)	0.20	0.06	0.10	0.09	100.00

Outfall site – 2018 Average sample similarity: 68%

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	4.36	15.23	1.49	22.33	22.33
Conniwinks (Lottorinidae *Bembicium*)	2.86	11.52	4.97	16.89	39.23
False limpets and rock limpets (Patellogastropoda)	2.47	10.26	5.71	15.05	54.27
Zebra top shell (Trochidae *Austrocochlea*)	2.58	9.94	3.25	14.58	68.86
Periwinkles (Littorinidae *Nodilitorina*)	2.58	6.59	0.79	9.66	78.51
Red Algae (Rhodophyta)	2.03	5.08	0.77	7.45	85.96
Nerite (Nertidae *Nerita*)	1.45	5.07	1.54	7.43	93.39
Oyster Borer (Muricidae *Morula marginalba*)	1.02	2.80	0.95	4.10	97.50
Green Algae (Chlorophyta)	0.93	1.49	0.43	2.19	99.68
Brown algae (Phaeophyta)	0.45	0.22	0.18	0.32	100.00
Encrusting tube worm (Serpilidae *Galeolaria caespitose*)	0.11	0.00	SD=0	0.00	100.00



Figure K-1 Barrack Point with a healthy intertidal rock platform community in 2018



Figure K-2 Barrack Point (in 2001) with an unhealthy intertidal rock platform community impacted by wastewater discharges from the Shellharbour WWTP prior to upgrade in the early to mid 2000's

Intertidal communities Shellharbour 2008 to 2018

Inclusion of yearly replicate samples from 2008 to 2018 allowed the factor 'Time' to be included in the above asymmetrical permutational analysis of variance test (PERMANOVA). Time was comprised of 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017 and 2018 surveys, which were conducted at varying times through late winter to late spring.

Asymmetrical PERMANOVA indicated there was no significant difference between 'Control and Impact' locations for the 2008 to 2018 period (Table K-3). However, differences between sites through time were indicated as a significant results were returned for the 'Site (Control and Impact)' and 'Site(Control / Impact) x Time' factors (Table K-3).

The non-metric multidimensional scaling (nMDS) ordination routine of PRIMER was used to produce two and three dimensional ordination plots. In these plots the relative distance between samples is proportional to the relative similarity in taxonomic composition and abundance – the closer the points on the graph the more similar the community (Clarke 1993). That is, site samples with similar taxa lay closer together and site samples with a differing taxon composition lie farther apart. An unconstrained ordination procedure such as nMDS inevitably introduces distortion when trying to simultaneously represent the similarities between large numbers of samples in a few dimensions. The success of the procedure is measured by a stress value, which indicates the degree of distortion imposed. In the PRIMER software package a stress value of below 0.2 indicates an acceptable representation of the original data, although lower values are desirable. Where stress values are just above 0.2, the patterns displayed should be confirmed with other techniques such as PERMANOVA. The returned two-dimensional stress value was 0.21 and an improved lower stress value of 0.15 was observed for the three-dimensional ordination plot.

To understand the context of 2018 site data to that of previous years (2008 to 2017), site sample data were colour coded as shown in Figure K-3. Data patterns displayed in this two-dimensional nMDS ordination plot indicated 2008 to 2017 Control site-1 samples overlapped with 2008 to 2017 outfall site samples. The 2018 outfall samples also overlaid this mass of samples. While the Control site-2 samples from 2018 overlaid the agglomeration of Control site-2 2008 to 2017 samples. The 2018 Control-site 1 samples tended to be spread within all locations, which indicates an increase in similarity of this site to the other locations compared to 2017 which showed samples sitting on the margins of the other sites. A three-dimensional nMDS ordination plot is presented in Figure K-4. It indicates a tighter agglomeration of samples than displayed in the two dimensional nMDS ordination plot in Figure K-3.

Under the nMDS routine, due to rank ordering of dissimilarities some detail can be hidden. This detail may be seen using a Principal Coordinates Analysis PCO routine as PCO is based upon original dissimilarities being projected onto axes in the space of the chosen resemblance measure (Anderson et al. 2008). As a check for any additional dimensionality in the multivariate data cloud, a PCO ordination plot was raised based on a fourth root transformation of the data and a Bray-Curtis resemblance measure. No additional dimensionality was indicated as the patterns between nMDS (Figure K-3, Figure K-4) and PCO ordination (Figure K-5) plots were very similar.

A Canonical Analysis of Principal Coordinates (CAP) ordination plot was also produced (Figure K-6). The CAP routine is designed to ask, 'Are there axes in the multivariate space that separate groups?' CAP is designed to purposely seek out and find groups even if differences occur in obscure directions and may not have been apparent from nMDS or PCO plots that provide views of the multivariate data

cloud as a whole (Anderson et al. 2008). A similar pattern to that in the nMDS (Figure K-3) and PCO (Figure K-5) ordination plots was displayed. This also suggested no hidden dimensionality, with good agreement between the nMDS, PCO and CAP ordination plots.

An additional run of the CAP routine was undertaken with placement of 2018 outfall samples onto the canonical axes of the existing CAP model from the initial run. Output from the second run indicated 2018 outfall samples were most similar to either the Outfall 2008 to 2017 samples or Control site 1 2008 to 2018 samples (Figure K-6). This result also reflected patterns displayed in the nMDS and PCO ordination plots (Figure K-4, Figure K-5 and Figure K-6).

The trend of taxonomic differences between sites situated close together on shorelines is known to occur and accounts for the differences between Control site-1 that is only 400 m from Control site-2 on the shoreline. It is mentioned by Underwood and Chapman (1998) who cite Underwood (1981) who states 'on exposed shores in New South Wales there are great differences in patterns of occupancy of space from one place to another not many metres away, even though these are not a function of gradients in wave action.'

In summary, a relatively stable equilibrium in rocky-intertidal community structure was indicated from these assessments of the 2008 to 2018 monitoring data at the three sites studied under the STSIMP. These results also suggest over the 2008 to 2018 period, no measurable impact had developed in the intertidal rock platform community near the outfall at Barrack Point from wastewater discharges from the Shellharbour WWTP as the community assemblage of the outfall site was very similar to Control site-1 for the 2008 to 2017 period. Results from Control site-2 represent natural variation in rocky-intertidal community structure that has been demonstrated to occur for closely spaced shoreline sites.

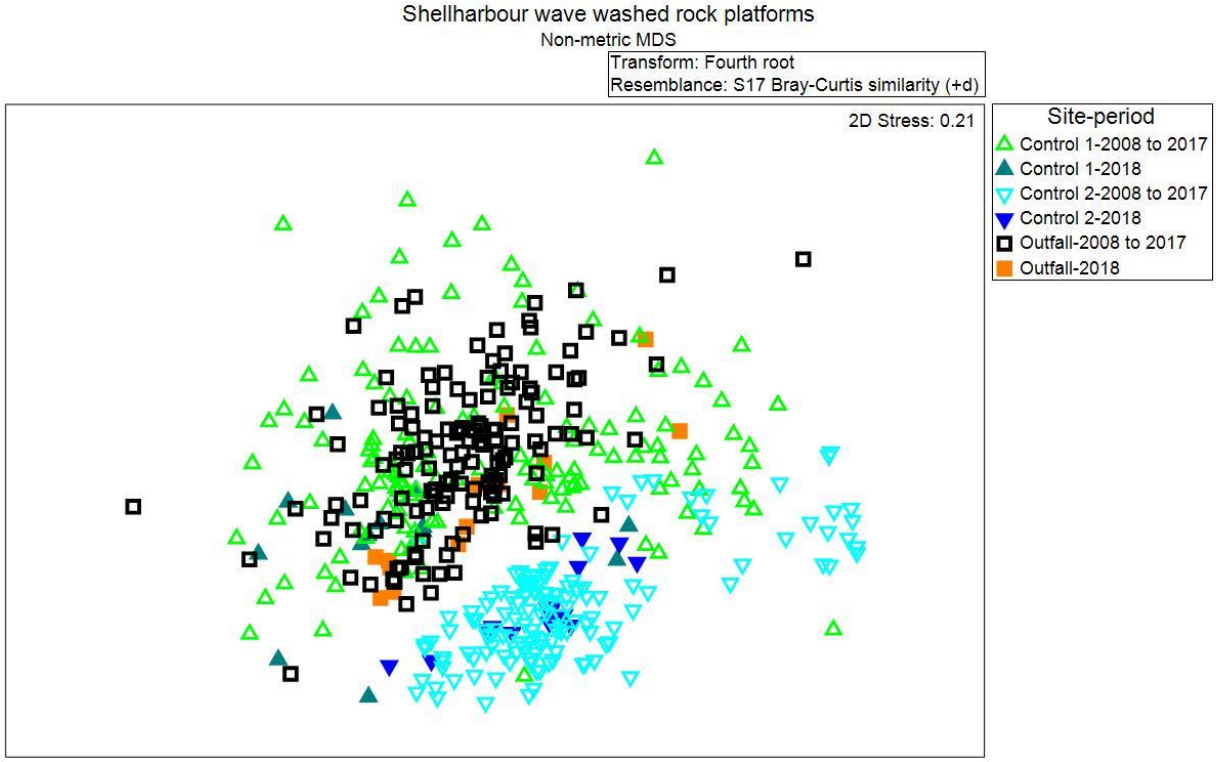


Figure K-3 Two-dimensional nMDS ordination plot of 2008 to 2018 intertidal rock platform community data

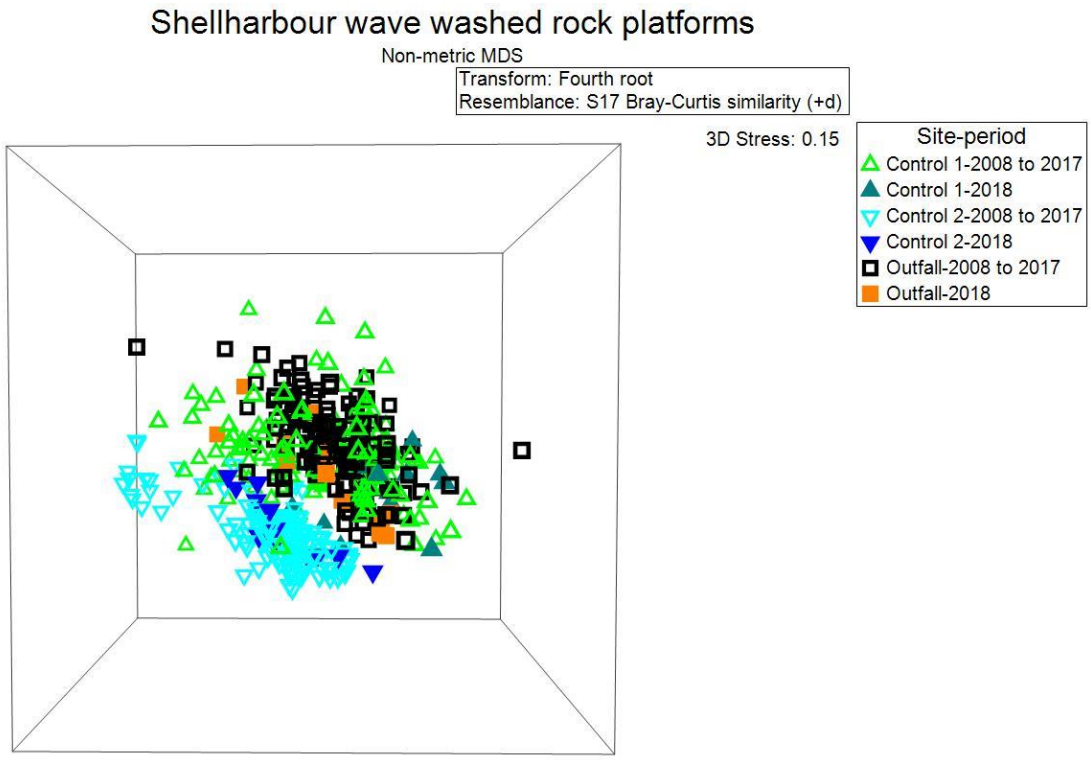


Figure K-4 Three-dimensional nMDS ordination plot of 2008 to 2018 intertidal rock platform community data

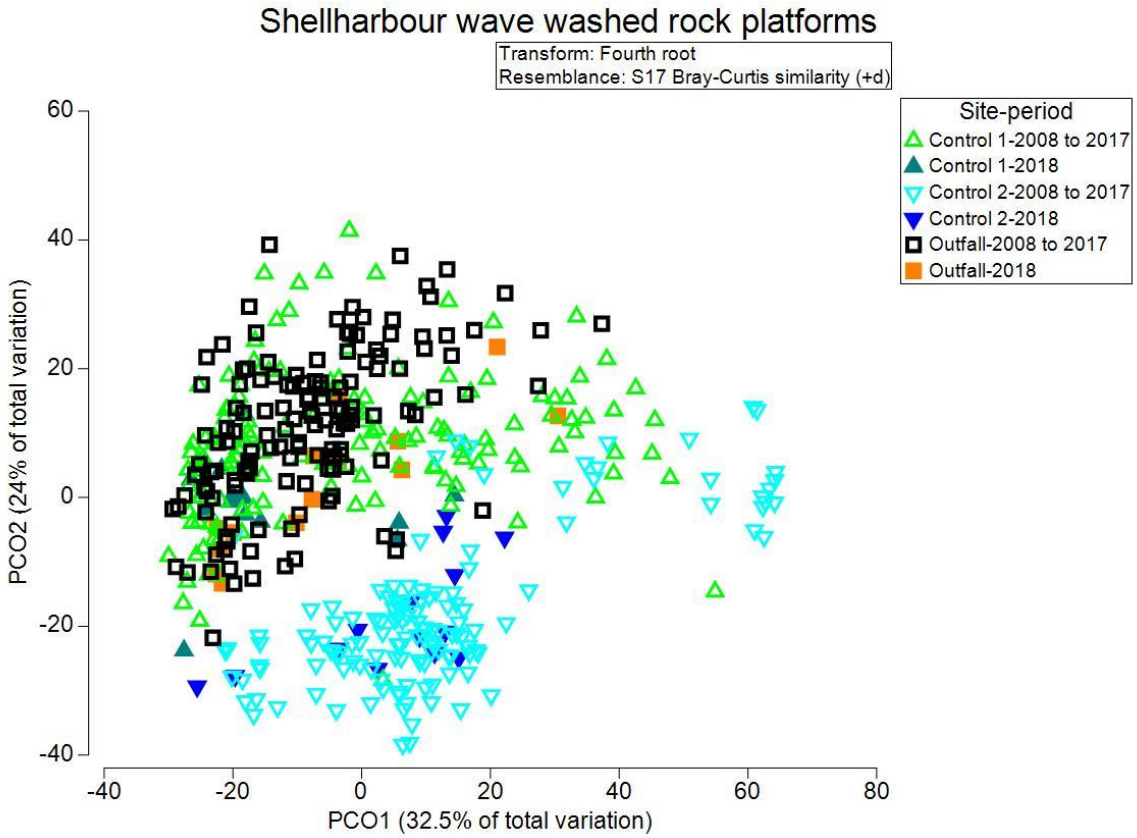


Figure K-5 PCO ordination plot of 2008 to 2018 intertidal rock platform community data - dimensional

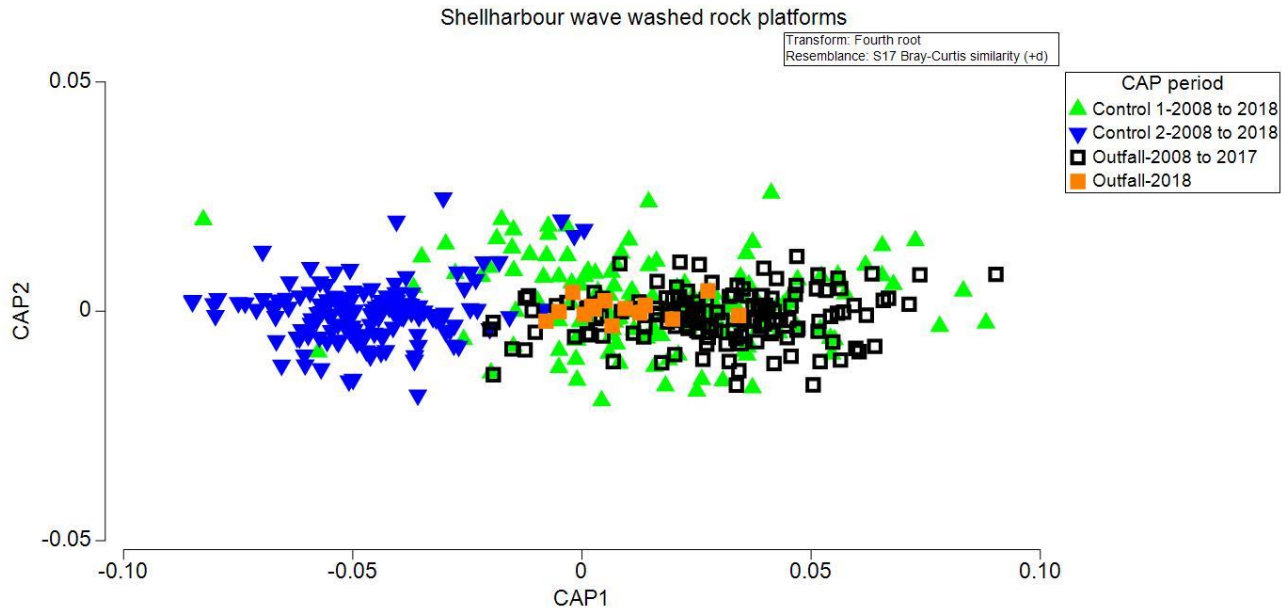


Figure K-6 CAP ordination plot of intertidal rock platform community data (2008 to 2018 for Control site 1 and Control site 2 and 2008 to 2017 outfall site) with 2018 outfall samples (orange squares) predicted

Table K-3 - Asymmetrical PERMANOVA of 2008 to 2018 intertidal assemblages

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Control / Impact	Fixed	2
Site	Random	3
Time	Fixed	11

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms	P(MC)
Control / Impact	1	54309	54309	0.73892	0.6695	3	0.6046
Time	10	56034	5603.4	1.1258	0.3385	9904	0.3735
Site(Control / Impact)	1	72095	72095	102.72	0.0001	9957	0.0001
Control / ImpactxTime	10	35022	3502.2	0.7046	0.8773	9898	0.847
Site(Control / Impact)xTime	10	48997	4899.7	6.9811	0.0001	9908	0.0001
Res	427	2.9969E+05	701.85				
Total	459	5.6833E+05					

Estimates of components of variation

Source	Estimate	Sq.root
S(Control / Impact)	-93.336	-9.6611
S(Time)	16.768	4.0949
V(Site(Control / Impact))	472.02	21.726
S(Control / ImpactxTime)	-78.75	-8.8741
V(Site(Control / Impact)xTime)	304.53	17.451
V(Res)	701.85	26.493

Table K-4 CAP analysis of 2008 to 2017 intertidal assemblages with 2018 outfall site samples predicted

Canonical analysis of principal coordinates
Second pass

Factor level for new samples group: Outfall-2018
Number of samples: 446
Choice of m: 3

CANONICAL ANALYSIS
Correlations

Eigenvalue	Correlation	Corr.Sq.
1	0.8398	0.7053
2	0.1503	0.0226

DIAGNOSTICS

m	prop.G	ssres	d_1^2	d_2^2	%correct
3	0.7224	1.2909	0.7053	0.0226	68.61

Cross Validation
Leave-one-out Allocation of Observations to Groups (for the choice of m: 3)
Classified

Orig. group	Control 1-2008 to 2018	Control 2-2008 to 2018	Outfall-2008 to 2017	Total	%correct
Control 1-2008 to 2018	72	17	65	154	46.753
Control 2-2008 to 2018	5	145	0	150	96.667
Outfall-2008 to 2017	49	4	89	142	62.676

Total correct: 306/446 (68.61%)
Mis-classification error: 31.39%

Individual samples that were mis-classified

Sample	Orig.group	Class.group
Control 1-2018-1	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2018-5	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2018-6	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2018-10	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2018-11	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2018-12	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2018-13	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2018-14	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2008-2	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-3	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-4	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-5	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-6	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-7	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-8	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-10	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2008-12	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-2	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-4	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-5	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-6	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-7	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-9	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-10	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-12	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-13	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2009-14	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2010-1	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2010-2	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2010-3	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2010-4	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2010-5	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2010-6	Control 1-2008 to 2018	Outfall-2008 to 2017

Control 1-2010-11	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2010-12	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2011-3	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2011-9	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2011-10	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2012-1	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2012-2	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2012-6	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2012-7	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2012-9	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2012-11	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2012-14	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2013-7	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2013-9	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2013-13	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-1	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-2	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-3	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-4	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-5	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-7	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-8	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-10	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-11	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-12	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-13	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2014-14	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2015-3	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2015-5	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2015-8	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2015-10	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2015-11	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2015-12	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2015-14	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2016-1	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2016-2	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2016-5	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2016-7	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2016-12	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2017-1	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2017-2	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2017-5	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2017-6	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2017-7	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2017-8	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2017-9	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2017-11	Control 1-2008 to 2018	Outfall-2008 to 2017
Control 1-2017-12	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 1-2017-14	Control 1-2008 to 2018	Control 2-2008 to 2018
Control 2-2008-2	Control 2-2008 to 2018	Control 1-2008 to 2018
Control 2-2008-6	Control 2-2008 to 2018	Control 1-2008 to 2018
Control 2-2008-10	Control 2-2008 to 2018	Control 1-2008 to 2018
Control 2-2008-13	Control 2-2008 to 2018	Control 1-2008 to 2018
Control 2-2008-14	Control 2-2008 to 2018	Control 1-2008 to 2018
Outfall-2008-12	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2010-7	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-1	Outfall-2008 to 2017	Control 2-2008 to 2018
Outfall-2011-2	Outfall-2008 to 2017	Control 2-2008 to 2018
Outfall-2011-3	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-5	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-7	Outfall-2008 to 2017	Control 2-2008 to 2018
Outfall-2011-8	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-9	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-10	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-11	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-13	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2011-14	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2012-2	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2012-11	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2013-3	Outfall-2008 to 2017	Control 2-2008 to 2018

Outfall-2013-12	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2013-14	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-1	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-2	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-4	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-5	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-8	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-9	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-10	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2014-11	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2015-4	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2015-6	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2015-8	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2015-13	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2015-14	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-1	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-3	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-4	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-5	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-6	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-9	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-11	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-12	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-13	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2016-14	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-1	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-2	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-3	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-4	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-5	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-6	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-8	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-9	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-10	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-11	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-12	Outfall-2008 to 2017	Control 1-2008 to 2018
Outfall-2017-14	Outfall-2008 to 2017	Control 1-2008 to 2018

PERMUTATION TEST
trace statistic = (tr(Q_m'HQ_m))
first squared canonical correlation = (delta_1^2)

tr(Q_m'HQ_m): 0.72789 P: 0.0001
delta_1^2: 0.7053 P: 0.0001
No. of permutations used: 9999

NEW SAMPLES

Canonical coordinate scores for New Samples

Sample	CAP1	CAP2
Outfall-2018-1	0.0127	-0.0004
Outfall-2018-2	0.0027	0.0005
Outfall-2018-3	0.0005	-0.0007
Outfall-2018-4	0.0198	-0.0017
Outfall-2018-5	0.0066	-0.0032
Outfall-2018-6	0.0138	0.0013
Outfall-2018-7	0.005	0.0023
Outfall-2018-8	0.0275	0.0044
Outfall-2018-9	-0.002	0.0041
Outfall-2018-10	0.0342	-0.0009
Outfall-2018-11	-0.0078	-0.0022
Outfall-2018-12	-0.005	-0.0001
Outfall-2018-13	0.0095	0.0006
Outfall-2018-14	0.0022	0.0011

New sample classification

Sample	Group
Outfall-2018-1	Control 1-2008 to 2018
Outfall-2018-2	Control 1-2008 to 2018
Outfall-2018-3	Control 1-2008 to 2018
Outfall-2018-4	Control 1-2008 to 2018
Outfall-2018-5	Control 1-2008 to 2018
Outfall-2018-6	Control 1-2008 to 2018
Outfall-2018-7	Control 1-2008 to 2018
Outfall-2018-8	Outfall-2008 to 2017
Outfall-2018-9	Control 1-2008 to 2018
Outfall-2018-10	Outfall-2008 to 2017
Outfall-2018-11	Control 1-2008 to 2018
Outfall-2018-12	Control 1-2008 to 2018
Outfall-2018-13	Control 1-2008 to 2018
Outfall-2018-14	Control 1-2008 to 2018

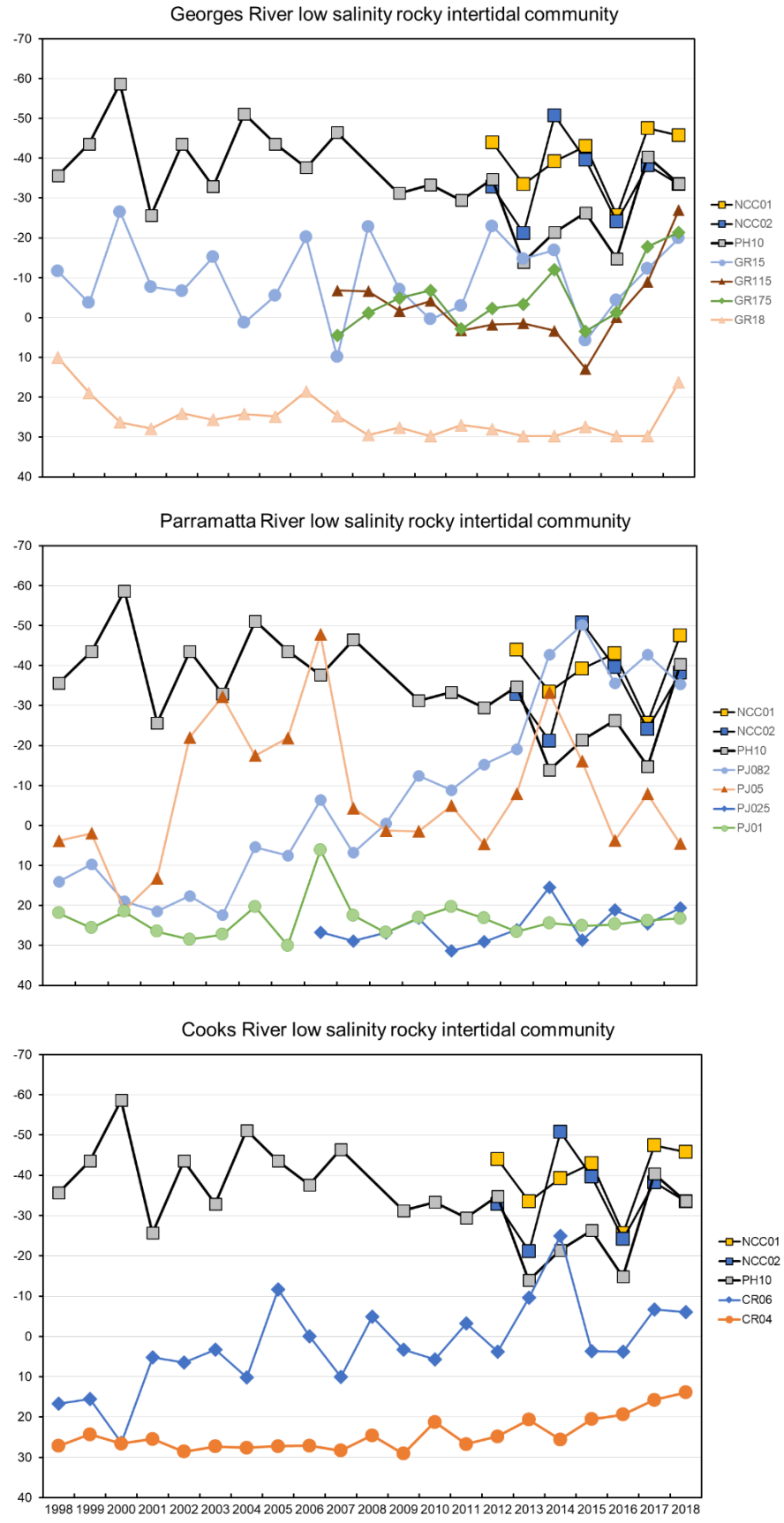
Appendix L Intertidal communities of Sydney's estuaries

Intertidal rock platform communities

As a check of potential change in community structure of intertidal rock platforms at test sites, a comparison was made between control sites and other sites situated below urban catchments. This check was conducted under Principal Coordinates analysis (PCO). PCO is an ordination technique that projects points onto axes that minimise the residual variation in the space of a chosen dissimilarity measure (Anderson et al. 2008). The user chooses the number of axes to be included in the output, but usually the first 2 or 3 axes contain most of the percent variation explained. In the analysis presented here, PCO was based on a Bray-Curtis distance measure matrix. The Bray-Curtis resemblance measure is focused on compositional changes in taxa identities (Anderson and Walsh 2013). The choice of this measure is considered appropriate as a change in taxonomic composition was recorded after remediation of the wastewater system (Sydney Water 2012). A separate analysis was conducted for each salinity zone.

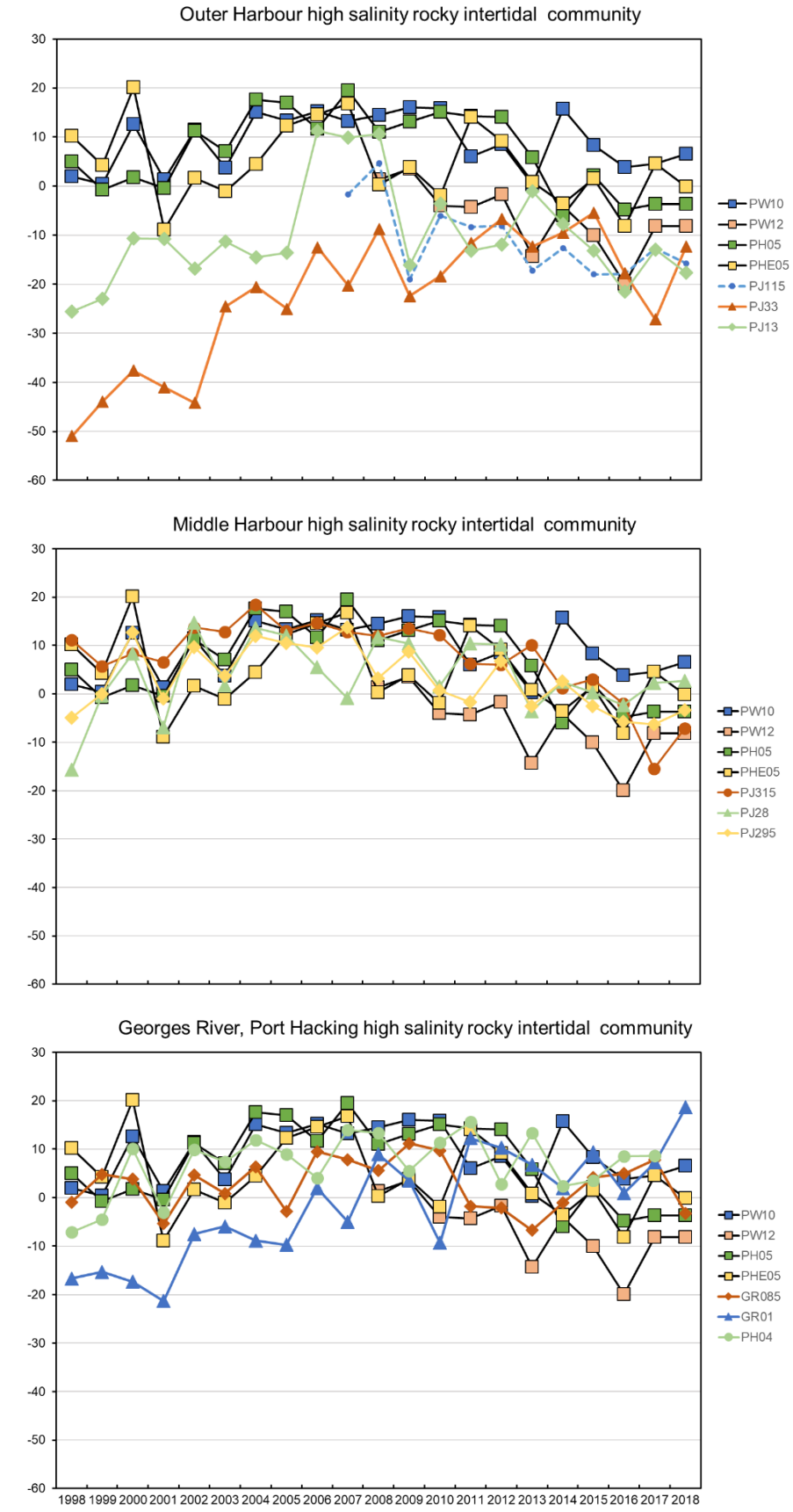
The PCO output allowed control chart style visualisation of centroids in Bray-Curtis space for each site by plotting output for PCO axis 1 against year. This explained about 64% of the variation for the low salinity zone and about 27% of the variation for the high salinity zone. This indicated the low salinity analysis described more variation in data of low salinity sites (85% of variation explained by the first two PCO axes) compared with that for the high salinity sites (47% of variation explained by the first two PCO axes) (Figure L-1 and Figure L-2) over the 1998 to 2018 period.

Test sites within higher salinity zones in 2018 were grouped near or within the range of variation recorded for higher salinity control sites. However, those in the lower salinity zone were well separated, particularly in the Parramatta River and Cooks River, from the recorded range of variation for the lower salinity control sites. In contrast, test sites within the Georges River (Como Woronora River GR15; Kyle Bay Georges River GR115; Edith Bay Georges River GR175) with the exception of Salt Pan Creek GR18 showed consistent improvement in the last three years and now sit within the range of control sites. This suggests the 2018 community structure in the lower salinity zone at most sites (Kissing Point Bay Parramatta River PJ025; Silverwater Bridge Parramatta River PJ01; Woolwich Baths Lane Cove River PJ05; Salt Pan Creek Georges River GR18; Alexandra Canal Cooks River CR04; Wolli Creek Cooks River CR06) were impaired. The exception being an improvement in the trend for the Hawthorn Canal arm within Iron Cove (PJ082).



Black line colour represents control sites: other line colours represent test sites

Figure L-1 Relatively lower salinity zone with year plotted against Principal Coordinates Analysis axis 1 of distance among centroids for sites



Black line colour represents control sites: other line colours represent test sites

Figure L-2 Relatively higher salinity zone with year plotted against Principal Coordinates Analysis axis 1 of distance among centroids for sites

Settlement panels

Settlement panels were used to supplement intertidal rock platform measurements and provide a focus on colonisation of intertidal larvae from the swimming juvenile life stages. Settlement panels were deployed at a number of sites that each included a large muddy intertidal area with mangroves. These areas of the estuaries did not have regular wave activity. The settlement panels consisted of weathered hardwood fence palings (weathered to remove tannins) that were vertically hammered into the mud at an intertidal height just below the lowest growing mangroves, and were left for four months to allow intertidal organisms to settle. After that time, they were removed and measured for the area covered by barnacles. Panels were deployed twice a year, during late spring and late autumn.

Barnacles were the dominant animal that settled and were a mixture of small types like *Elminius* and *Chamaesipho,* as well as some larger animals like *Balanus*. The relatively short deployment time of approximately four months, was inadequate for taxa such as snails (Mollusca) to develop to a sufficient size compared to barnacles that developed in a relatively shorter time where conditions were suitable for barnacle settlement. Previous analysis by Sydney Water (2012) showed reductions in barnacle cover (for example Rushcutters Bay PJ33) following sewer remediation suggesting higher levels of barnacle cover to be a possible indicator of wastewater overflows in wave-sheltered areas of the estuaries around Sydney.

In wave exposed areas of the coast and outer estuaries where there is regular wave occurrence, barnacles naturally grow on hard substrates and are not an indicator of the presence of wastewater. An estimate of barnacle cover was formed by multiplying the average size of barnacles with measured abundance.

Analysis of variance (ANOVA) indicated significant differences between sites situated in relatively higher salinity waters of the outer estuaries of Sydney (df = 9, MS = 364.495, F = 3.15, p 0.0049). A multiple mean (SNK) comparison indicated two overlapping groups of sites Figure L-3.

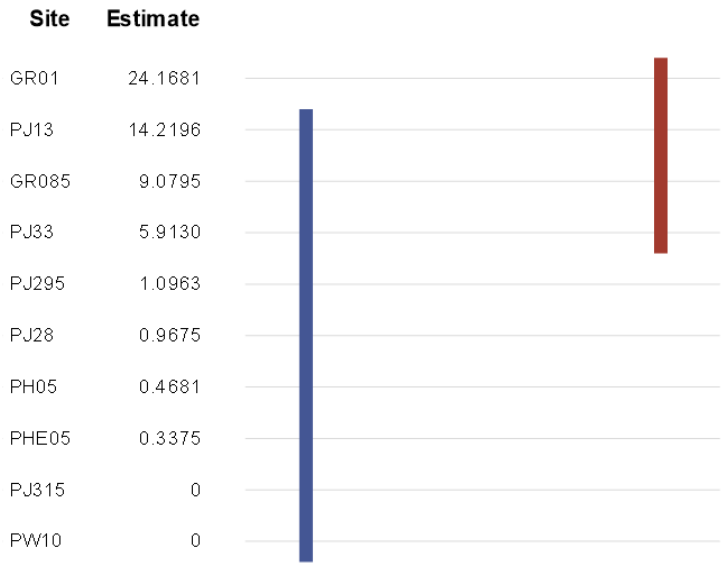


Figure L-3 Multiple mean comparison groupings of relatively high salinity locations for 2018-19. (means covered by the same bar are not significantly different)

ANOVA indicated significant differences between sites situated in relatively lower salinity waters of the inner estuaries of Sydney (df = 11, MS = 2019.871, F = 4.99, p <0.0001). A multiple mean (SNK) comparison test indicated three overlapping groups of sites.

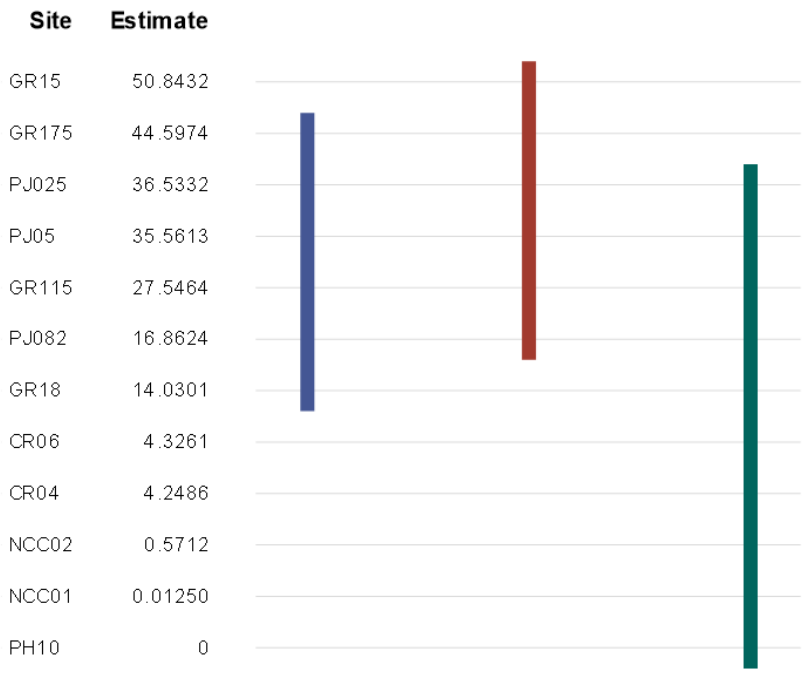


Figure L-4 Multiple mean comparison groupings of relatively lower salinity locations for 2018-19. (means covered by the same bar are not significantly different)

Appendix M Hawkesbury-Nepean River water quality trends

The Hawkesbury-Nepean River sites are presented in the following order from upstream to downstream:

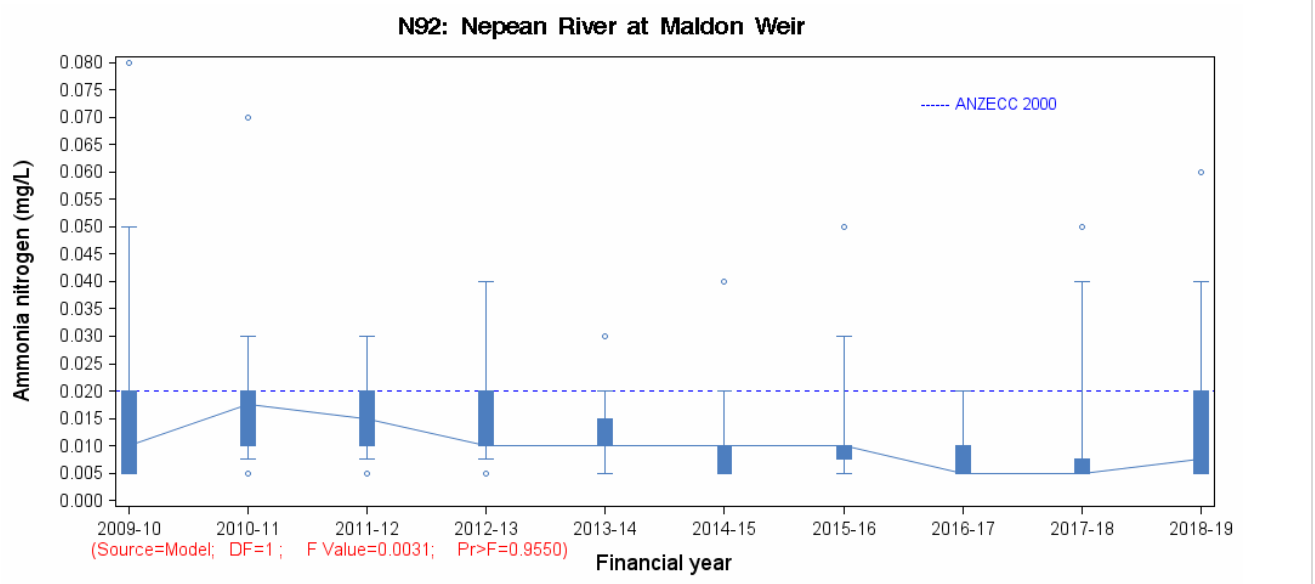
- N92: Nepean River at Maldon Weir
- N75: Nepean River at Sharpes Weir
- N67: Nepean River at Wallacia Bridge
- N57: Nepean River at Penrith Weir
- N51: Nepean River opposite Fitzgerald Creek
- N48A: Nepean River at Smith Road
- N44: Nepean River at Yarramundi Bridge
- N42: Hawkesbury River at North Richmond
- N39: Hawkesbury River at Freemans Reach
- NS04A: Lower South Creek at Fitzroy Bridge
- N35: Hawkesbury River at Wilberforce
- NC11A: Lower Cattai Creek at Cattai Ridge Road
- N3001: Hawkesbury River off Cattai SRA
- N26: Hawkesbury River at Sackville Ferry
- N2202: Lower Colo River at Putty Road
- N18: Hawkesbury River at Leets Vale
- NB13: Berowra Creek at Calabash Bay
- NB11: Berowra Creek off Square Bay

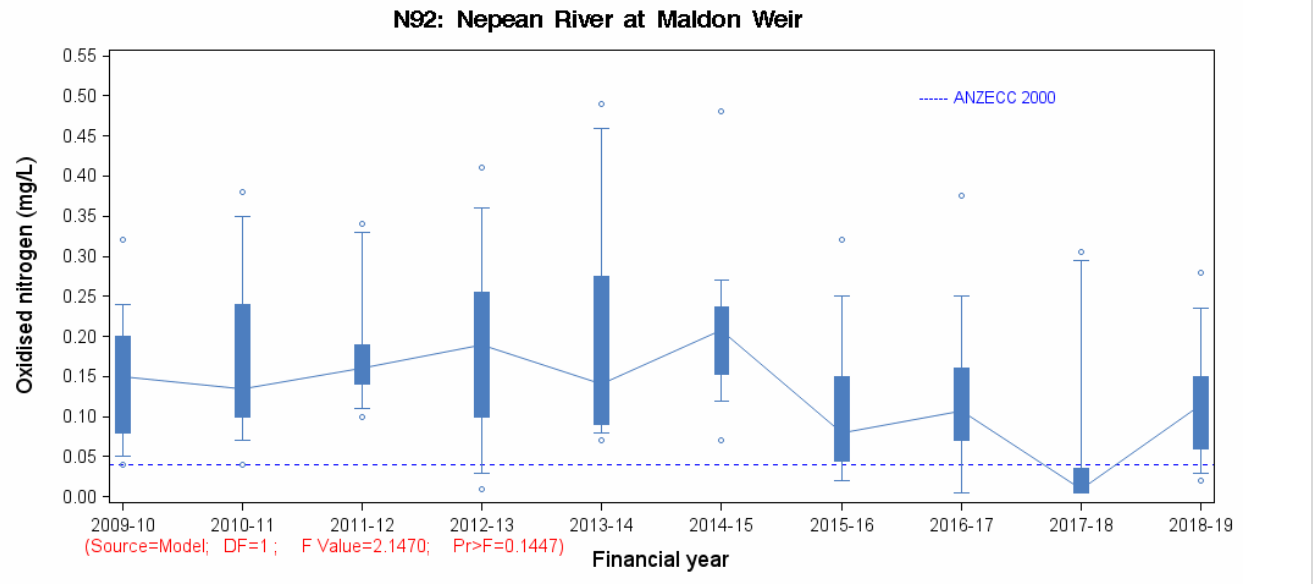
The water quality plots are presented in the following groups and order of analytes:

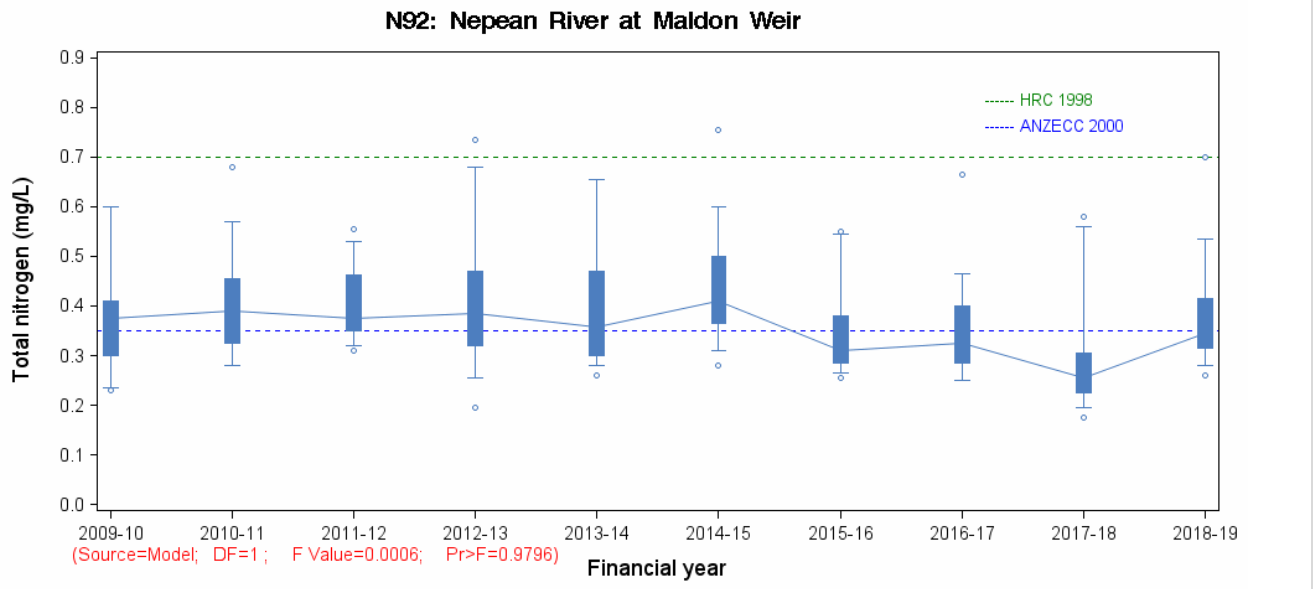
- Nutrients, chlorophyll-*a* and algae
    - Ammonia nitrogen
    - Oxidised nitrogen
    - Total nitrogen
    - Filterable total phosphorus
    - Total phosphorus
    - Chlorophyll-*a*
    - Total algal biovolume
    - Blue-green algal biovolume
    - Toxic blue-green algal biovolume
    - Toxic blue-green algal count
- Other physico-chemical analytes
    - Conductivity
    - Dissolved oxygen (mg/L)
    - Dissolved oxygen saturation (%)
    - pH
    - Temperature
    - Turbidity

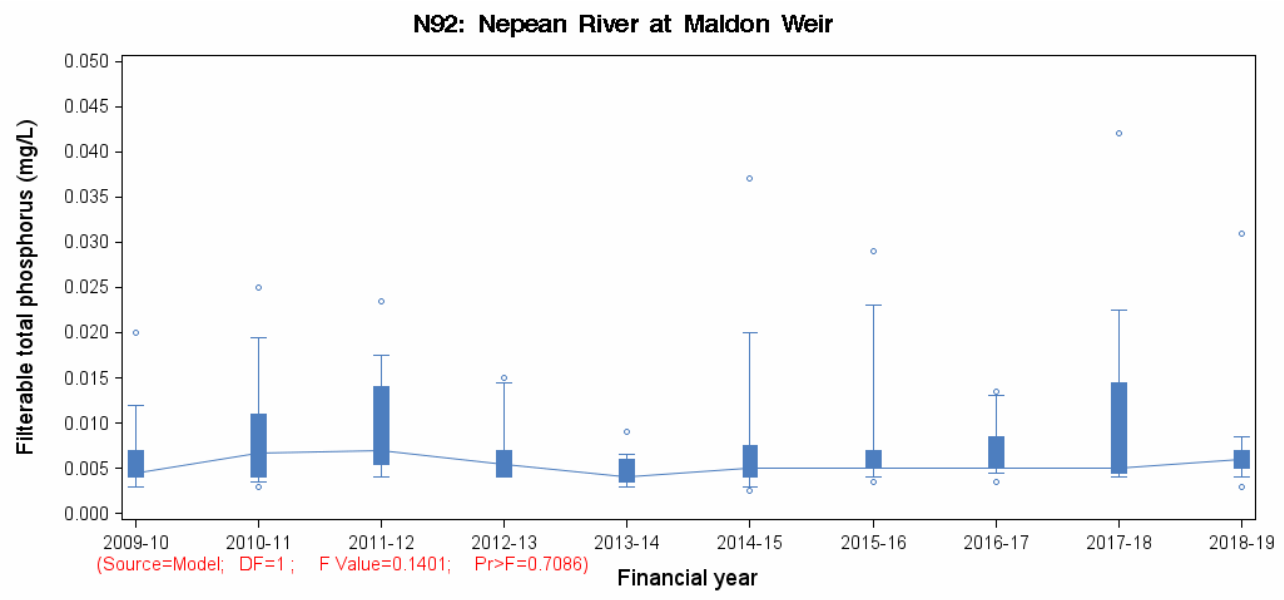
N92: Nepean River at Maldon Weir

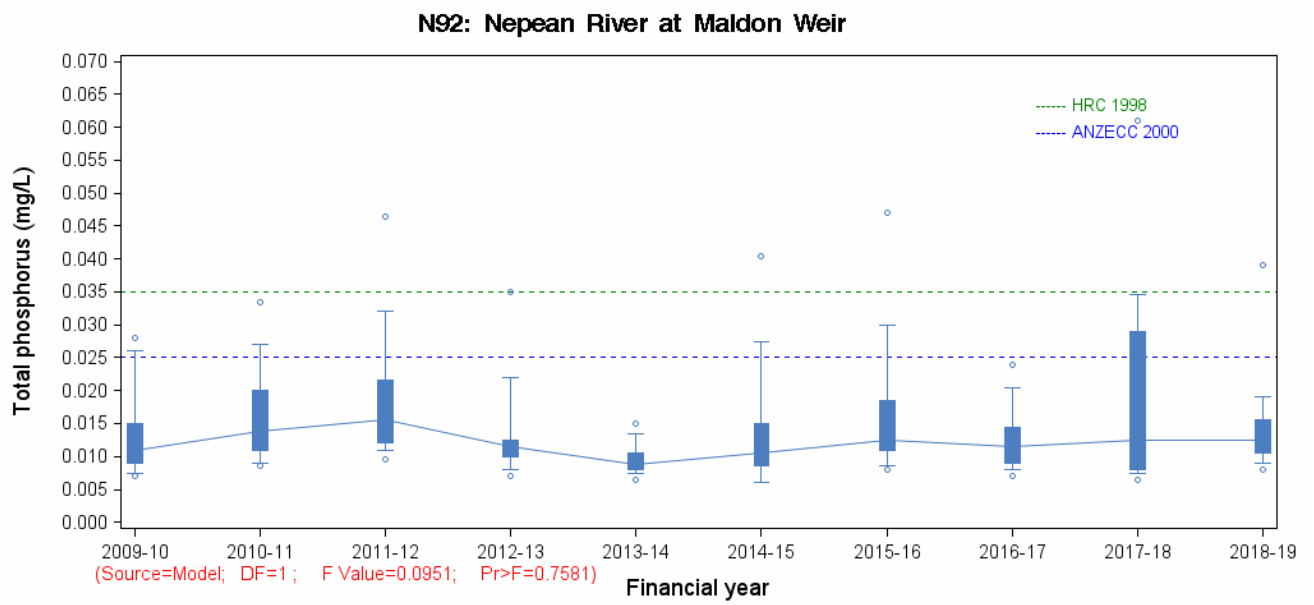
Nutrients, chlorophyll-*a* and algae

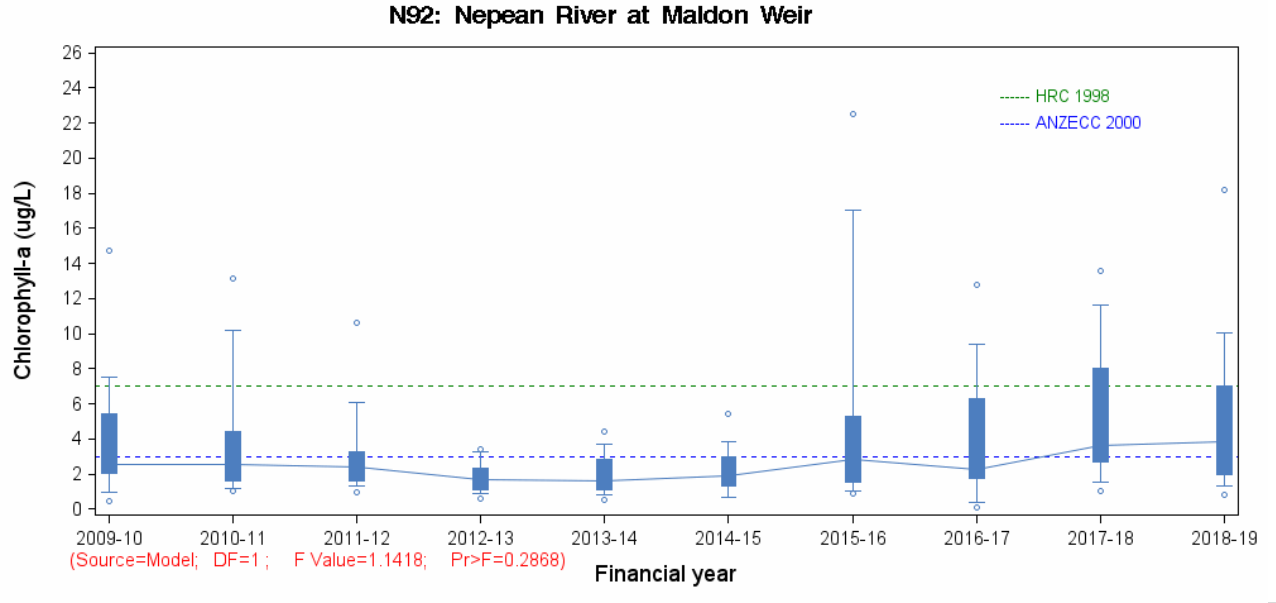


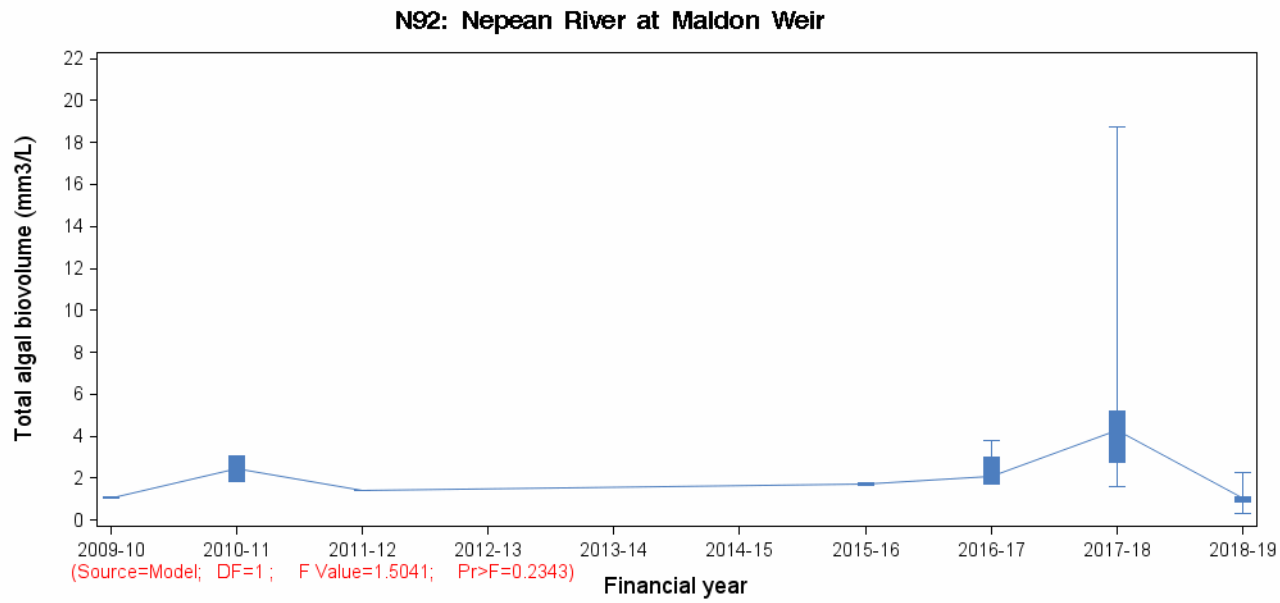


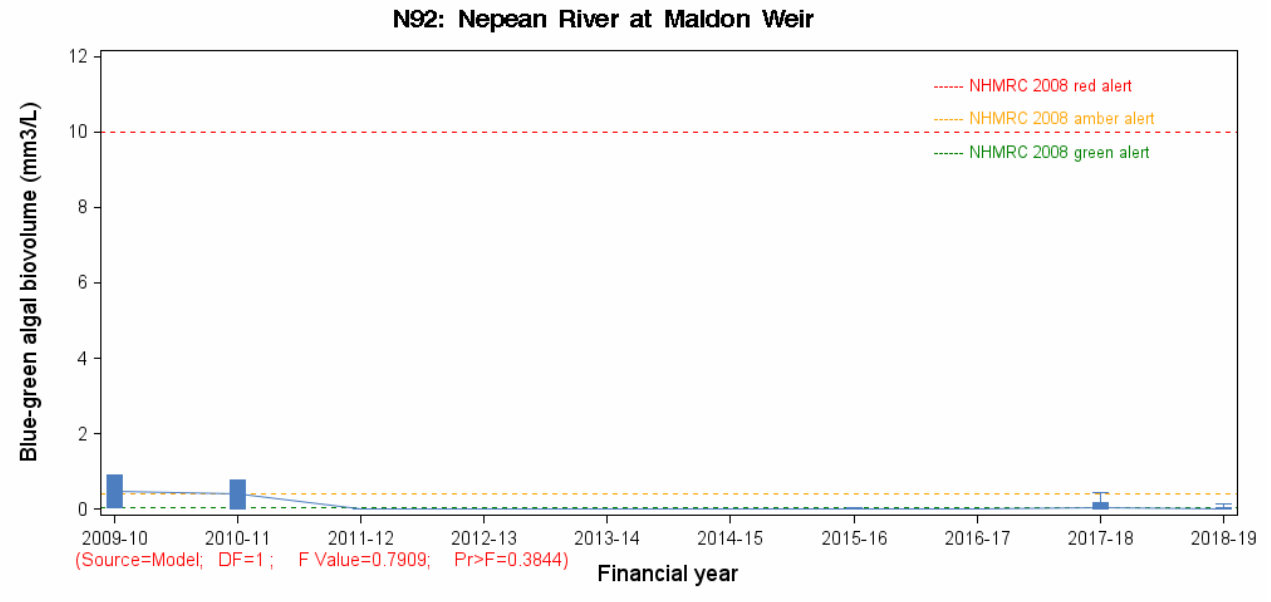


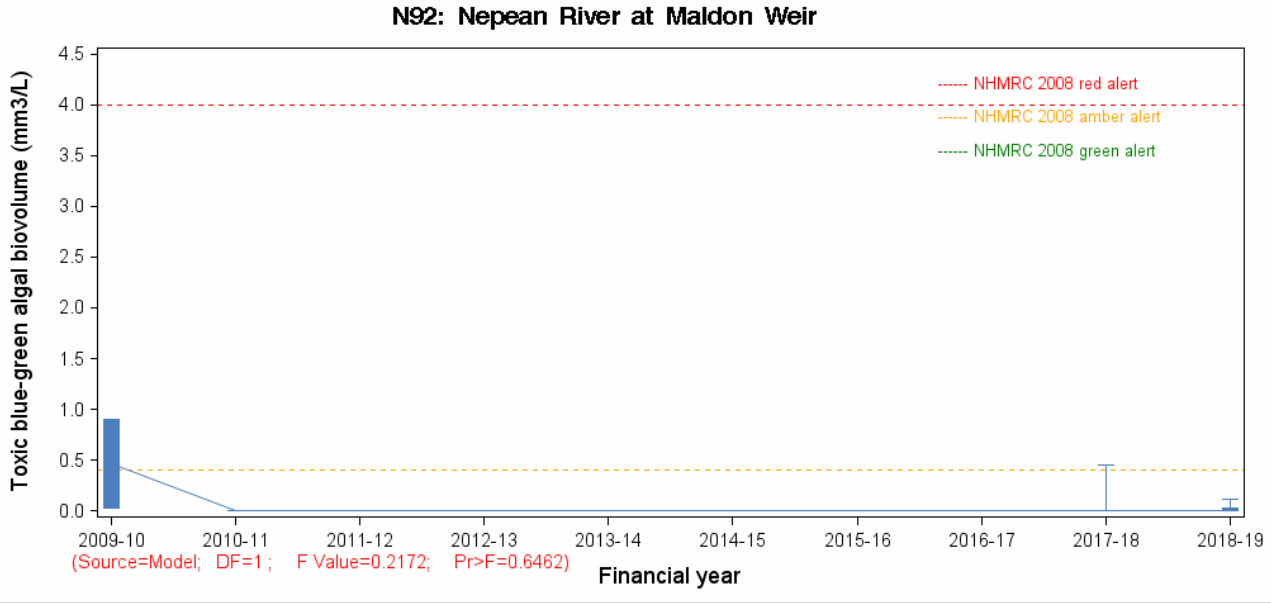

N92: Nepean River at Maldon Weir
Filterable total phosphorus (mg/L)
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

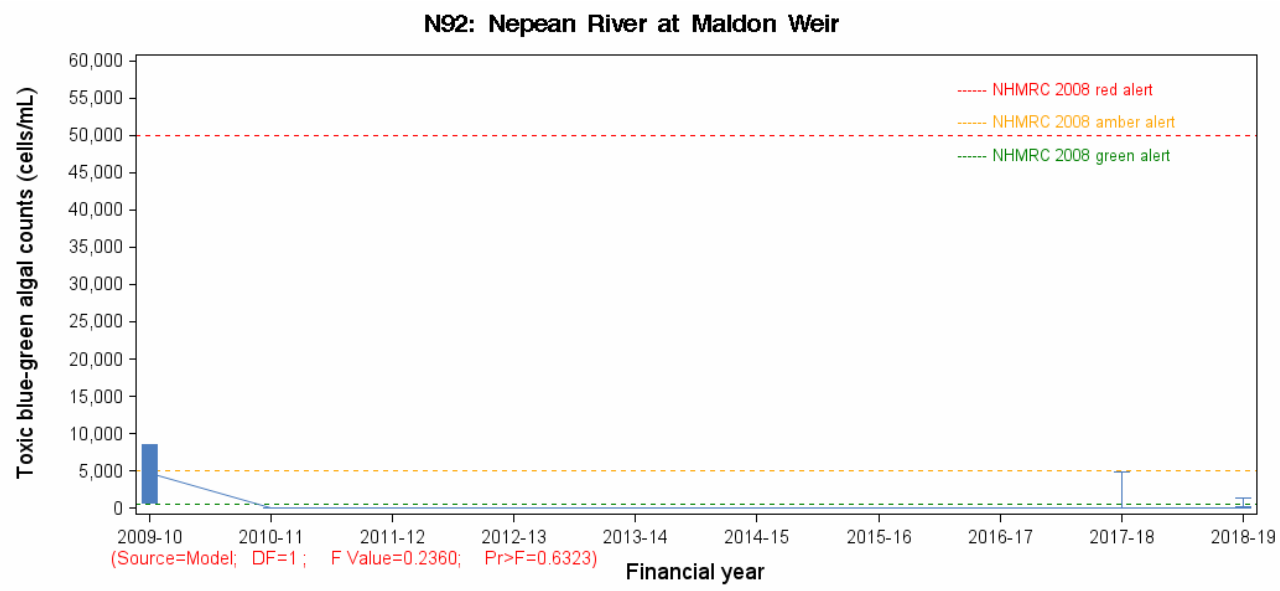

N92: Nepean River at Maldon Weir
Total phosphorus (mg/L)
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
----- HRC 1998
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year


N92: Nepean River at Maldon Weir
Chlorophyll-a (ug/L)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
----- HRC 1998
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

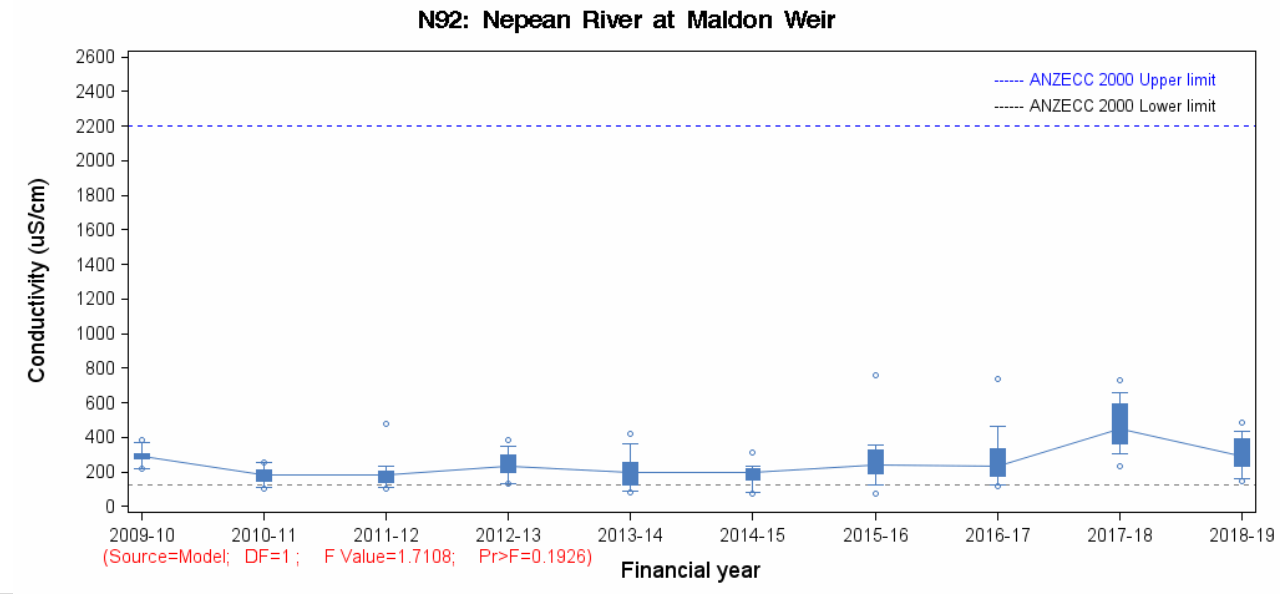

N92: Nepean River at Maldon Weir
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
18
20
22
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

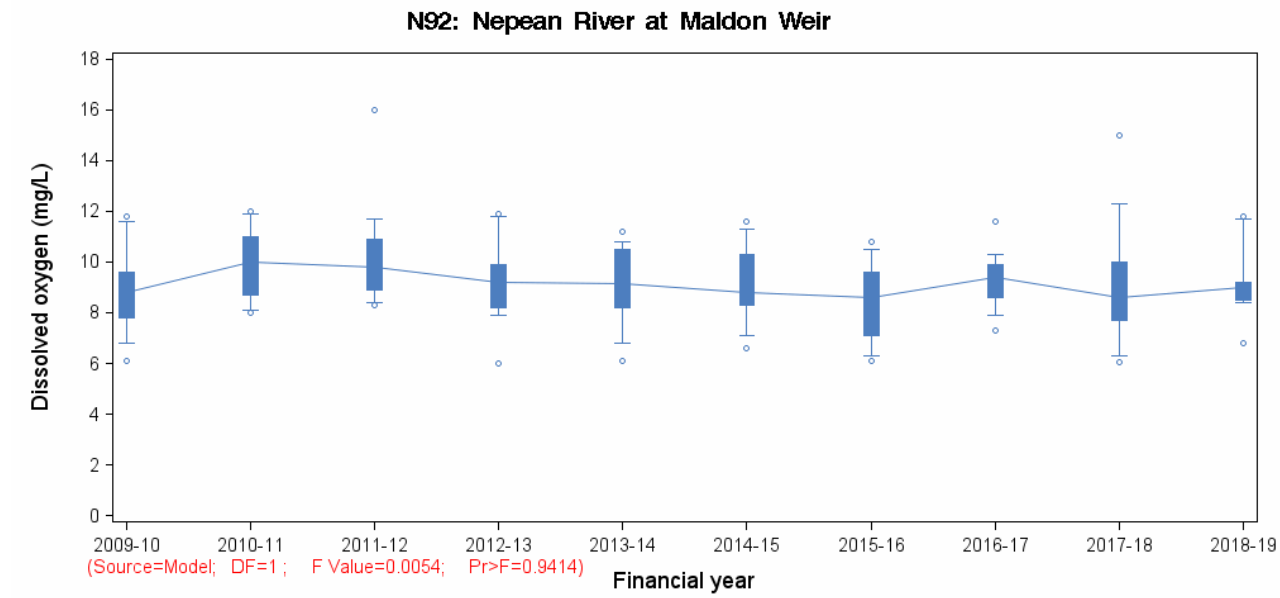

N92: Nepean River at Maldon Weir
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

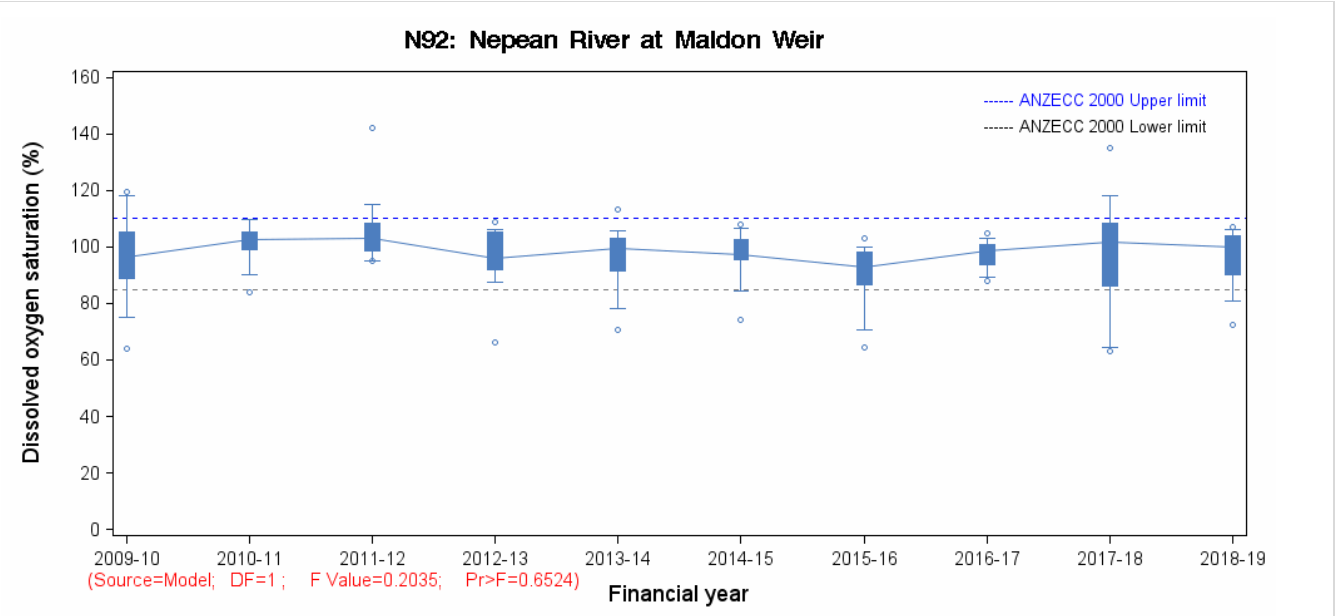

N92: Nepean River at Maldon Weir
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

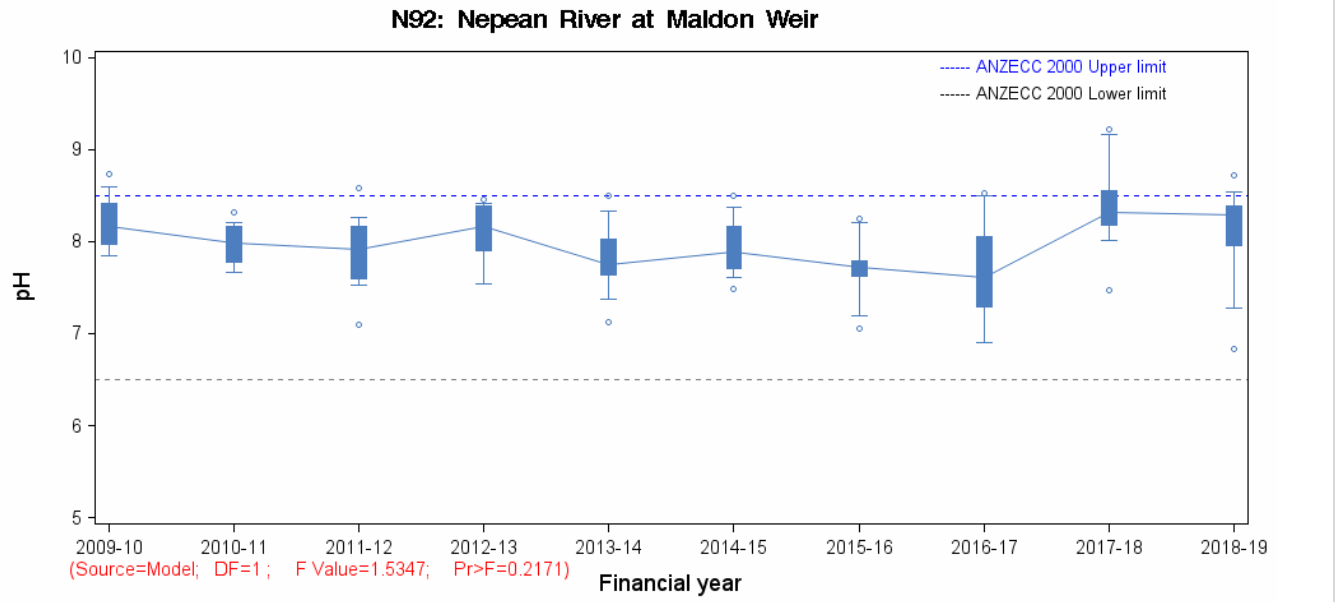


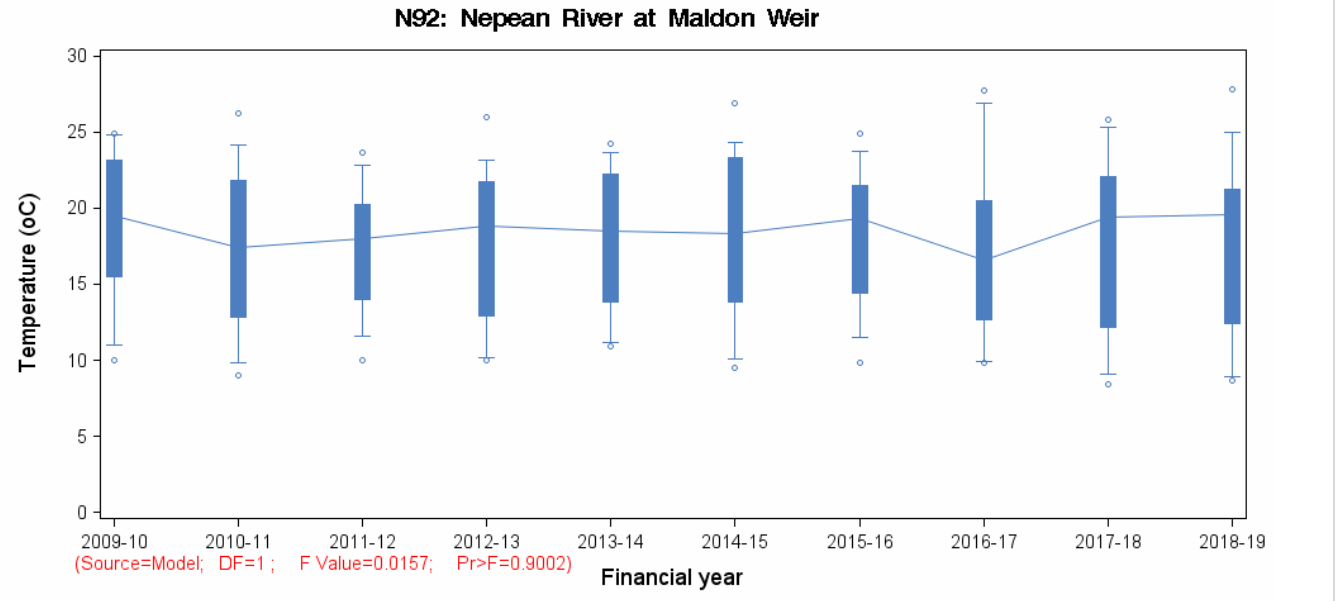
Other physico-chemical analytes

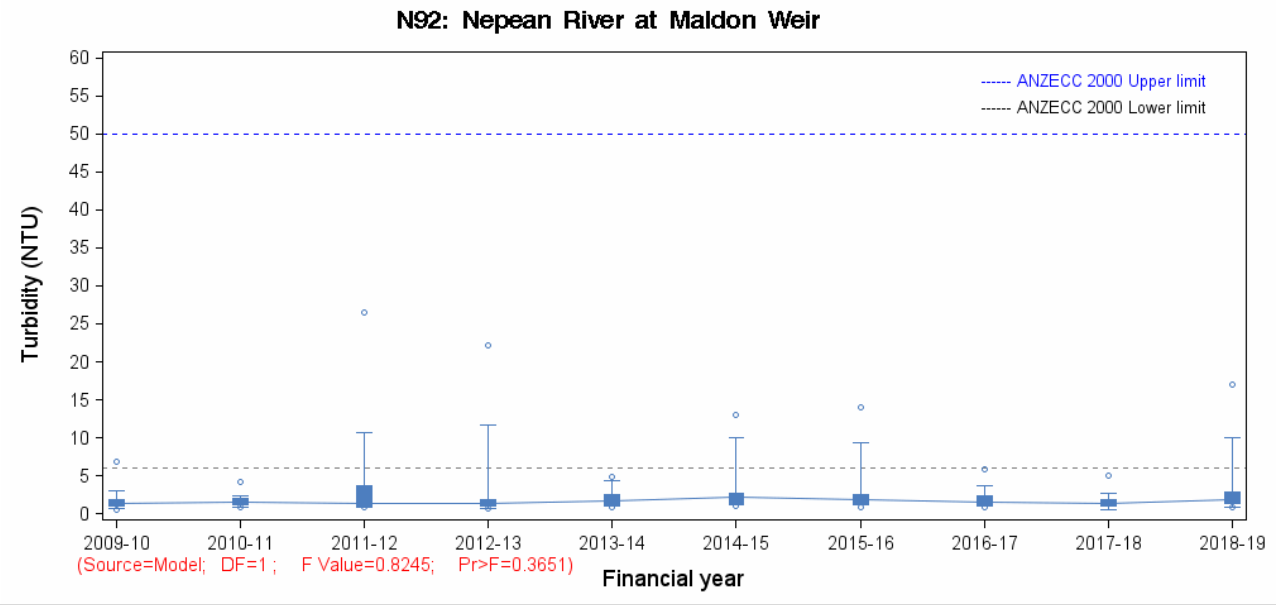


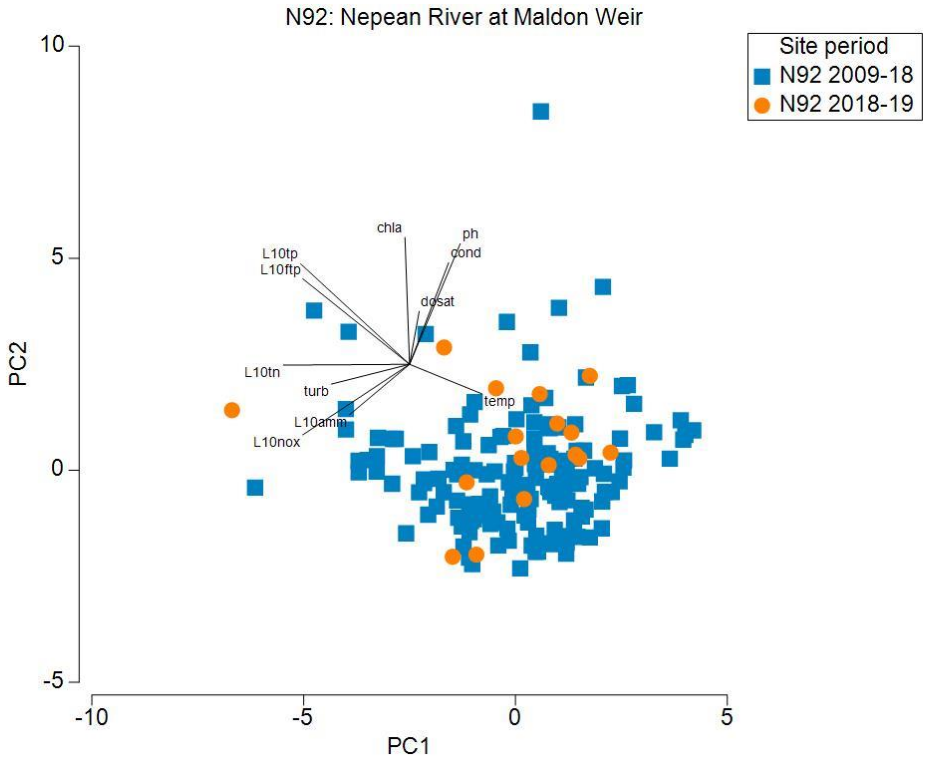



N92: Nepean River at Maldon Weir
Dissolved oxygen saturation (%)
160
140
120
100
80
60
40
20
0
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2035; Pr>F=0.6524)
Financial year


N92: Nepean River at Maldon Weir
pH
10
9
8
7
6
5
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.5347; Pr>F=0.2171)
Financial year


N92: Nepean River at Maldon Weir
Temperature (oC)
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0157; Pr>F=0.9002)
Financial year

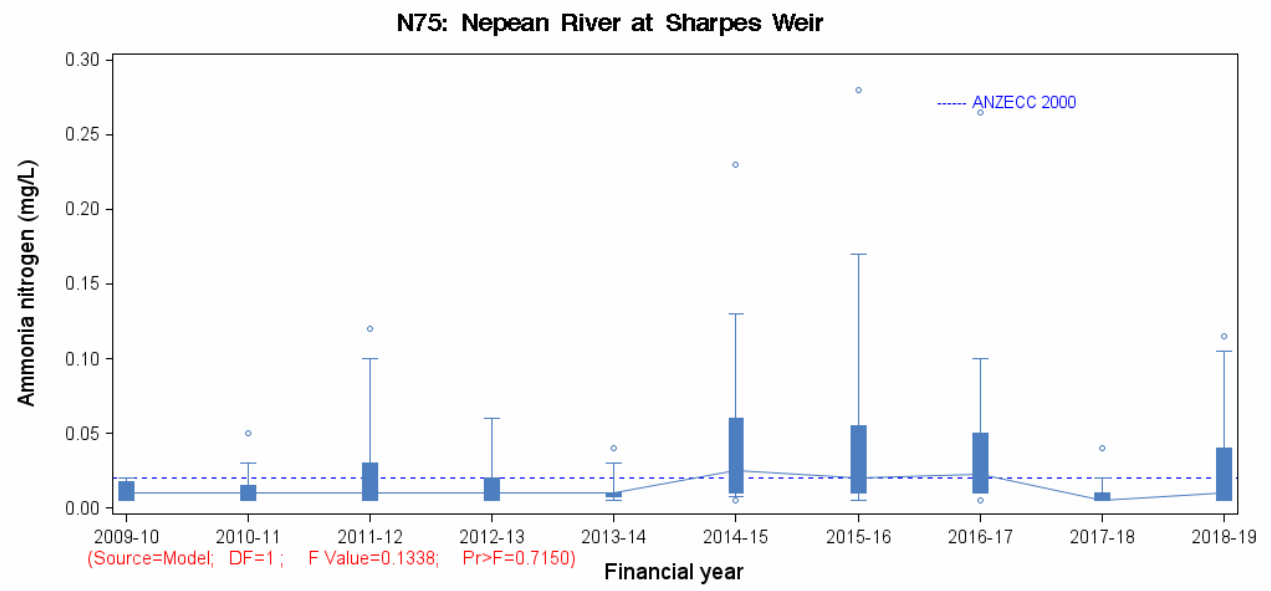


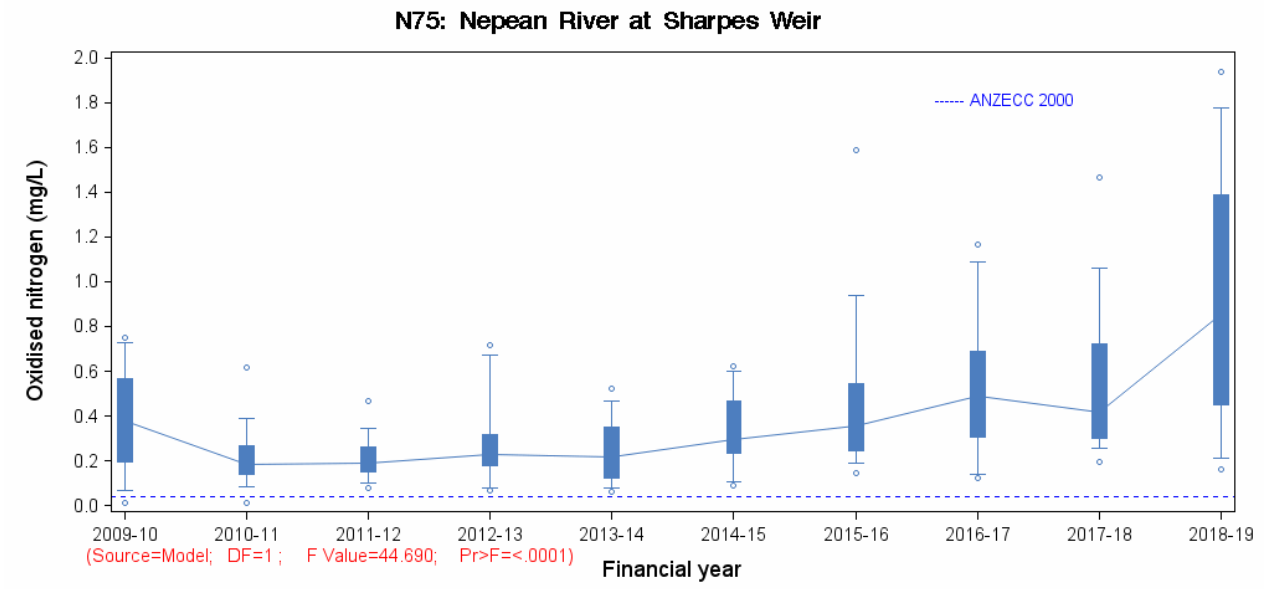


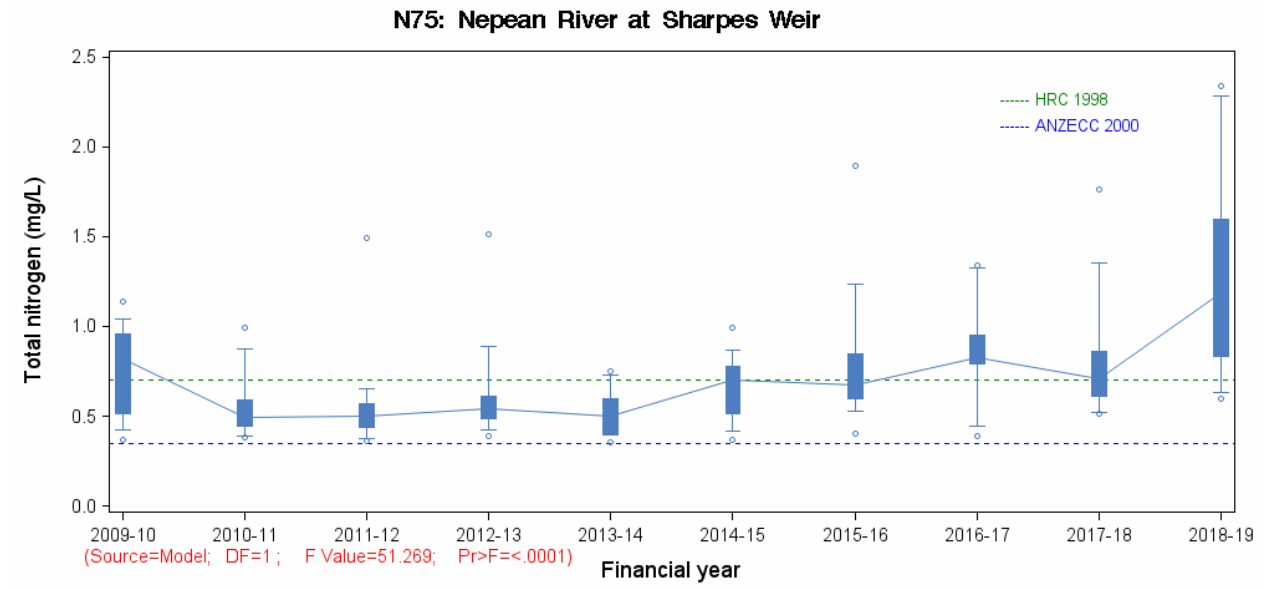
The ordination plot from Principal Components Analysis suggested water quality of the Nepean River at Maldon Weir in 2018-19 was similar in variability to that recorded in the period 2009 to 2018.

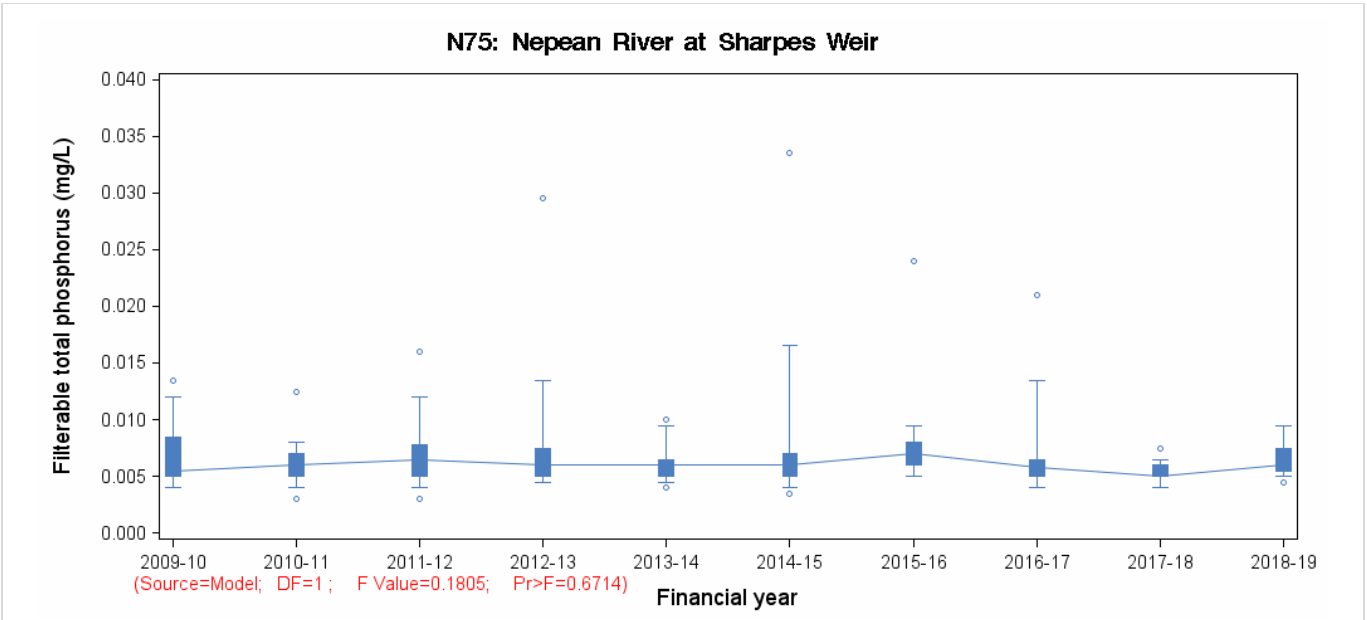
N75: Nepean River at Sharpes Weir

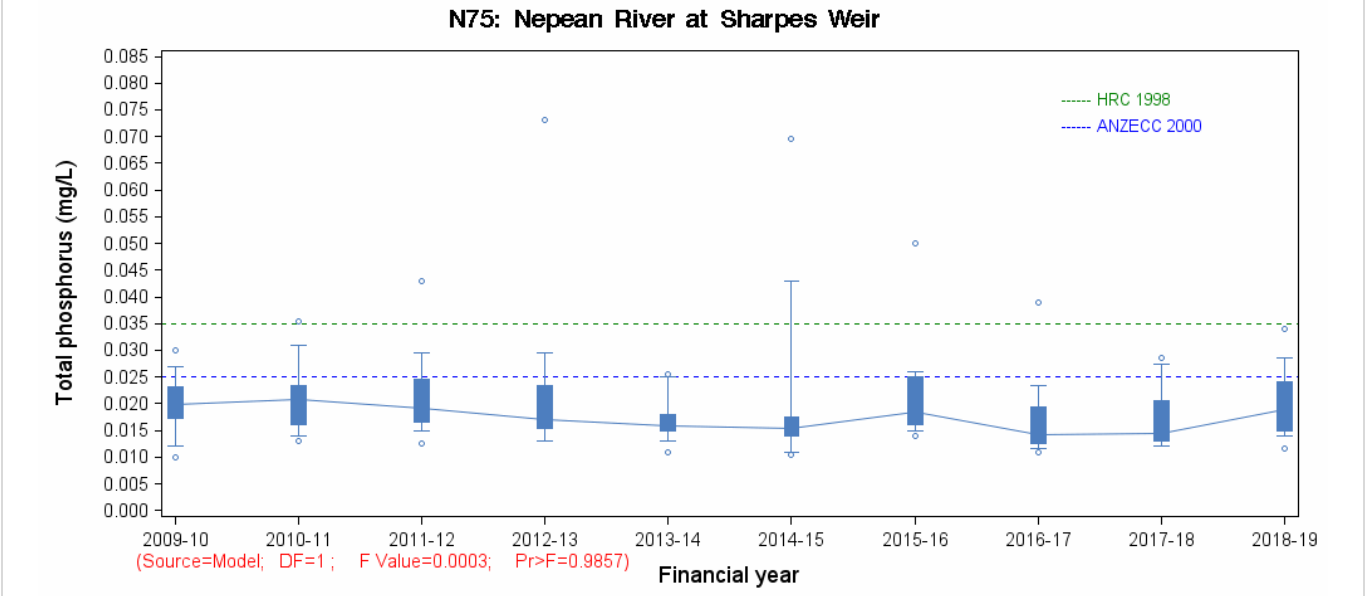
Nutrients, chlorophyll-*a* and algae

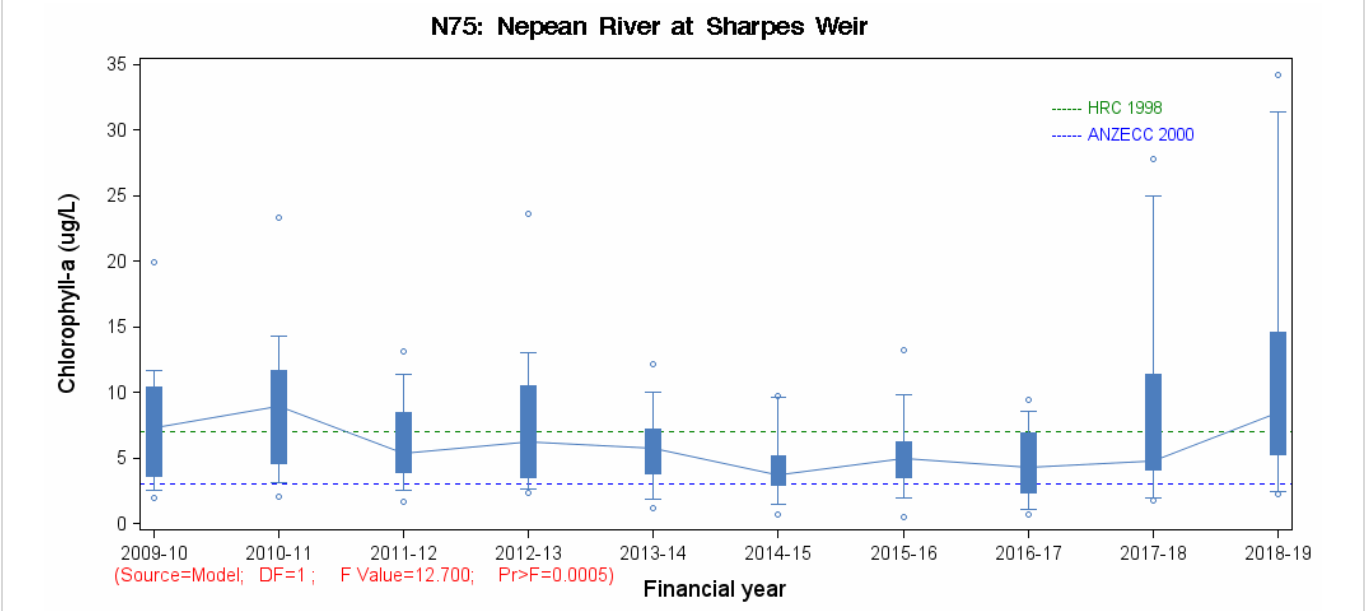


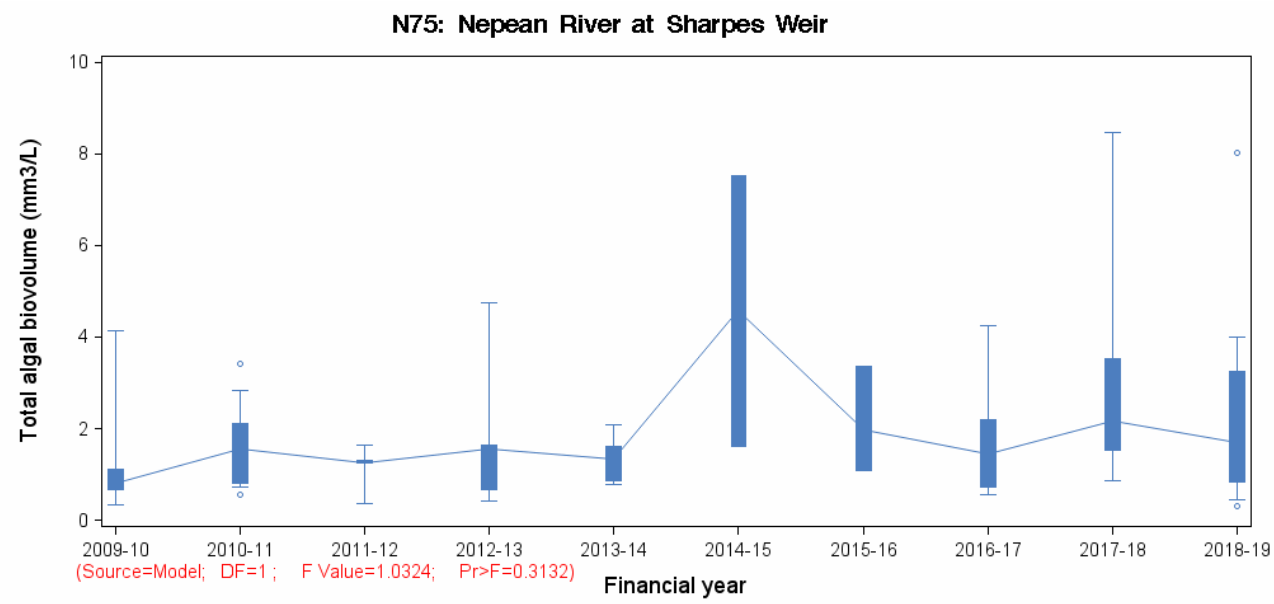


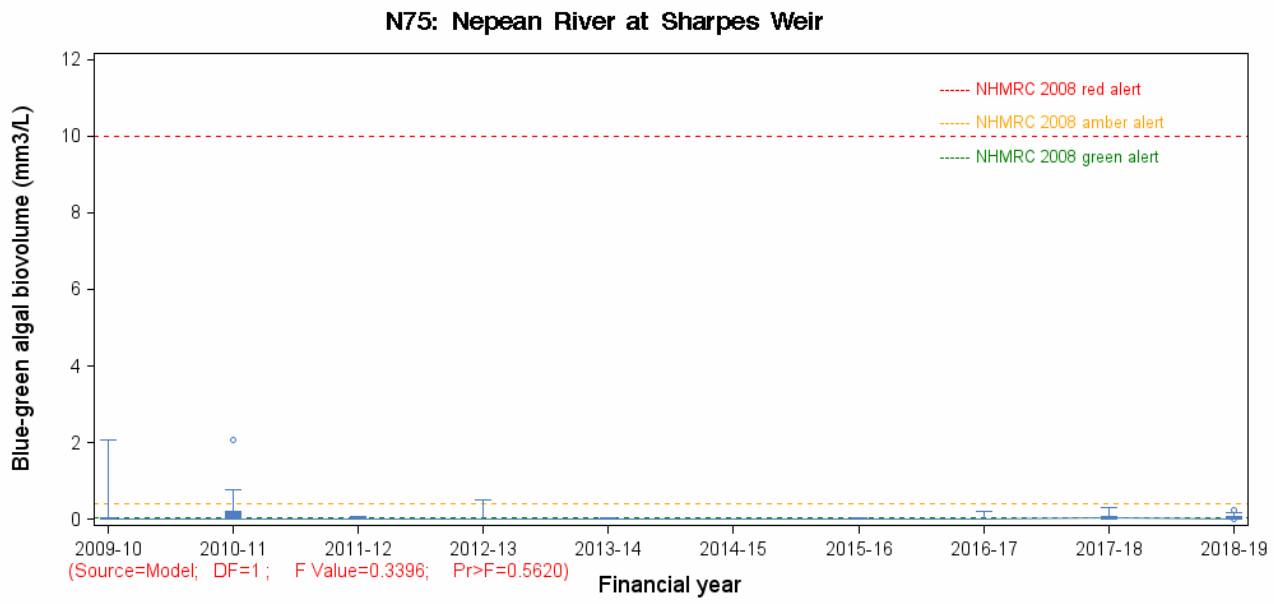


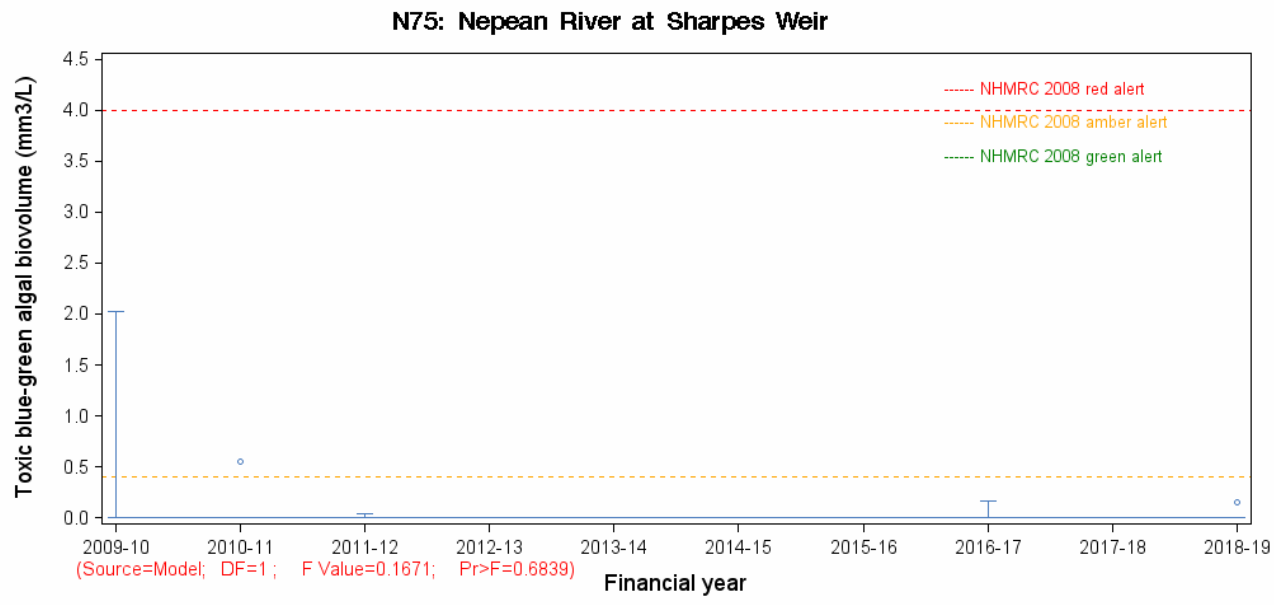

N75: Nepean River at Sharpes Weir
Filterable total phosphorus (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

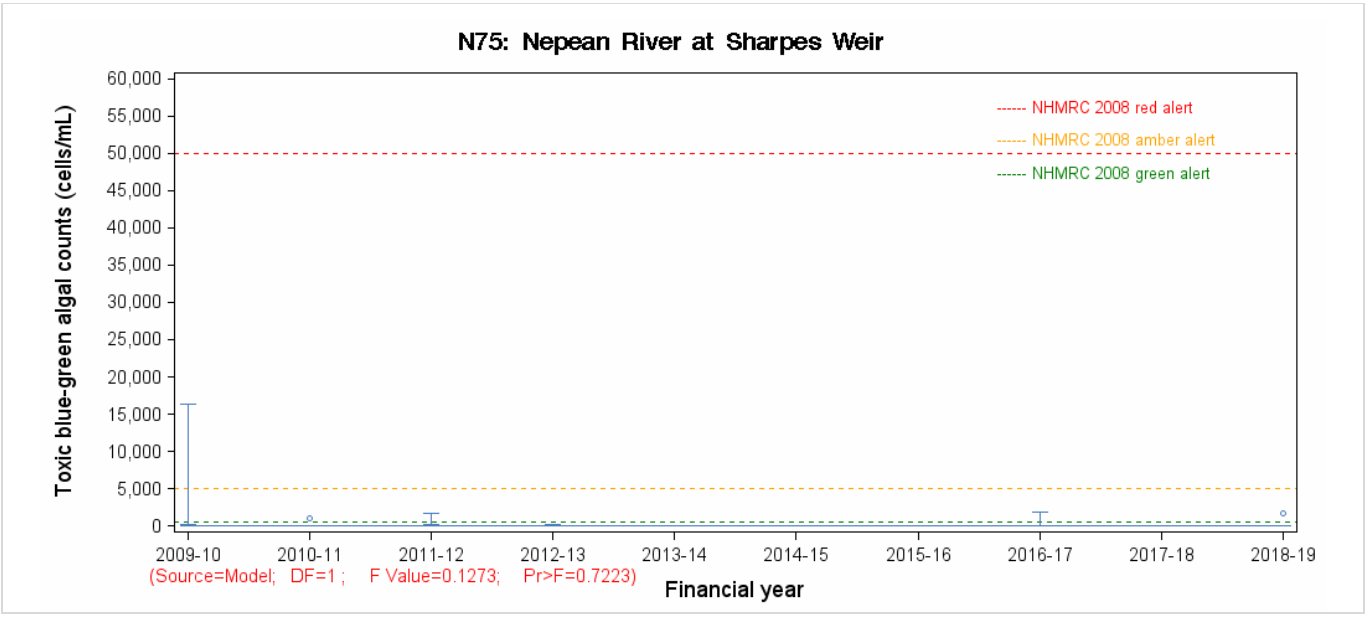

N75: Nepean River at Sharpes Weir
Total phosphorus (mg/L)
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0003; Pr>F=0.9857)
Financial year


N75: Nepean River at Sharpes Weir
Chlorophyll-a (ug/L)
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=12.700; Pr>F=0.0005)
Financial year

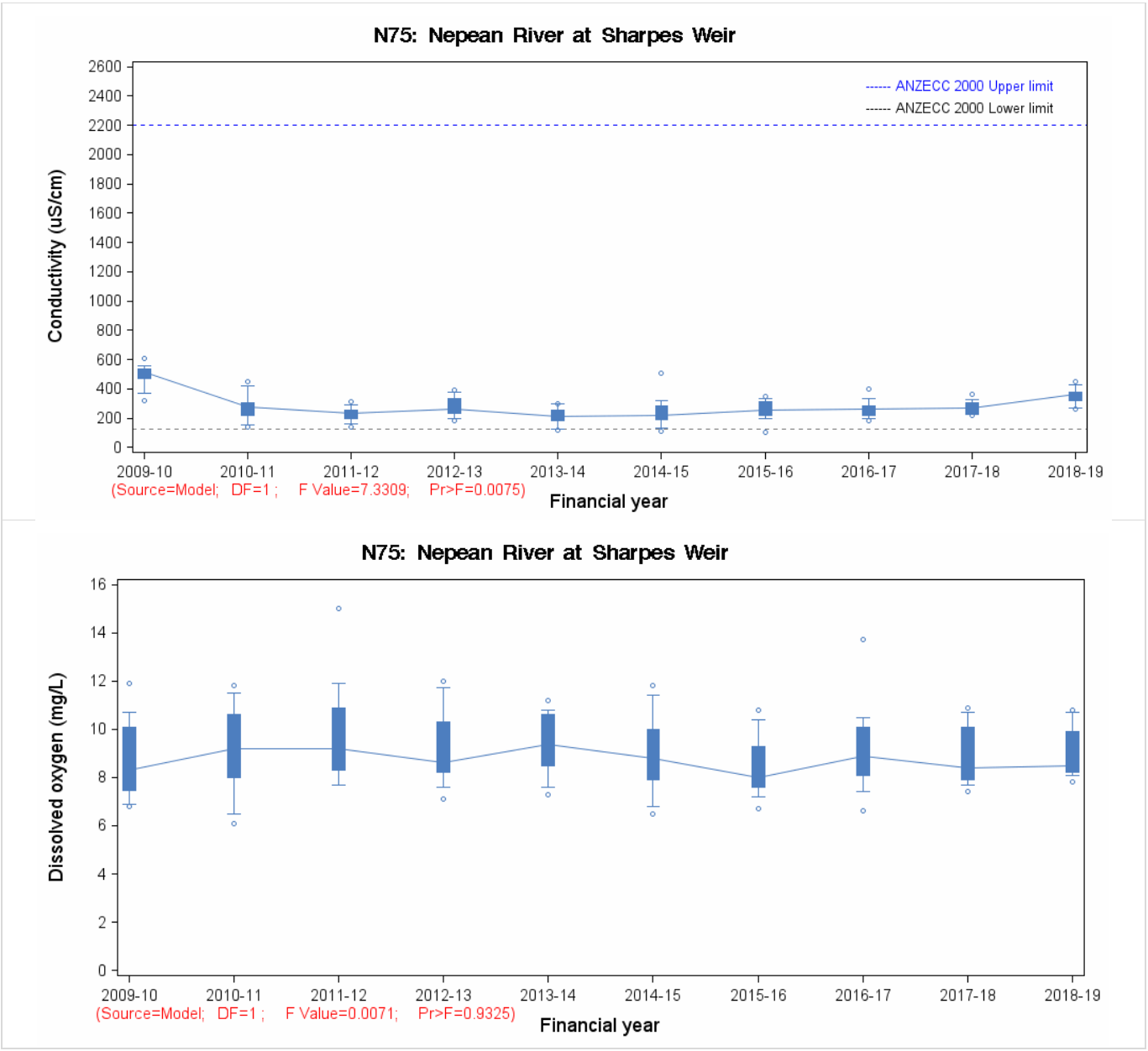

N75: Nepean River at Sharpes Weir
Total algal biovolume (mm3/L)
0
2
4
6
8
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.0324; Pr>F=0.3132)
Financial year

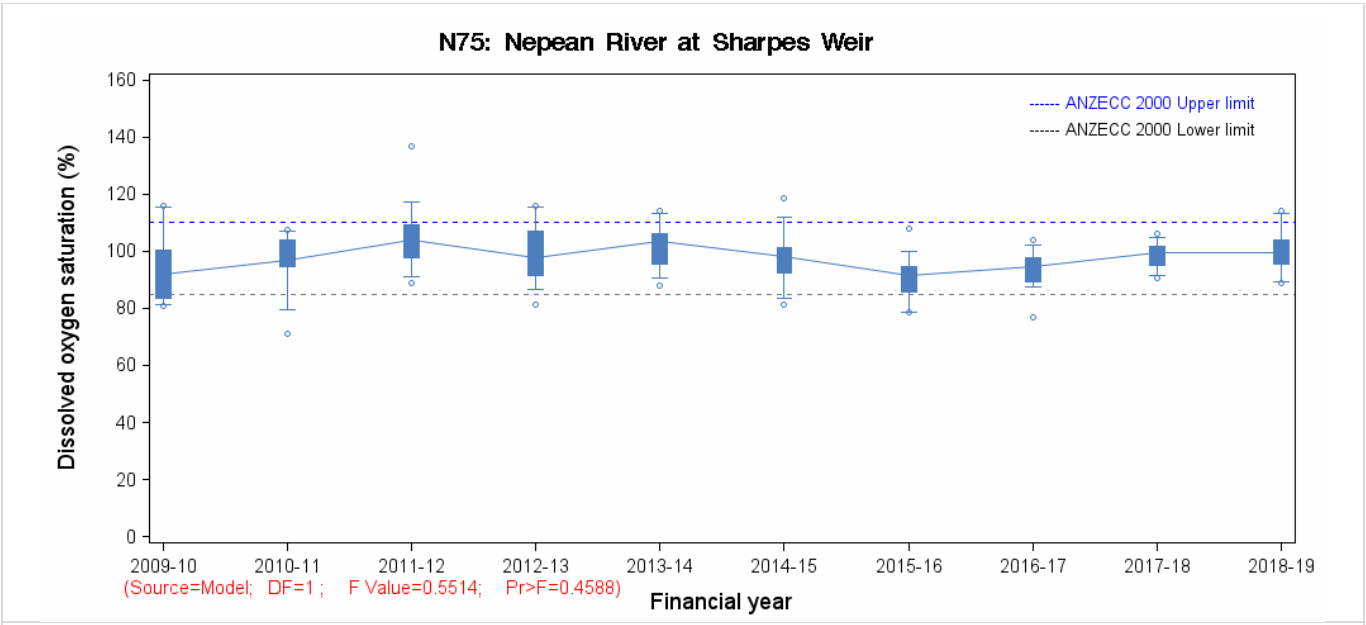

N75: Nepean River at Sharpes Weir
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3396; Pr>F=0.5620)
Financial year

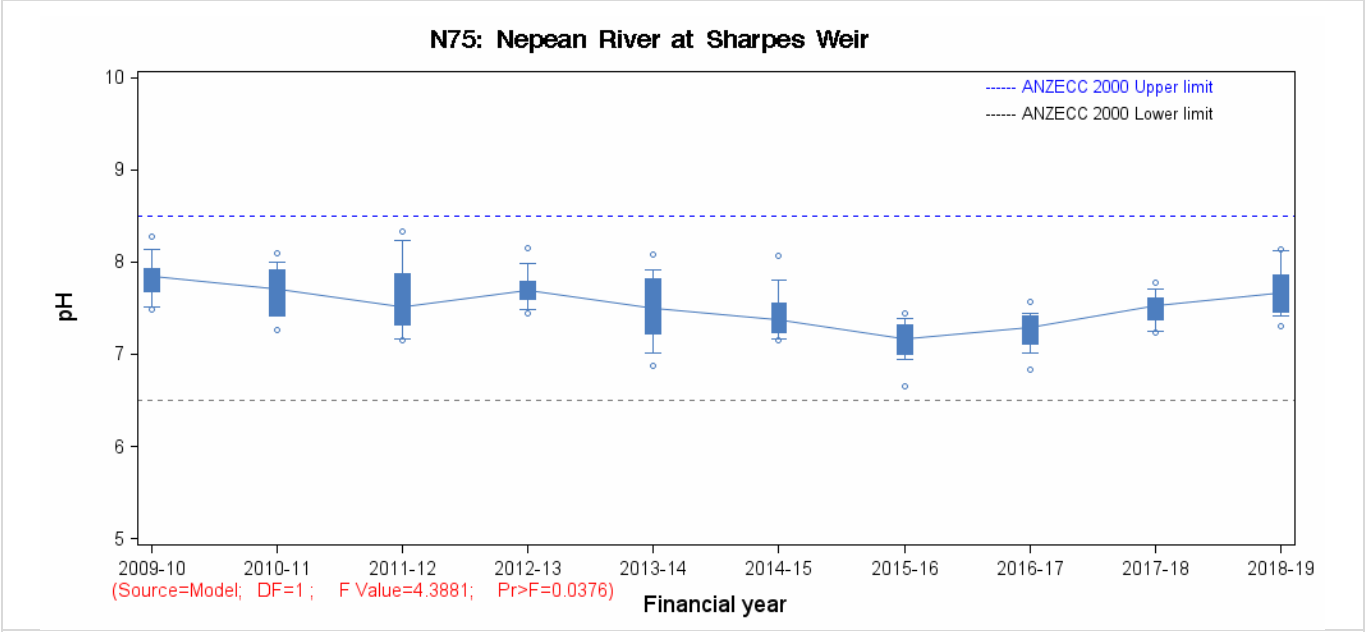

N75: Nepean River at Sharpes Weir
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1671; Pr>F=0.6839)
Financial year

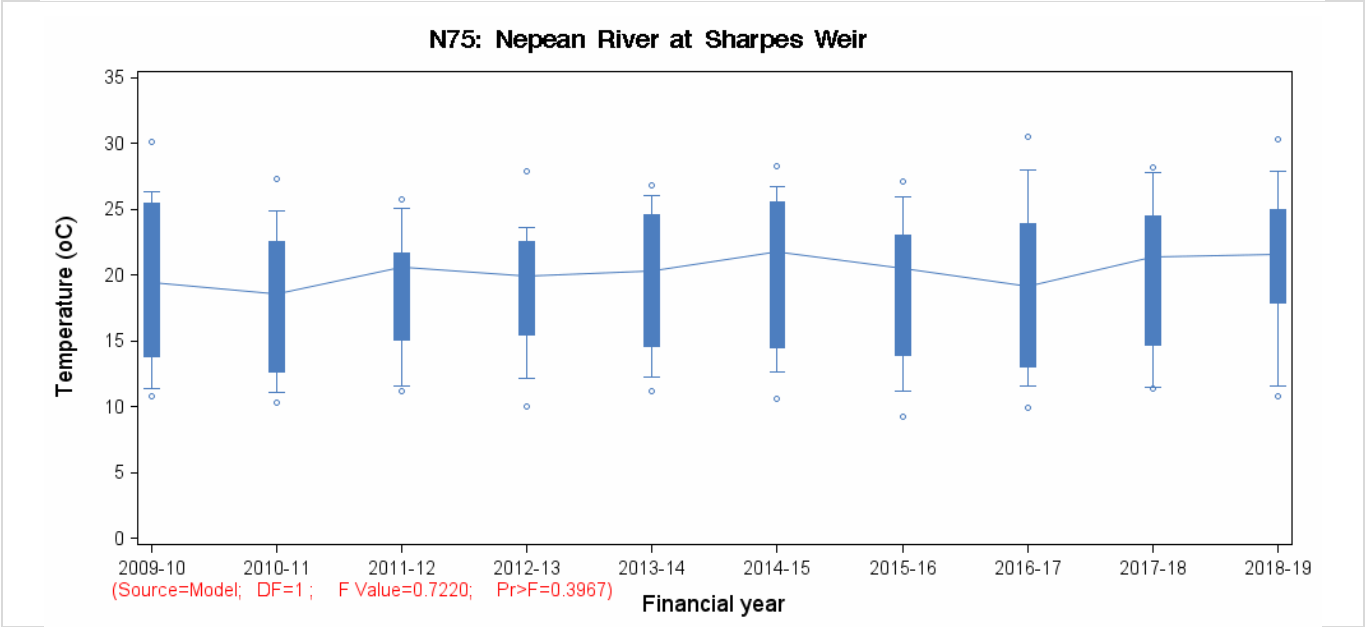


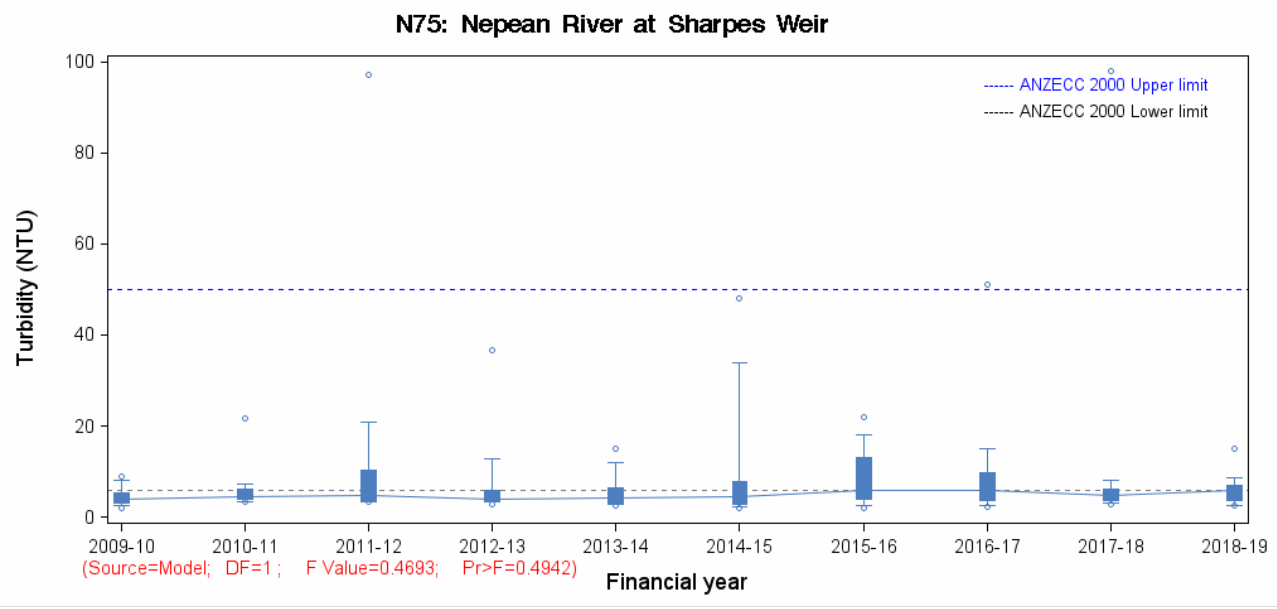
Other physico-chemical analytes

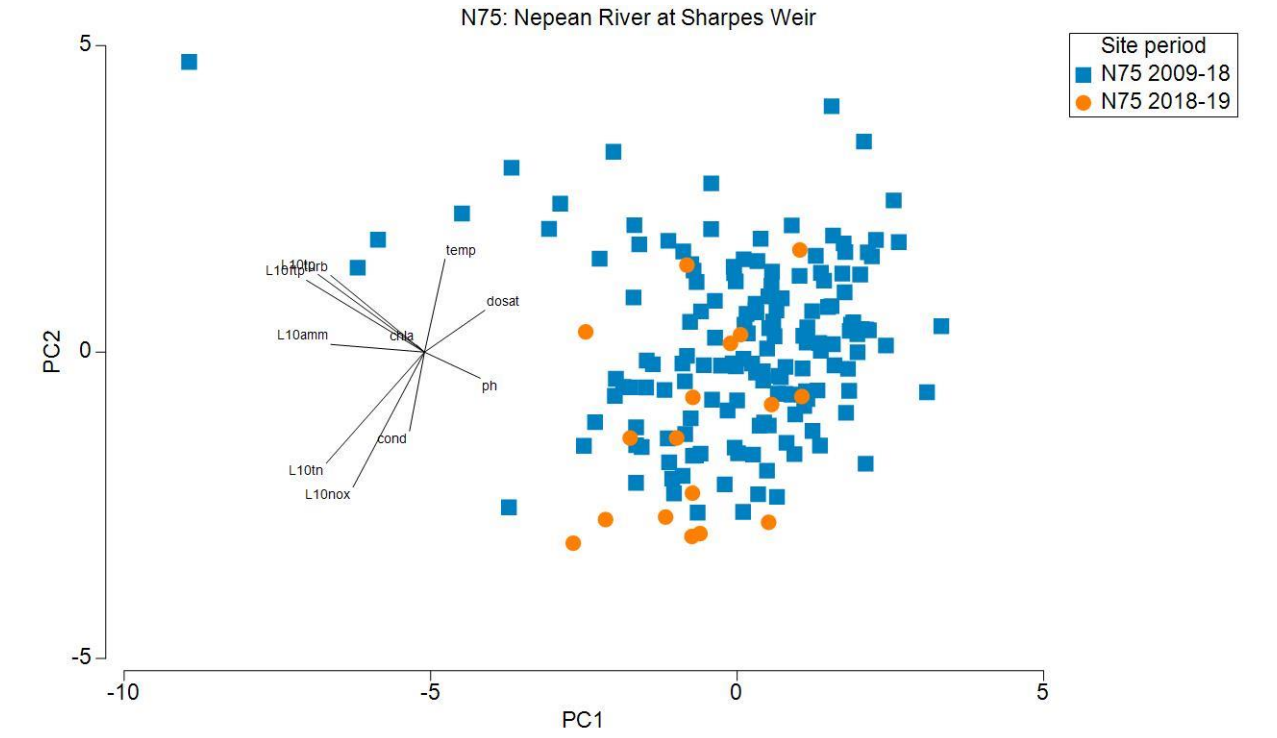



N75: Nepean River at Sharpes Weir
Dissolved oxygen saturation (%)
160
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5514; Pr>F=0.4588)
Financial year


N75: Nepean River at Sharpes Weir
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.3881; Pr>F=0.0376)
Financial year


N75: Nepean River at Sharpes Weir
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.7220; Pr>F=0.3967)
Financial year

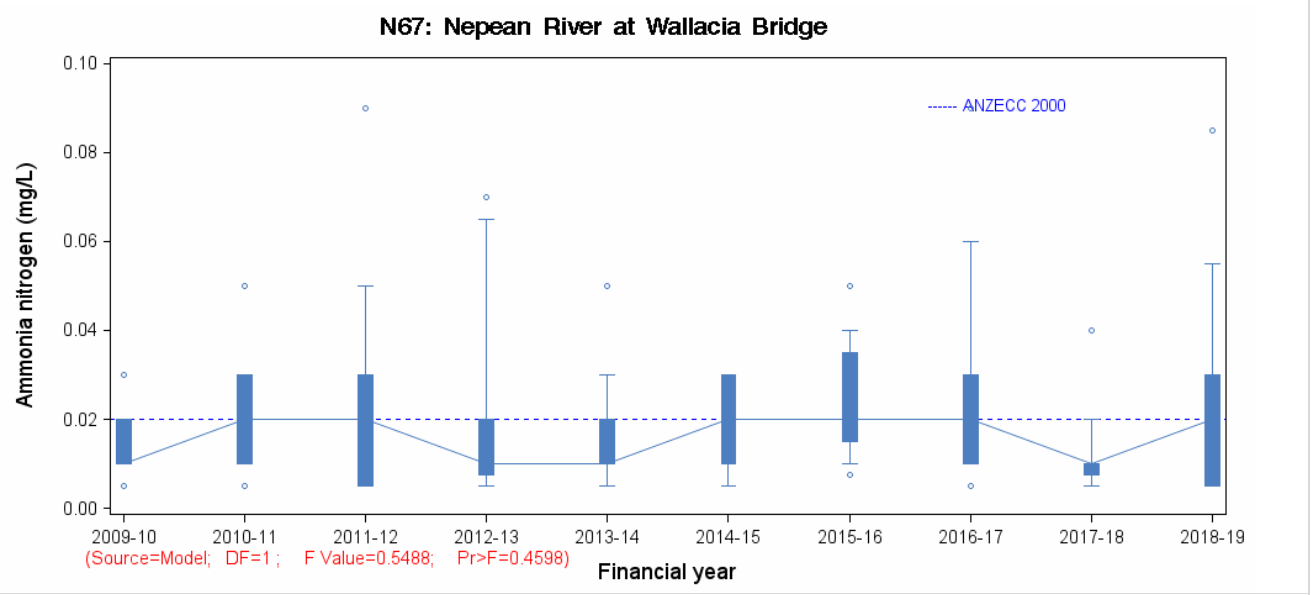


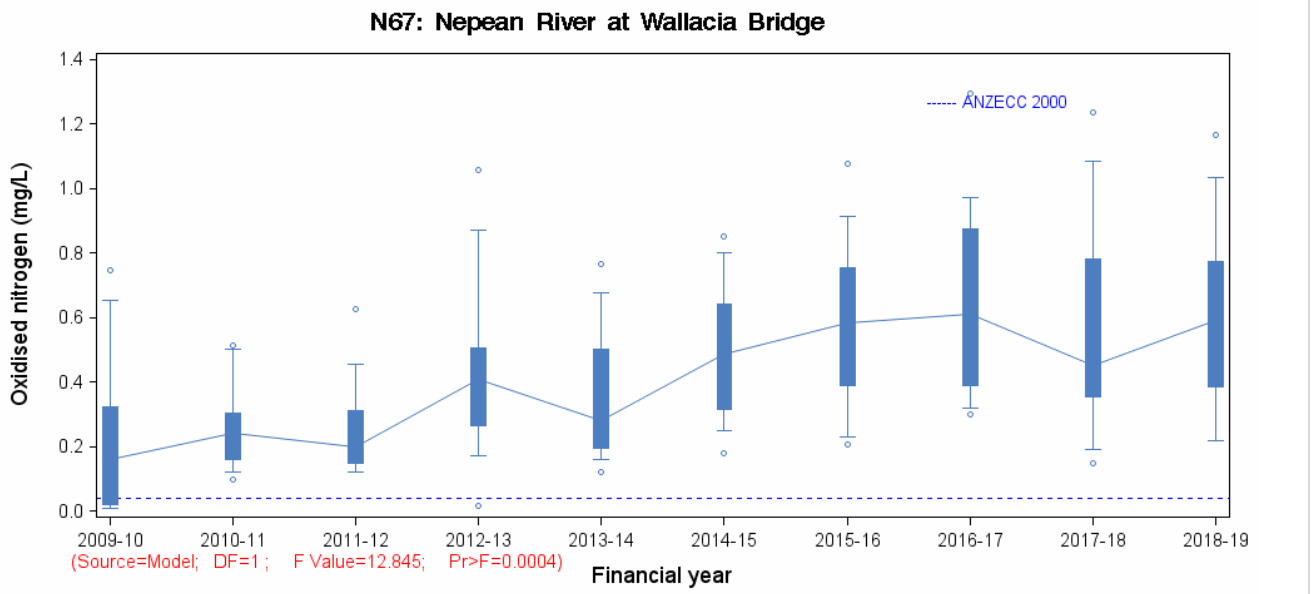


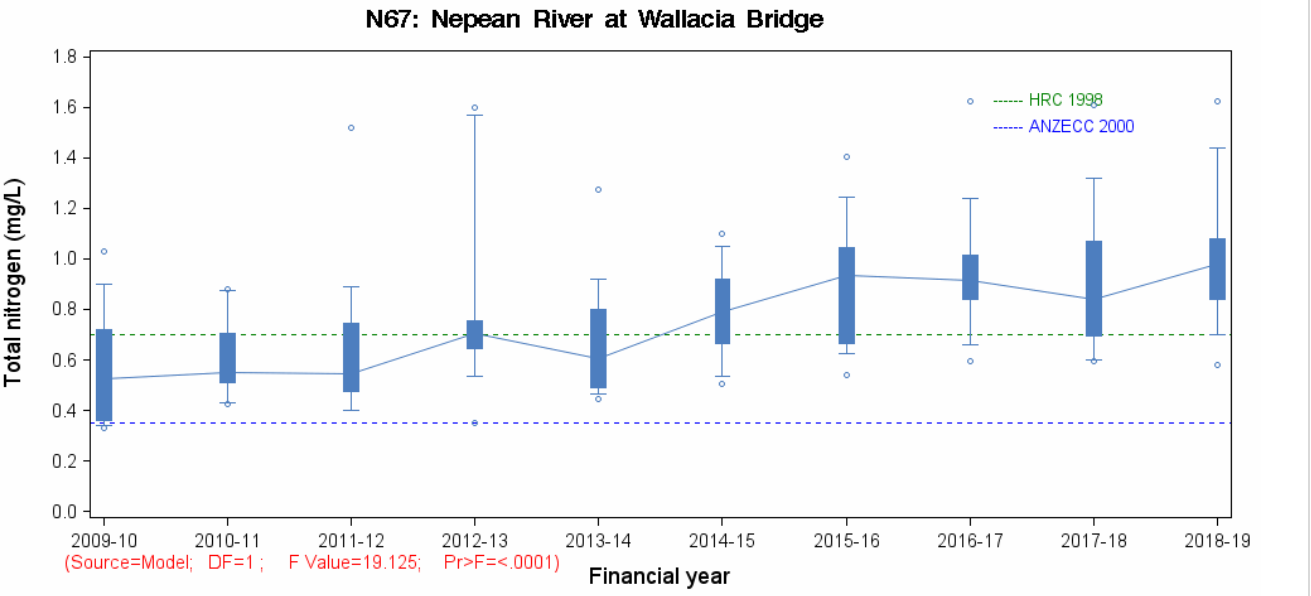
The ordination plot from Principal Components Analysis suggested water quality of the Nepean River at Sharpes Weir in 2018-19 was similar to that recorded in the period 2009 to 2018.

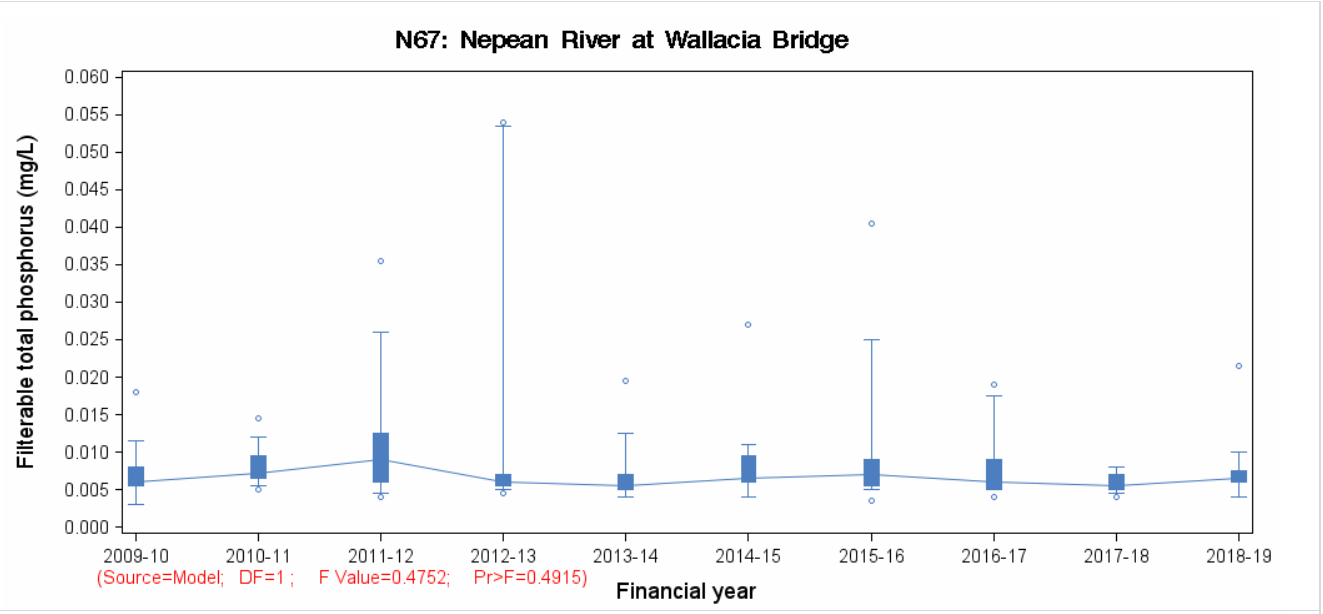
N67: Nepean River at Wallacia Bridge

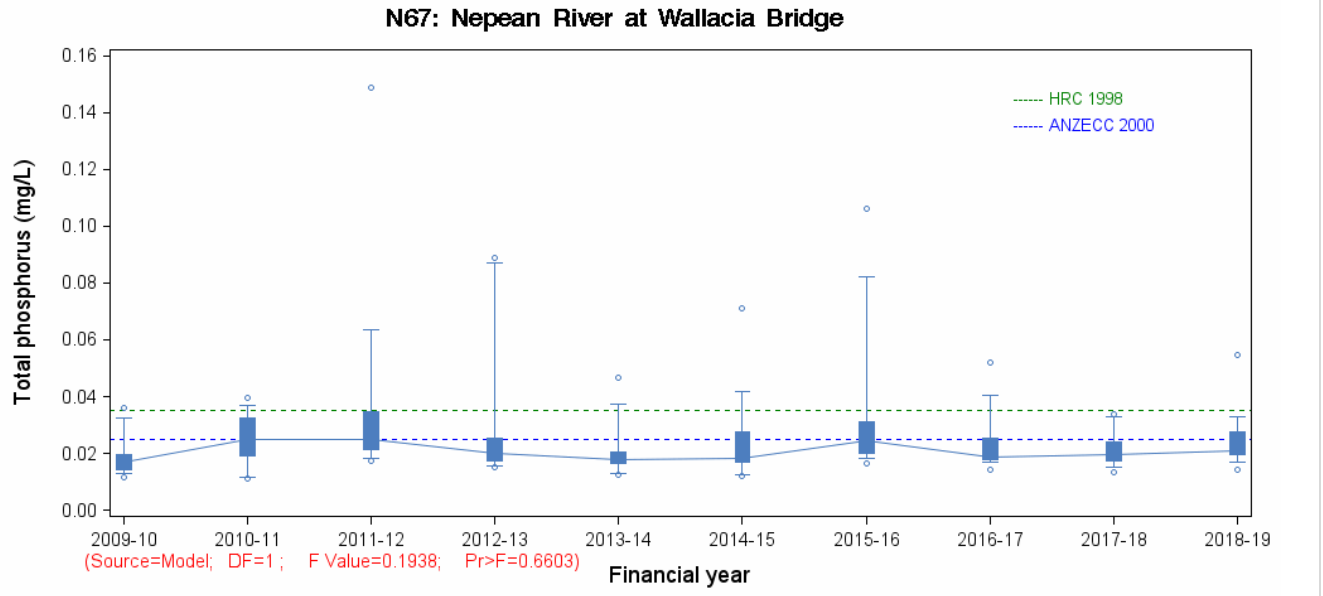
Nutrients, chlorophyll-*a* and algae

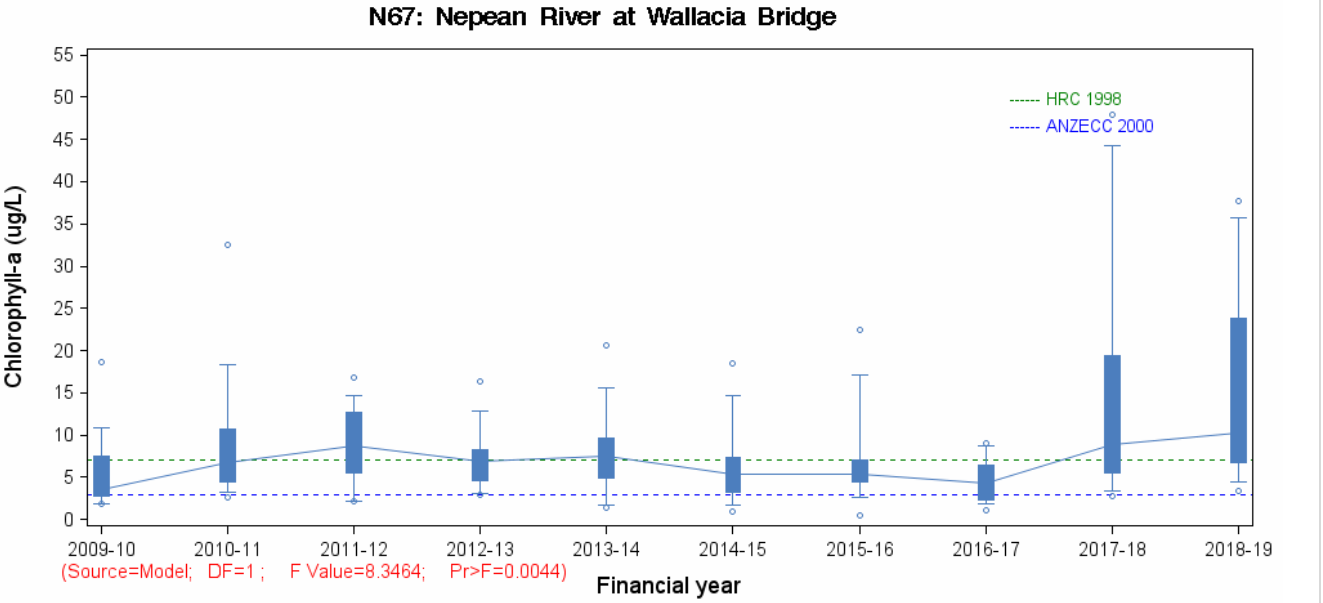


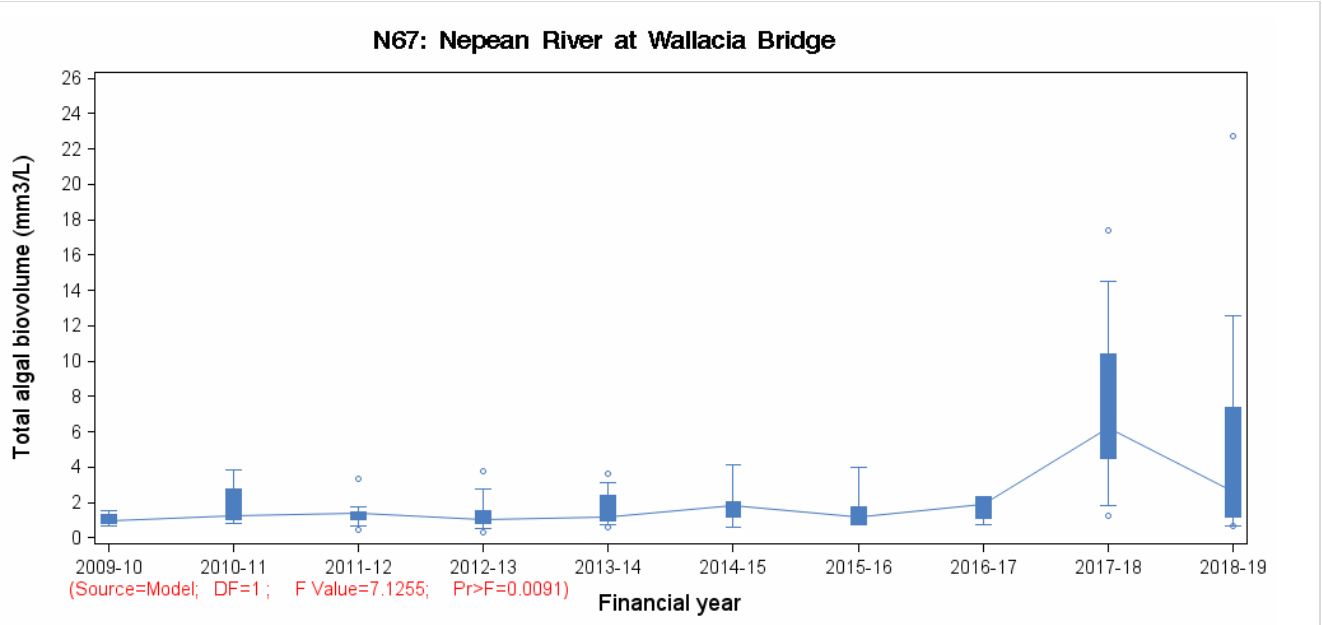


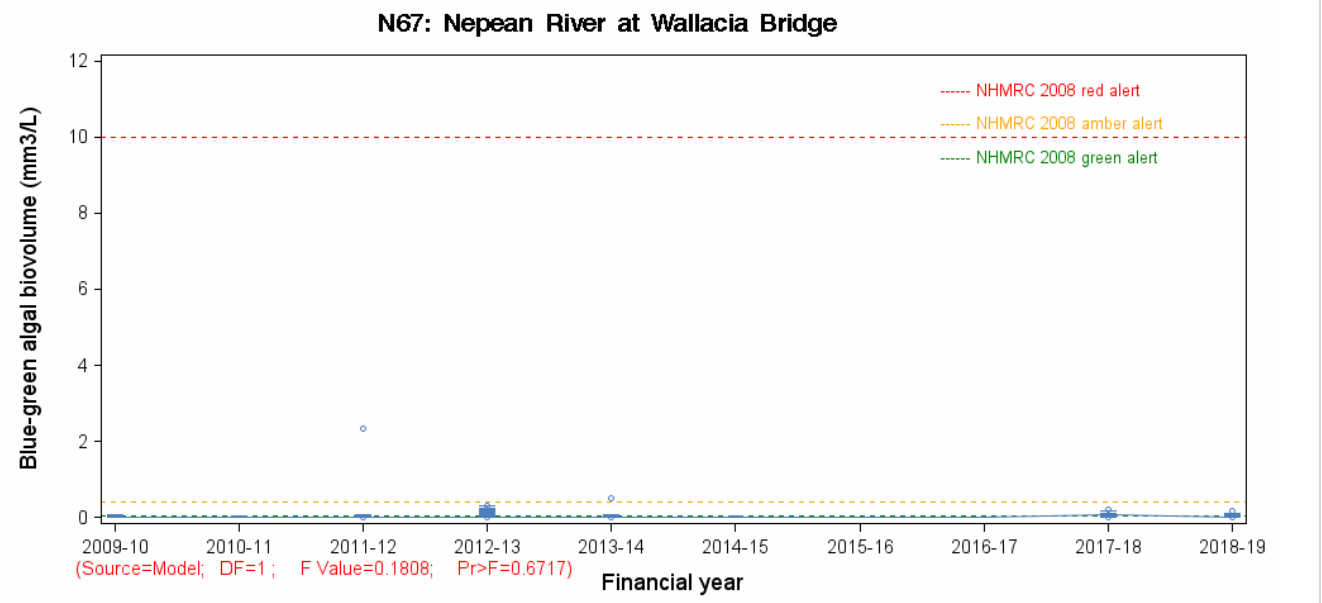


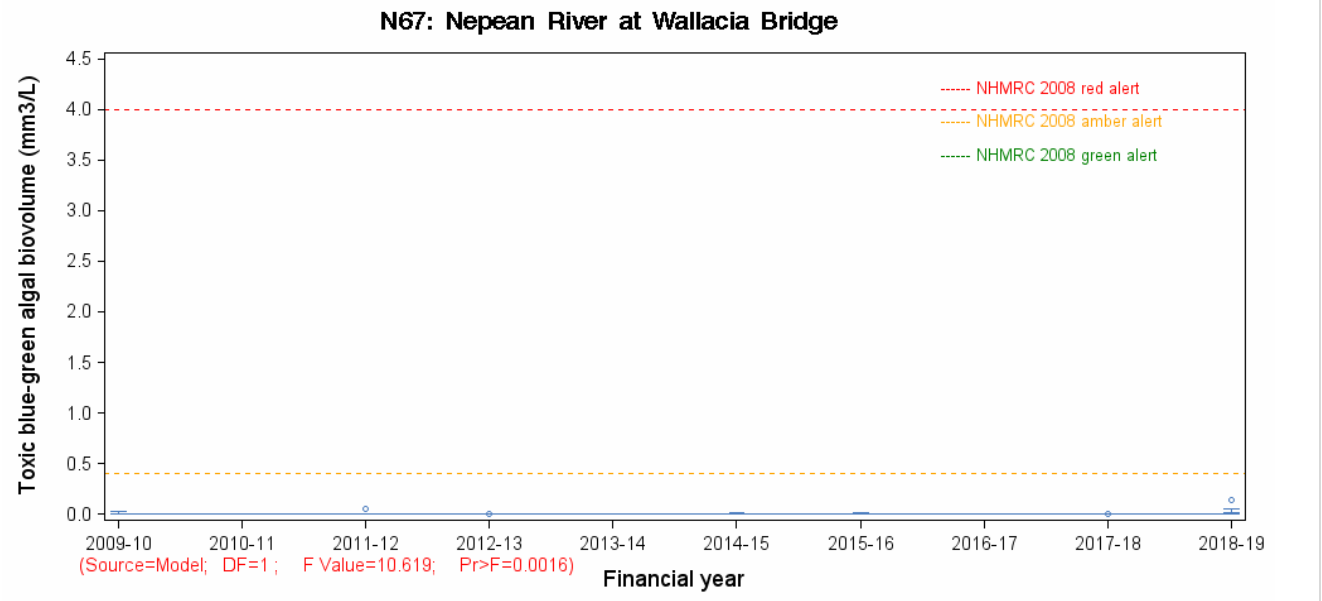

N67: Nepean River at Wallacia Bridge
Filterable total phosphorus (mg/L)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.4752; Pr>F=0.4915)
Financial year

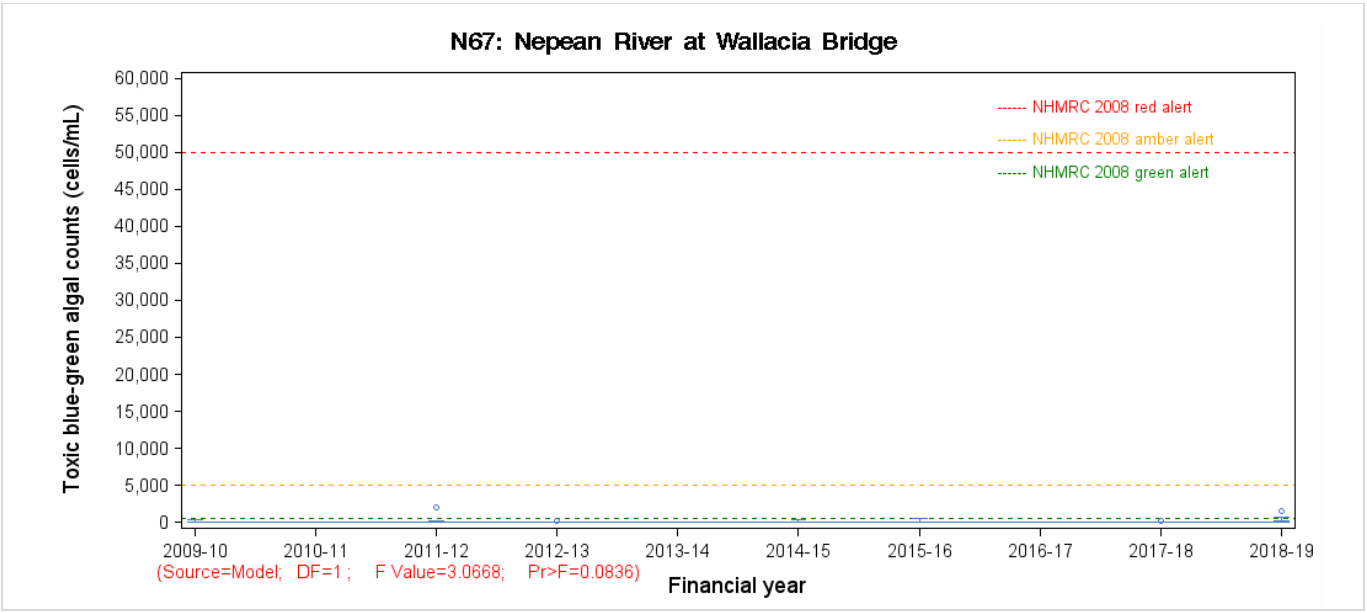

N67: Nepean River at Wallacia Bridge
Total phosphorus (mg/L)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1938; Pr>F=0.6603)
Financial year


N67: Nepean River at Wallacia Bridge
Chlorophyll-a (ug/L)
55
50
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=8.3464; Pr>F=0.0044)
Financial year

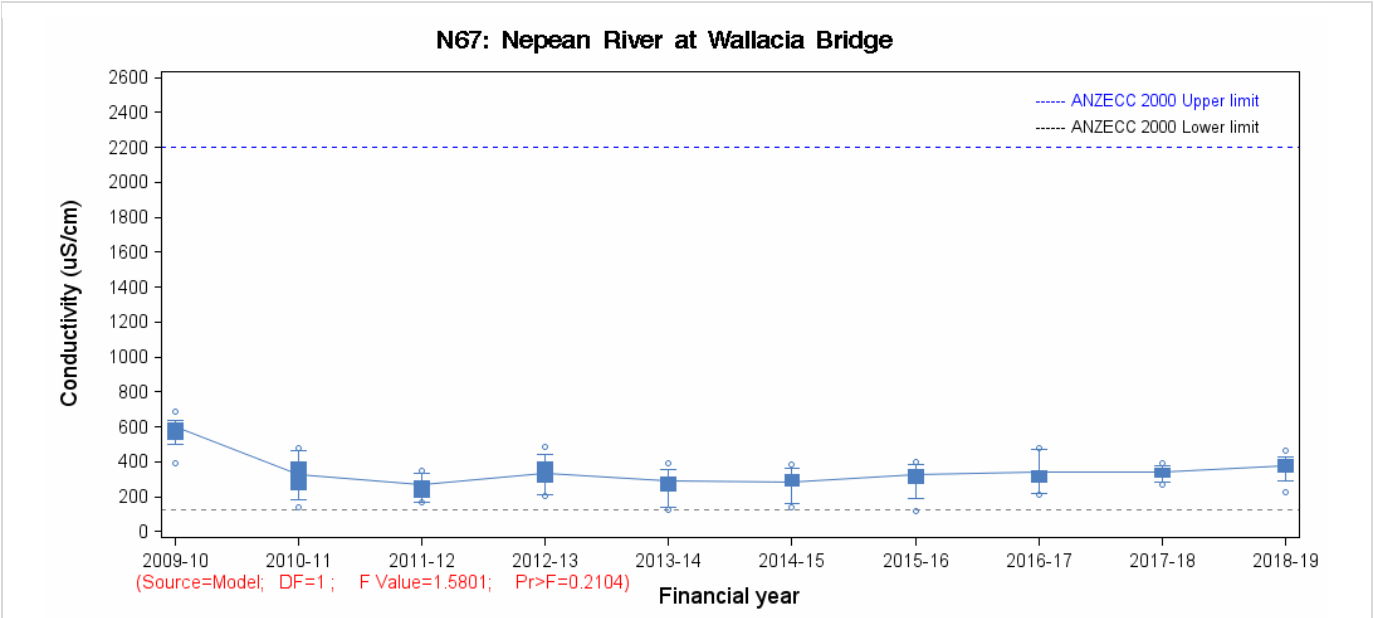

N67: Nepean River at Wallacia Bridge
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.1255; Pr>F=0.0091)
Financial year

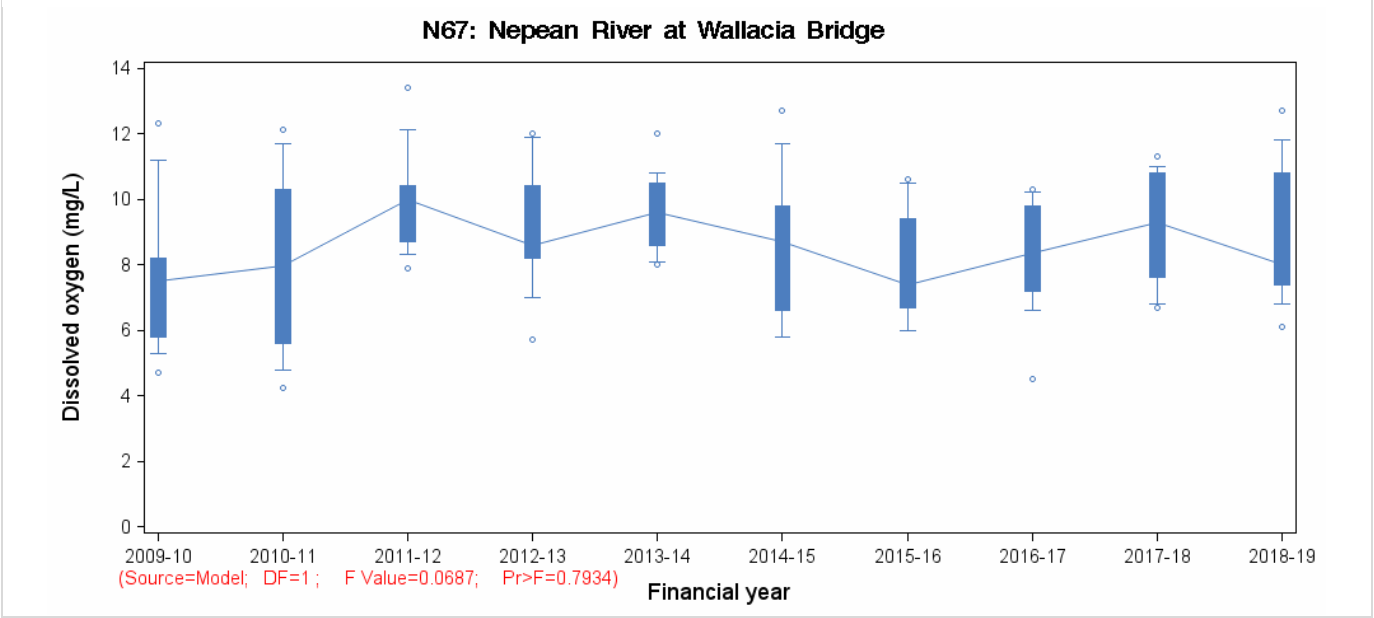

N67: Nepean River at Wallacia Bridge
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1808; Pr>F=0.6717)
Financial year

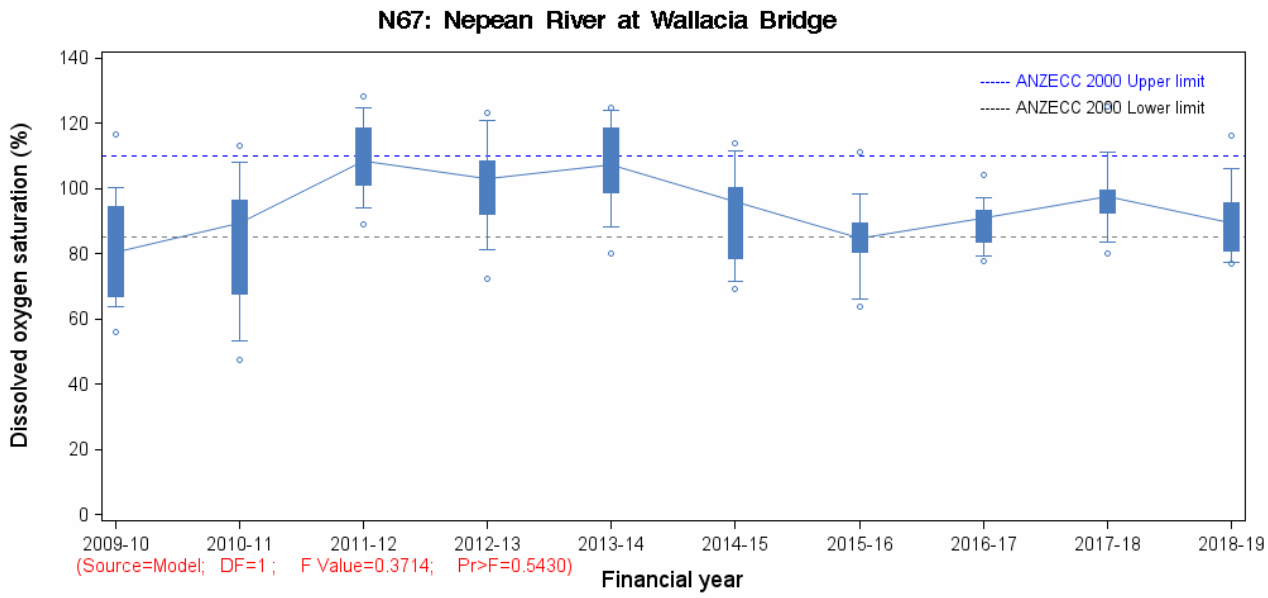

N67: Nepean River at Wallacia Bridge
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=10.619; Pr>F=0.0016)
Financial year

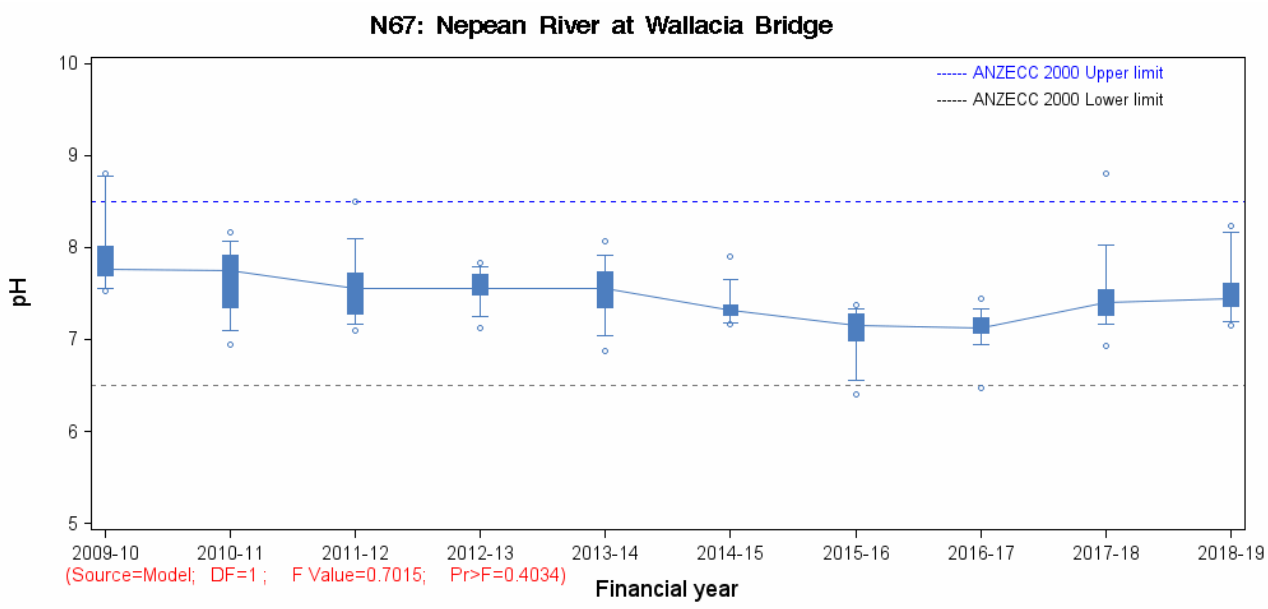


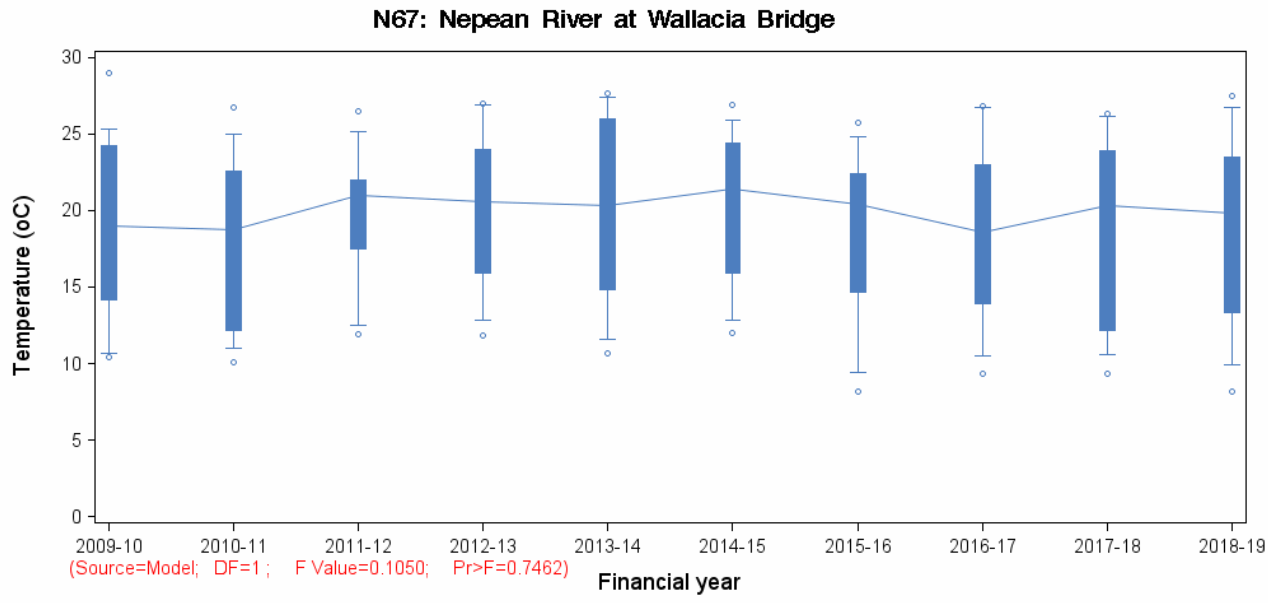
Other physico-chemical analytes

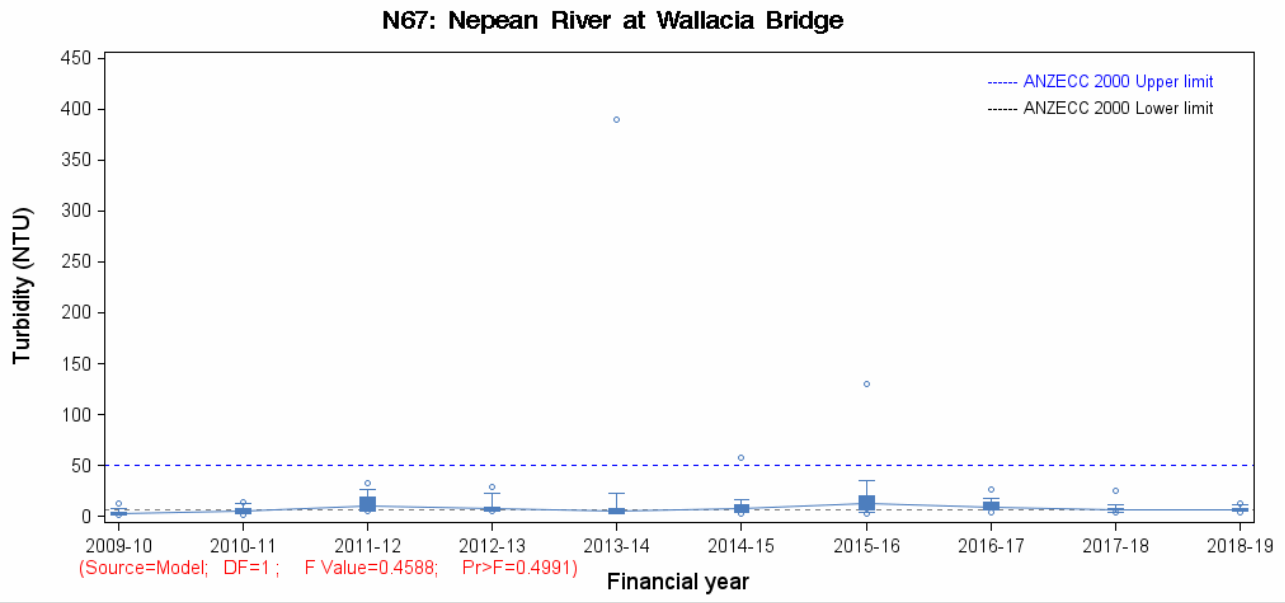


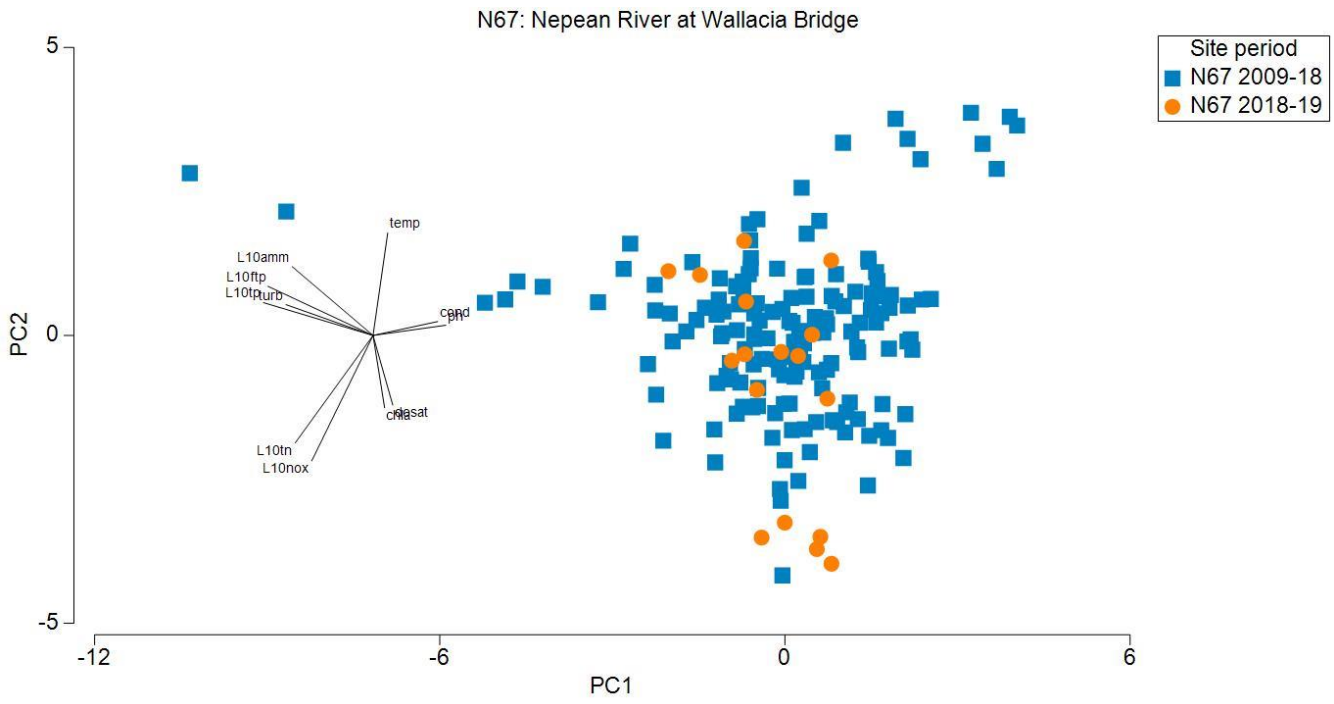



N67: Nepean River at Wallacia Bridge
Dissolved oxygen saturation (%)
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3714; Pr>F=0.5430)
Financial year


N67: Nepean River at Wallacia Bridge
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.7015; Pr>F=0.4034)
Financial year


N67: Nepean River at Wallacia Bridge
Temperature (oC)
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1050; Pr>F=0.7462)
Financial year

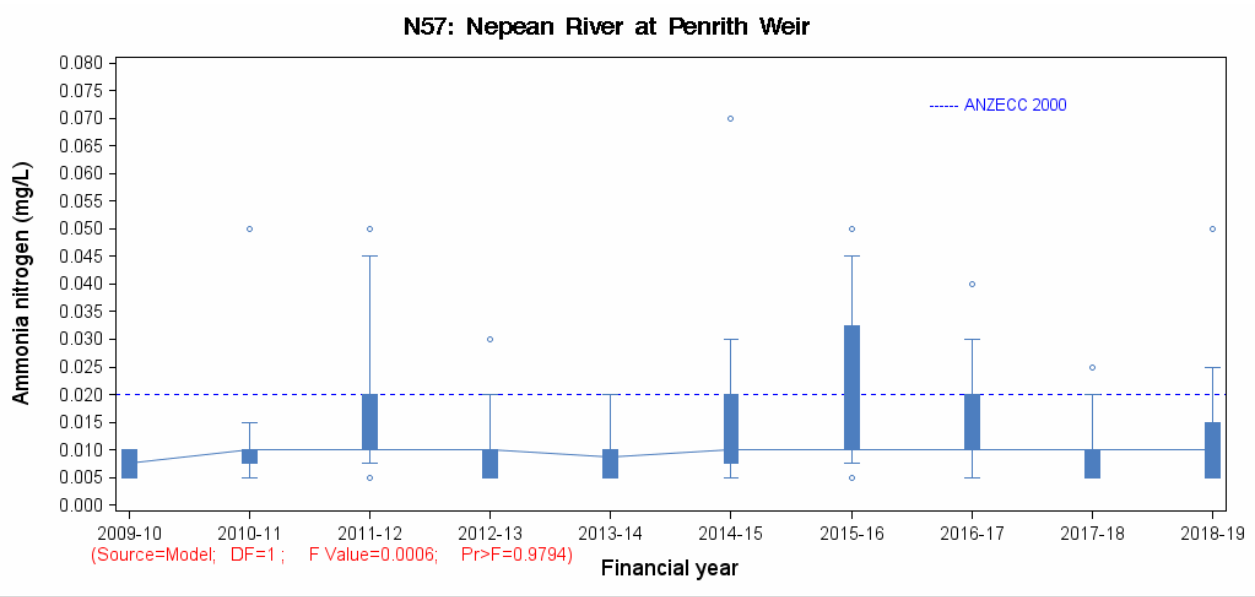


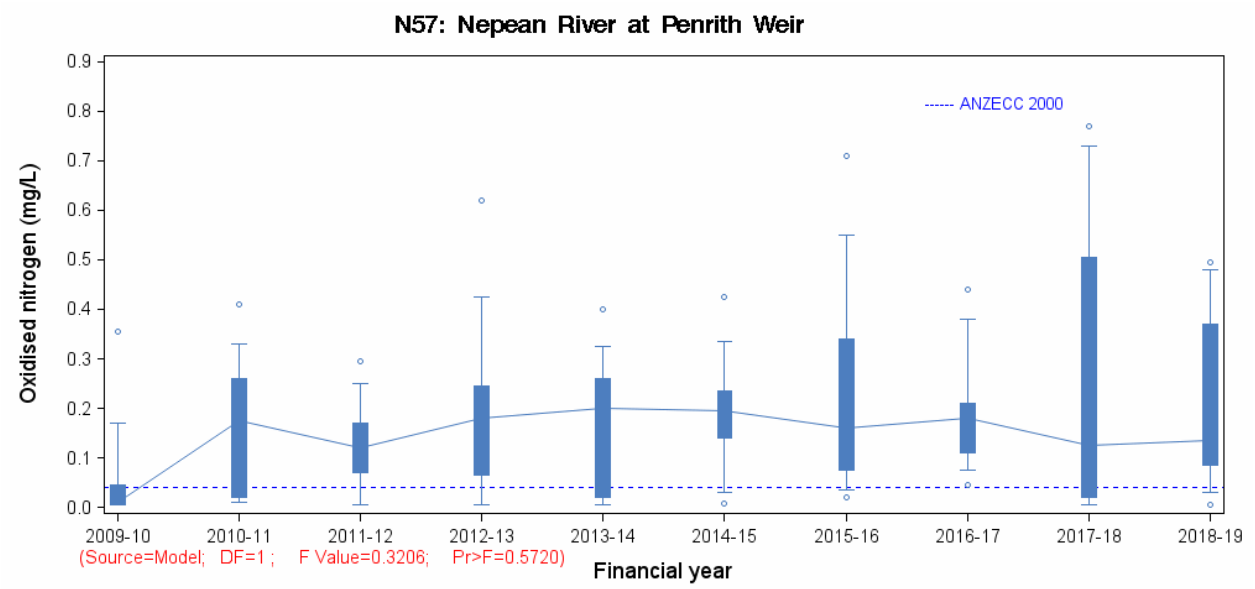


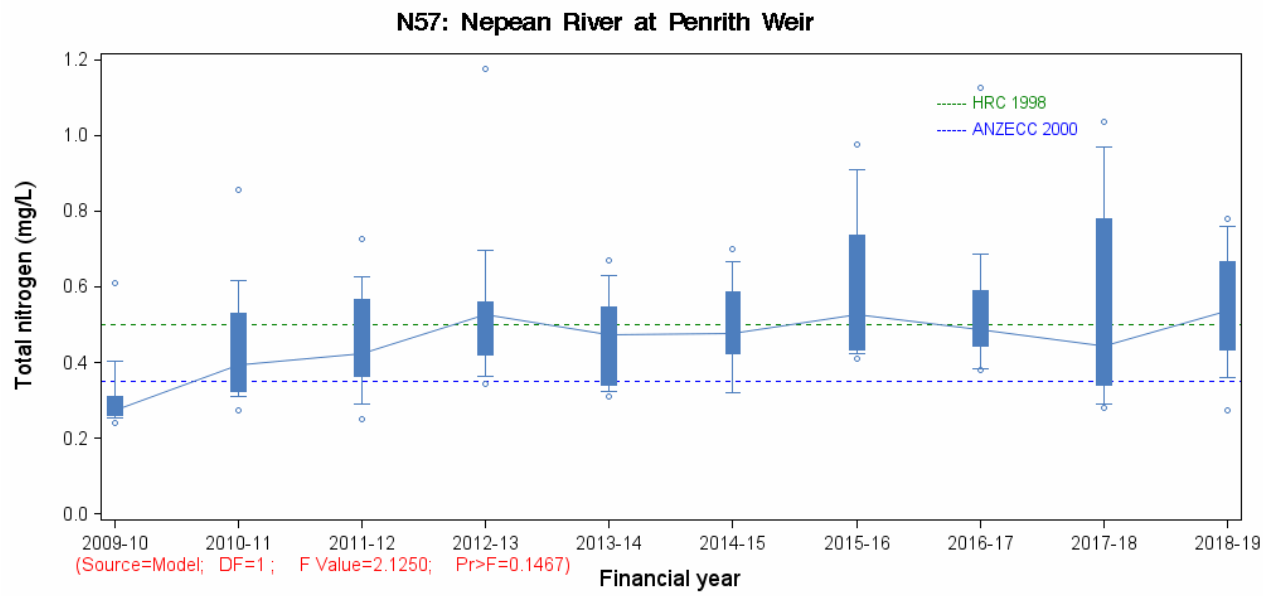
The ordination plot from Principal Components Analysis suggested water quality of the Nepean River at Wallacia Bridge in 2018-19 was similar to that recorded in the period 2009 to 2018.

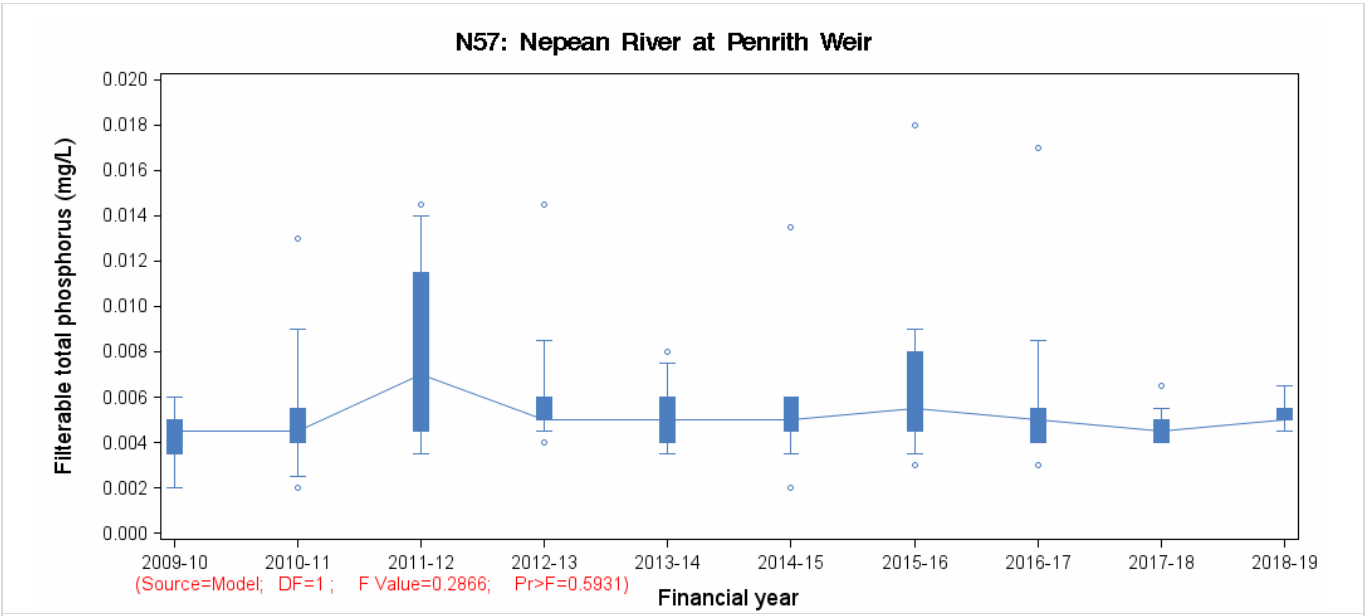
N57: Nepean River at Penrith Weir

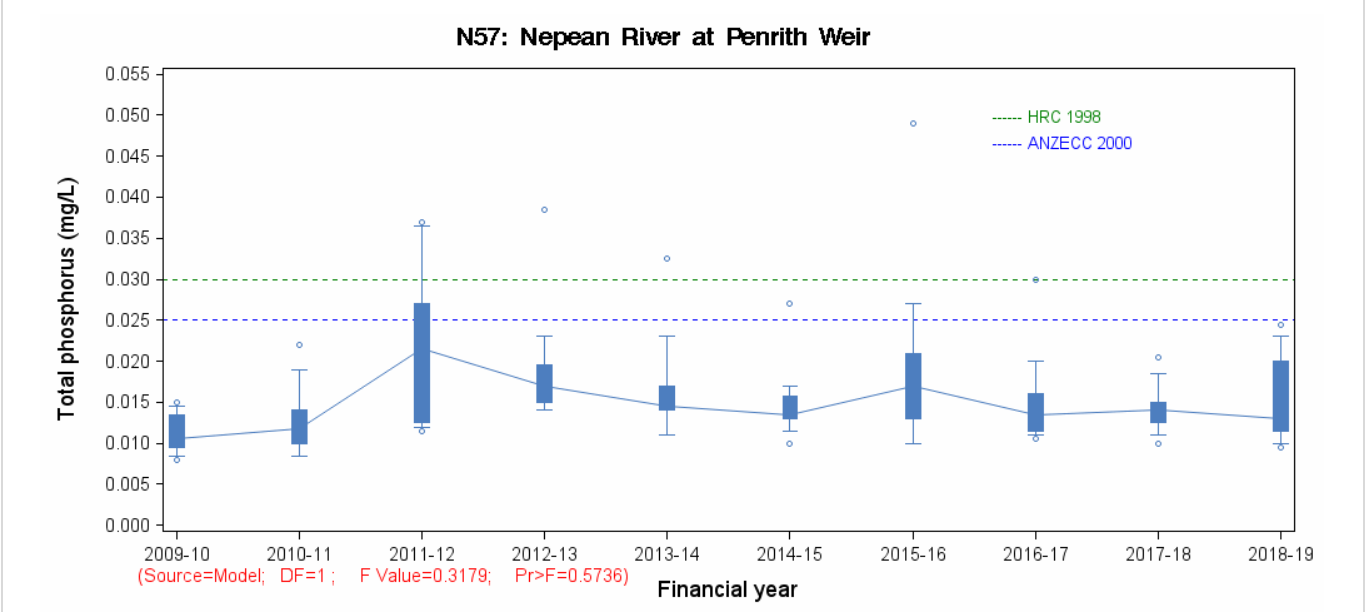
Nutrients, chlorophyll-*a* and algae

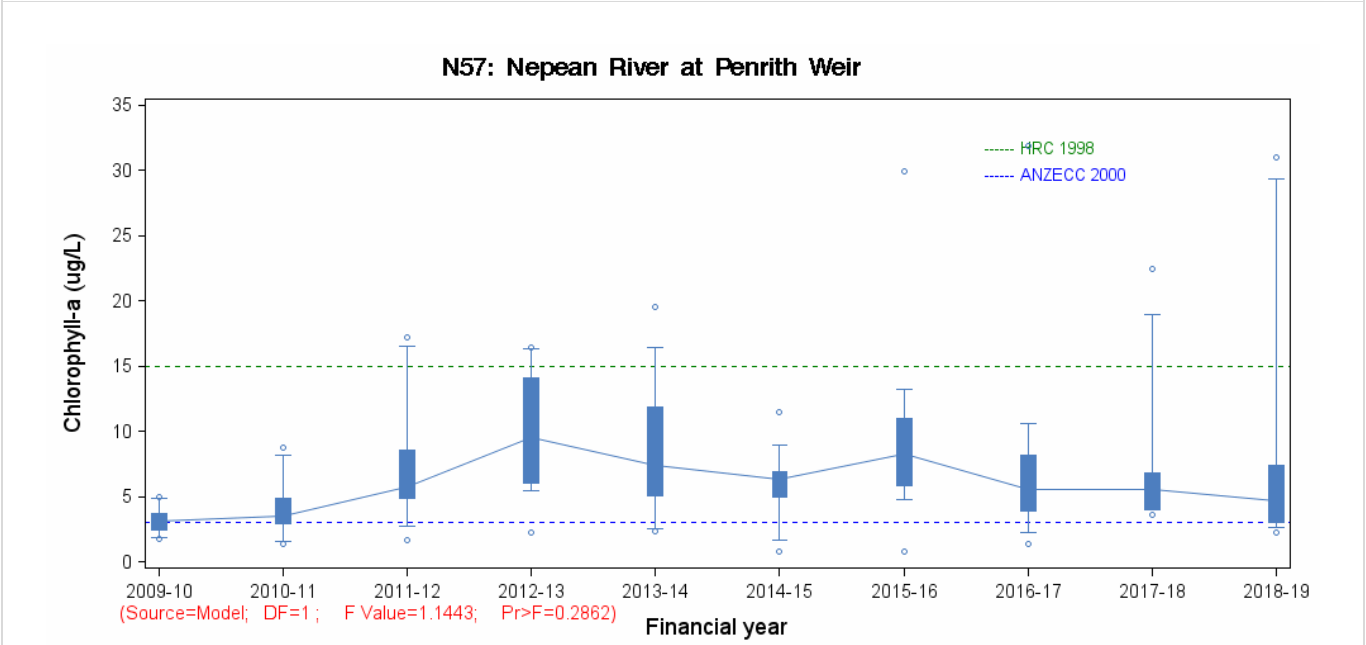


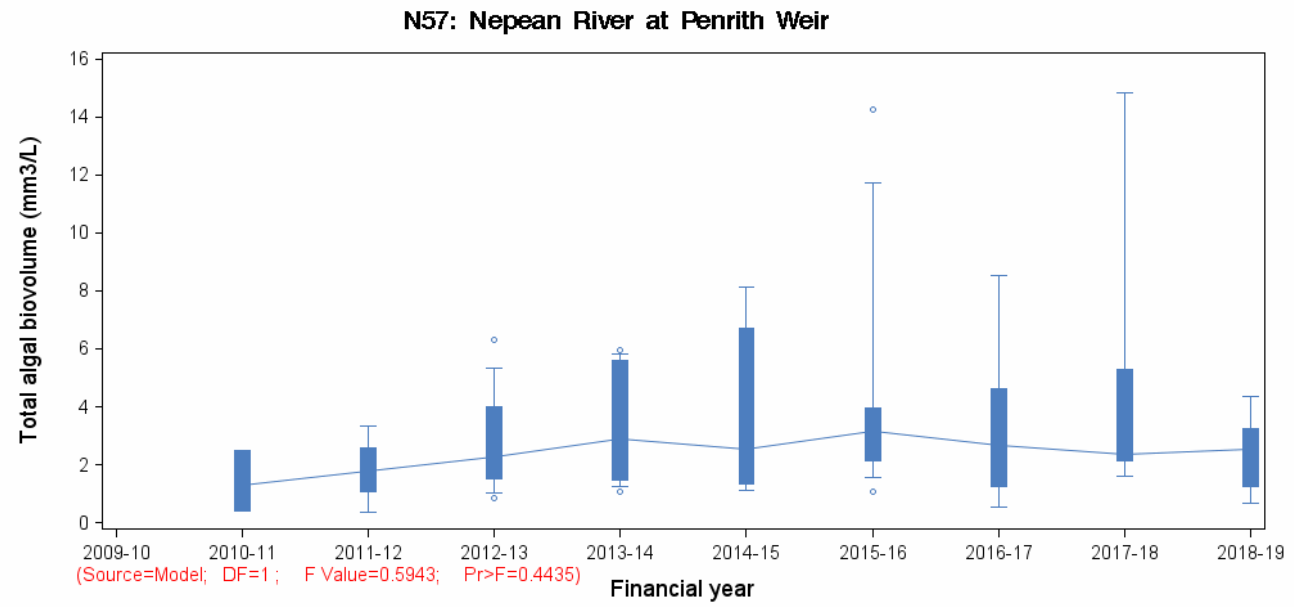


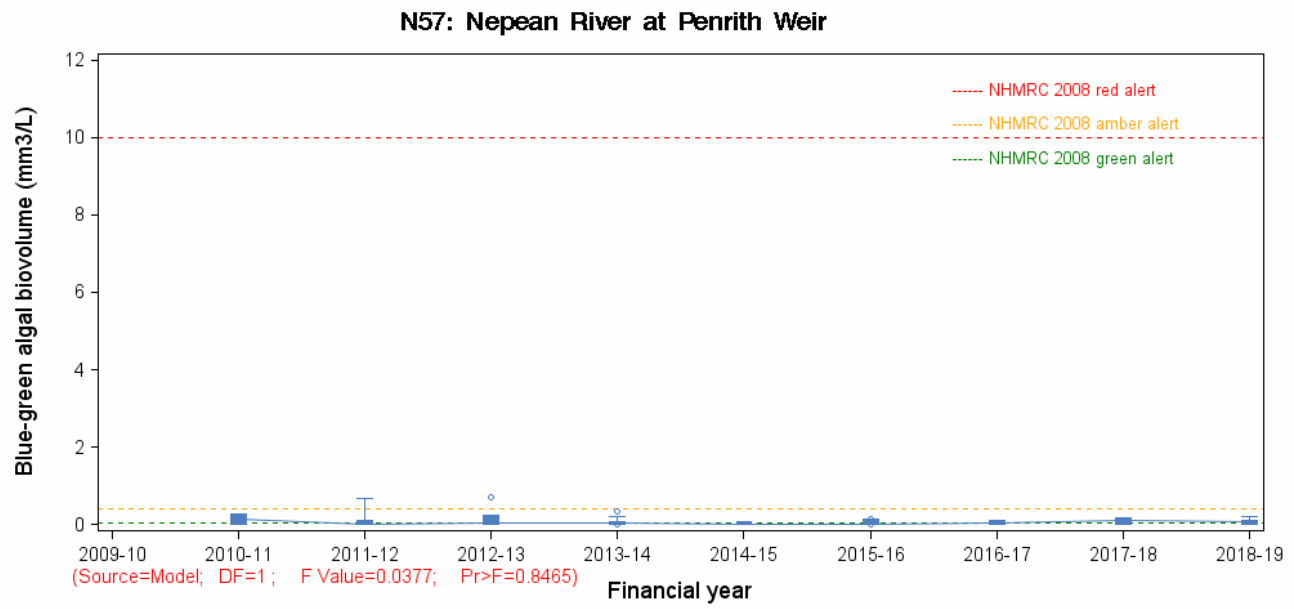


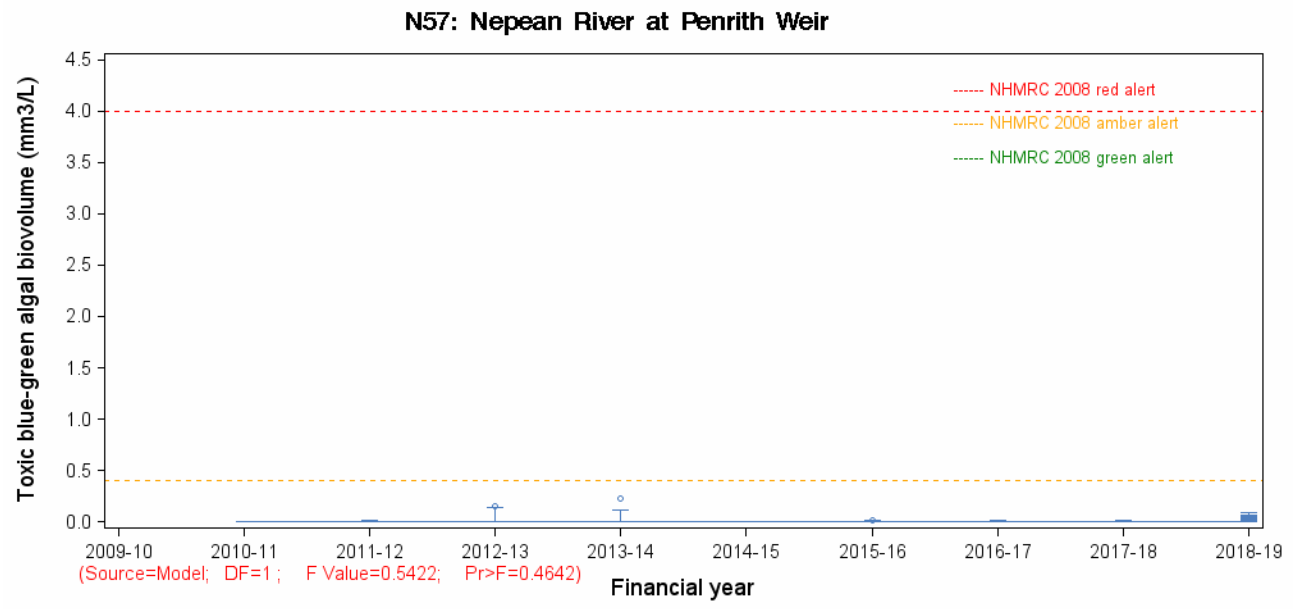

N57: Nepean River at Penrith Weir
Filterable total phosphorus (mg/L)
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2866; Pr>F=0.5931)
Financial year

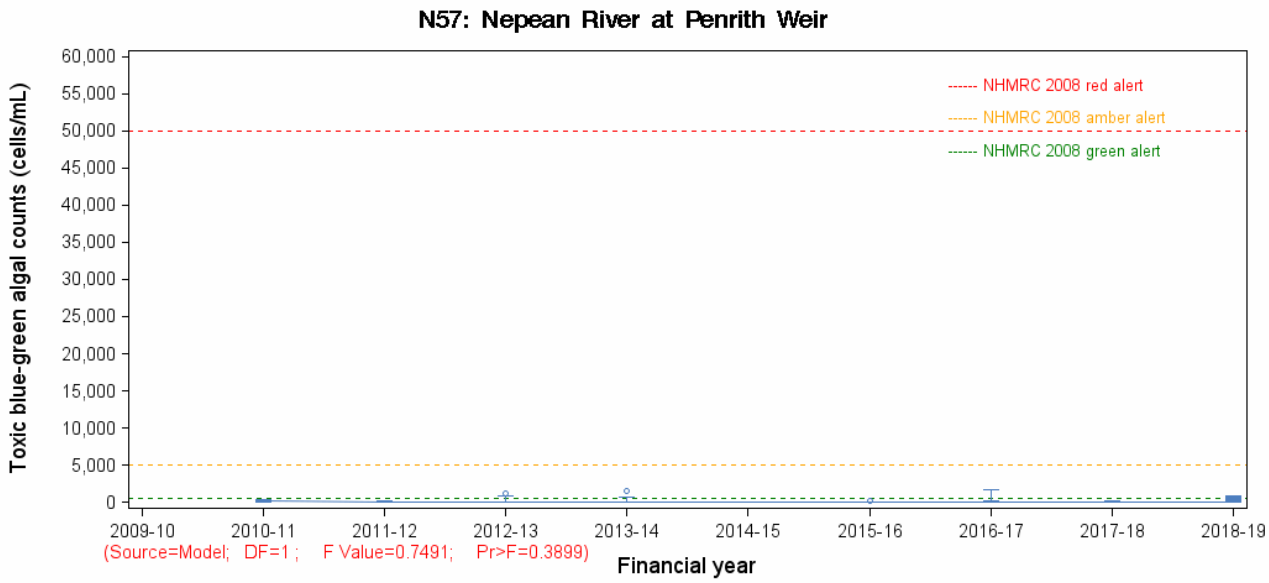

N57: Nepean River at Penrith Weir
Total phosphorus (mg/L)
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3179; Pr>F=0.5736)
Financial year


N57: Nepean River at Penrith Weir
Chlorophyll-a (ug/L)
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.1443; Pr>F=0.2862)
Financial year

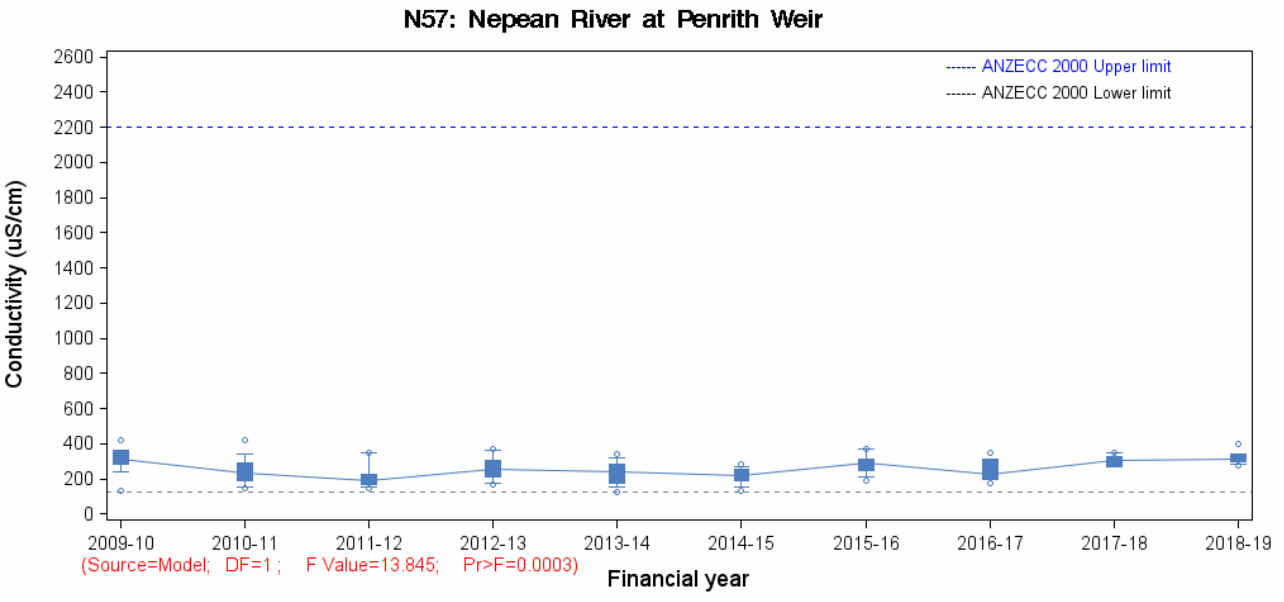

N57: Nepean River at Penrith Weir
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5943; Pr>F=0.4435)
Financial year

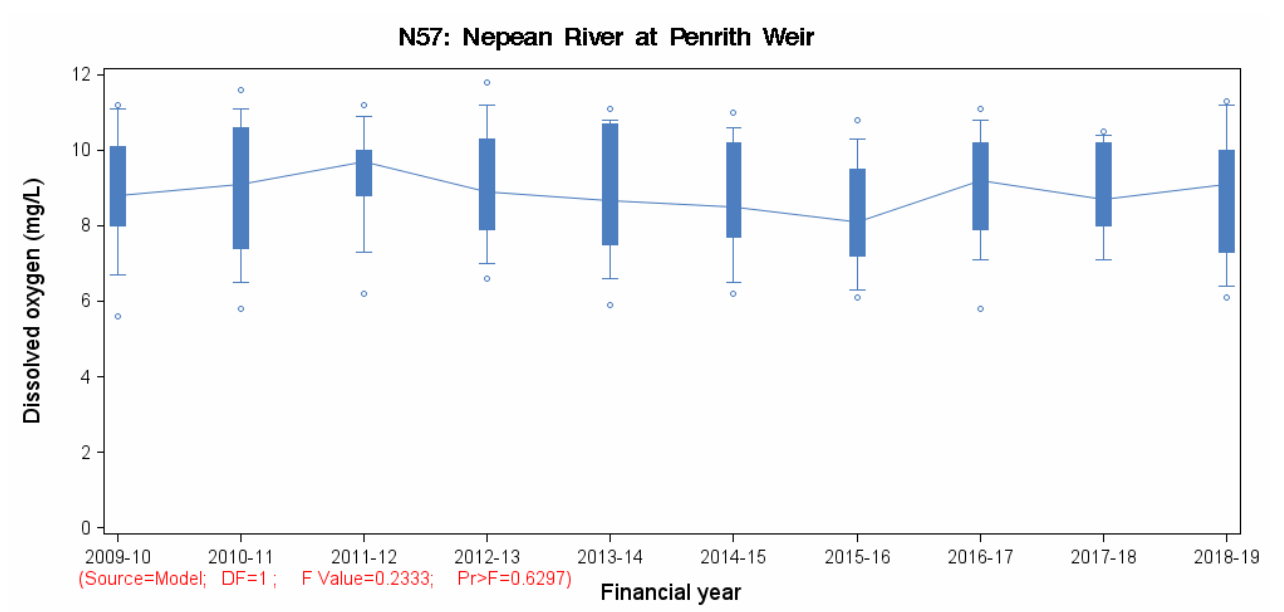

N57: Nepean River at Penrith Weir
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0377; Pr>F=0.8465)
Financial year

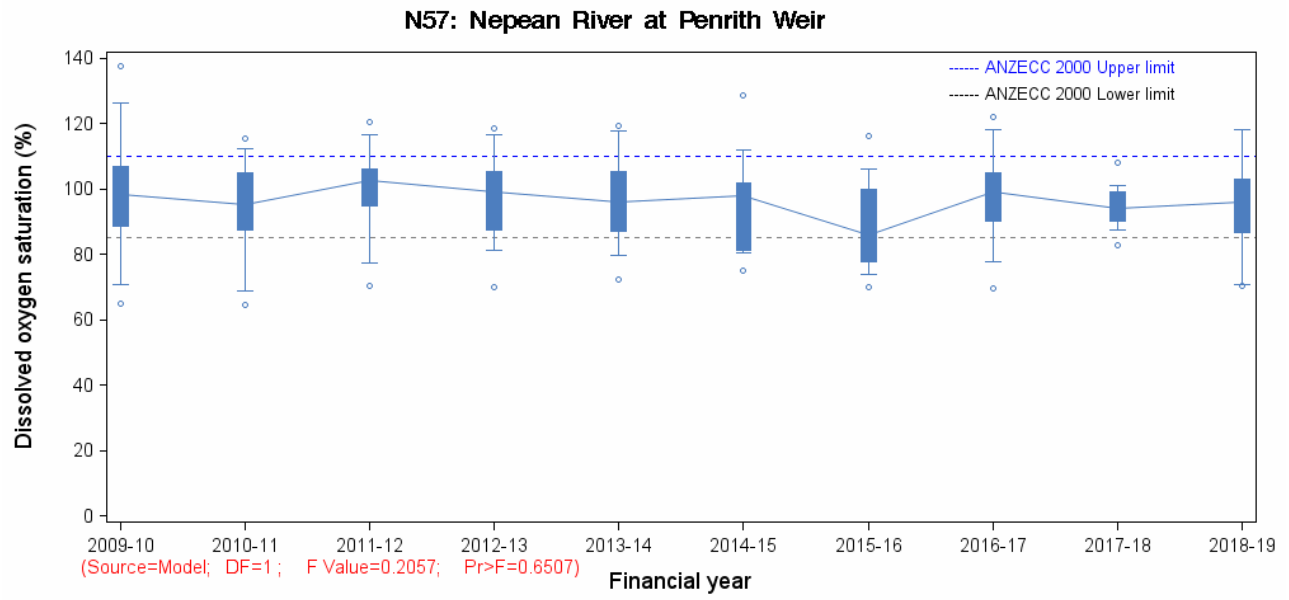

N57: Nepean River at Penrith Weir
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5422; Pr>F=0.4642)
Financial year

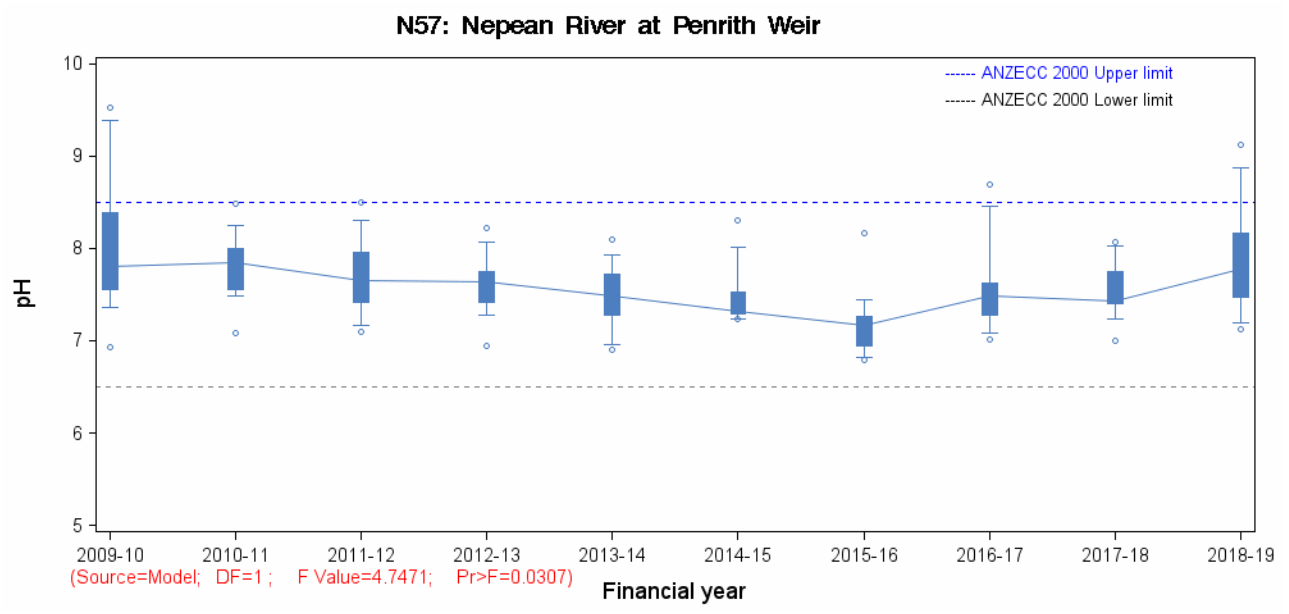


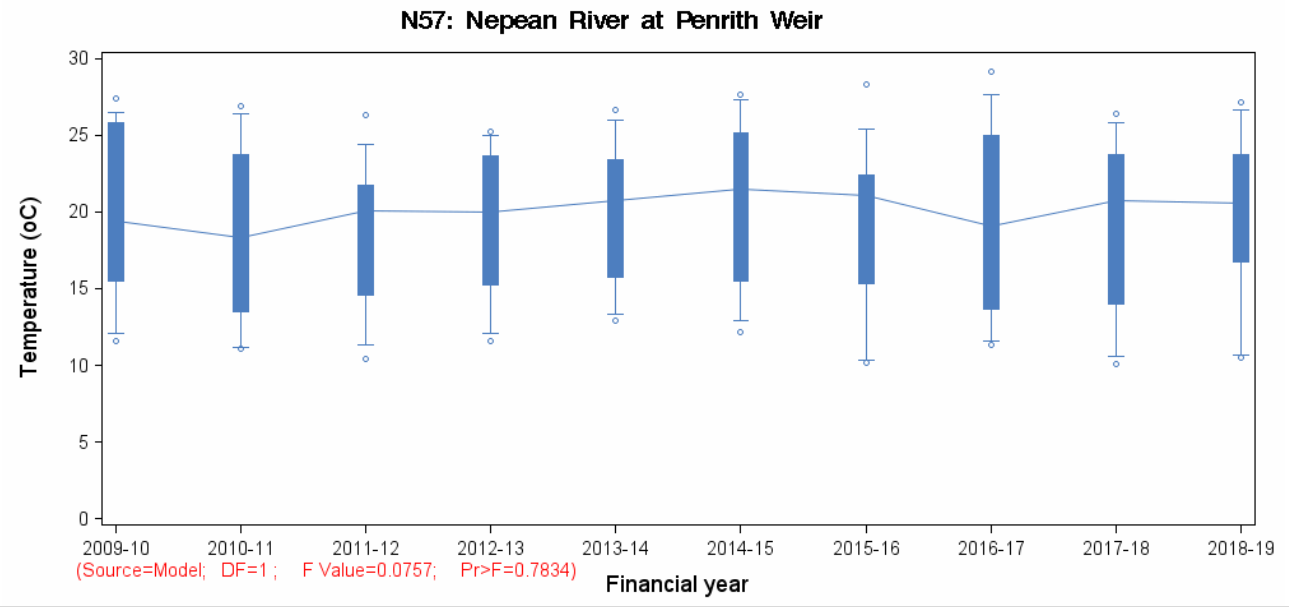
Other physico-chemical analytes

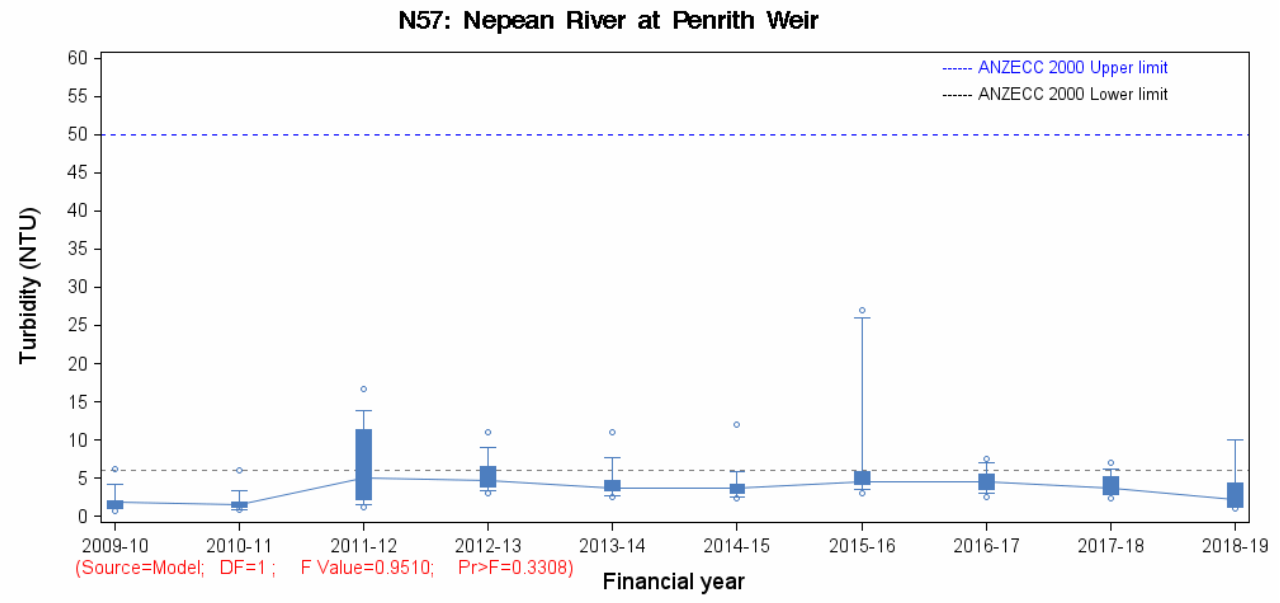


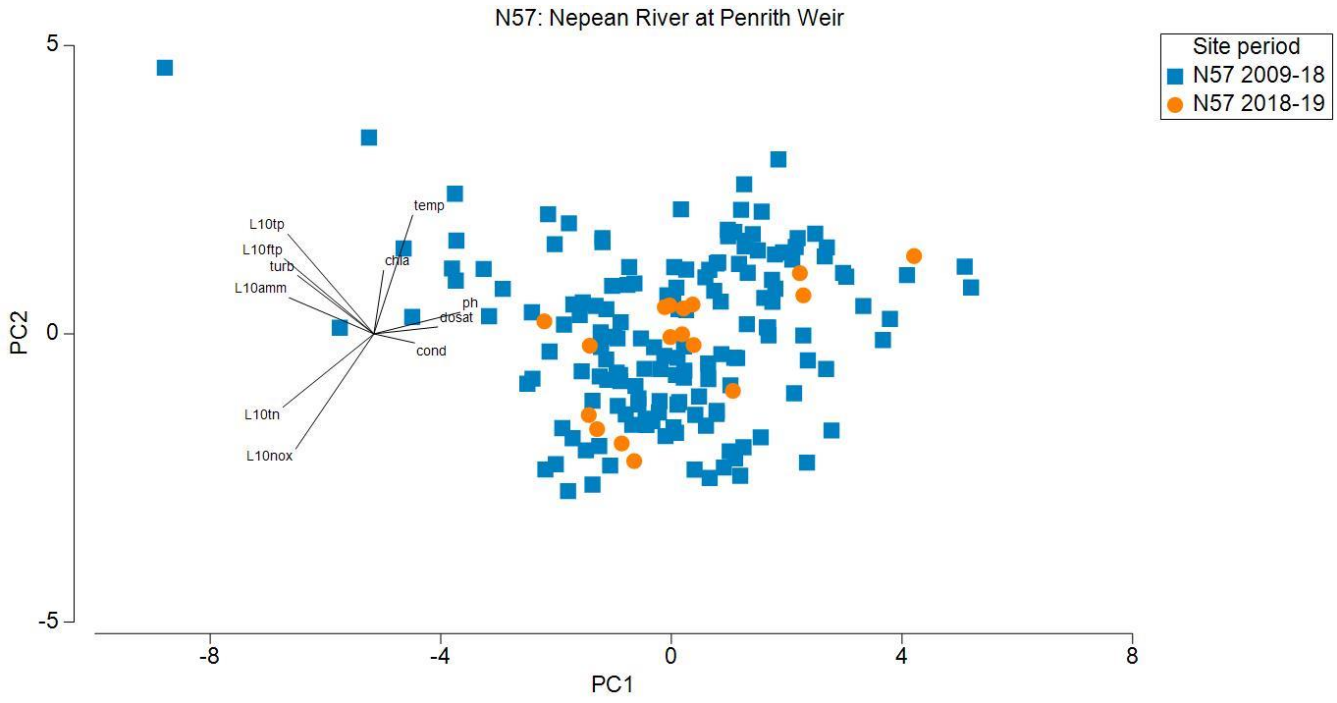



N57: Nepean River at Penrith Weir
Dissolved oxygen saturation (%)
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2057; Pr>F=0.6507)
Financial year


N57: Nepean River at Penrith Weir
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.7471; Pr>F=0.0307)
Financial year


N57: Nepean River at Penrith Weir
Temperature (oC)
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0757; Pr>F=0.7834)
Financial year

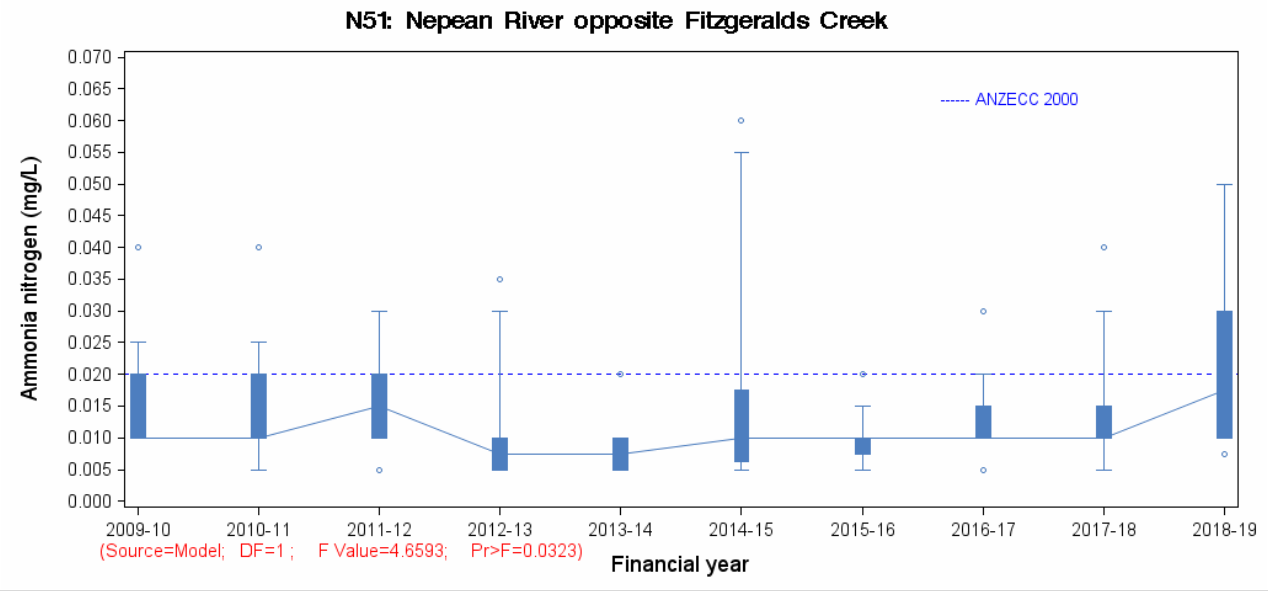


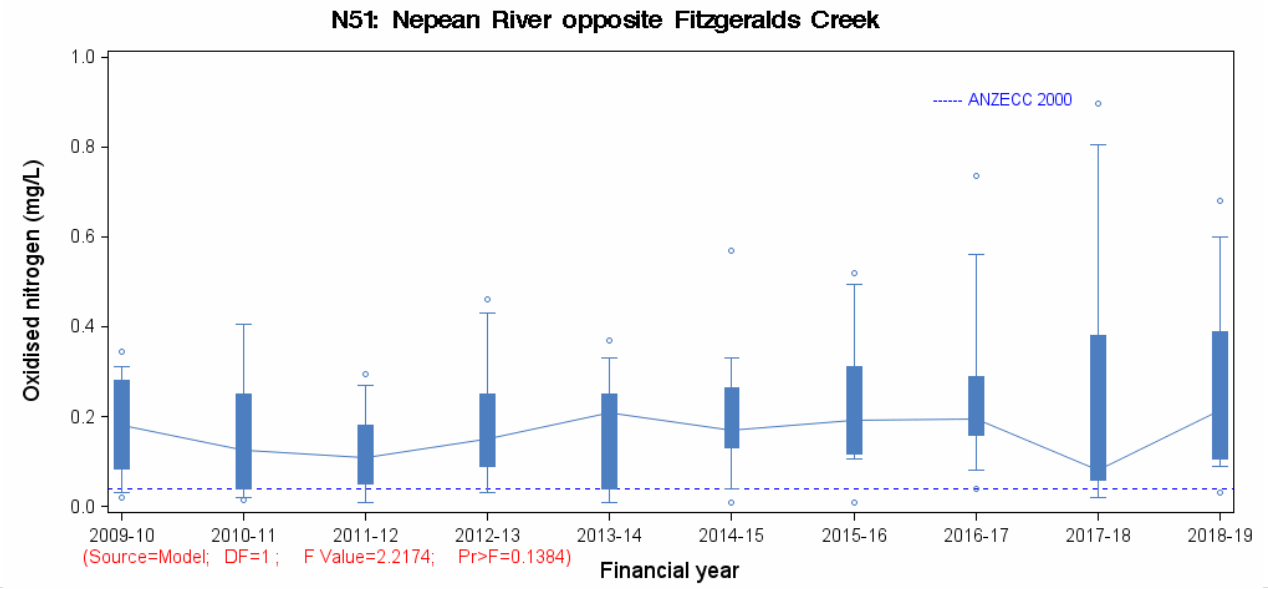


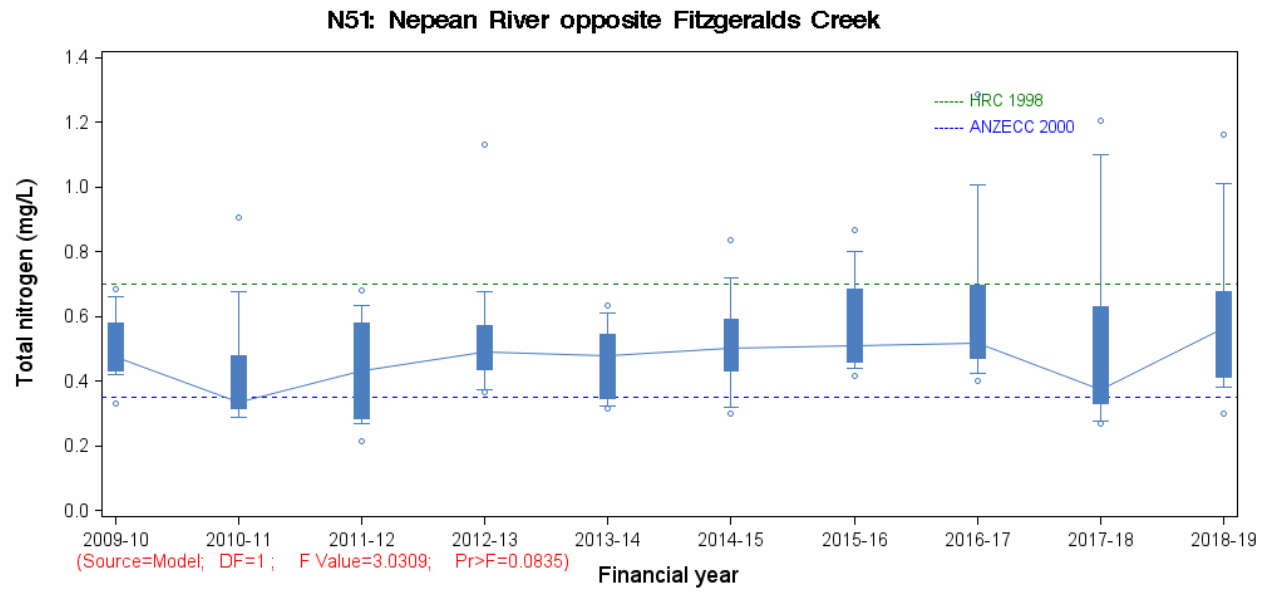
The ordination plot from Principal Components Analysis suggested water quality of the Nepean River at Penrith Weir in 2018-19 was similar to that recorded in the period 2009 to 2018

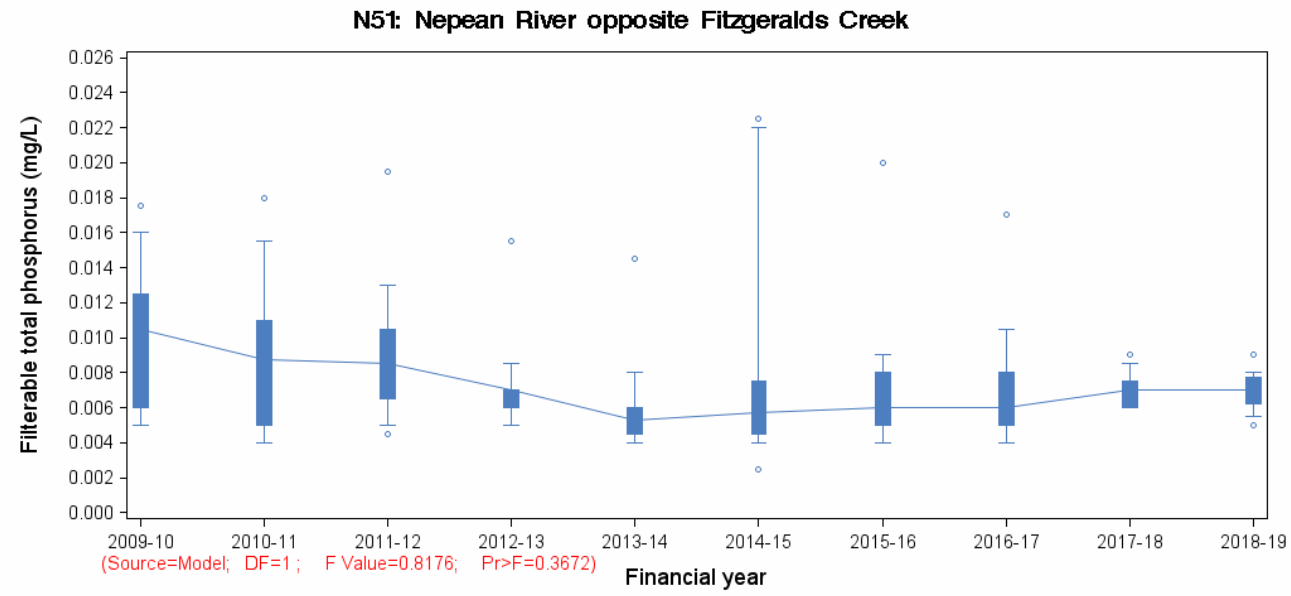
N51: Nepean River opposite Fitzgerald Creek

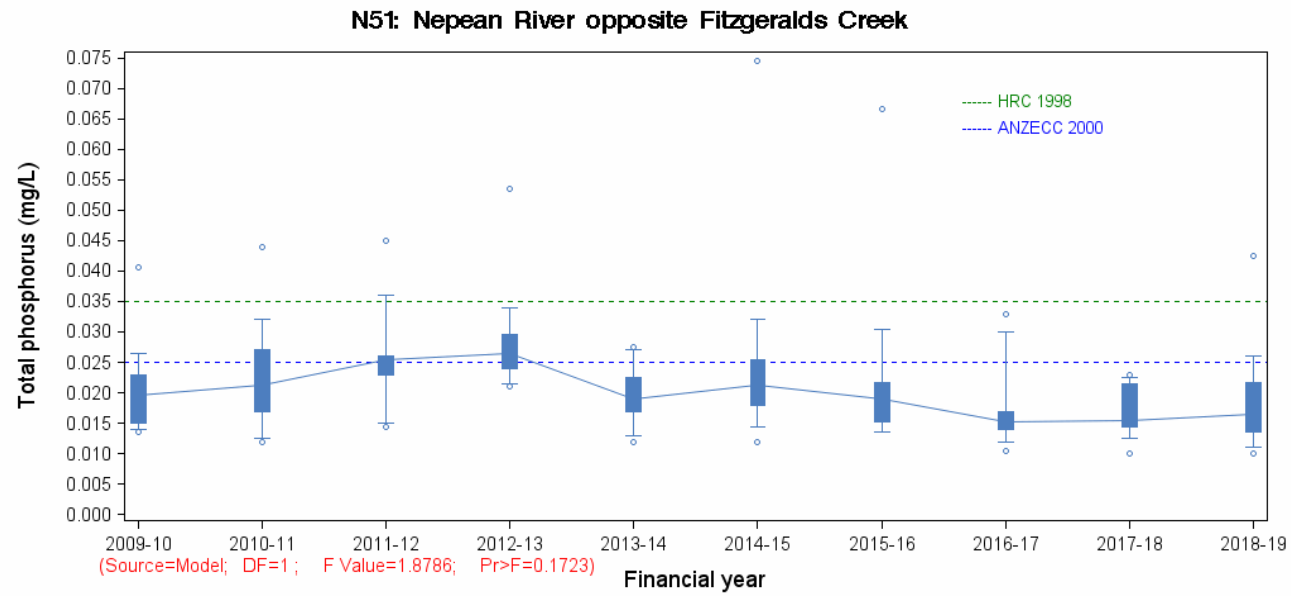
Nutrients, chlorophyll-*a* and algae

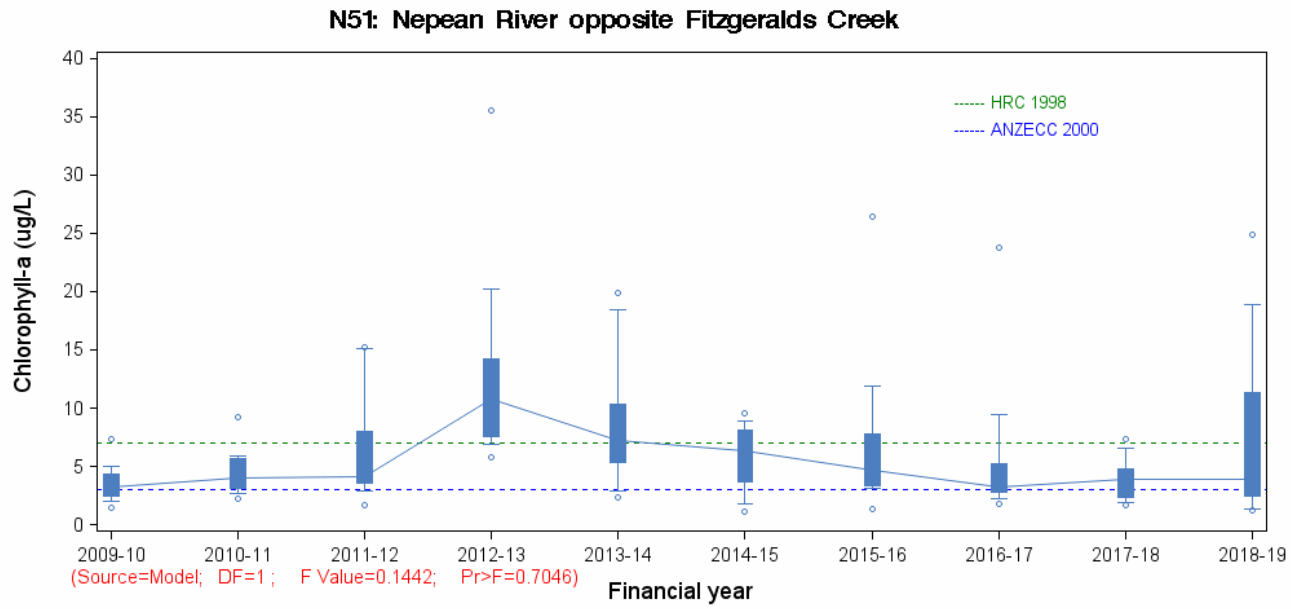


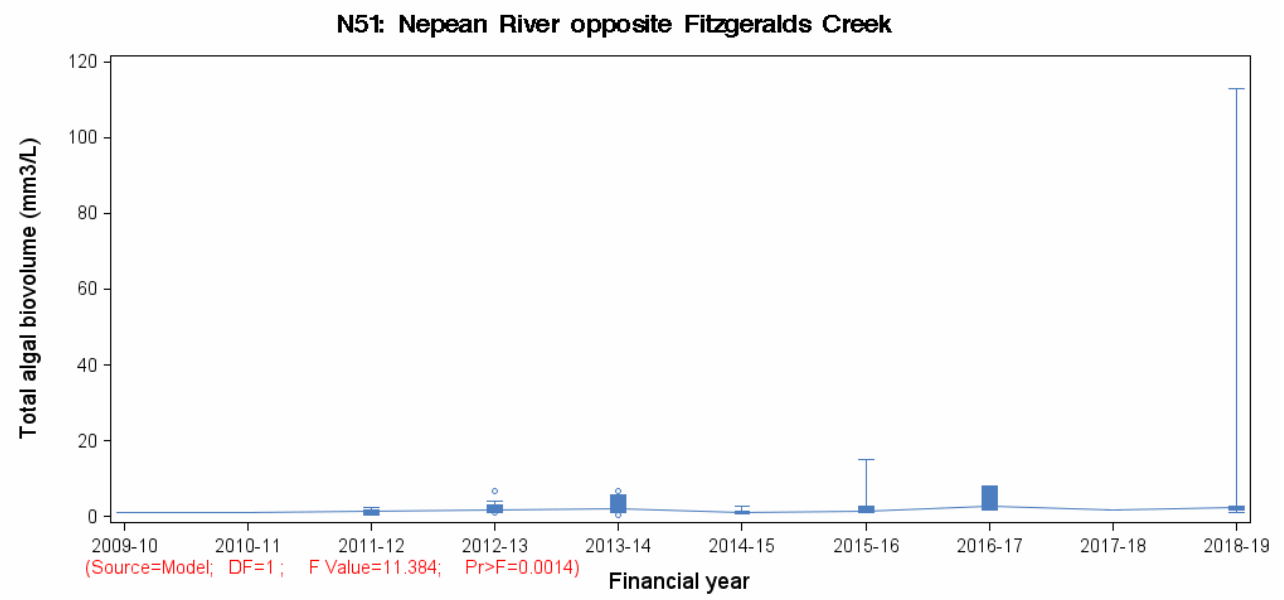


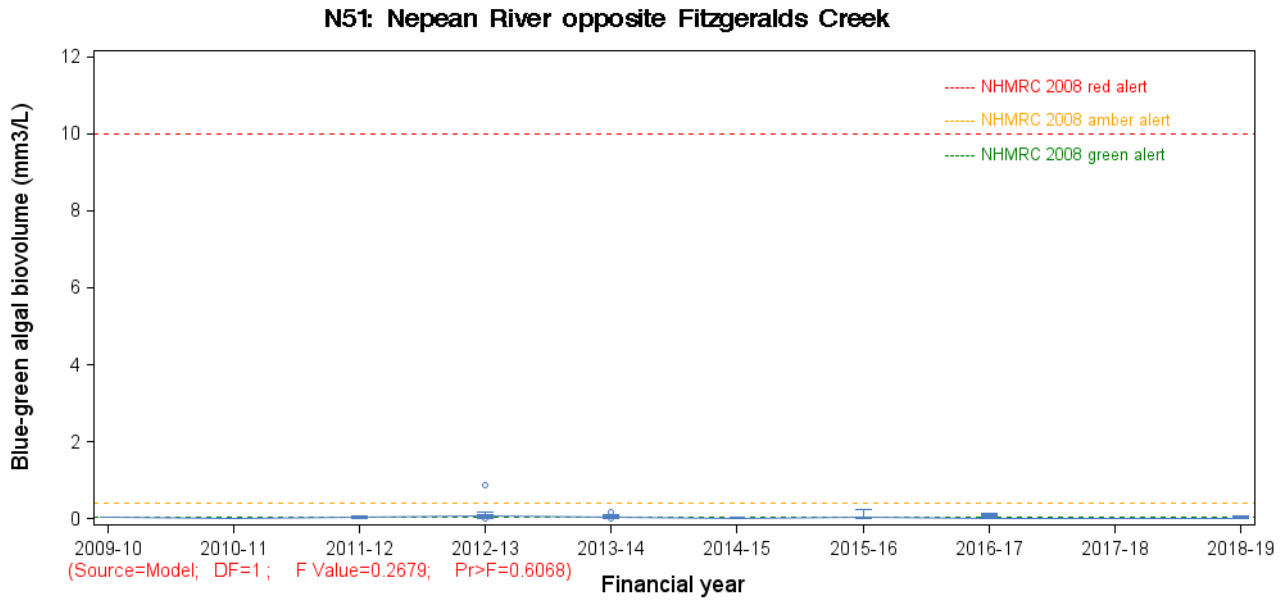


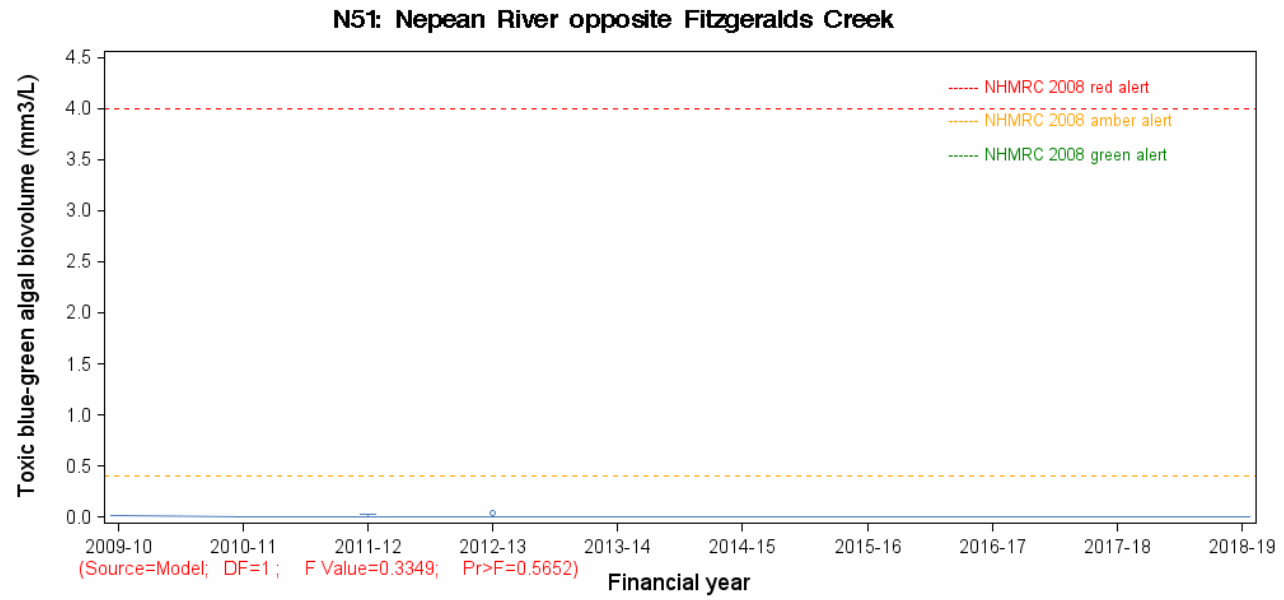

N51: Nepean River opposite Fitzgeralds Creek
Filterable total phosphorus (mg/L)
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.8176; Pr>F=0.3672)
Financial year

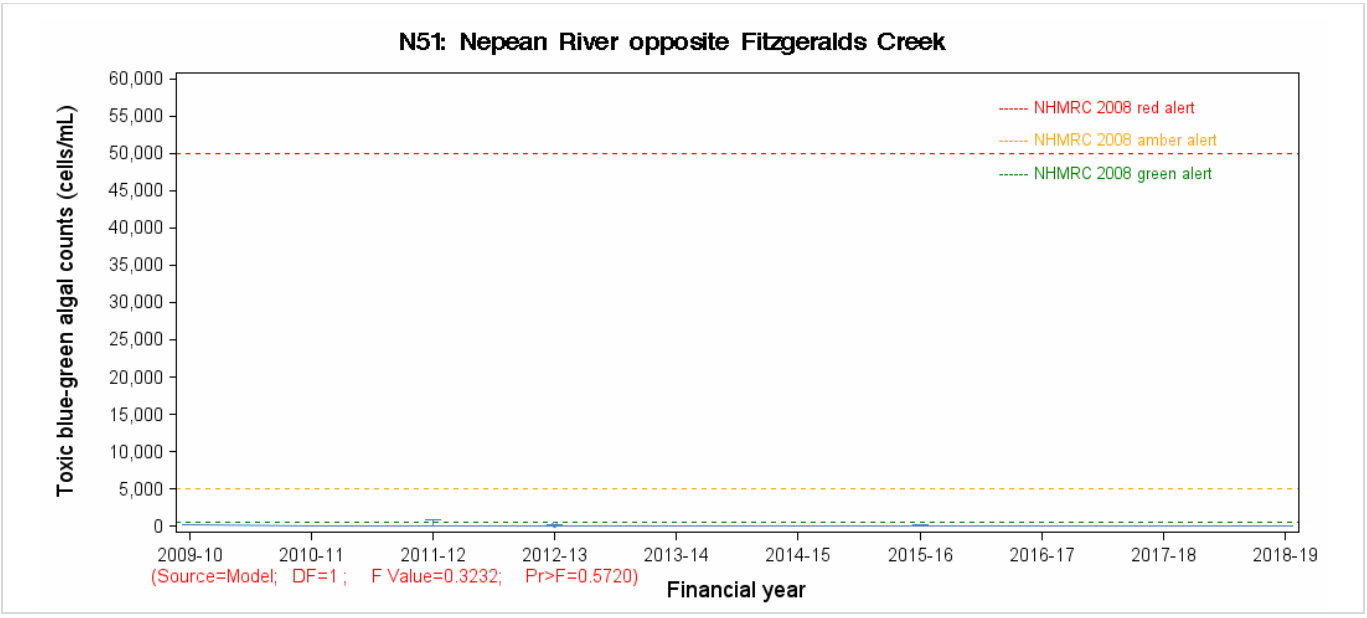

N51: Nepean River opposite Fitzgeralds Creek
Total phosphorus (mg/L)
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.8786; Pr>F=0.1723)
Financial year


N51: Nepean River opposite Fitzgeralds Creek
Chlorophyll-a (ug/L)
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1442; Pr>F=0.7046)
Financial year

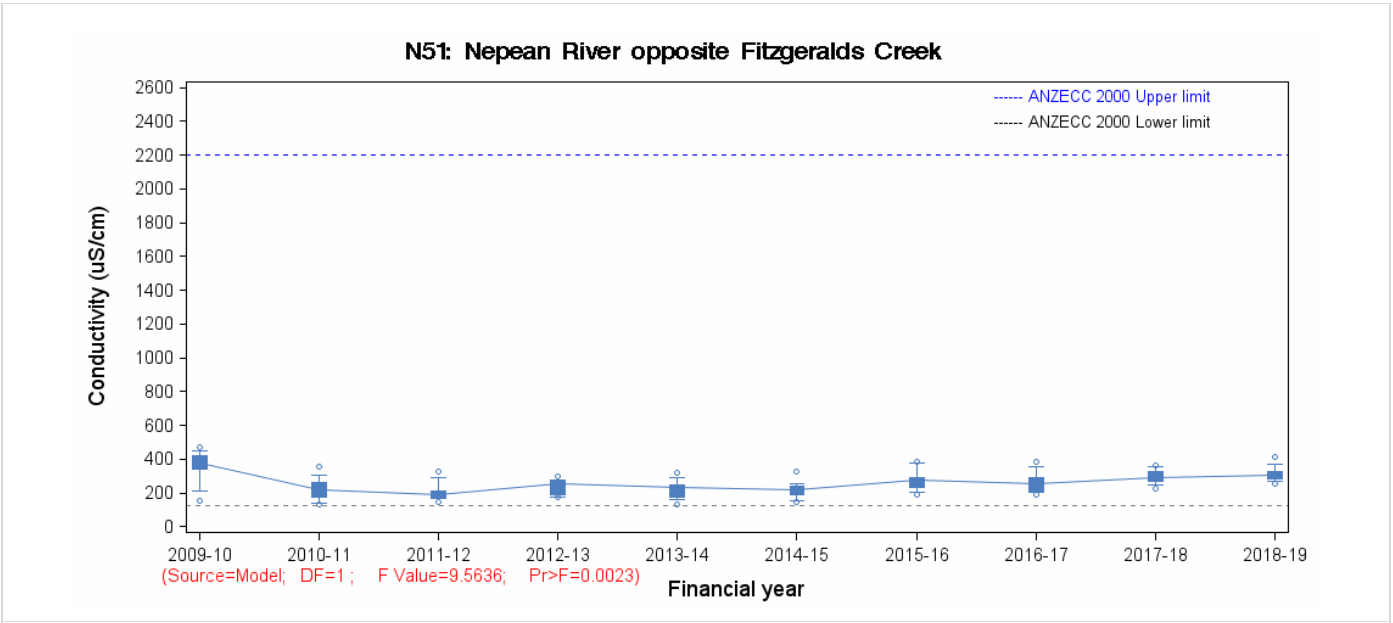

N51: Nepean River opposite Fitzgeralds Creek
Total algal biovolume (mm3/L)
120
100
80
60
40
20
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=11.384; Pr>F=0.0014)
Financial year

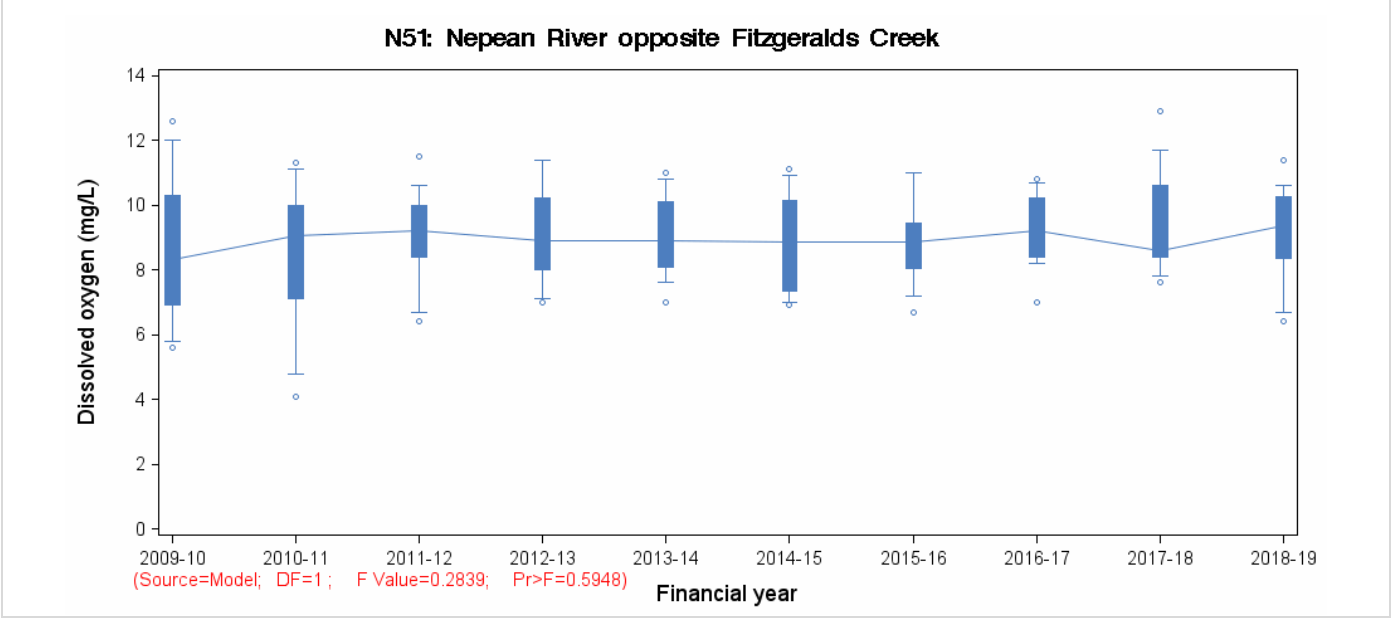

N51: Nepean River opposite Fitzgeralds Creek
Blue-green algal biovolume (mm3/L)
12
10
8
6
4
2
0
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2679; Pr>F=0.6068)
Financial year

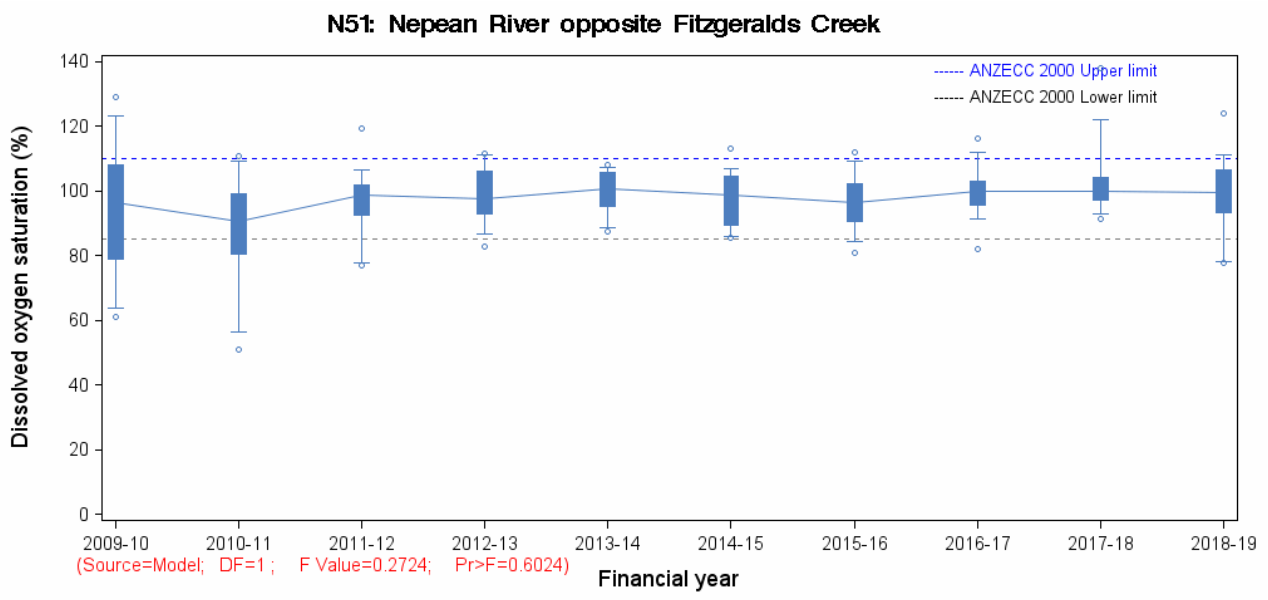

N51: Nepean River opposite Fitzgeralds Creek
Toxic blue-green algal biovolume (mm3/L)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3349; Pr>F=0.5652)
Financial year

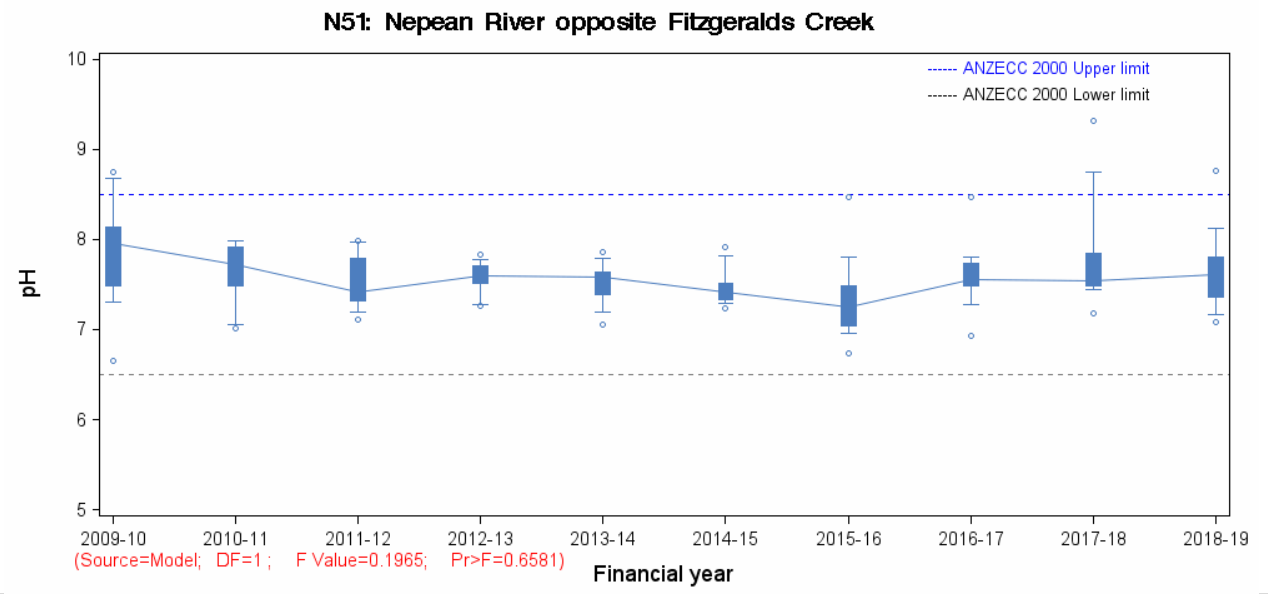


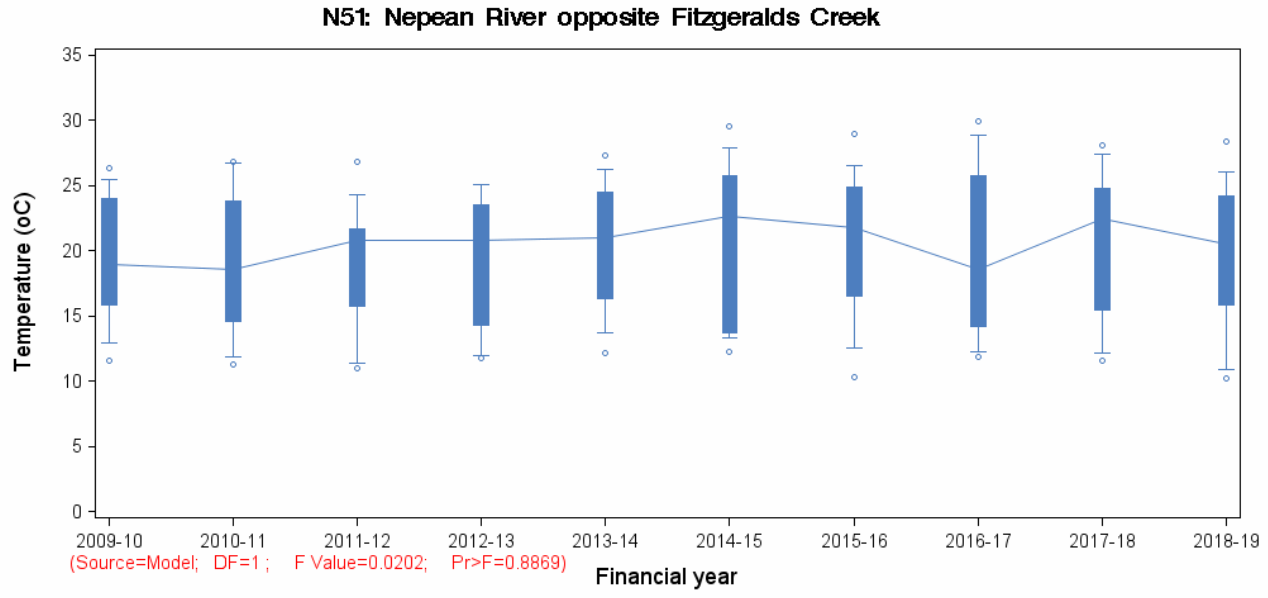
Other physico-chemical analytes

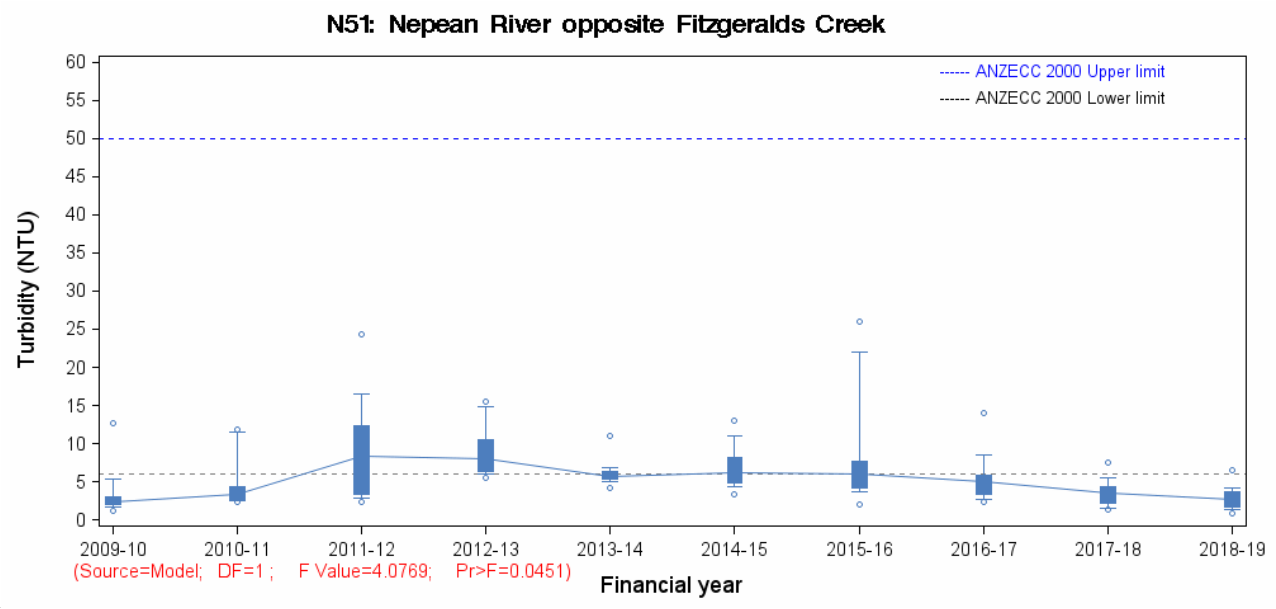


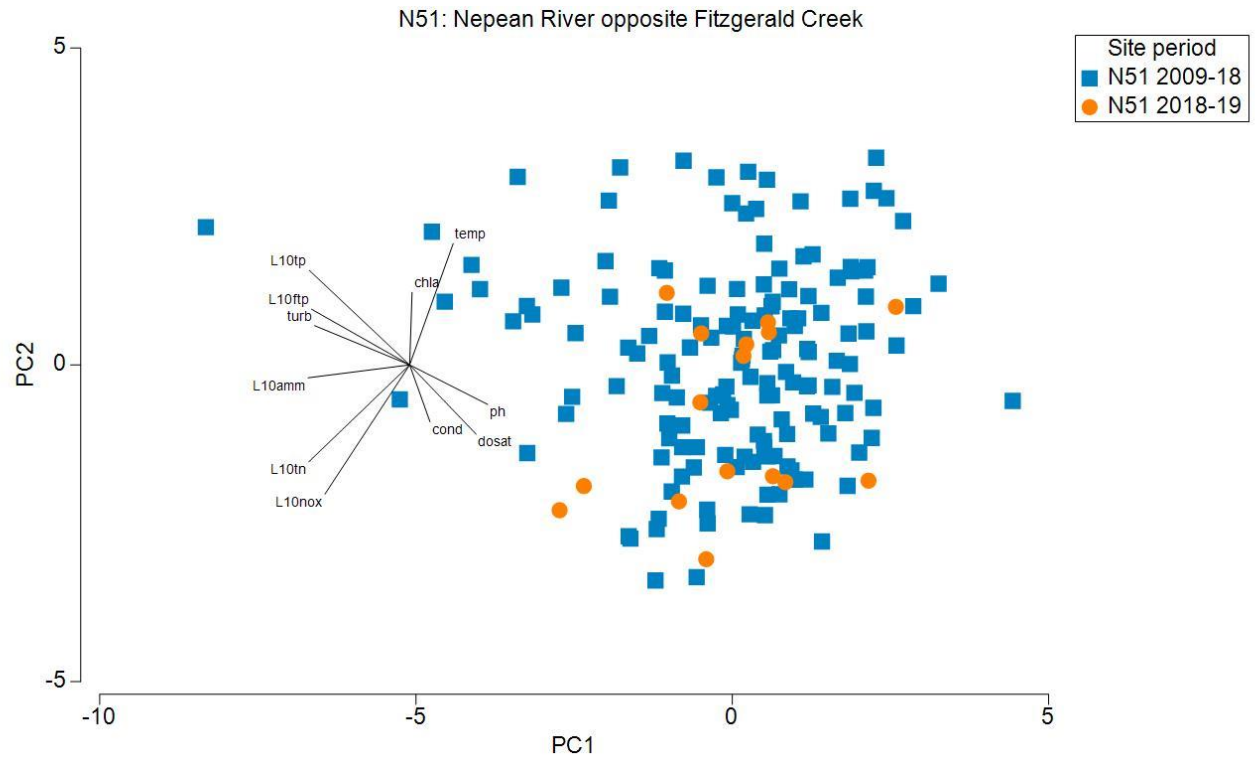



N51: Nepean River opposite Fitzgeralds Creek
Dissolved oxygen saturation (%)
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
140
120
100
80
60
40
20
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2724; Pr>F=0.6024)
Financial year


N51: Nepean River opposite Fitzgeralds Creek
pH
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
10
9
8
7
6
5
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1965; Pr>F=0.6581)
Financial year


N51: Nepean River opposite Fitzgeralds Creek
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0202; Pr>F=0.8869)
Financial year

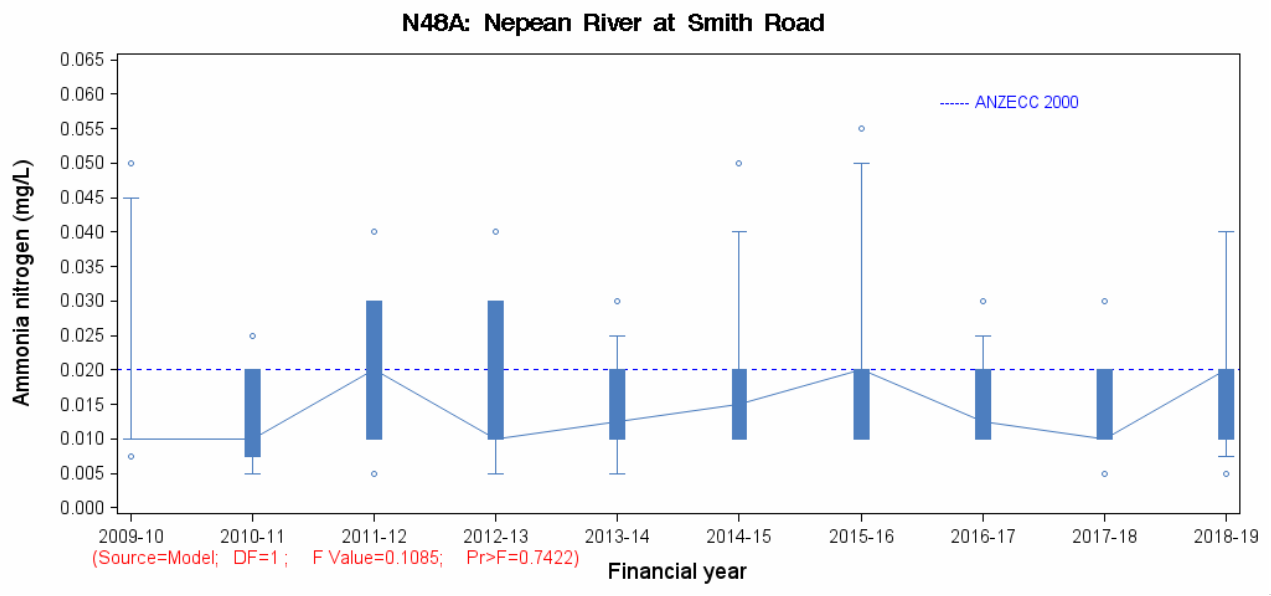


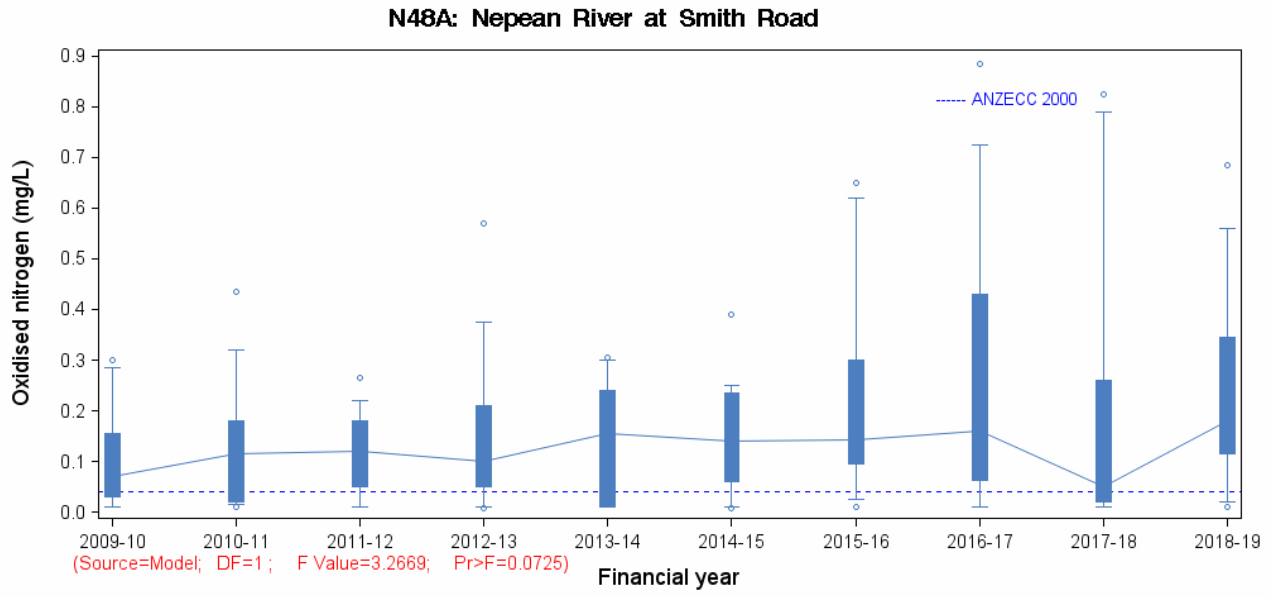


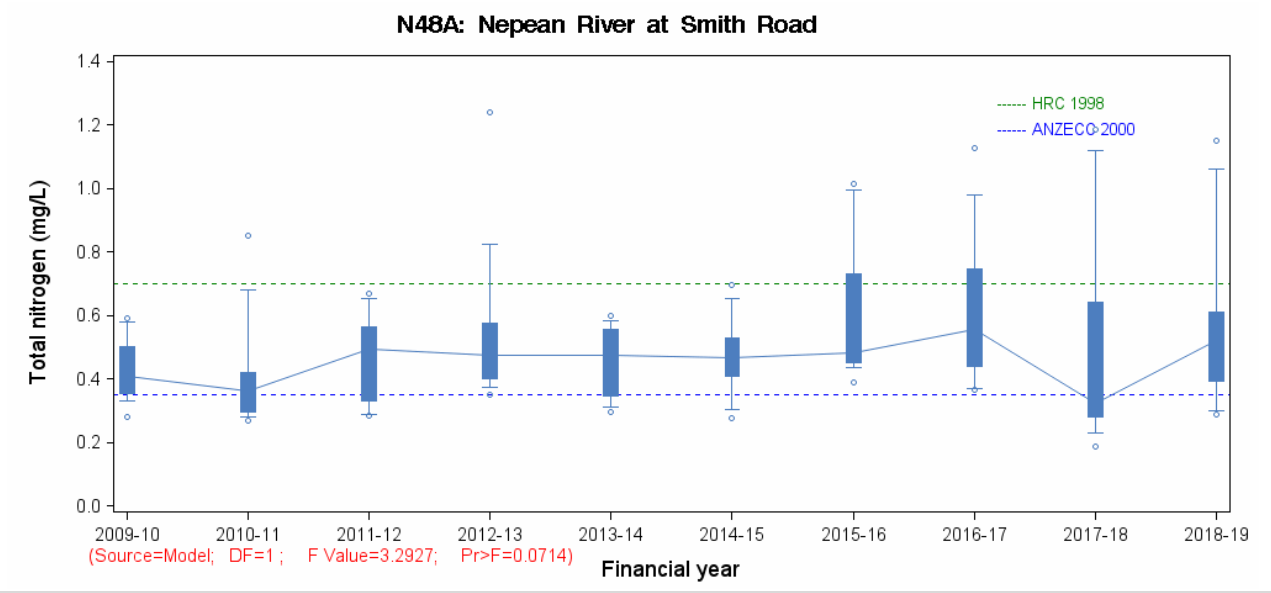
The ordination plot from Principal Components Analysis suggested water quality of the Nepean River opposite Fitzgerald Creek in 2018-19 was similar to that recorded in the period 2009 to 2018.

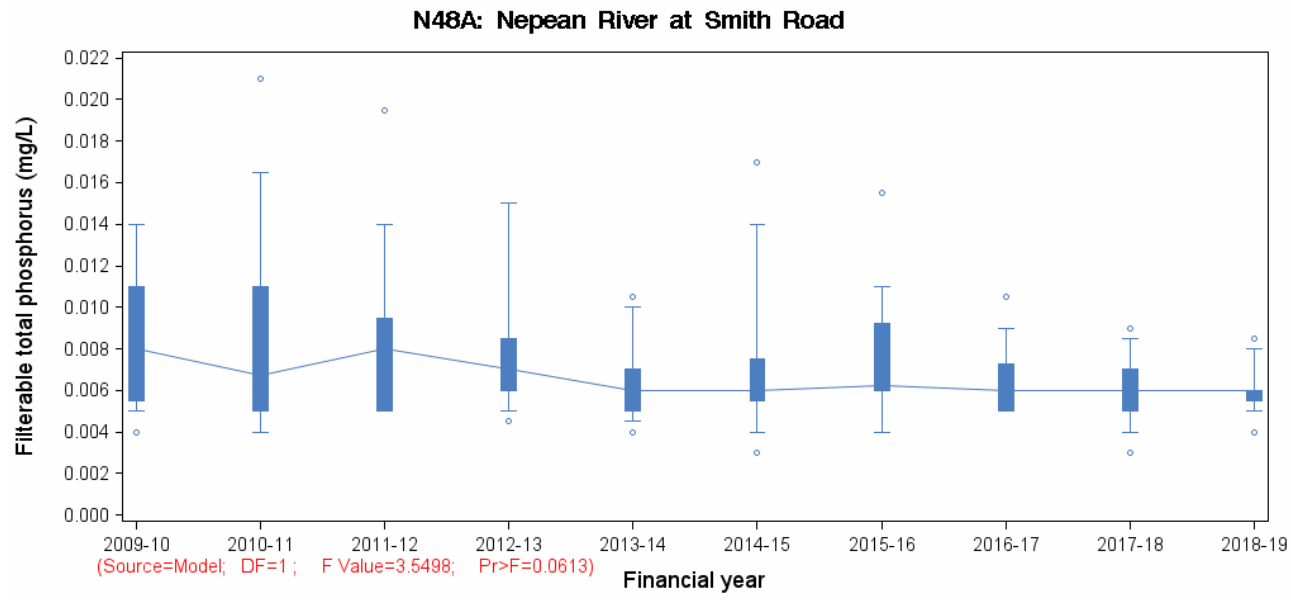
N48A: Nepean River at Smith Road

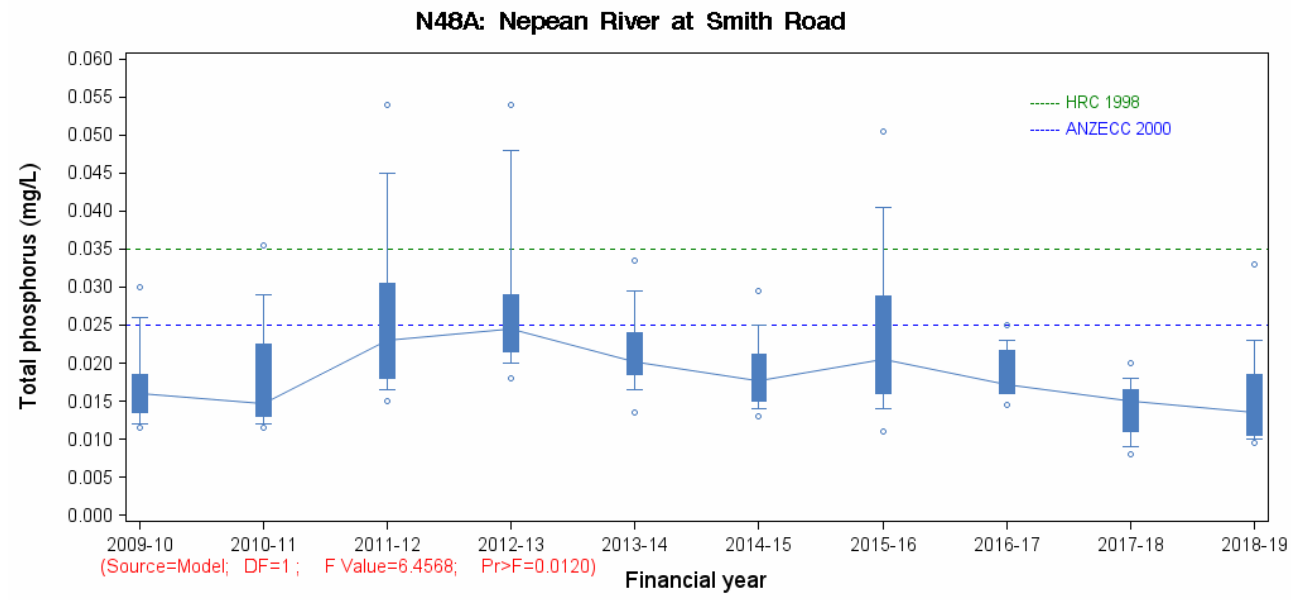
Nutrients, chlorophyll-*a* and algae

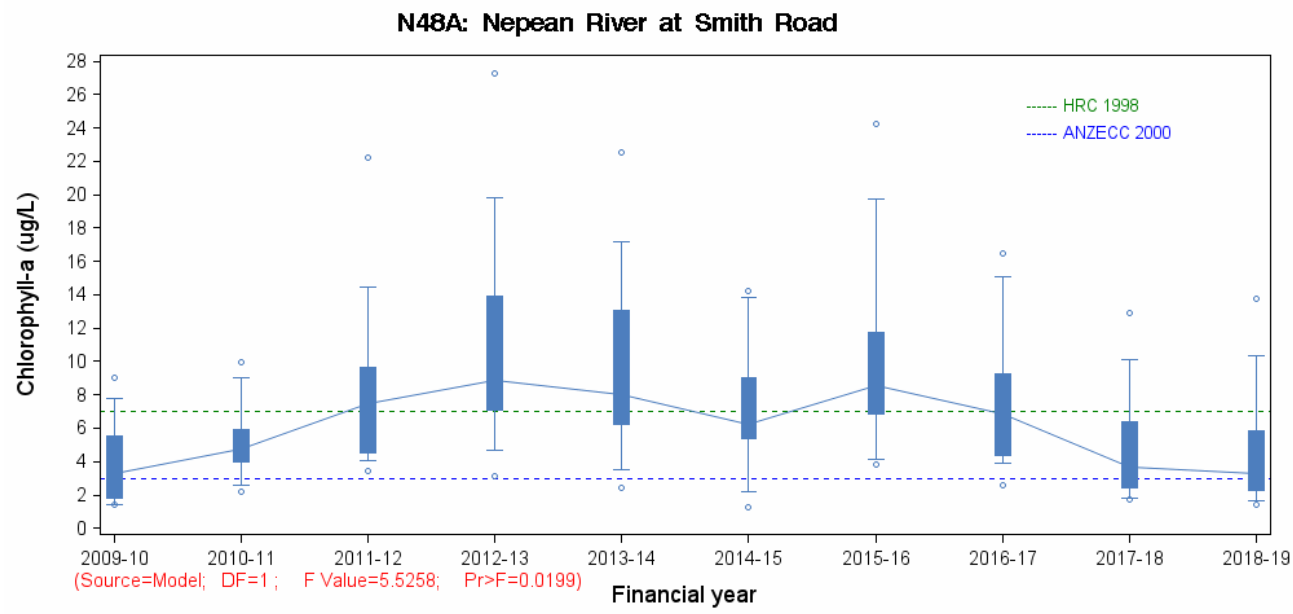


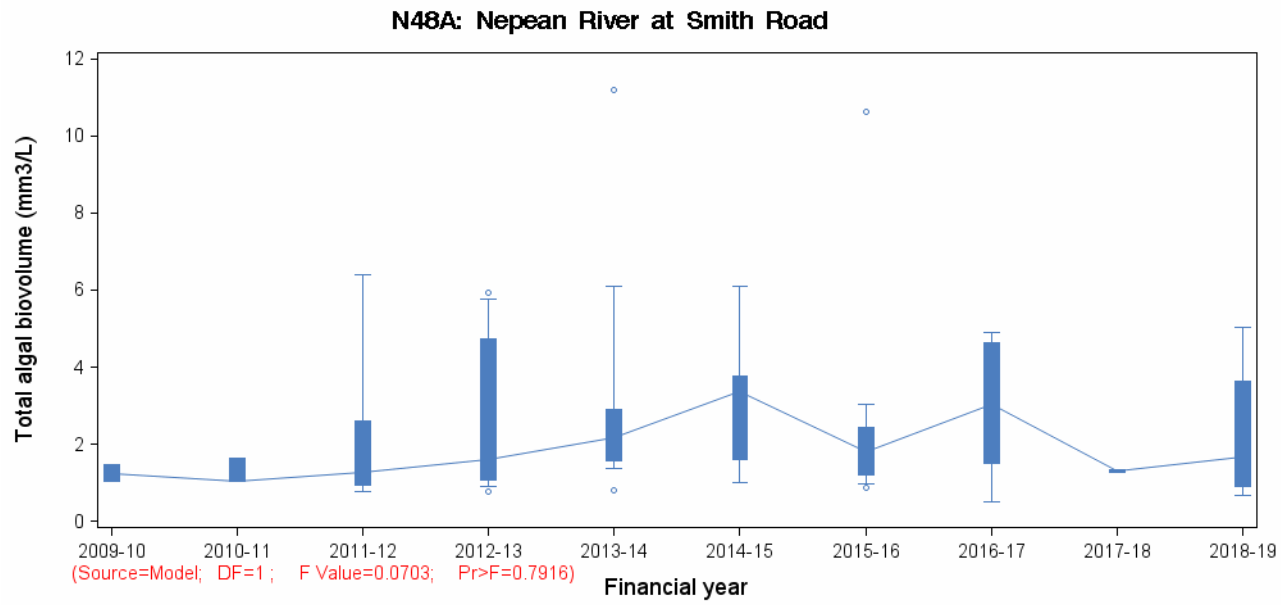


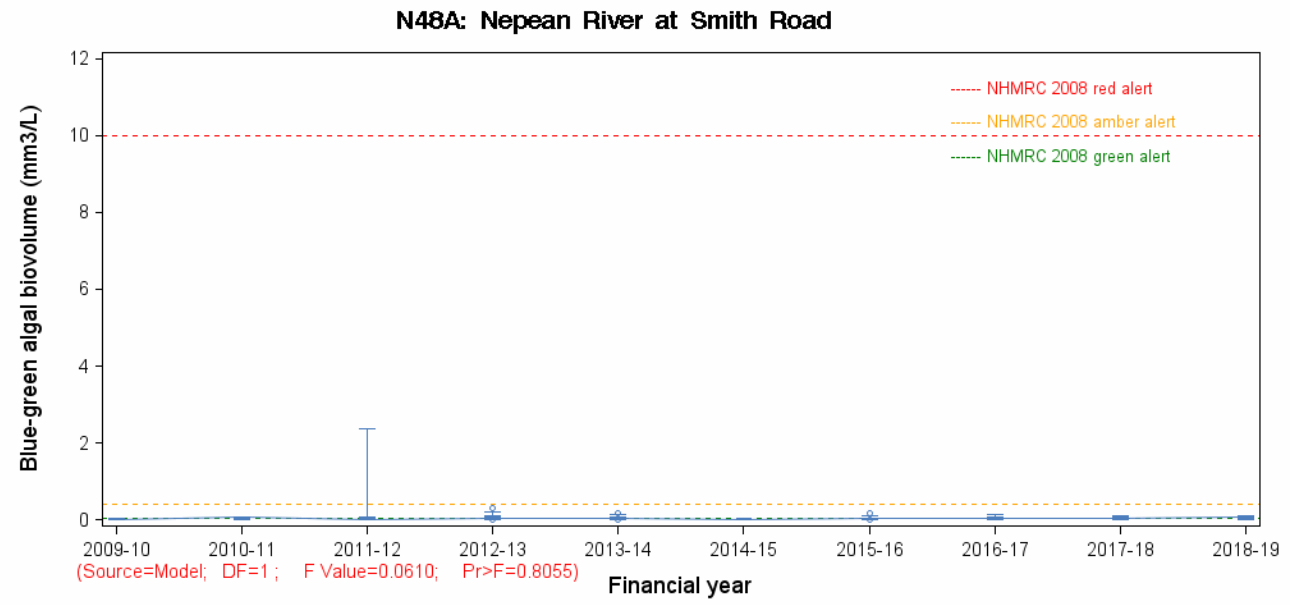


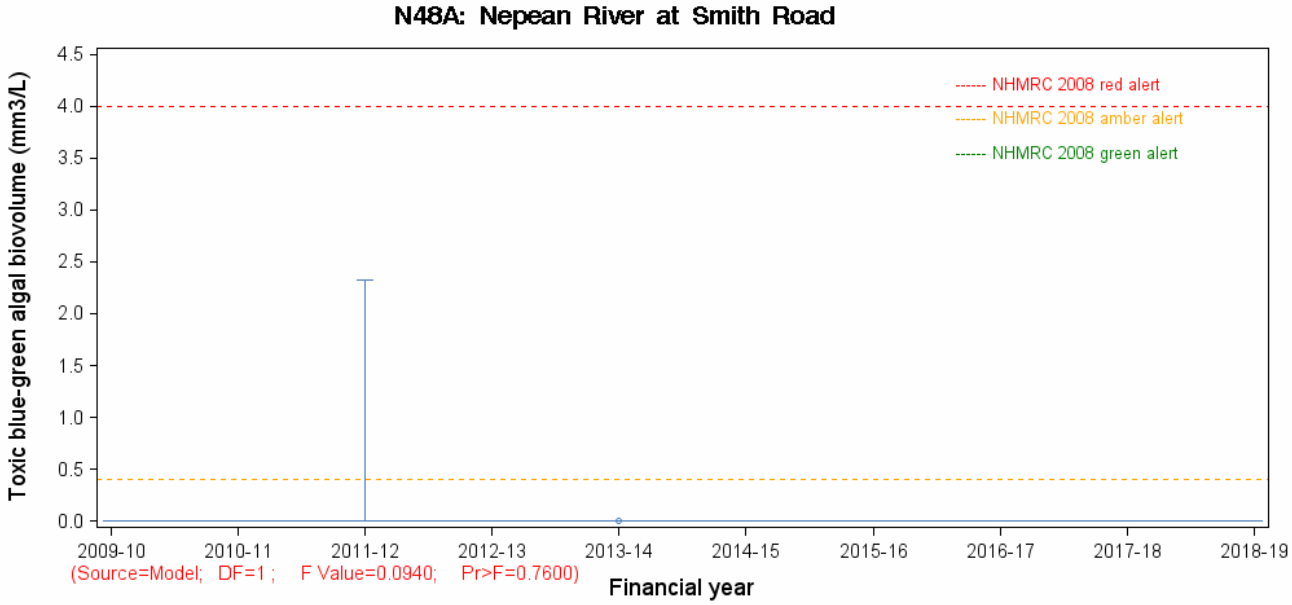

N48A: Nepean River at Smith Road
Filterable total phosphorus (mg/L)
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.5498; Pr>F=0.0613)
Financial year

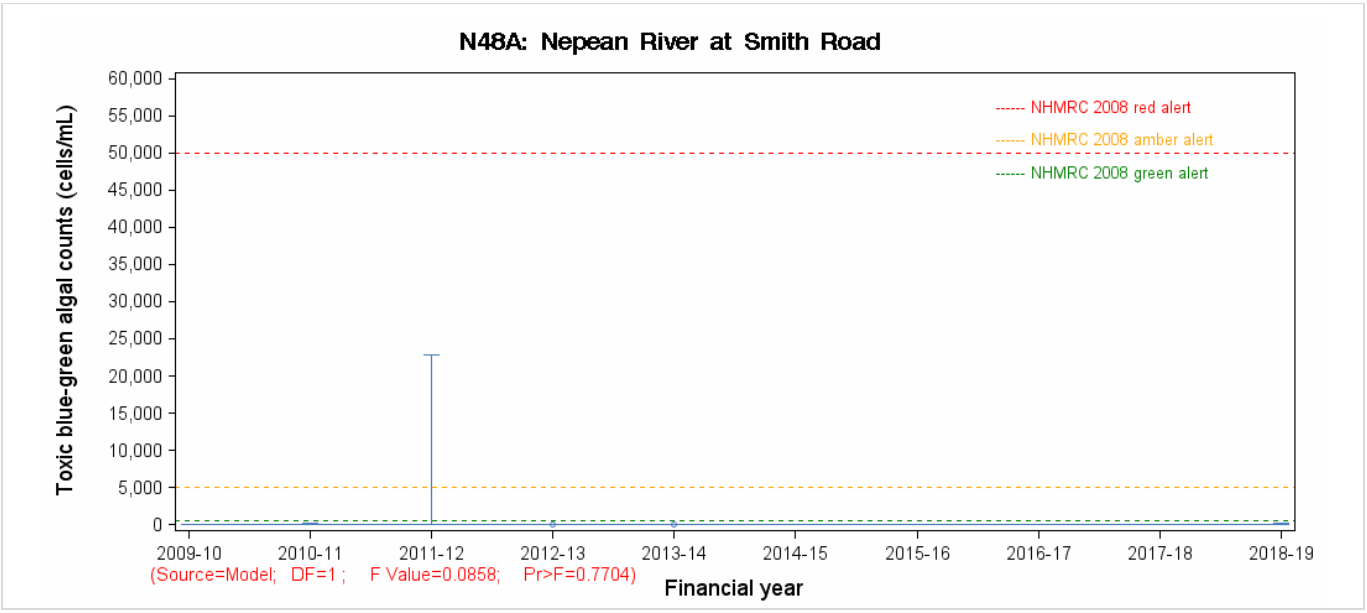

N48A: Nepean River at Smith Road
Total phosphorus (mg/L)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
----- HRC 1998
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=6.4568; Pr>F=0.0120)
Financial year


N48A: Nepean River at Smith Road
Chlorophyll-a (ug/L)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
----- HRC 1998
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.5258; Pr>F=0.0199)
Financial year

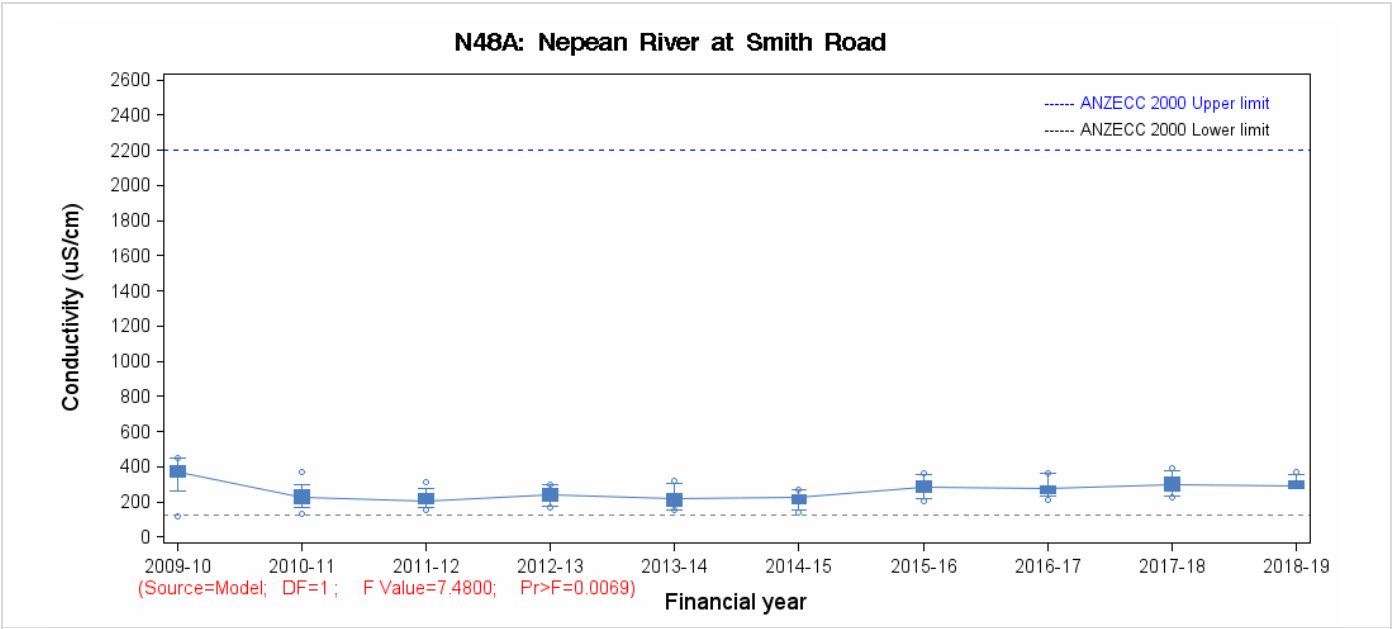

N48A: Nepean River at Smith Road
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0703; Pr>F=0.7916)
Financial year

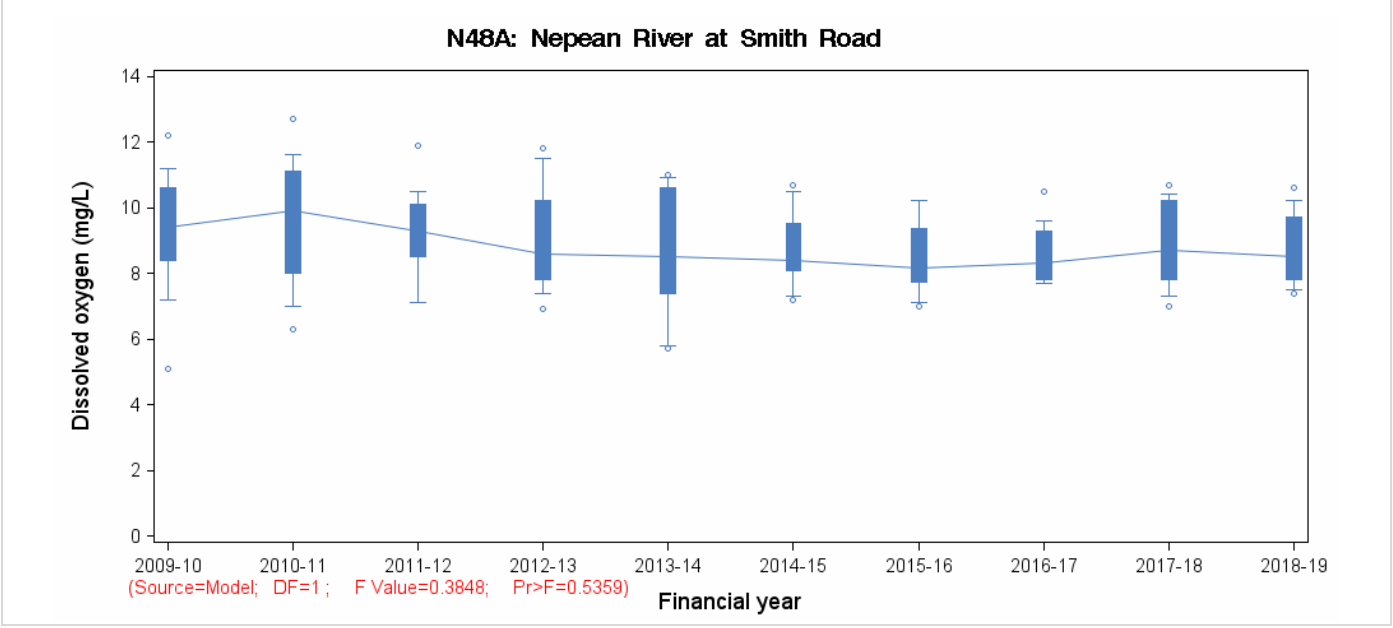

N48A: Nepean River at Smith Road
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0610; Pr>F=0.8055)
Financial year

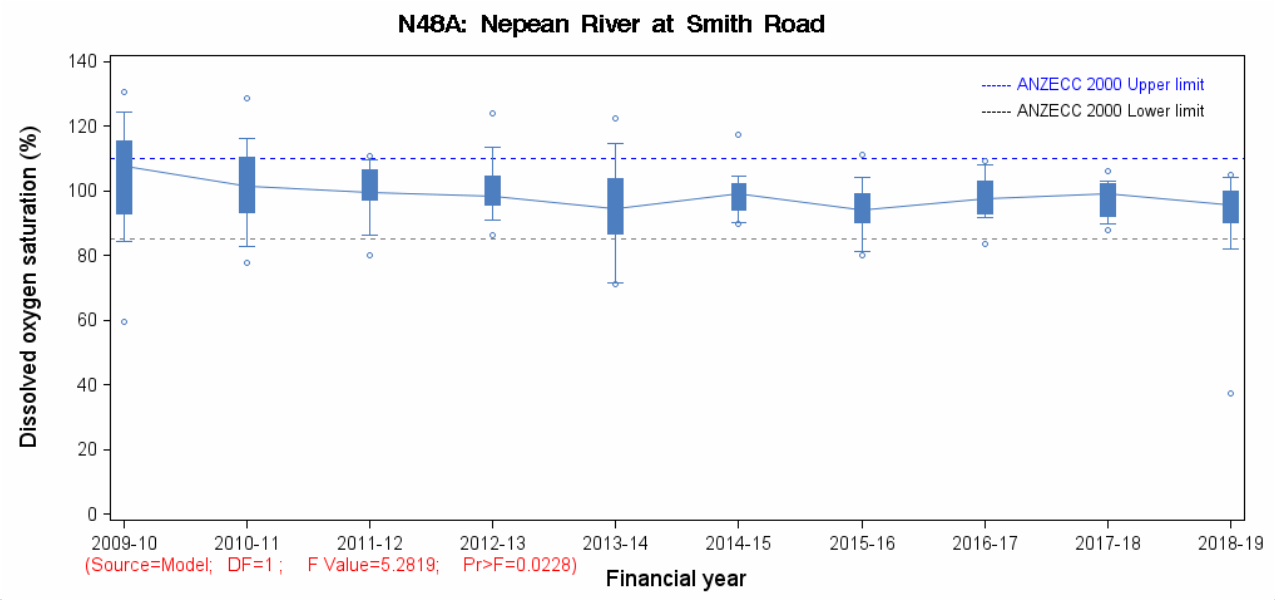

N48A: Nepean River at Smith Road
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0940; Pr>F=0.7600)
Financial year

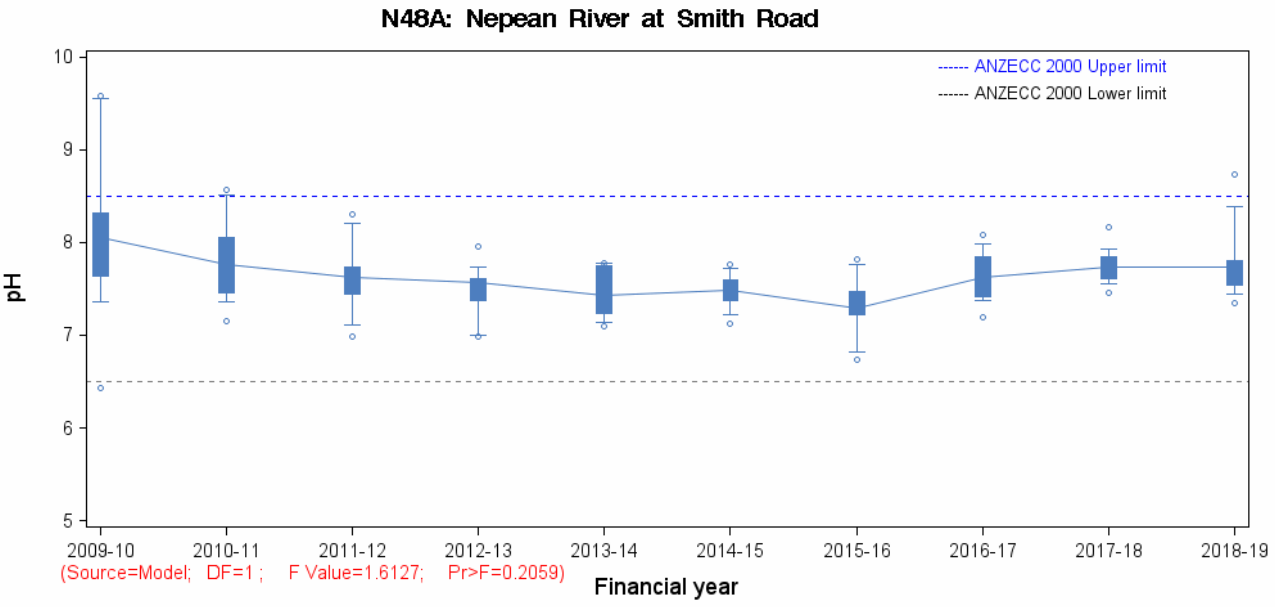


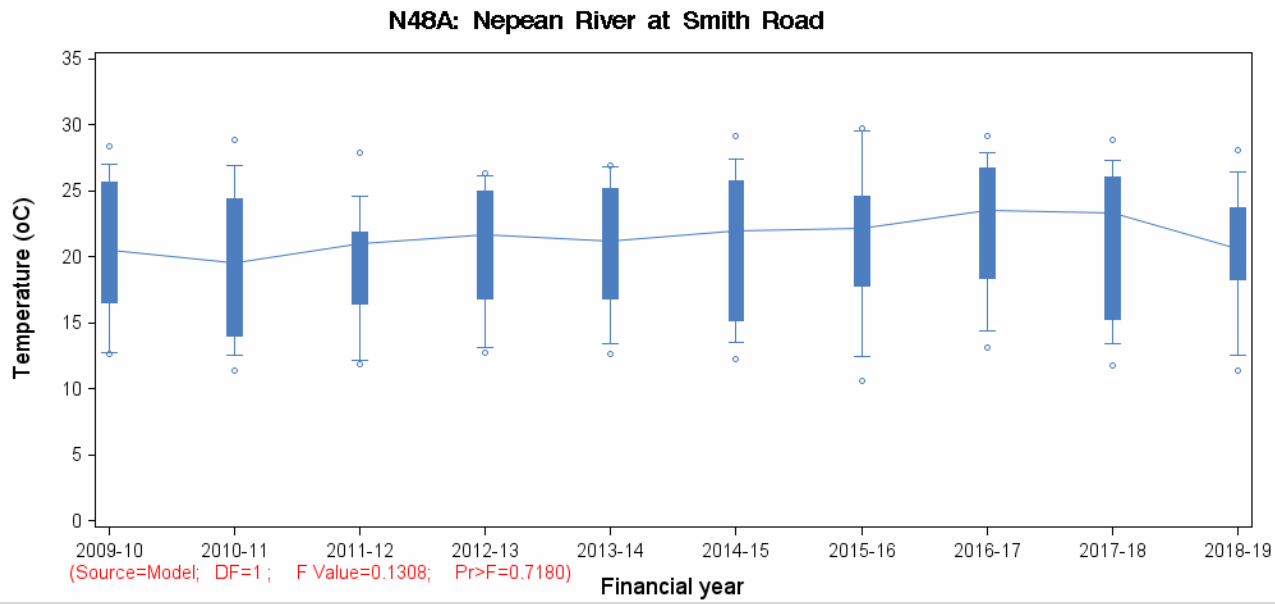
Other physico-chemical analytes

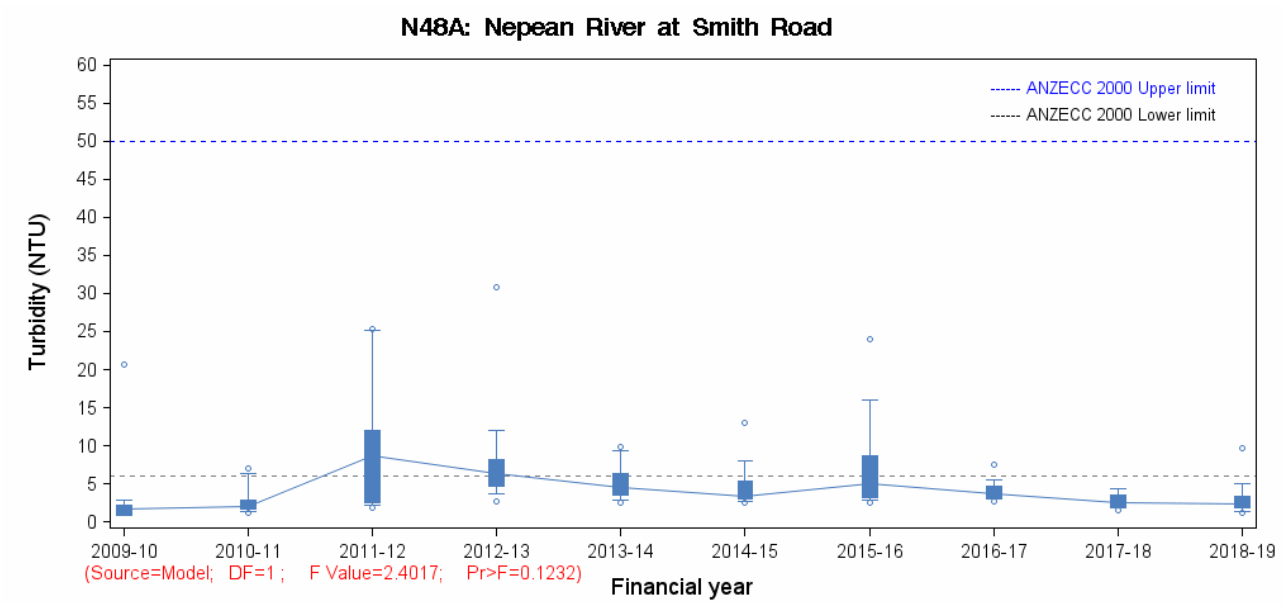


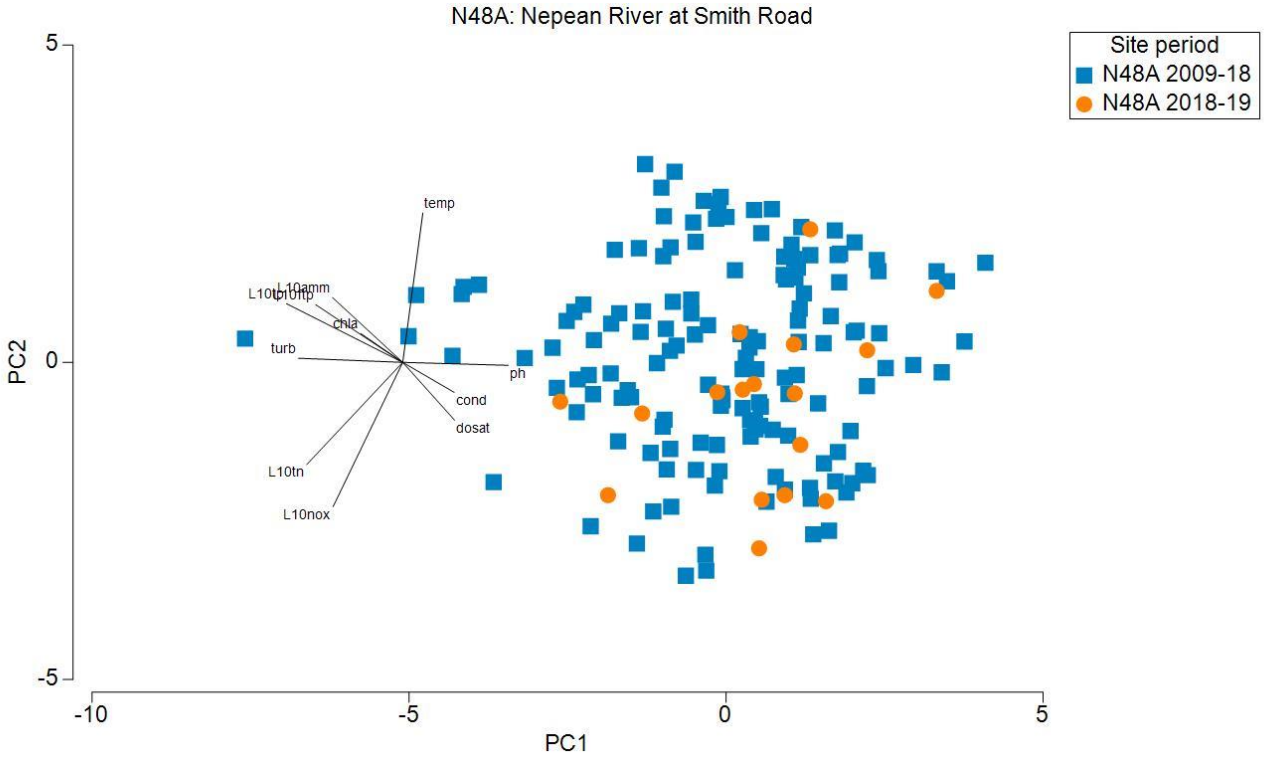



N48A: Nepean River at Smith Road
Dissolved oxygen saturation (%)
140
120
100
80
60
40
20
0
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.2819; Pr>F=0.0228)
Financial year


N48A: Nepean River at Smith Road
pH
10
9
8
7
6
5
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.6127; Pr>F=0.2059)
Financial year


N48A: Nepean River at Smith Road
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1308; Pr>F=0.7180)
Financial year

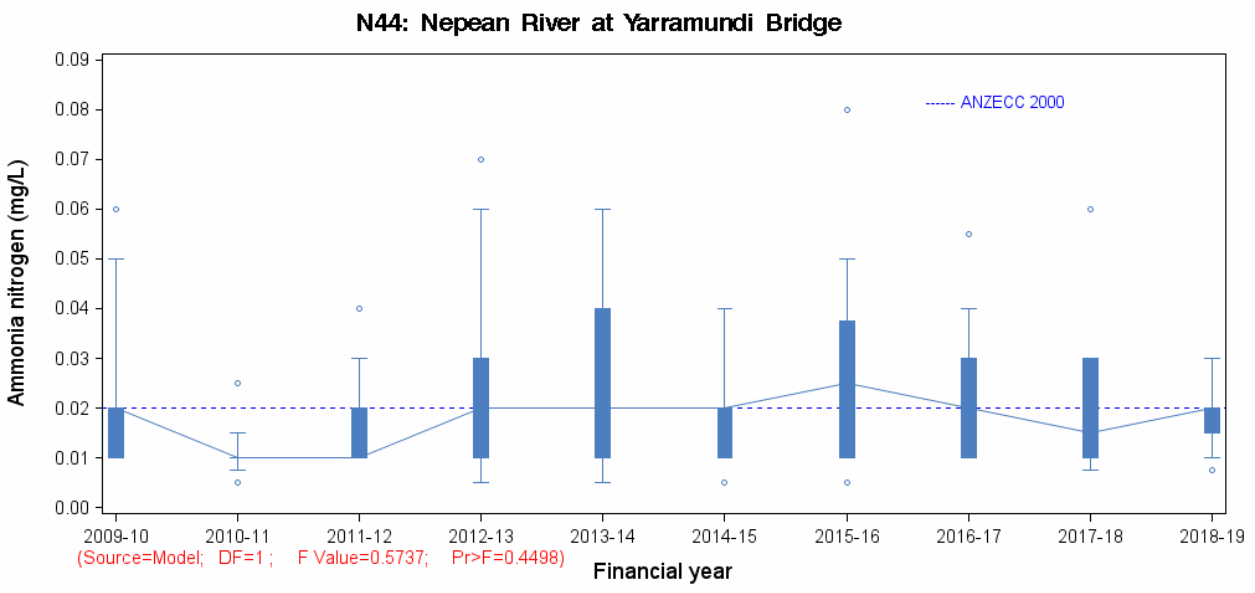


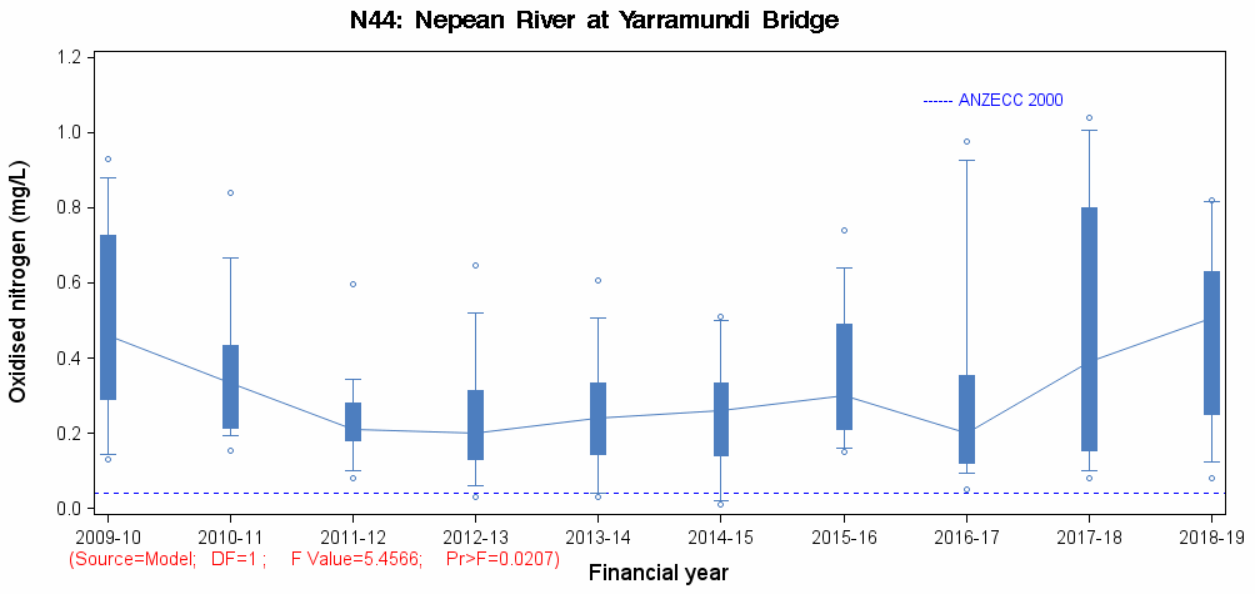


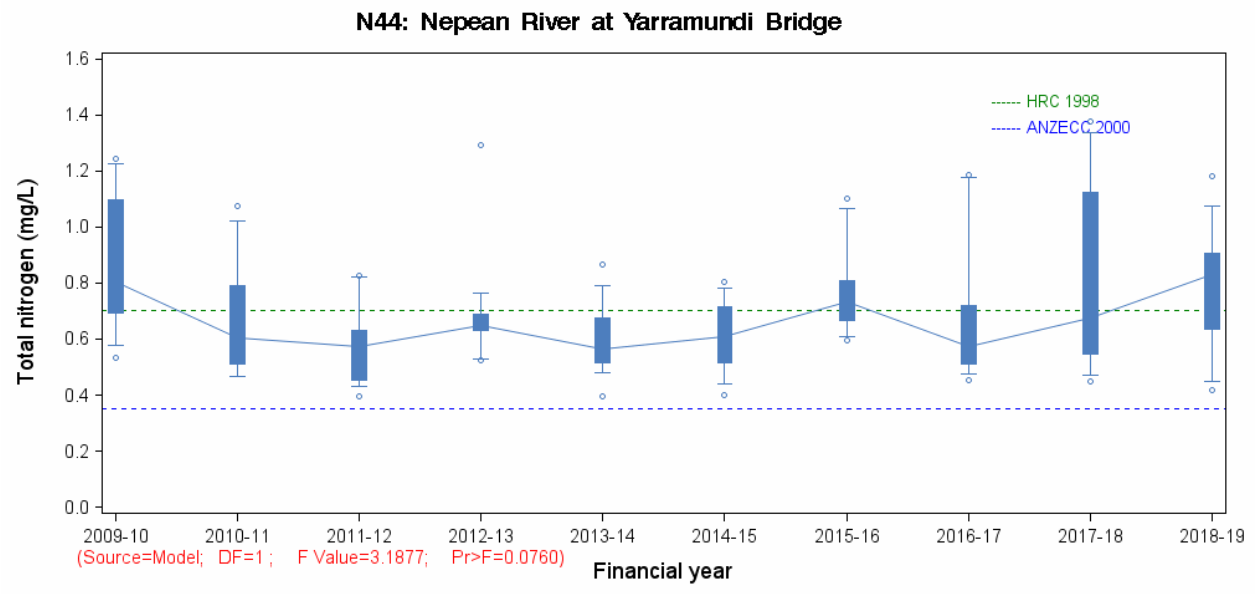
The ordination plot from Principal Components Analysis suggested water quality of the Nepean River at Smith Road in 2018-19 was similar to that recorded in the period 2009 to 2018.

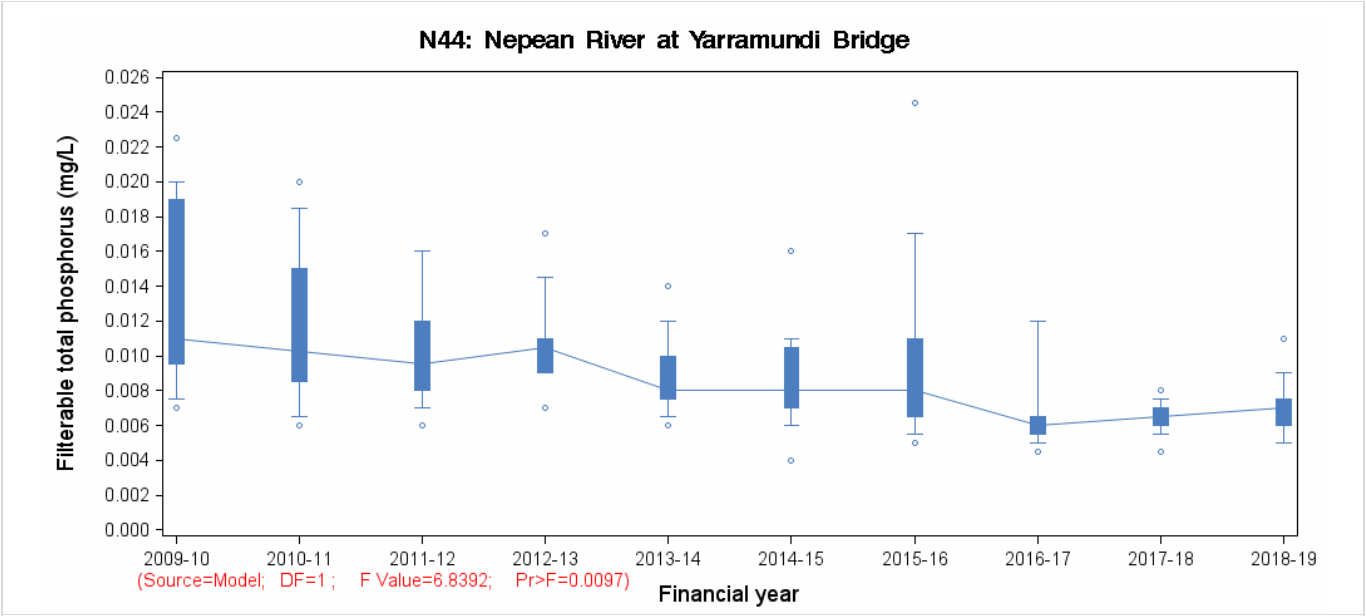
N44: Nepean River at Yarramundi Bridge

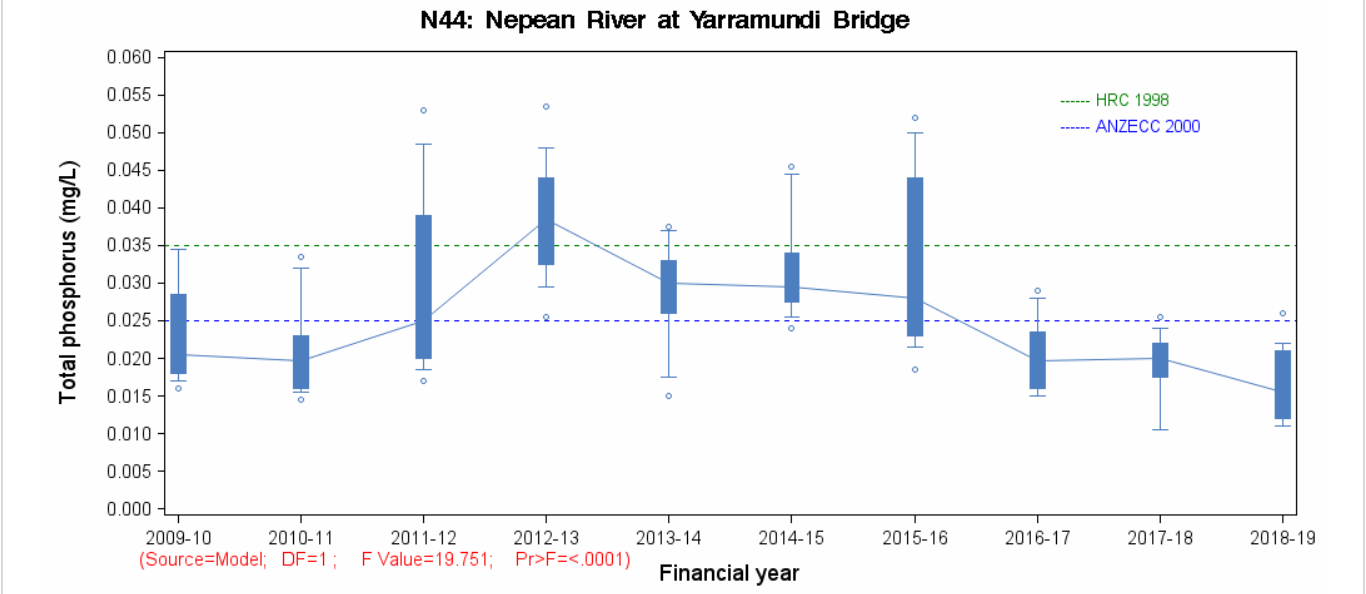
Nutrients, chlorophyll-*a* and algae

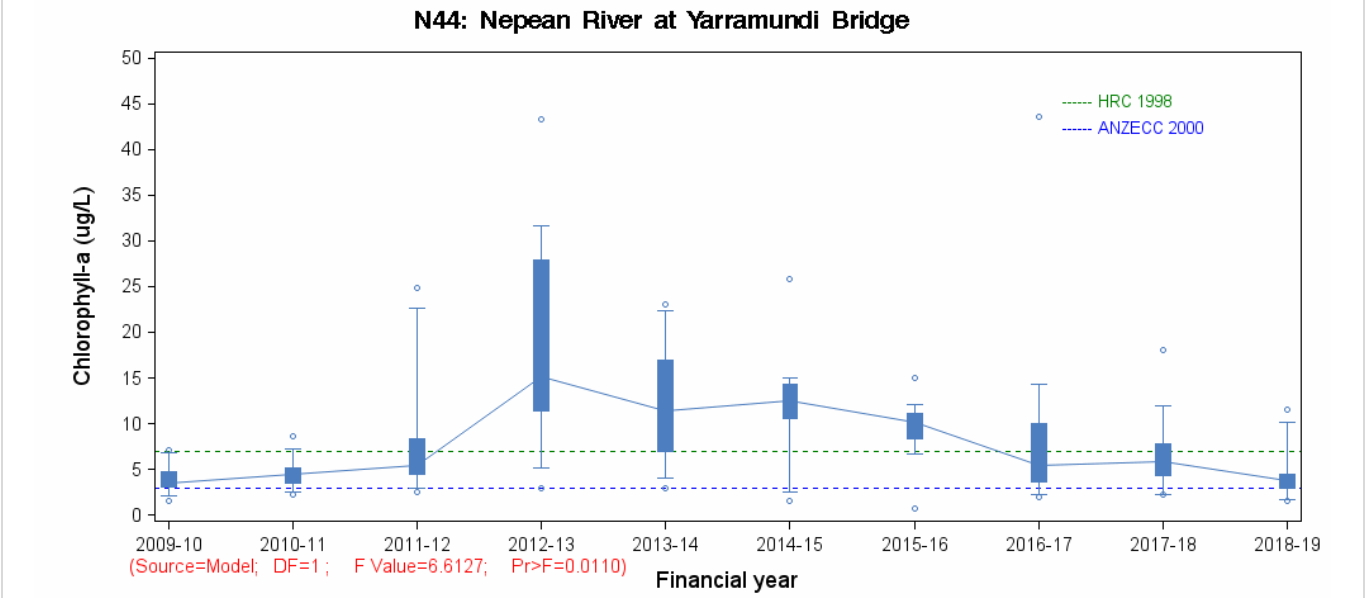


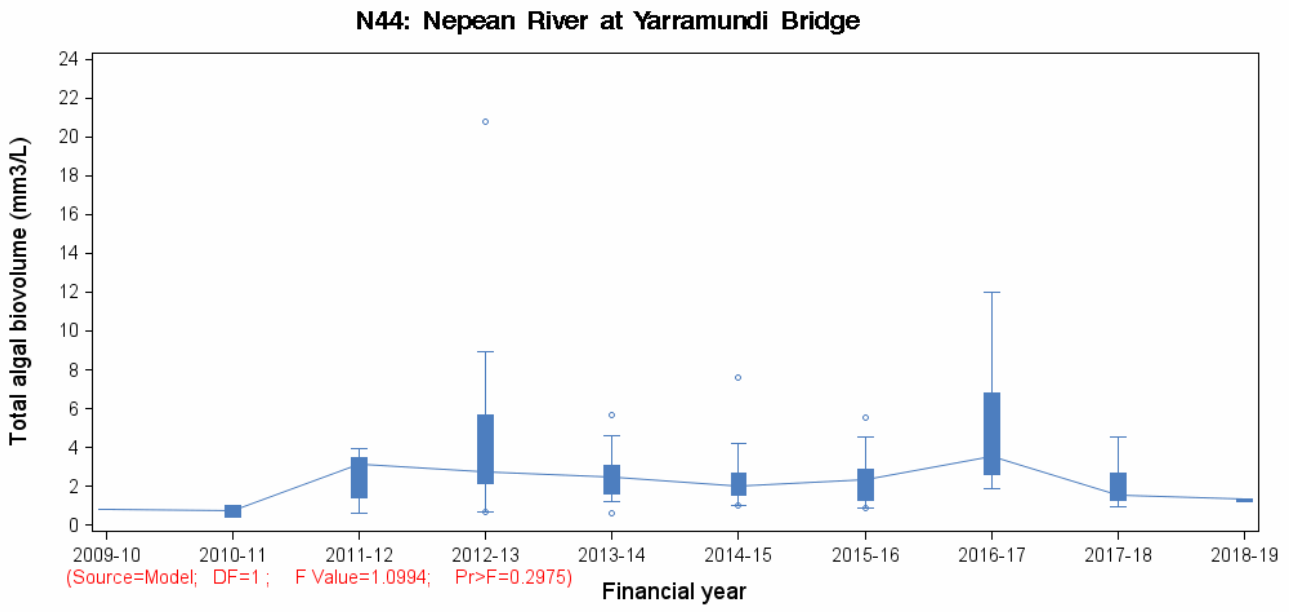


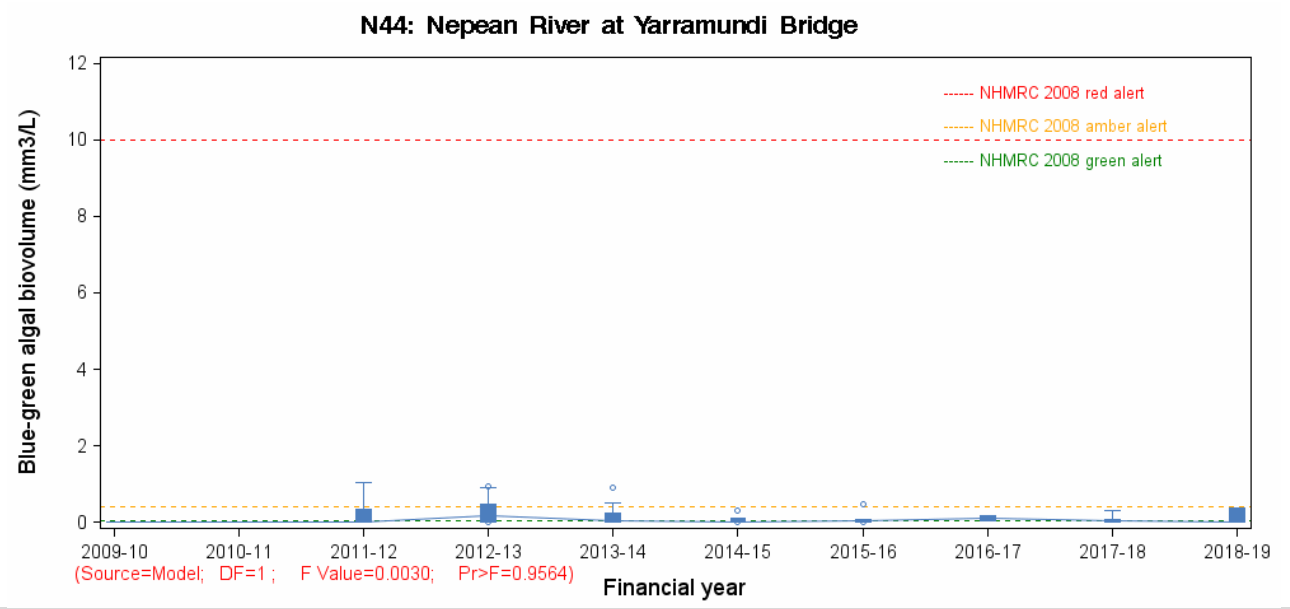


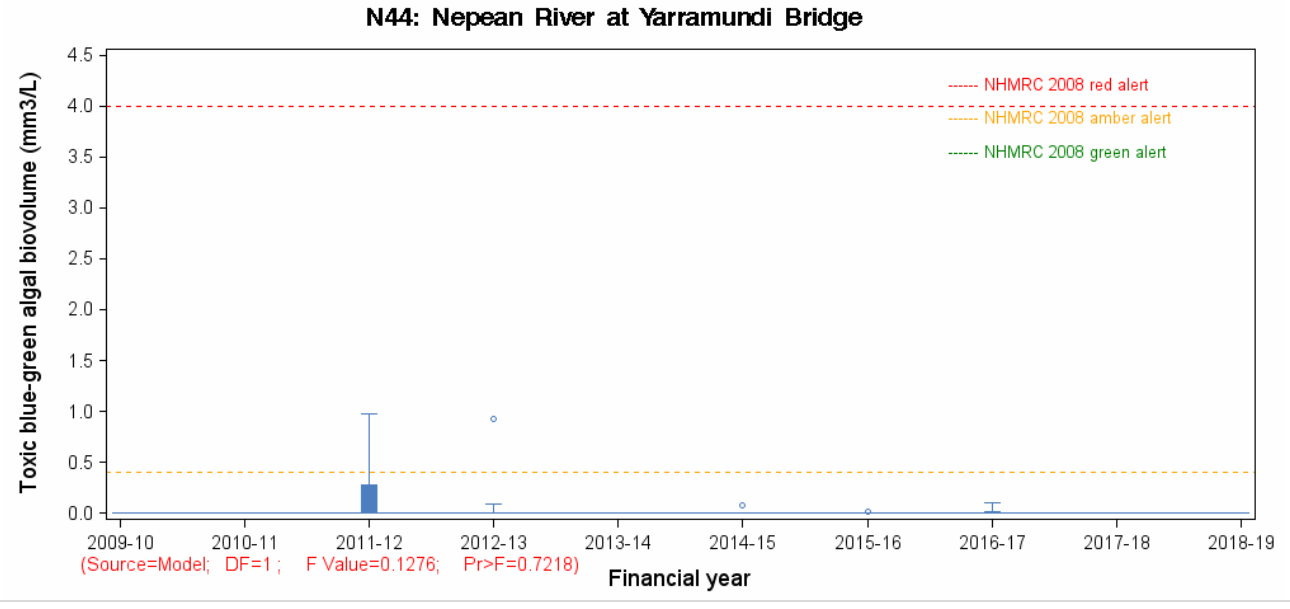

N44: Nepean River at Yarramundi Bridge
Filterable total phosphorus (mg/L)
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=6.8392; Pr>F=0.0097)
Financial year

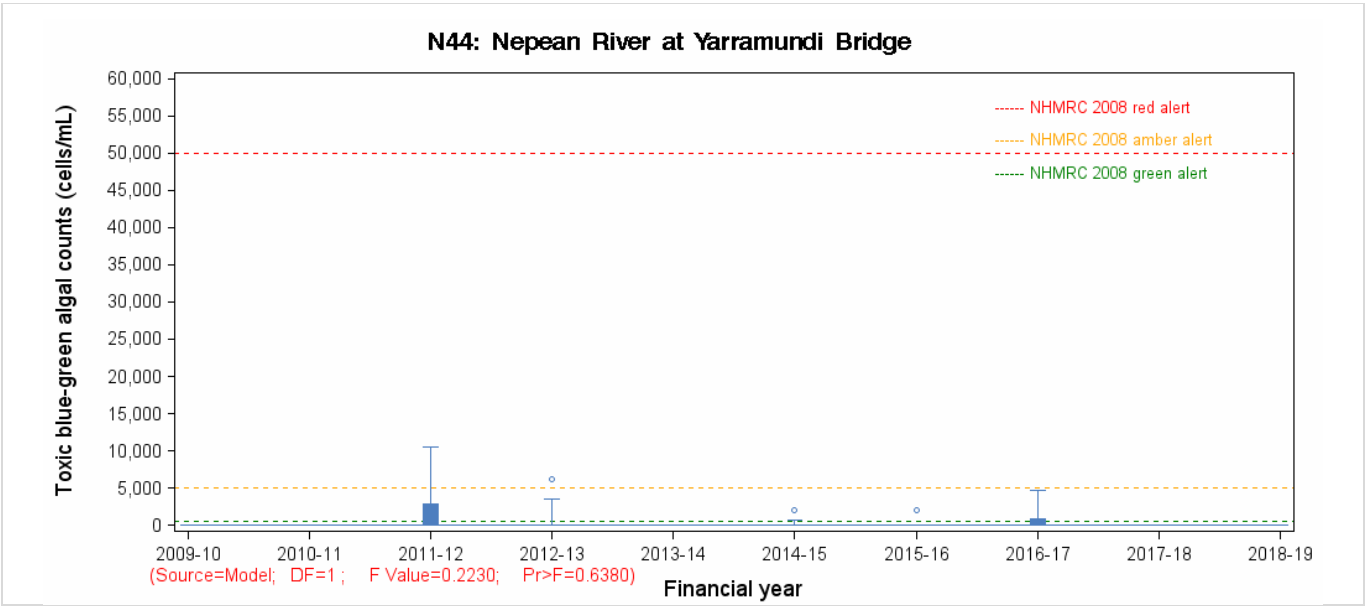

N44: Nepean River at Yarramundi Bridge
Total phosphorus (mg/L)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=19.751; Pr>F=<.0001)
Financial year


N44: Nepean River at Yarramundi Bridge
Chlorophyll-a (ug/L)
50
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=6.6127; Pr>F=0.0110)
Financial year

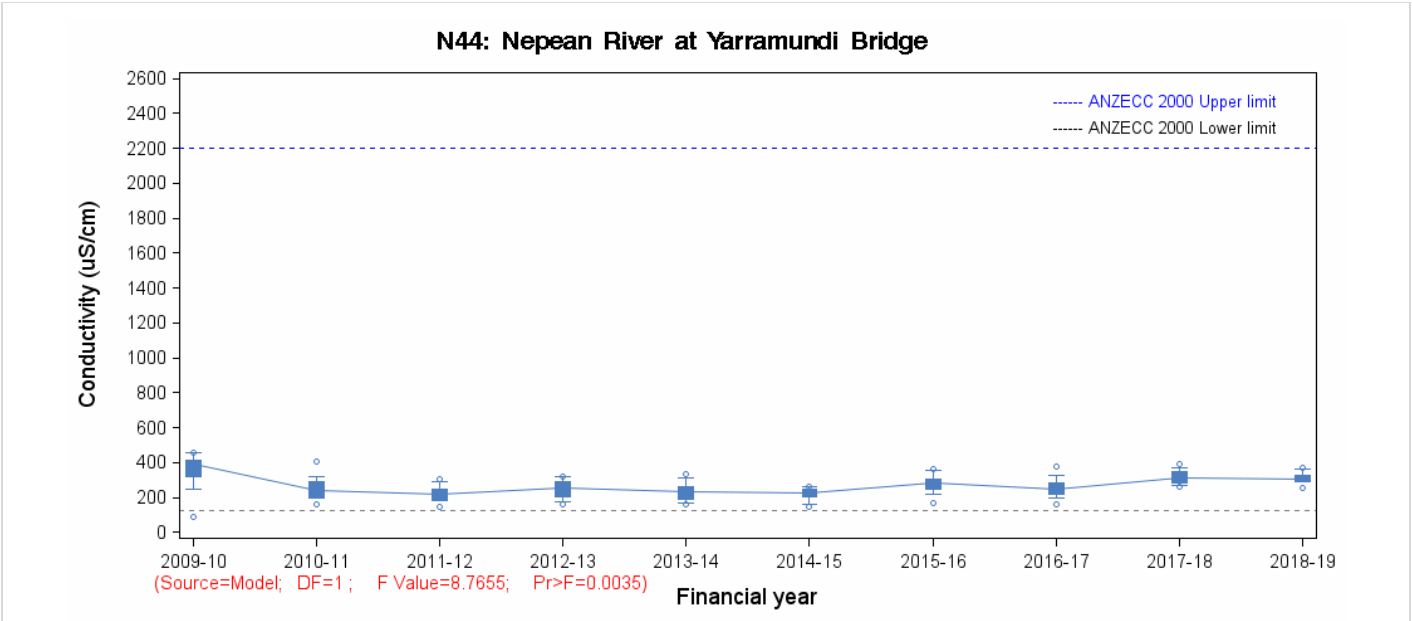

N44: Nepean River at Yarramundi Bridge
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
18
20
22
24
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.0994; Pr>F=0.2975)
Financial year

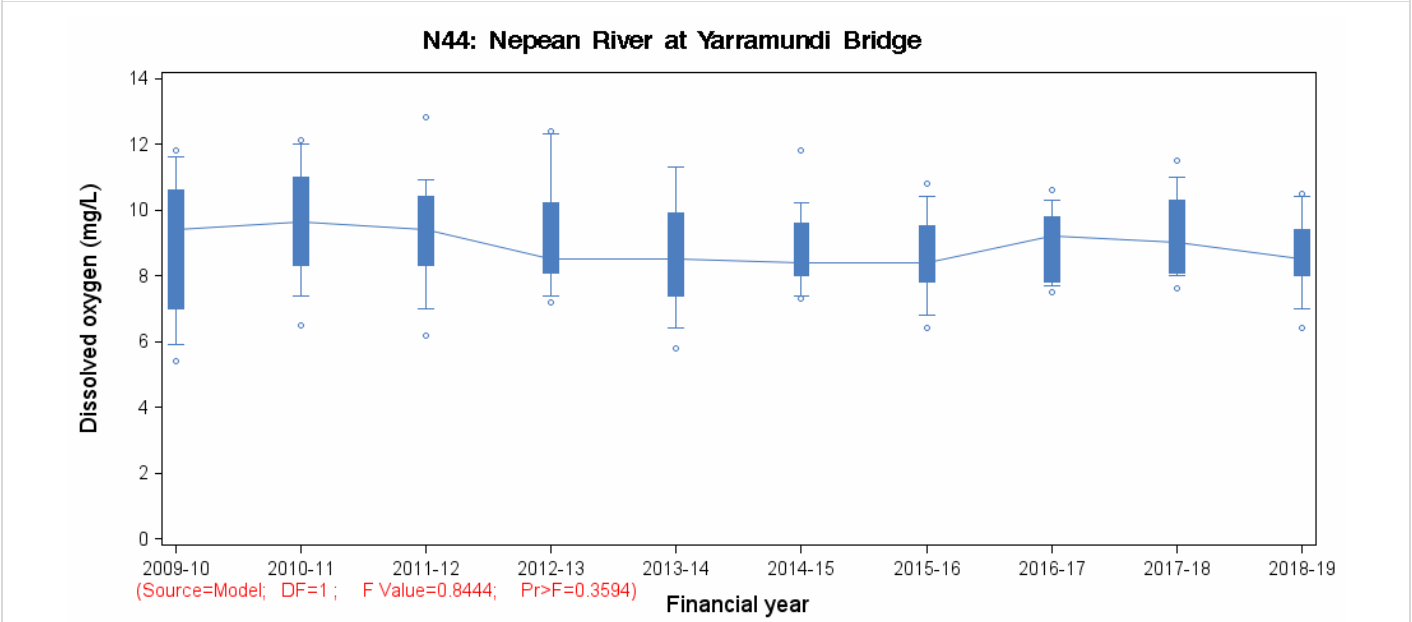

N44: Nepean River at Yarramundi Bridge
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0030; Pr>F=0.9564)
Financial year

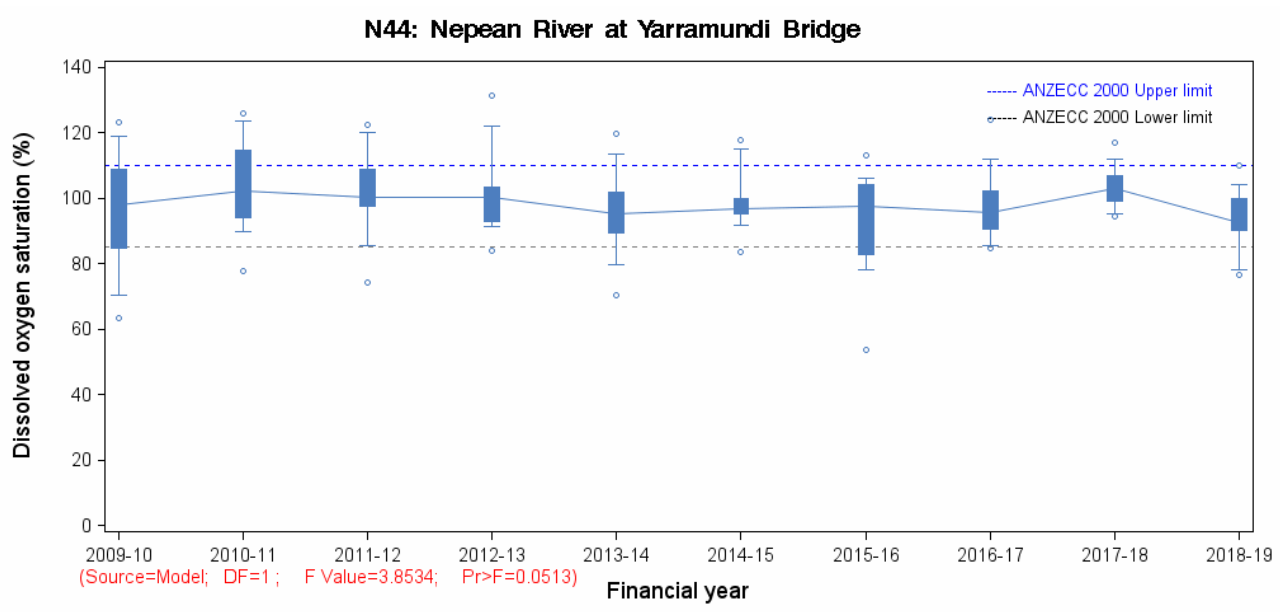

N44: Nepean River at Yarramundi Bridge
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1276; Pr>F=0.7218)
Financial year

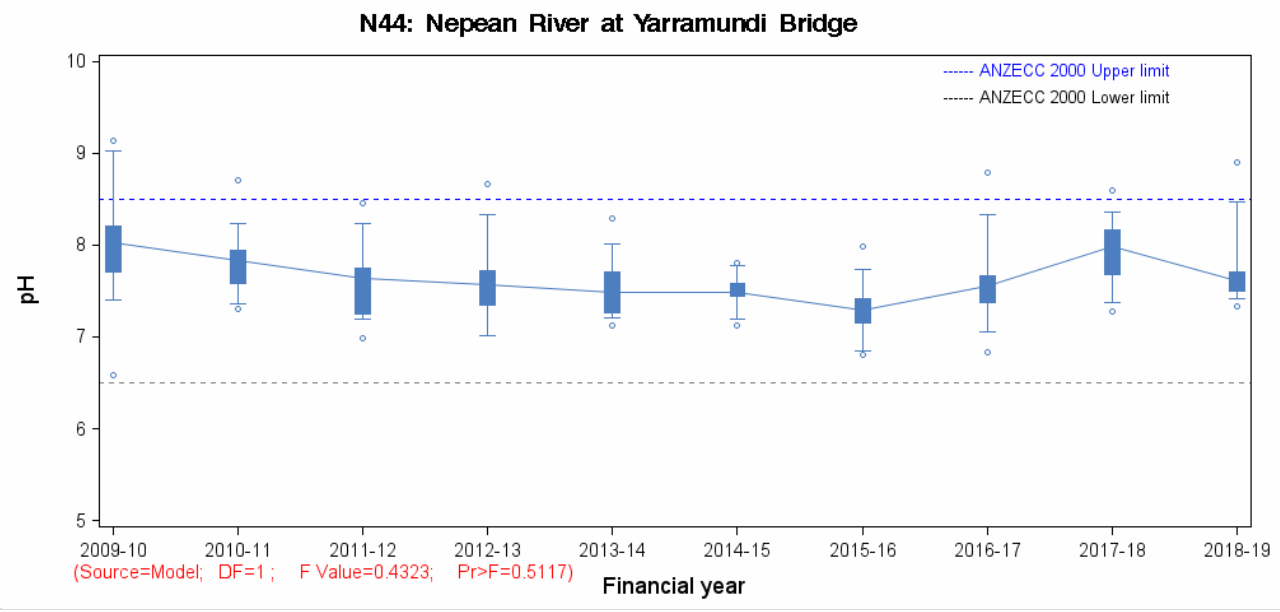


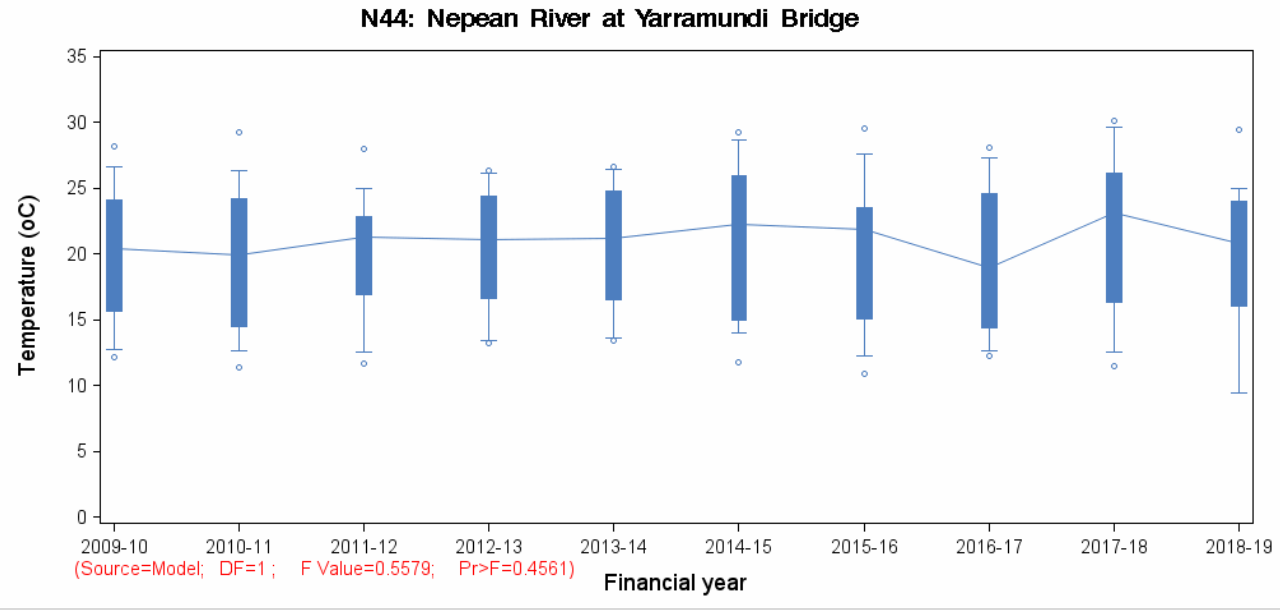
Other physico-chemical analytes

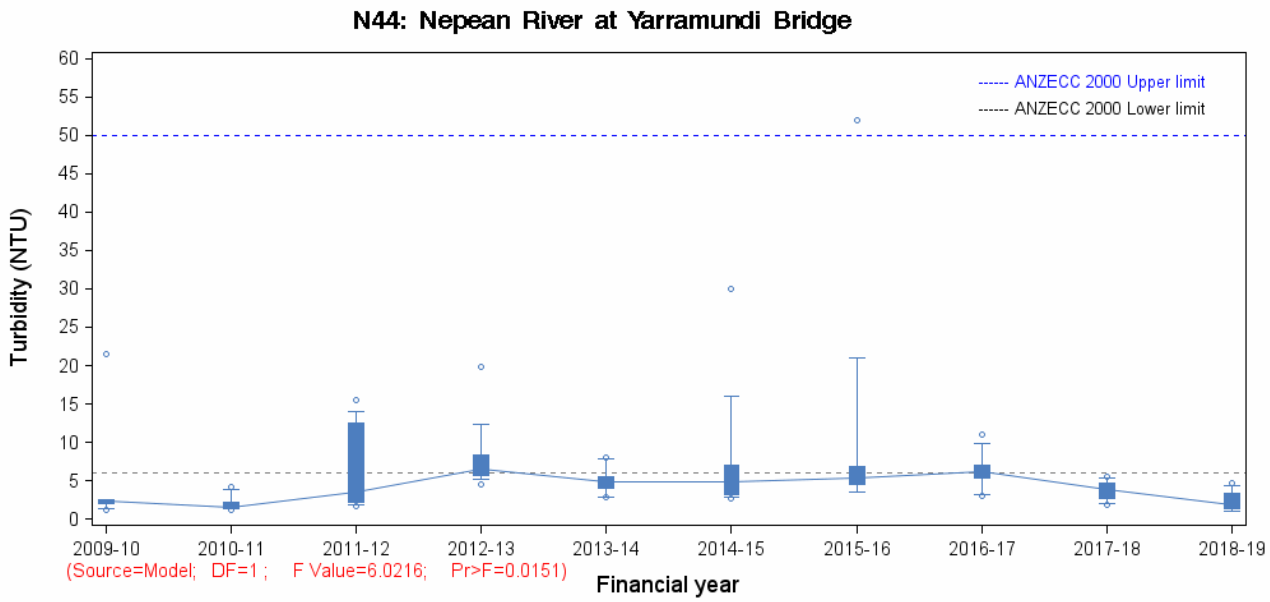


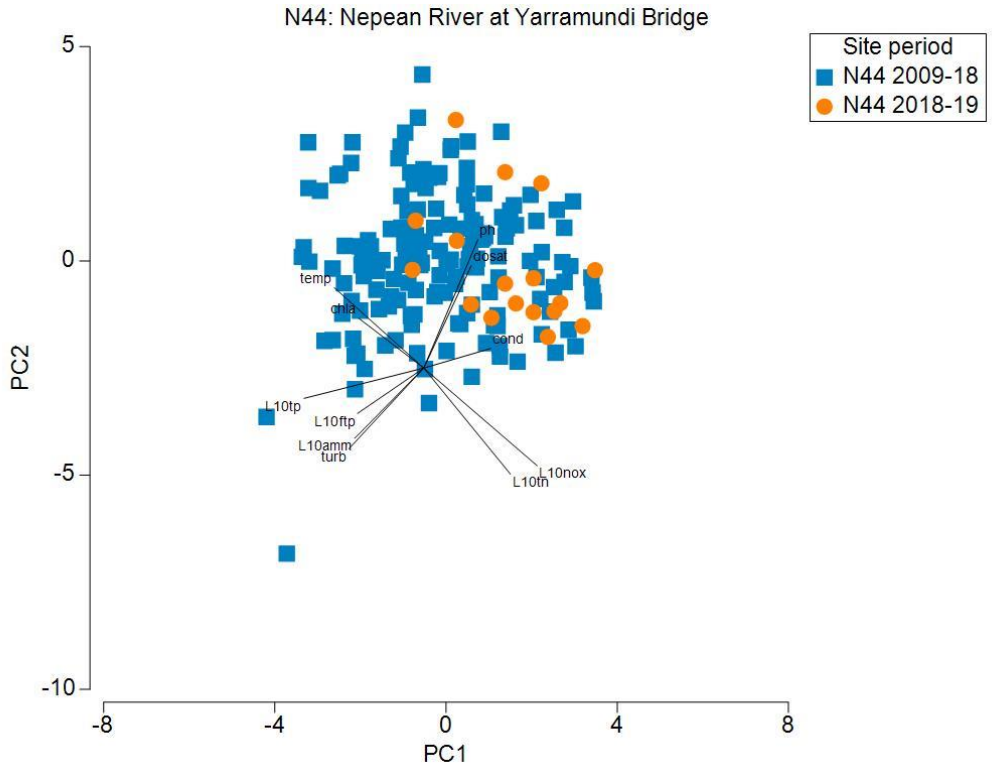



N44: Nepean River at Yarramundi Bridge
Dissolved oxygen saturation (%)
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.8534; Pr>F=0.0513)
Financial year


N44: Nepean River at Yarramundi Bridge
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.4323; Pr>F=0.5117)
Financial year


N44: Nepean River at Yarramundi Bridge
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5579; Pr>F=0.4561)
Financial year

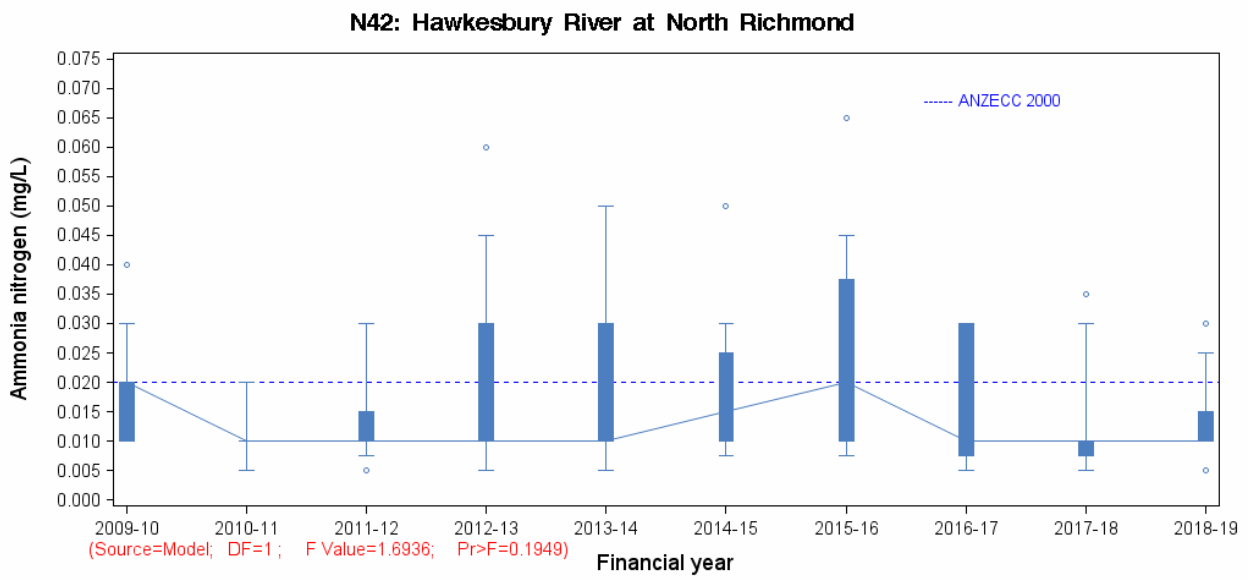


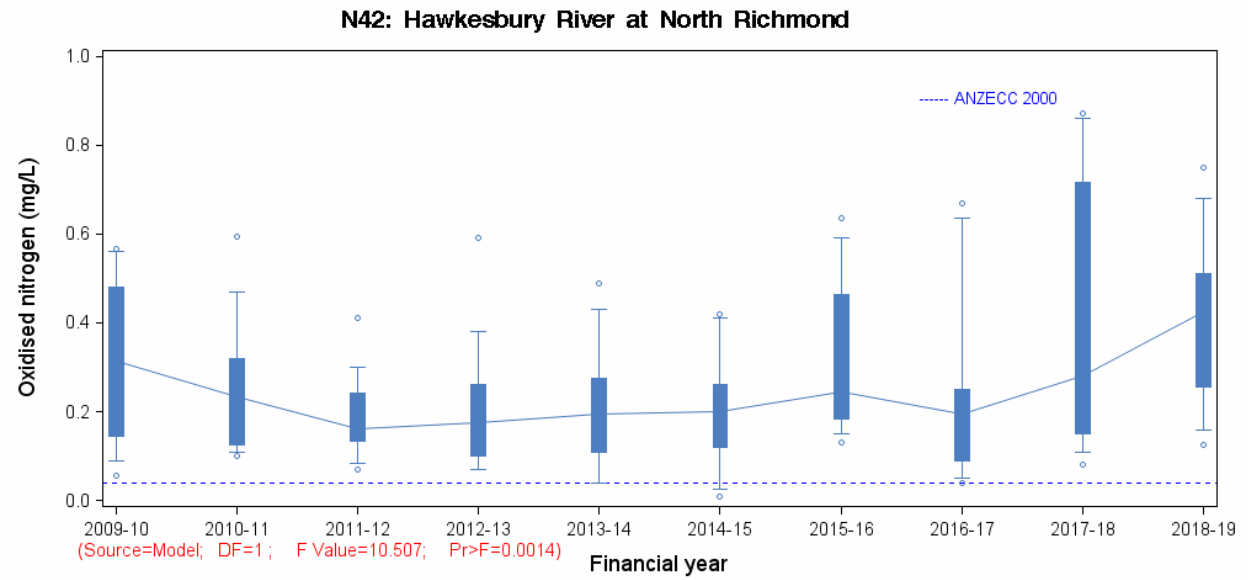


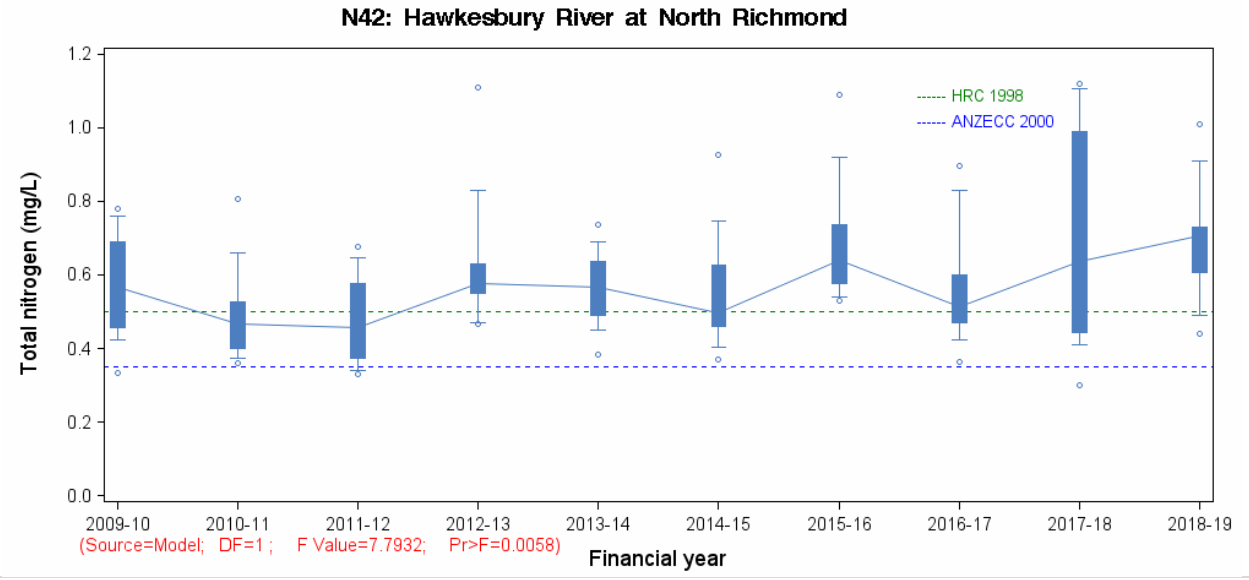
The ordination plot from Principal Components Analysis suggested water quality of the Nepean River at Yarramundi Bridge in 2018-19 was similar to that recorded in the period 2009 to 2018.

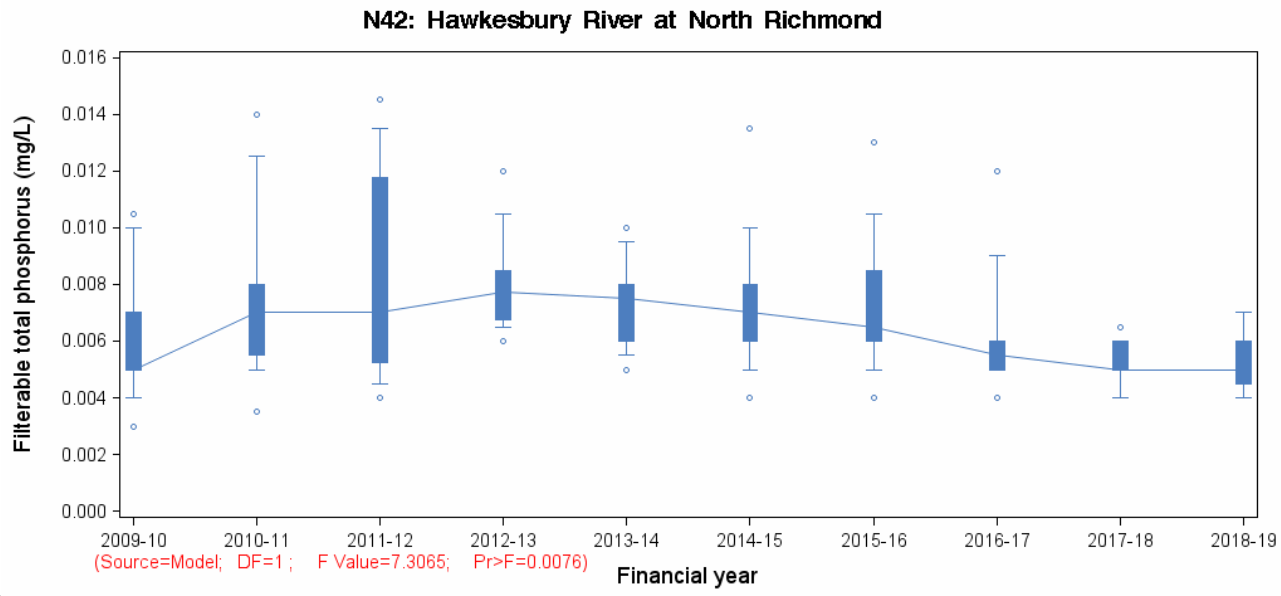
N42: Hawkesbury River at North Richmond

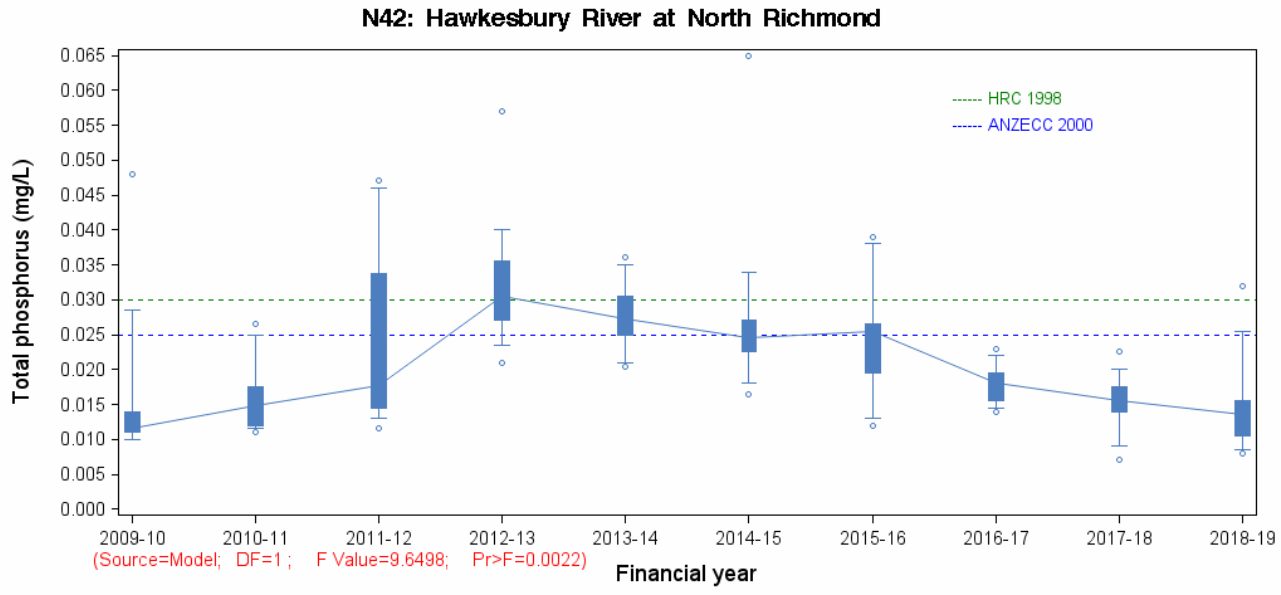
Nutrients, chlorophyll-*a* and algae

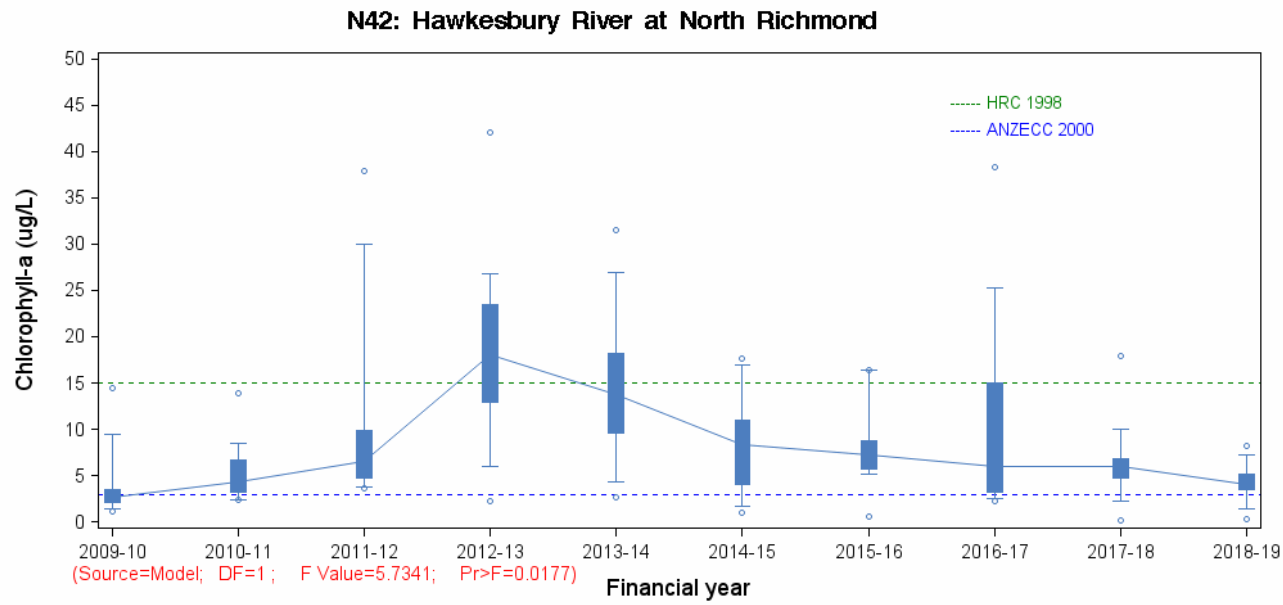


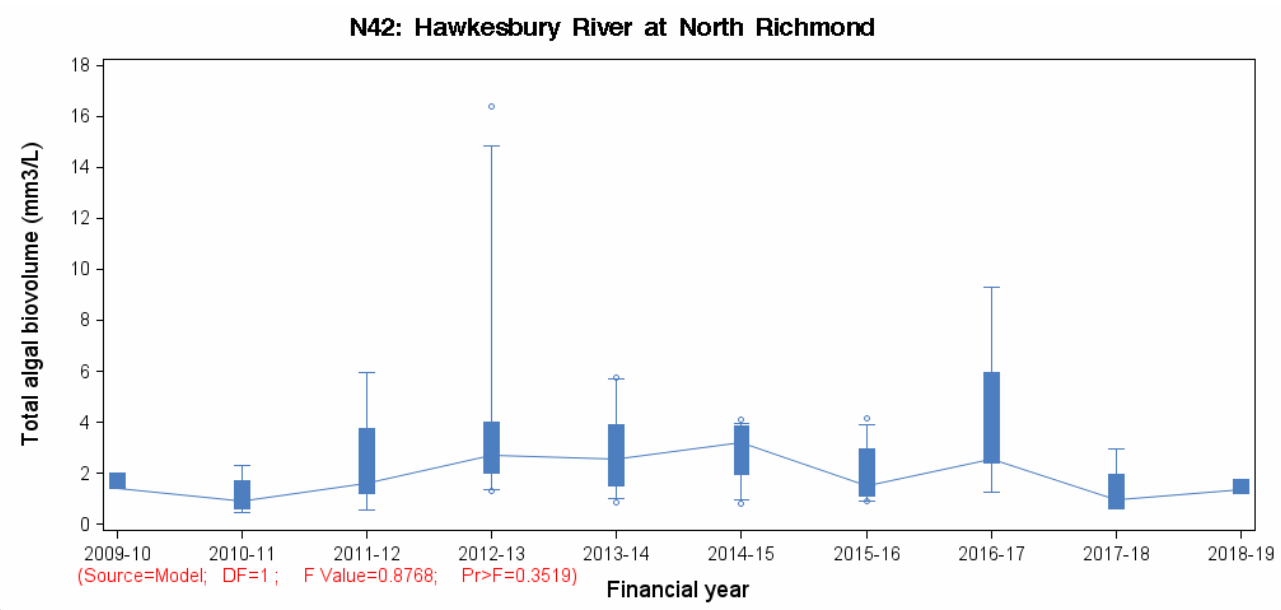


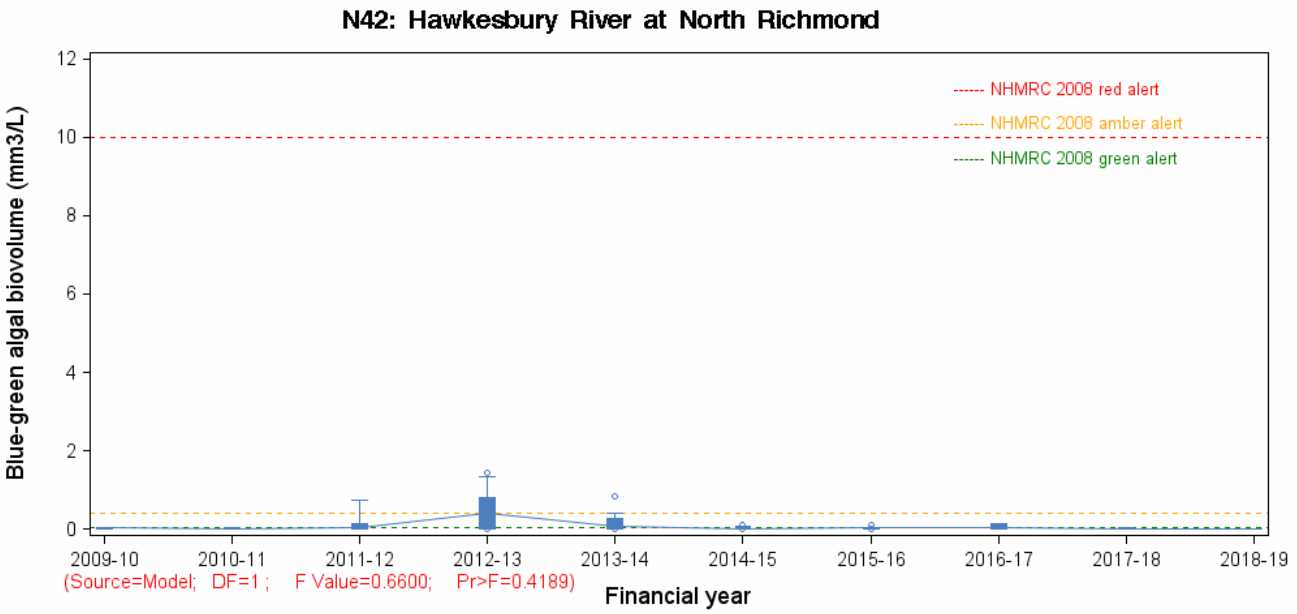


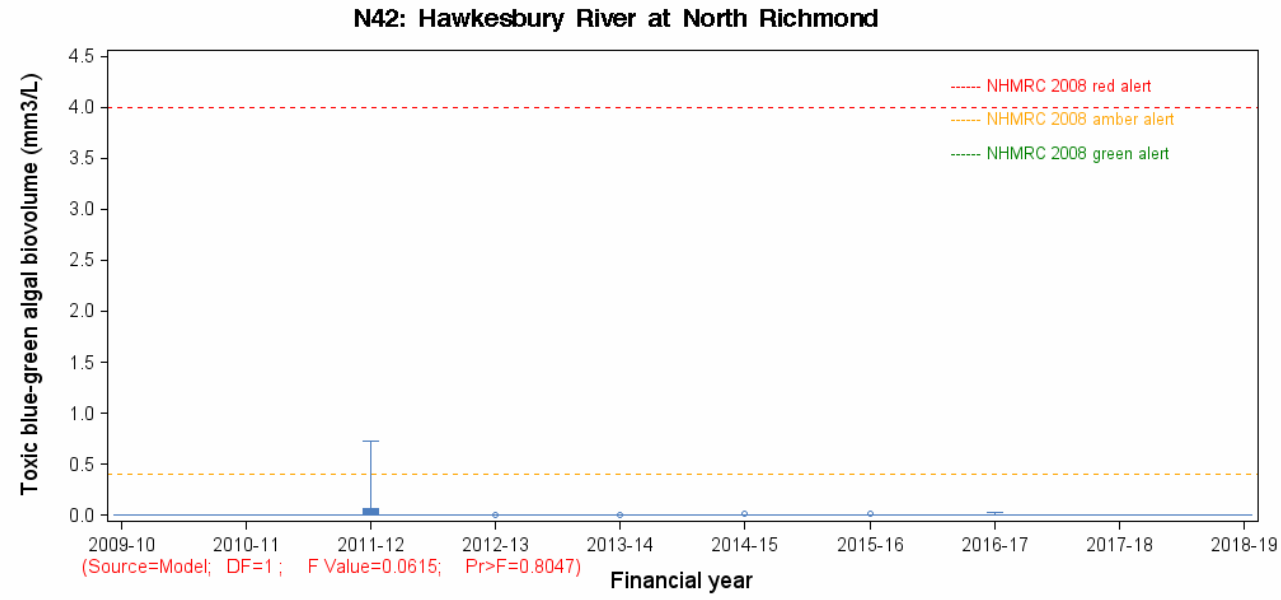

N42: Hawkesbury River at North Richmond
Filterable total phosphorus (mg/L)
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.3065; Pr>F=0.0076)
Financial year

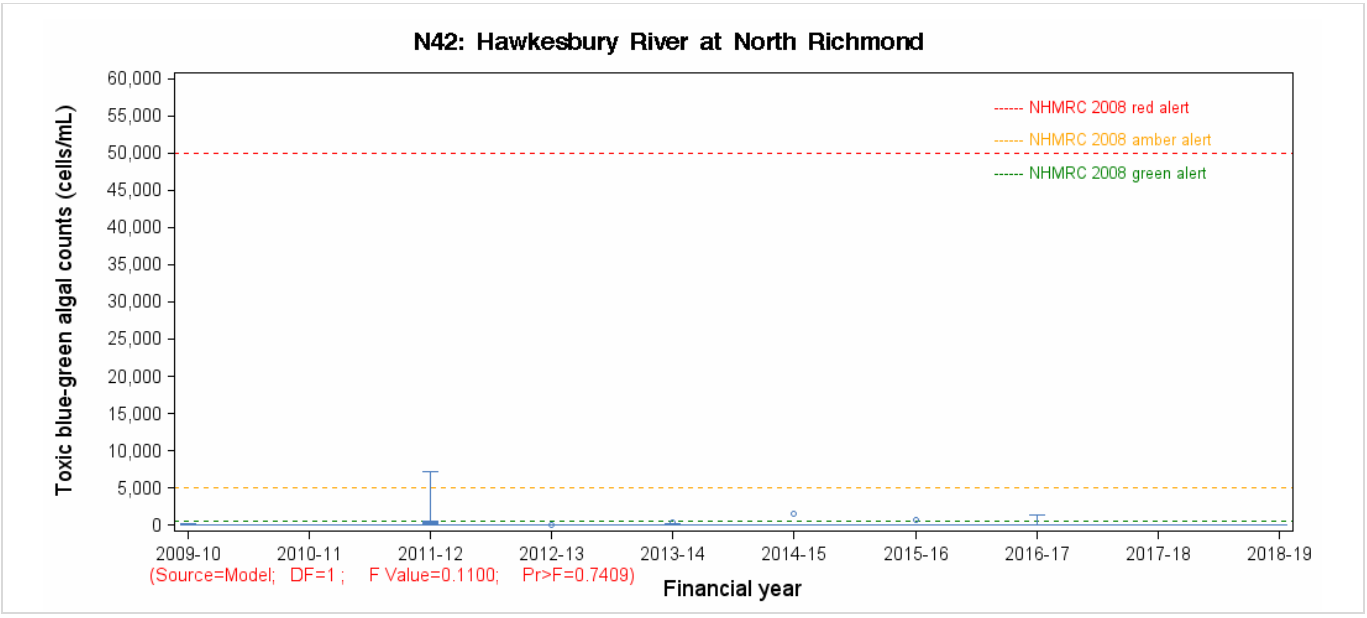

N42: Hawkesbury River at North Richmond
Total phosphorus (mg/L)
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=9.6498; Pr>F=0.0022)
Financial year


N42: Hawkesbury River at North Richmond
Chlorophyll-a (ug/L)
50
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.7341; Pr>F=0.0177)
Financial year

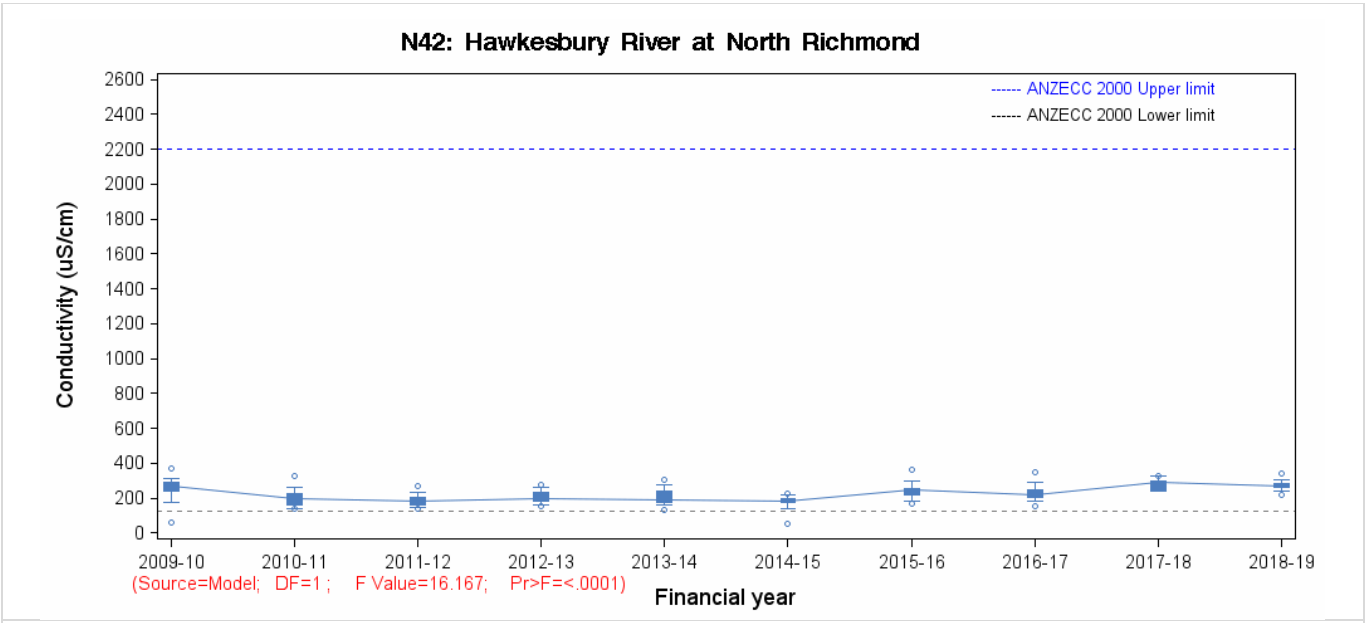

N42: Hawkesbury River at North Richmond
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
18
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.8768; Pr>F=0.3519)
Financial year

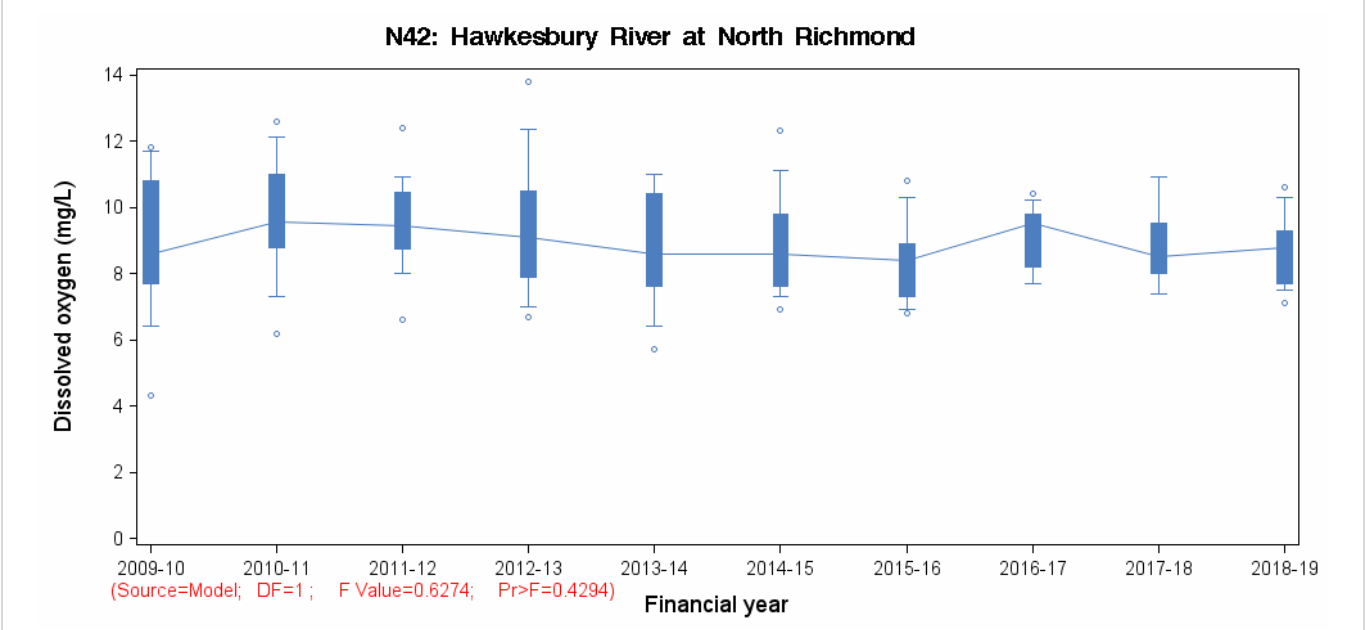

N42: Hawkesbury River at North Richmond
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6600; Pr>F=0.4189)
Financial year

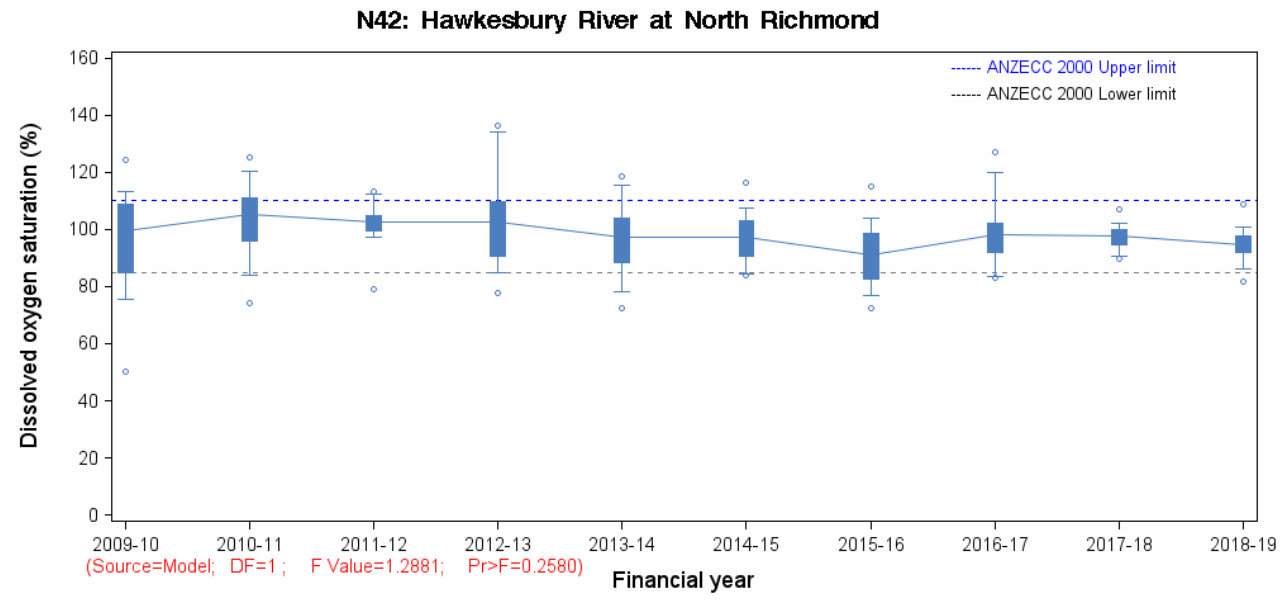

N42: Hawkesbury River at North Richmond
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0615; Pr>F=0.8047)
Financial year

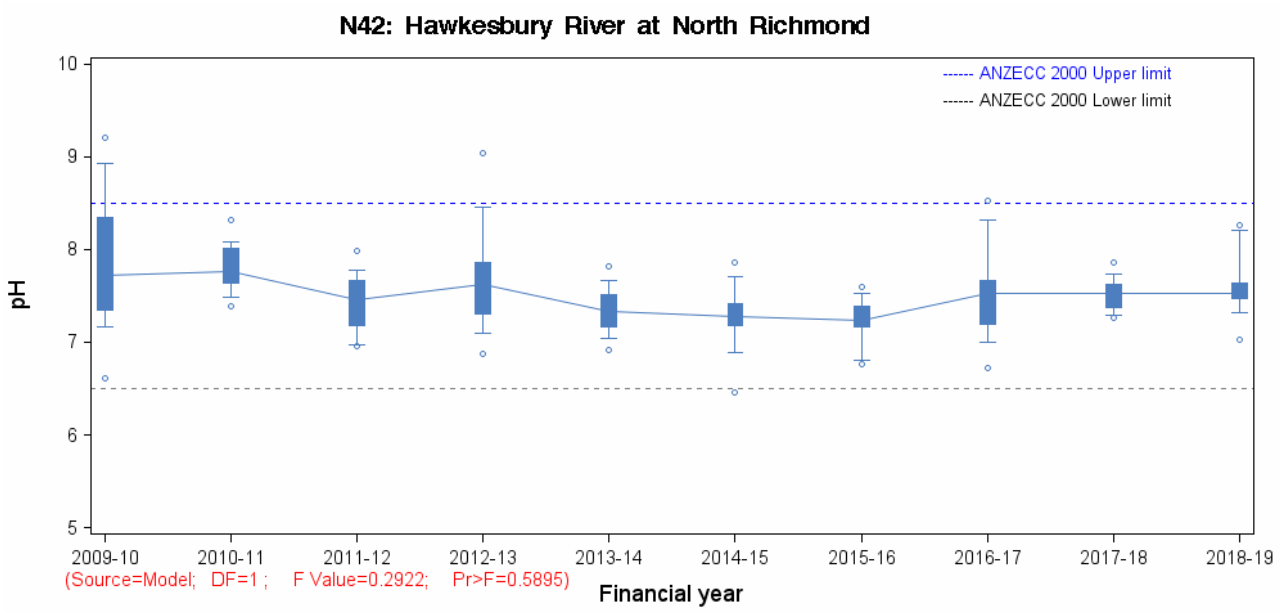


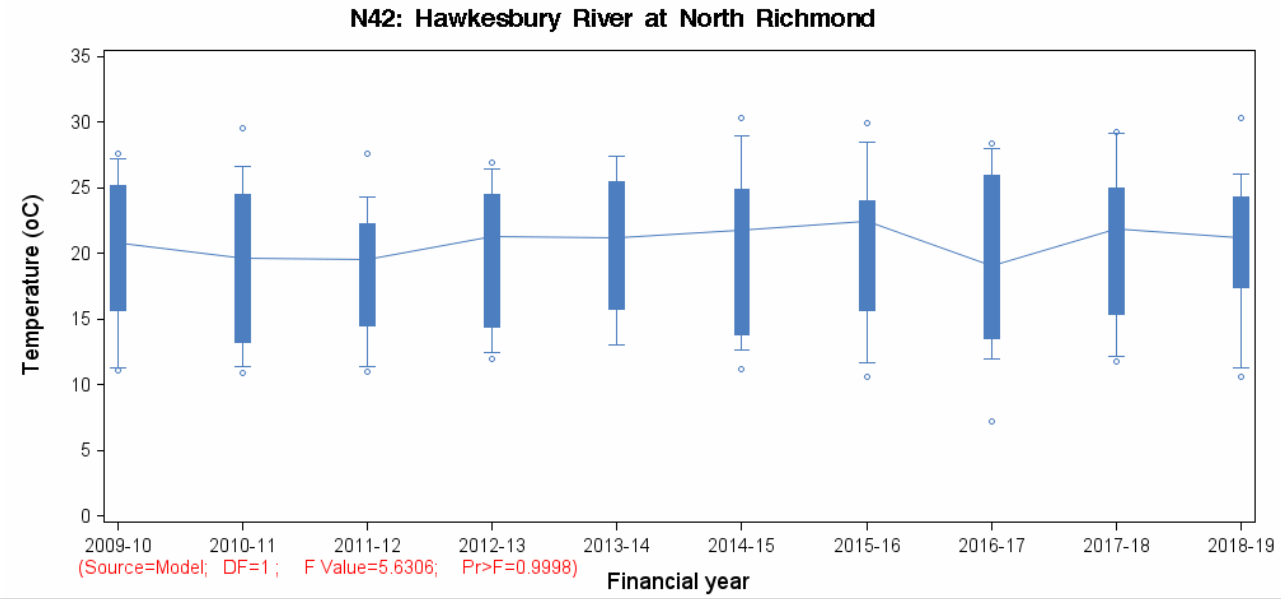
Other physico-chemical analytes

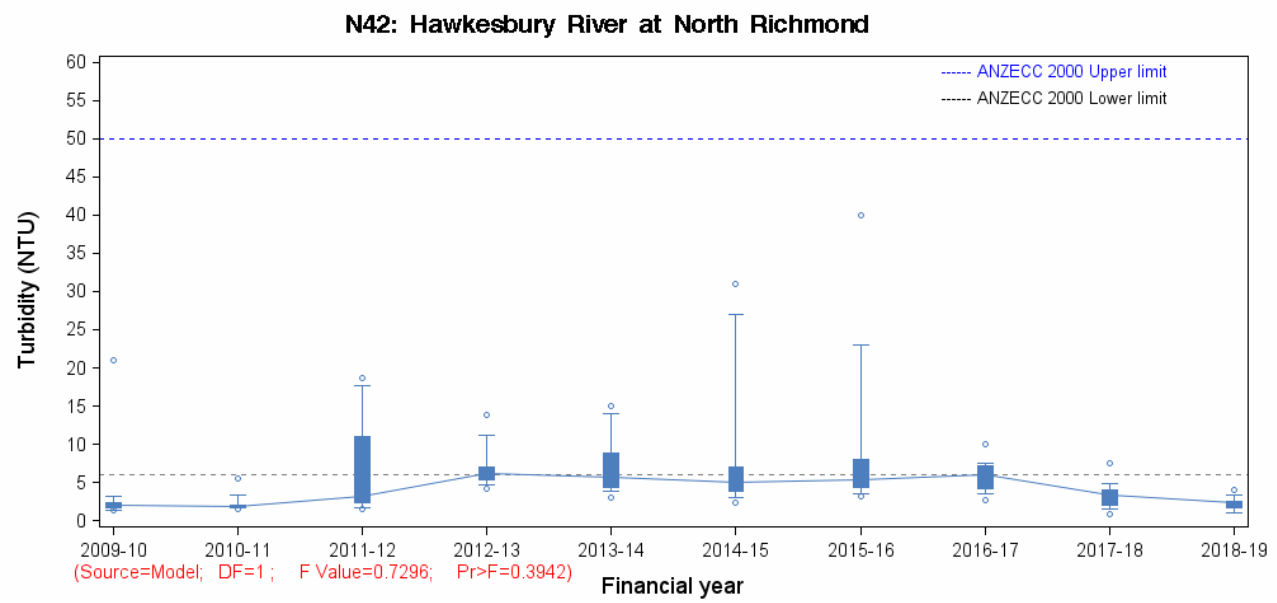


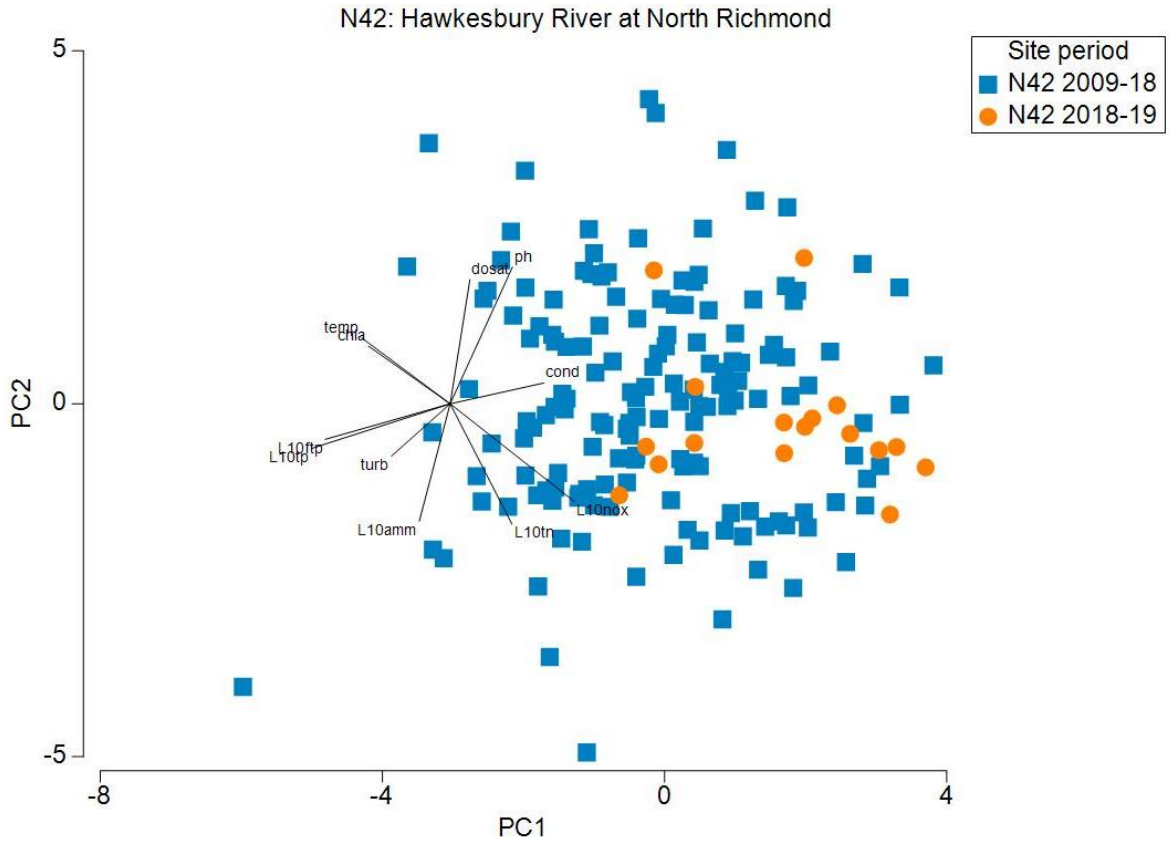



N42: Hawkesbury River at North Richmond
Dissolved oxygen saturation (%)
160
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.2881; Pr>F=0.2580)
Financial year


N42: Hawkesbury River at North Richmond
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2922; Pr>F=0.5895)
Financial year


N42: Hawkesbury River at North Richmond
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=5.6306; Pr>F=0.9998)
Financial year

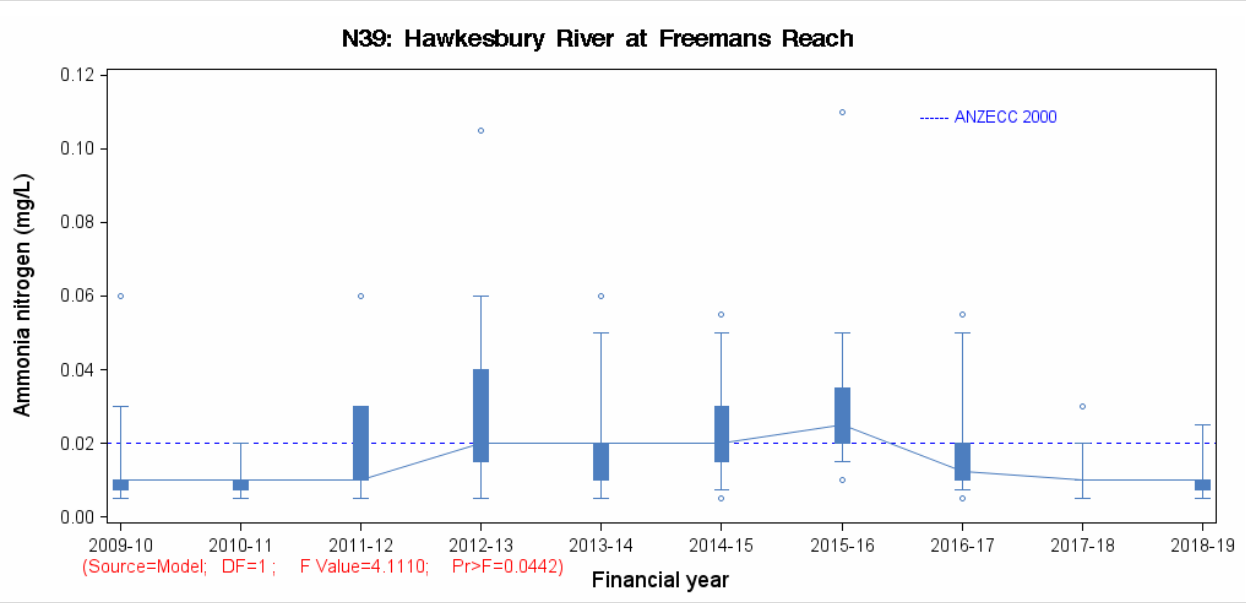


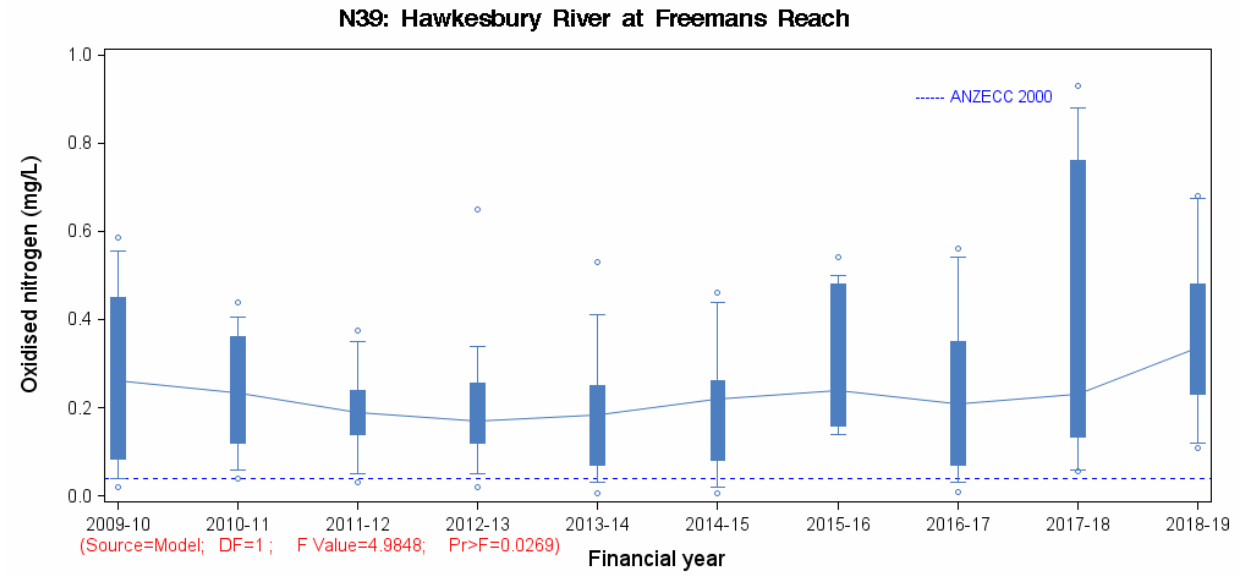


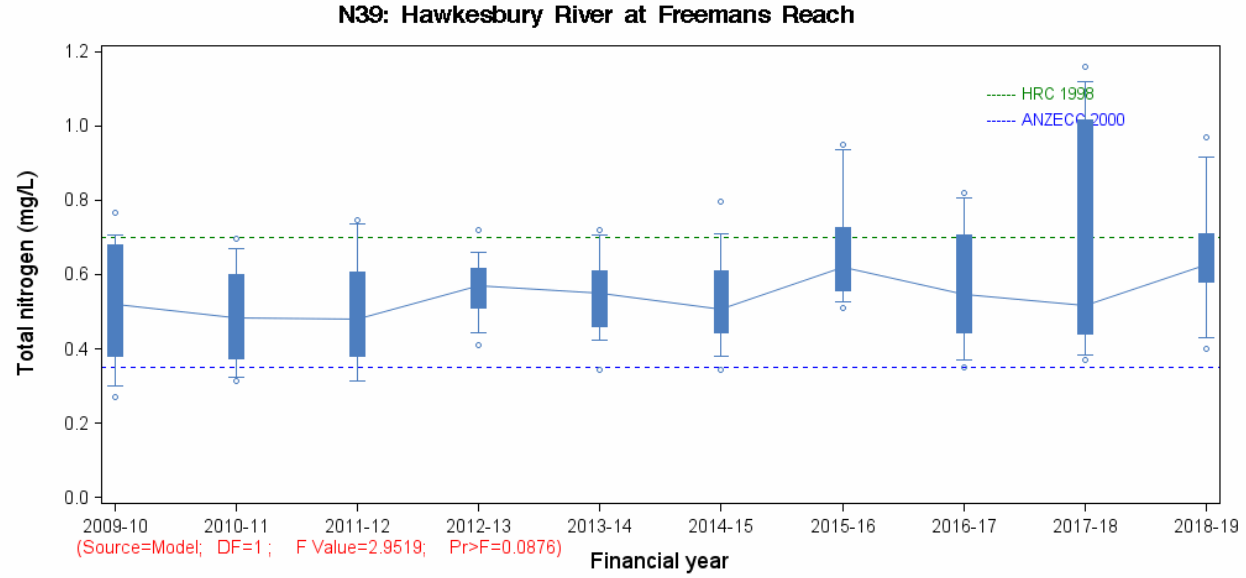
The ordination plot from Principal Components Analysis suggested water quality of the Hawkesbury River at North Richmond in 2018-19 was similar to that recorded in the period 2008 to 2018.

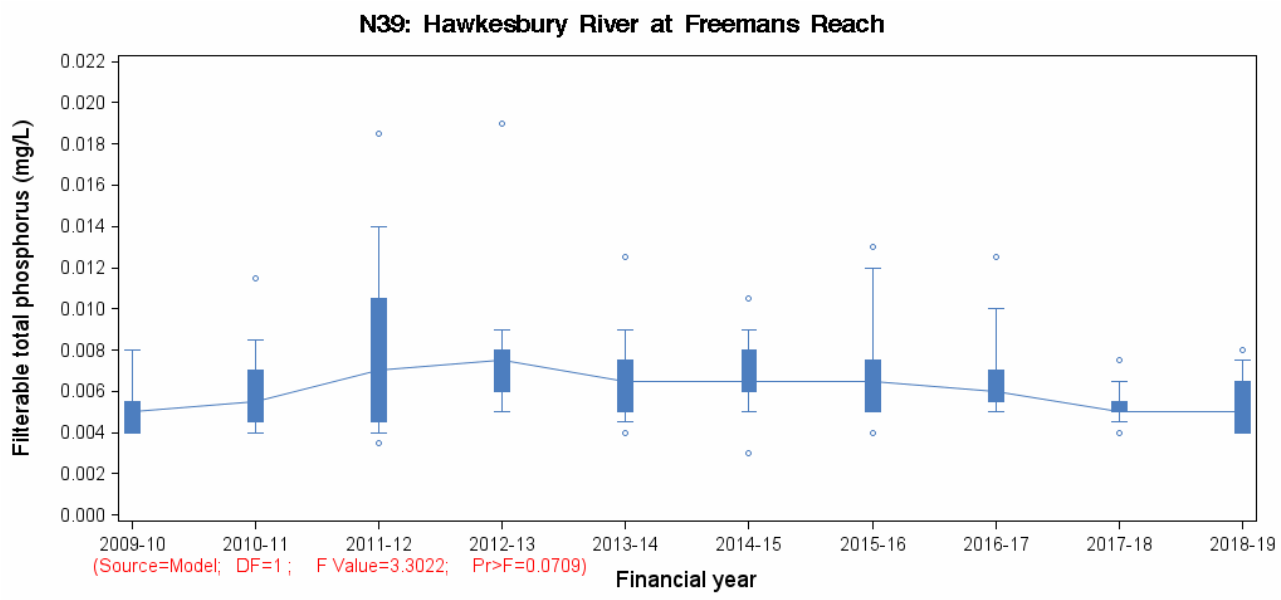
N39: Hawkesbury River at Freemans Reach

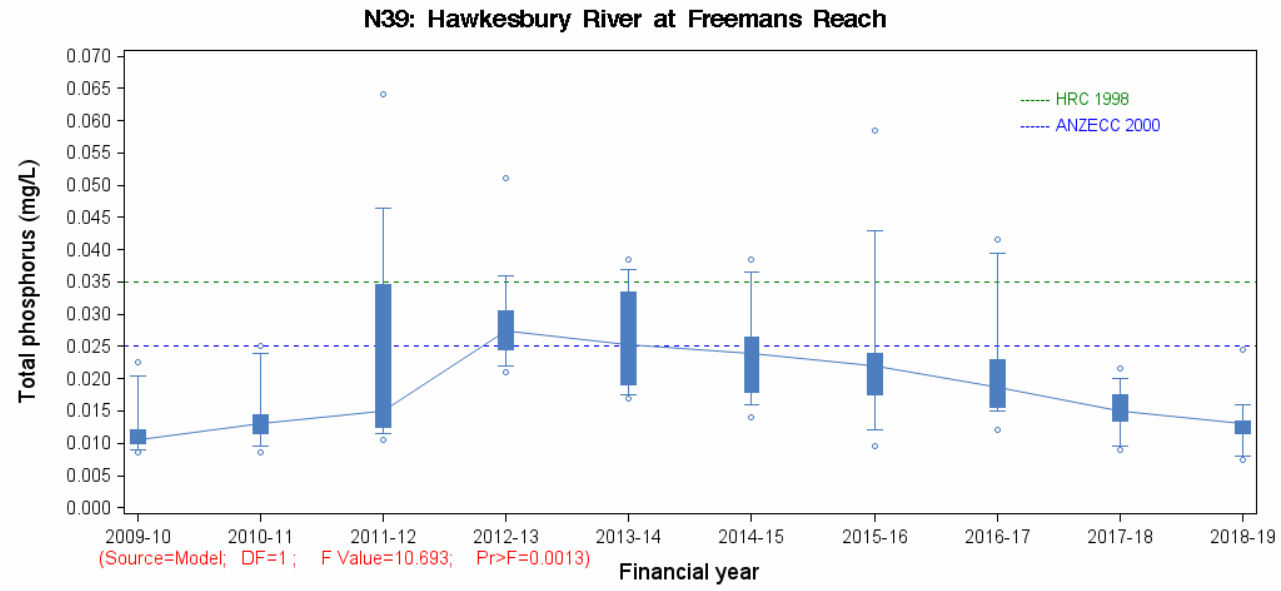
Nutrients, chlorophyll-*a* and algae

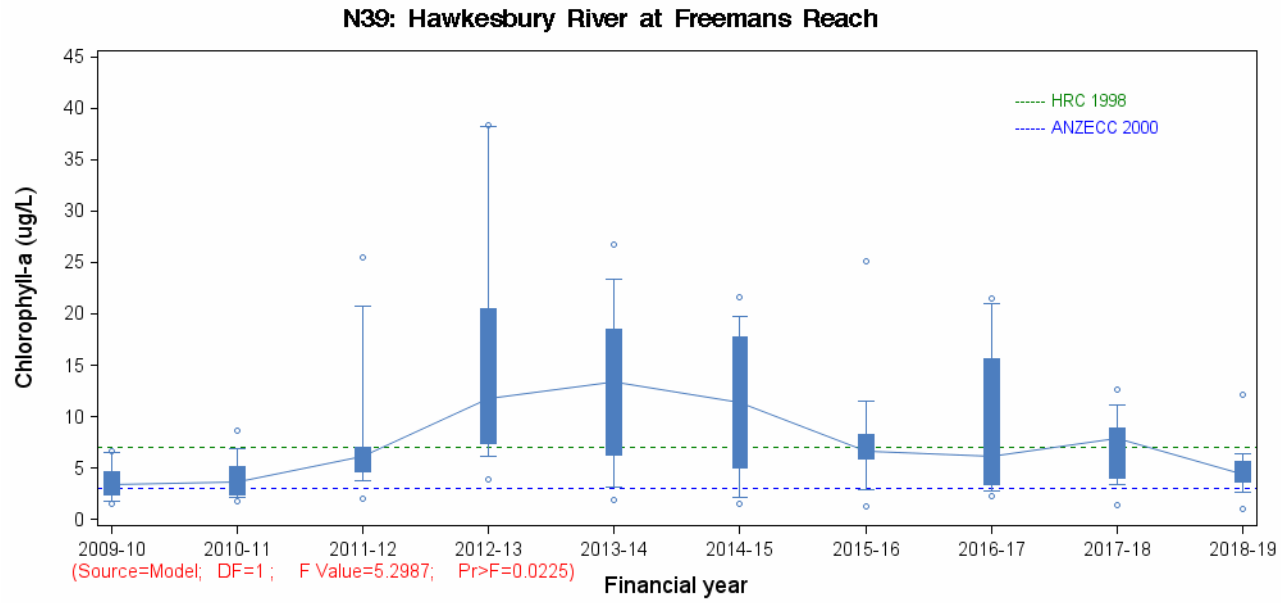


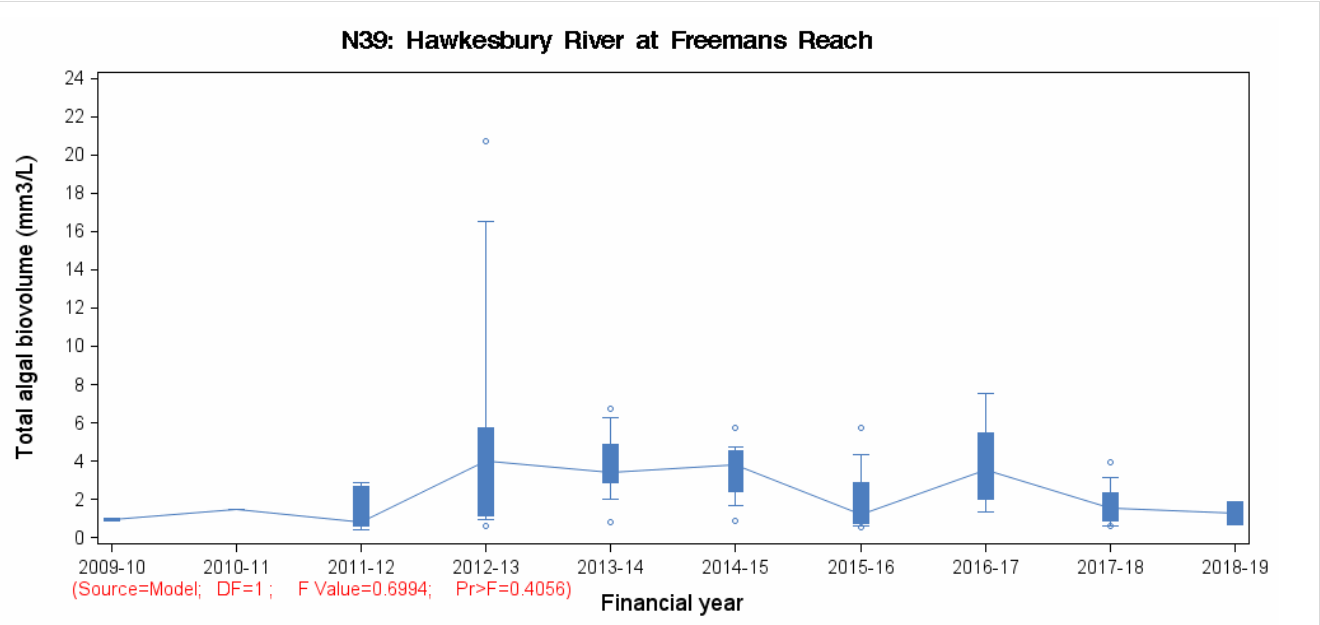


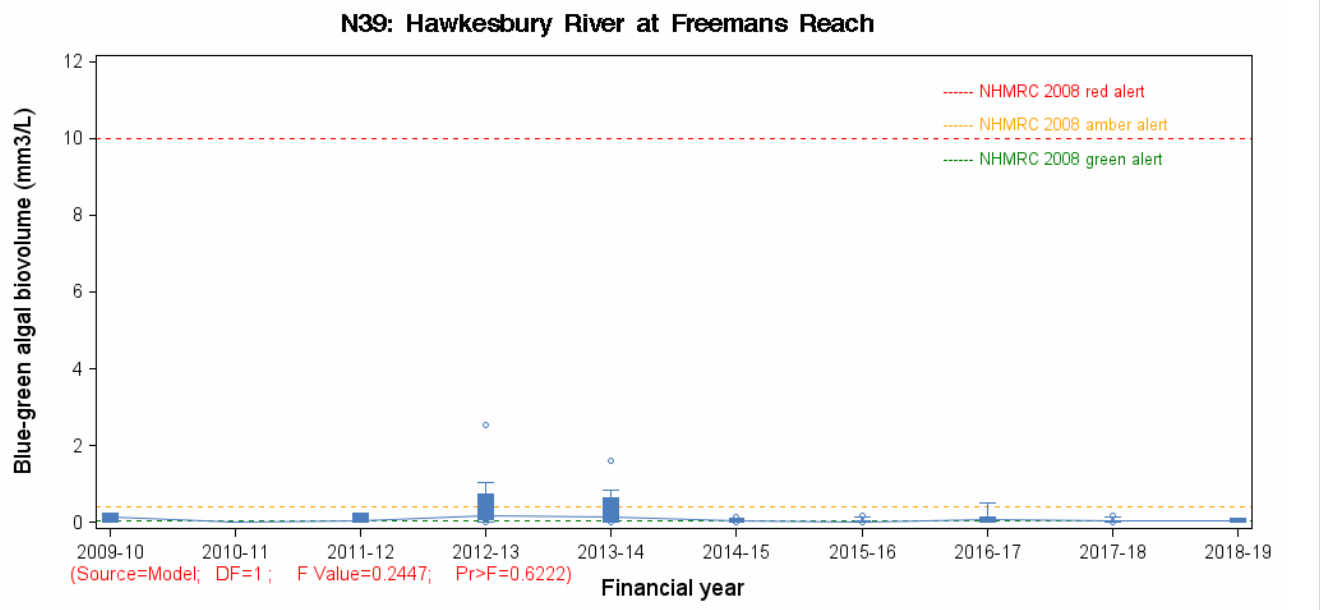


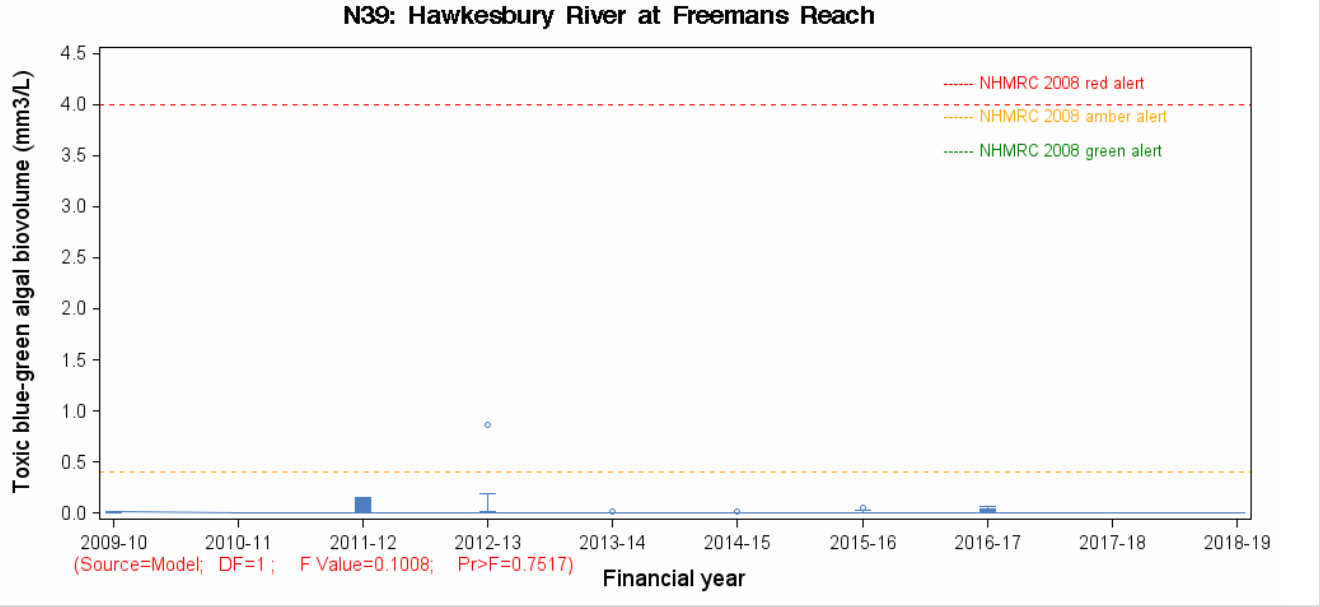

N39: Hawkesbury River at Freemans Reach
Filterable total phosphorus (mg/L)
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

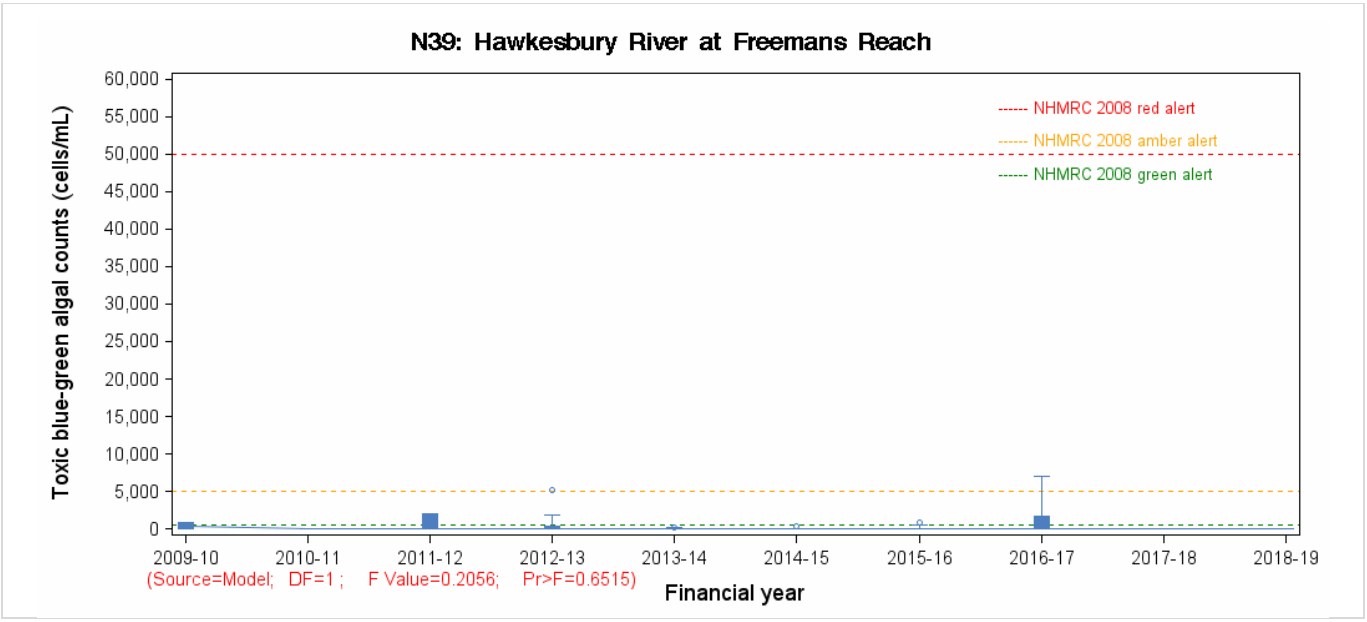

N39: Hawkesbury River at Freemans Reach
Total phosphorus (mg/L)
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=10.693; Pr>F=0.0013)
Financial year


N39: Hawkesbury River at Freemans Reach
Chlorophyll-a (ug/L)
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

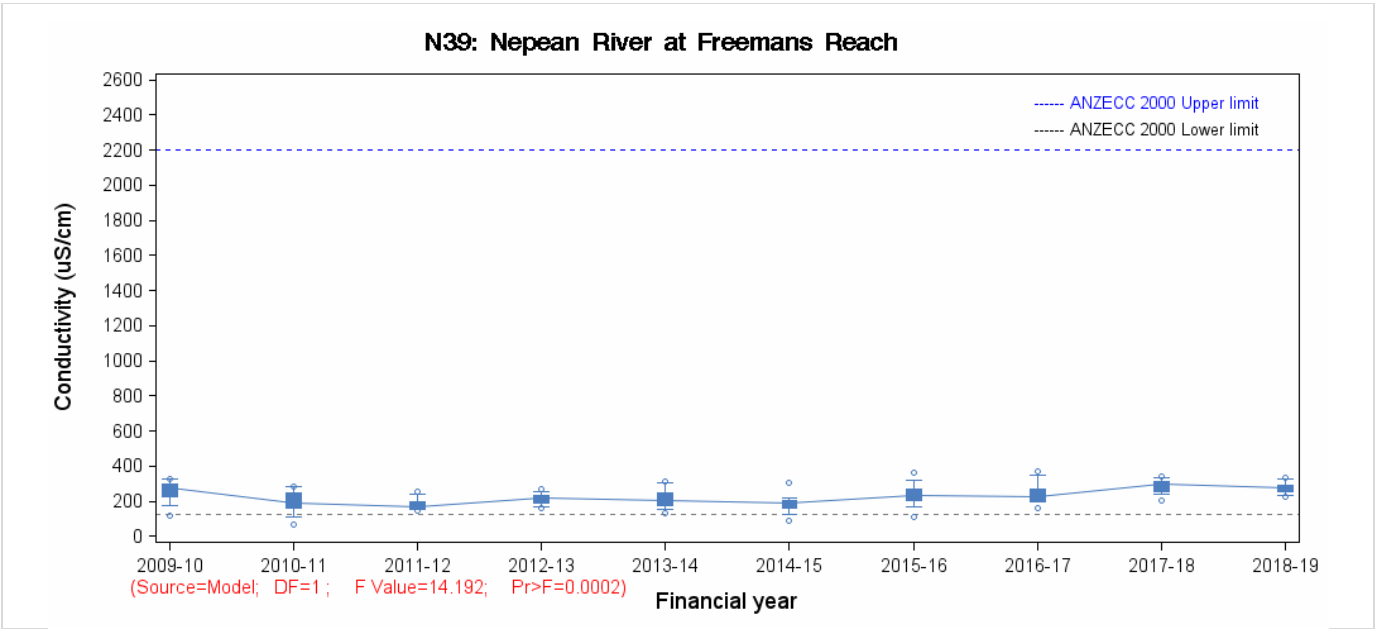

N39: Hawkesbury River at Freemans Reach
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
18
20
22
24
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6994; Pr>F=0.4056)
Financial year

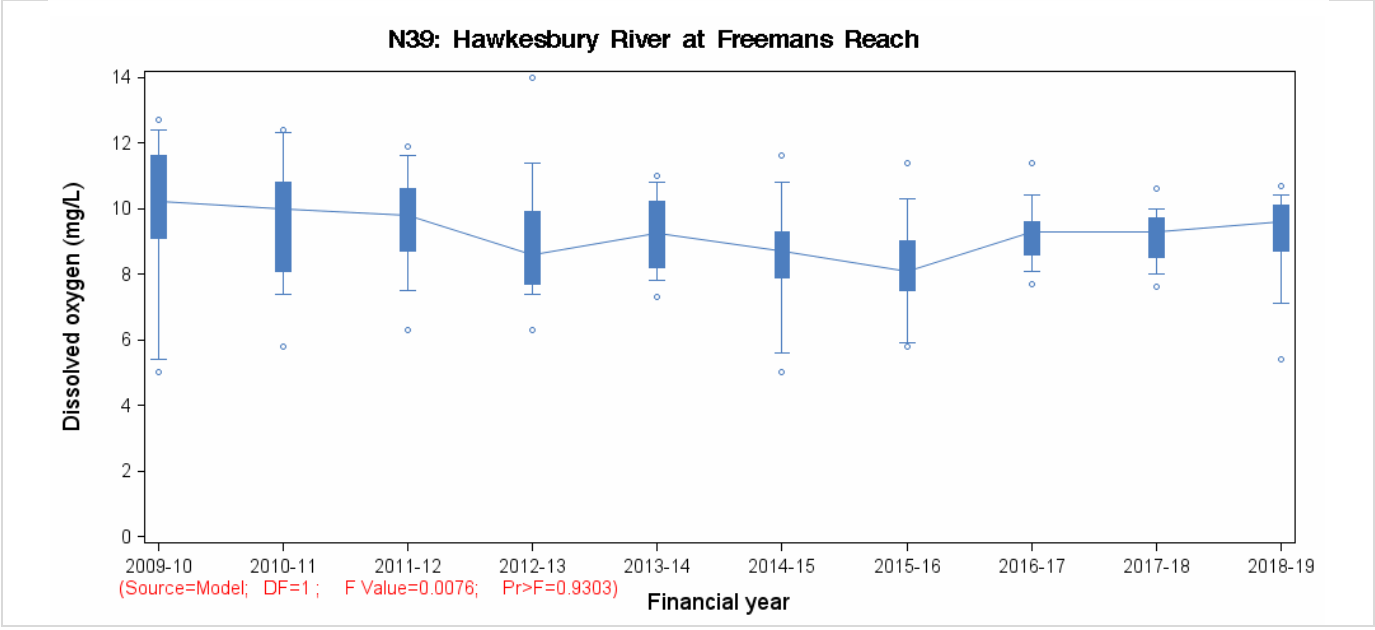

N39: Hawkesbury River at Freemans Reach
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2447; Pr>F=0.6222)
Financial year

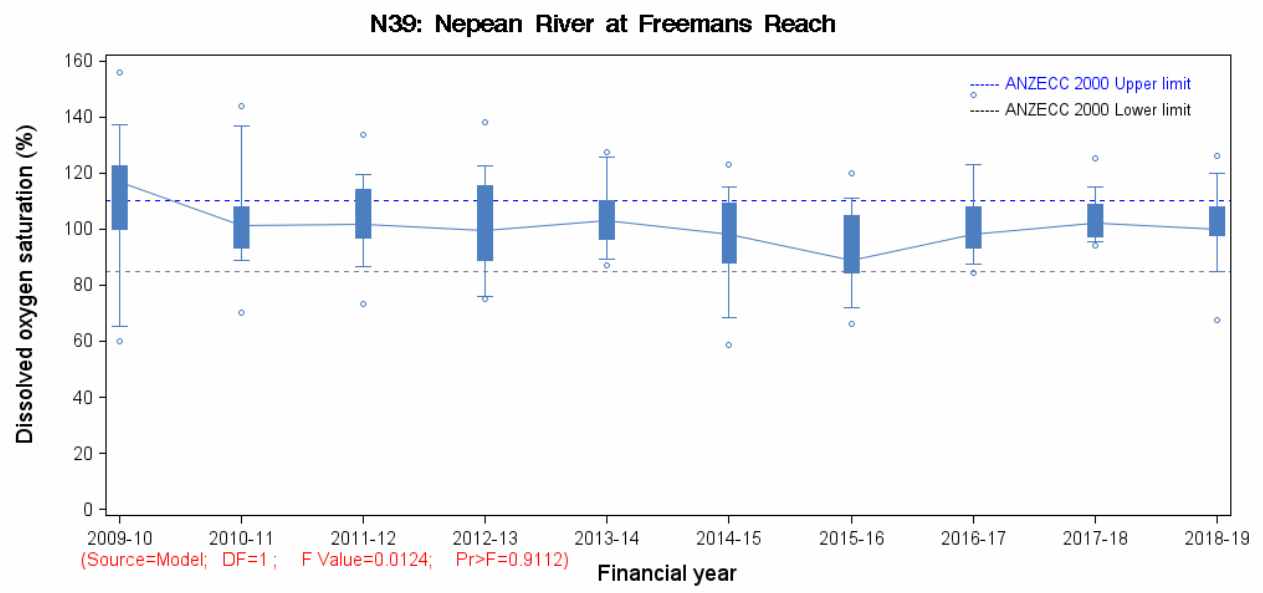

N39: Hawkesbury River at Freemans Reach
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1008; Pr>F=0.7517)
Financial year

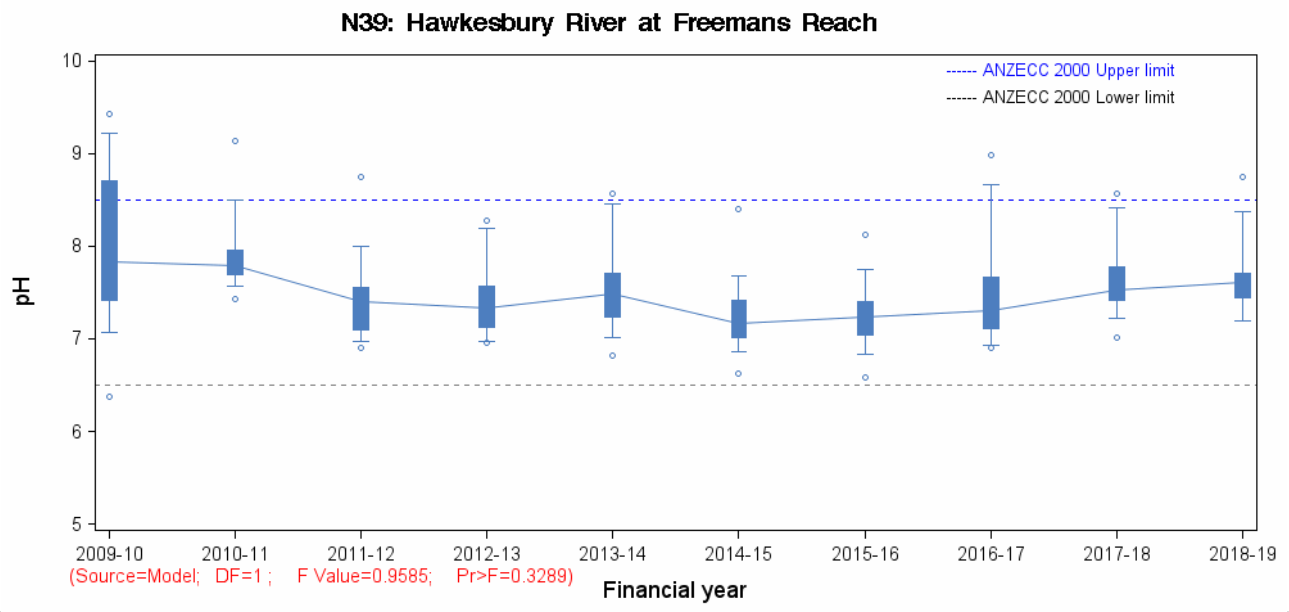


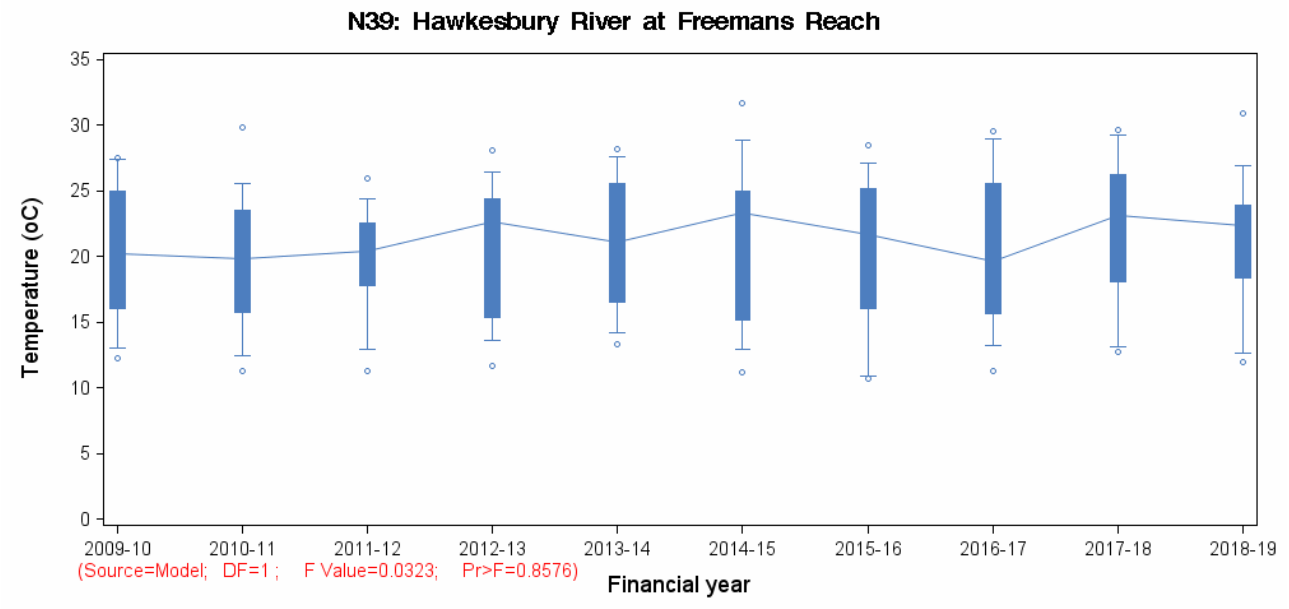
Other physico-chemical analytes

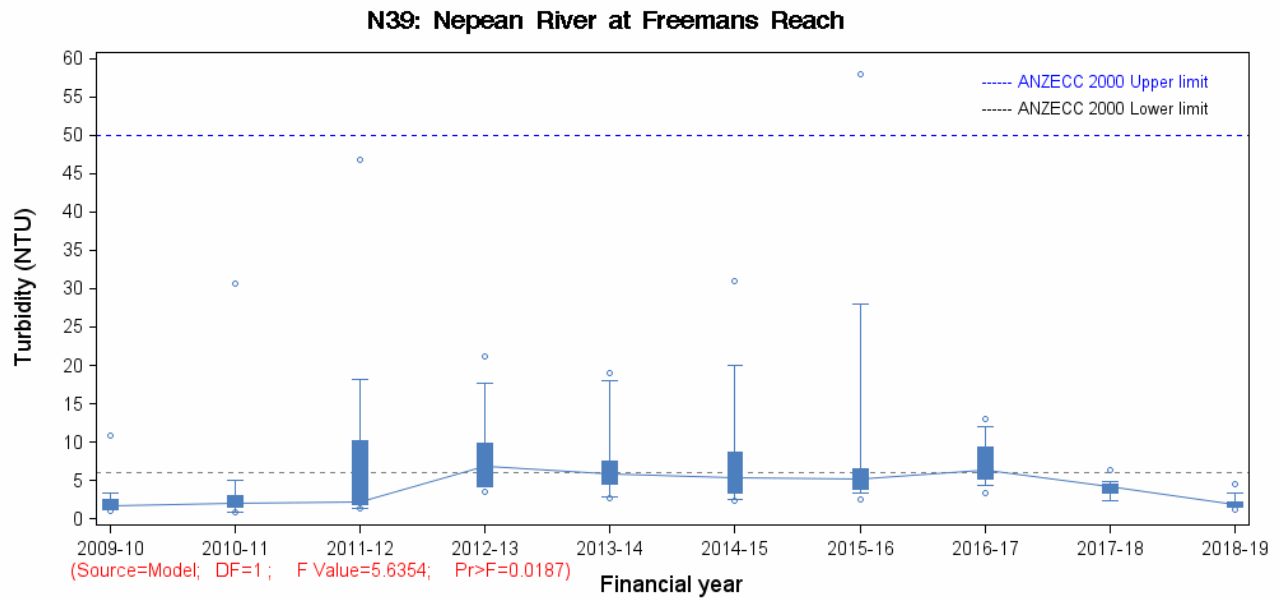


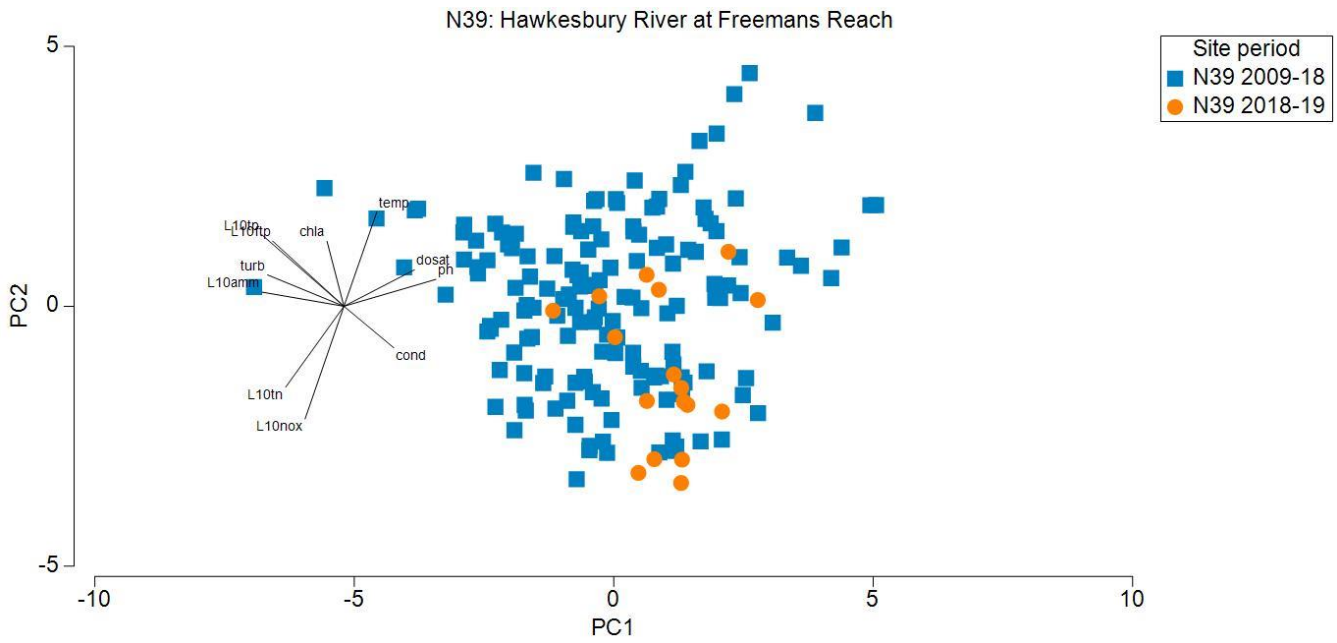



N39: Nepean River at Freemans Reach
Dissolved oxygen saturation (%)
160
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0124; Pr>F=0.9112)
Financial year


N39: Hawkesbury River at Freemans Reach
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.9585; Pr>F=0.3289)
Financial year


N39: Hawkesbury River at Freemans Reach
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0323; Pr>F=0.8576)
Financial year

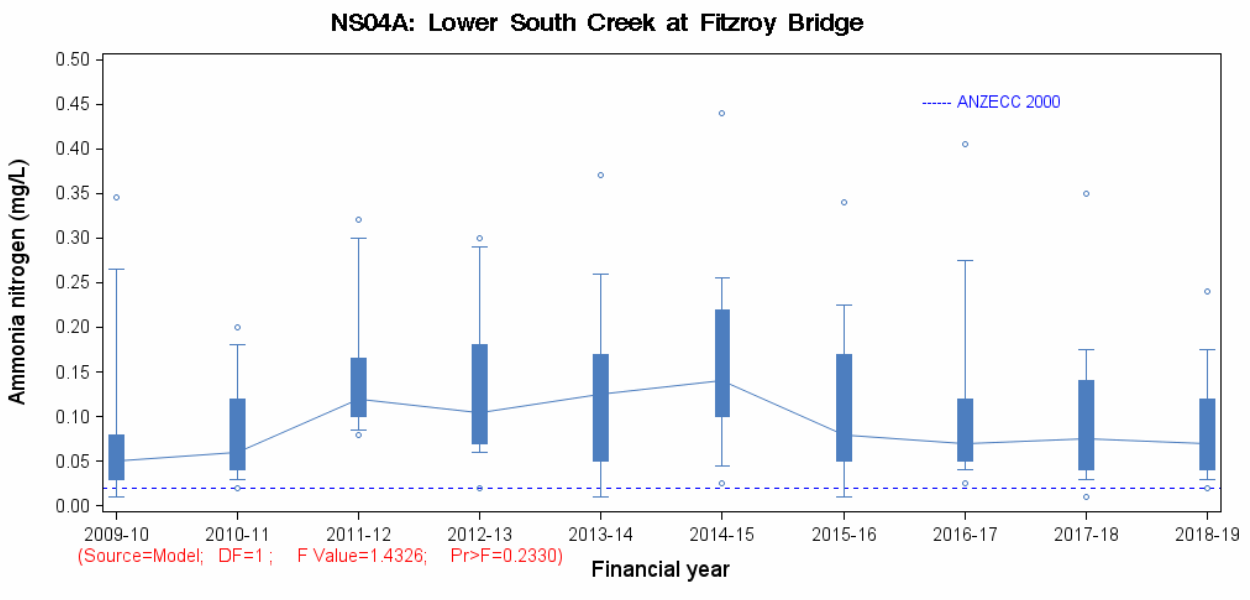


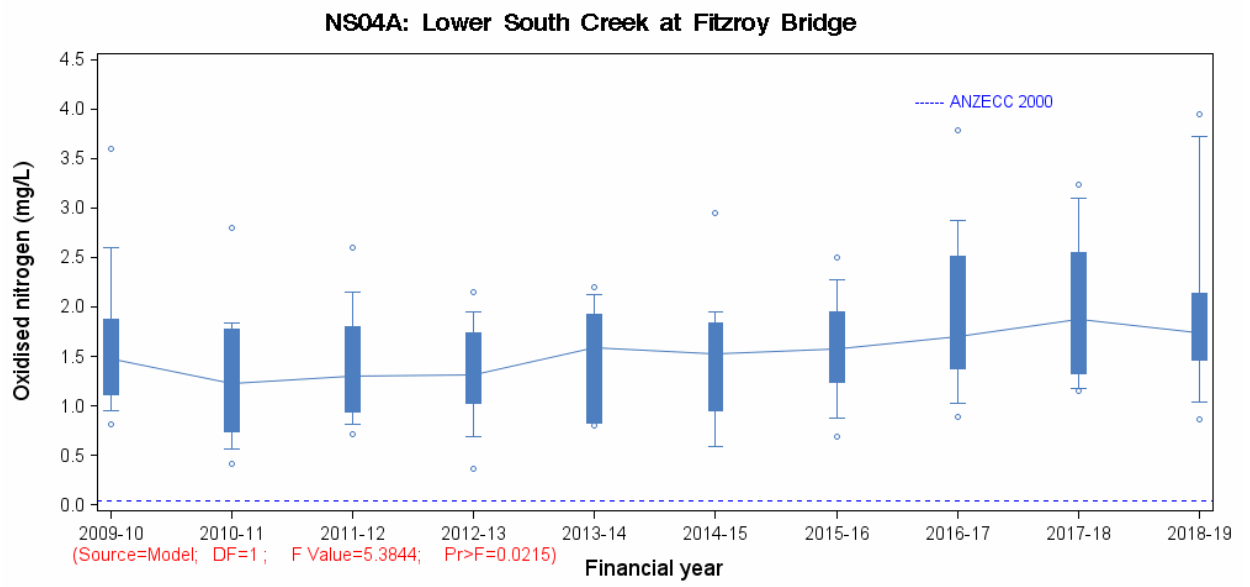


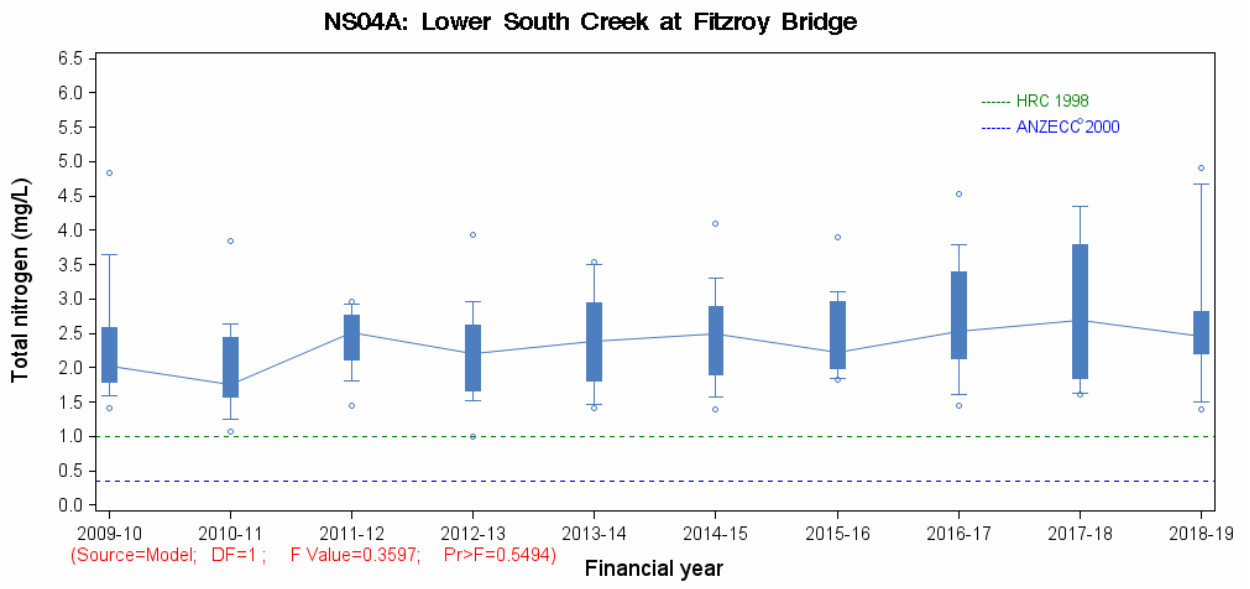
The ordination plot from Principal Components Analysis suggested water quality of the Hawkesbury River at Freemans Reach in 2018-19 was similar to that recorded in the period 2009 to 2018.

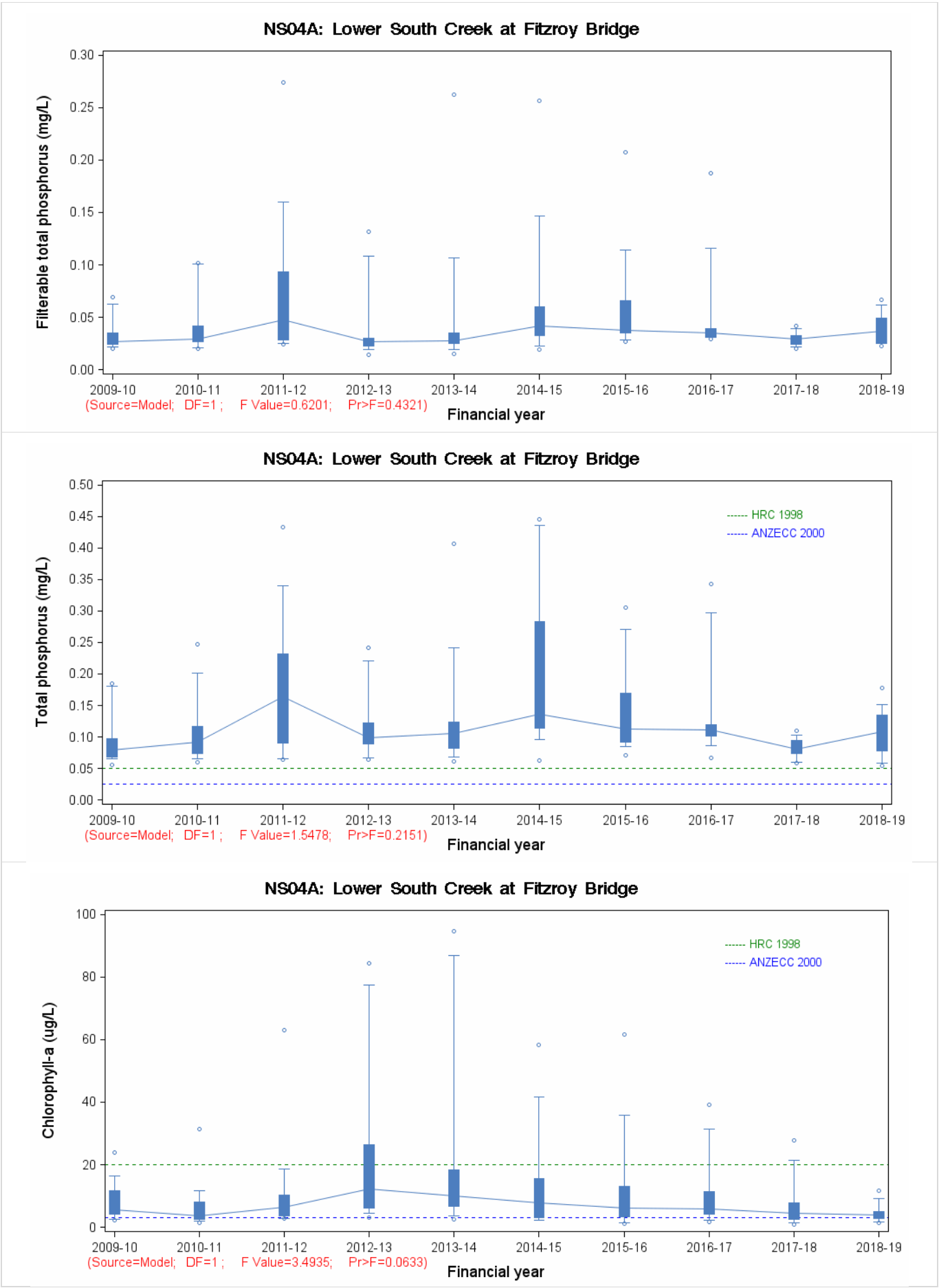
NS04A: Lower South Creek at Fitzroy Bridge

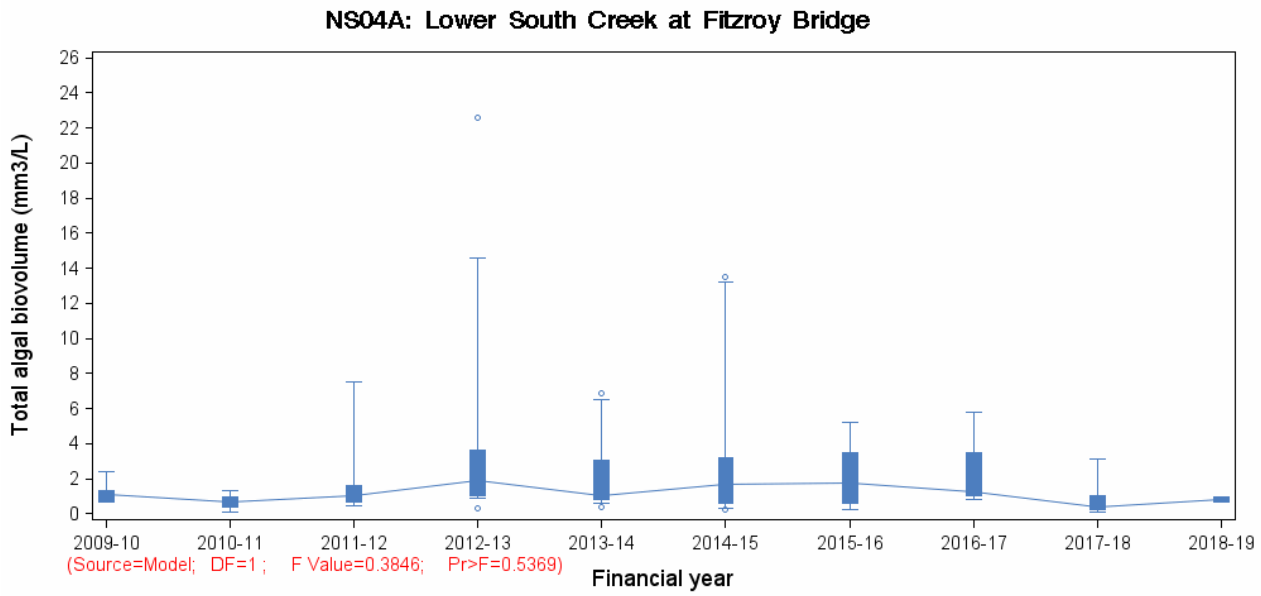
Nutrients, chlorophyll-*a* and algae

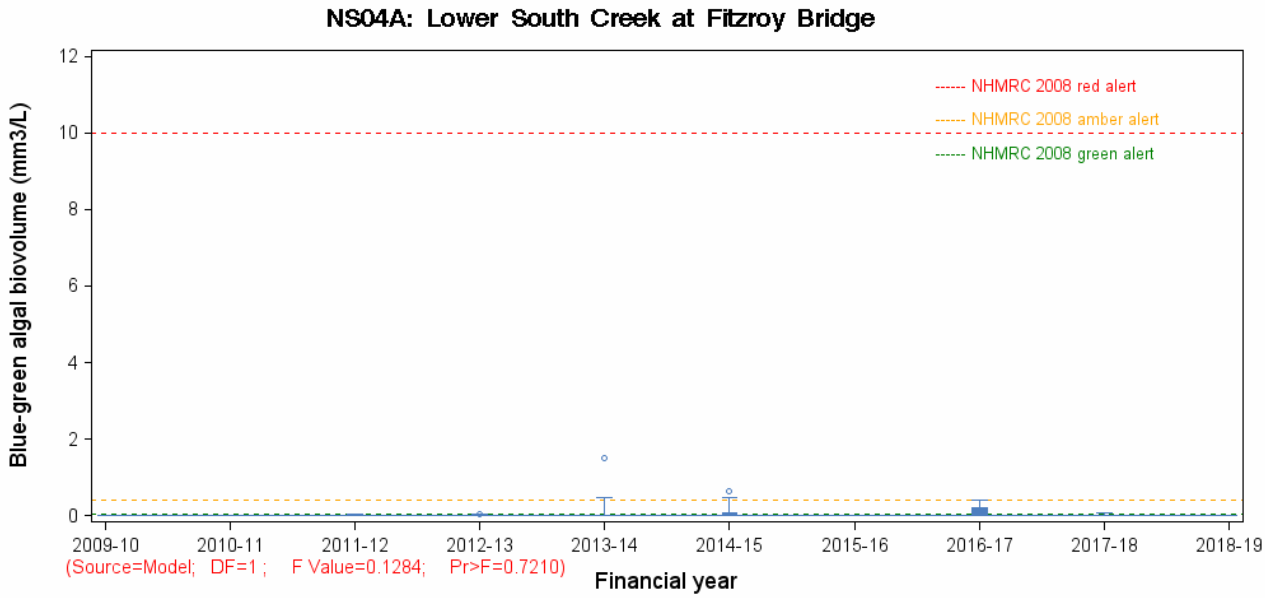


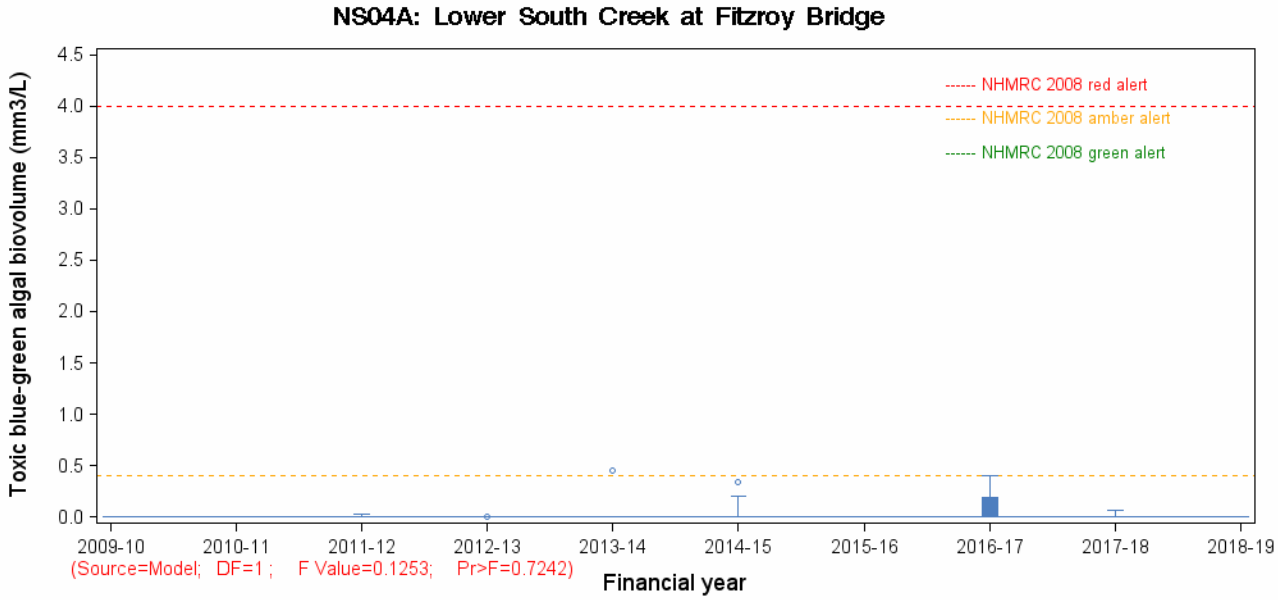


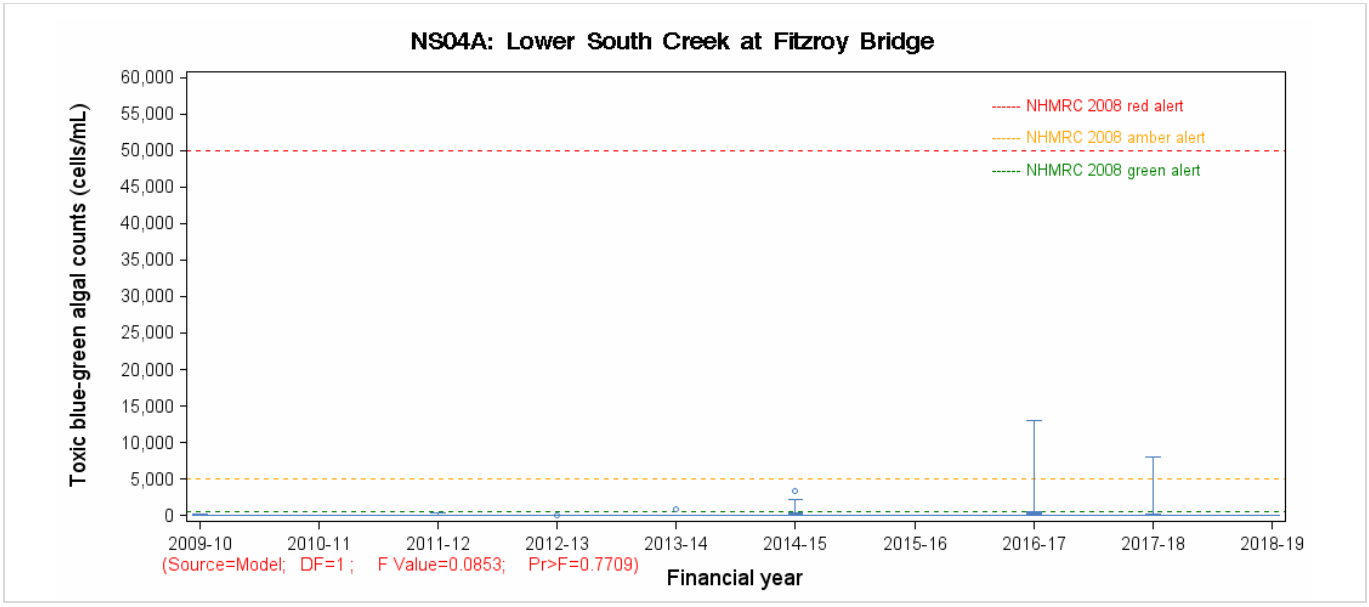



NS04A: Lower South Creek at Fitzroy Bridge
Filterable total phosphorus (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6201; Pr>F=0.4321)
Financial year
NS04A: Lower South Creek at Fitzroy Bridge
Total phosphorus (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.5478; Pr>F=0.2151)
Financial year
NS04A: Lower South Creek at Fitzroy Bridge
Chlorophyll-a (ug/L)
100
80
60
40
20
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.4935; Pr>F=0.0633)
Financial year

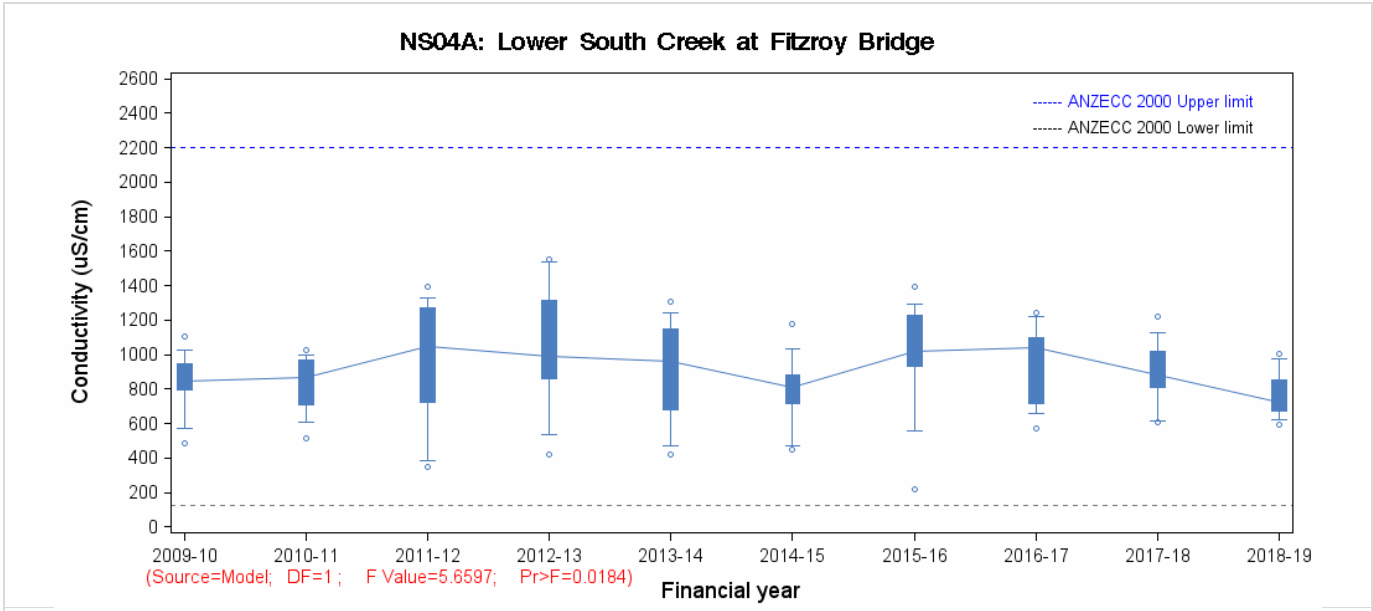

NS04A: Lower South Creek at Fitzroy Bridge
Total algal biovolume (mm3/L)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3846; Pr>F=0.5369)
Financial year

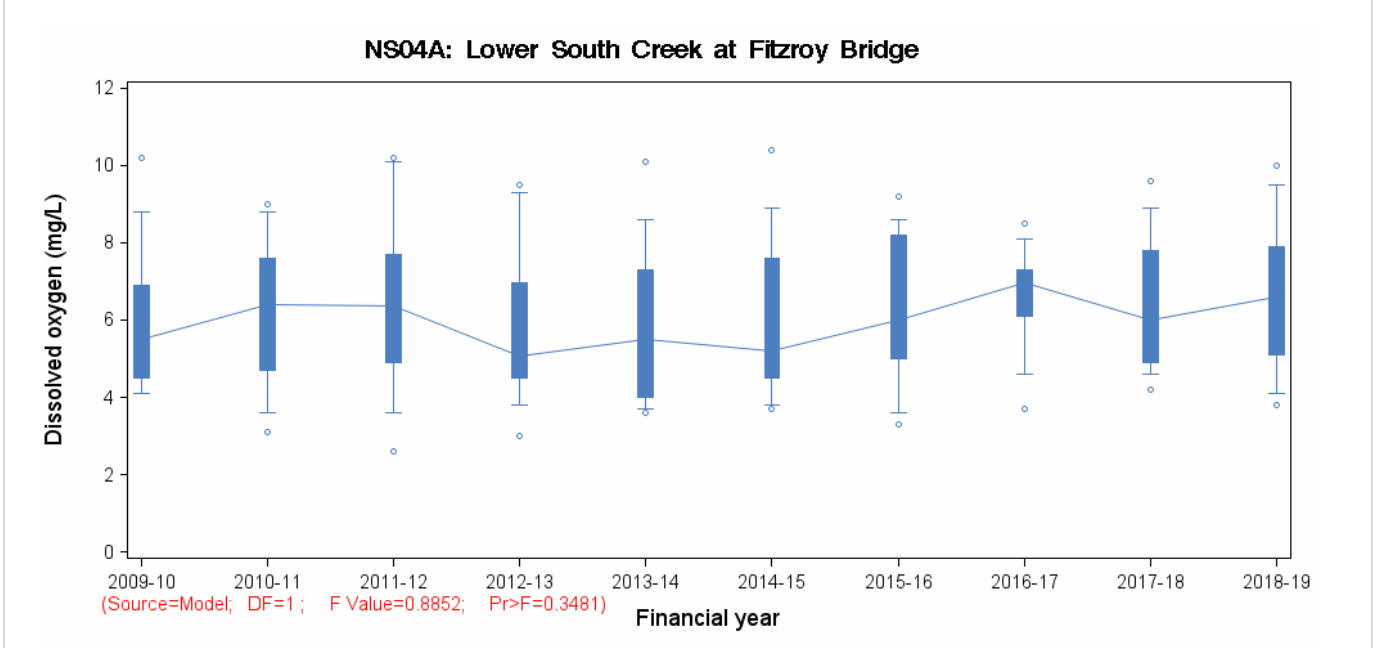

NS04A: Lower South Creek at Fitzroy Bridge
Blue-green algal biovolume (mm3/L)
12
10
8
6
4
2
0
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1284; Pr>F=0.7210)
Financial year

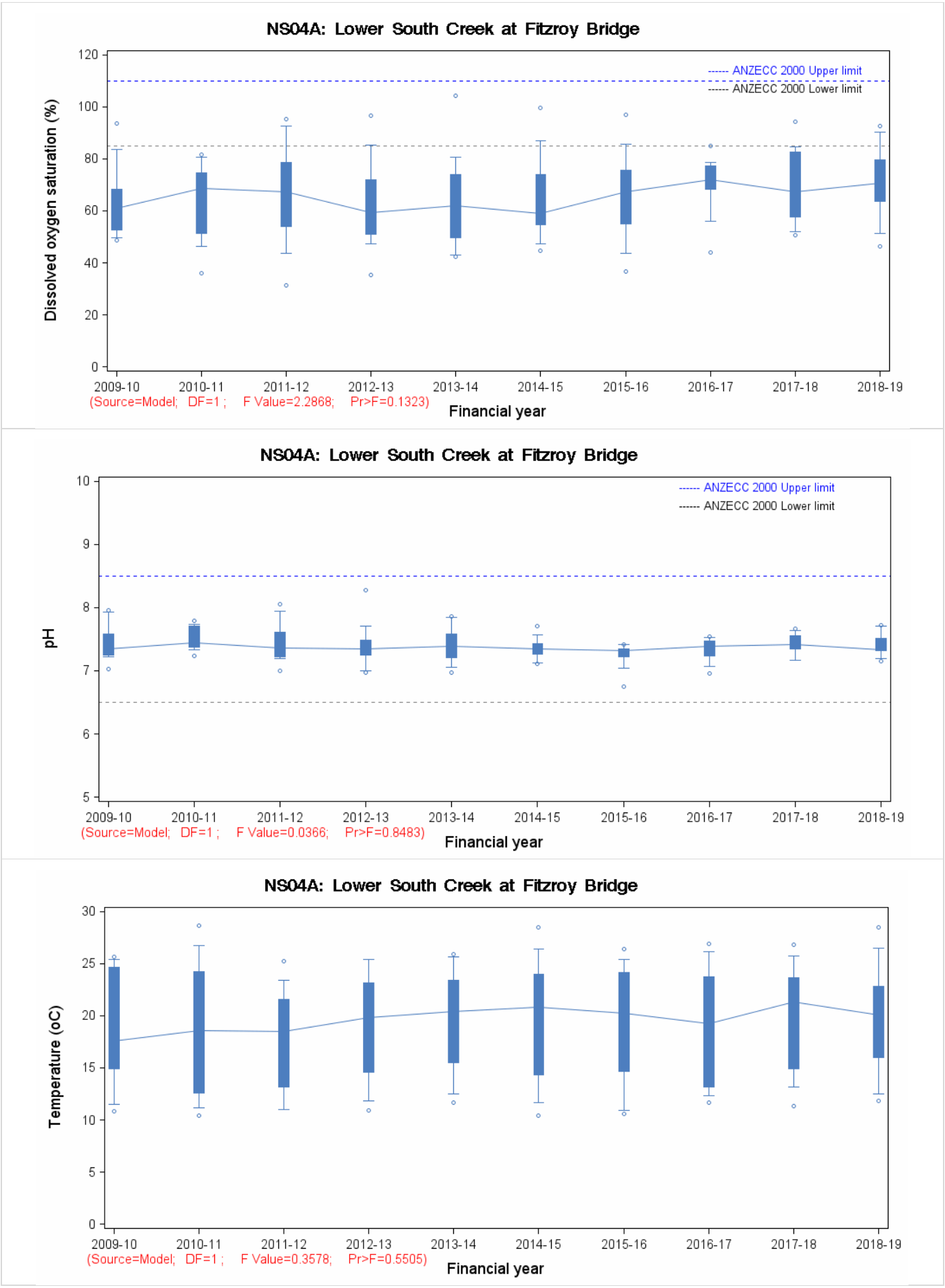

NS04A: Lower South Creek at Fitzroy Bridge
Toxic blue-green algal biovolume (mm3/L)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1253; Pr>F=0.7242)
Financial year

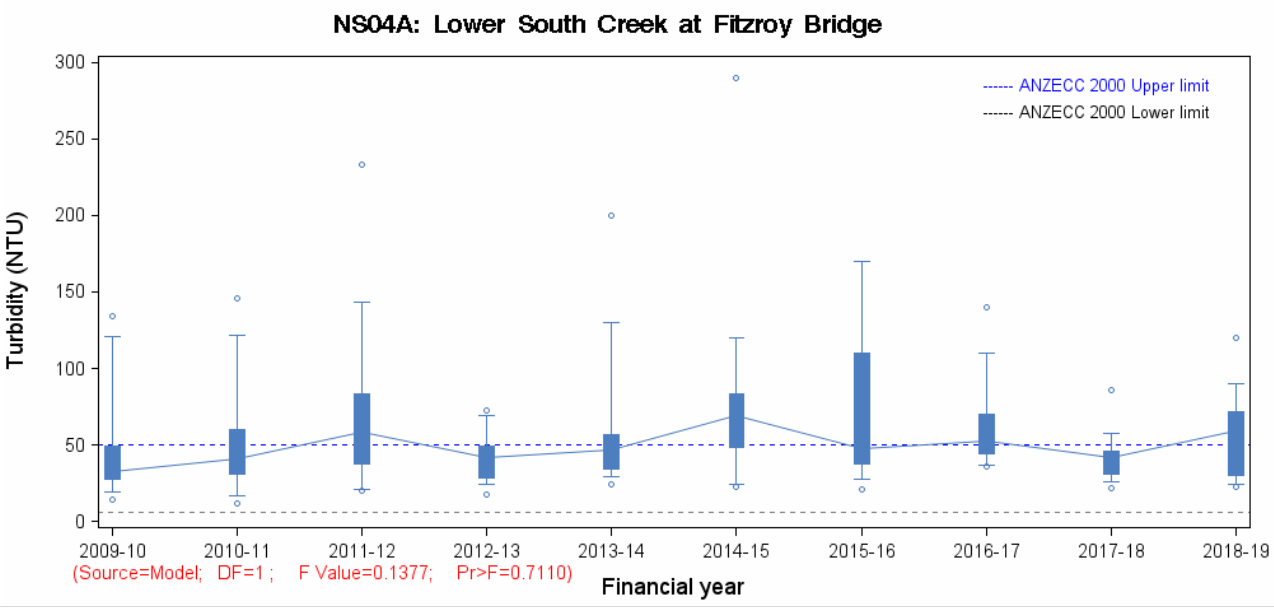


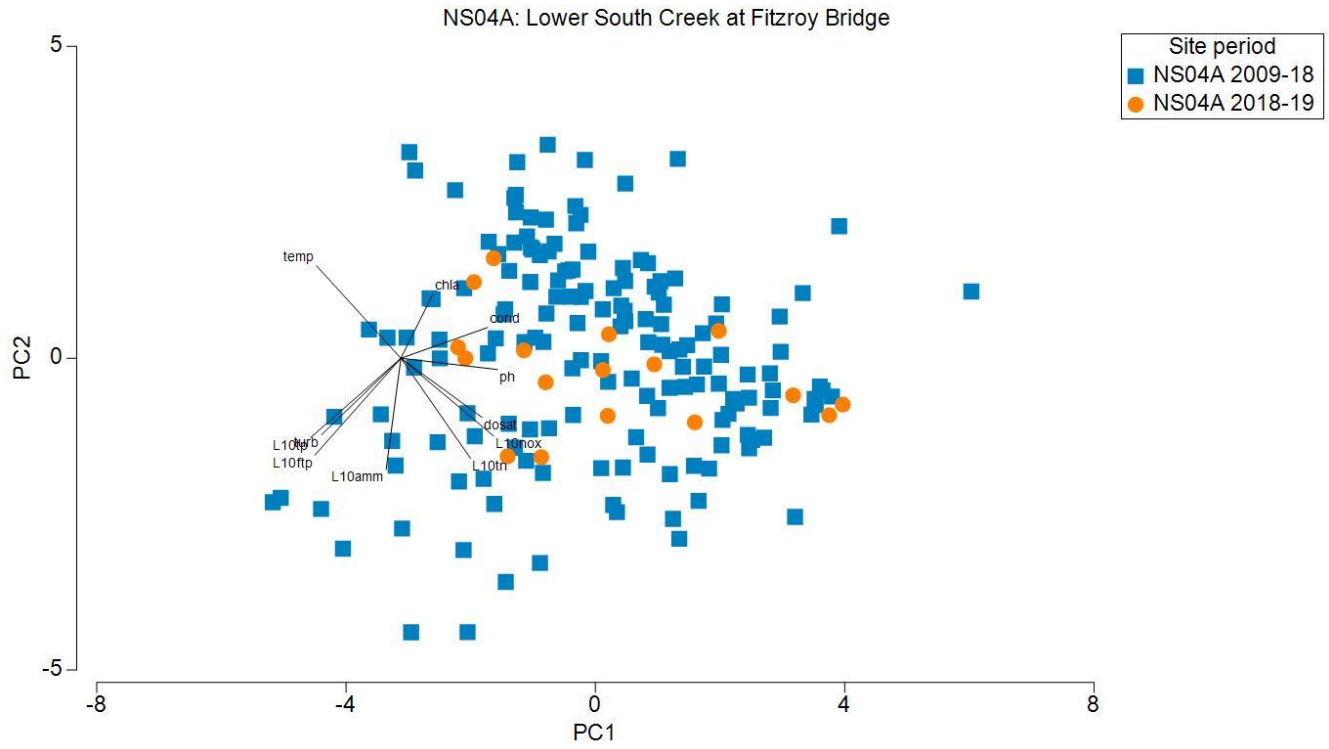
Other physico-chemical analytes






NS04A: Lower South Creek at Fitzroy Bridge
Dissolved oxygen saturation (%)
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.2868; Pr>F=0.1323)
Financial year
NS04A: Lower South Creek at Fitzroy Bridge
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0366; Pr>F=0.8483)
Financial year
NS04A: Lower South Creek at Fitzroy Bridge
Temperature (oC)
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3578; Pr>F=0.5505)
Financial year

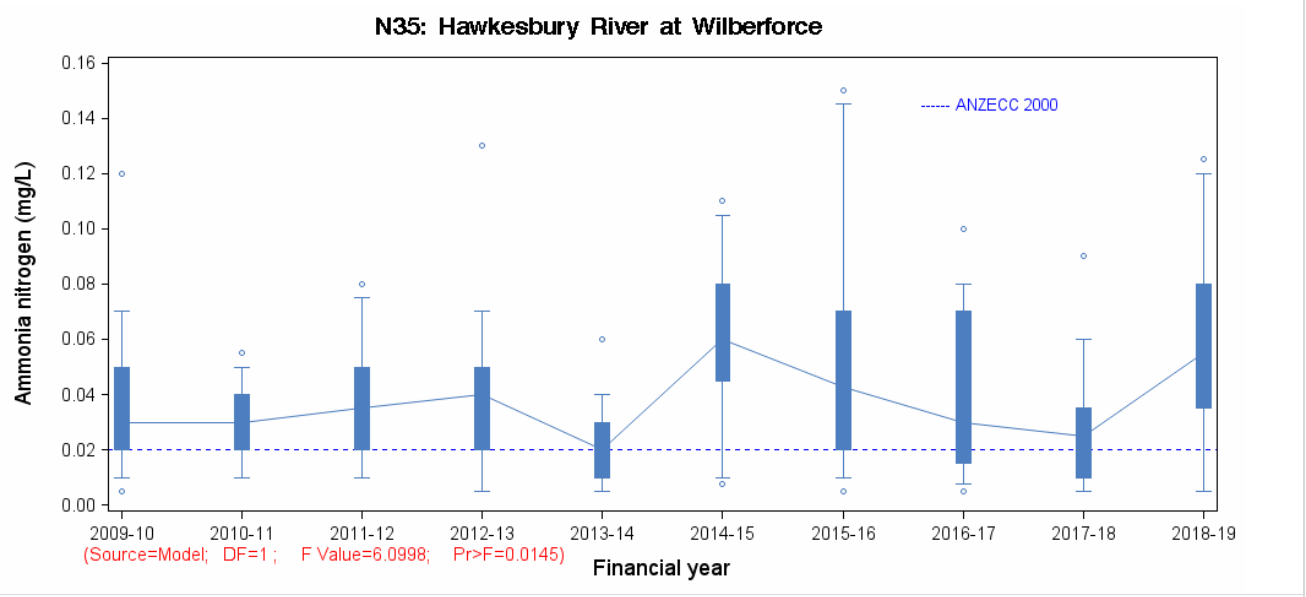


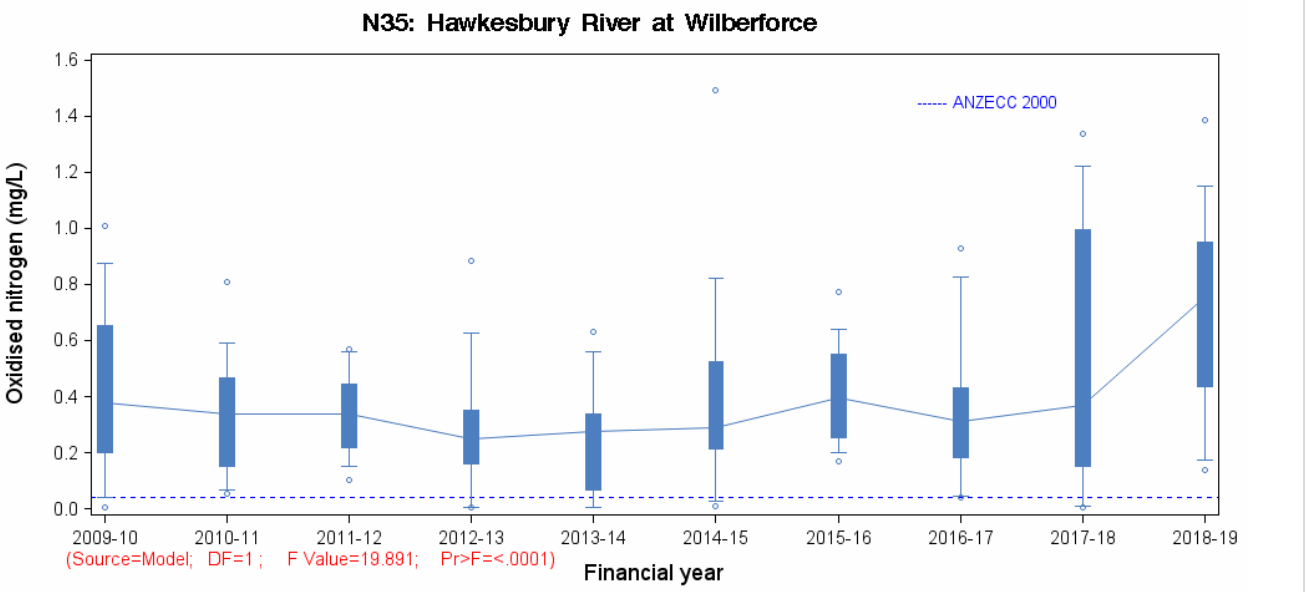


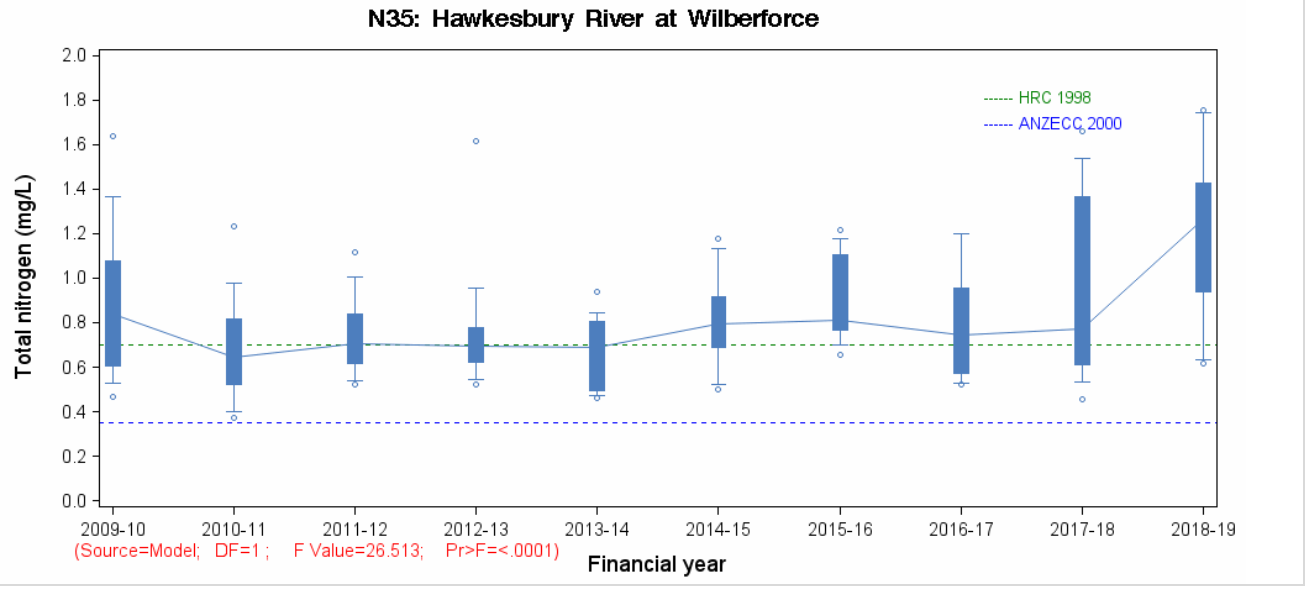
The ordination plot from Principal Components Analysis suggested water quality of Lower South Creek at Fitzroy Bridge in 2018-19 had relatively similar variability to that recorded in the period 2009 to 2018.

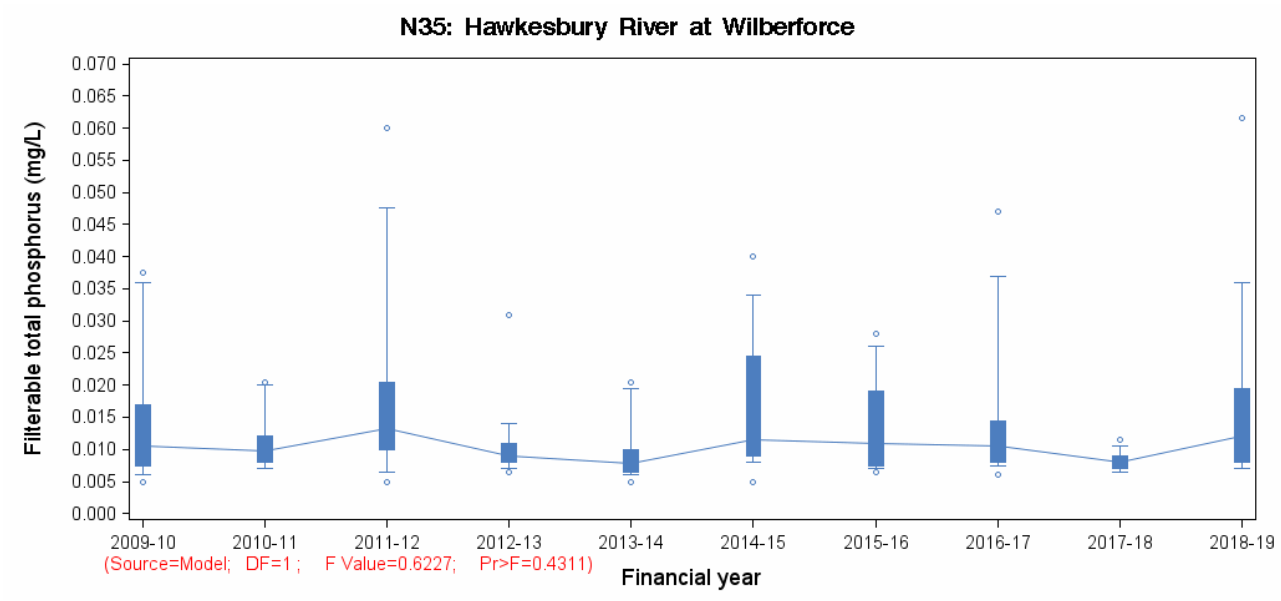
N35: Hawkesbury River at Wilberforce

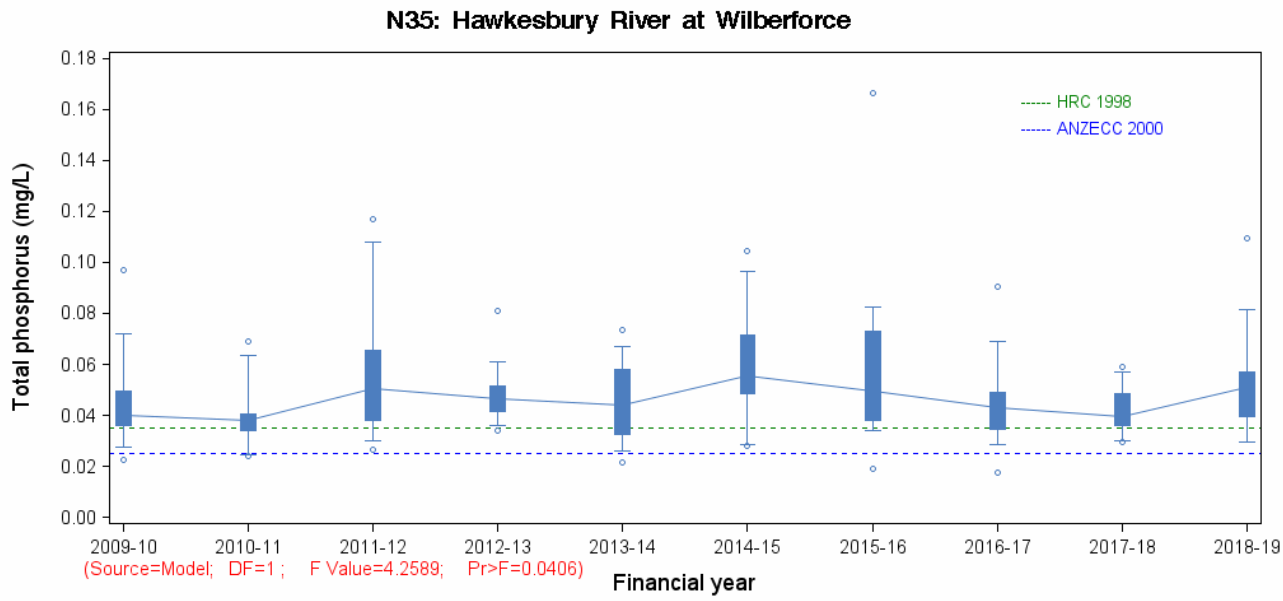
Nutrients, chlorophyll-*a* and algae

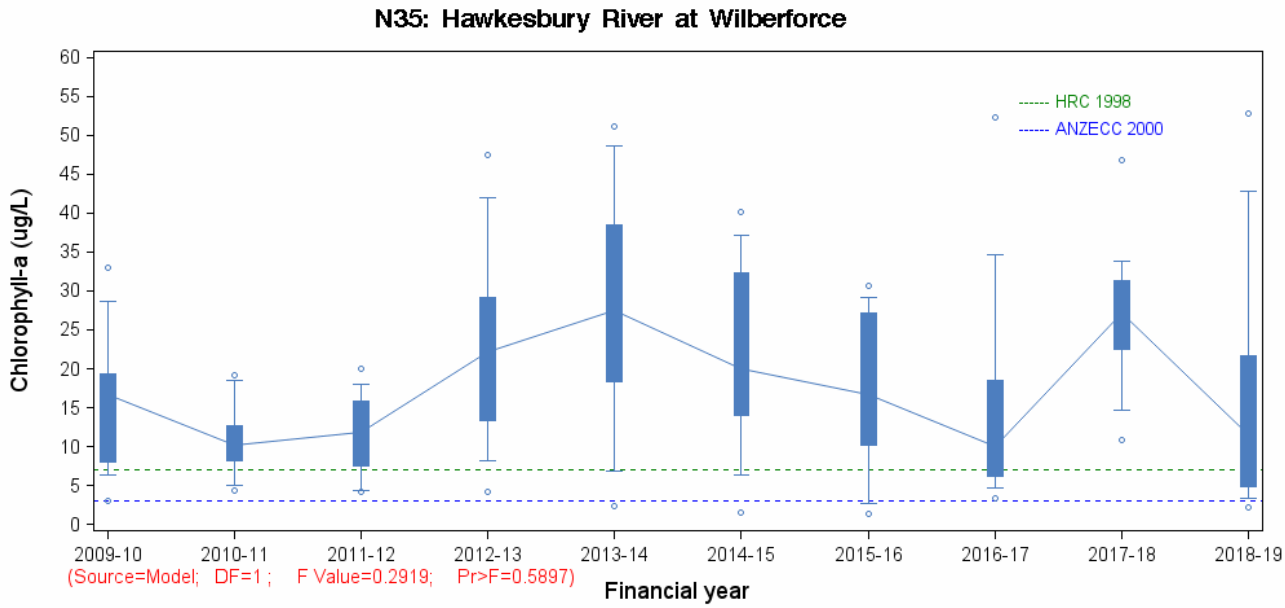


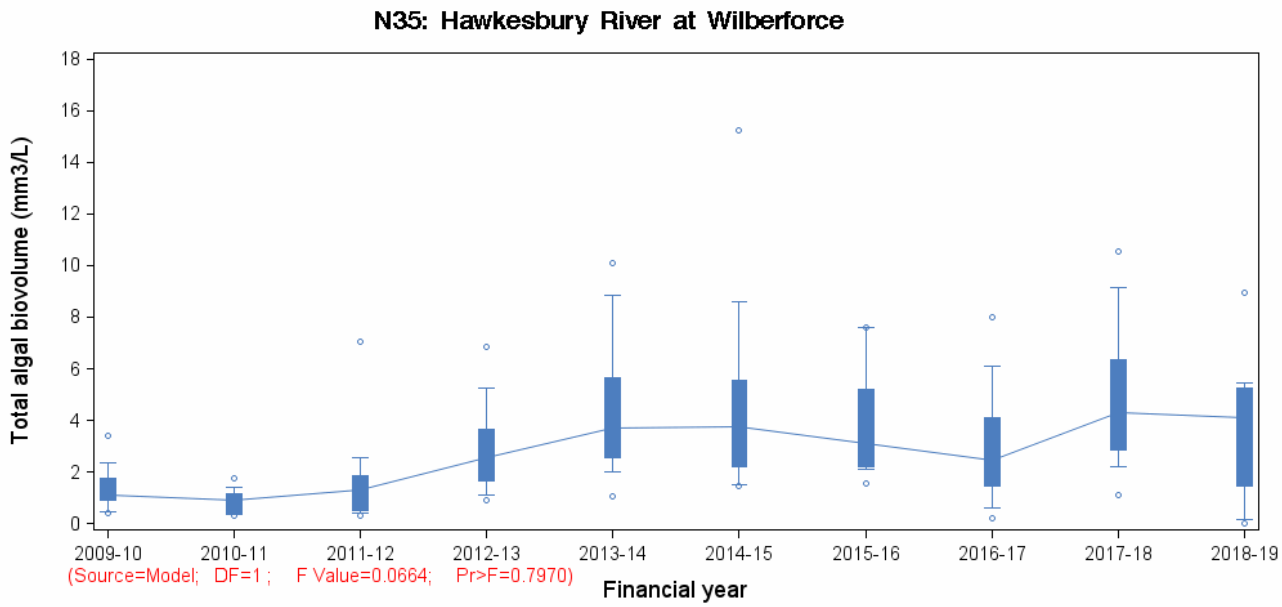


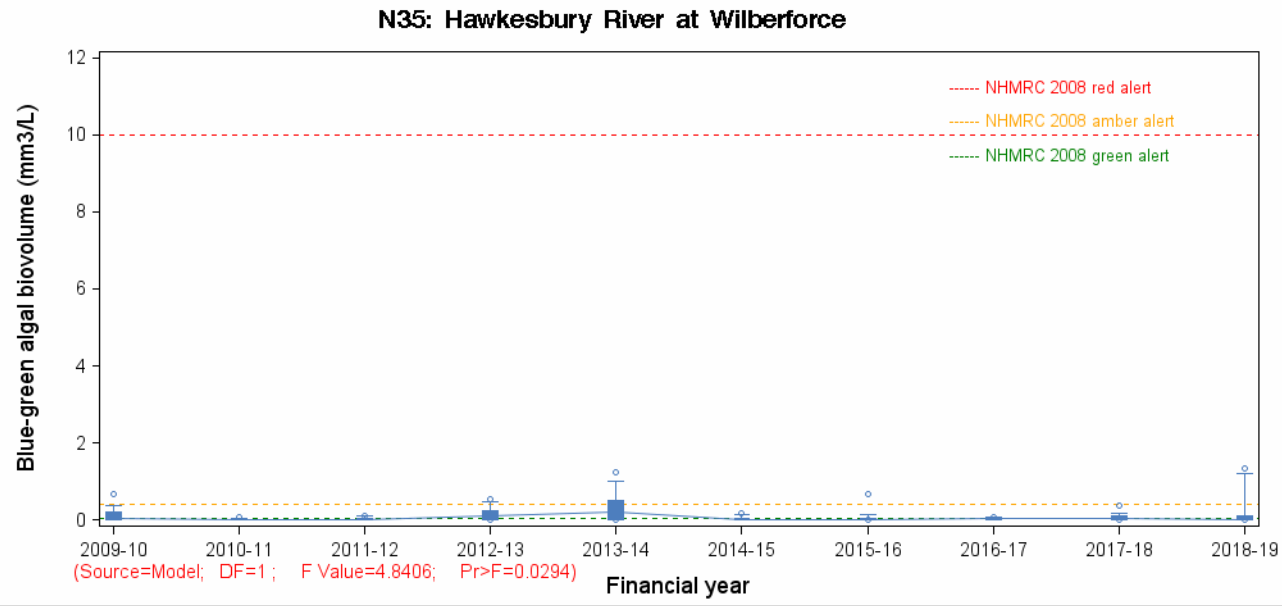


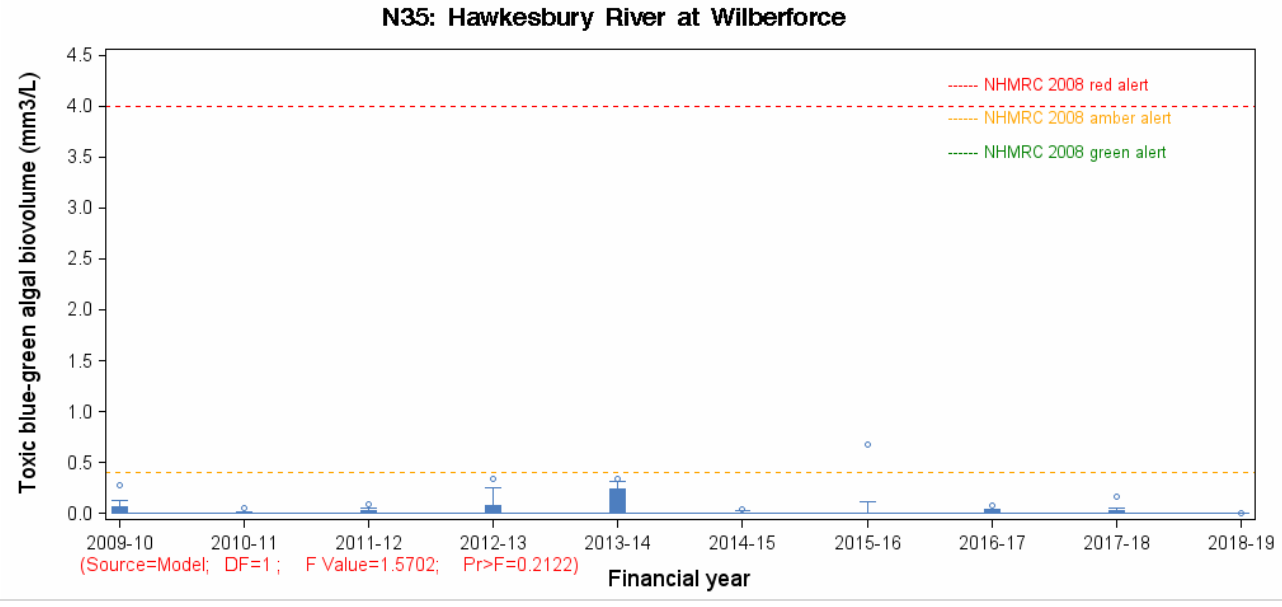

N35: Hawkesbury River at Wilberforce
Filterable total phosphorus (mg/L)
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6227; Pr>F=0.4311)
Financial year

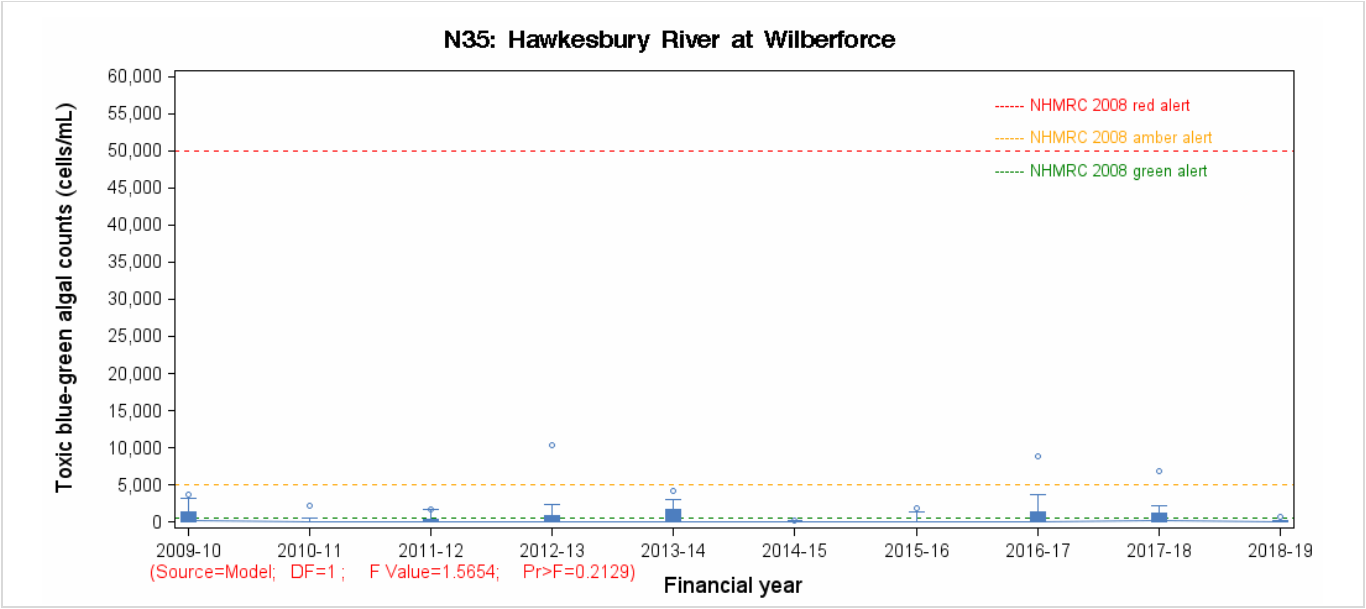

N35: Hawkesbury River at Wilberforce
Total phosphorus (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.2589; Pr>F=0.0406)
Financial year


N35: Hawkesbury River at Wilberforce
Chlorophyll-a (ug/L)
60
55
50
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2919; Pr>F=0.5897)
Financial year

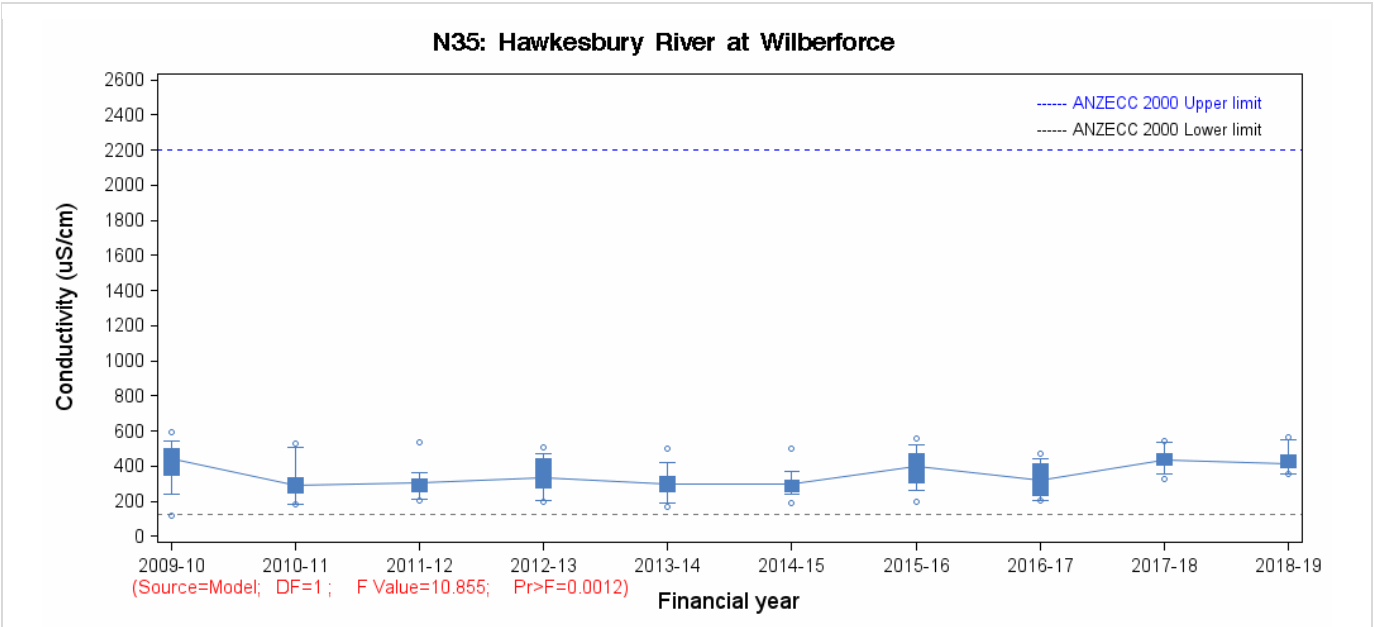

N35: Hawkesbury River at Wilberforce
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
18
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0664; Pr>F=0.7970)
Financial year

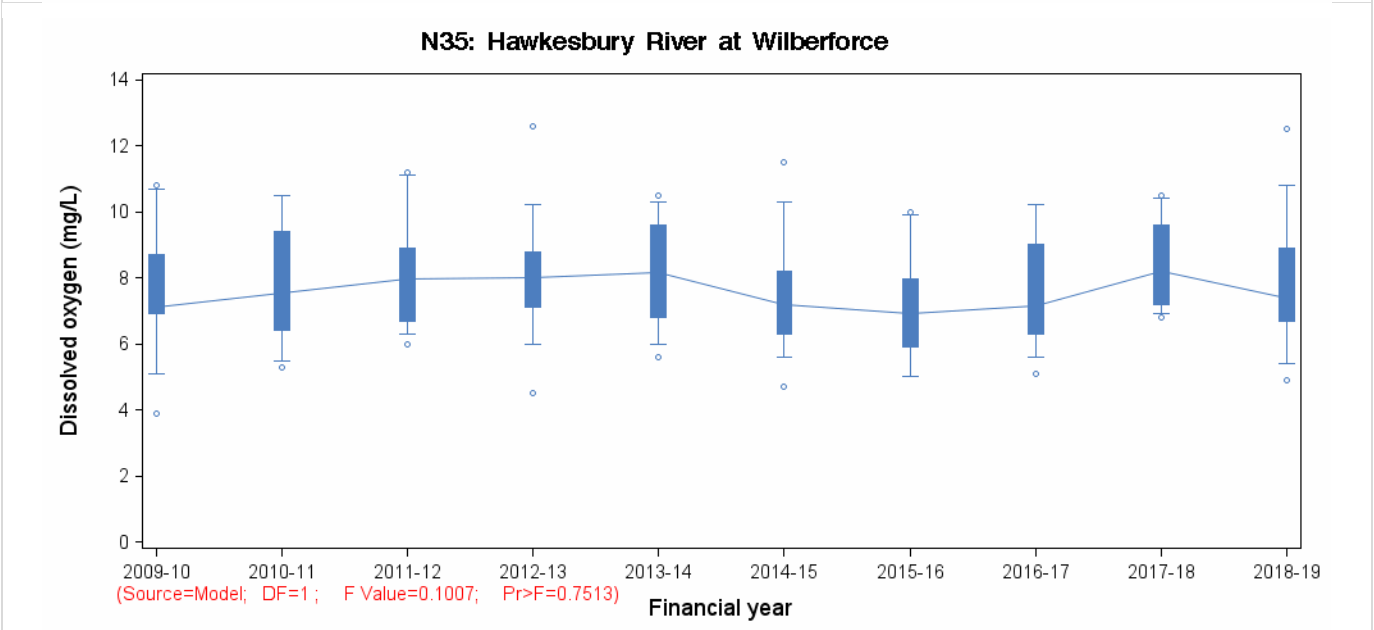

N35: Hawkesbury River at Wilberforce
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.8406; Pr>F=0.0294)
Financial year

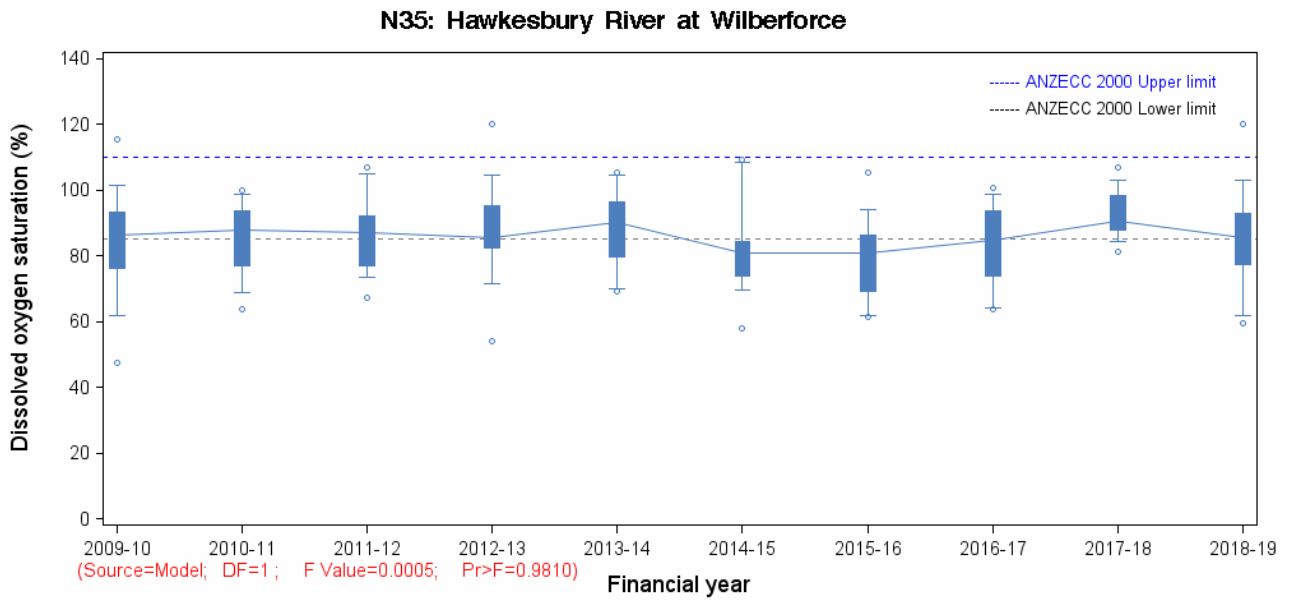

N35: Hawkesbury River at Wilberforce
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.5702; Pr>F=0.2122)
Financial year

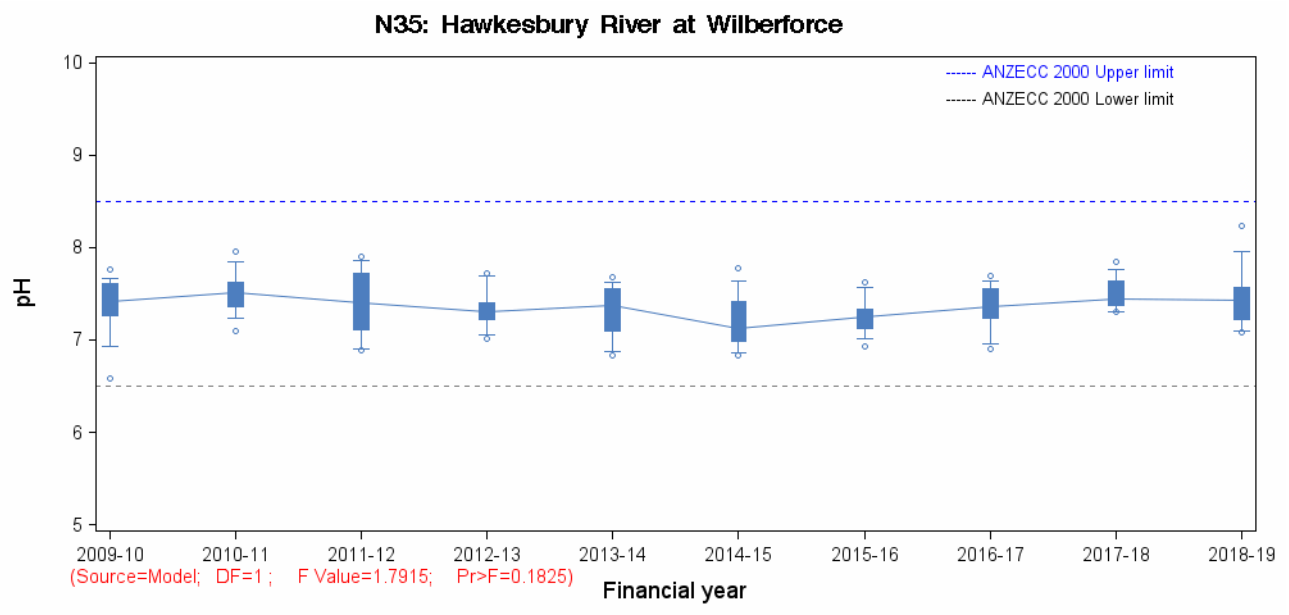


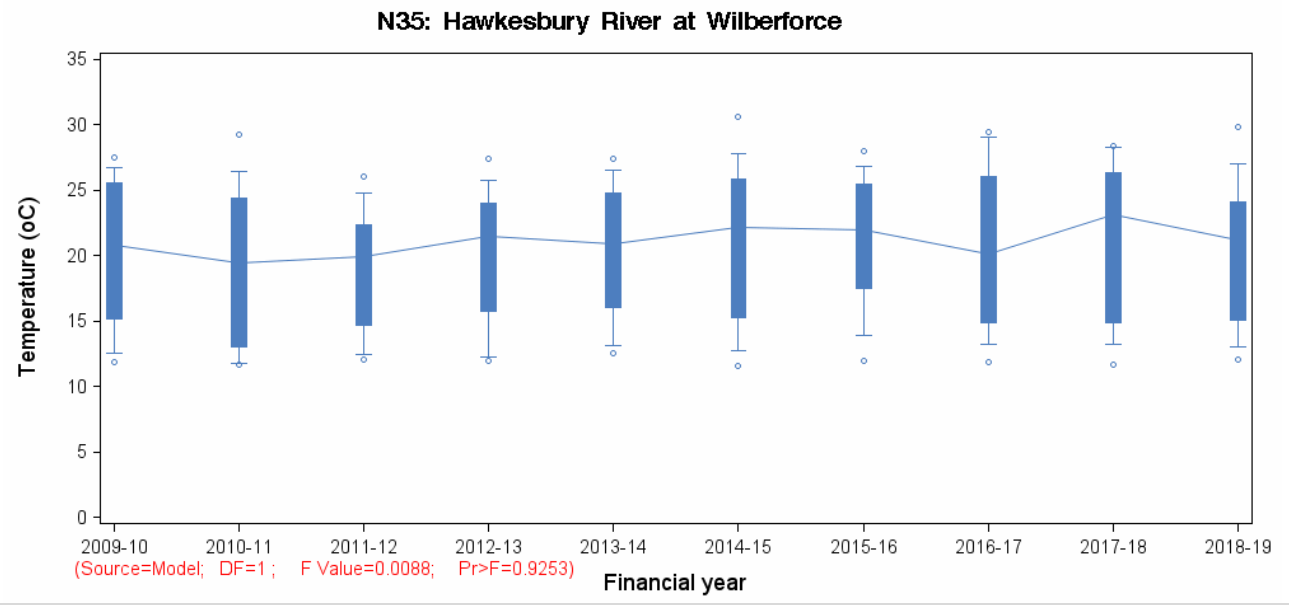
Other physico-chemical analytes

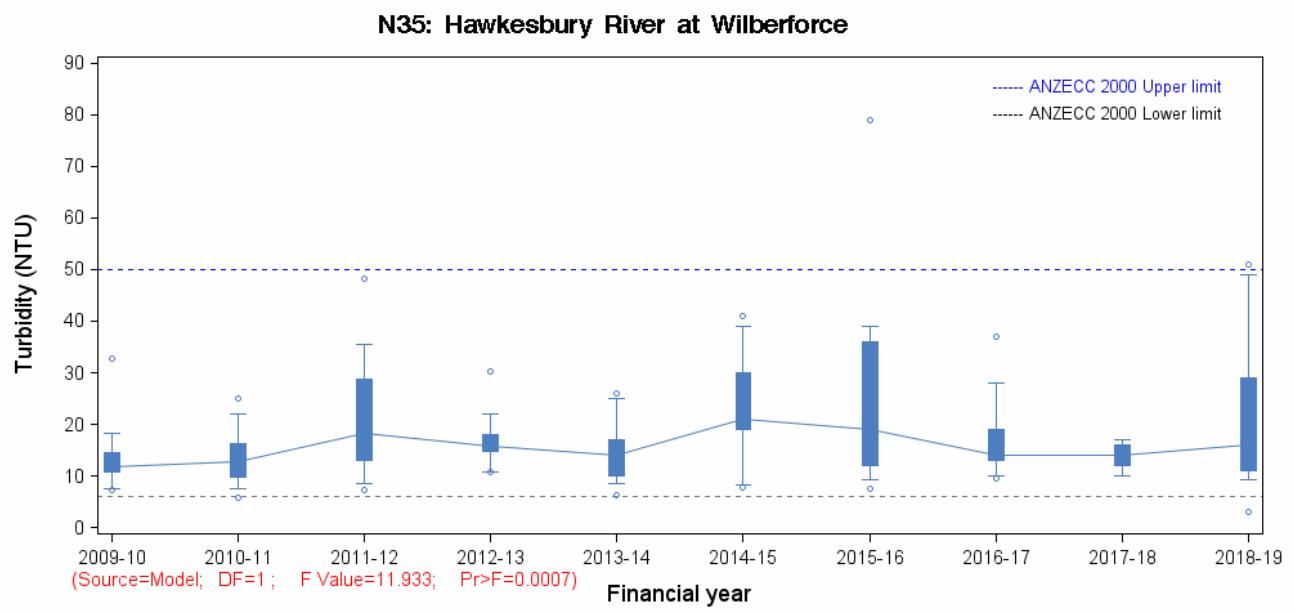


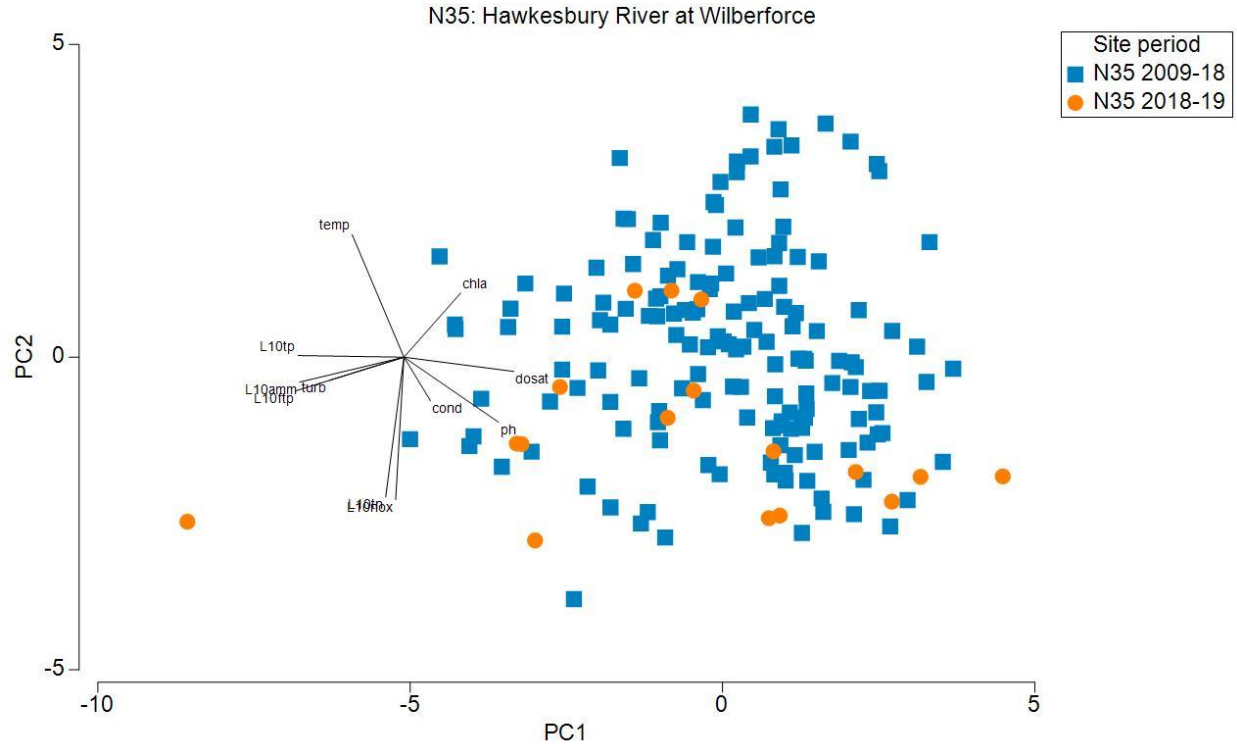



N35: Hawkesbury River at Wilberforce
Dissolved oxygen saturation (%)
140
120
100
80
60
40
20
0
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0005; Pr>F=0.9810)
Financial year


N35: Hawkesbury River at Wilberforce
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.7915; Pr>F=0.1825)
Financial year


N35: Hawkesbury River at Wilberforce
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0088; Pr>F=0.9253)
Financial year

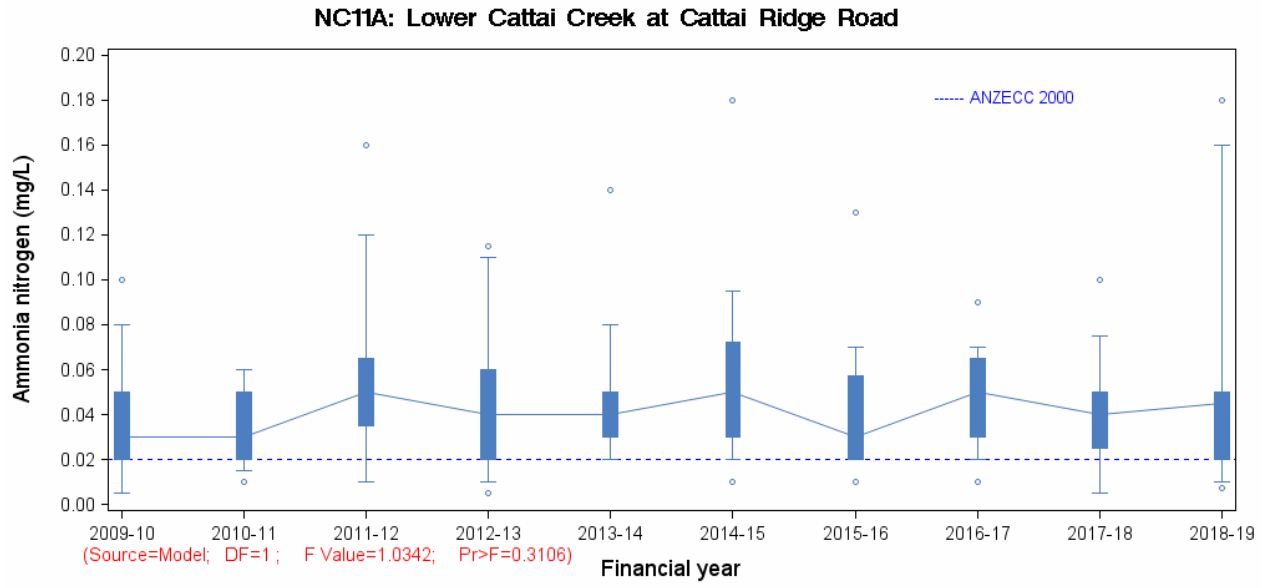


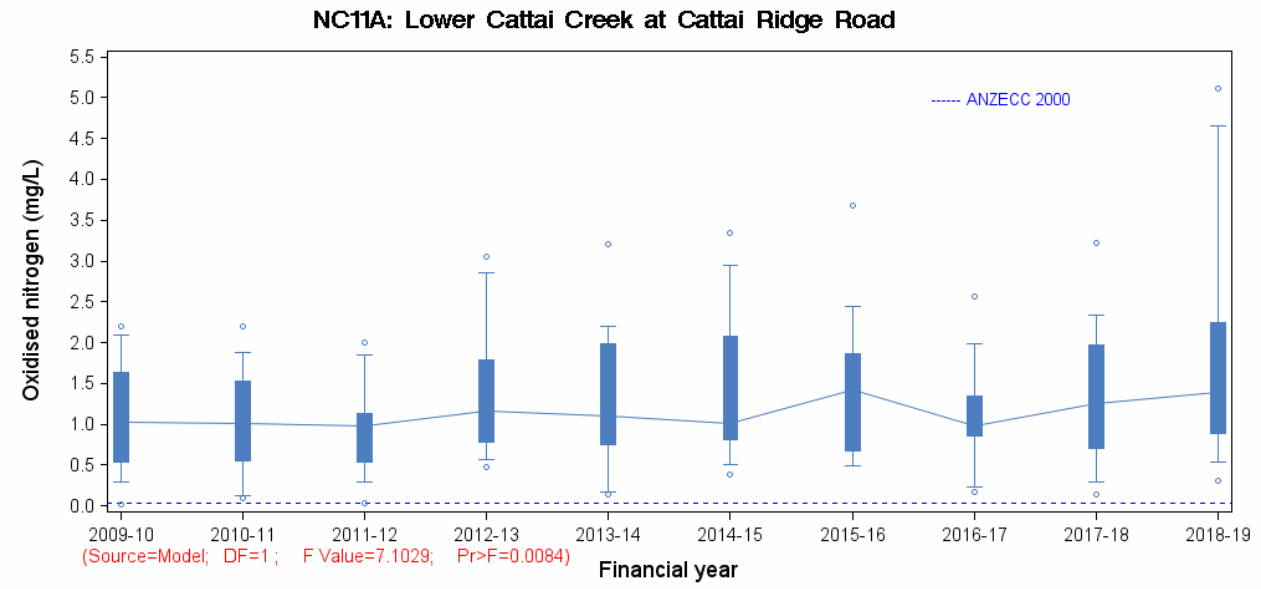


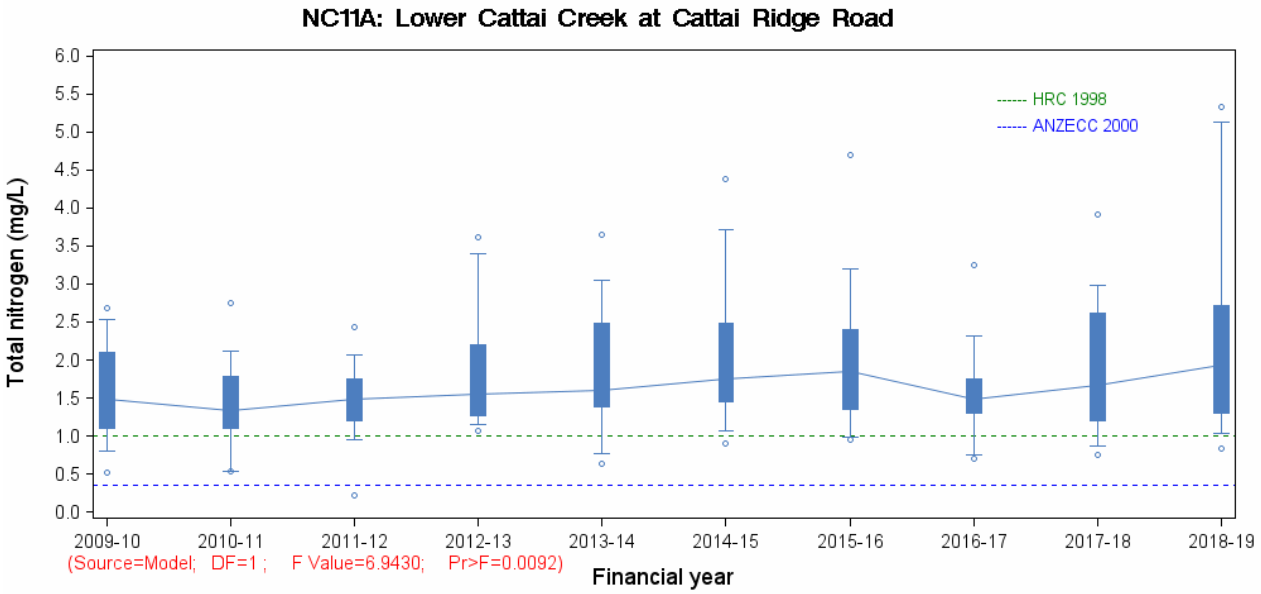
The ordination plot from Principal Components Analysis suggested water quality of the Hawkesbury River at Wilberforce in 2018-19 was similar to that recorded in the period 2009 to 2018.

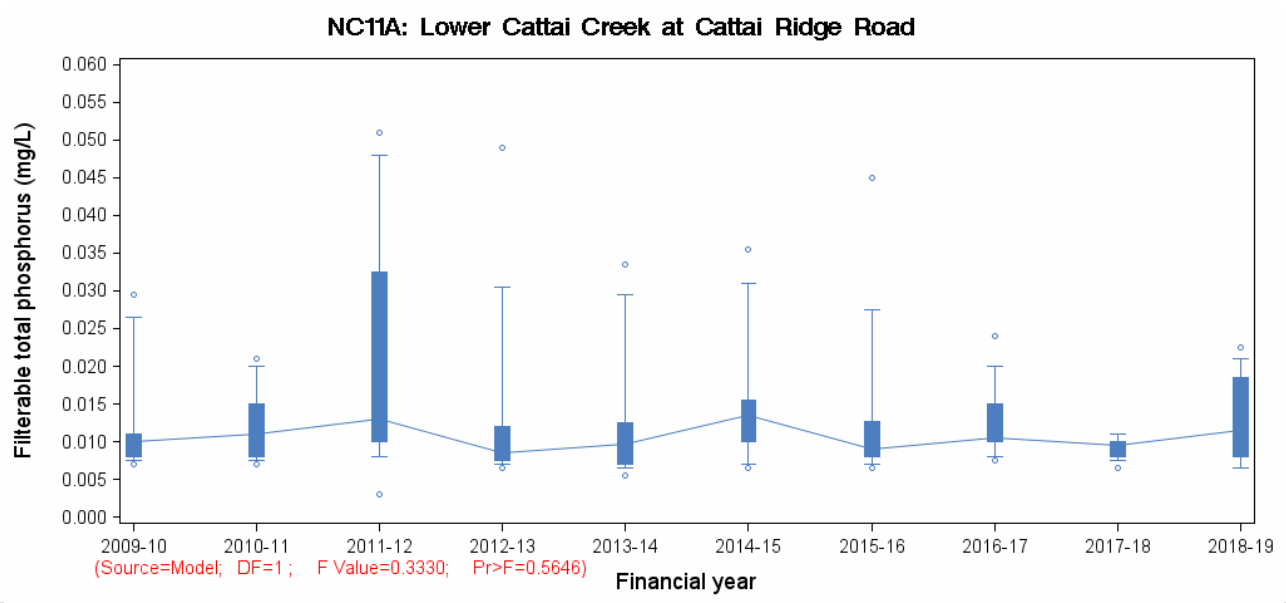
NC11A: Lower Cattai Creek at Cattai Ridge Road

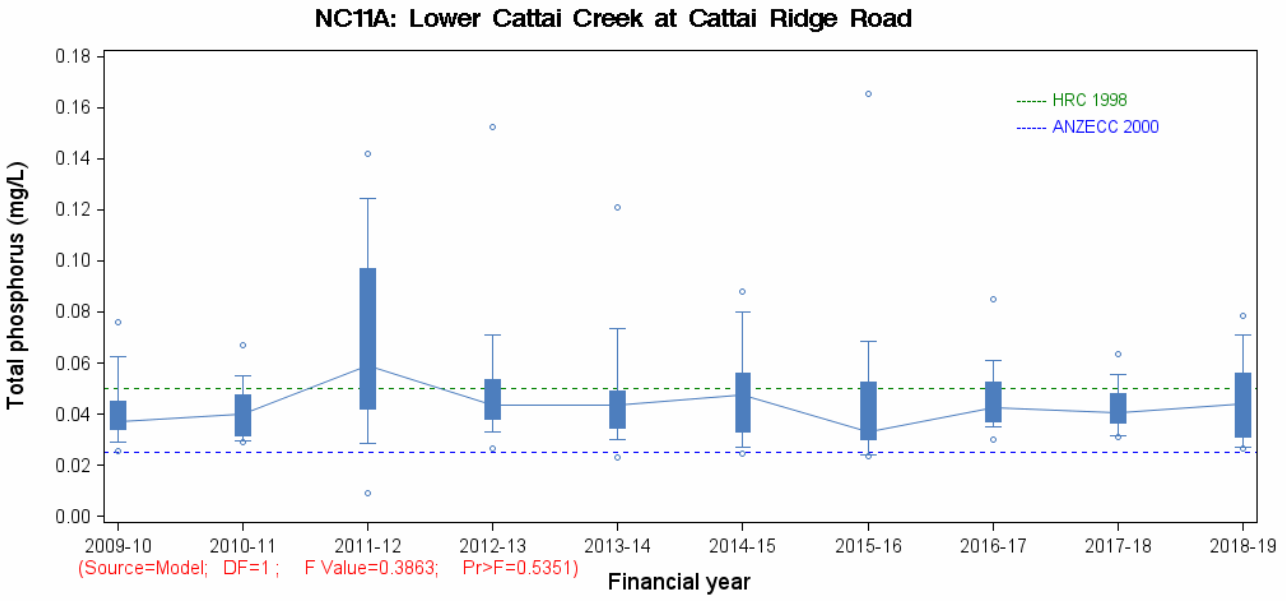
Nutrients, chlorophyll-*a* and algae

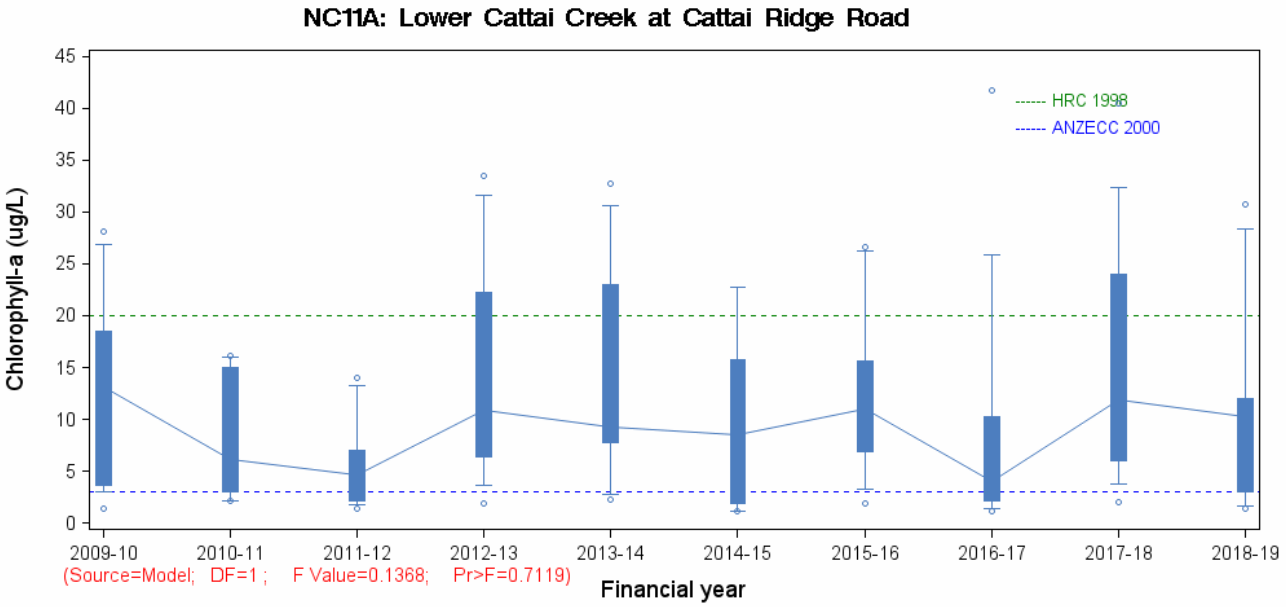


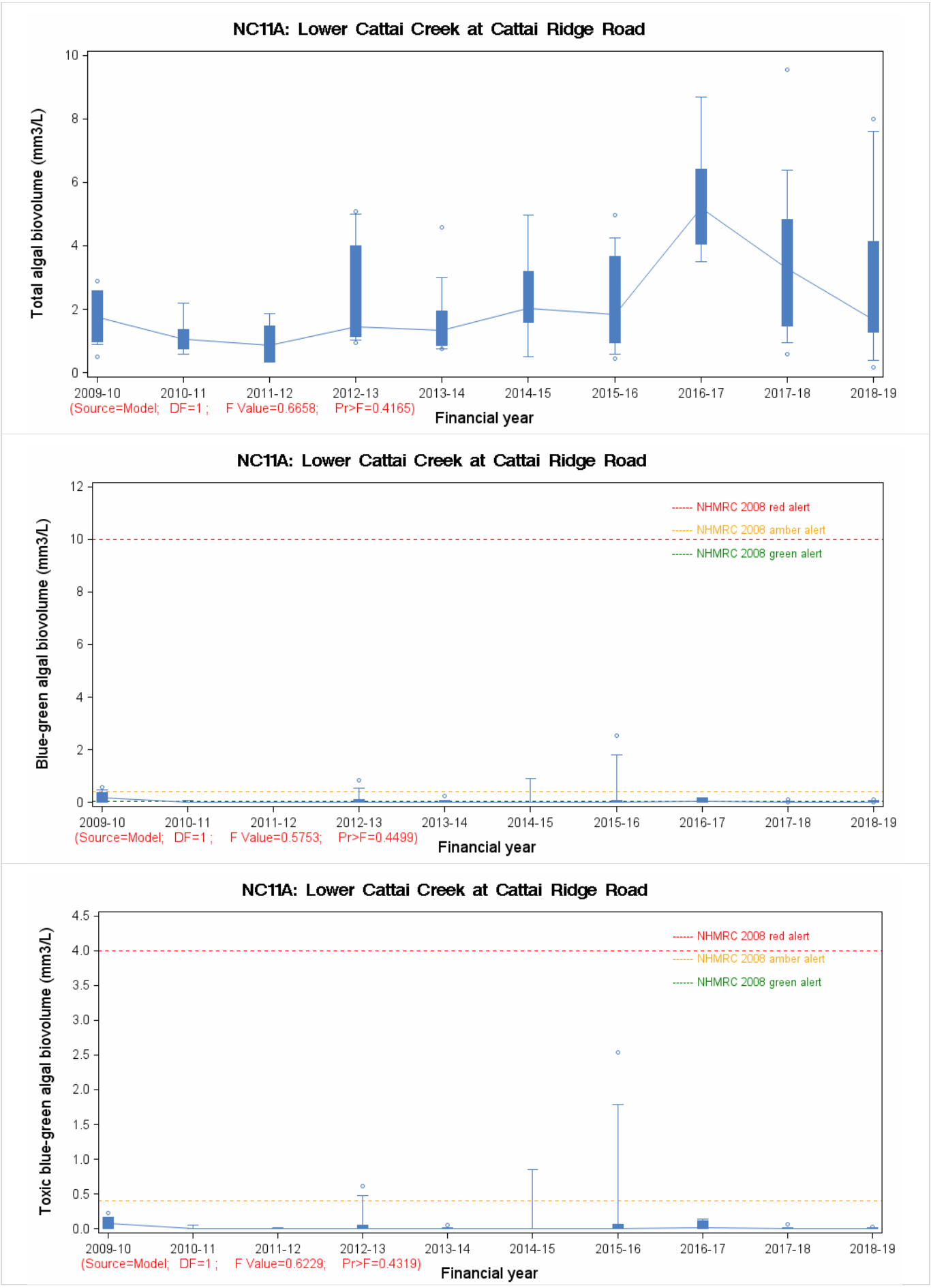


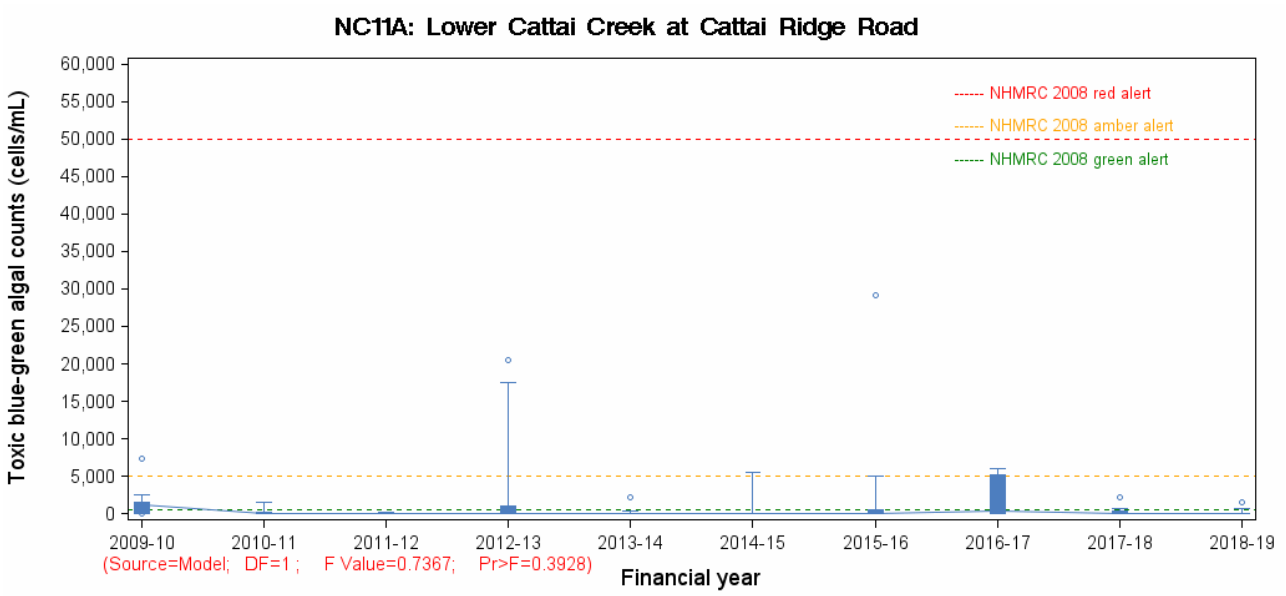



NC11A: Lower Cattai Creek at Cattai Ridge Road
Filterable total phosphorus (mg/L)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3330; Pr>F=0.5646)
Financial year

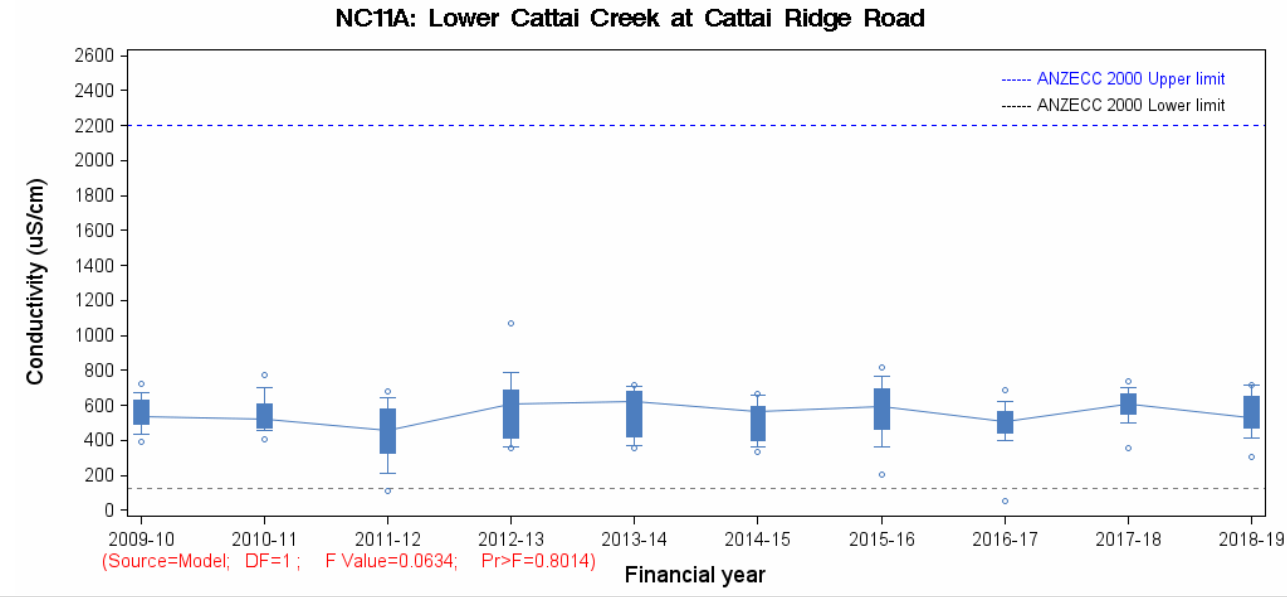

NC11A: Lower Cattai Creek at Cattai Ridge Road
Total phosphorus (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3863; Pr>F=0.5351)
Financial year

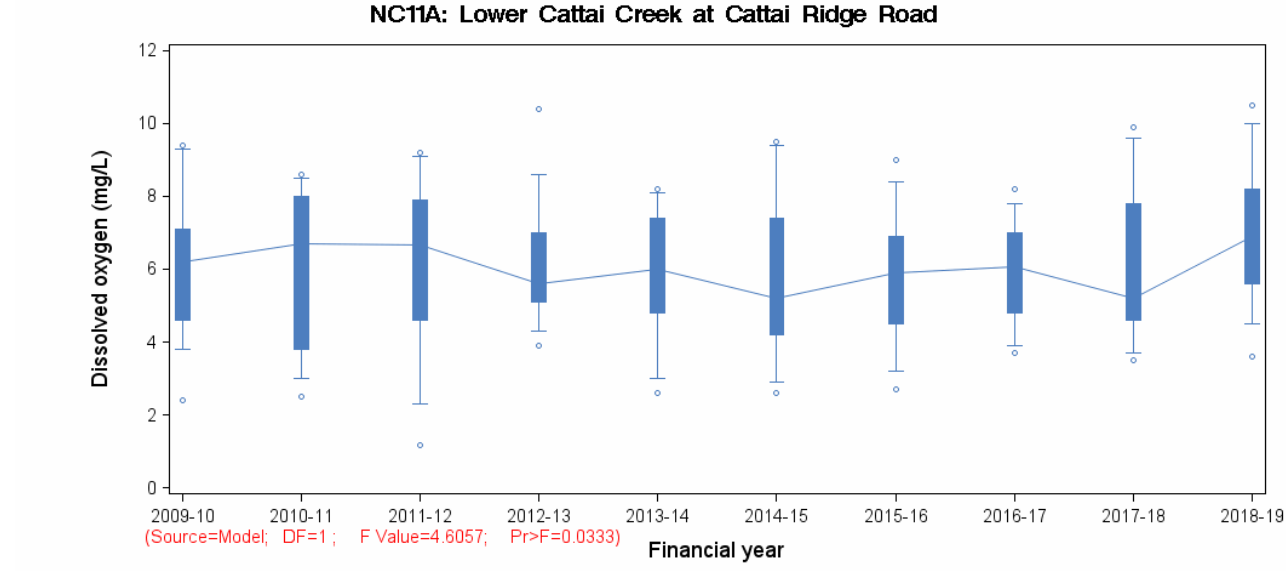

NC11A: Lower Cattai Creek at Cattai Ridge Road
Chlorophyll-a (ug/L)
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1368; Pr>F=0.7119)
Financial year

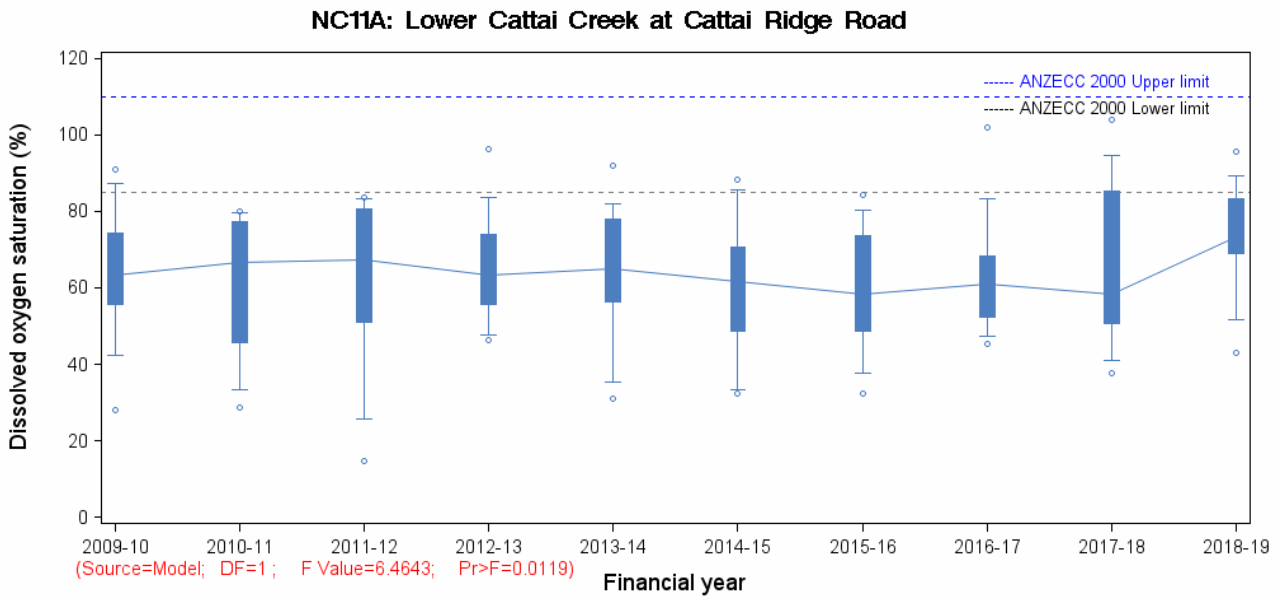

NC11A: Lower Cattai Creek at Cattai Ridge Road
Total algal biovolume (mm3/L)
0
2
4
6
8
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6658; Pr>F=0.4165)
Financial year
NC11A: Lower Cattai Creek at Cattai Ridge Road
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5753; Pr>F=0.4499)
Financial year
NC11A: Lower Cattai Creek at Cattai Ridge Road
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6229; Pr>F=0.4319)
Financial year

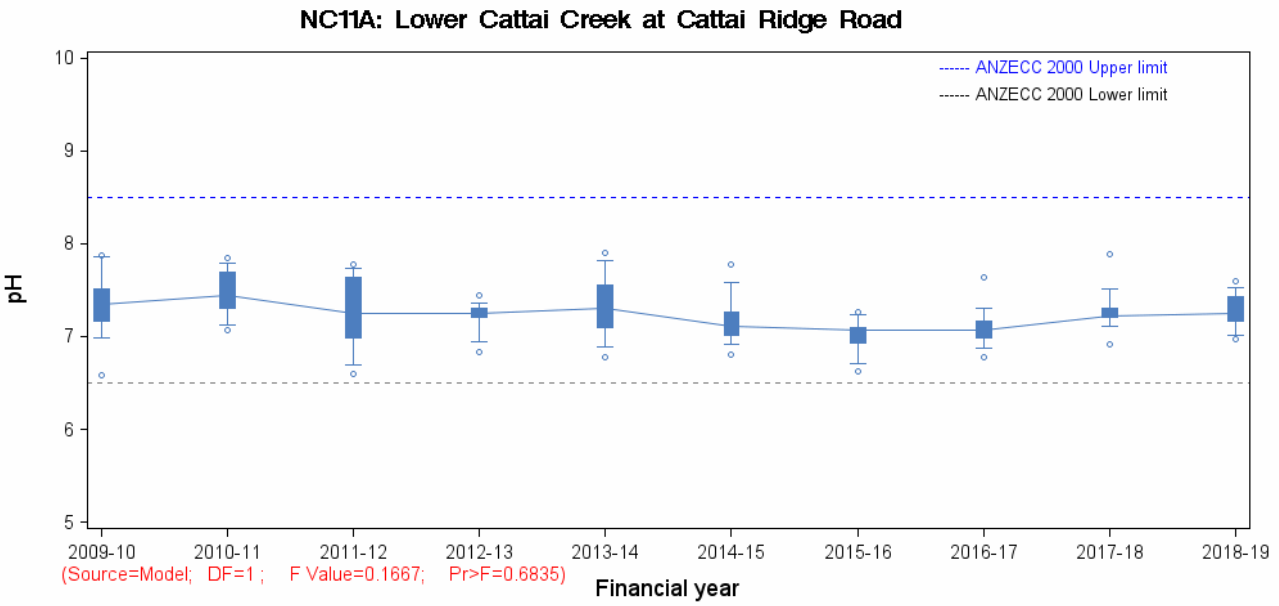


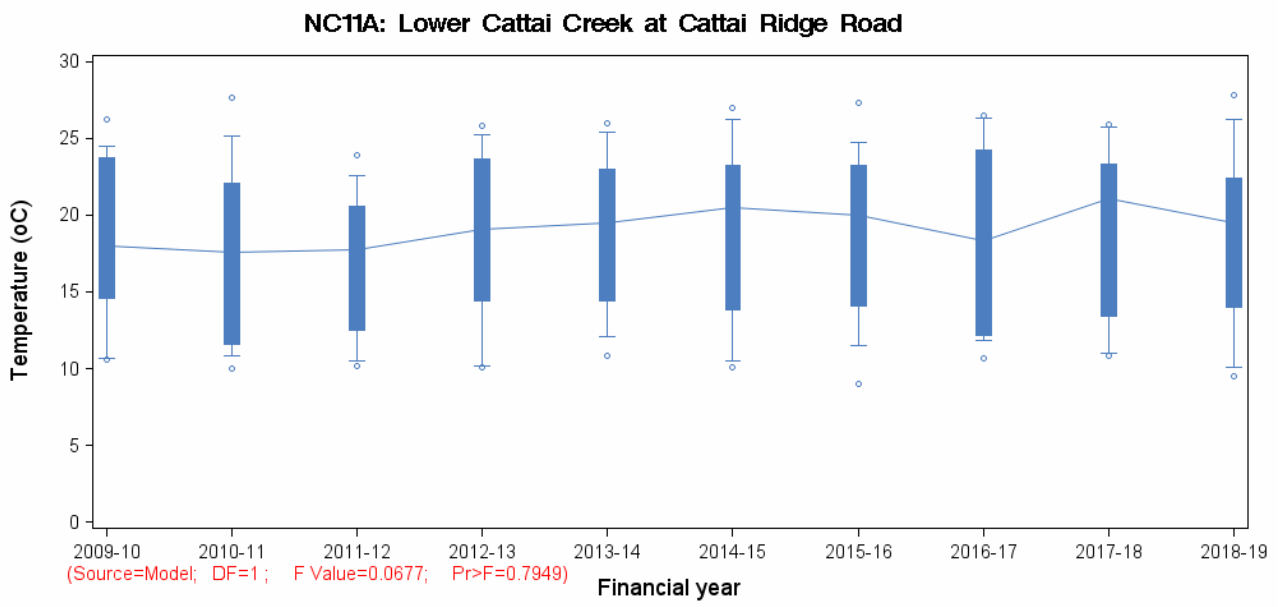
Other physico-chemical analytes

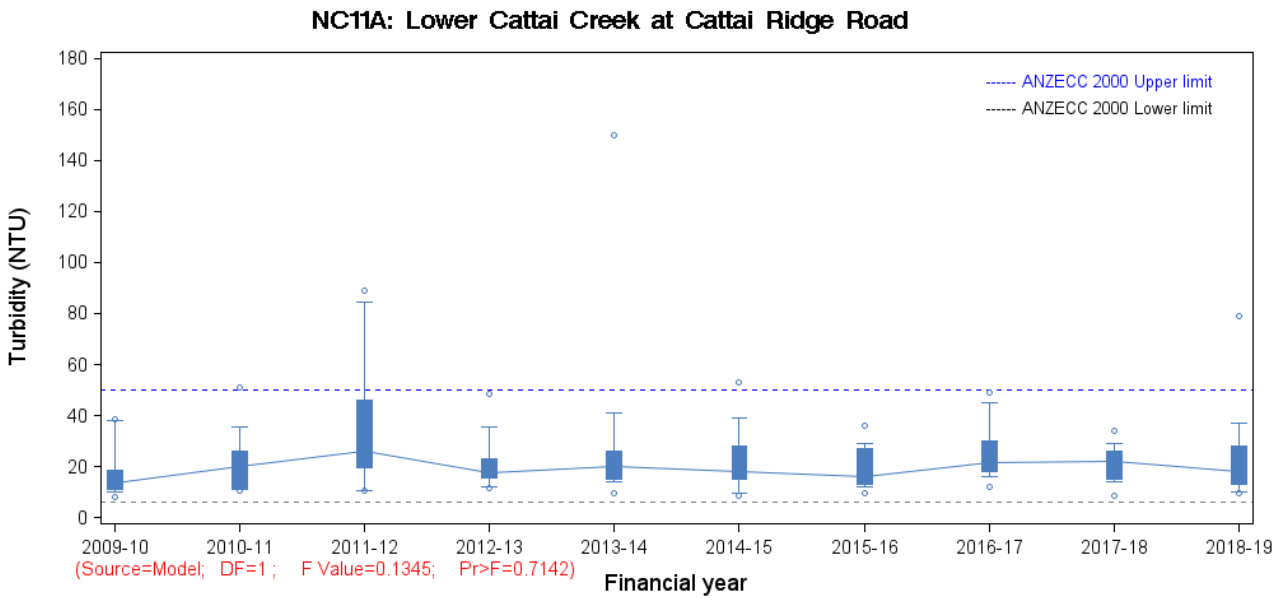


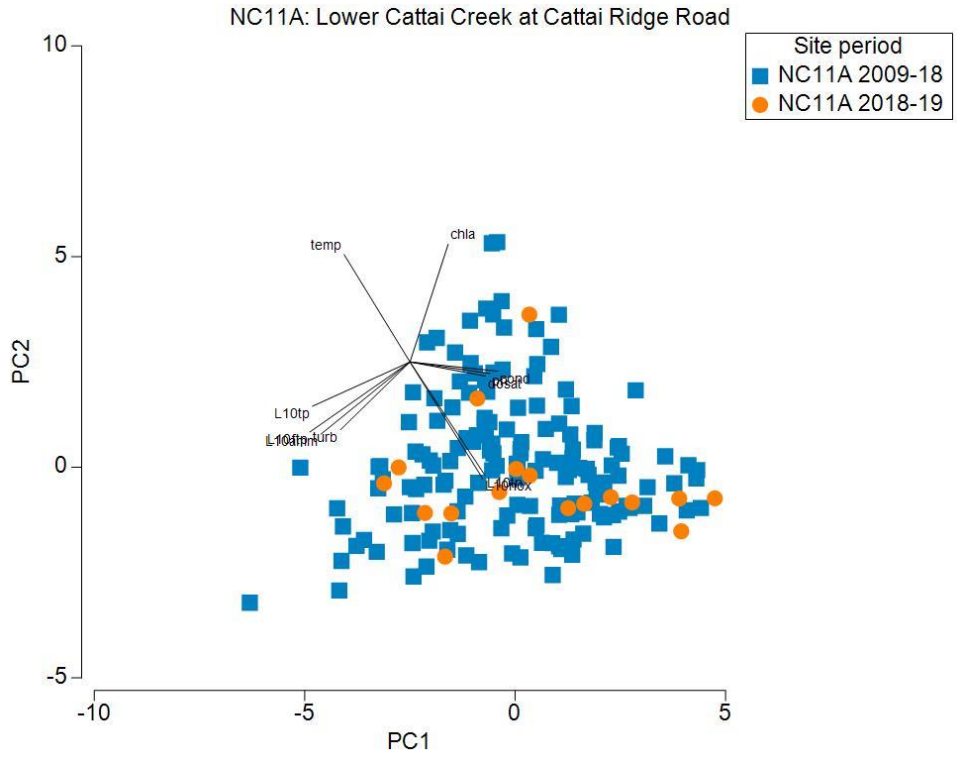



NC11A: Lower Cattai Creek at Cattai Ridge Road
Dissolved oxygen saturation (%)
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=6.4643; Pr>F=0.0119)
Financial year


NC11A: Lower Cattai Creek at Cattai Ridge Road
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1667; Pr>F=0.6835)
Financial year


NC11A: Lower Cattai Creek at Cattai Ridge Road
Temperature (oC)
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0677; Pr>F=0.7949)
Financial year

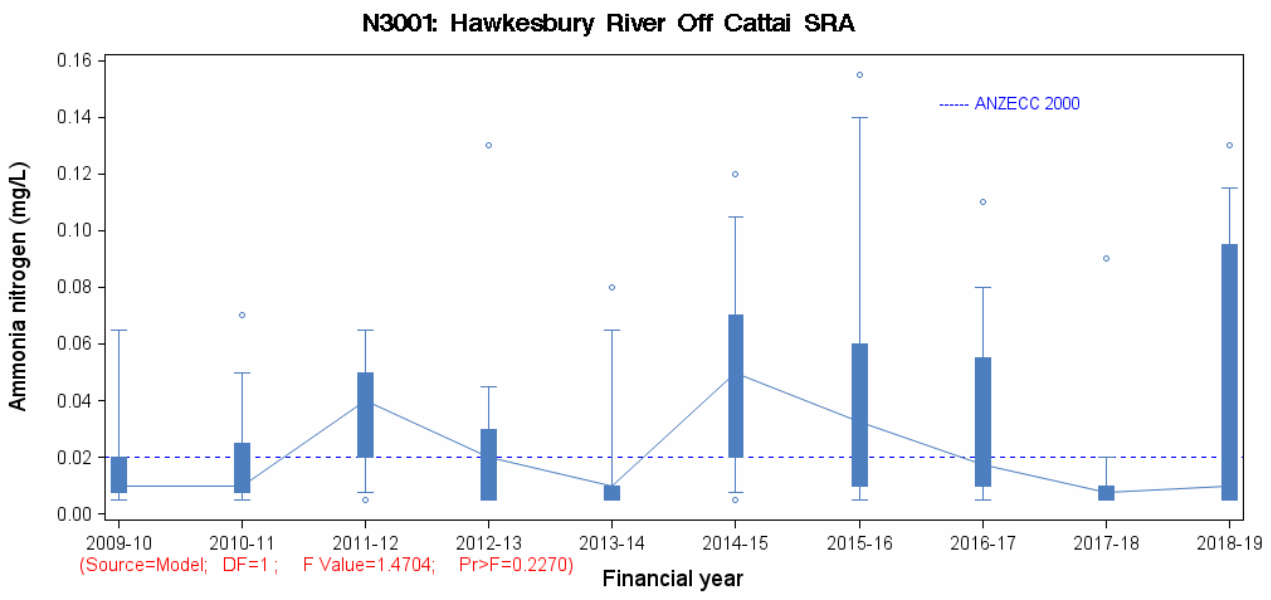


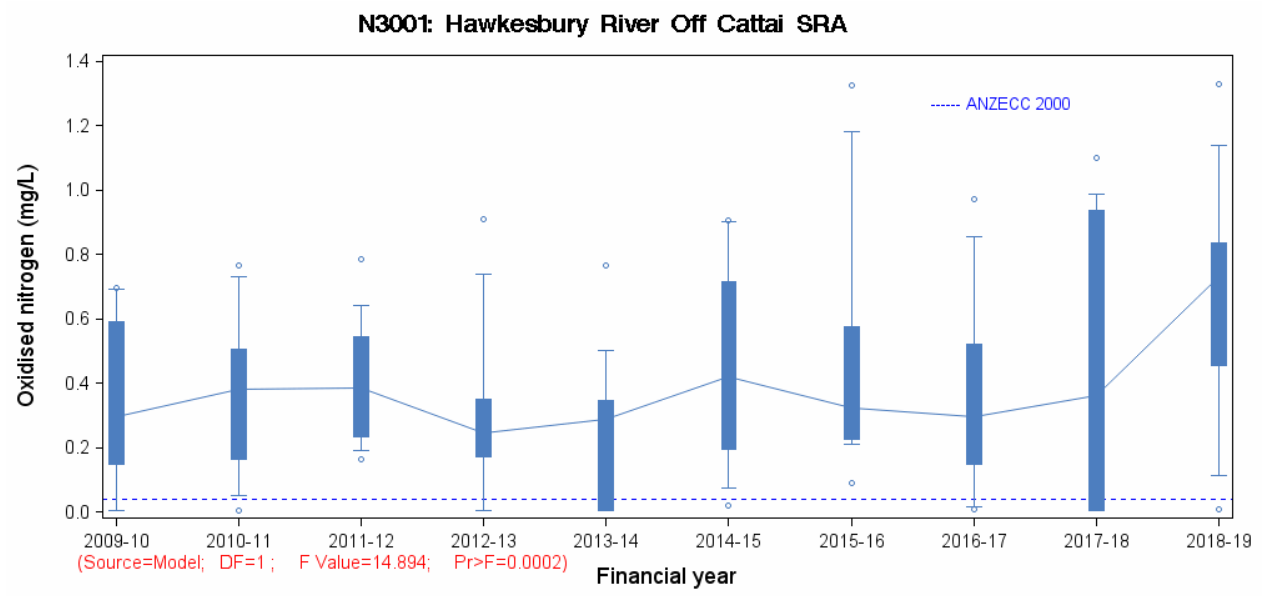


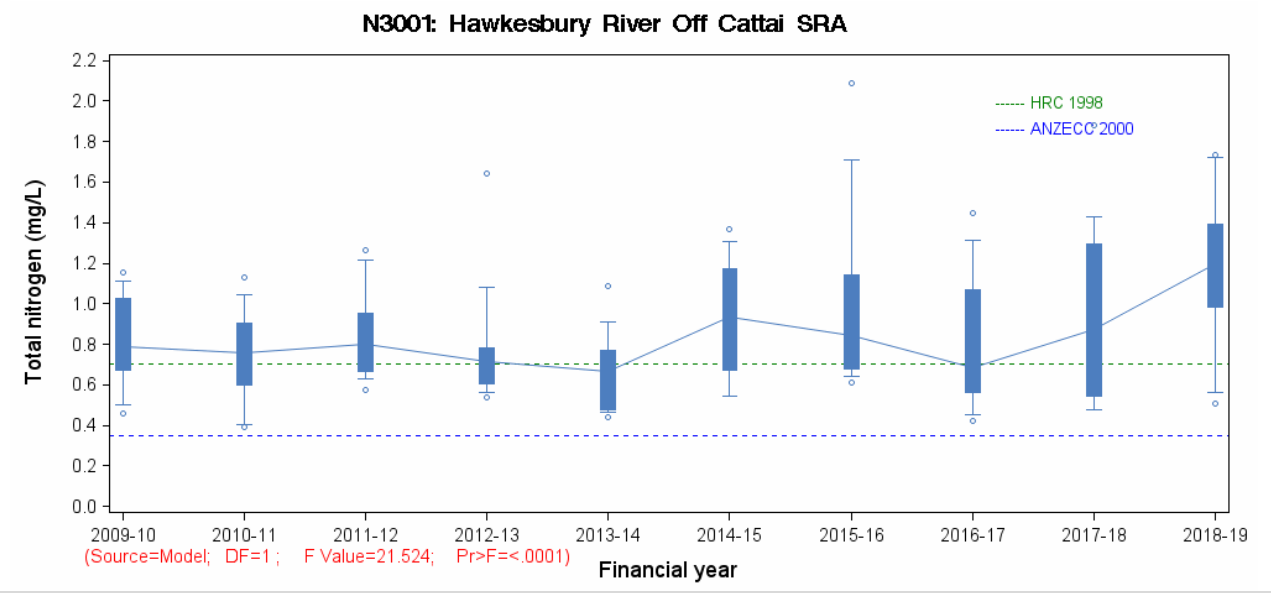
The ordination plot from Principal Components Analysis suggested water quality of the Lower Cattai Creek at Cattai Ridge Road in 2018-19 had similar variability to that recorded in the period 2009 to 2018.

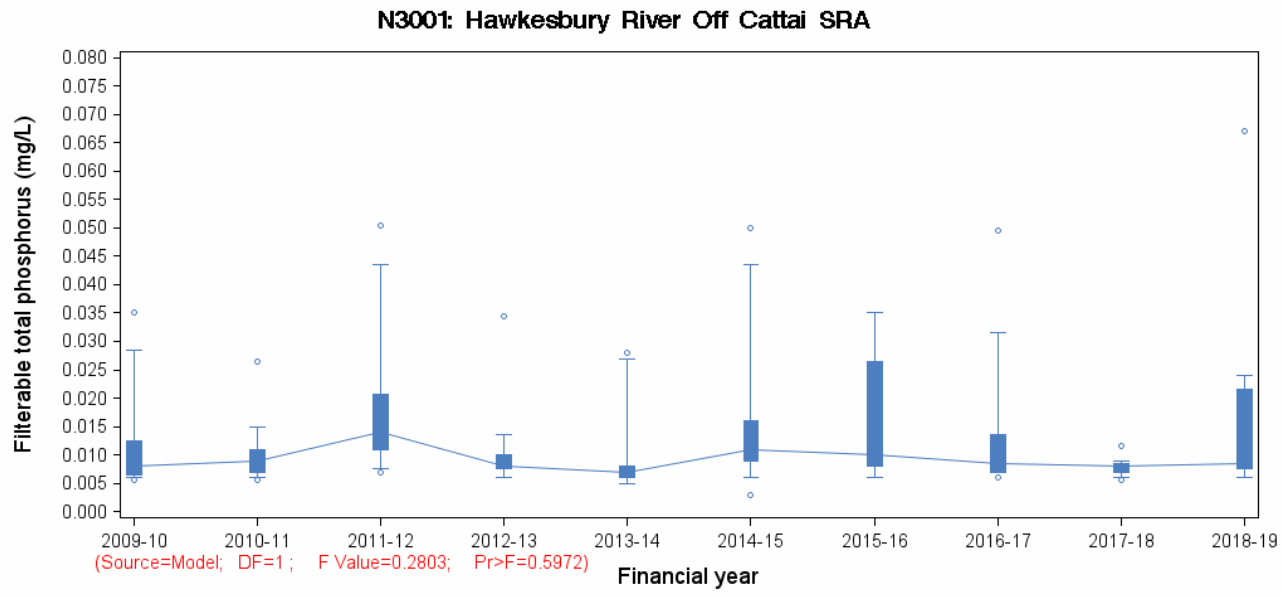
N3001: Hawkesbury River off Cattai SRA

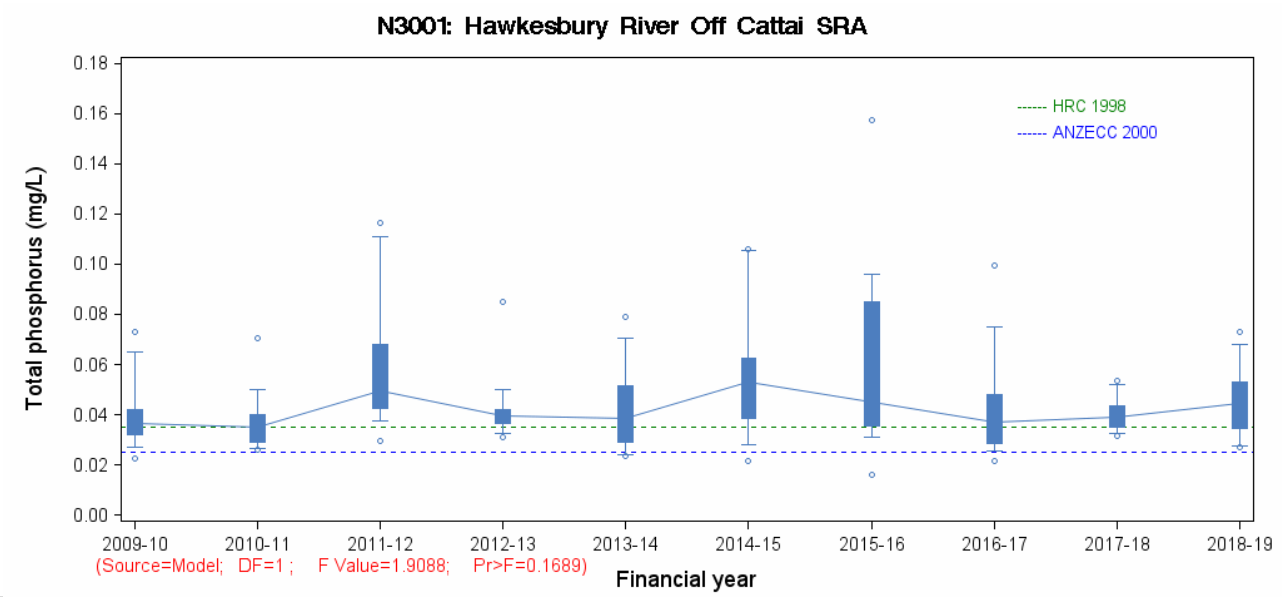
Nutrients, chlorophyll-*a* and algae

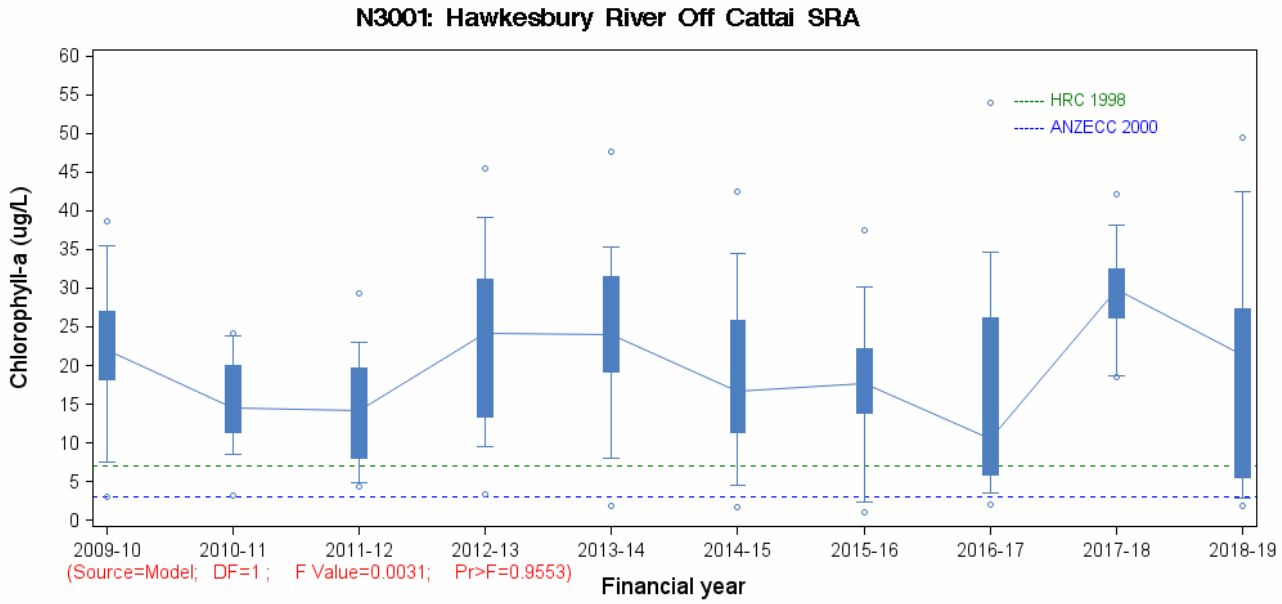


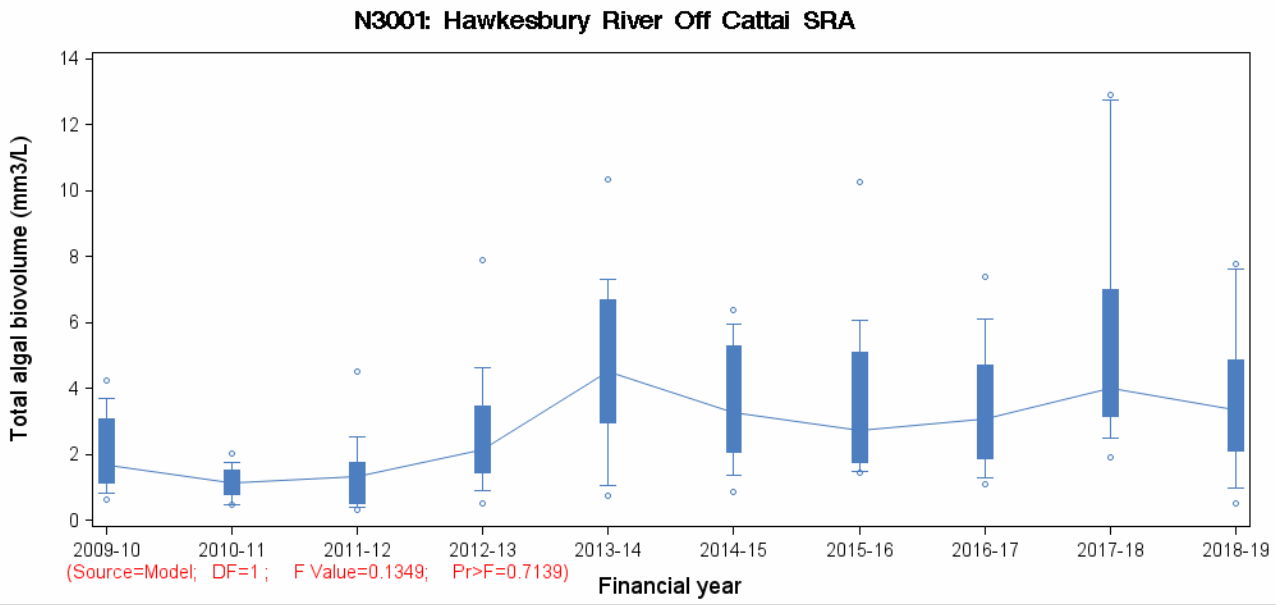


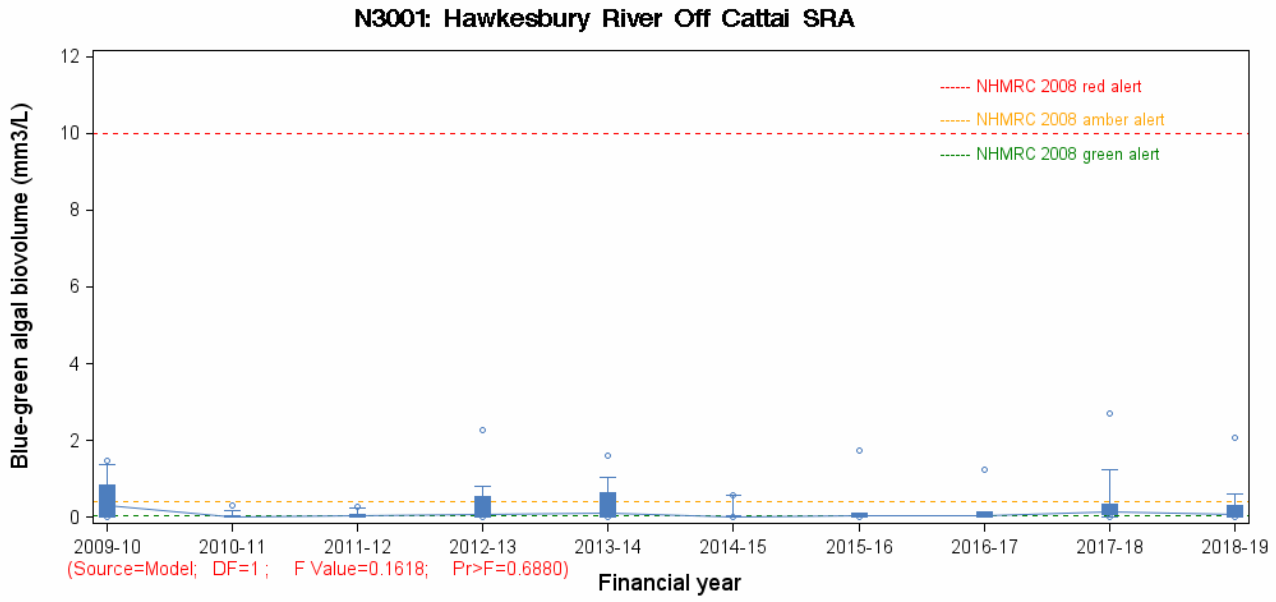


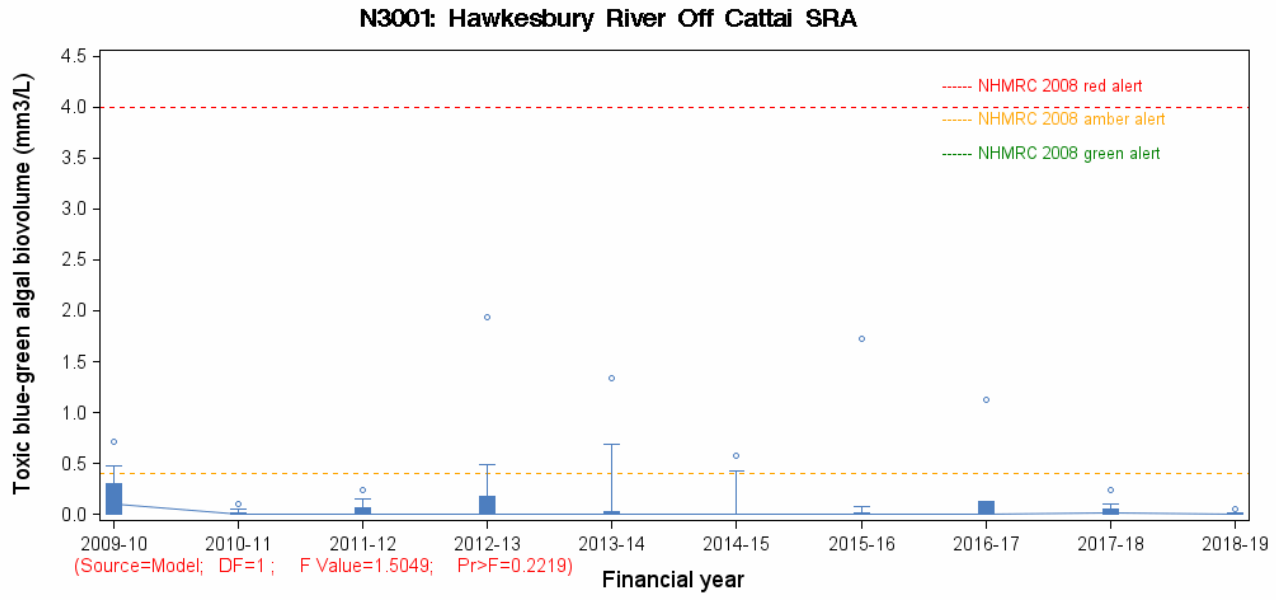

N3001: Hawkesbury River Off Cattai SRA
Filterable total phosphorus (mg/L)
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2803; Pr>F=0.5972)
Financial year

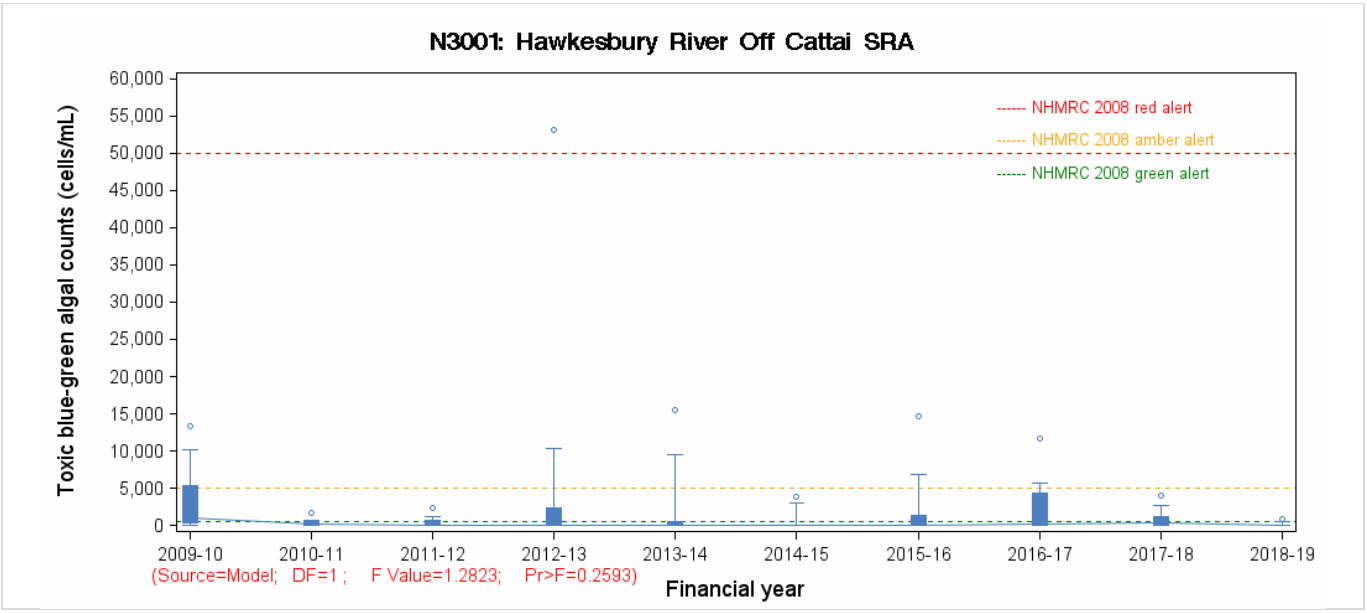

N3001: Hawkesbury River Off Cattai SRA
Total phosphorus (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.9088; Pr>F=0.1689)
Financial year


N3001: Hawkesbury River Off Cattai SRA
Chlorophyll-a (ug/L)
60
55
50
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0031; Pr>F=0.9553)
Financial year

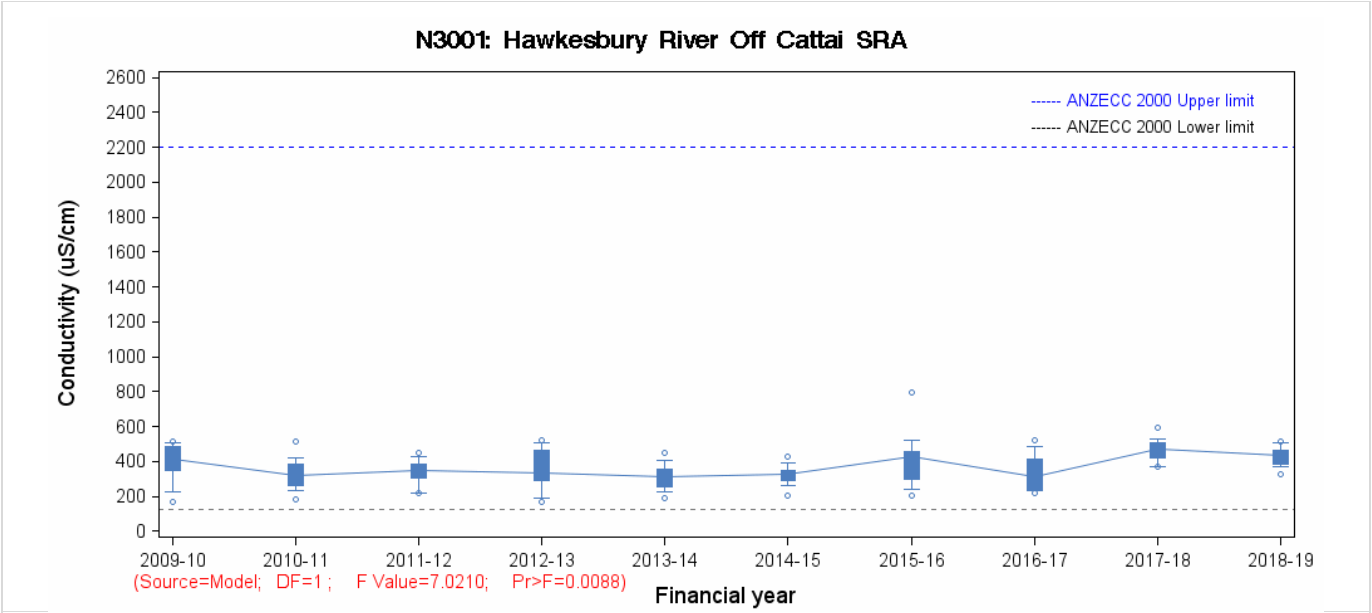

N3001: Hawkesbury River Off Cattai SRA
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1349; Pr>F=0.7139)
Financial year

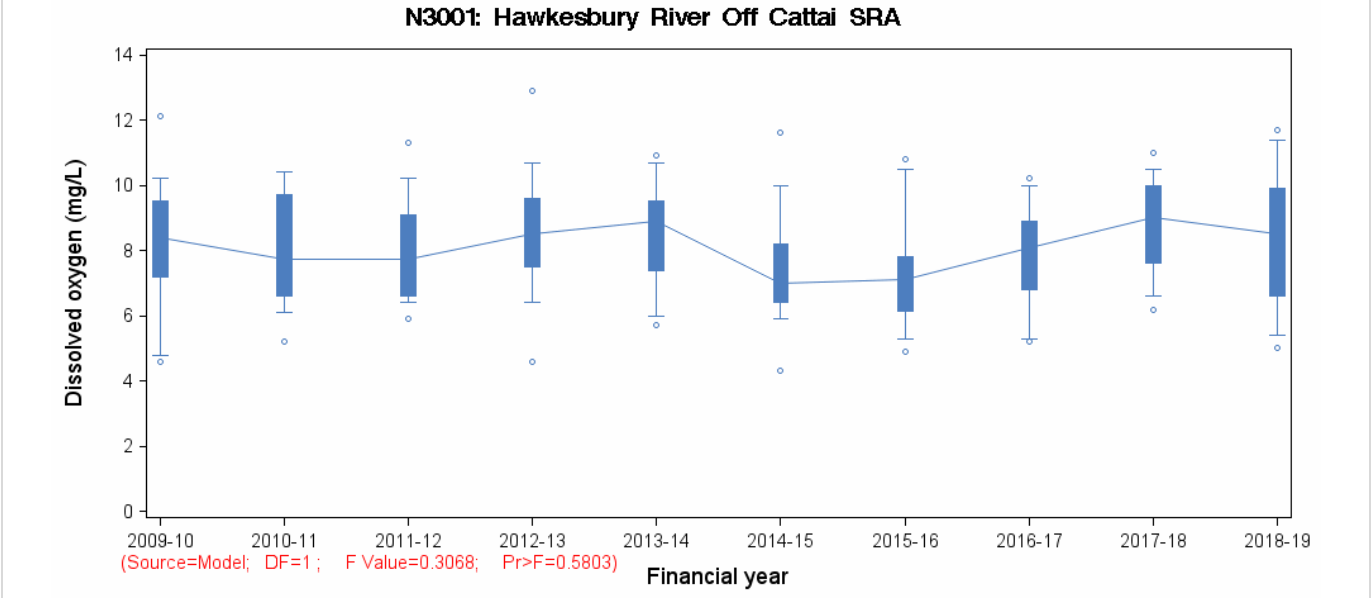

N3001: Hawkesbury River Off Cattai SRA
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1618; Pr>F=0.6880)
Financial year

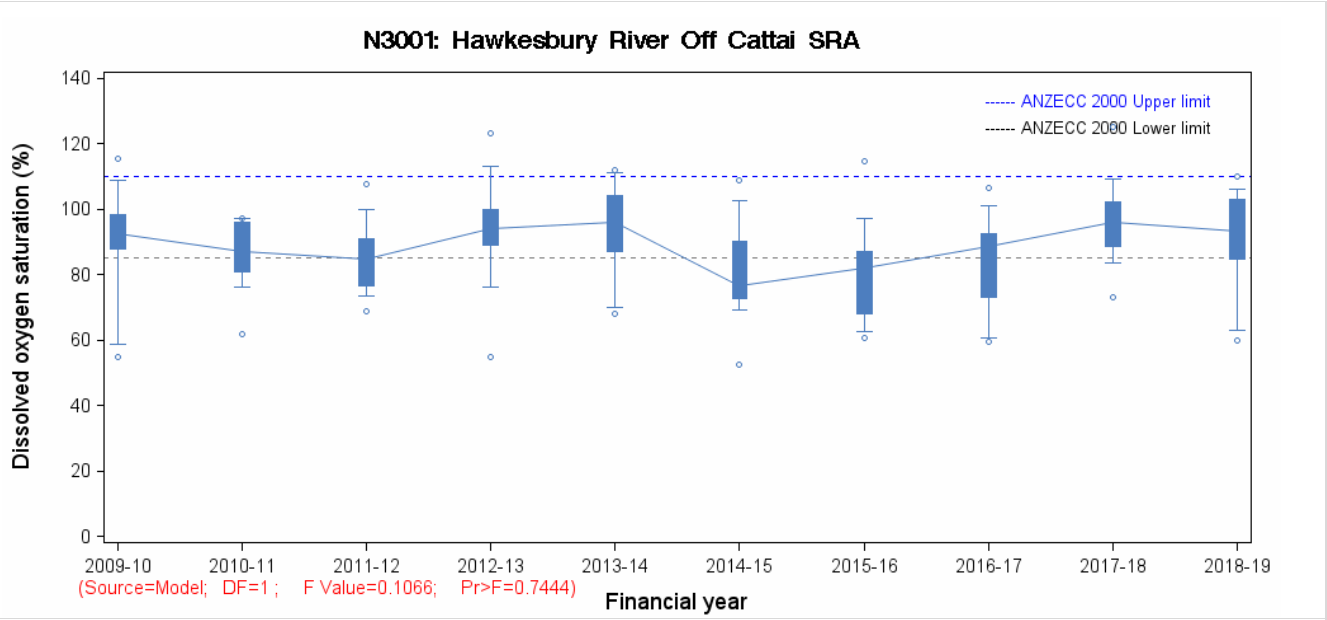

N3001: Hawkesbury River Off Cattai SRA
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.5049; Pr>F=0.2219)
Financial year

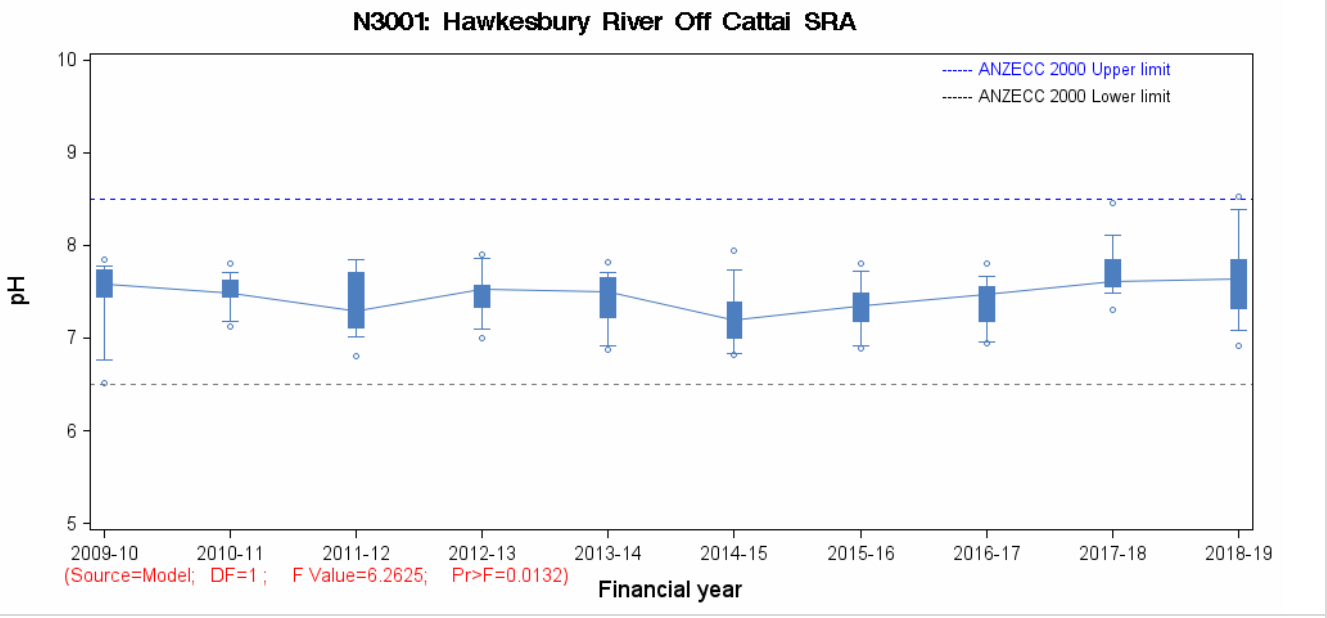


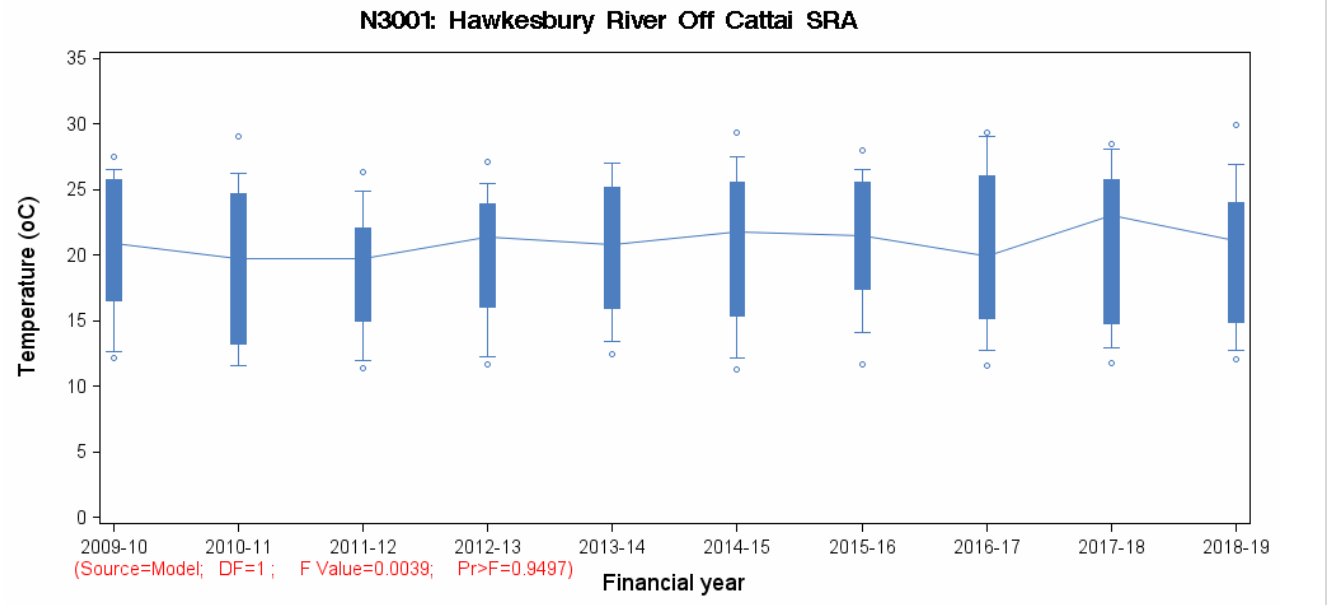
Other physico-chemical analytes

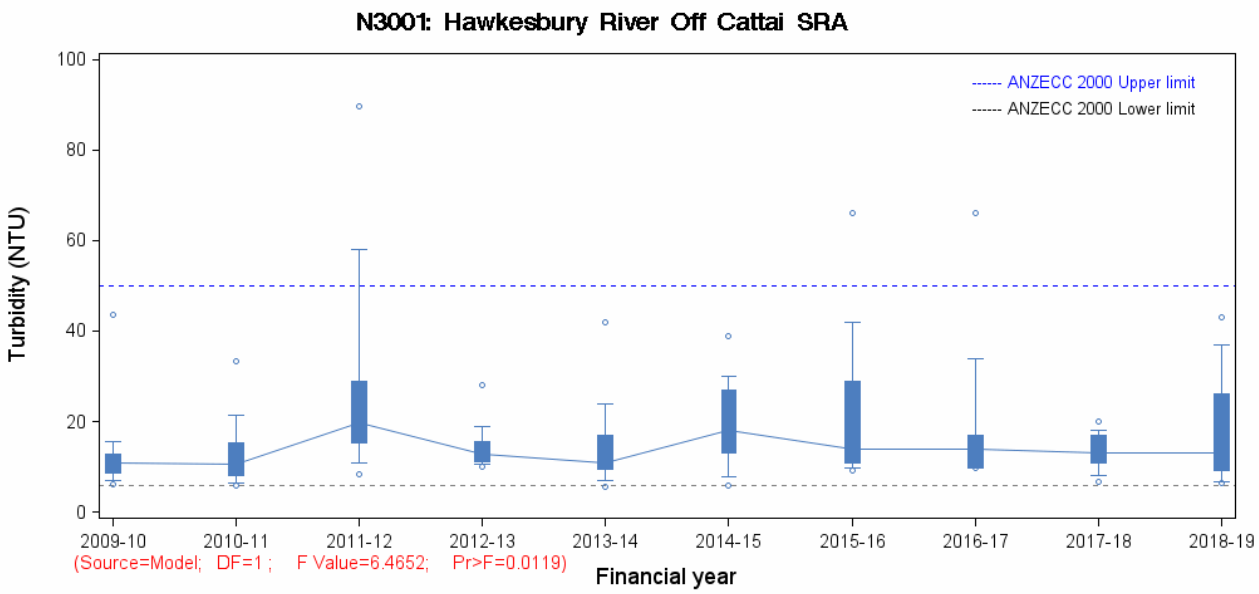


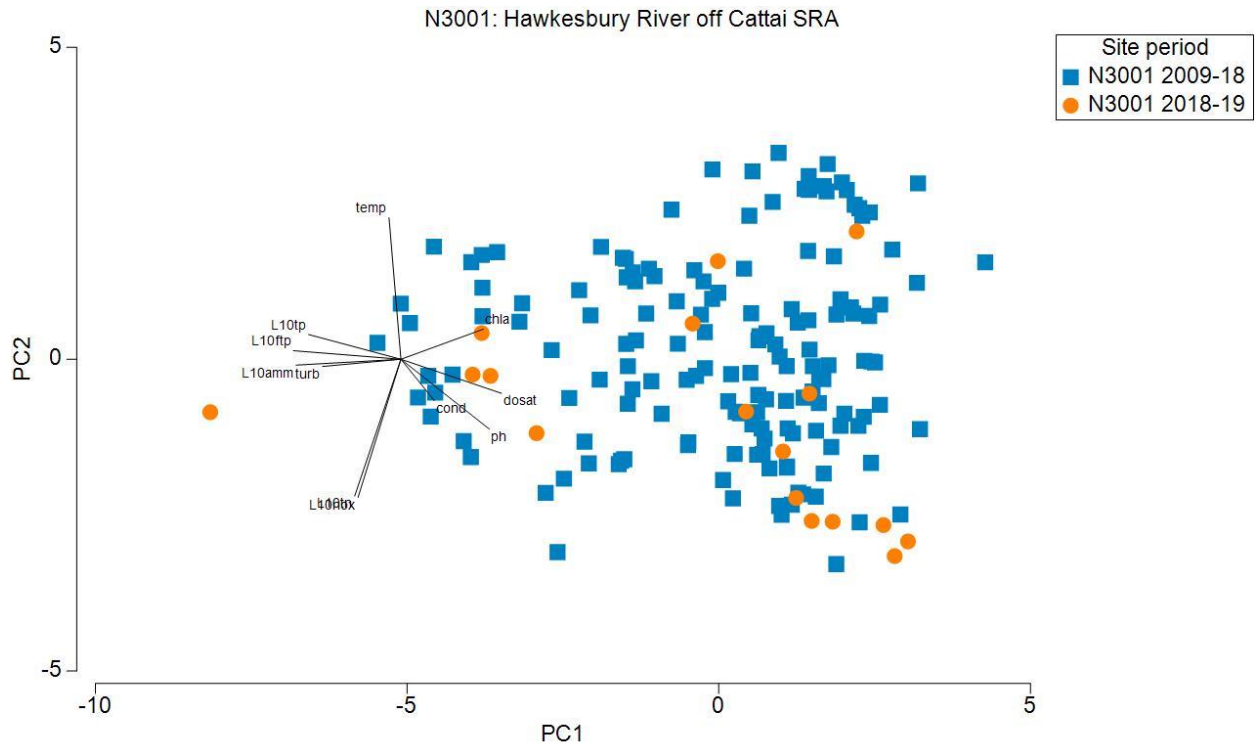



N3001: Hawkesbury River Off Cattai SRA
Dissolved oxygen saturation (%)
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1066; Pr>F=0.7444)
Financial year


N3001: Hawkesbury River Off Cattai SRA
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=6.2625; Pr>F=0.0132)
Financial year


N3001: Hawkesbury River Off Cattai SRA
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0039; Pr>F=0.9497)
Financial year

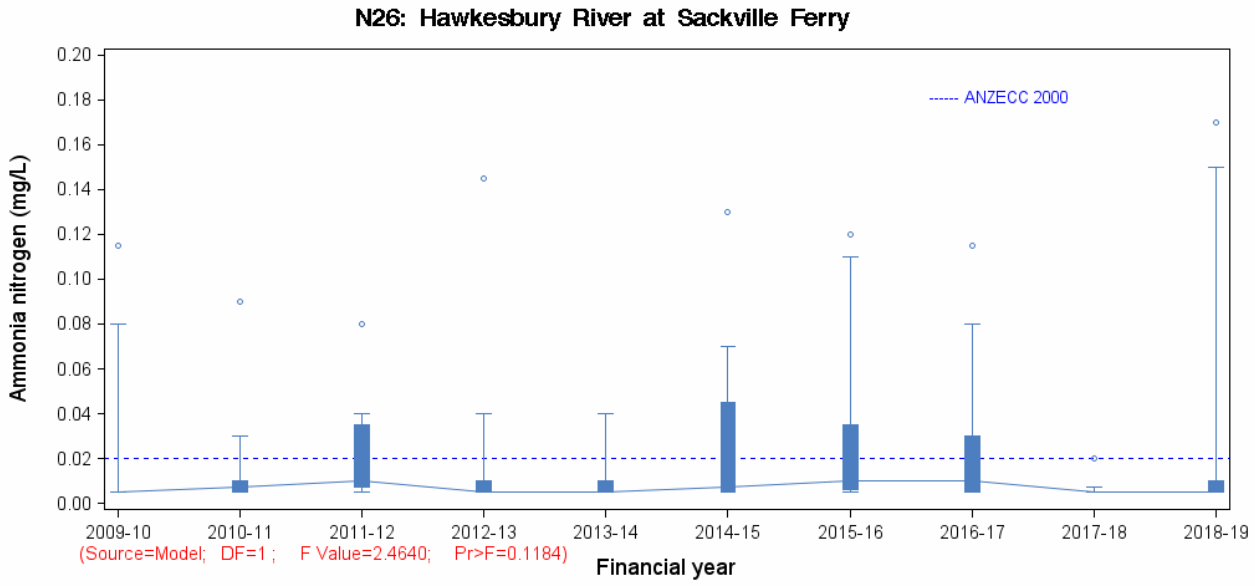


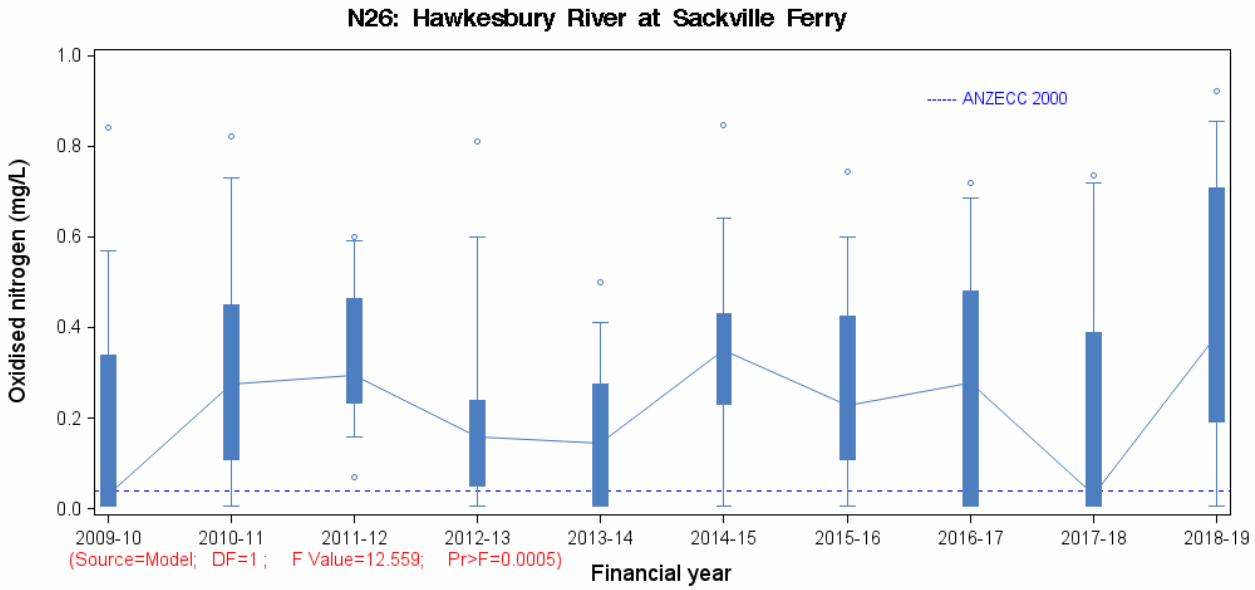


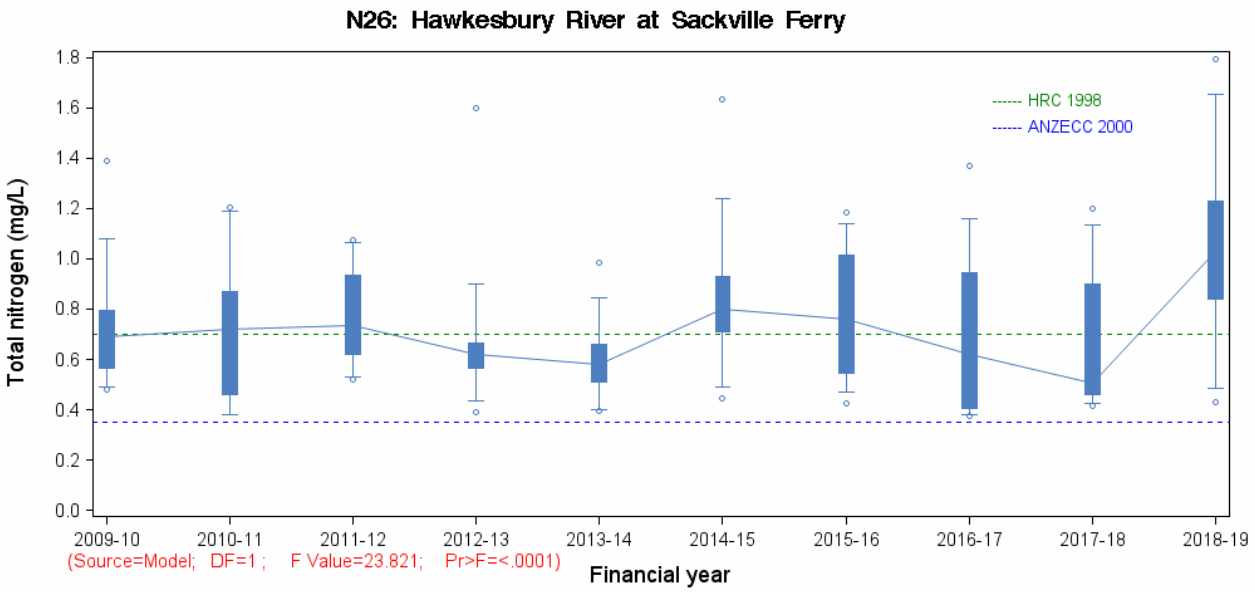
The ordination plot from Principal Components Analysis suggested water quality of the Hawkesbury River off Cattai SRA in 2018-19 was similar to that recorded in the period 2009 to 2018.

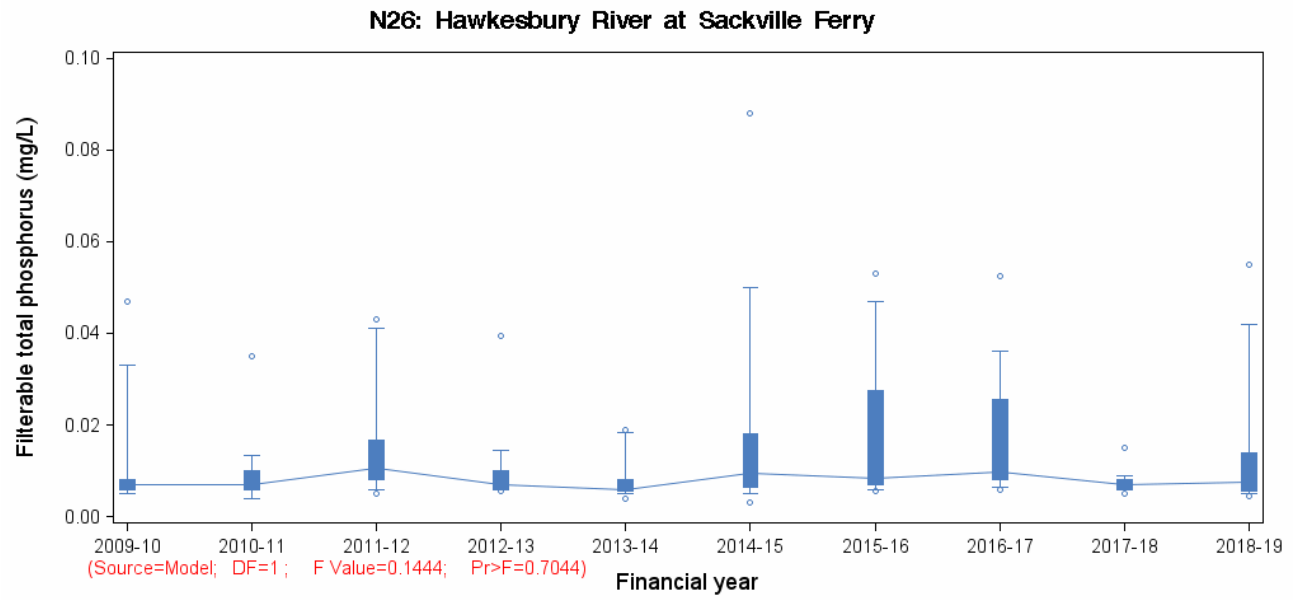
N26: Hawkesbury River at Sackville Ferry

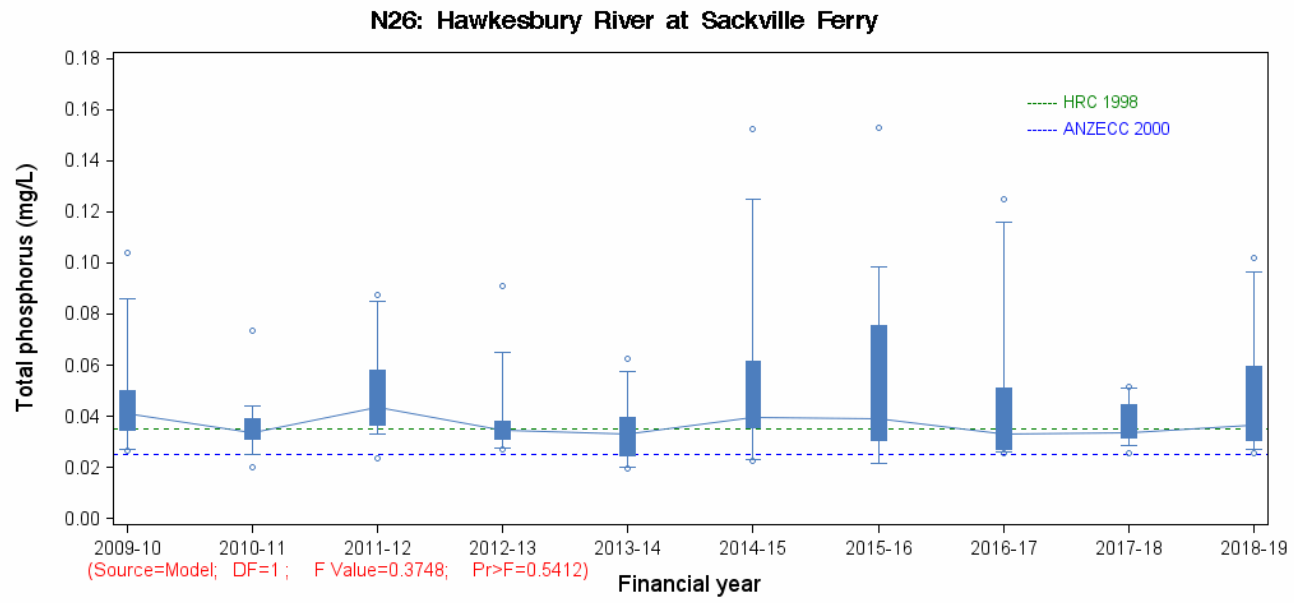
Nutrients, chlorophyll-*a* and algae

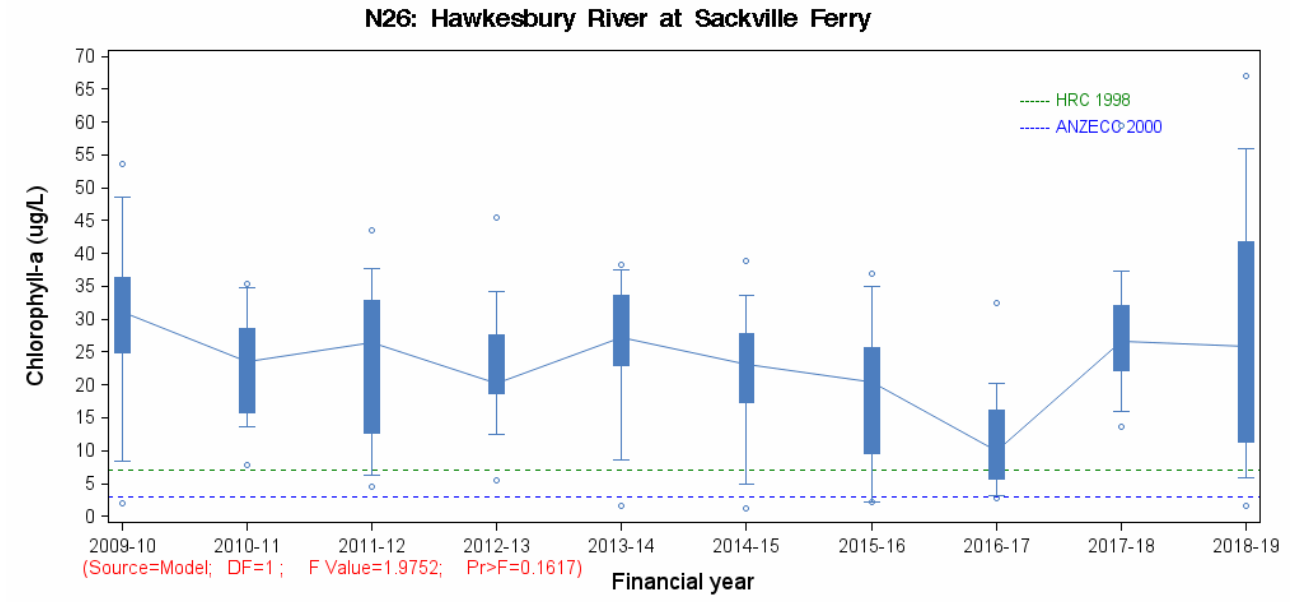


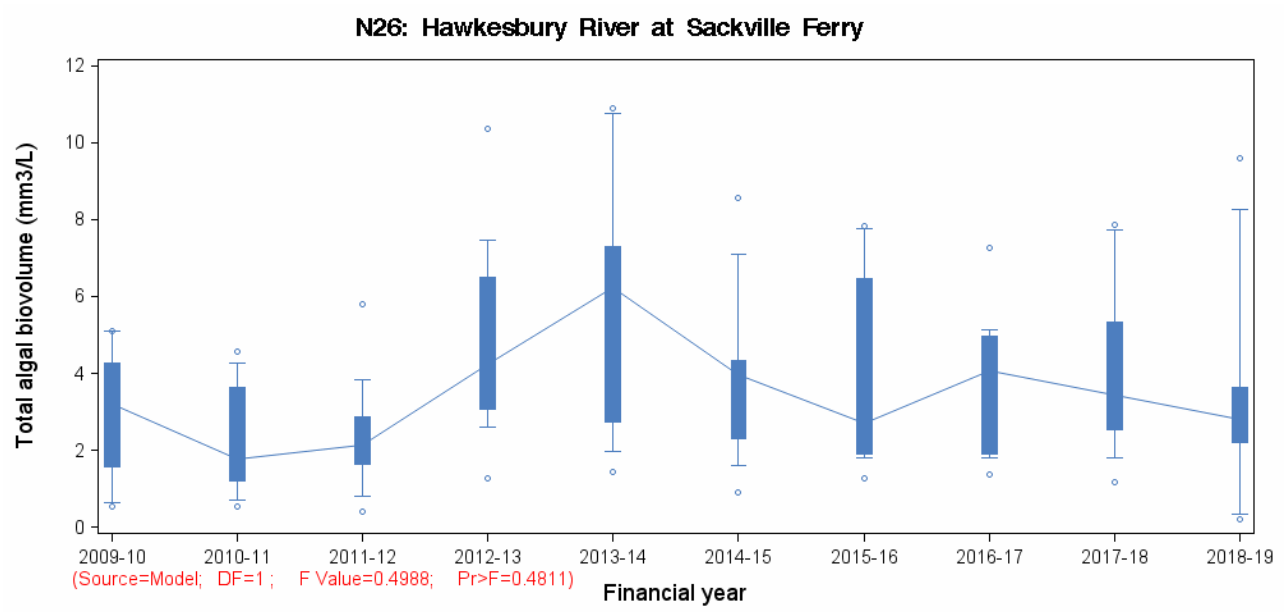


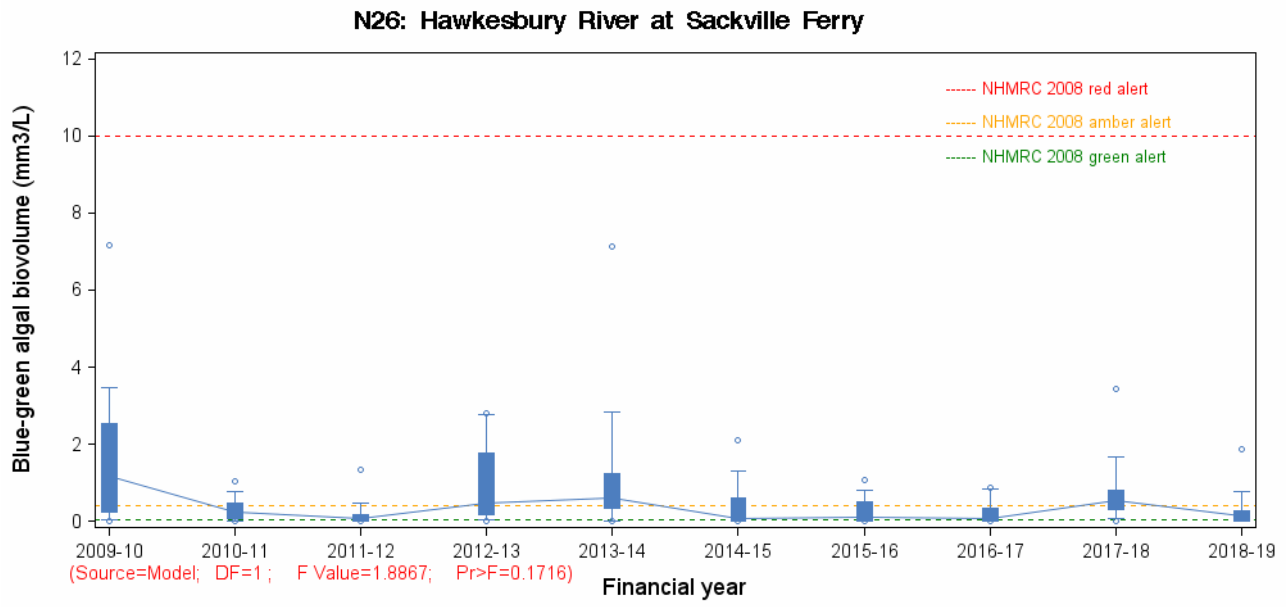


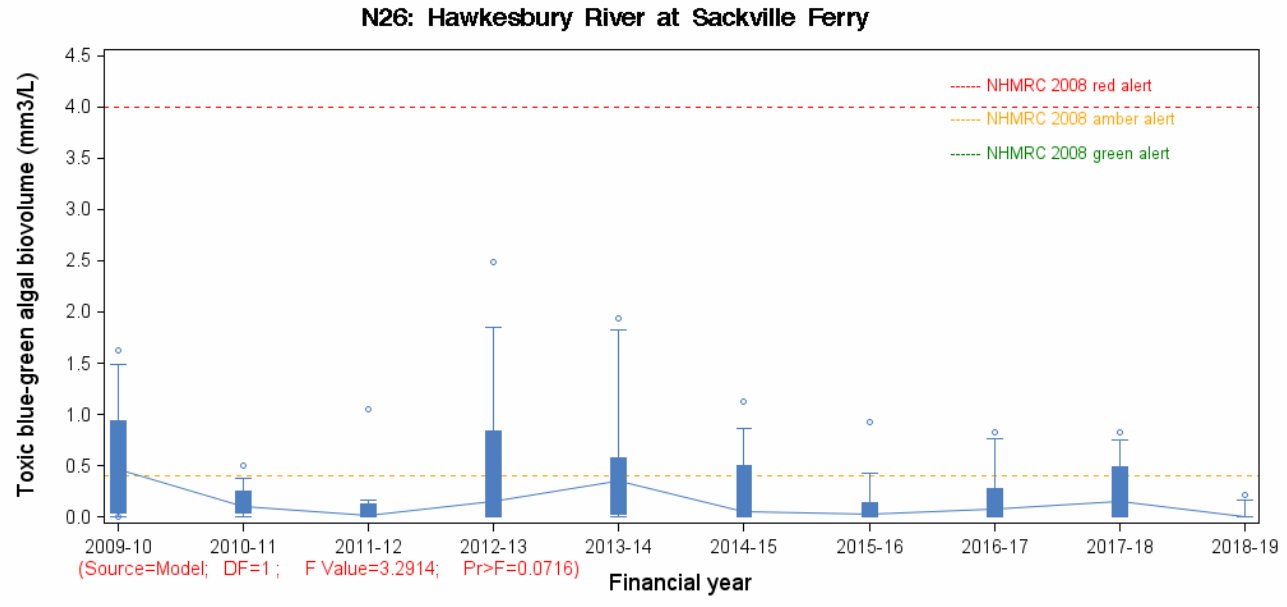

N26: Hawkesbury River at Sackville Ferry
Filterable total phosphorus (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1444; Pr>F=0.7044)
Financial year

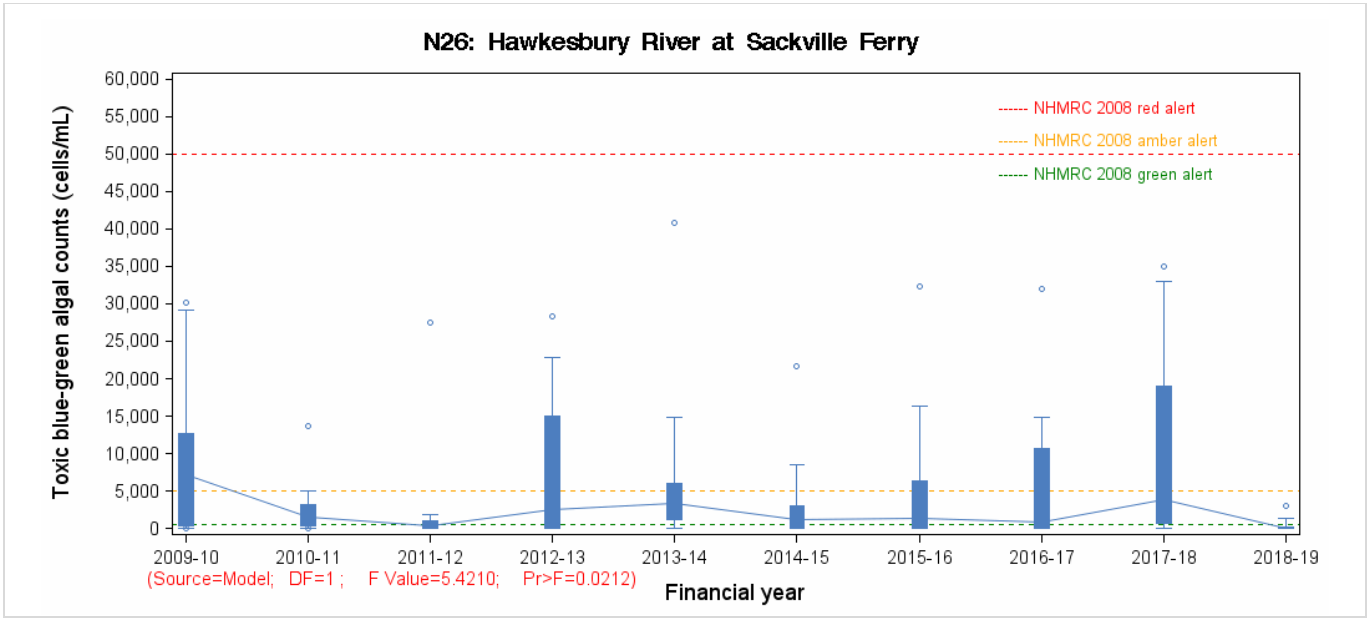

N26: Hawkesbury River at Sackville Ferry
Total phosphorus (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
----- HRC 1998
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.3748; Pr>F=0.5412)
Financial year


N26: Hawkesbury River at Sackville Ferry
Chlorophyll-a (ug/L)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
----- HRC 1998
----- ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.9752; Pr>F=0.1617)
Financial year

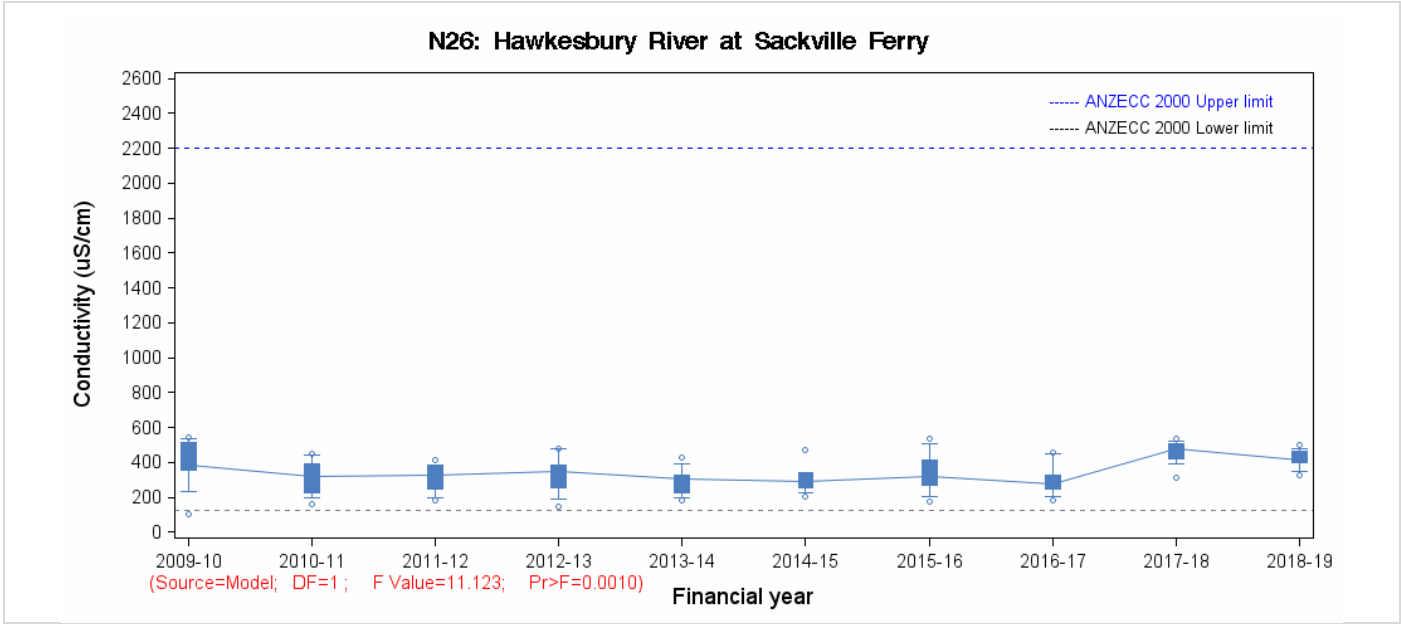

N26: Hawkesbury River at Sackville Ferry
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.4988; Pr>F=0.4811)
Financial year

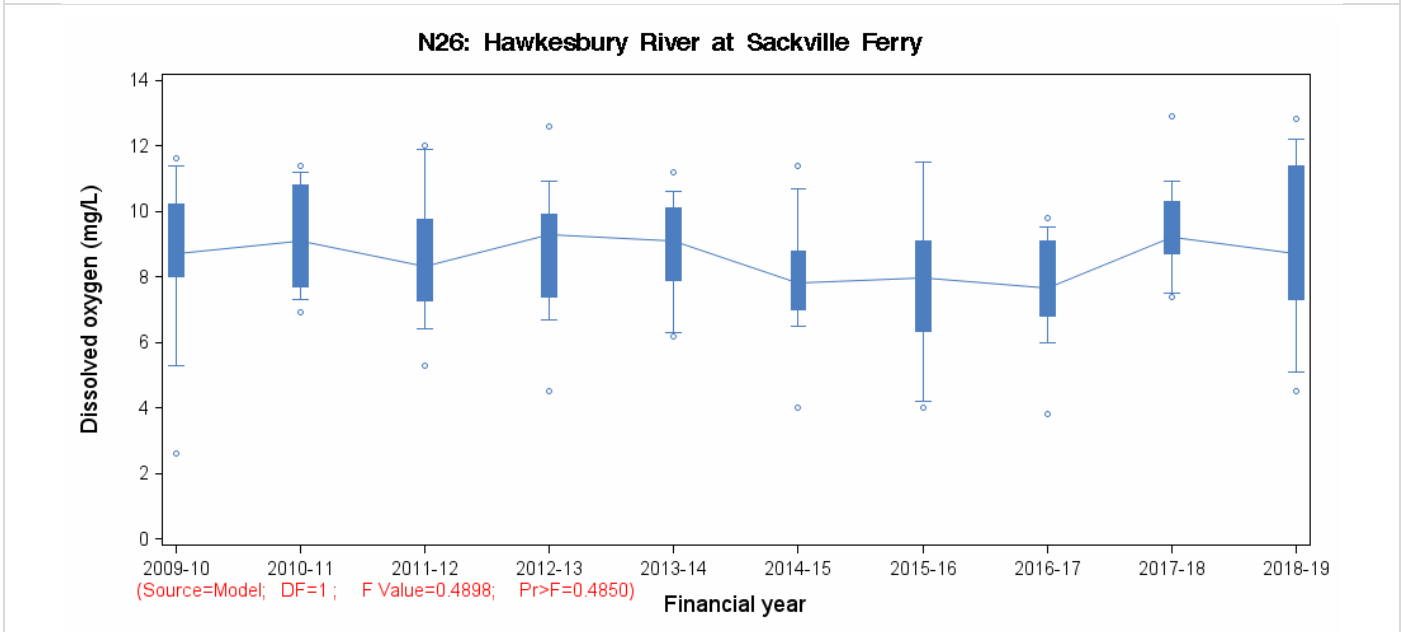

N26: Hawkesbury River at Sackville Ferry
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.8867; Pr>F=0.1716)
Financial year

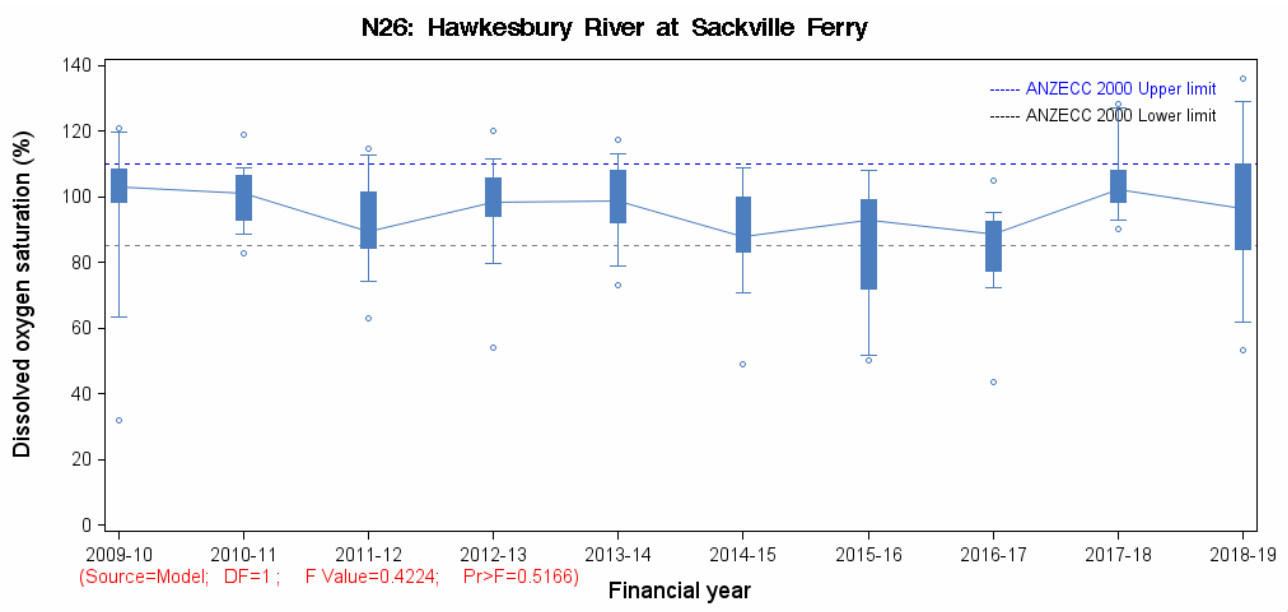

N26: Hawkesbury River at Sackville Ferry
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
----- NHMRC 2008 red alert
----- NHMRC 2008 amber alert
----- NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.2914; Pr>F=0.0716)
Financial year

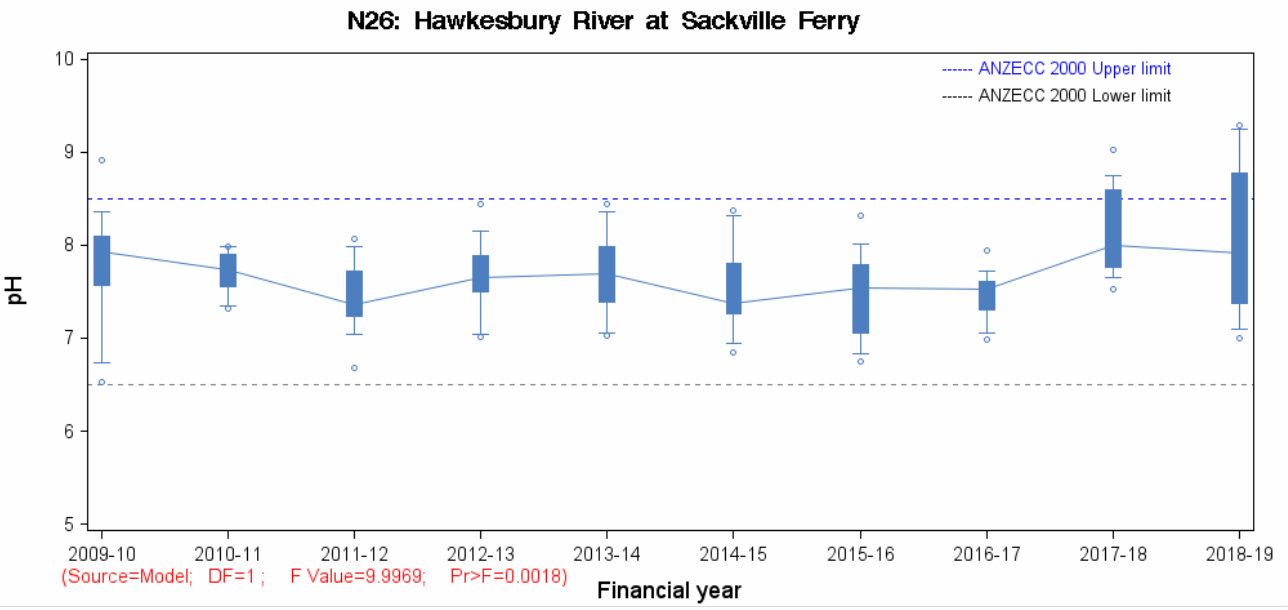


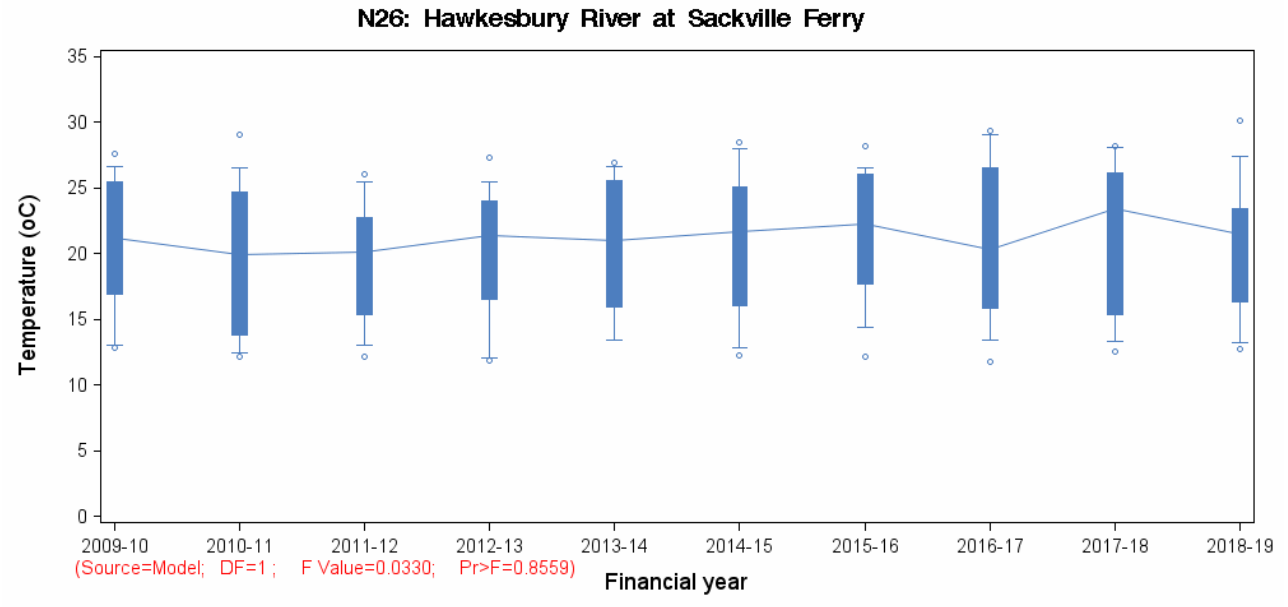
Other physico-chemical analytes

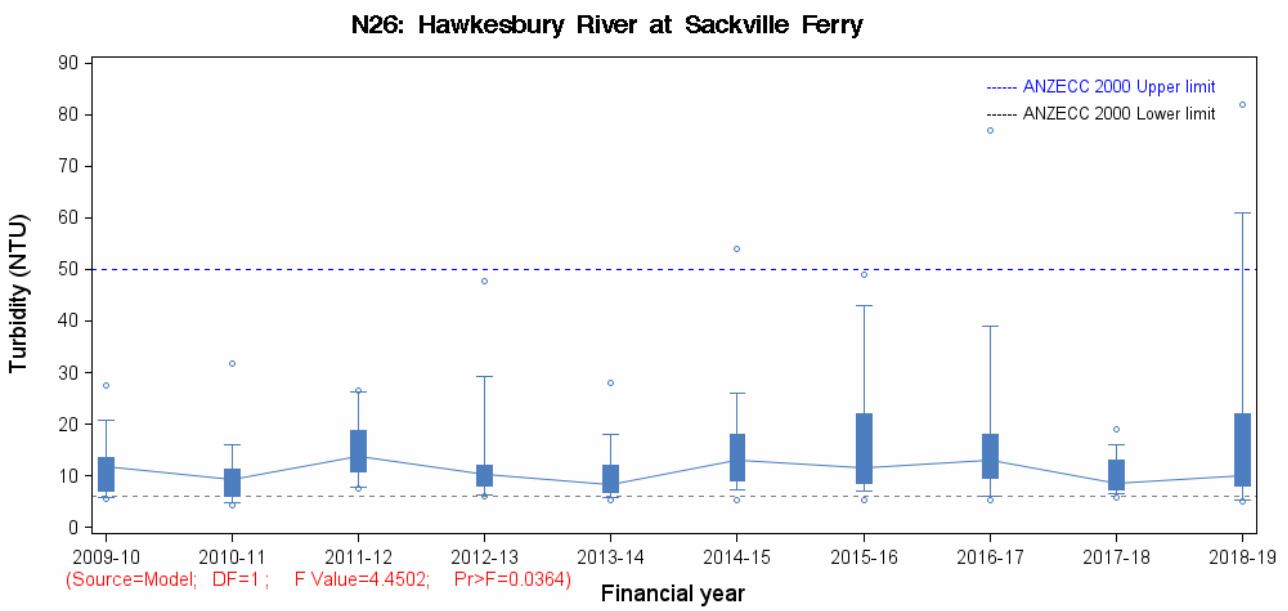


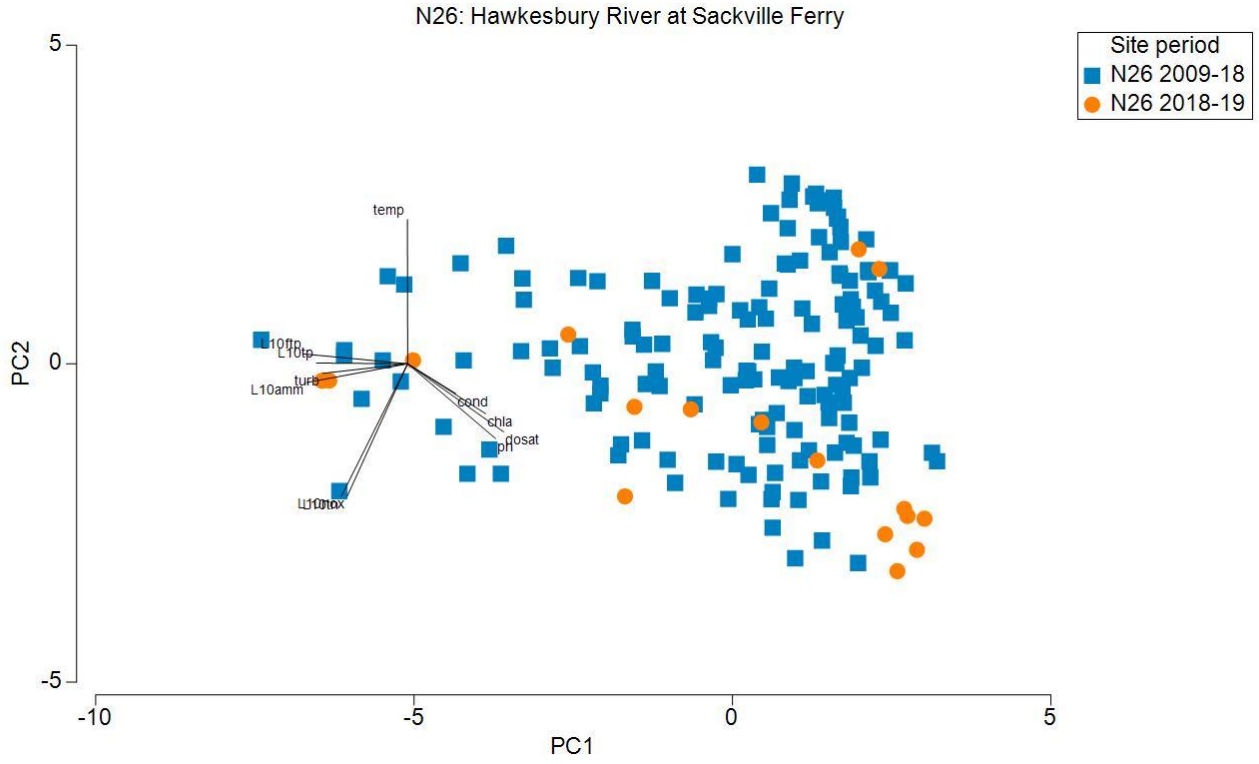



N26: Hawkesbury River at Sackville Ferry
Dissolved oxygen saturation (%)
ANZECC 2000 Upper limit
ANZECC 2000 Lower limit
0
20
40
60
80
100
120
140
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.4224; Pr>F=0.5166)
Financial year


N26: Hawkesbury River at Sackville Ferry
pH
ANZECC 2000 Upper limit
ANZECC 2000 Lower limit
5
6
7
8
9
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=9.9969; Pr>F=0.0018)
Financial year


N26: Hawkesbury River at Sackville Ferry
Temperature (oC)
0
5
10
15
20
25
30
35
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0330; Pr>F=0.8559)
Financial year

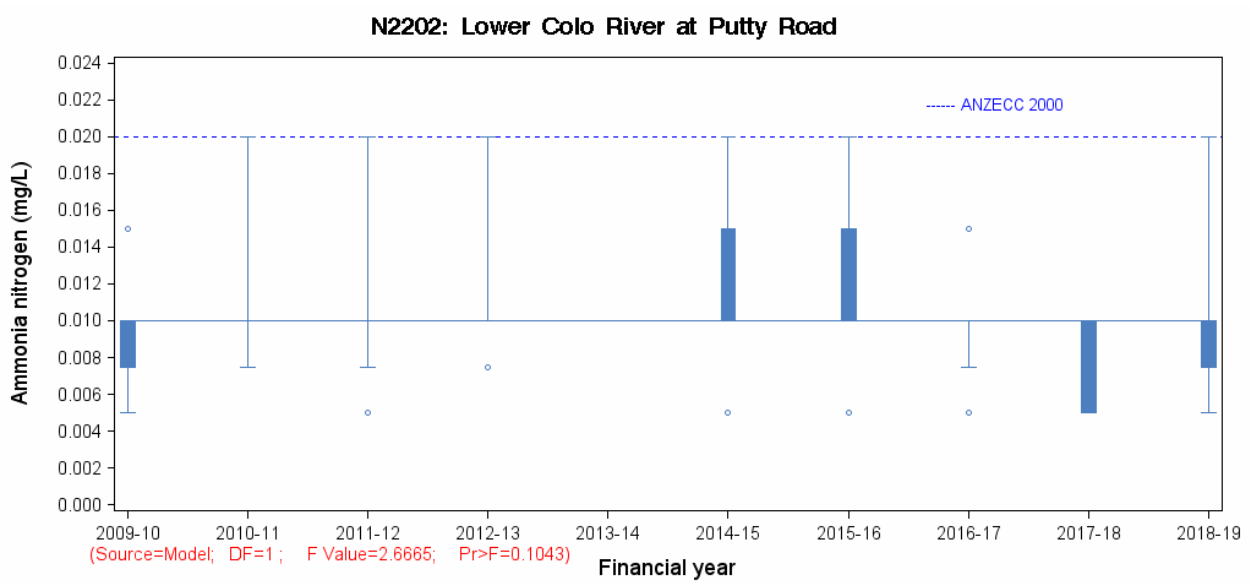




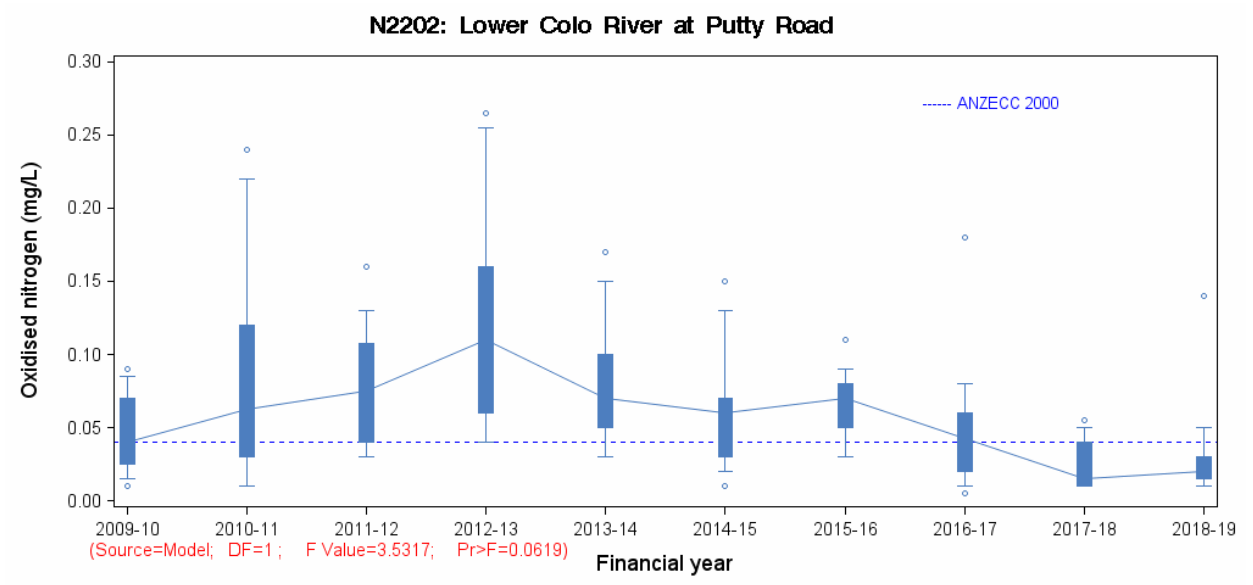
The ordination plot from Principal Components Analysis suggested water quality of the Hawkesbury River at Sackville ferry in 2018-19 was similar to that recorded in the period 2009 to 2018.

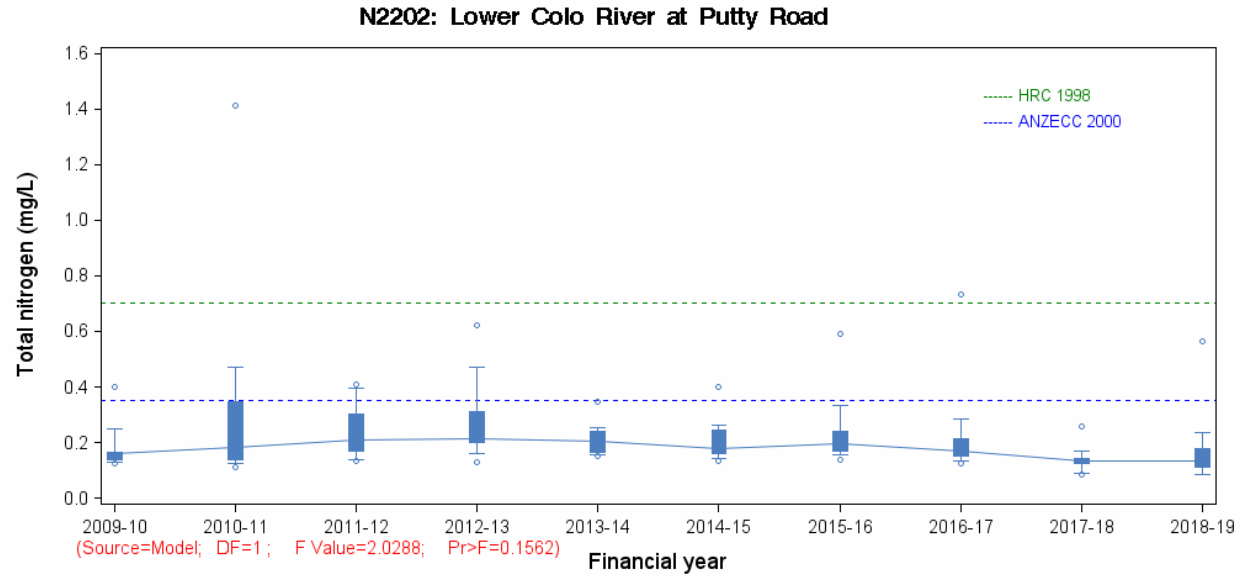
N2202: Lower Colo River at Putty Road

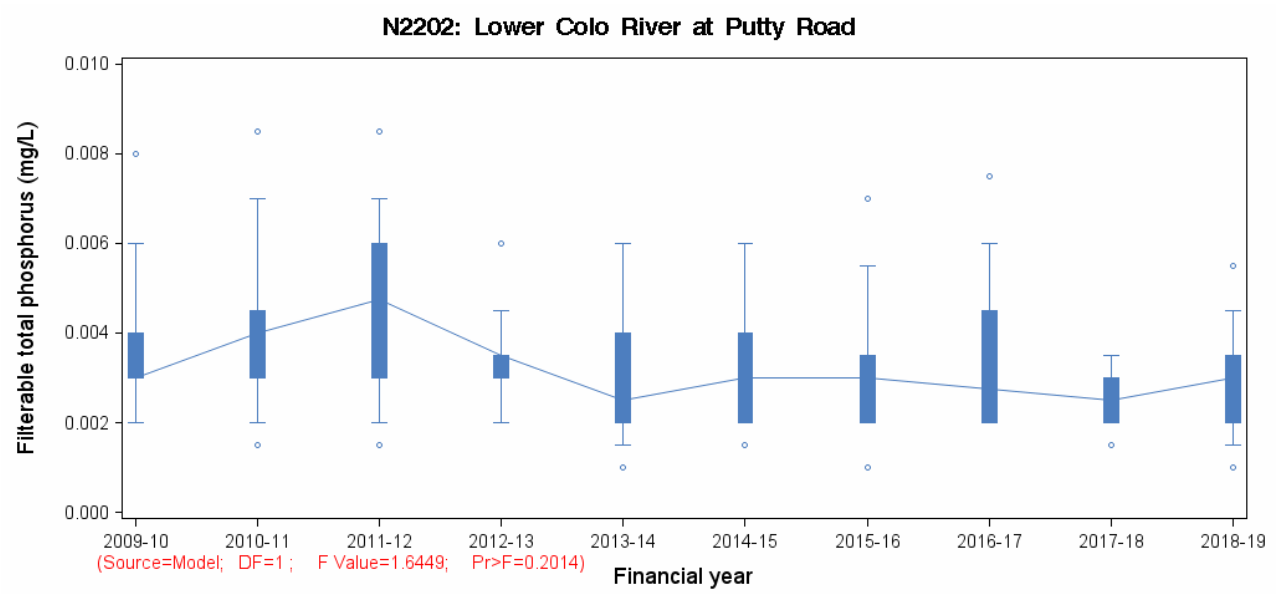
Nutrients, chlorophyll-*a* and algae

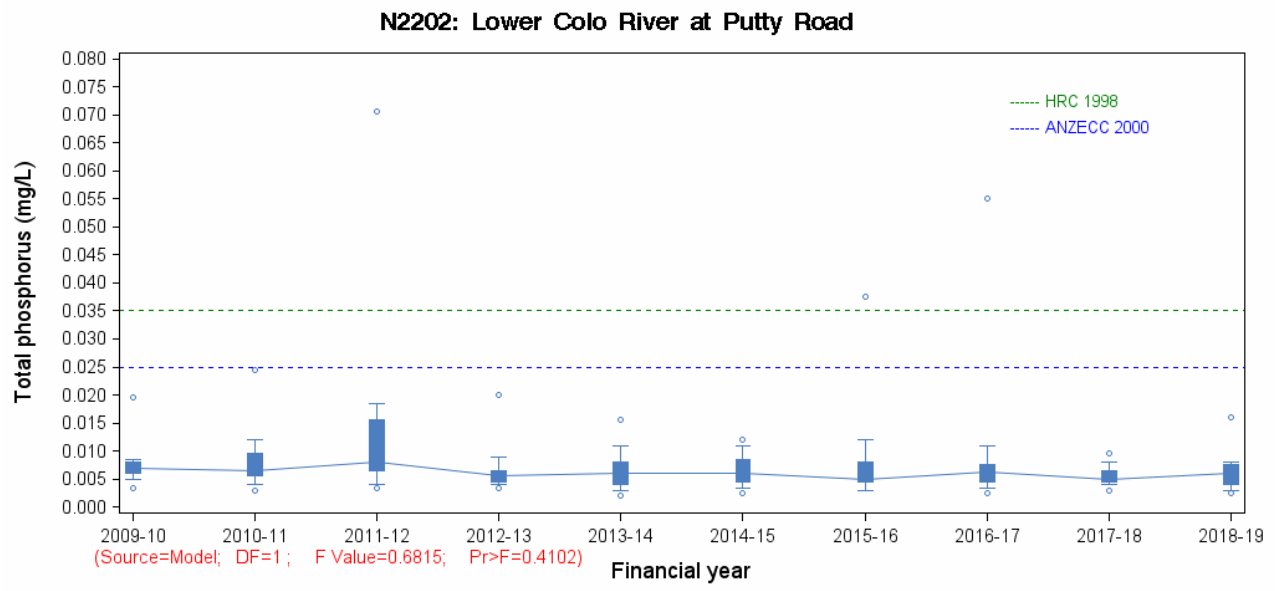


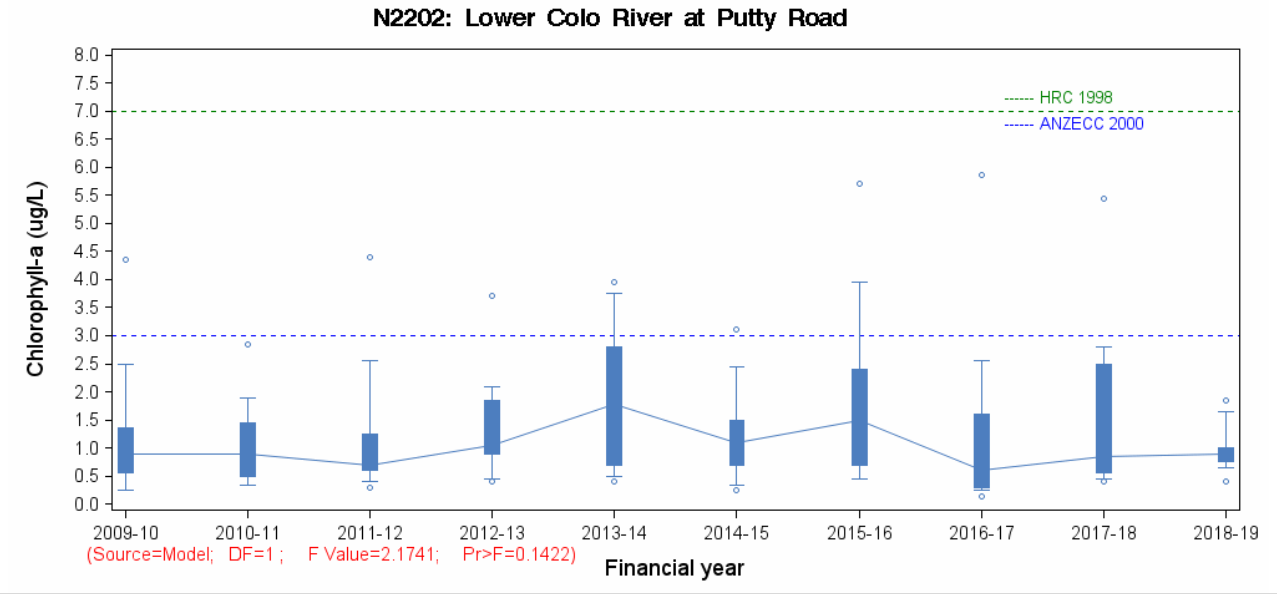
Note: Ammonia nitrogen concentrations varied 0.01 to 0.2 mg/L throughout the years

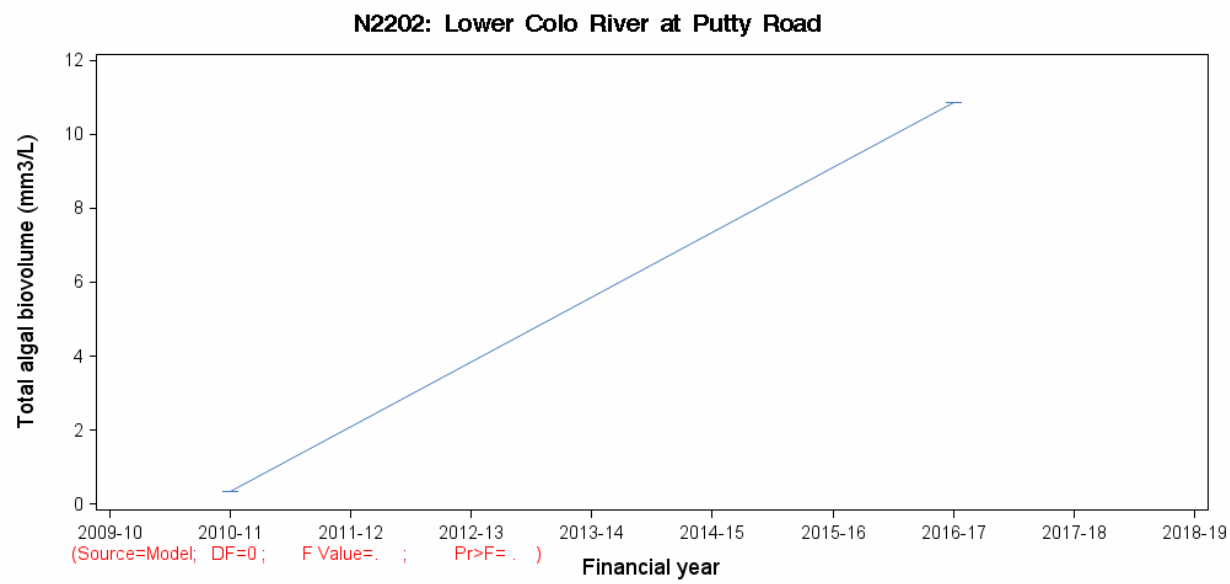




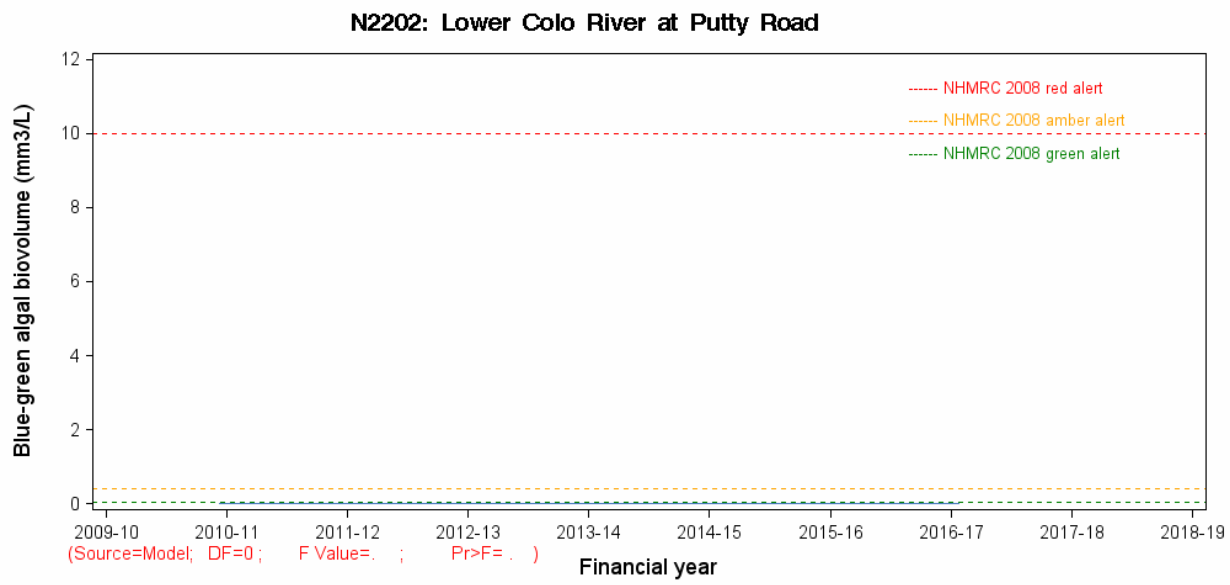

N2202: Lower Colo River at Putty Road
Filterable total phosphorus (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.6449; Pr>F=0.2014)
Financial year


N2202: Lower Colo River at Putty Road
Total phosphorus (mg/L)
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.6815; Pr>F=0.4102)
Financial year

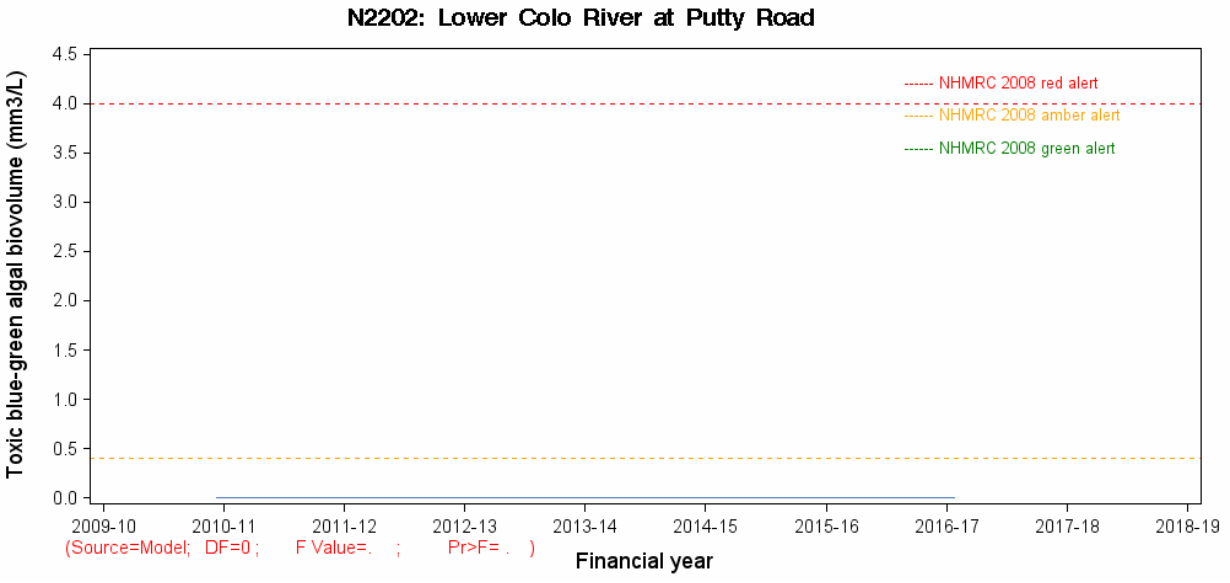

N2202: Lower Colo River at Putty Road
Chlorophyll-a (ug/L)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.1741; Pr>F=0.1422)
Financial year



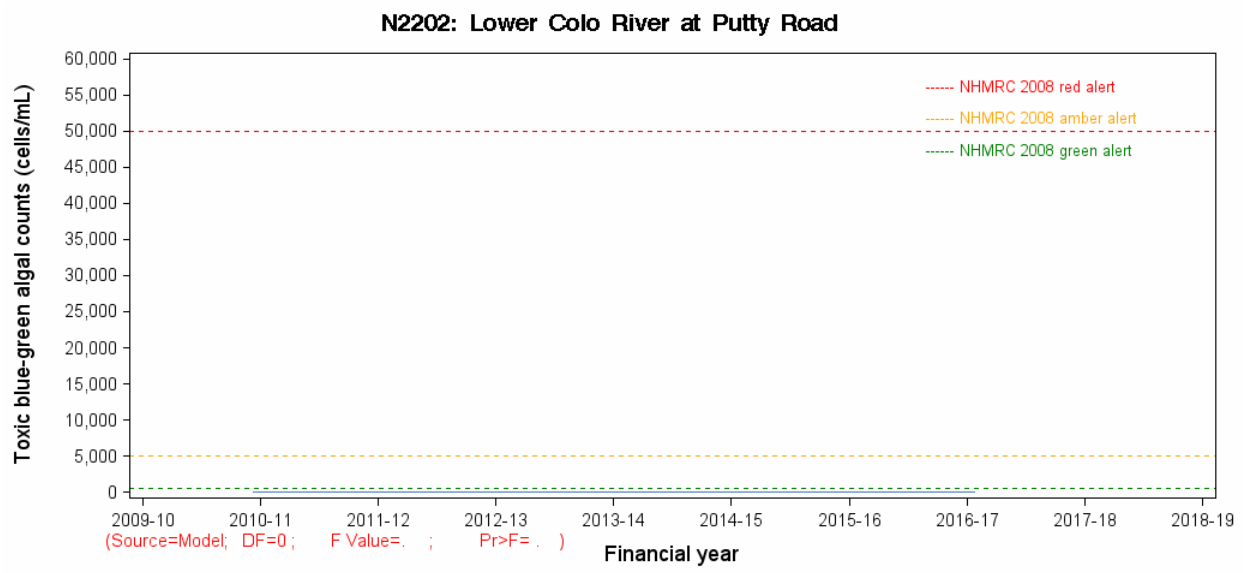
Note: There were only two occassions when the water sample qualified for algal counting (chlorophyll-*a* >7 μg/L)



Note: There were only two occassions when the water sample qualified for algal counting (chlorophyll-*a* >7 μg/L). No blue-green algae was detected in these samples

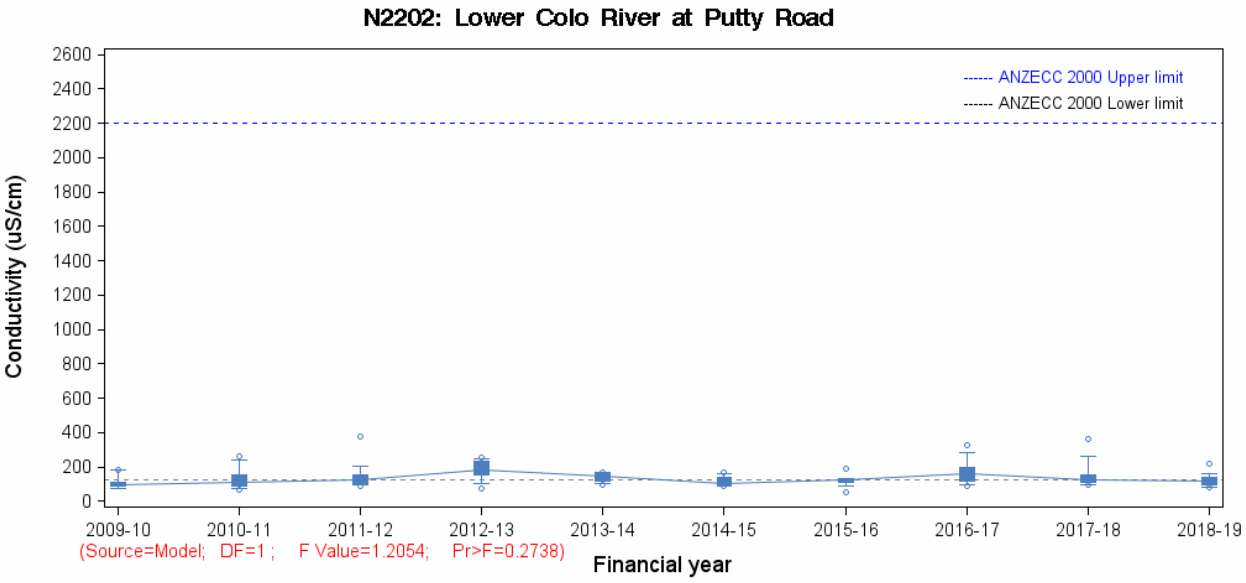


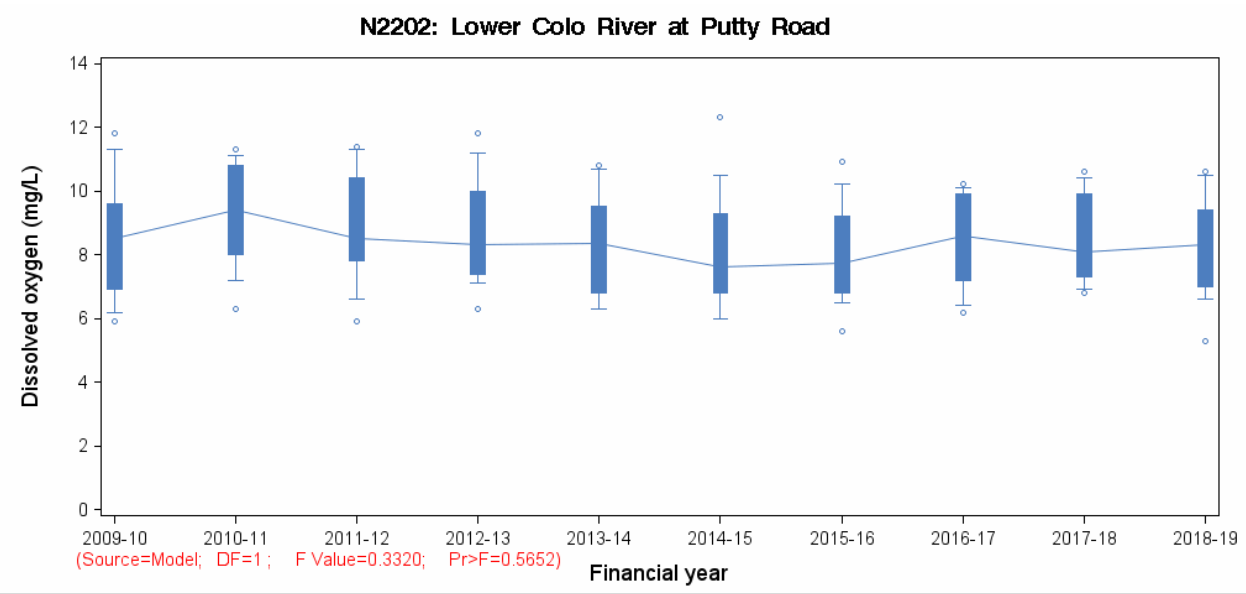
Note: There were only two occassions when the water sample qualified for algal counting (chlorophyll-*a* >7 μg/L). No blue-green algae was detected in these samples

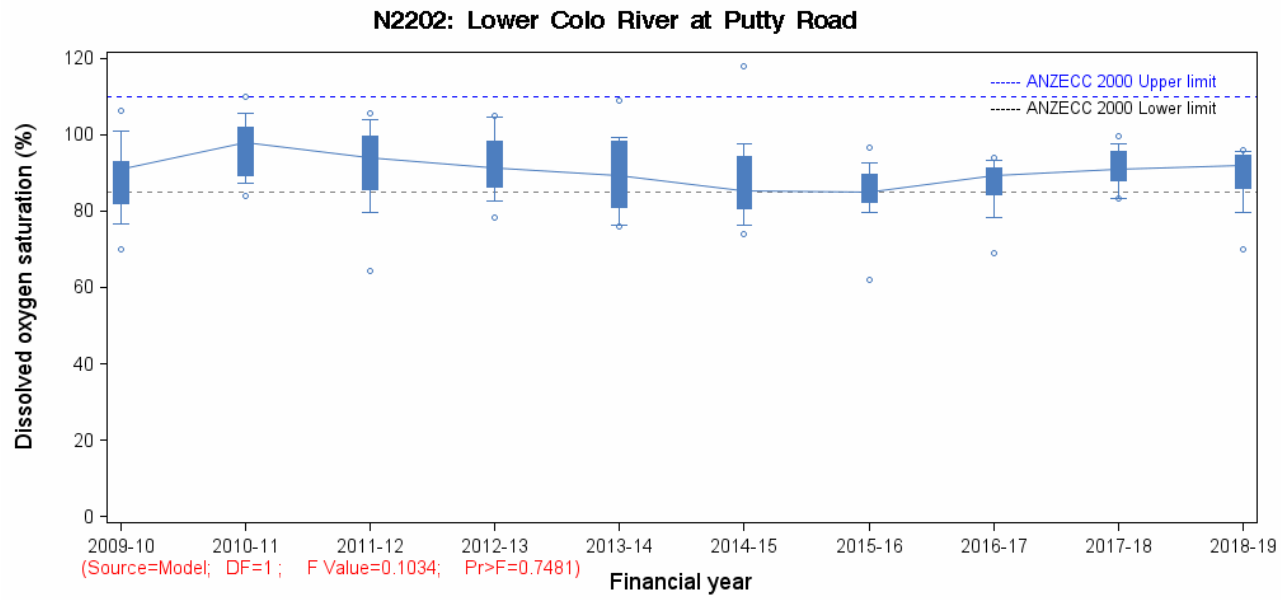


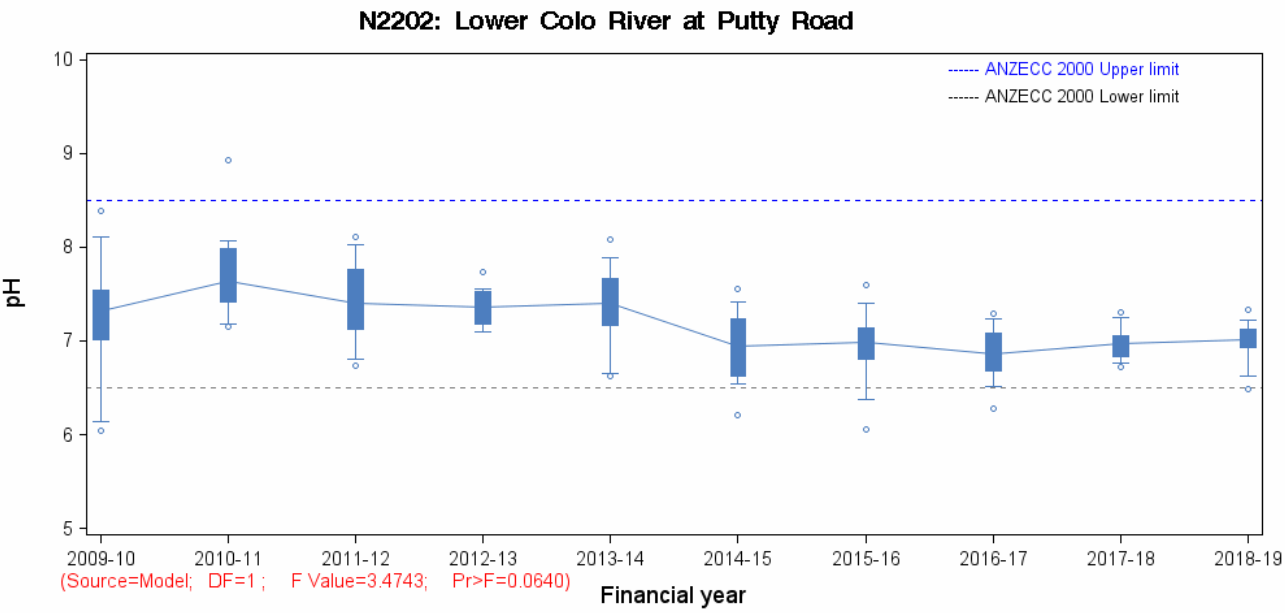
Note: There were only two occassions when the water sample qualified for algal counting (chlorophyll-*a* >7 µg/L). No blue-green algae was detected in these samples

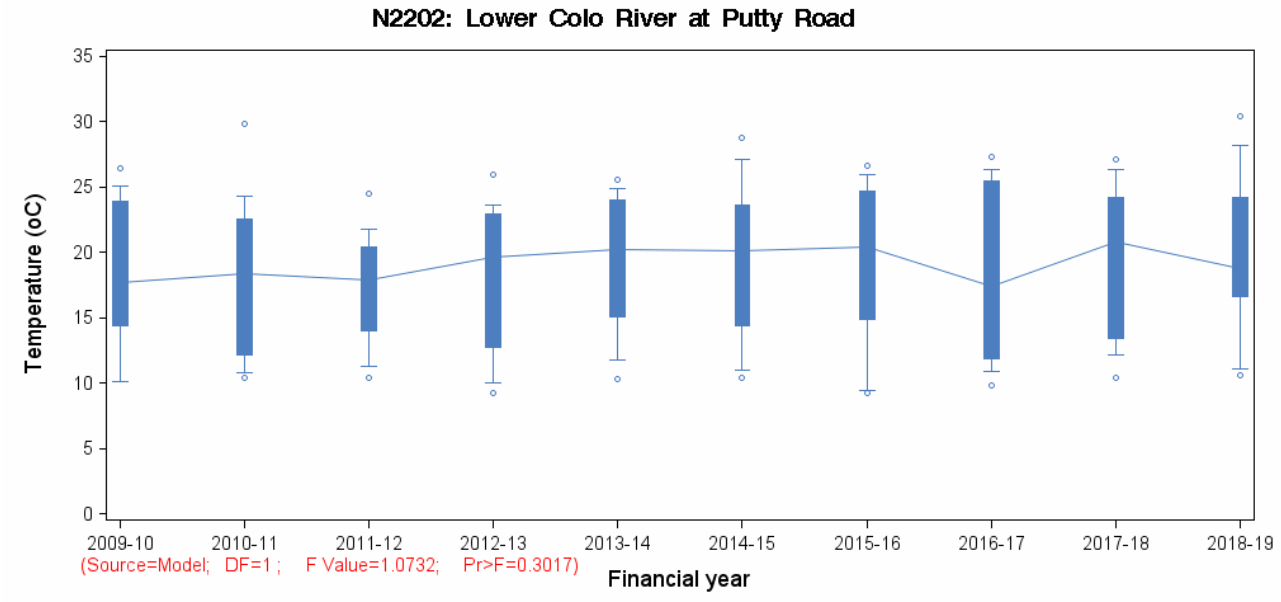
Other physico-chemical analytes

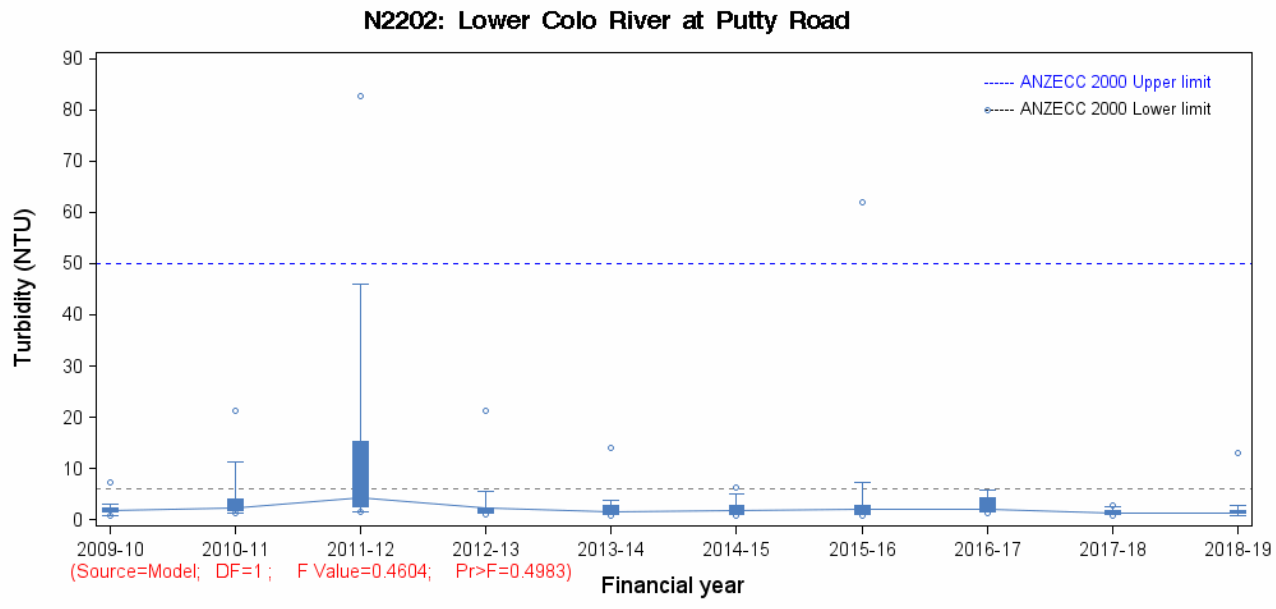


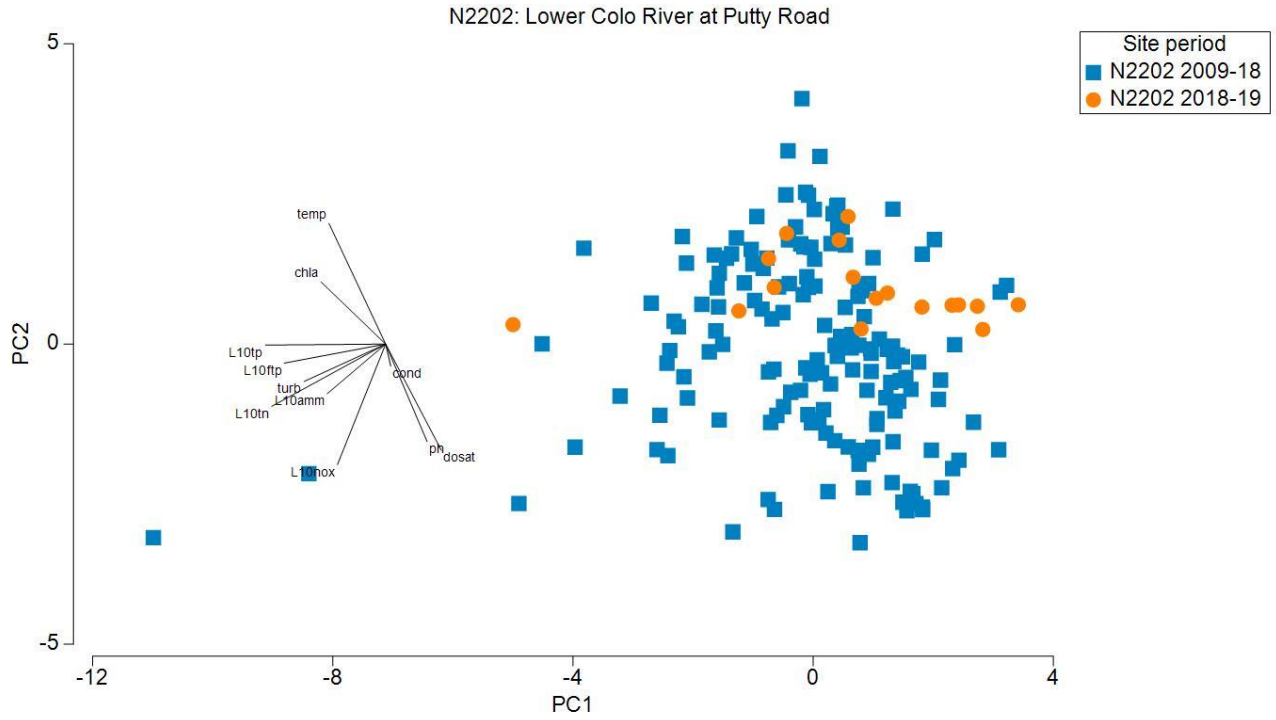



N2202: Lower Colo River at Putty Road
Dissolved oxygen saturation (%)
120
100
80
60
40
20
0
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1034; Pr>F=0.7481)
Financial year


N2202: Lower Colo River at Putty Road
pH
10
9
8
7
6
5
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.4743; Pr>F=0.0640)
Financial year


N2202: Lower Colo River at Putty Road
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.0732; Pr>F=0.3017)
Financial year

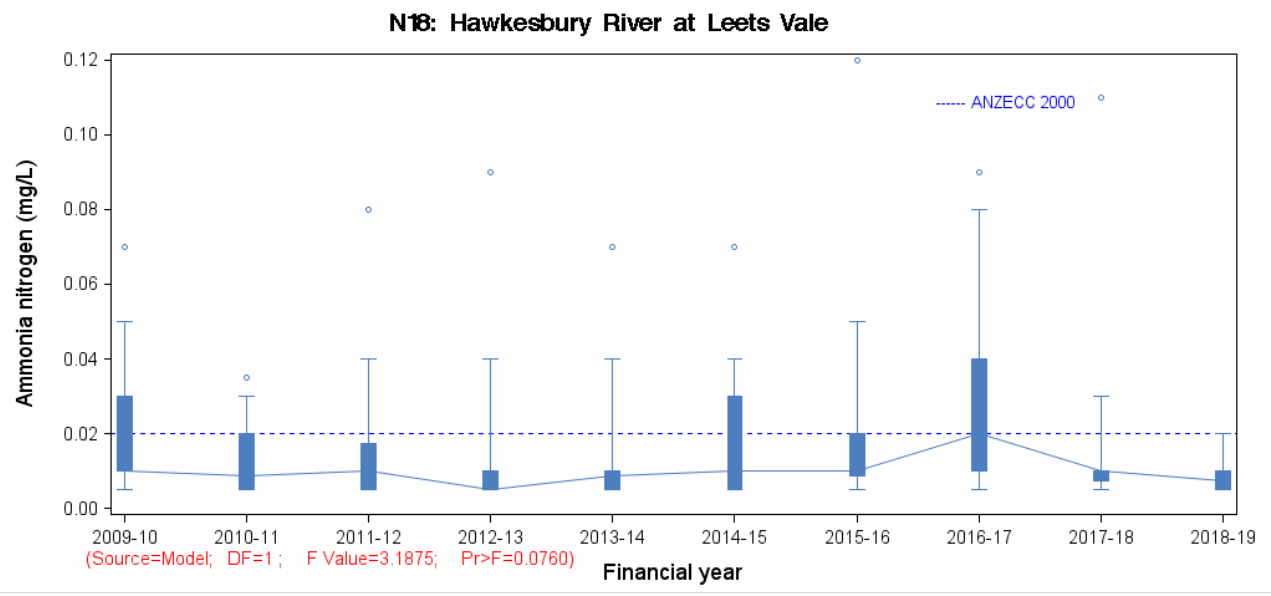


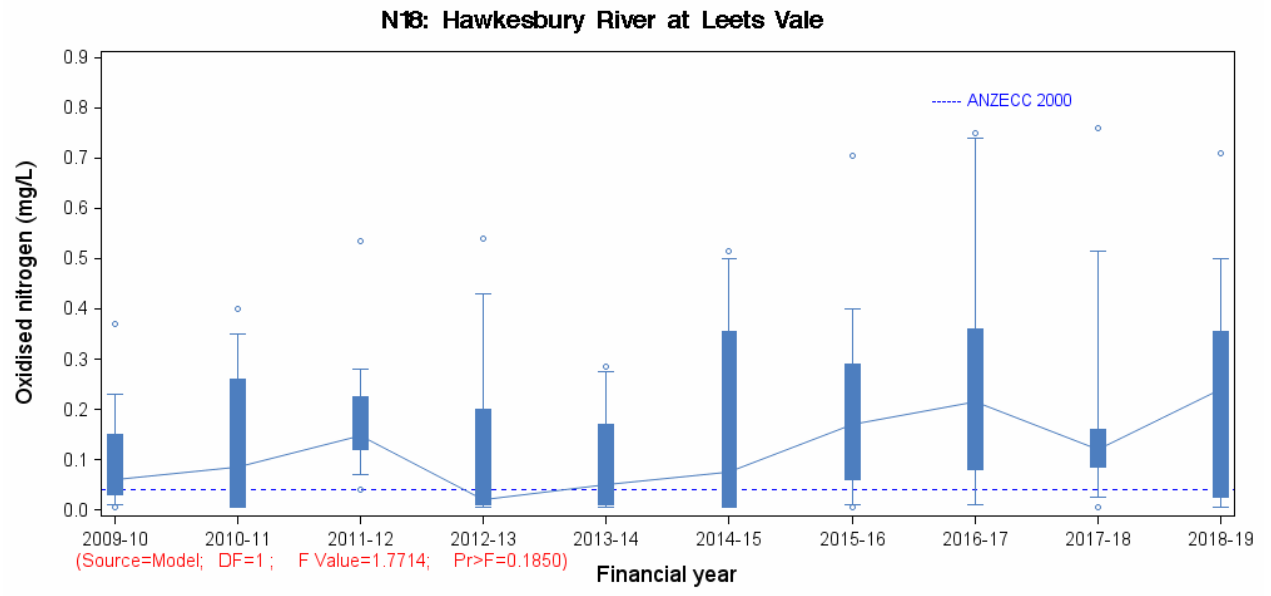


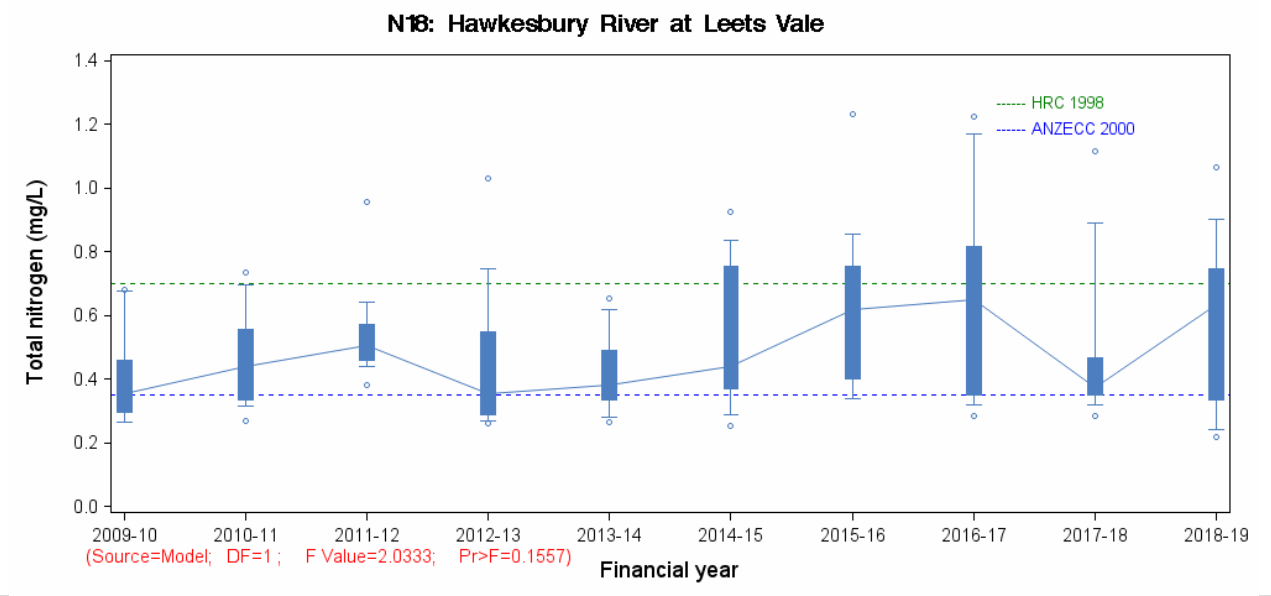
The ordination plot from Principal Components Analysis suggested water quality of the Lower Colo River at Putty Road in 2018-19 was generally similar to that recorded in the period 2009 to 2018.

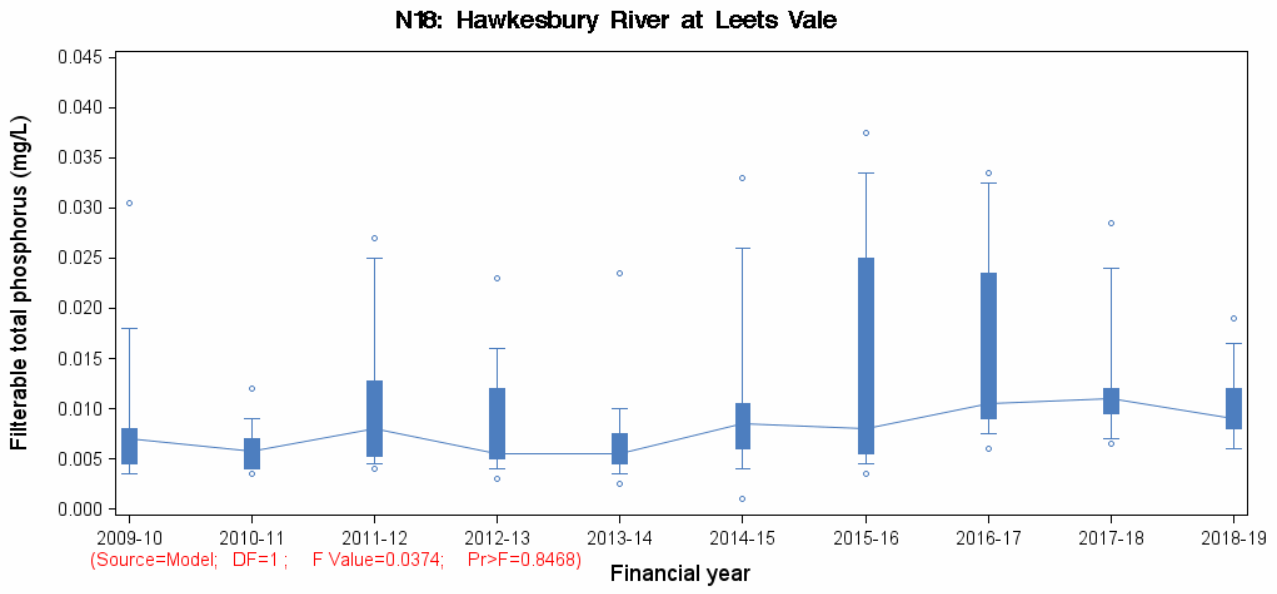
N18: Hawkesbury River at Leets Vale

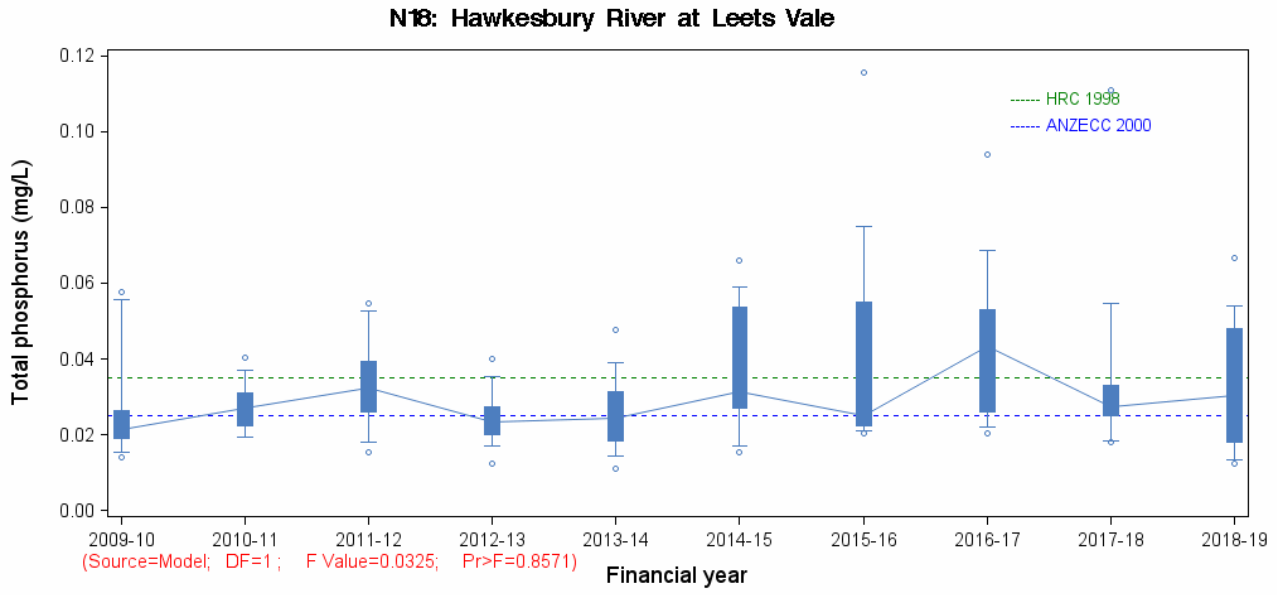
Nutrients, chlorophyll-*a* and algae

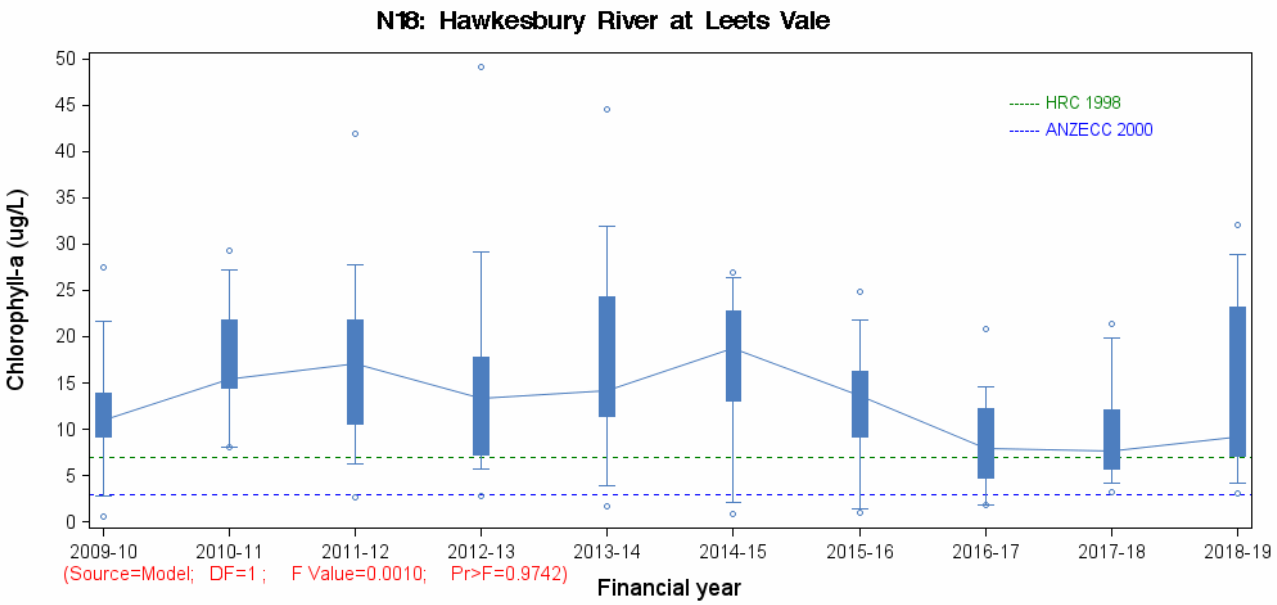


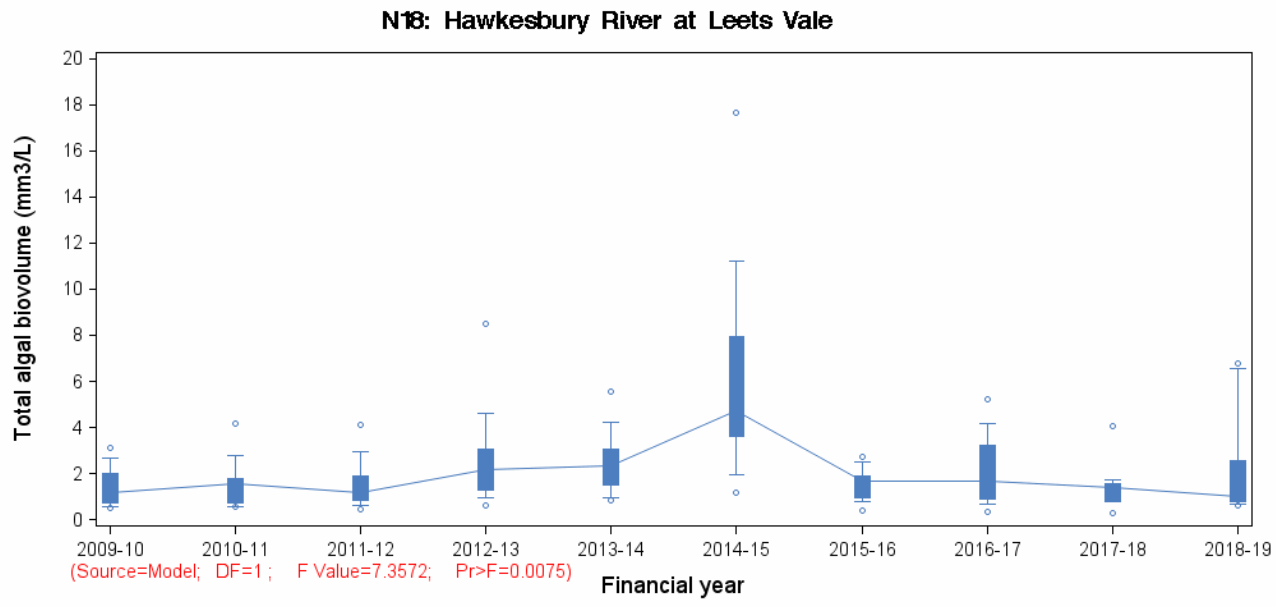


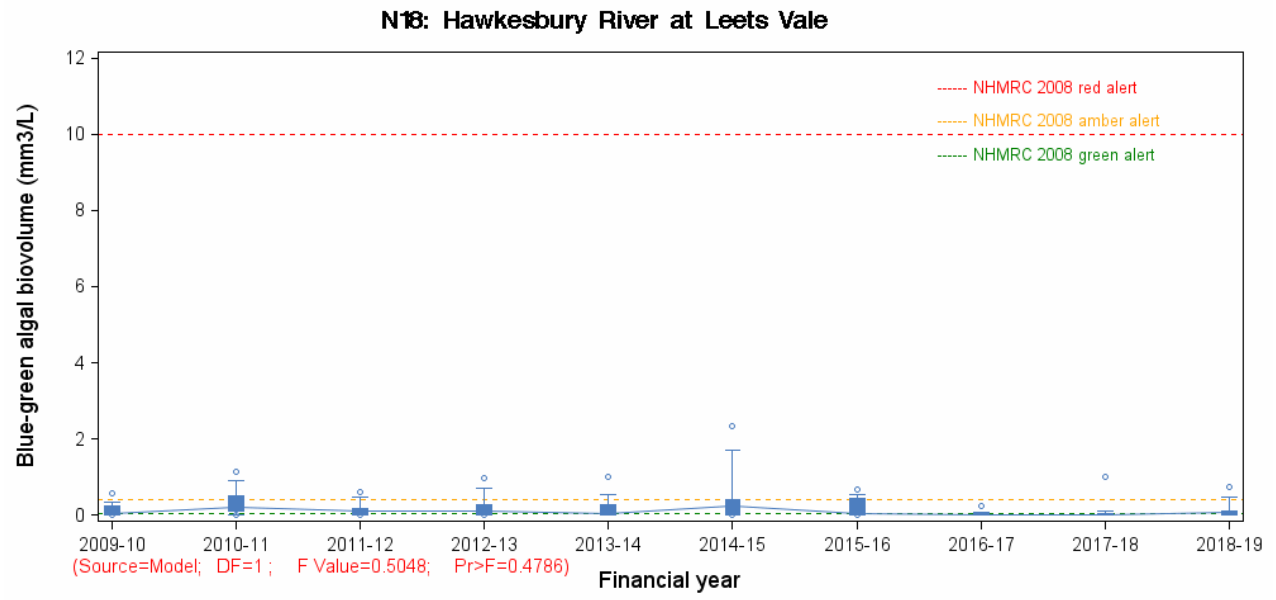


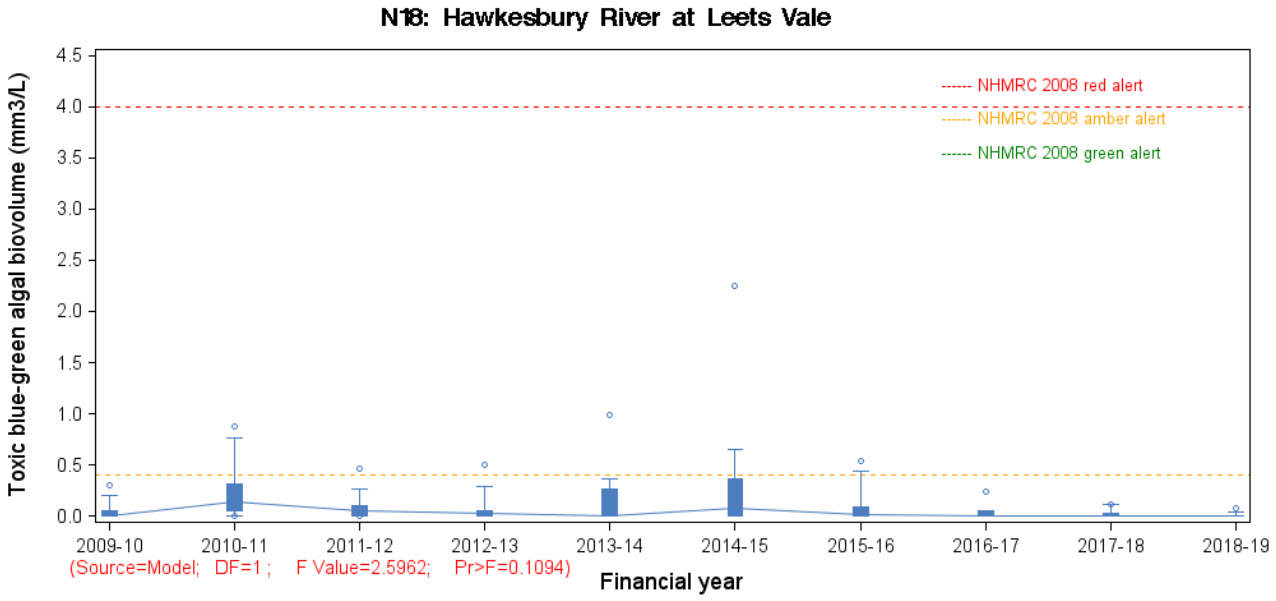

N18: Hawkesbury River at Leets Vale
Filterable total phosphorus (mg/L)
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0374; Pr>F=0.8468)
Financial year

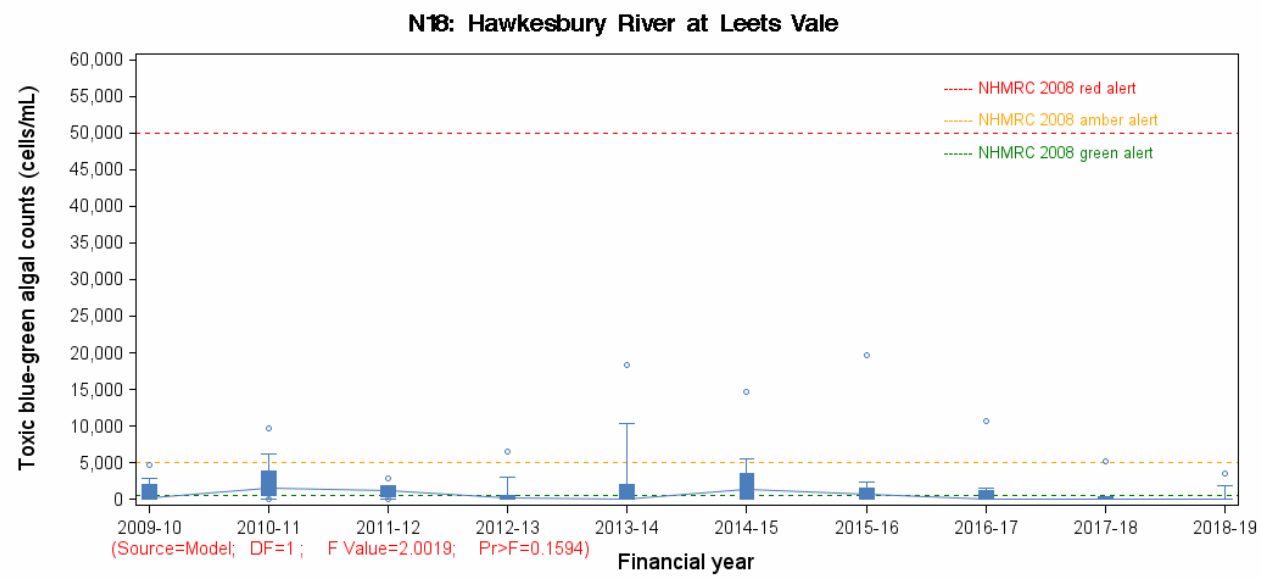

N18: Hawkesbury River at Leets Vale
Total phosphorus (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0325; Pr>F=0.8571)
Financial year


N18: Hawkesbury River at Leets Vale
Chlorophyll-a (ug/L)
50
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0010; Pr>F=0.9742)
Financial year

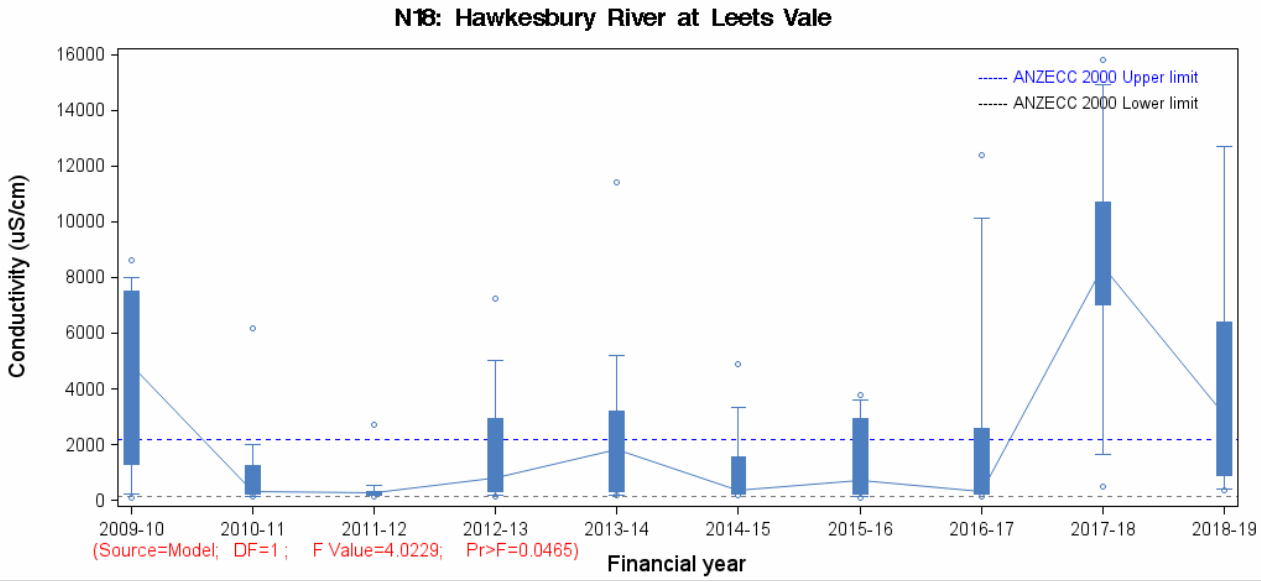

N18: Hawkesbury River at Leets Vale
Total algal biovolume (mm3/L)
0
2
4
6
8
10
12
14
16
18
20
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.3572; Pr>F=0.0075)
Financial year

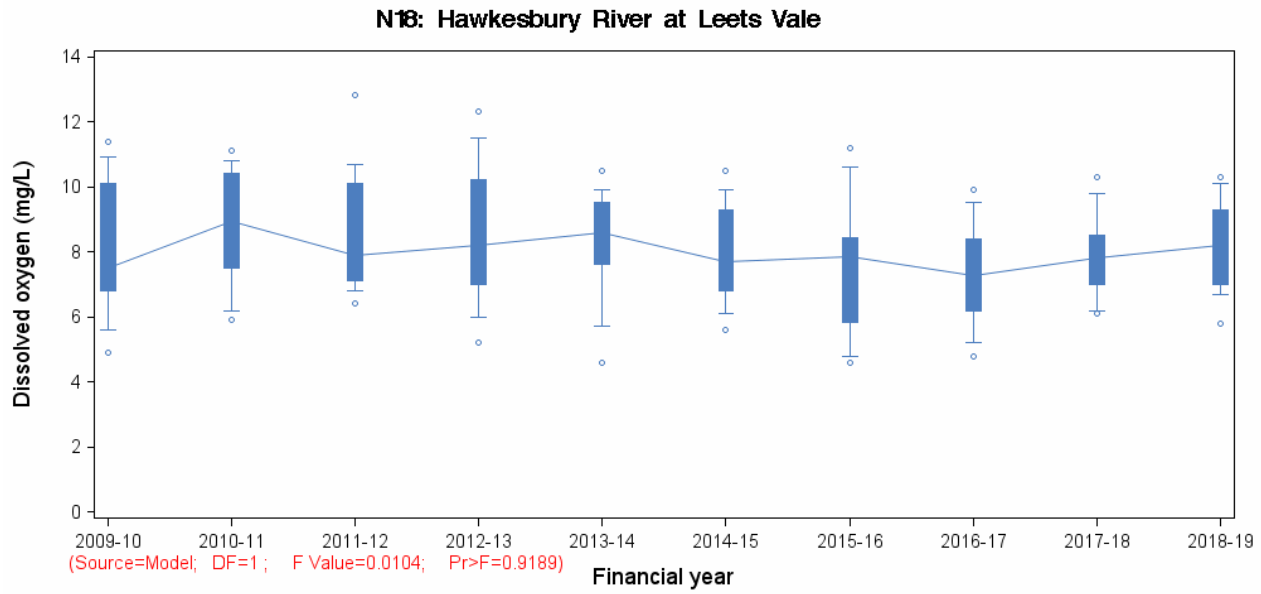

N18: Hawkesbury River at Leets Vale
Blue-green algal biovolume (mm3/L)
0
2
4
6
8
10
12
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.5048; Pr>F=0.4786)
Financial year

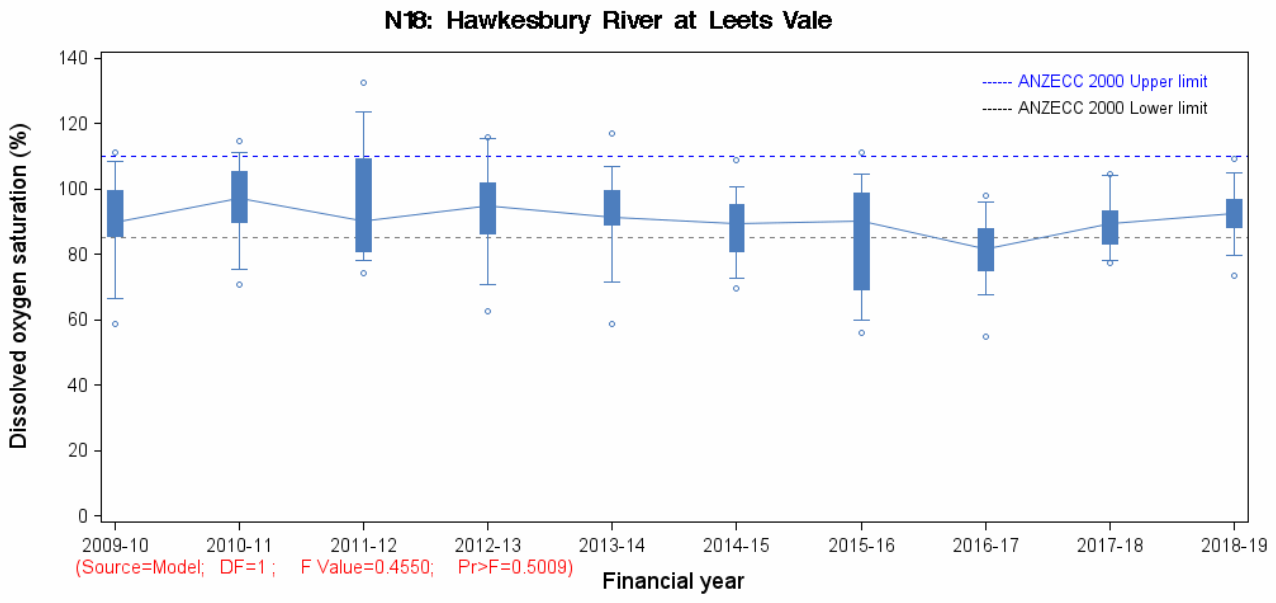

N18: Hawkesbury River at Leets Vale
Toxic blue-green algal biovolume (mm3/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
NHMRC 2008 red alert
NHMRC 2008 amber alert
NHMRC 2008 green alert
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
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Financial year

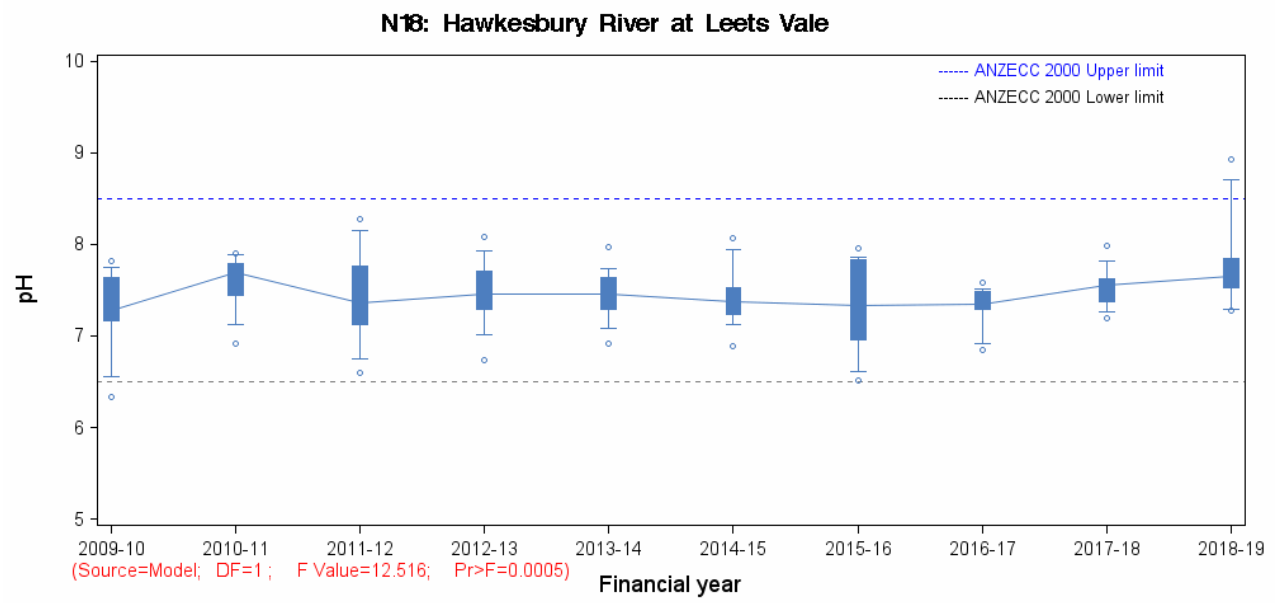


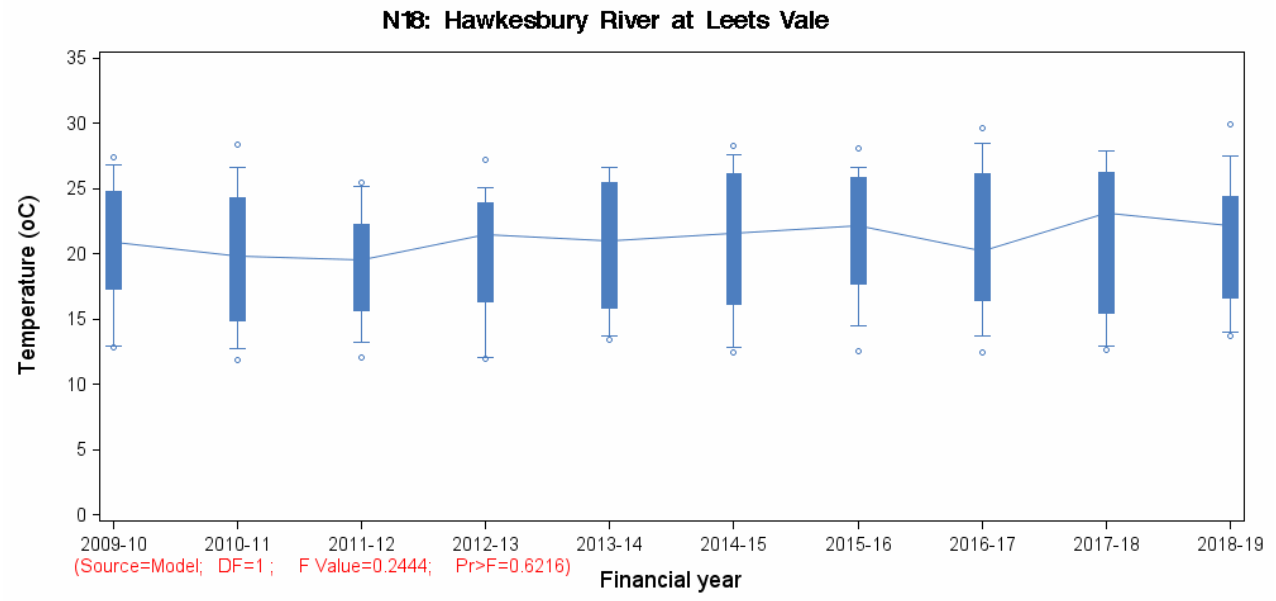
Other physico-chemical analytes

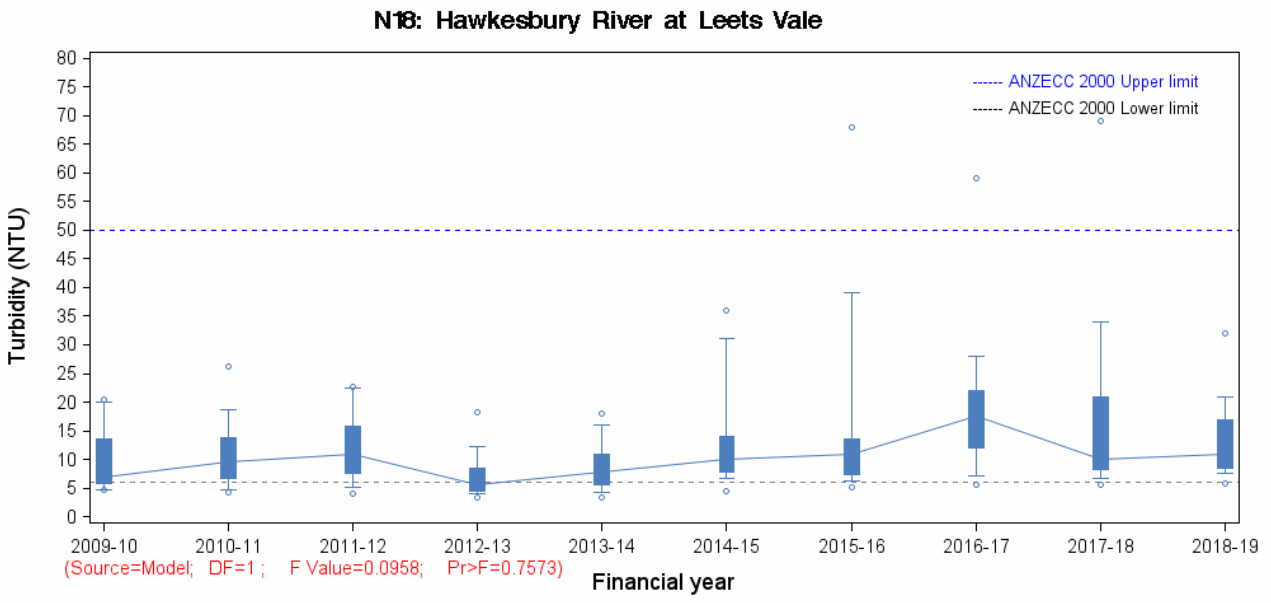


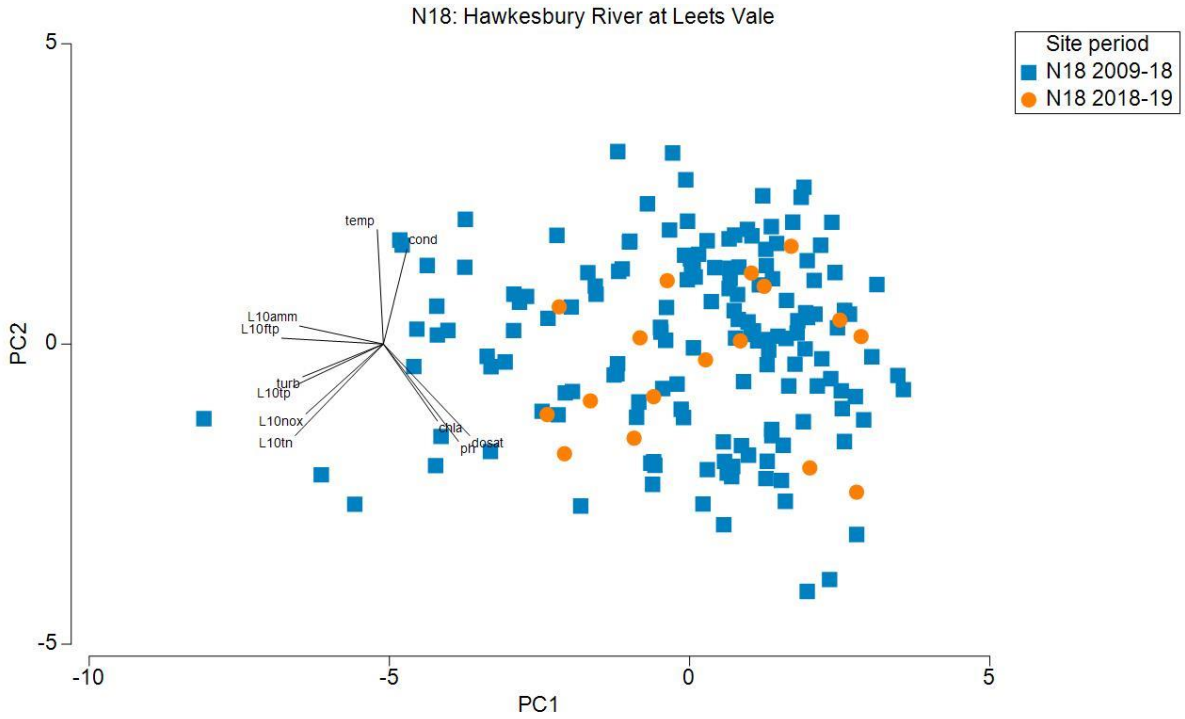



N18: Hawkesbury River at Leets Vale
Dissolved oxygen saturation (%)
140
120
100
80
60
40
20
0
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.4550; Pr>F=0.5009)
Financial year


N18: Hawkesbury River at Leets Vale
pH
10
9
8
7
6
5
----- ANZECC 2000 Upper limit
----- ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=12.516; Pr>F=0.0005)
Financial year


N18: Hawkesbury River at Leets Vale
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.2444; Pr>F=0.6216)
Financial year

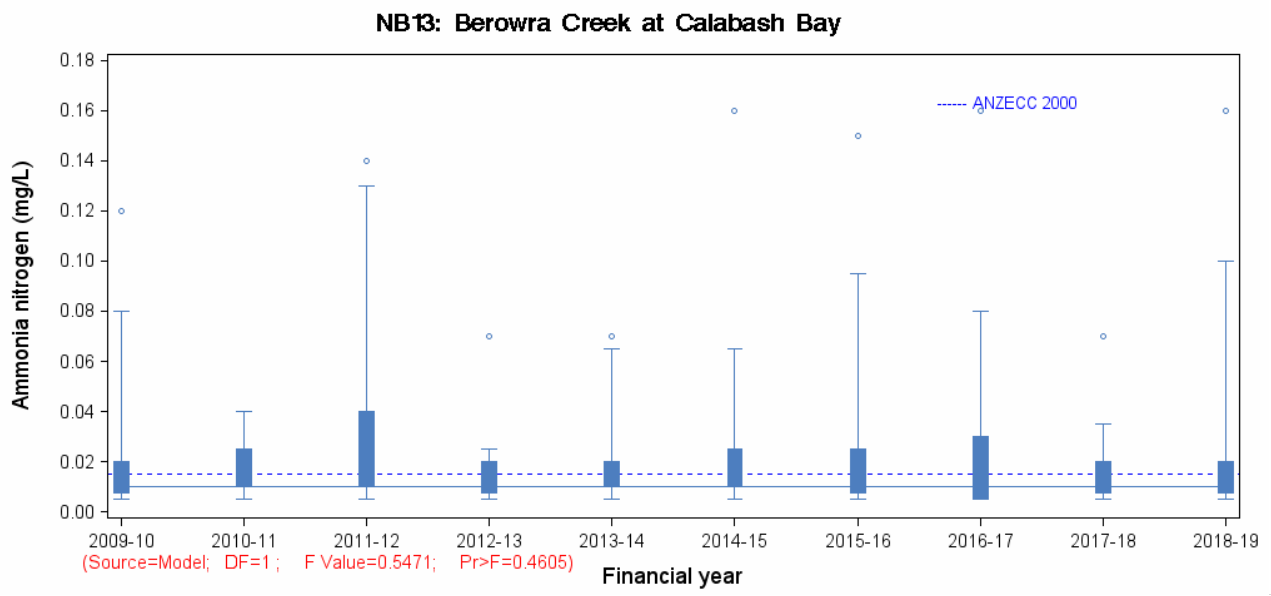


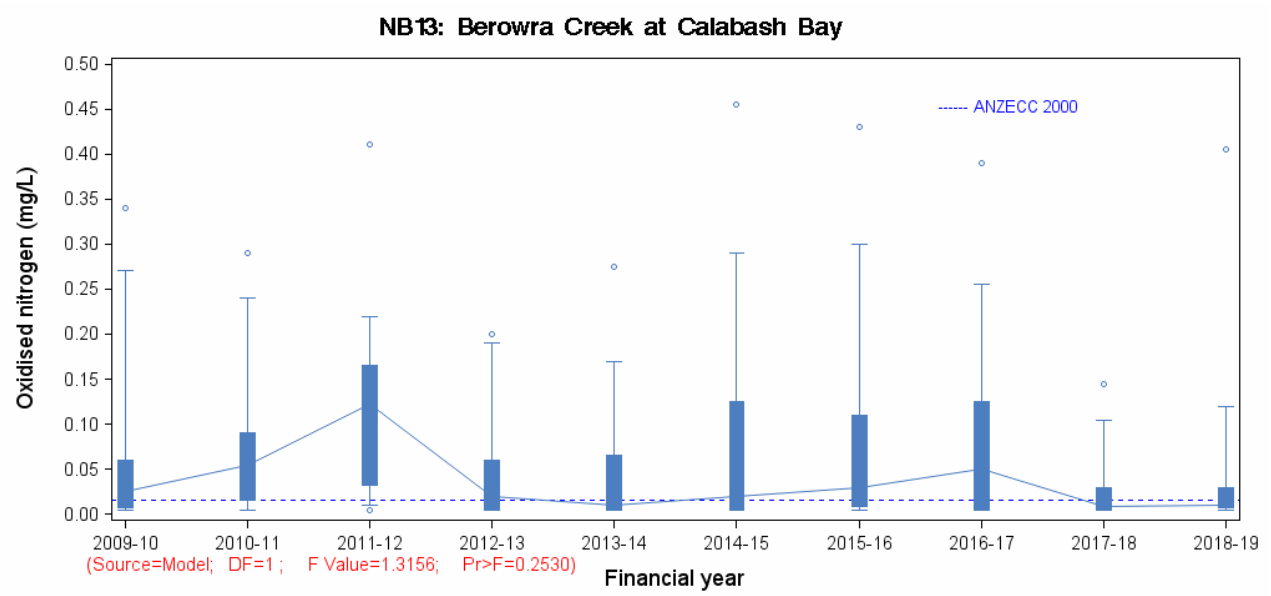


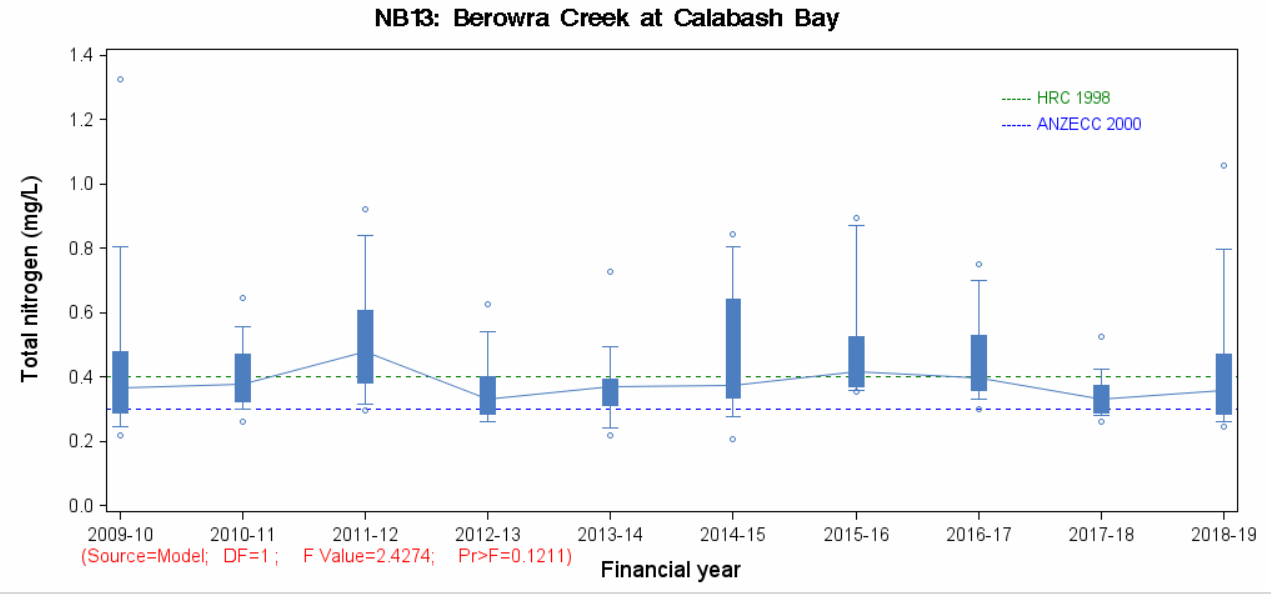
The ordination plot from Principal Components Analysis suggested water quality of the Hawkesbury River at Leets Vale in 2018-19 had similar variability to that recorded in the period 2009 to 2018.

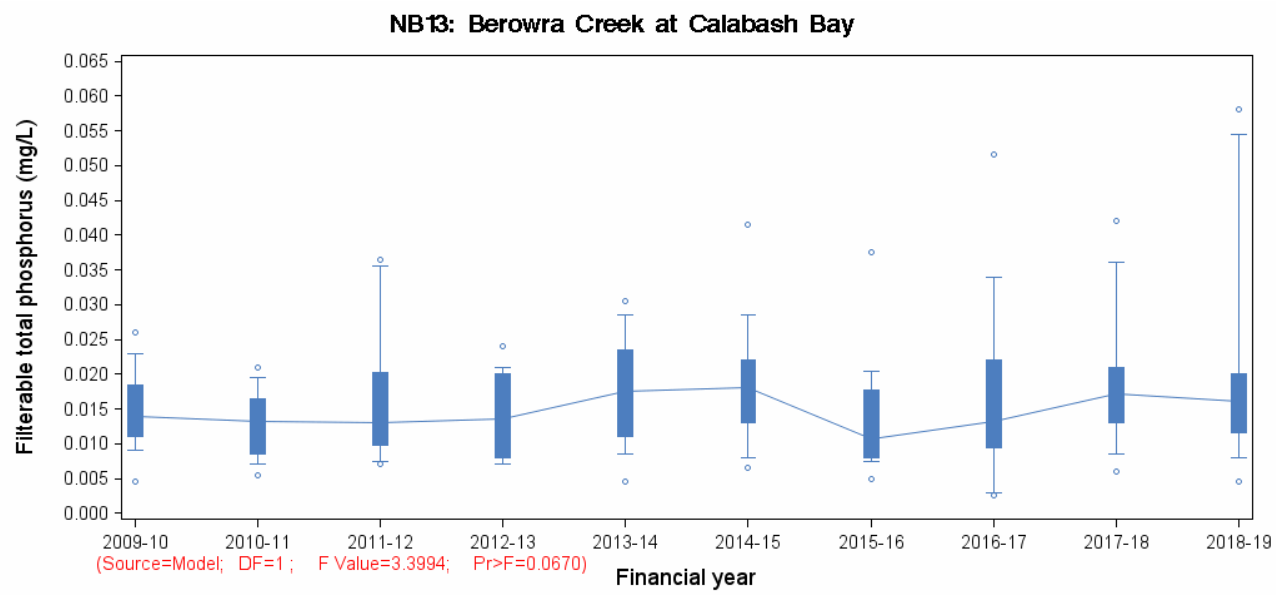
NB13: Berowra Creek at Calabash Bay

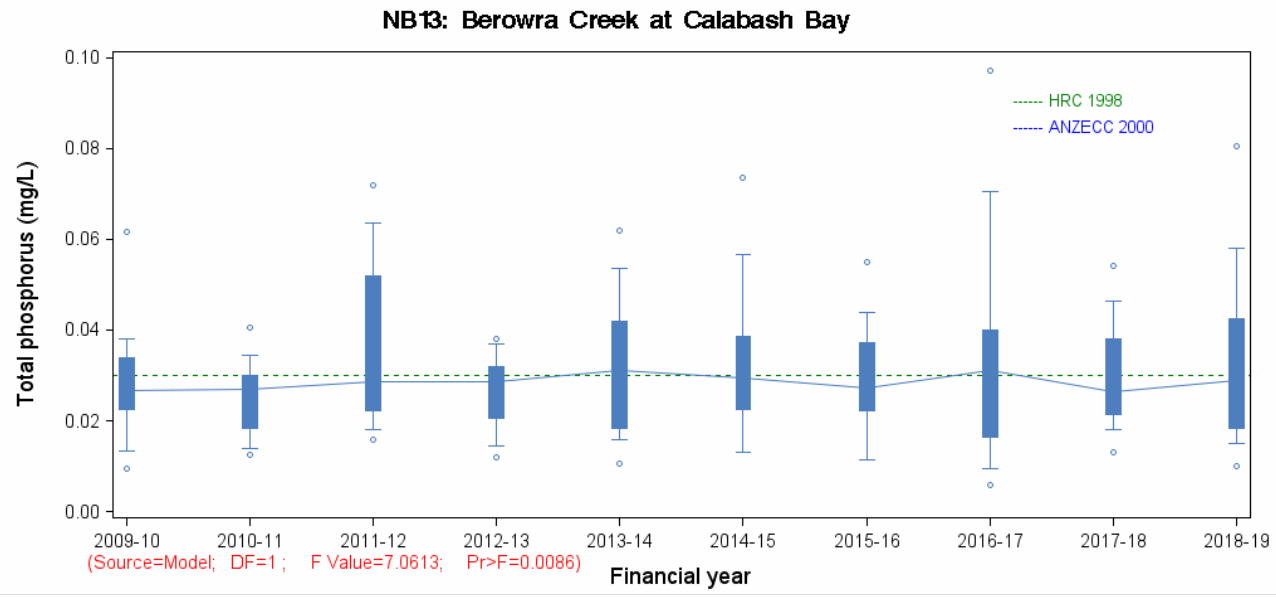
Nutrients, chlorophyll-*a* and algae

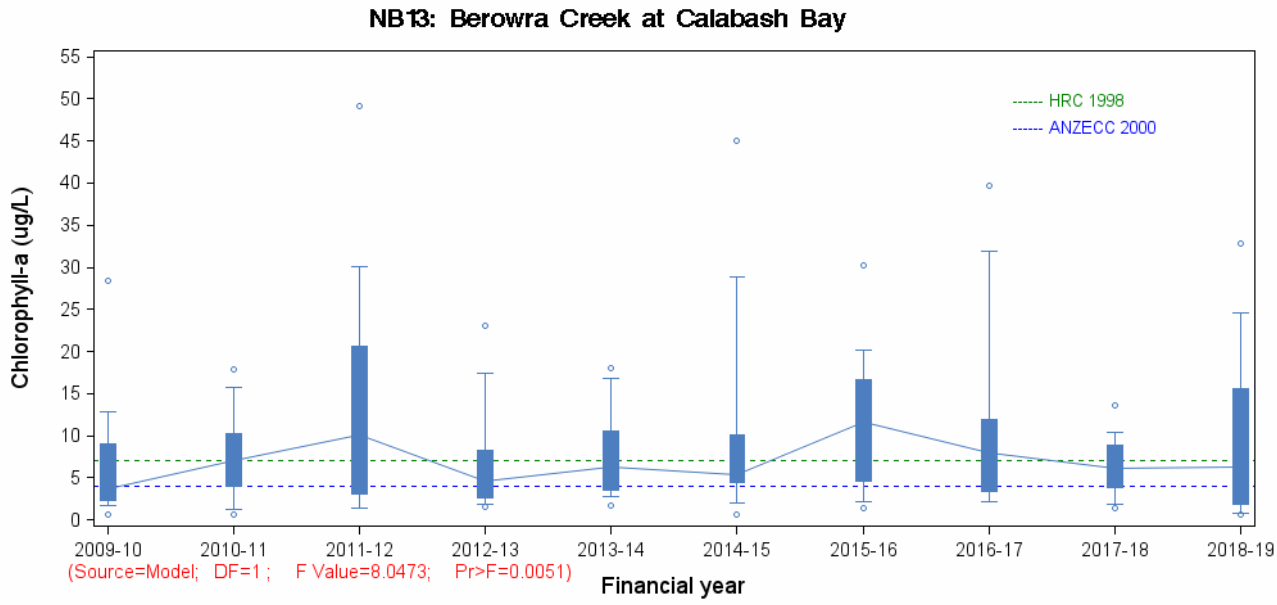


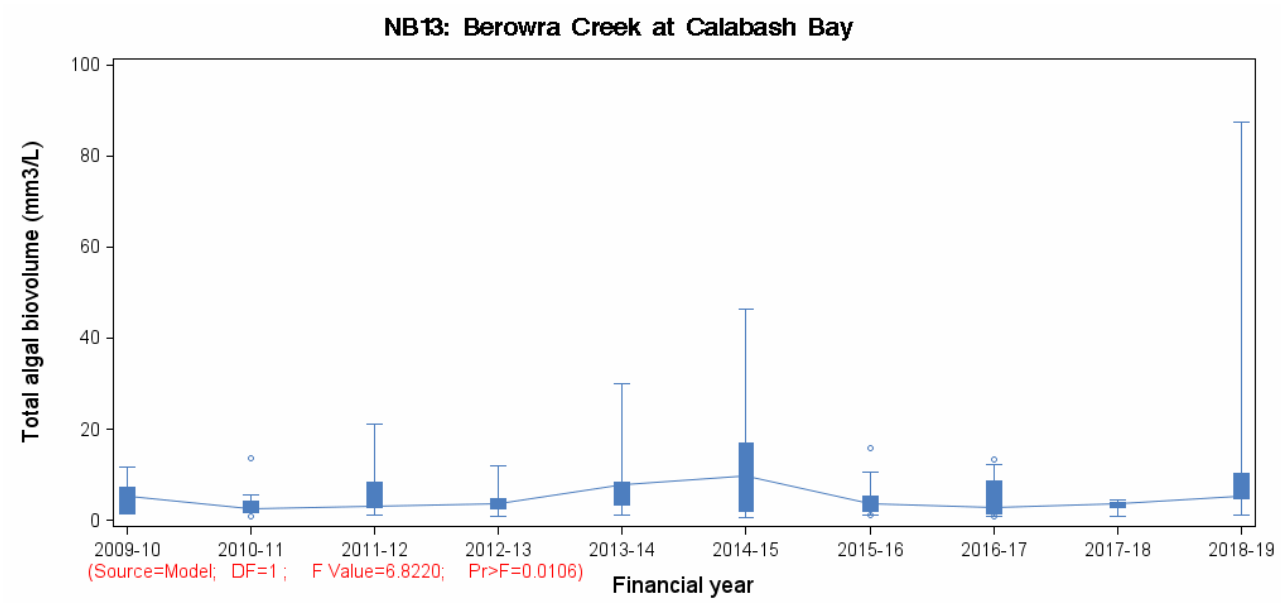





NB13: Berowra Creek at Calabash Bay
Filterable total phosphorus (mg/L)
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=3.3994; Pr>F=0.0670)
Financial year


NB13: Berowra Creek at Calabash Bay
Total phosphorus (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=7.0613; Pr>F=0.0086)
Financial year


NB13: Berowra Creek at Calabash Bay
Chlorophyll-a (ug/L)
55
50
45
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=8.0473; Pr>F=0.0051)
Financial year

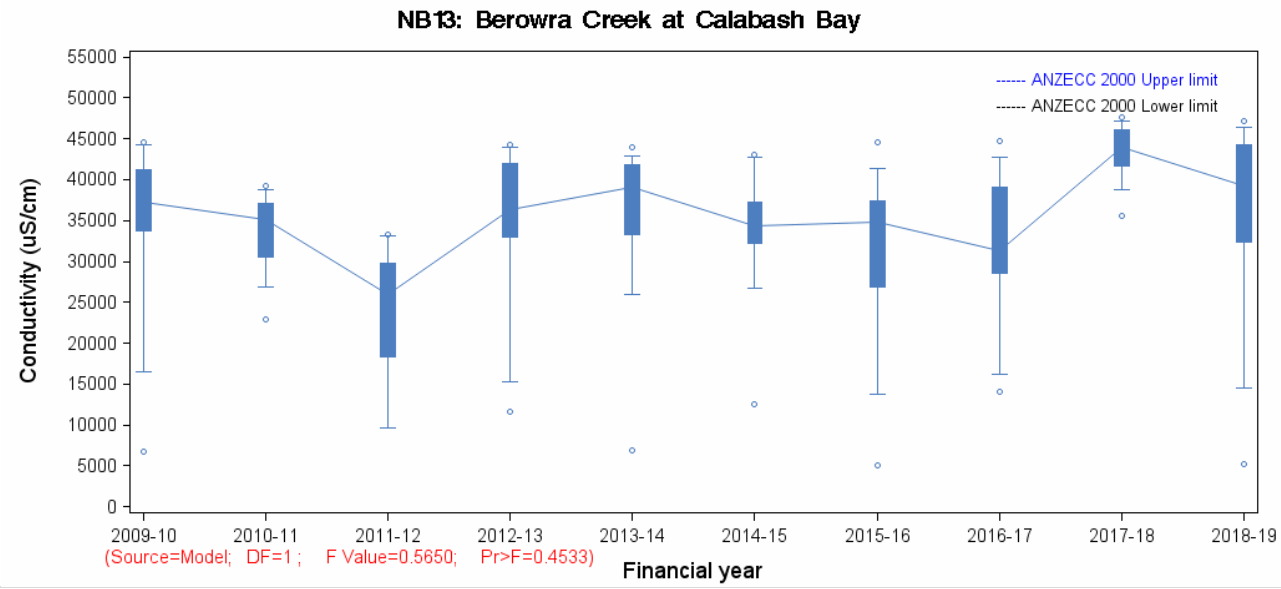


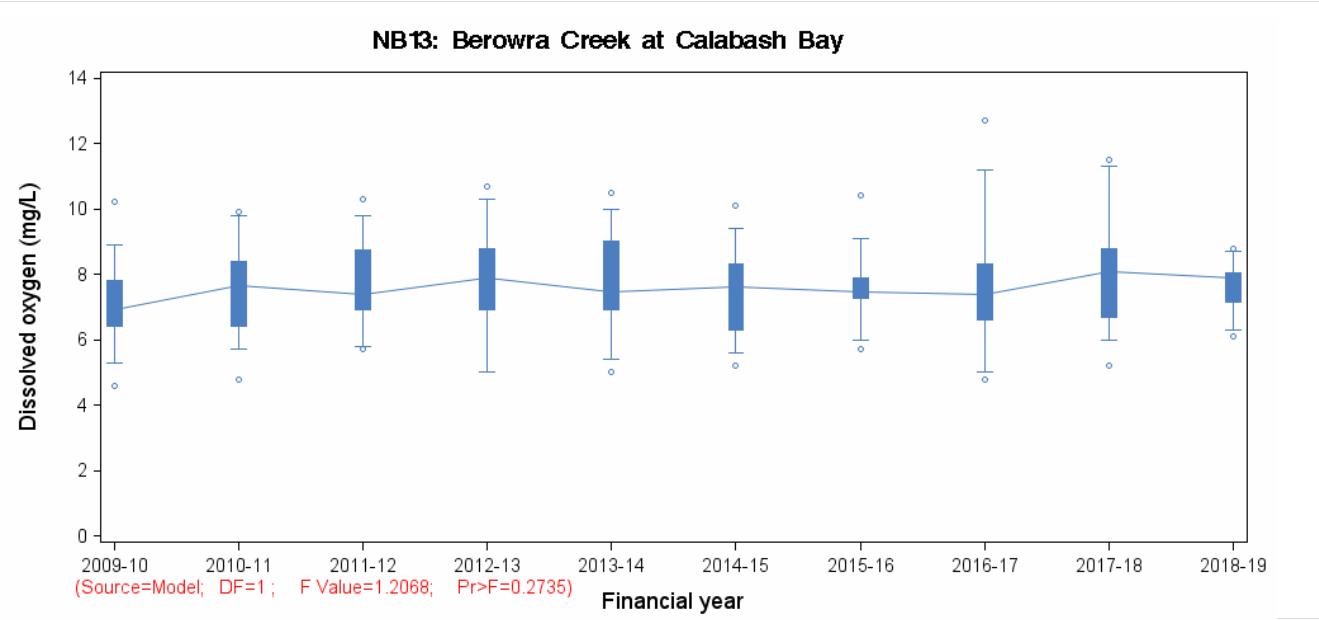
Note: Insufficient data to draw a plot on blue-green algal biovolume

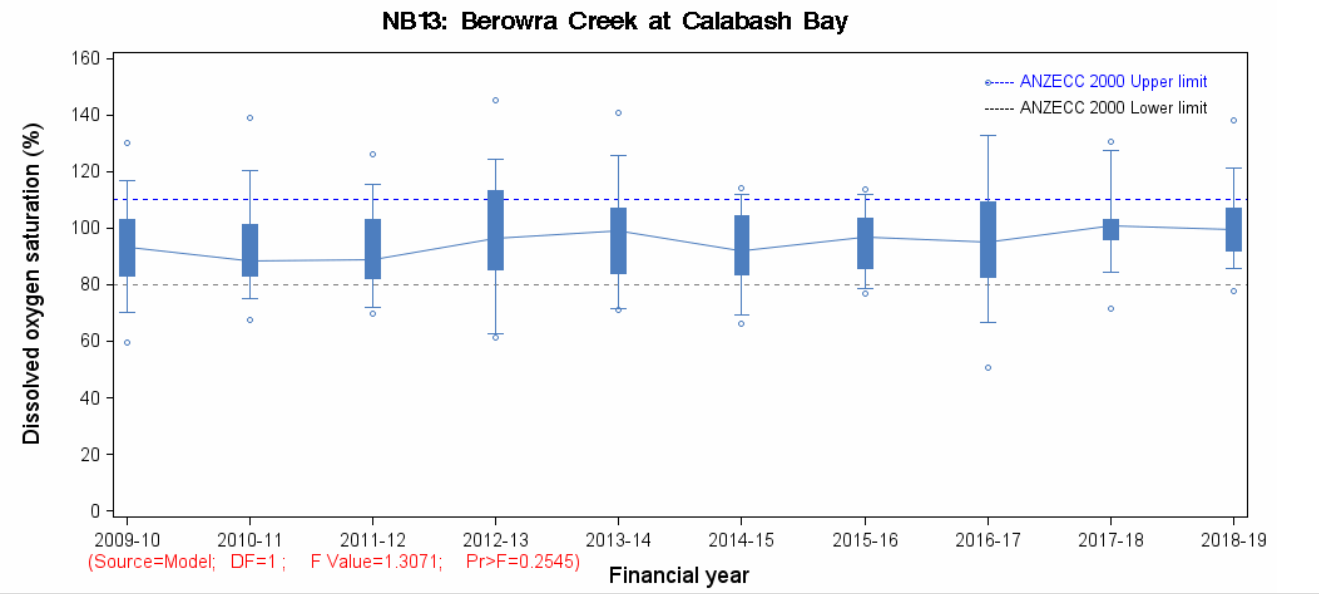
Note: Insufficient data to draw a plot on toxic blue-green algal biovolume

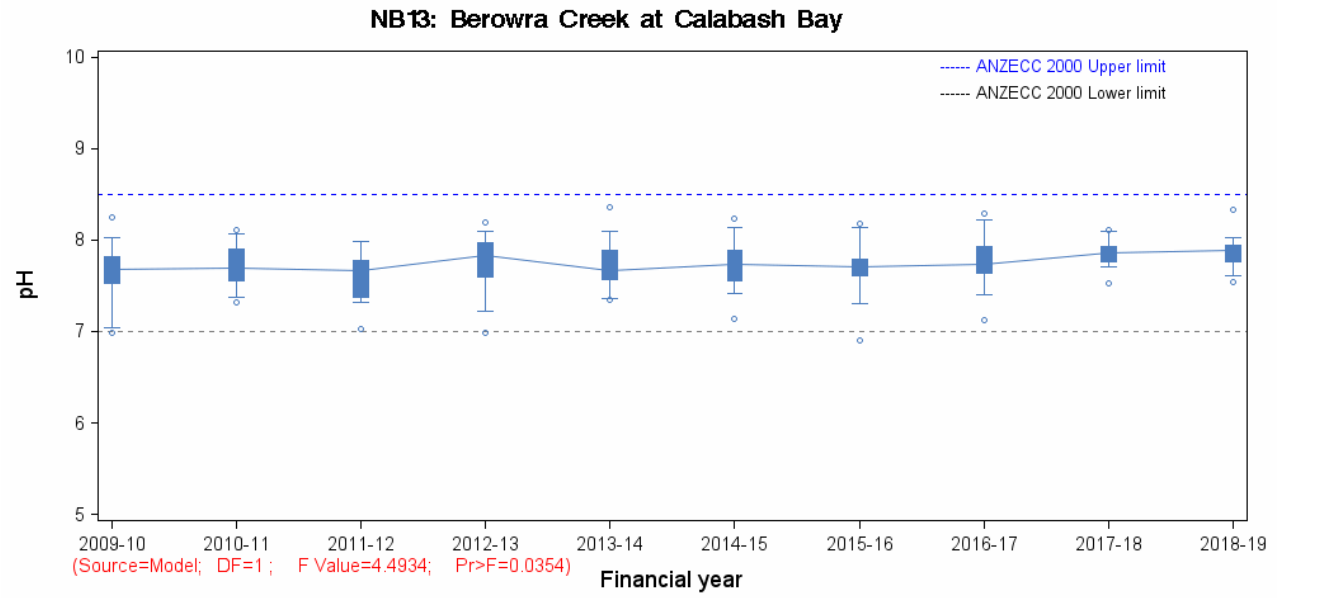
Note: Insufficient data to draw a plot on toxic blue-green algal count

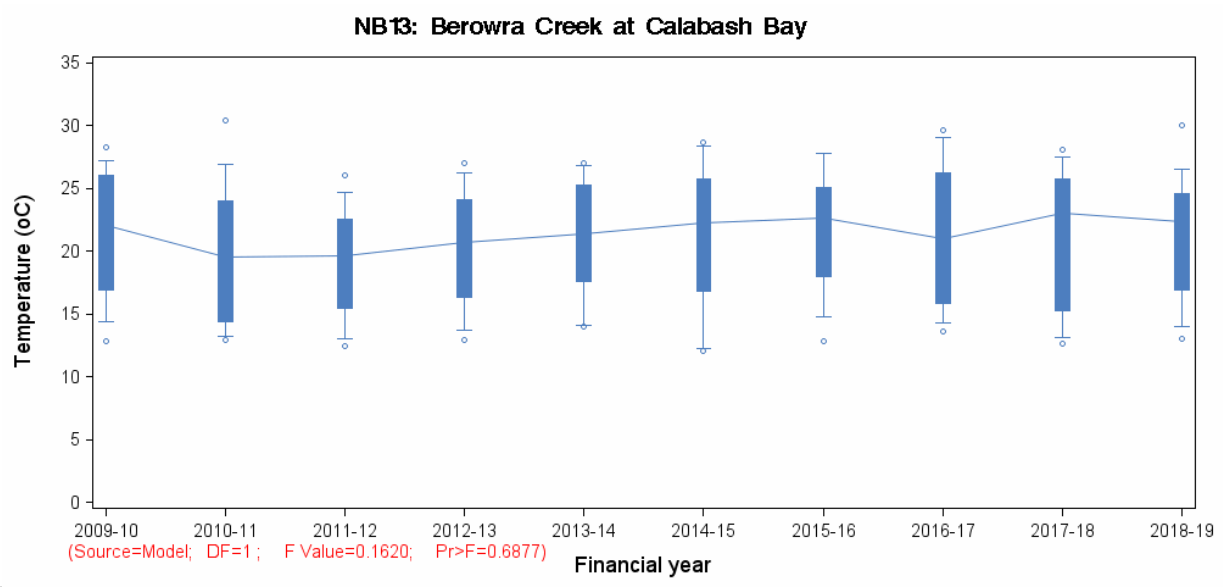
Other physico-chemical analytes

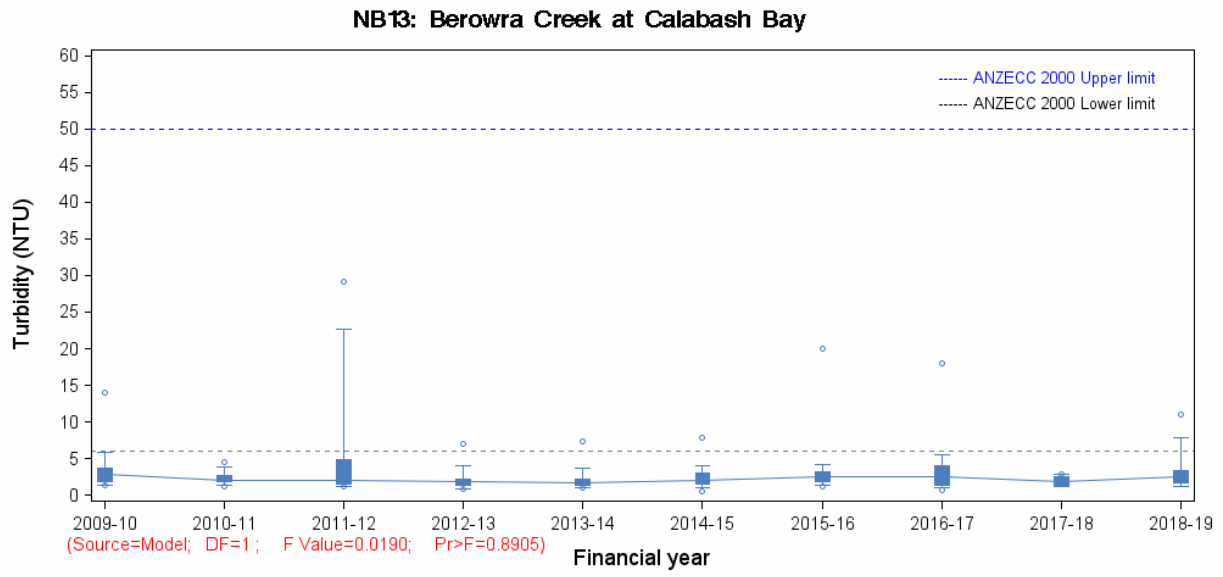


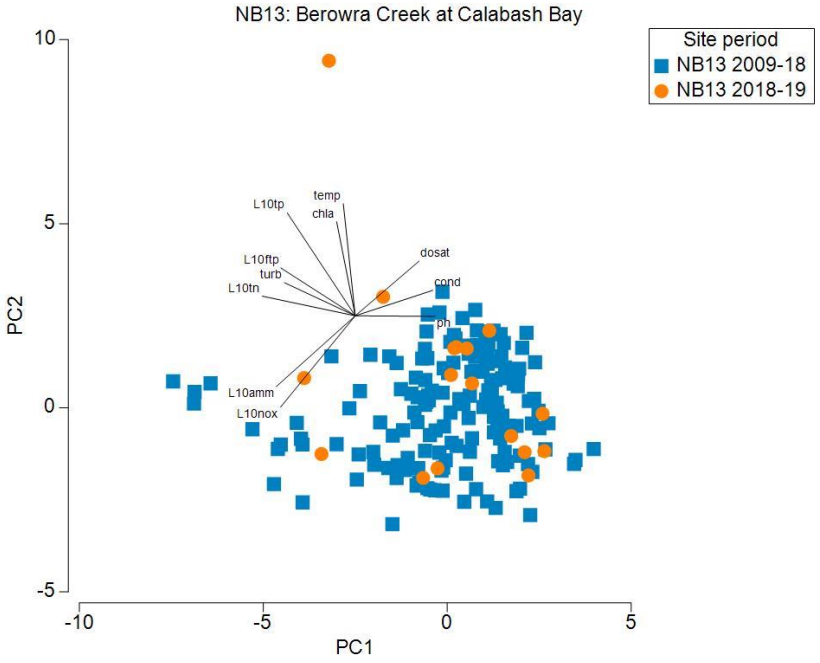

NB13: Berowra Creek at Calabash Bay
Dissolved oxygen (mg/L)
0
2
4
6
8
10
12
14
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.2068; Pr>F=0.2735)
Financial year


NB13: Berowra Creek at Calabash Bay
Dissolved oxygen saturation (%)
ANZECC 2000 Upper limit
ANZECC 2000 Lower limit
0
20
40
60
80
100
120
140
160
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=1.3071; Pr>F=0.2545)
Financial year


NB13: Berowra Creek at Calabash Bay
pH
ANZECC 2000 Upper limit
ANZECC 2000 Lower limit
5
6
7
8
9
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.4934; Pr>F=0.0354)
Financial year



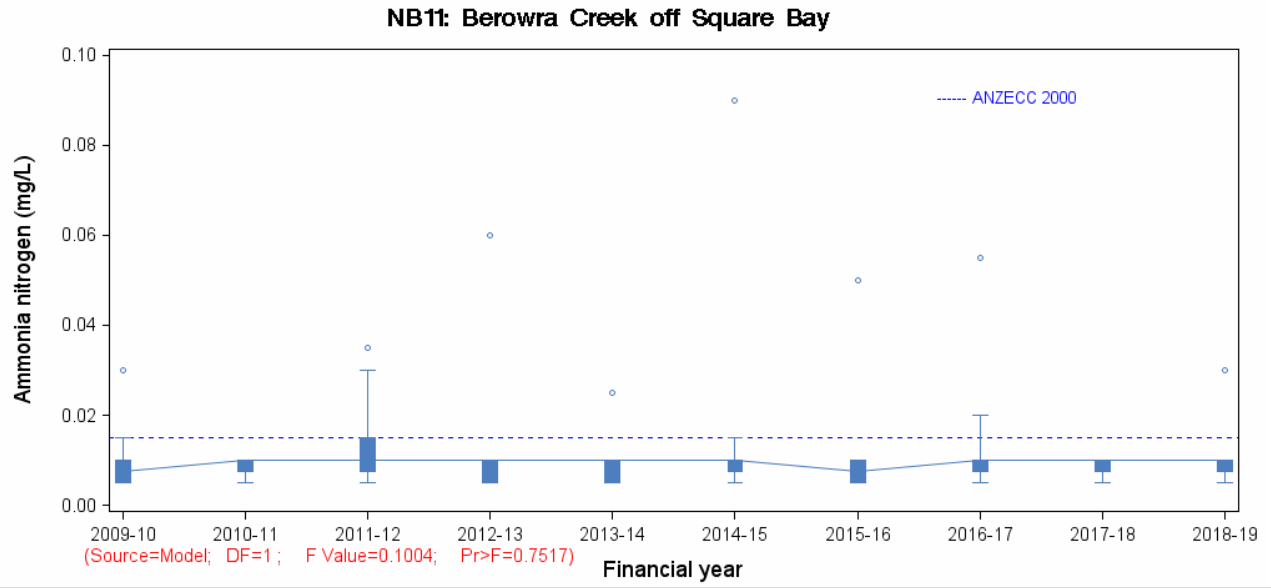


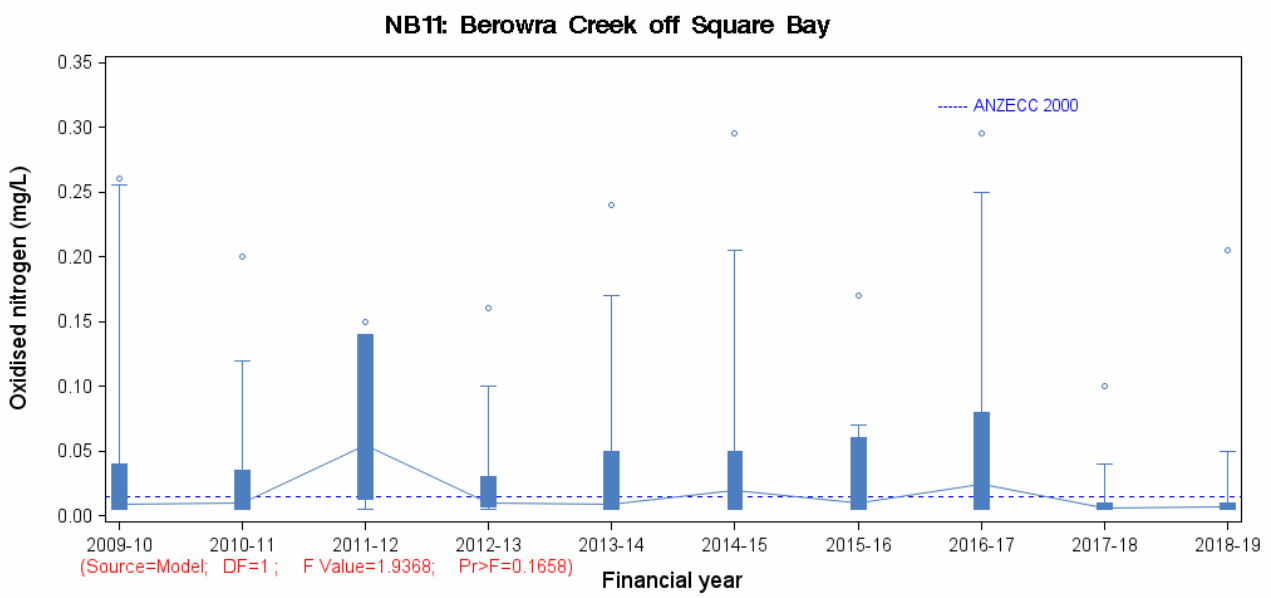


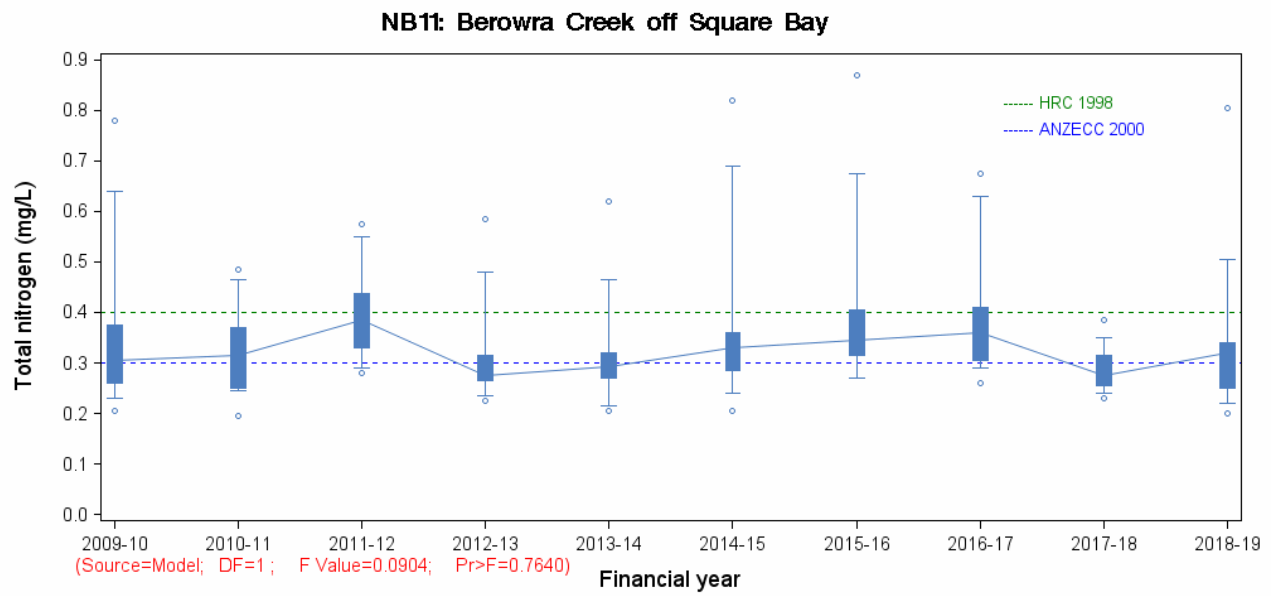
The ordination plot from Principal Components Analysis suggested water quality of Berowra Creek at Calabash Bay in 2018-19 was similar to that recorded in the period 2009 to 2018.

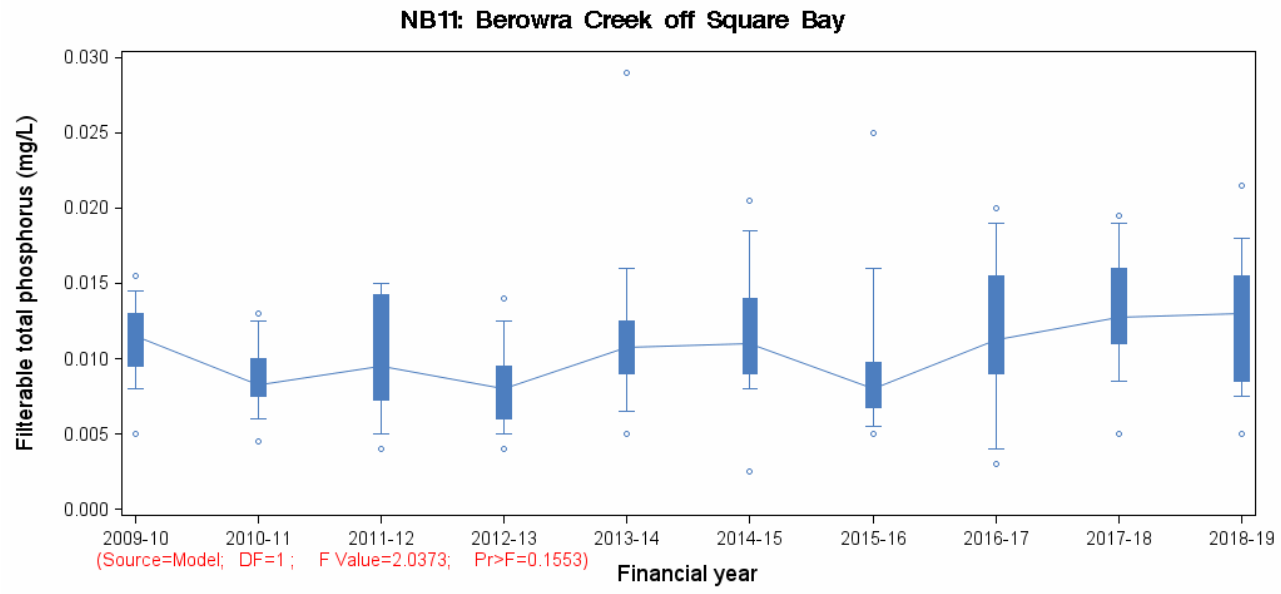
NB11: Berowra Creek off Square Bay

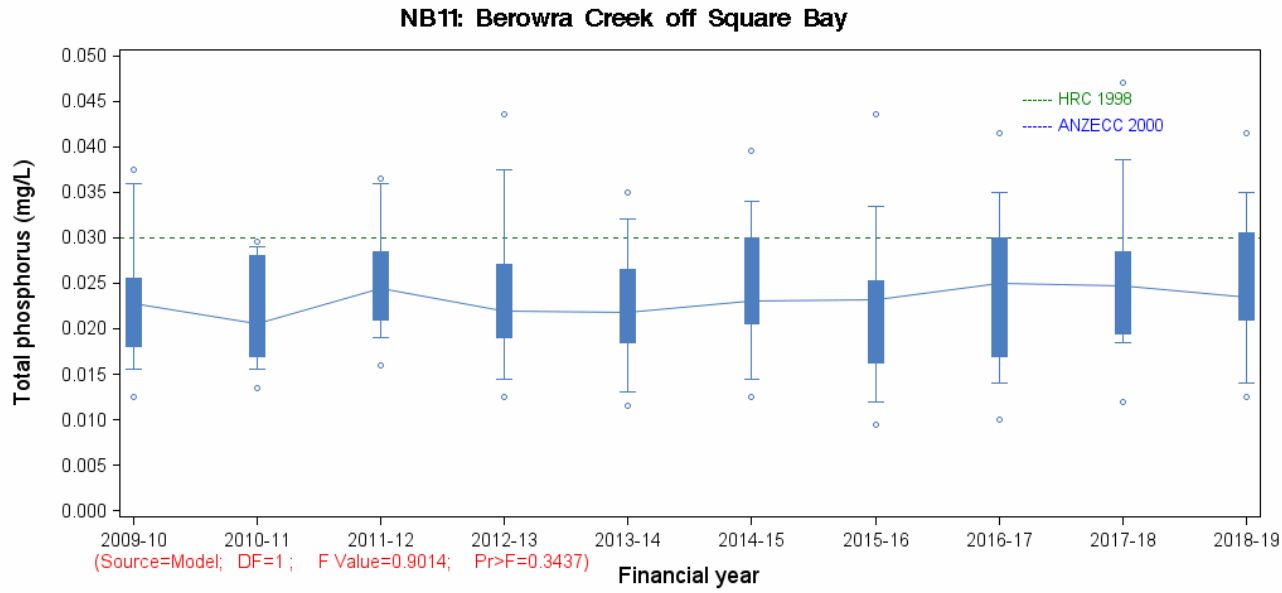
Nutrients, chlorophyll-*a* and algae

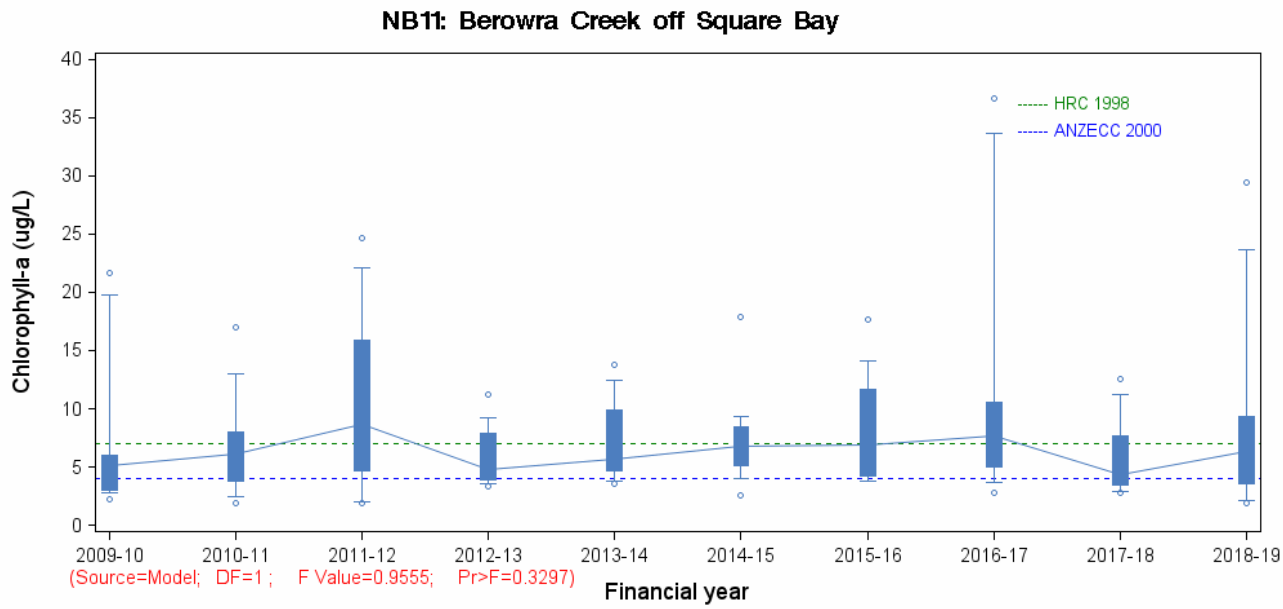


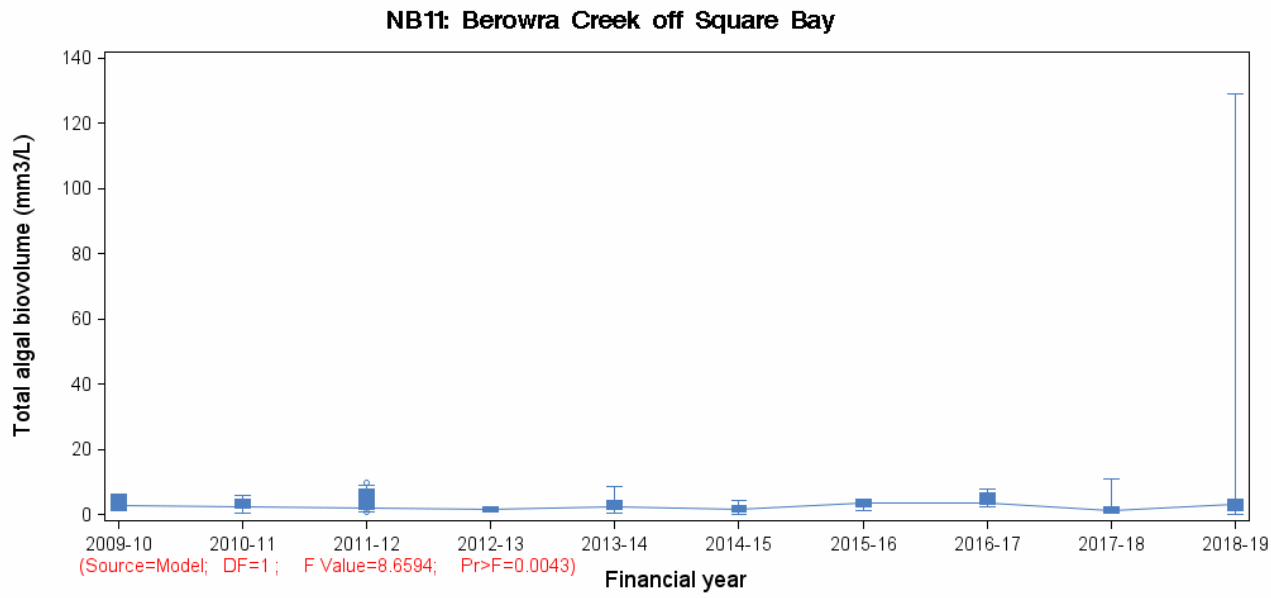





NB11: Berowra Creek off Square Bay
Filterable total phosphorus (mg/L)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=2.0373; Pr>F=0.1553)
Financial year


NB11: Berowra Creek off Square Bay
Total phosphorus (mg/L)
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.9014; Pr>F=0.3437)
Financial year


NB11: Berowra Creek off Square Bay
Chlorophyll-a (ug/L)
40
35
30
25
20
15
10
5
0
HRC 1998
ANZECC 2000
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.9555; Pr>F=0.3297)
Financial year

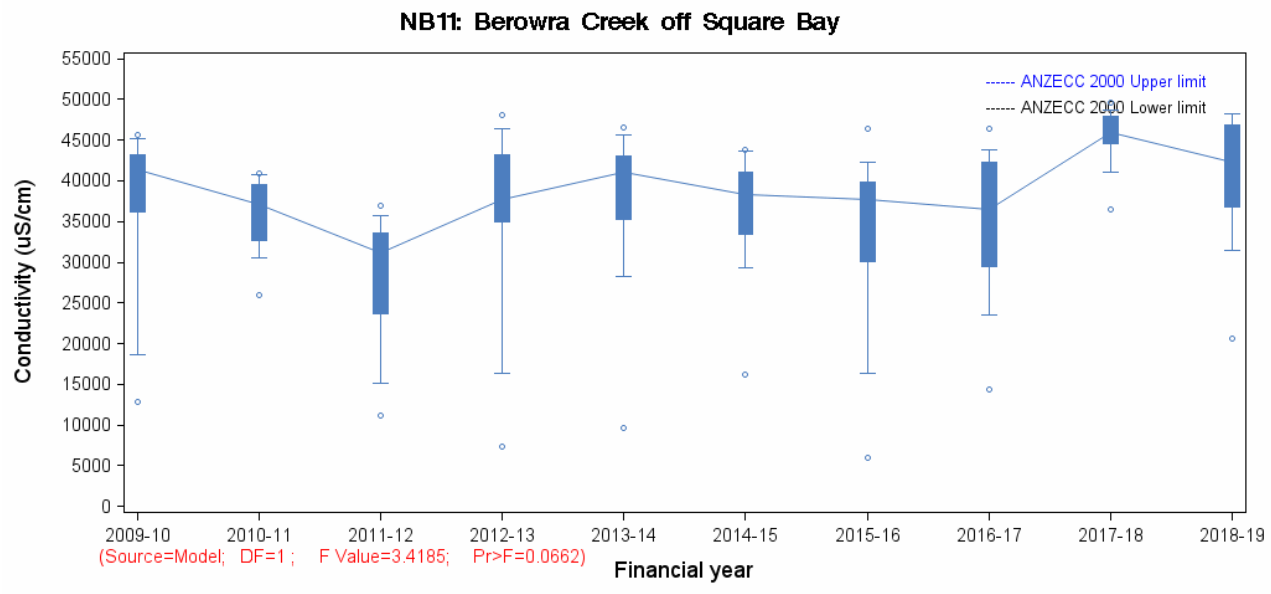


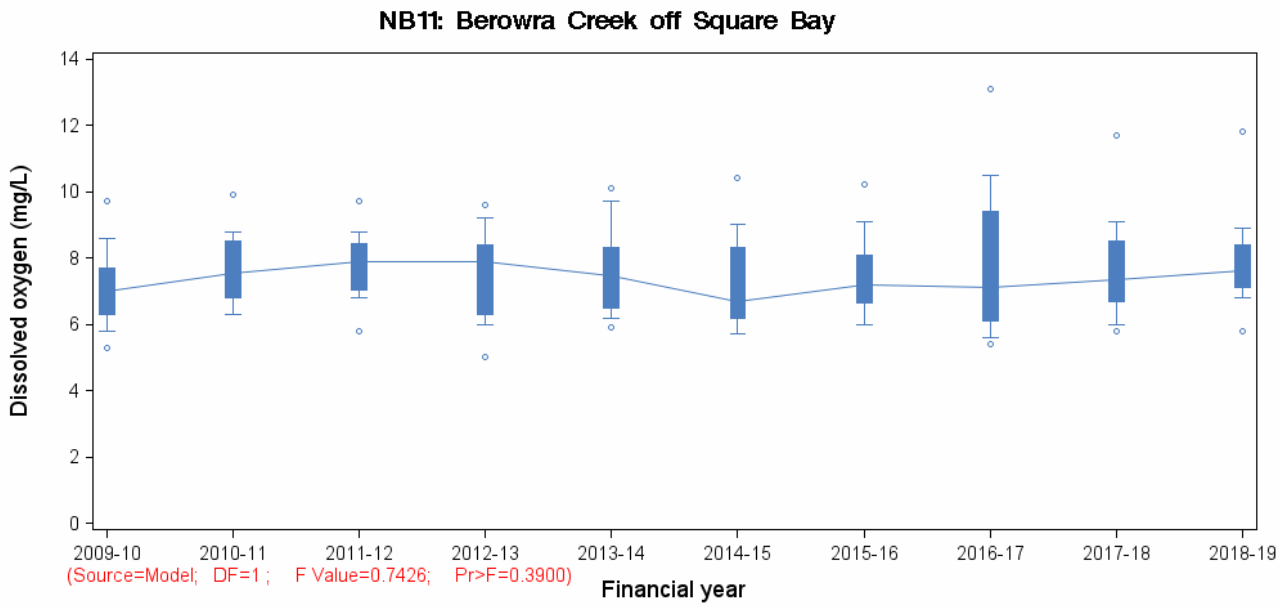
Note: Blue-green algae were detected on few occasions (all values were<0.001 mm^3/L)

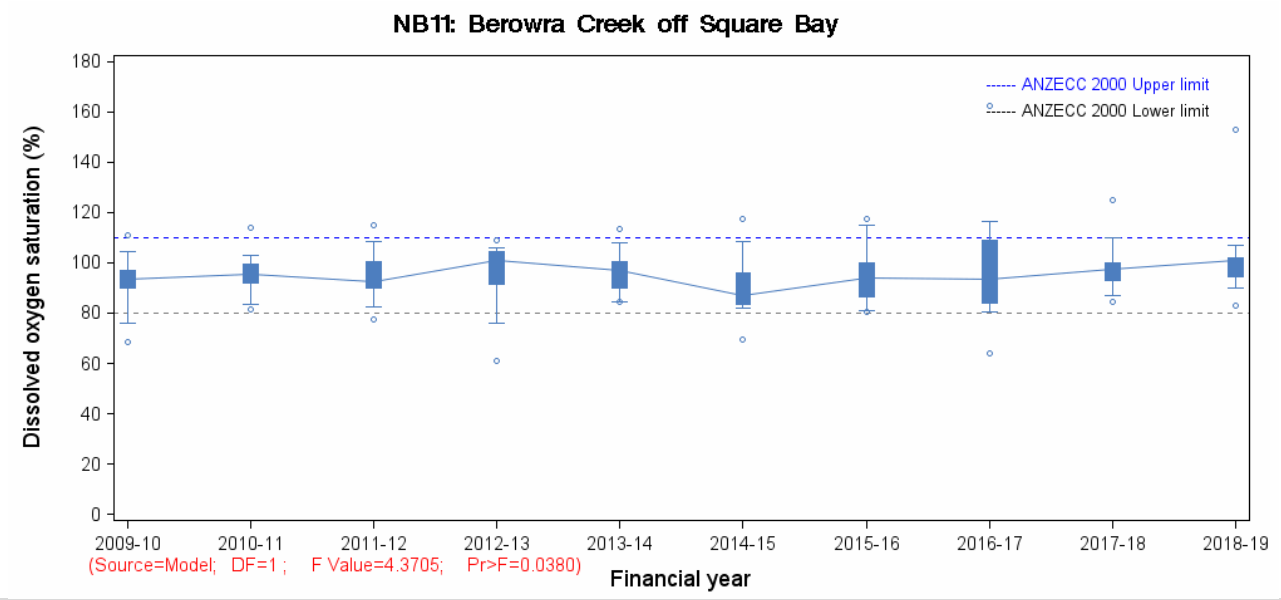
Note: Toxic blue-green algae was detected only once (0.014 mm^3/L)

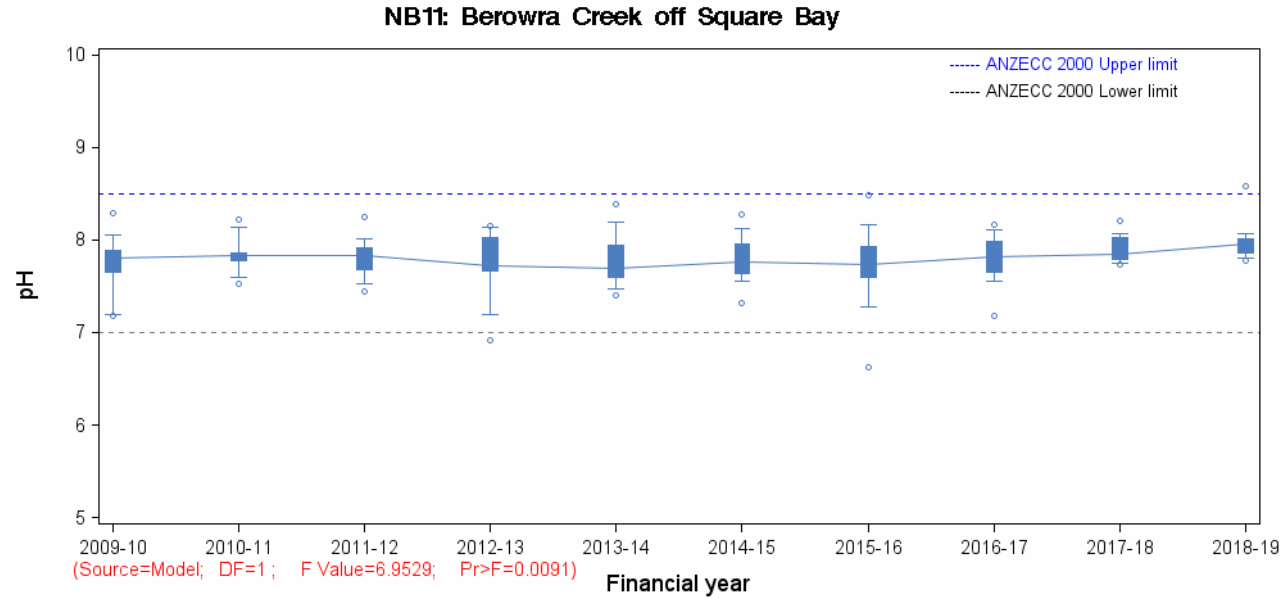
Note: Toxic blue-green algae was detected only once (95 cells/mL)

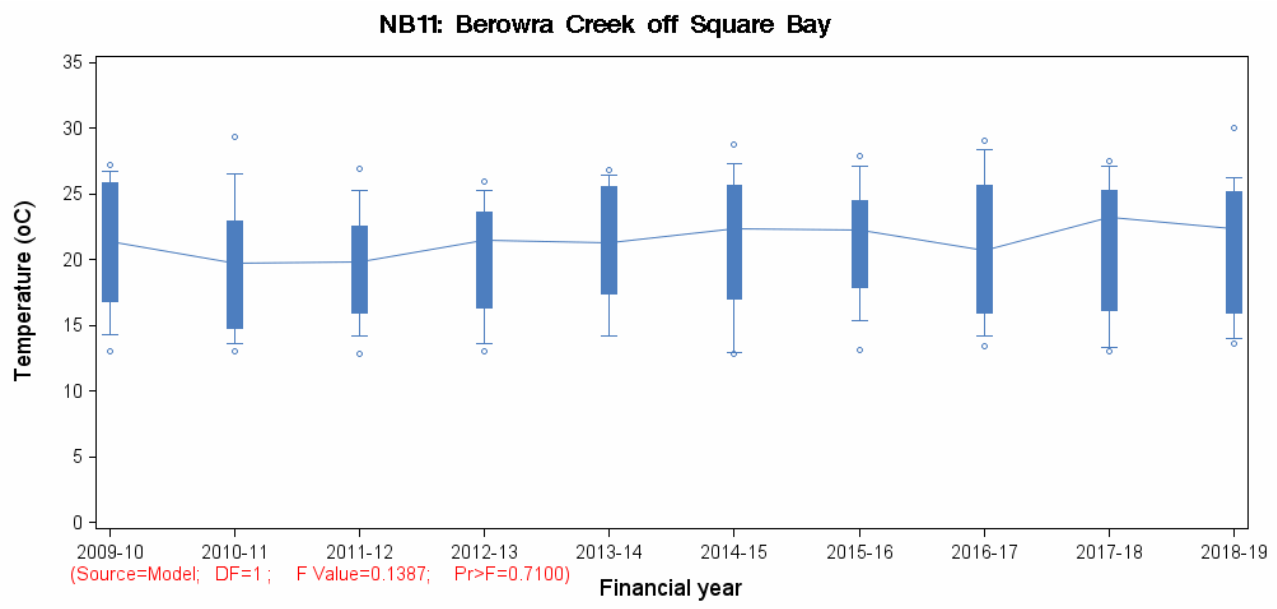
Other physico-chemical analytes

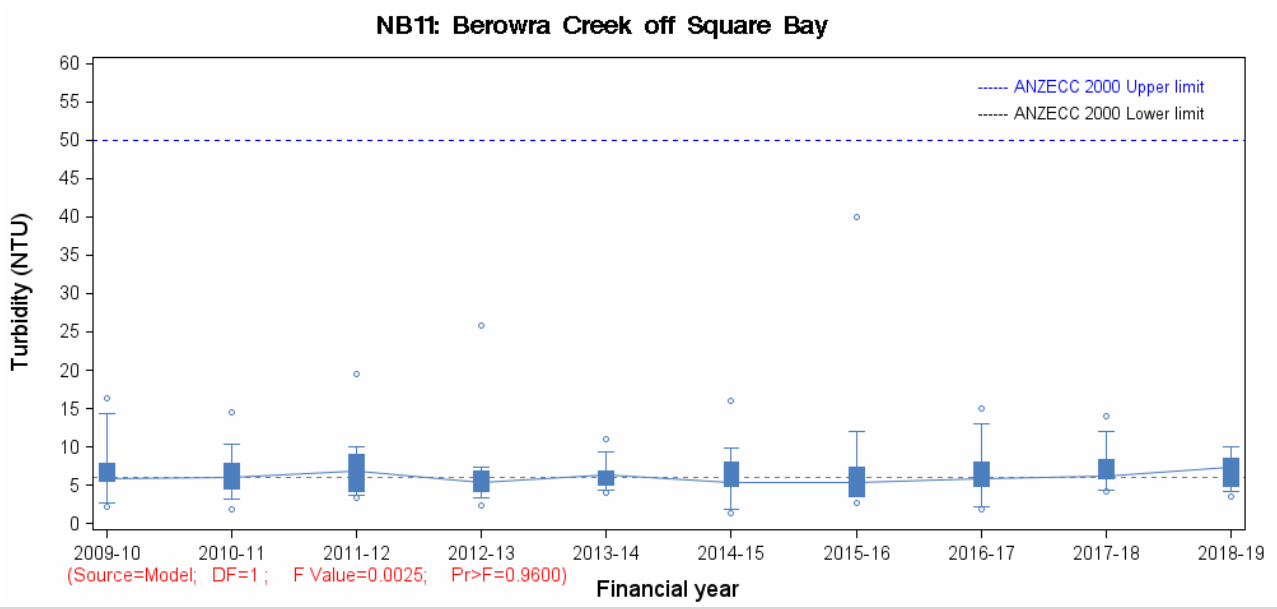


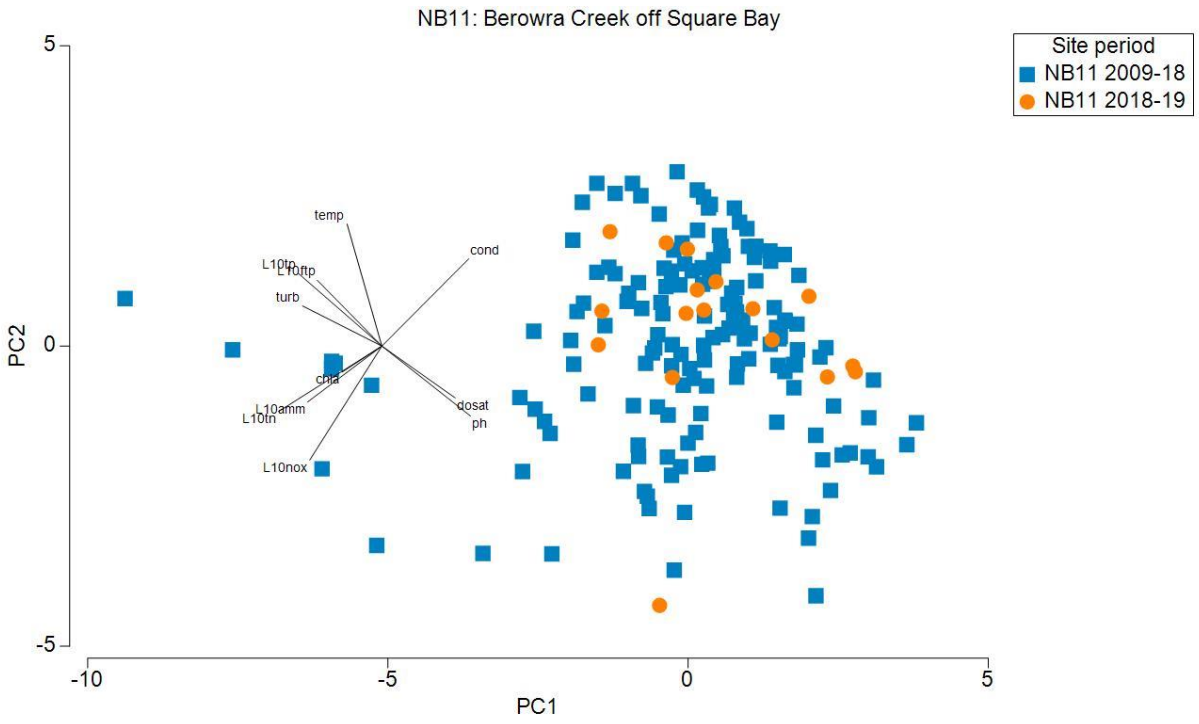

NB11: Berowra Creek off Square Bay
Dissolved oxygen (mg/L)
0
2
4
6
8
10
12
14
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.7426; Pr>F=0.3900)
Financial year


NB11: Berowra Creek off Square Bay
Dissolved oxygen saturation (%)
ANZECC 2000 Upper limit
ANZECC 2000 Lower limit
0
20
40
60
80
100
120
140
160
180
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=4.3705; Pr>F=0.0380)
Financial year


NB11: Berowra Creek off Square Bay
pH
ANZECC 2000 Upper limit
ANZECC 2000 Lower limit
5
6
7
8
9
10
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=6.9529; Pr>F=0.0091)
Financial year


NB11: Berowra Creek off Square Bay
Temperature (oC)
35
30
25
20
15
10
5
0
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.1387; Pr>F=0.7100)
Financial year


NB11: Berowra Creek off Square Bay
Turbidity (NTU)
60
55
50
45
40
35
30
25
20
15
10
5
0
------ ANZECC 2000 Upper limit
------ ANZECC 2000 Lower limit
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
(Source=Model; DF=1 ; F Value=0.0025; Pr>F=0.9600)
Financial year



The ordination plot from Principal Components Analysis suggested water quality of Berowra Creek off Square Bay in 2018-19 was generally similar to that recorded in the period 2009 to 2018.

Appendix N Stream health of Hawkesbury-Nepean River

Stream health responses for the following inland WWTPs are presented in following order of upstream to downstream sites:

- Picton WWTP
- West Camden WWTP
- Wallacia WWTP
- Penrith WWTP
- Winmalee WWTP
- North Richmond WWTP
- St Mary's WWTP
- Quakers Hill WWTP
- Riverstone WWTP
- Castle Hill WWTP
- Rouse Hill WWTP
- Hornsby Heights WWTP
- West Hornsby WWTP

Stream health near Picton WWTP

The SIGNAL-SG plot for the Nepean River provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1995 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site recorded over the 1995 to 2018 period indicating wastewater discharge from Picton WWTP did not have a measurable negative impact on stream health during 2018-19 (Figure N-1).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under t-tests returned non-significant test outcomes (Table N-40) and confirmed the visual trend for 2018-19.

As no measurable negative impact on downstream stream health was detected, no further data analysis was undertaken.

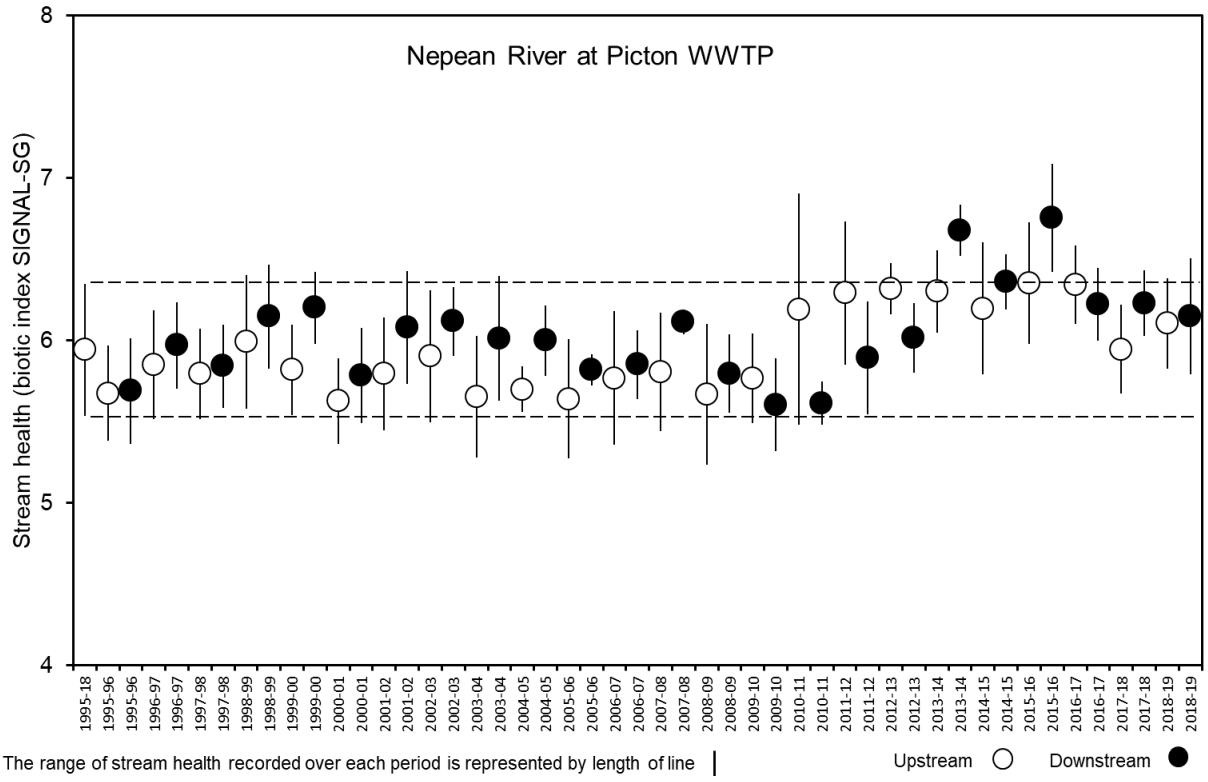


Figure N-1 Stream health of Nepean River near Picton WWTP

Table N-1 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Nepean River near Picton WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	14	-0.25	0.8055

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	7	7	1.65	0.5256

Stream health near West Camden WWTP

The SIGNAL-SG plots provided assessments of stream health for both Matahil Creek near West Camden WWTP and in the Nepean River upstream-downstream of the confluence with Matahil Creek. These plots were based upon macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 2004 to 2018 for the Matahil Creek and 1995 to 2018 for the Nepean River. These visual comparisons suggest downstream stream health was maintained in the Nepean River over 1995 to 2018 with upstream stream health in 2018-19 at the second highest level recorded over the 1995 to 2019 year period (Figure N-3). A localised impact in stream health was indicated for the Matahil Creek in 2018-19 (Figure N-2).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under t-tests returned significant test outcomes (Table N-2) and confirmed the visual trends (Figure N-3).

As a measurable negative impact on downstream stream health was detected on Matahil Creek, further data analysis was undertaken.

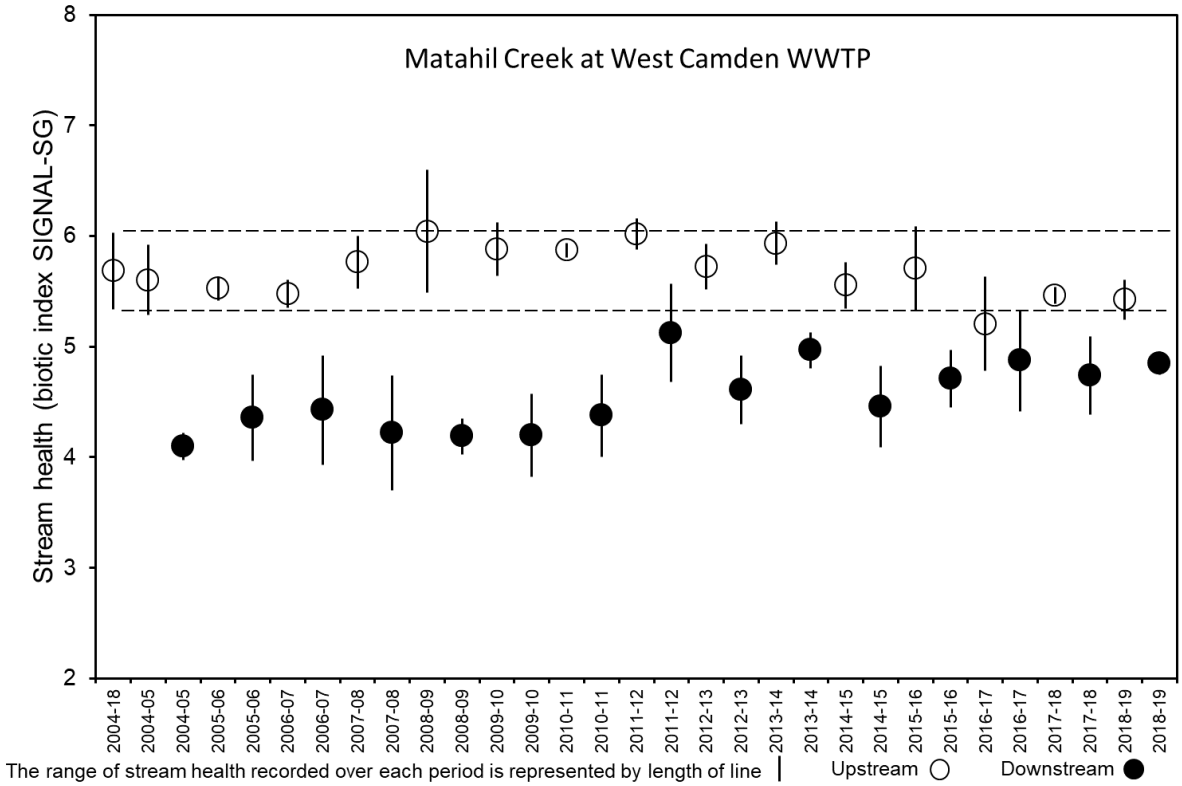


Figure N-2 Stream health of Matahil Creek near West Camden WWTP

Table N-2 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Matahil Creek near West Camden WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	7	-6.28	0.0004

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	2	5	3.10	0.2664

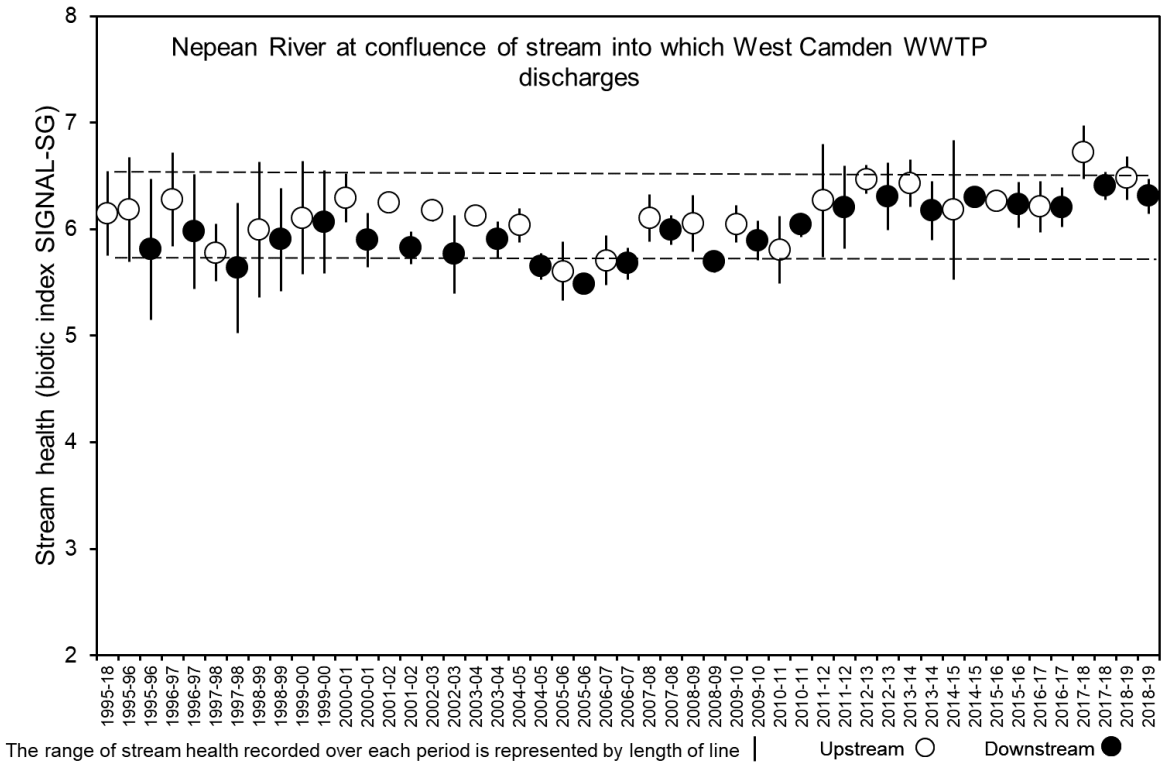


Figure N-3 Stream health of the Nepean River near West Camden WWTP

Table N-3 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Nepean River near West Camden WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	-1.58	0.1455

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	5	5	1.54	0.6472

Edge habitat samples were collected consistently enough from Matahil Creek to allow multivariate analysis for the monitoring period 2004 to 2019. Distinct groups of samples separated by site were evident for Matahil Creek in the two-dimensional ordination plot (Figure N-4).

The ordination pattern was confirmed in the corresponding tree diagram (dendrogram) from classification analysis as the first division separated all upstream site samples from all downstream site samples (Figure N-5). This initial separation also occurred at a quite low similarity of 14% (Figure N-5) compared with all Nepean River sites samples which exhibited a greater initial similarity level of 38% (Figure N-8).

The clear separation of Matahil Creek sites was also evident in the corresponding shade plot (Figure N-6) where downstream samples displayed less diversity when compared to the upstream site. The shade plot displayed a few taxa in common between the two sites such as the freshwater snail Physidae *Physela*, the caddisfly larvae Leptoceridae *Triplectides* and the non-biting midge larvae Chironimidae *chironomus*. The corresponding SIGNAL-SG grades showed that dominant taxa that occured downstream have lower SIGNAL-SG grades than those of the upstream site (Figure N-6), which is reflected in the separation of site SIGNAL scores displayed in Figure N-2.

The BVSTEP routine was used to find a subset of taxa whose multivariate pattern matched that of the full dataset with 15 taxa identified for the edge habitat (Table N-8) out of 97 taxa. These taxa reflected those taxa which formed the main patterns within the shade plot (Figure N-6).

The PERMDISP analysis indicated a similar pattern of dispersion (spacing between same site samples) for the two sites (Figure N-6). This outcome suggests the variability in taxonomic make-up of samples collected over time was at similar levels for both sites through the period tested (2005 to 2019). This result then also implies subsequent results of ANOSIM tests are focused on community structure differences between sites.

The ANOSIM test run on the factor 'Site' returned a high range value (R = 0.993; P = 0.001) confirming community structure was distinct at each site (Table N-4).

To further explore community structure, hypothesis testing was conducted with PERMANOVA. The PERMANOVA model comprised the fixed factors 'Site' and 'Year'. 'Year' represented samples collected in years between 2005 and 2019. 'Site' had two levels, upstream and downstream. A statistically non-significant 'Site x Year' interaction was returned (Table N-5). This non-significant result allowed us to view the 'Site' and 'Year' results. A statistically non-significant 'year' result was returned, however 'site' resulted in a statistically significant results indicating differences exist between the upstream and downstream sites.

A second run of ANOSIM based on Site-period sample groups displayed in above ordination plots returned a significant global R-value at a high level of 0.727 (Table N-7). Pairwise tests indicated the four upstream versus downstream comparisons also had high level R-values (close to or equalling the maximum R-value of 1). In contrast, the same site comparison of the two time periods within each site were non-significant and returned a low level R-values. These pairwise test results suggest clear differences in assemblage structure between upstream and downstream sites, and that each site had a relatively stable community structure through time (Table N-7).

These results suggested downstream community structure in Matahil Creek was consistently altered by wastewater discharge from West Camden WWTP.

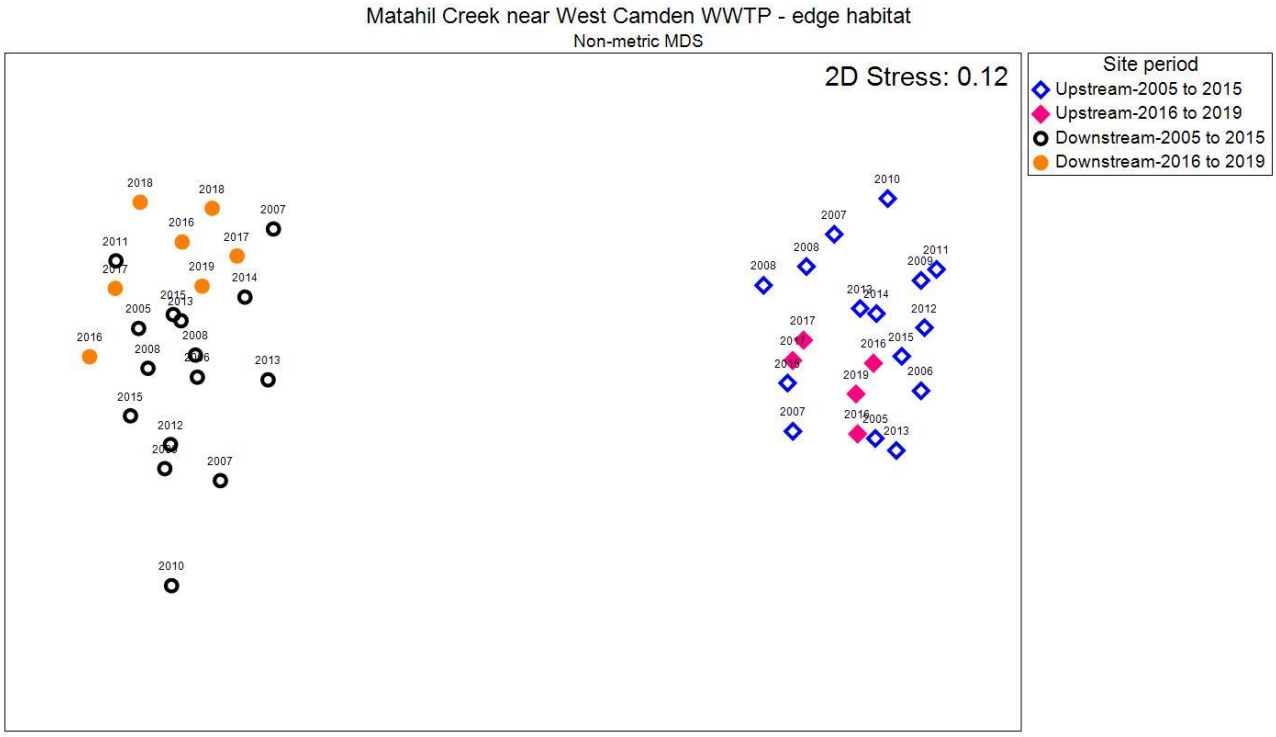


Figure N-4 Two-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of Matahil Creek upstream and downstream sites of West Camden WWTP

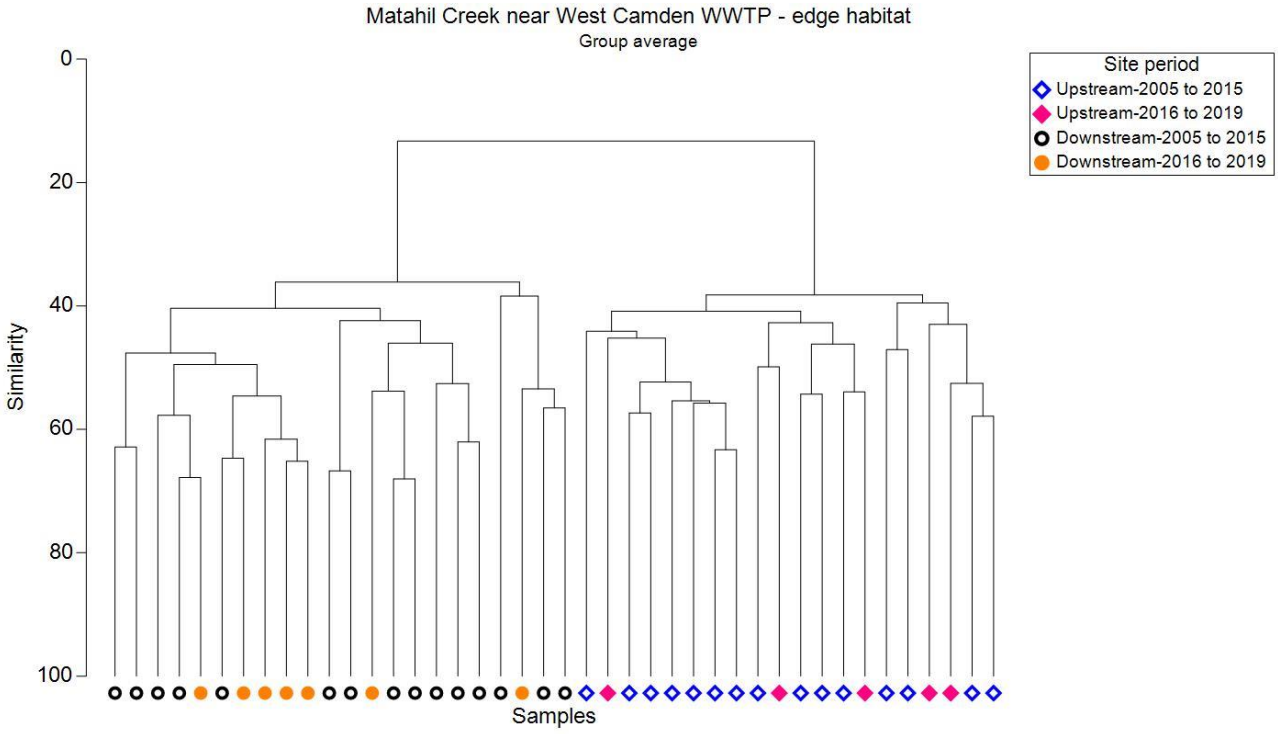


Figure N-5 Tree diagram of freshwater macroinvertebrate edge habitat community structure of Matahil Creek upstream and downstream sites of West Camden WWTP

Table N-4 ANOSIM test of 'Site' factor for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP

Analysis of Similarities
Site levels
Downstream
Upstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.993
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-5 PERMANOVA test of 'Site' and 'Year' factors for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP

Permutational MANOVA
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	15

PERMANOVA table of results

	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	39237	39237	22.584	0.0001	9938
Year	14	26503	1893.1	1.0896	0.2523	9773
SitexYear**	13	20183	1552.5	0.8936	0.7808	9808
Res	13	22586	1737.4			
Total	41	1.1368E+05				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	2104.6	45.876
S(Year)	56.253	7.5002
S(SitexYear)	-130.6	-11.428
V(Res)	1737.4	41.682

Table N-6 PERMDISP test of 'Site' factor for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP

Distance-based test for homogeneity of multivariate dispersions
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999

Number of groups: 2
Number of samples: 42

DEVIATIONS FROM CENTROID
F: 0.027504 df1: 1 df2: 40
P(perm): 0.8765

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Downstream	22	40.113	1.2993
Upstream	20	40.387	0.9812

Table N-7 ANOSIM test of 'Site period' samples for edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP

Analysis of Similarities
Global Test
Sample statistic (R): 0.727
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Downstream-2005 to 2015, Downstream-2016 to 2019	0.044	28	170544	999	279
Downstream-2005 to 2015, Upstream-2005 to 2015	0.997	0.1	77558760	999	0
Downstream-2005 to 2015, Upstream-2016 to 2019	0.995	0.1	15504	999	0
Downstream-2016 to 2019, Upstream-2005 to 2015	0.998	0.1	170544	999	0
Downstream-2016 to 2019, Upstream-2016 to 2019	1	0.1	792	792	1
Upstream-2005 to 2015, Upstream-2016 to 2019	0.105	17.6	15504	999	175

Table N-8 Genera subset whose multivariate pattern matches full genera set of the edge habitat of Matahil Creek upstream and downstream sites of West Camden WWTP

Subset of 15 (correlation 0.953) genera from edge habitat whose pattern matches that of the full set of 97 genera identified with the same subset found on 1 run from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:
Physidae *Physella*,Leptoceridae *Triplectides*,Chironomidae *Cricotopus*,Coenagrionidae *Ischnura*,Chironomidae *Kiefferulus*,Chironomidae *Chironomus*,Dytiscidae *Necterosoma*,Hydrophilidae *Berosus*,Baetidae *Cloeon*,Simuliidae *Simulium*,Tateidae *Potamopyrgus*,Chironomidae *Paralimnophyes*,Scyphacidae *Haloniscus*,Corixidae *Sigara*,Libellulidae *Nannophlebia*.

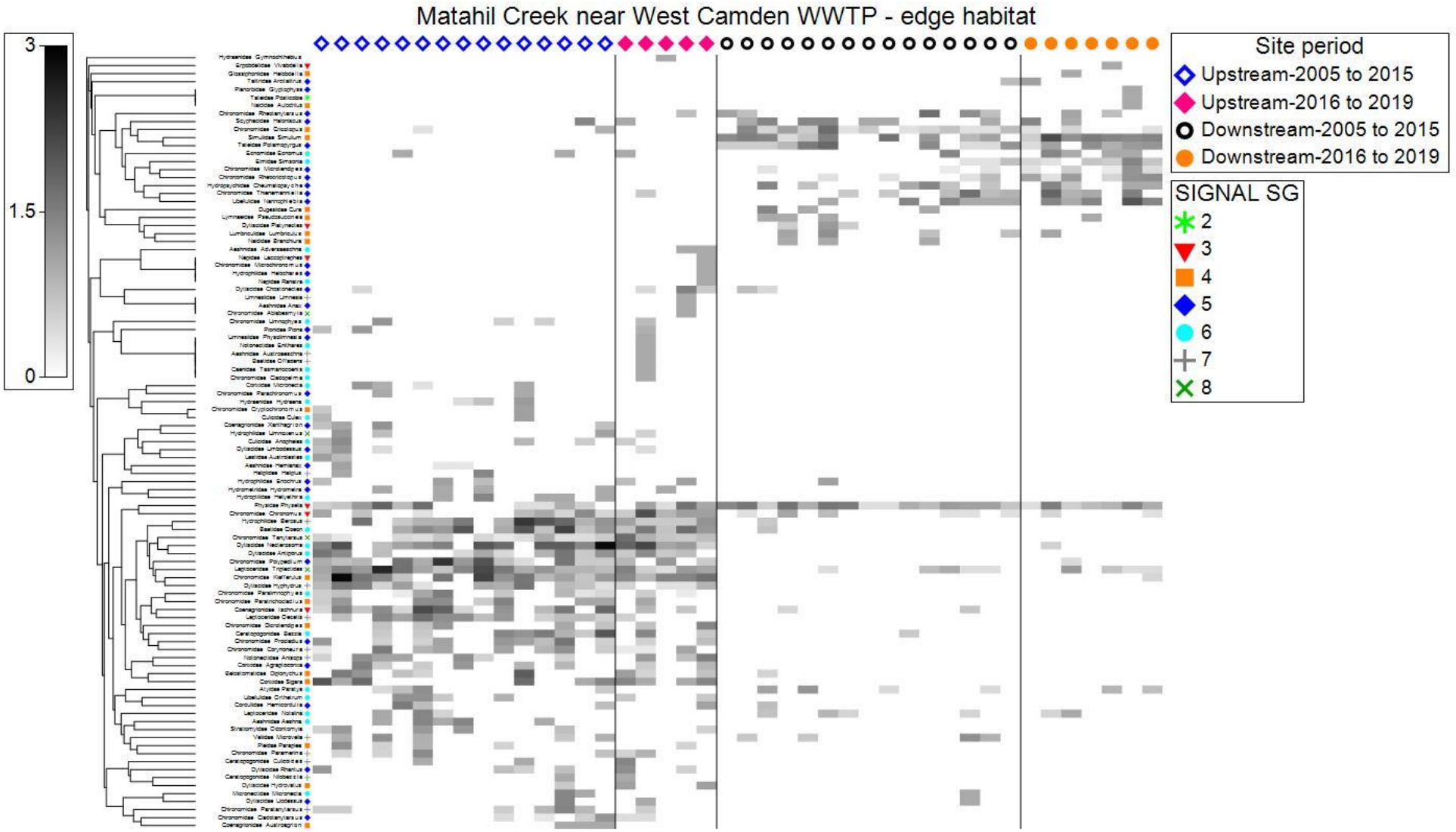


Figure N-6 Shade plot of freshwater macroinvertebrate edge habitat community structure of Matahil Creek upstream and downstream sites of West Camden WWTP

At both upstream and downstream sites on the Nepean-River, edge habitat data was collected consistently enough through time (less sample collection gaps outlined in Volume 1 (Table 3-2) to allow multivariate analysis.

The Nepean River edge habitat data pattern was visually displayed in a three-dimensional nMDS ordination plot, as the two dimensional plot had a poor (stress) value of 0.25. A stress value of that size potentially represents points being placed almost arbitrarily in two dimensional space and suggests that there is no clear pattern of upstream downstream differences in the data. Addition of a third dimension provided a more acceptable stress value of 0.18. Data points were colour coded by Site-time periods (Figure N-7). Addition of a third dimension did not reveal a clear separation of groups of upstream and downstream samples in the corresponding ordination plot (Figure N-7).

The lack of a clear upstream downstream site pattern in the ordination plot was confirmed in the corresponding tree diagram (Figure N-8). Initial separation of samples occurred at a moderate level of similarity (38%) (Figure N-8).

The shade plot of the Nepean River edge habitat lacked a distinct site difference in the taxa pattern as seen for the Matahil Creek sites. Rather a less distinct difference between the 2017 to 2019 and 1995 to 2016 periods was apparent for both sites (Figure N-9). Looking at corresponding SIGNAL-SG grades revealed a mix of mid range grades in both periods for both sites (Figure N-9).

The BVSTEP routine was used to find a subset of taxa whose multivariate pattern matched that of the full dataset with 57 taxa for the edge habitat (Table N-13) out of 145 taxa. This subset of taxa formed the main visual pattern in the respective shade plot (Figure N-9).

The PERMDISP analysis indicated a similar pattern of dispersion (spacing between same site samples) for the two sites (Table N-11). This suggests the variability in taxonomic make-up of samples collected over time was at similar levels for both sites through the period tested (1995 to 2019). This result then also implies subsequent results of ANOSIM tests are focused on community structure differences between sites rather than within.

An ANOSIM test was run on the factor ‘Site’. The returned ANOSIM R-value was almost zero (Table N-9), implying there was a lack of clearly different taxonomic assemblages present at each site, which was in contrast to the distinct community structure differences shown for Matahil Creek.

To further explore community structure, hypothesis testing was conducted using PERMANOVA (Table N-10). This model included the fixed factors ‘Site’ and ‘Year’. ‘Year’ represented samples collected in years between 1995 and 2019 whereas ‘Site’ had two levels, upstream and downstream. A statistically non-significant ‘Site x Year’ interaction was returned (Table N-10). This non-significant result allowed us to view the ‘Site’ and ‘Year’ results. Significant results were returned for ‘Site’ and ‘Year’. The components of variation output indicated ‘Year’ explained approximately nine times the variation than explained by ‘Site’ (Table N-10).

A second run of ANOSIM based on Site-period sample groups returned a significant global R-value at a low level of 0.109 (Table N-12). Pairwise test outputs indicated a temporal change in community structure exhibited at both sites in the ordination plots, although four of the six comparisons were non-significant.

Both SIGNAL-SG and multivariate analysis results suggested downstream community structure in Matahil Creek was consistently altered by wastewater discharge from West Camden WWTP but this impact did not extend as far as the Nepean River.

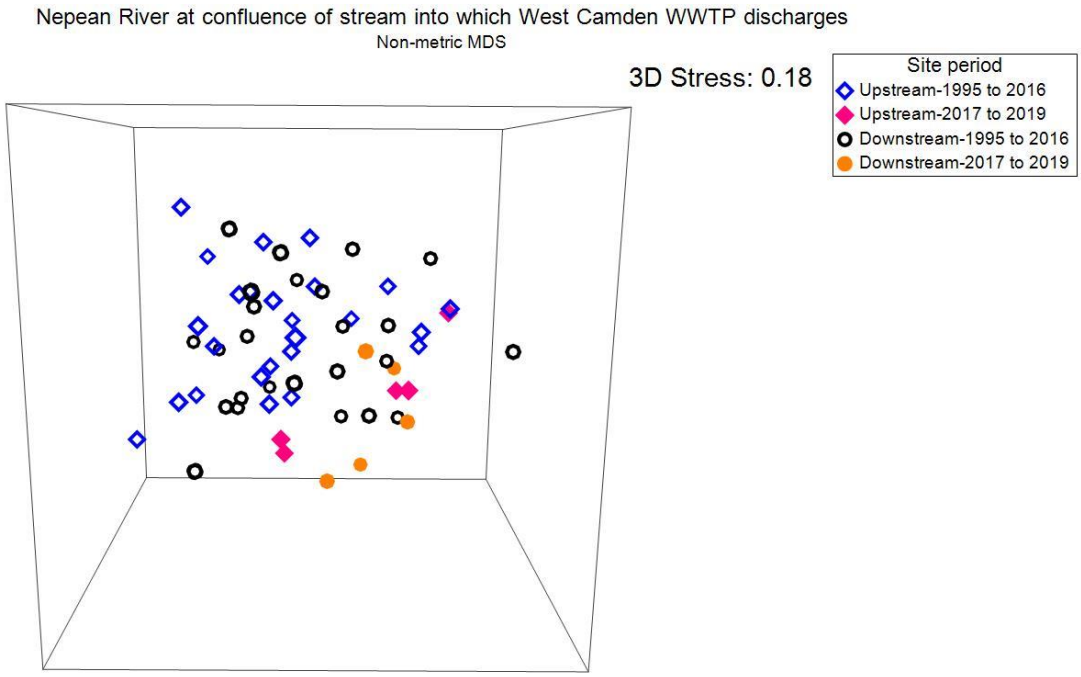


Figure N-7 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

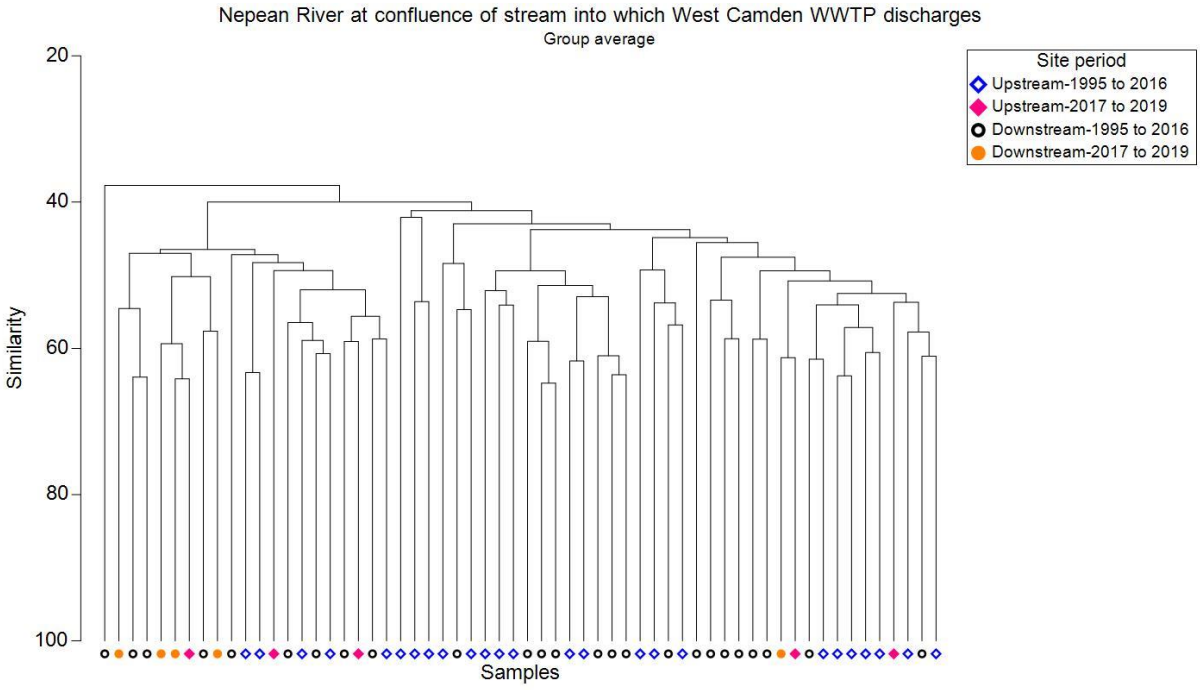


Figure N-8 Tree diagram of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

Table N-9 ANOSIM test of Site for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

Analysis of Similarities
Site levels
Downstream
Upstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.058
Significance level of sample statistic: 2.2%
Number of permutations: 999 (Random sample from a large number)

Table N-10 PERMANOVA test of Site and Year factors for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

Permutational MANOVA
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	17

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	2488	2488	1.882	0.0216	9915
Year	16	42610	2663.1	2.0145	0.0001	9746
SitexYear	16	17254	1078.4	0.81575	0.982	9728
Res	26	34372	1322			
Total	59	97079				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	42.364	6.5088
S(Year)	381.36	19.528
S(SitexYear)	-138.53	-11.77
V(Res)	1322	36.359

Table N-11 PERMDISP test of Site for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

Distance-based test for homogeneity of multivariate dispersions
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999

Number of groups: 2
Number of samples: 60

DEVIATIONS FROM CENTROID
F: 0.0065268 df1: 1 df2: 58
P(perm): 0.9374

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Downstream	30	39.411	0.84048
Upstream	30	39.313	0.86942

Table N-12 ANOSIM test of Site period for edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

Analysis of Similarities
Global Test
Sample statistic (R): 0.109
Significance level of sample statistic: 0.8%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Downstream-1995 to 2016, Downstream-2017 to 2019	0.126	16.1	142506	999	160
Downstream-1995 to 2016, Upstream-1995 to 2016	0.07	2	Very large	999	19
Downstream-1995 to 2016, Upstream-2017 to 2019	0.095	22.8	142506	999	227
Downstream-2017 to 2019, Upstream-1995 to 2016	0.292	1.8	142506	999	17
Downstream-2017 to 2019, Upstream-2017 to 2019	-0.096	73	126	126	92
Upstream-1995 to 2016, Upstream-2017 to 2019	0.167	7.2	142506	999	71

Table N-13 Genera subset whose multivariate pattern matches full genera set of the edge habitat of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

Subset of 57 (correlation 0.950) genera from edge habitat whose pattern matches that of the full set of 145 genera identified with the same subset found on 2 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:
Leptoceridae *Triplectides*, Atyidae *Paratya*, Calamoceratidae *Anisocentropus*, Corixidae *Micronecta*, Chironomidae *Polypedilum*, Leptoceridae *Oecetis*, Unionicolidae *Recifella*, Chironomidae *Procladius*, Leptoceridae *Notalina*, Hydrodromidae *Hydrodroma*, Physidae *Physella*, Hydrophilidae *Berosus*, Isostictidae *Rhadinosticta*, Caenidae *Tasmanocoenis*, Oxidae *Oxus*, Unionicolidae *Koenikea*, Aturidae *Albia*, Baetidae *Cloeon*, Mideopsidae *Gretacarus*, Ceratopogonidae *Bezzia*, Dytiscidae *Necterosoma*, Chironomidae *Tanytarsus*, Coenagrionidae *Ischnura*, Dugesiidae *Cura*, Limnesiidae *Limnesia*, Veliidae *Microvelia*, Chironomidae *Cladotanytarsus*, Chironomidae *Cricotopus*, Corbiculidae *Corbicula*, Dytiscidae *Sternopriscus*, Chironomidae *Parakiefferiella*, Gomphidae *Austrogomphus*, Chironomidae *Cryptochironomus*, Elmidae *Coxelmis*, Elmidae *Ovolara*, Hydrophilidae *Helochares*, Chironomidae *Ablabesmyia*, Chironomidae *Corynoneura*, Glossiphoniidae *Helobdella*, Stratiomyidae *Odontomyia*, Chironomidae *Larsia*, Elmidae *Austrolimnius*, Libellulidae *Diplacodes*, Pleidae *Paraplea*, Chironomidae *Chironomus*, Ceratopogonidae *Monohelea*, Chironomidae *Skusella*, Dytiscidae *Antiporus*, Dytiscidae *Hyphydrus*, Hygrobatidae *Coaustraliobates,* Oxidae *Frontipoda*, Micronectidae *Micronecta*, Elmidae *Simsonia*, Oxidae *Flabellifrontipoda,* Chironomidae *Paratanytarsus*, Aturidae *Wheenyella*, Limnesiidae *Physolimnesia*.

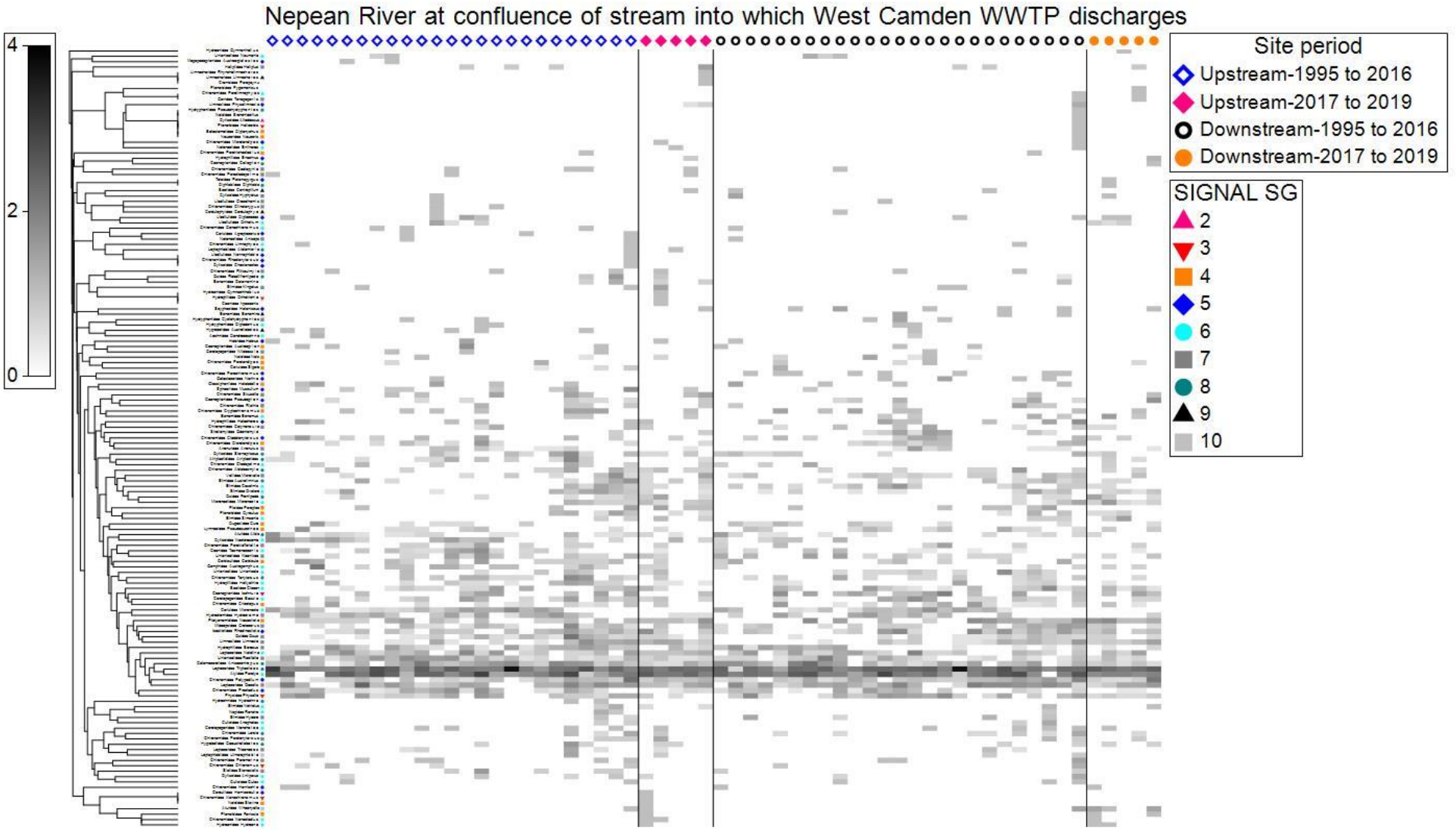


Figure N-9 Shade plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Nepean River at the confluence of Matahil Creek into which West Camden WWTP discharges

Stream health near Wallacia WWTP

The SIGNAL-SG plot for the Warragamba River provided an assessment of stream health. This plot was based upon macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 2008 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site indicating wastewater discharge from Wallacia WWTP did not have a measurable impact on stream health during 2018-19 (Figure N-10).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a non-significant test outcome (Figure N-10) and confirmed the visual trend.

As no measurable impact on downstream stream health was detected, no further data analysis was undertaken.

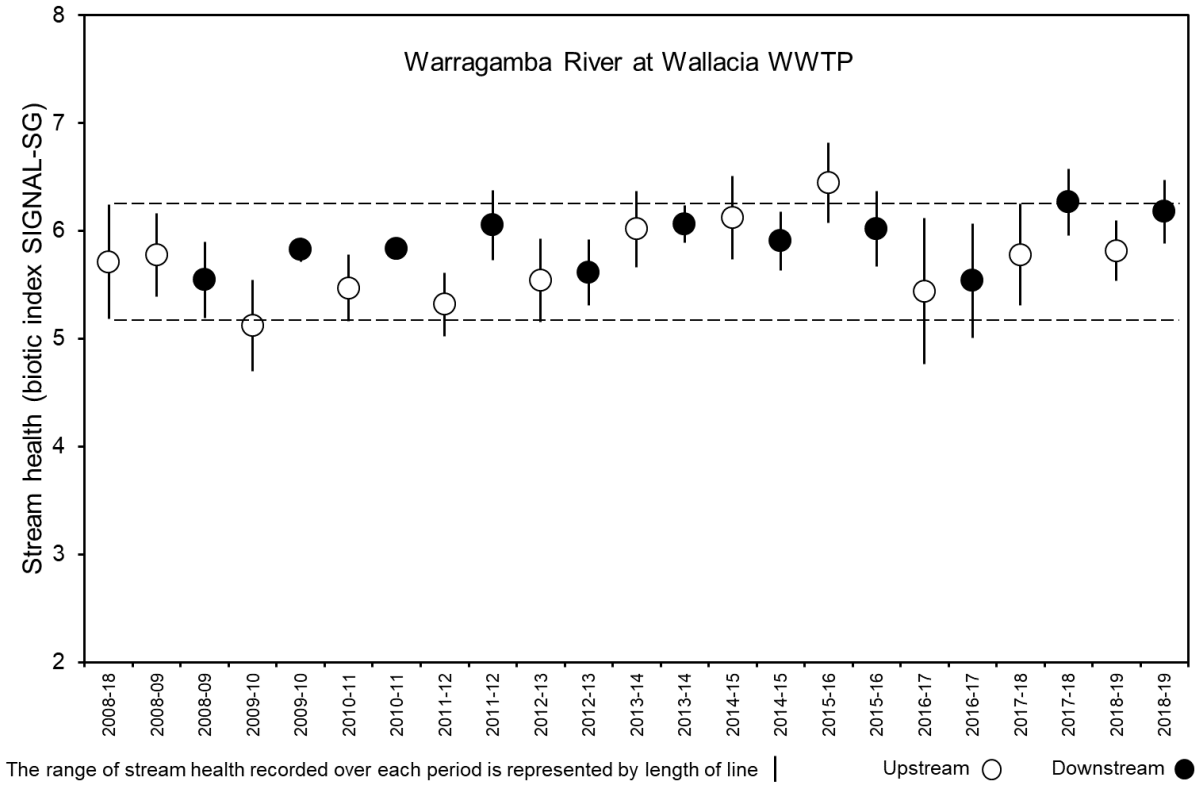


Figure N-10 Stream health of Warragamba River near Wallacia WWTP

Table N-14 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Warragamba River near Wallacia WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	1.70	0.1195

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	2.46	0.3450

Stream health near Penrith WWTP

The SIGNAL-SG plots provided assessments of stream health for both Boundary Creek near Penrith WWTP and the Nepean River upstream-downstream of the confluence with Boundary Creek. These plots were based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 2003 to 2018 for the Boundary Creek sites and 1995 to 2018 for the Nepean River sites. These visual comparisons suggest downstream stream health was maintained at least at a level comparable to that of the upstream site indicating that the wastewater discharge from the Penrith WWTP did not have a measurable negative impact on stream health of either Boundary Creek (Figure N-11) or the Nepean River during 2018-19 (Figure N-12).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under t-tests returned a non-significant test outcome for the Nepean River comparison (Figure N-12) as well as the Boundary Creek comparison (Table N-15). Visually, downstream Boundary Creek reflected improved stream health, which has been previously documented in Volume 2 of the 2014 STSIMP case study 'Assessing the impact of the St Marys Water Recycling Initiative on the Hawkesbury Nepean River'. This improvement is evident in the SIGNAL-SG plot for Boundary Creek (Figure N-11).

As no measurable negative impact on downstream stream health was detected on either Boundary Creek or the Nepean River, no further data analysis was undertaken.

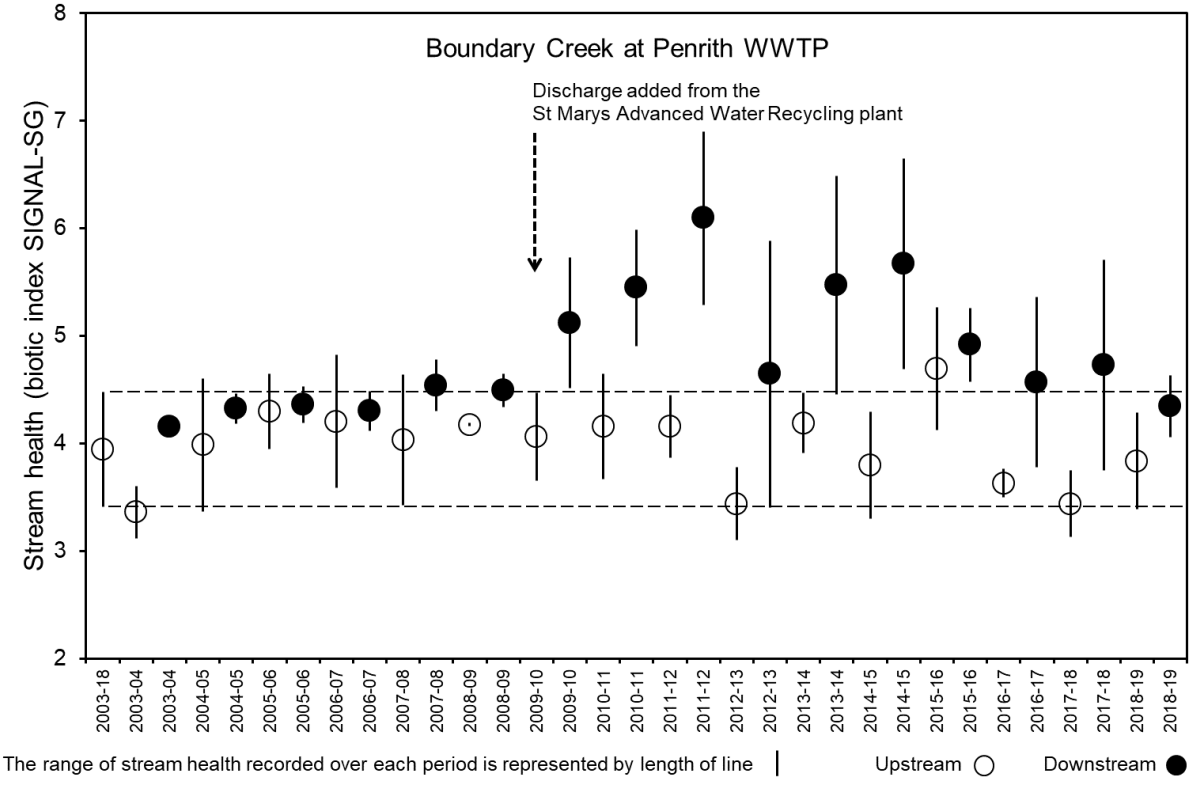


Figure N-11 Stream health of Boundary Creek near Penrith WWTP

Table N-15 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Boundary Creek near Penrith WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	2.33	0.0418

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	5	5	2.40	0.3593

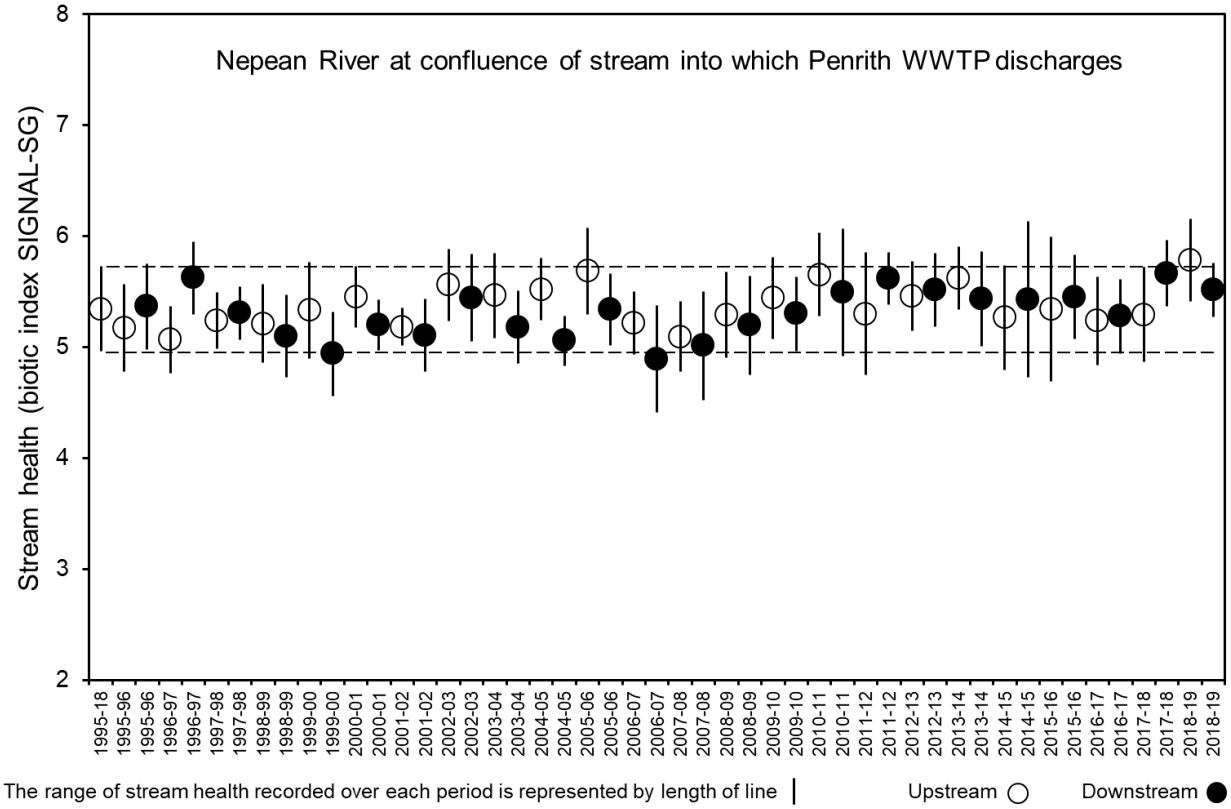


Figure N-12 Stream health of the Nepean River upstream-downstream of the confluence of Boundary Creek near Penrith WWTP

Table N-16 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Nepean River near Penrith WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	-1.50	0.1633

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	5	5	2.34	0.3718

Stream health and community structure of the unnamed creek and the Nepean River near Winmalee WWTP

The SIGNAL-SG plots provided assessments of stream health for both the unnamed creek near Winmalee WWTP and in the Nepean River situated upstream-downstream of the confluence with the unnamed creek. These plots were based upon macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 2004 to 2018 for the unnamed creek and 1995 to 2018 for the Nepean River. These visual comparisons suggest downstream stream health was maintained in the Nepean River (Figure N-14) but a persistent localised impact in stream health was indicated for the unnamed creek (Figure N-13).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under t-tests returned a non-significant test outcome for the Nepean River comparison (Table N-18) while a significant test outcome was returned for the unnamed creek comparison of both downstream sites

As a measurable localised negative impact on downstream stream health in the unnamed creek was detected, further data analysis was undertaken.

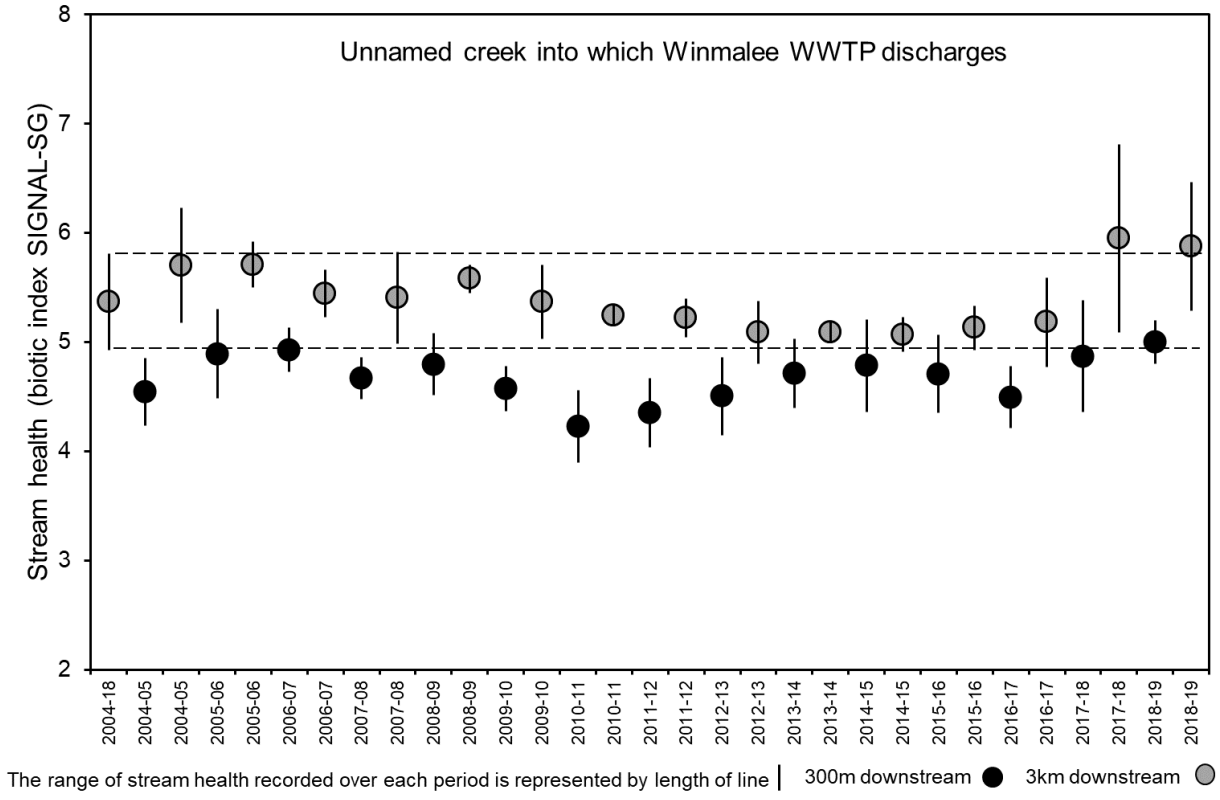


Figure N-13 Stream health of unnamed creek below Winmalee WWTP for two downstream sites

Table N-17 t-test of both downstream site SIGNAL-SG scores from 2018-19 for unnamed creek below Winmalee WWTP

Method	Variances	DF	t Value	Pr > |t|
Satterthwaite	Unequal	6.1273	3.44	0.0133

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	5	5	8.76	0.0326

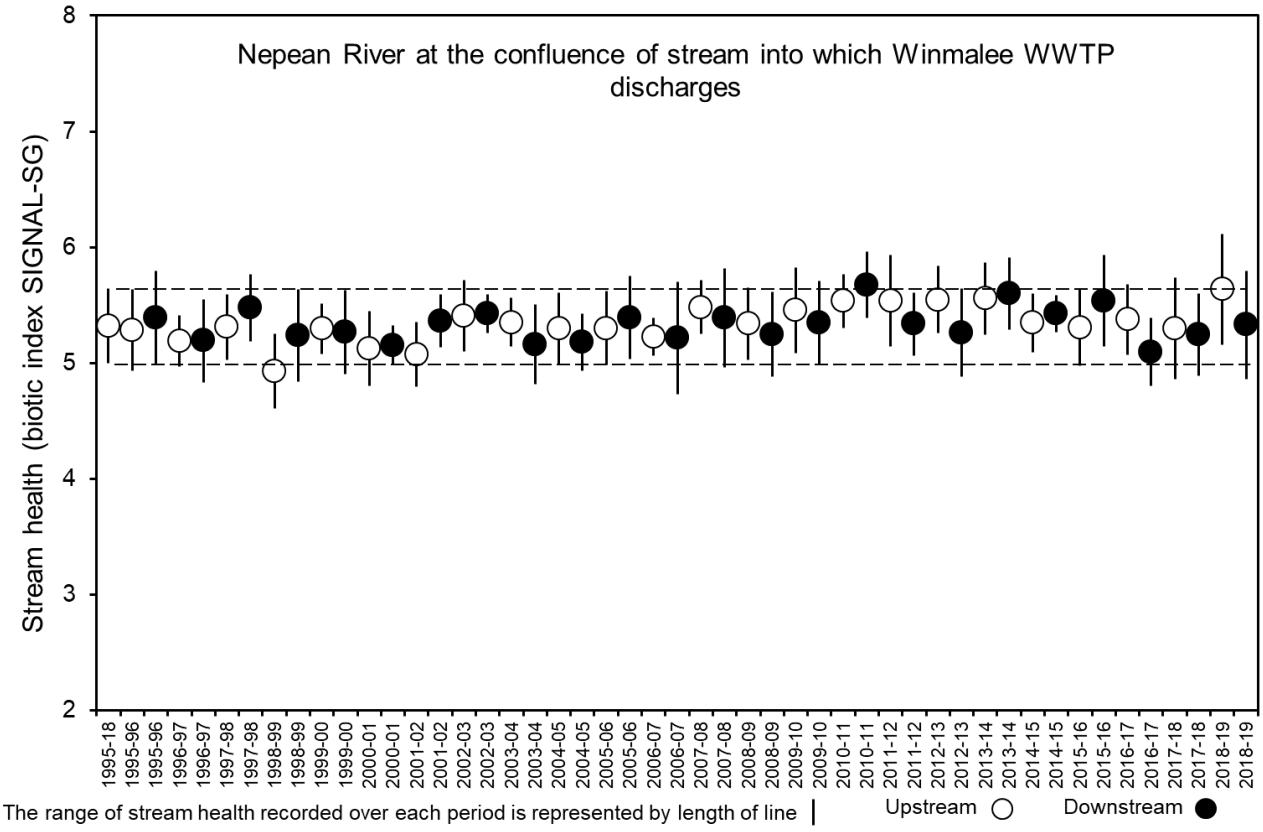


Figure N-14 Stream health of the Nepean River near Winmalee WWTP

Table N-18 t-test of upstream-downstream SIGNAL-SG scores from 2018-19 for the Nepean River near Winmalee WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	14	-1.29	0.2185

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	8	6	1.01	1.0000

Winmalee - unnamed creek

As the unnamed creek has no flow upstream of Winmalee WWTP under dry weather conditions, both sampling sites were situated downstream of the WWTP. The first site is located 0.3 km downstream of the WWTP, while the second downstream site is situated 3 km downstream of the WWTP in a natural bushland catchment that lacks other anthropogenic influences. Both edge and riffle habitat data were collected consistently at both downstream sites on the same sampling occasions to allow multivariate analysis for the monitoring period of 2004 to 2019. Samples from each habitat were analysed separately.

Distinct groups of samples were evident in the three-dimensional ordination plot of edge habitat of the unnamed creek (Figure N-15). The n-MDS ordination pattern was confirmed in the corresponding tree diagram (Figure N-17) from classification analysis where the first and second divisions separated the 2018 to 2019 period samples, whereas the fourth division separated most 0.3 km downstream samples from most 3 km downstream samples (Figure N-17). Despite not showing the early separation between time periods, the riffle habitat showed a similar split between sites at around the fourth separation level in the corresponding tree diagram (Figure N-18) and two-dimensional ordination plot (Figure N-16).

The corresponding shade plots (Figure N-19 and Figure N-20) both displayed the tolerant taxon the Blackfly larvae Simulium (SIGNAL-SG grade 4) as persistent through time and consistently abundant at the site 0.3 km downstream of the WWTP in both habitats. This taxa was absent on most collection occasions or occurred in much lower numbers at the 3 km downstream site. These shade plots illustrated that higher graded SIGNAL-SG taxa such as the non-biting midge larvae Chironomidae Parametriocnemis and Chironomidae Paratanytarsus were more consistently collected from the site 3 km downstream, suggesting recovery in water quality with distance from the WWTP.

The BVSTEP routine was used to find a subset of taxa whose multivariate pattern matched that of the full dataset with 24 taxa (out of 87) identified for the edge habitat (Table N-27) and 18 taxa (out of 44) for the riffle habitat (Table N-28). These subsets of taxa form the main visual patterns in the respective shade plots Figure N-19 and Figure N-20).

The PERMDISP analysis indicated a non-significant patterns of dispersion (spacing between same site samples) for the edge (Table N-23) and riffle (Figure N-24) habitats. These results imply results of ANOSIM tests are focused on community structure differences between rather than within sites.

An ANOSIM test was run on the factor ‘Site’. The returned ANOSIM R-values were at mid-range levels (Table N-19) and (Table N-20), implying both downstream sites assemblage structures were distinguishable for both habitats.

To further explore the community structure, hypothesis testing was conducted with a PERMANOVA model. This model comprised the fixed factors ‘Site’ and ‘Year’. ‘Year’ represented samples collected in years between 2004 and 2019 and ‘Site’ having two levels, 0.3 km downstream and 3 km downstream. A statistically non-significant ‘Site x Year’ interaction was returned for the riffle habitat (Table N-22). This non-significant result allowed us to view the ‘Site’ and ‘Year’ results. Statistically significant results were returned for ‘Year’ and ‘Site’ factors. The estimates of components of variation indicated ‘Site’ explained approximately five times the

variation than that explained by 'Year' (Table N-22). A statistically significant 'Site x Year' interaction was returned for the edge habitat (Table N-21) suggesting less stability in edge habitat assemblages through time at both sites.

A second run of ANOSIM based on 'Site-period' groups displayed in ordination plots Figure N-15 and Figure N-16 returned a significant global mid-range R-value of 0.686 for the edge habitat. In the resulting pairwise comparisons, four tests returned R-values at a level (R = 0.998, 0.933, 0.922 and 0.876, Table N-25) that can be expected from natural differences between groups from variation in the substratum composition of the habitats between sites.. Besley and Chessman (2008) found R-values up to 0.66 for sites on the same near-pristine stream. A lower mid-range global R-value of 0.419 was returned for the riffle habitat. Corresponding pairwise tests for the riffle habitat returned R-values (Table N-26) at a level that suggest natural substratum differences between sites with all R-values below 0.66.

These multivariate analysis results suggested community structure alteration from wastewater discharge in the unnamed creek was most evident in macroinvertebrate assemblages within the edge habitat.

Winmalee – Nepean River

Sufficient macrophyte and edge habitat data were collected consistently enough at upstream-downstream sites on the same sampling occasions to allow multivariate analysis for the monitoring period of 2004 to 2019 (less sample collection gaps outlined in Volume 1 Table 3-2). Samples from each habitat were analysed separately.

The Nepean River macrophyte habitat data pattern was visually displayed in a two-dimensional nMDS ordination plot while the edge habitat data had more inherent variation which required a three-dimension ordination plot to achieve an acceptable level of fit (stress). Data points were colour coded by 'Site period' with two periods 2004 to 2016 and 2017 to 2019. There was no clear separation of groups of upstream and downstream samples in either of the ordination plots (Figure N-21 and Figure N-22). Rather a mix of upstream and downstream samples was observed, with most recent samples intermingling with past samples.

The lack of a clear pattern between sites in the ordination plots (Figure N-21 and Figure N-22) was also apparent in the corresponding tree diagrams (Figure N-23 and Figure N-24) and shade plots (Figure N-25 and Figure N-26) suggesting communities between sites were similar. Subsets of taxa defining the multivariate pattern are listed in Table N-37 and Table N-38.

The PERMDISP analysis indicated a higher pattern of dispersion (spacing between same site samples) for the upstream-downstream sites for the macrophyte habitat (Table N-33) compared to the edge (Table N-34) habitat however both were non-significant. This implies results of ANOSIM tests are focused on community structure differences between upstream-downstream sites.

An ANOSIM test was run on the factor 'Site'. The returned ANOSIM R-values were at very low levels (Table N-29 and Table N-30) implying the assemblage structure of sites were almost indistinguishable.

To further explore community structure, hypothesis testing was conducted with a PERMANOVA model. This model comprised the fixed factors 'Site' and 'Year' with 'Year' representing samples collected in years between 2004 and 2019 and 'Site' having two levels, upstream and downstream.

For the macrophyte habitat a statistically non-significant ‘Site x Year’ interaction was returned (Table N-31). This non-significant result allowed us to view the ‘Site’ and ‘Year’ results. Significant results were returned for ‘Site’ and ‘Year’ factors. Inspecting estimates of components of variation output indicated that ‘Year’ explained four times the variation than that explained by ‘Site’ (Table N-31). For the edge habitat, a statistically non-significant ‘Site x Year’ interaction was returned (Table N-32). Both ‘Site’ and ‘Year’ factors resulted in significant results. Inspecting estimates of components of variation output indicated ‘Year’ explained more than twice the variation than that explained by ‘Site’ (Table N-32).

A second run of ANOSIM based on ‘Site-period’ samples displayed in ordination plots (Figure N-21 and Figure N-22) returned a non-significant global R-value for the macrophyte habitat and for the edge habitat a significant global R-value of 0.139, but this was relatively low (Table N-35). Inspection of pairwise tests for the edge habitat indicated four of the six comparisons were non-significant and the only significant test had a low-range R-value of 0.106 (Table N-36).

These results suggested community structure in the unnamed creek near the WWTP was altered by wastewater discharge from Winmalee WWTP but this impact did not extend as far as the Nepean River.

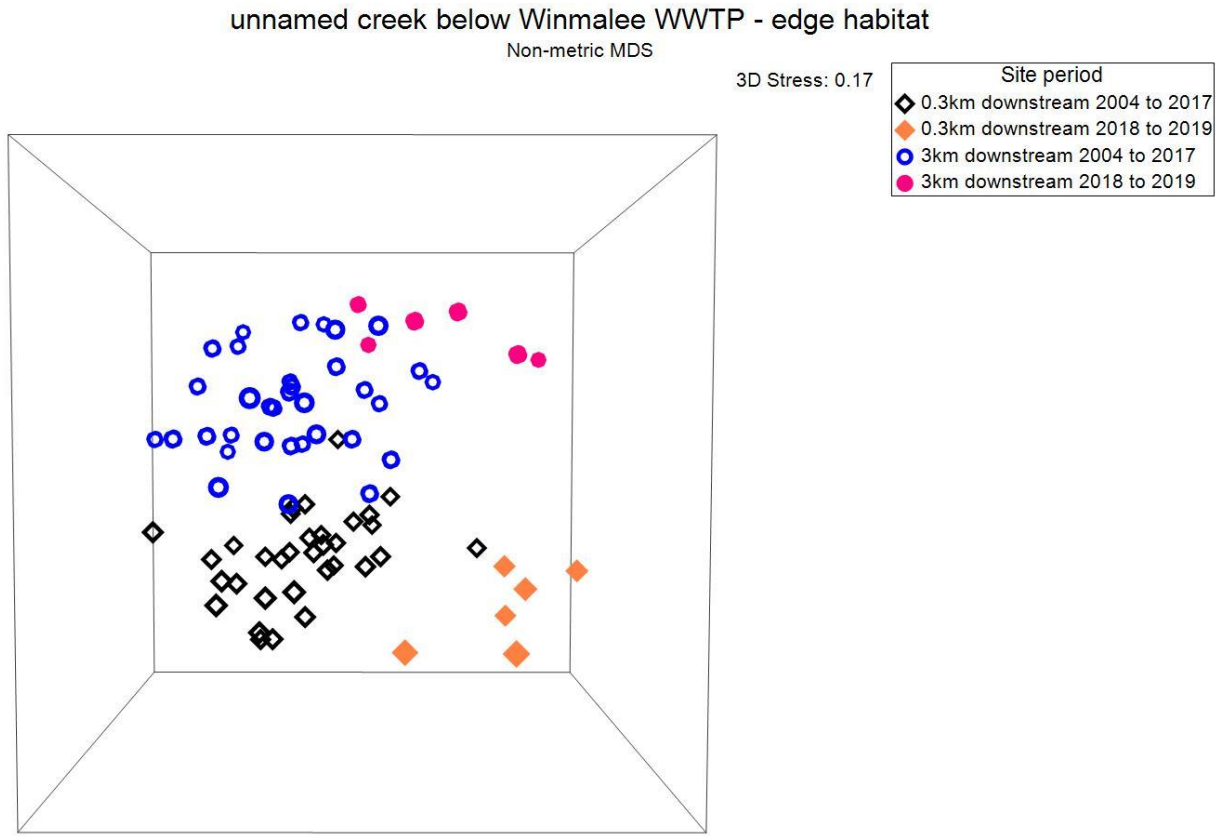


Figure N-15 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP

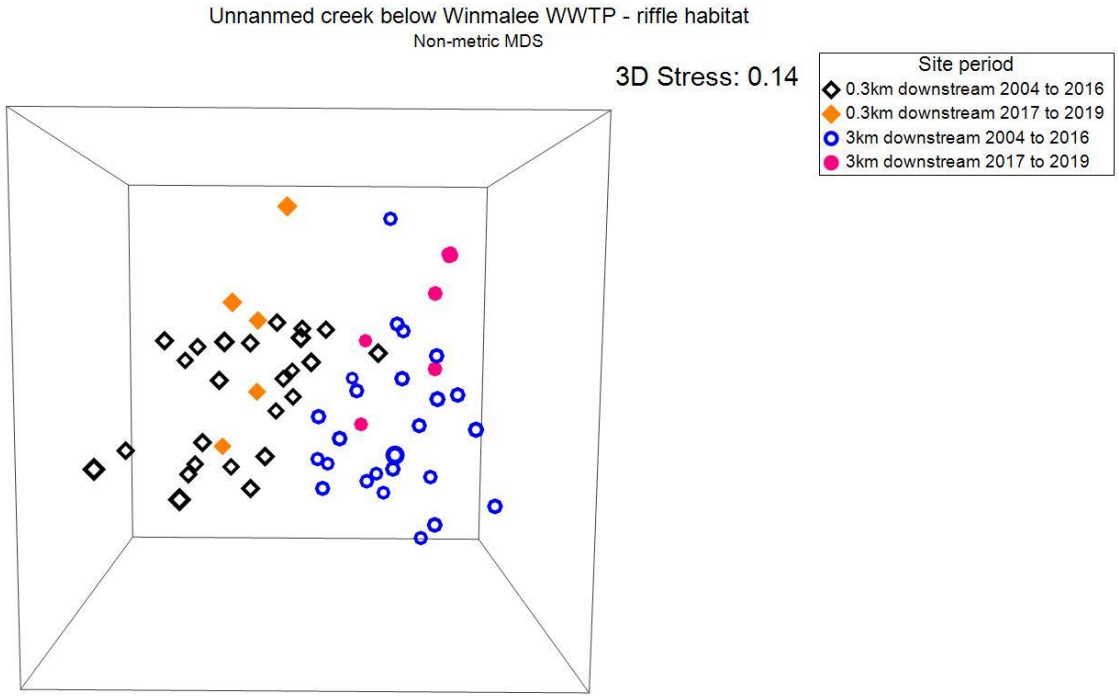


Figure N-16 Three-dimensional ordination plot of freshwater macroinvertebrate riffle habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP

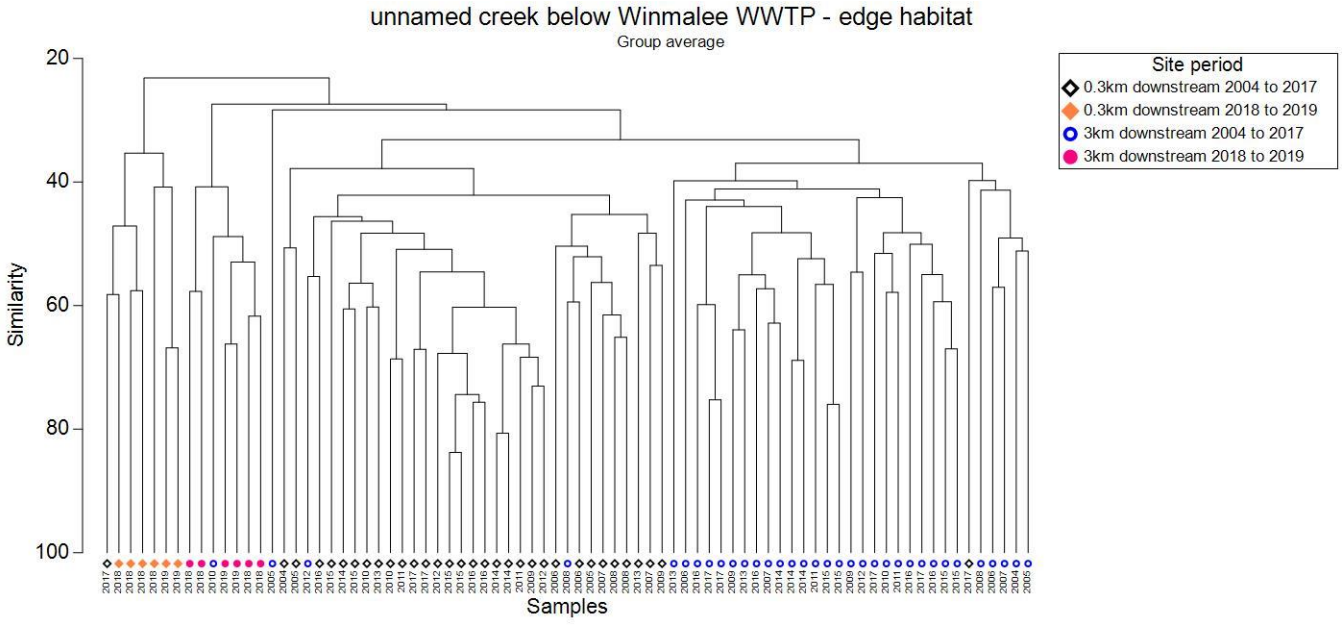


Figure N-17 Tree diagram of freshwater macroinvertebrate edge habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP

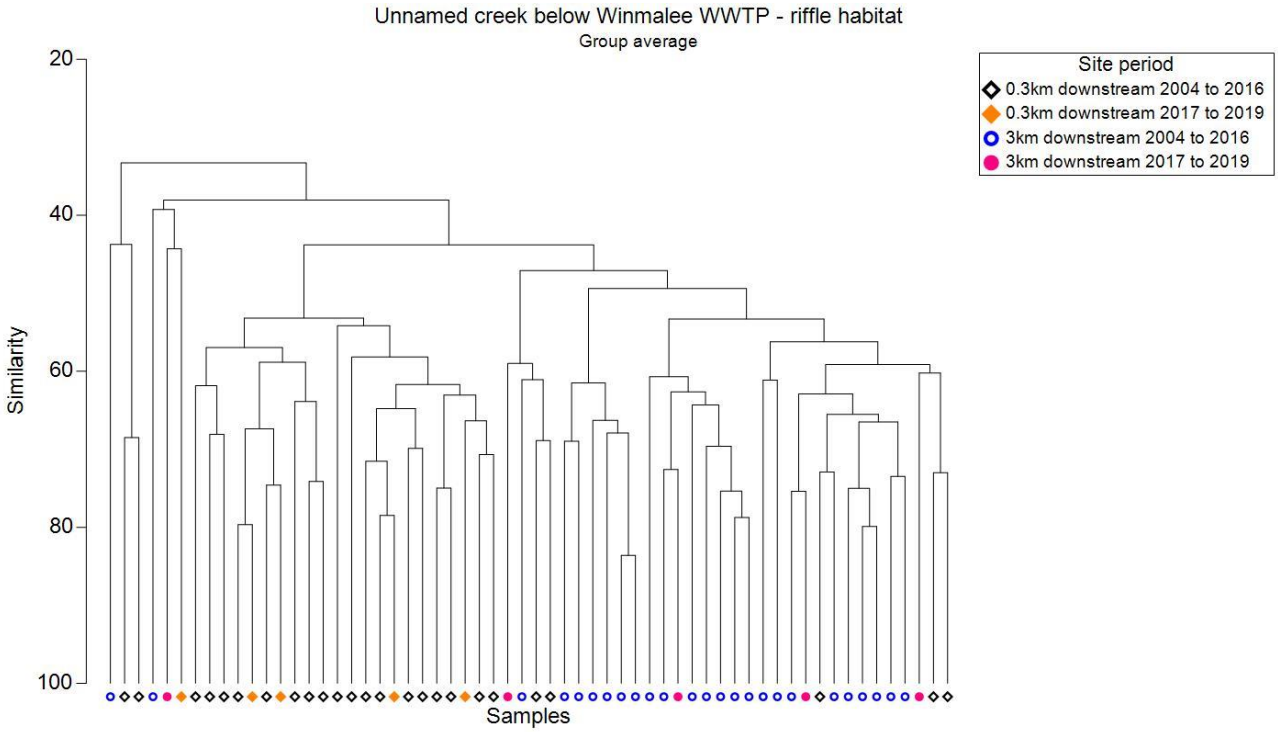


Figure N-18 Tree diagram of freshwater macroinvertebrate riffle habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP

Table N-19 ANOSIM test of 'Site' factor for edge habitat unnamed creek near Winmalee WWTP

Analysis of Similarities

Site levels
3km downstream
0.3km downstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.485
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-20 ANOSIM test of 'Site' factor for riffle habitat unnamed creek below Winmalee WWTP

WWTP
Analysis of Similarities

Site levels
0.3km downstream
3km downstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.483
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-21 PERMANOVA test of 'Site' and 'Year' factors for edge habitat unnamed creek below Winmalee WWTP

Permutational MANOVA

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	16

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	22713	22713	17.884	0.0001	9934
Year	15	55540	3702.7	2.9155	0.0001	9756
SitexYear	15	31272	2084.8	1.6416	0.0001	9741
Res	47	59690	1270			
Total	78	1.7369E+05				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	617.73	24.854
S(Year)	497.88	22.313
S(SitexYear)	333.52	18.263
V(Res)	1270	35.637

Table N-22 PERMANOVA test of 'Site' and 'Year' factors for riffle habitat unnamed creek below Winmalee WWTP

Permutational MANOVA

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	16

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	18241	18241	15.965	0.001	999
Year	15	23647	1576.5	1.3798	0.019	996
SitexYear*	14	12741	910.05	0.79651	0.926	999
Res	29	33134	1142.5			
Total	59	88360				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	620.62	24.912
S(Year)	118.09	10.867
S(SitexYear)	-122.54	-11.07
V(Res)	1142.5	33.801

Table N-23 PERMDISP test of 'Site' factor for edge habitat unnamed creek below Winmalee WWTP

Distance-based test for homogeneity of multivariate dispersions

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999
Number of groups: 2
Number of samples: 79

DEVIATIONS FROM CENTROID
F: 0.59172 df1: 1 df2: 77
P(perm): 0.4901

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
3km downstream	40	43.032	1.0735
0.3km downstream	39	41.651	1.4463

Table N-24 PERMDISP test of 'Site' factor for riffle habitat unnamed creek below Winmalee WWTP

Distance-based test for homogeneity of multivariate dispersions

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999
Number of groups: 2
Number of samples: 60

DEVIATIONS FROM CENTROID
F: 0.028391 df1: 1 df2: 58
P(perm): 0.8729

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
0.3km downstream	30	33.304	1.3746
3km downstream	30	33.618	1.2609

Table N-25 ANOSIM test of 'Site period' samples for edge habitat unnamed creek below Winmalee WWTP

Analysis of Similarities

Global Test
Sample statistic (R): 0.686
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
3km downstream 2004 to 2017, 3km downstream 2018 to 2019	0.517	0.1	3838380	999	0
3km downstream 2004 to 2017, 0.3km downstream 2004 to 2017	0.581	0.1	Very large	999	0
3km downstream 2004 to 2017, 0.3km downstream 2018 to 2019	0.922	0.1	3838380	999	0
3km downstream 2018 to 2019, 0.3km downstream 2004 to 2017	0.933	0.1	3262623	999	0
3km downstream 2018 to 2019, 0.3km downstream 2018 to 2019	0.998	0.2	462	462	1
0.3km downstream 2004 to 2017, 0.3km downstream 2018 to 2019	0.876	0.1	3262623	999	0

Table N-26 ANOSIM test of 'Site period' samples for riffle habitat unnamed creek below Winmalee WWTP

Analysis of Similarities

Global Test
Sample statistic (R): 0.419
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
0.3km downstream 2004 to 2016, 0.3km downstream 2017 to 2019	0.039	36.1	142506	999	360
0.3km downstream 2004 to 2016, 3km downstream 2004 to 2016	0.483	0.1	Very large	999	0
0.3km downstream 2004 to 2016, 3km downstream 2017 to 2019	0.531	0.3	142506	999	2
0.3km downstream 2017 to 2019, 3km downstream 2004 to 2016	0.609	0.1	142506	999	0
0.3km downstream 2017 to 2019, 3km downstream 2017 to 2019	0.516	0.8	126	126	1
3km downstream 2004 to 2016, 3km downstream 2017 to 2019	0.161	11.6	142506	999	115

Table N-27 Genera subset whose multivariate pattern matches full genera set of the edge habitat unnamed creek below Winmalee WWTP

Subset of 24 (correlation 0.952) genera from edge habitat whose pattern matches that of the full set of 87 genera identified with the same subset found on 41 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:
Coenagrionidae *Ischnura*, Physidae *Physella*, Chironomidae *Cricotopus*, Dugesiidae *Cura*, Lumbriculidae *Lumbriculus*, Simuliidae *Simulium*, Chironomidae *Microtendipes*, Chironomidae *Polypedilum*, Chironomidae *Rheocricotopus*, Chironomidae *Rheotanytarsus*, Chironomidae *Thienemanniella*, Hydropsychidae *Cheumatopsyche*, Libellulidae *Nannophlebia*, Scyphacidae *Haloniscus*, Talitridae *Arcitalitrus*, Tateidae *Potamopyrgus*, Atyidae *Paratya*, Elmidae *Notriolus*, Elmidae *Simsonia*, Leptoceridae *Notalina*, Micronectidae *Micronecta*, Aeshnidae *Austroaeschna*, Veliidae *Microvelia*, Leptoceridae *Triplectides*.

Table N-28 Genera subset whose multivariate pattern matches full genera set of the riffle habitat unnamed creek below Winmalee WWTP

Subset of 18 (correlation 0.955) genera from riffle habitat whose pattern matches that of the full set of 44 genera identified with the same subset found on 8 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:
Elmidae *Simsonia*, Chironomidae *Cricotopus*, Hydropsychidae *Cheumatopsyche*, Chironomidae *Rheotanytarsus*, Simuliidae *Simulium*, Elmidae *Notriolus*, Aeshnidae *Austroaeschna*, Chironomidae *Polypedilum*, Chironomidae *Eukiefferiella*, Chironomidae *Rheocricotopus*, Physidae *Physella,* Chironomidae *Cardiocladius*, Chironomidae *Thienemanniella*, Chironomidae *Parametriocnemus*, Dugesiidae *Cura*, Naididae *Nais*, Scyphacidae *Haloniscus*, Chironomidae *Microtendipes*.

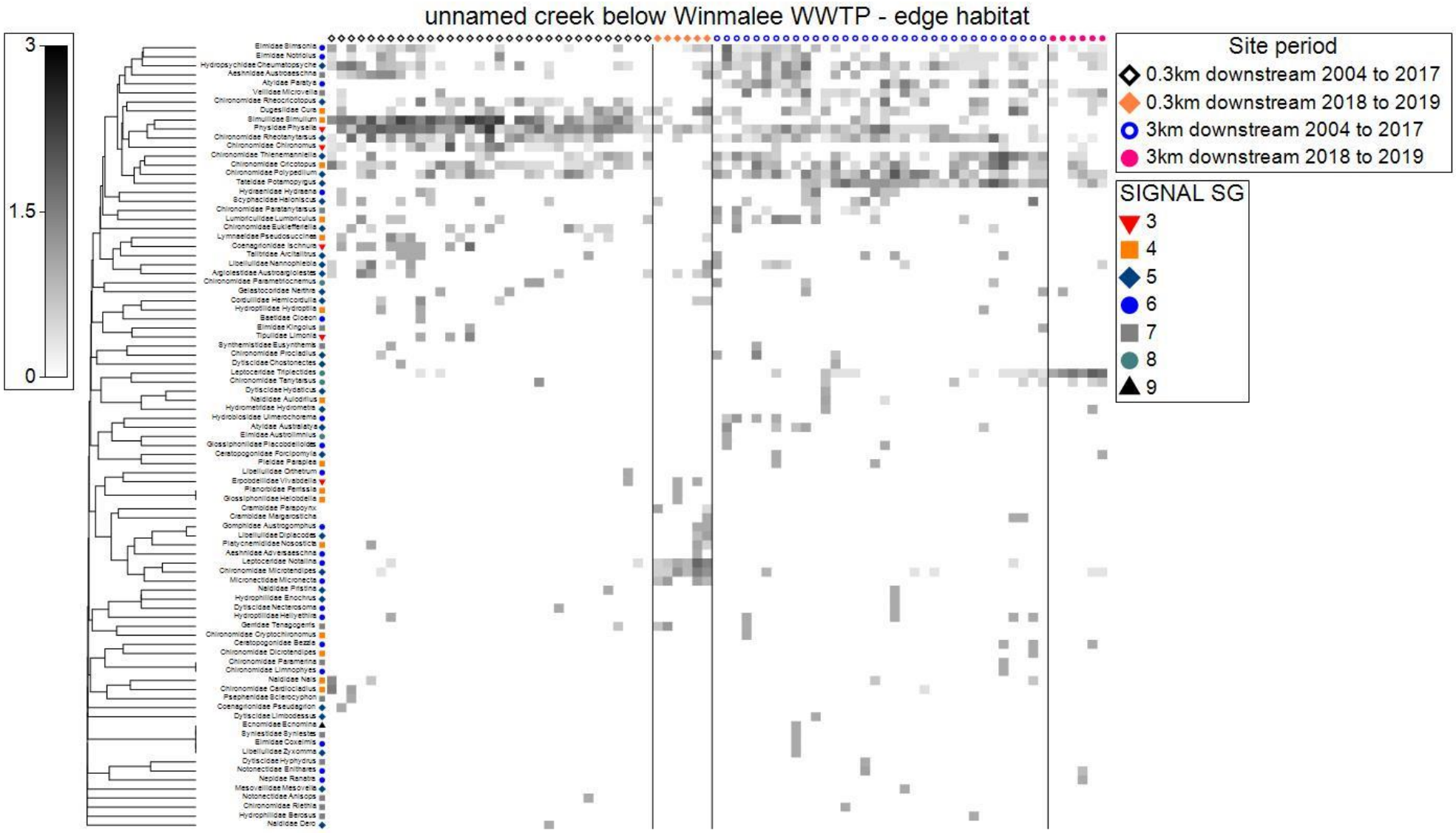


Figure N-19 Shade plot of freshwater macroinvertebrate edge habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP

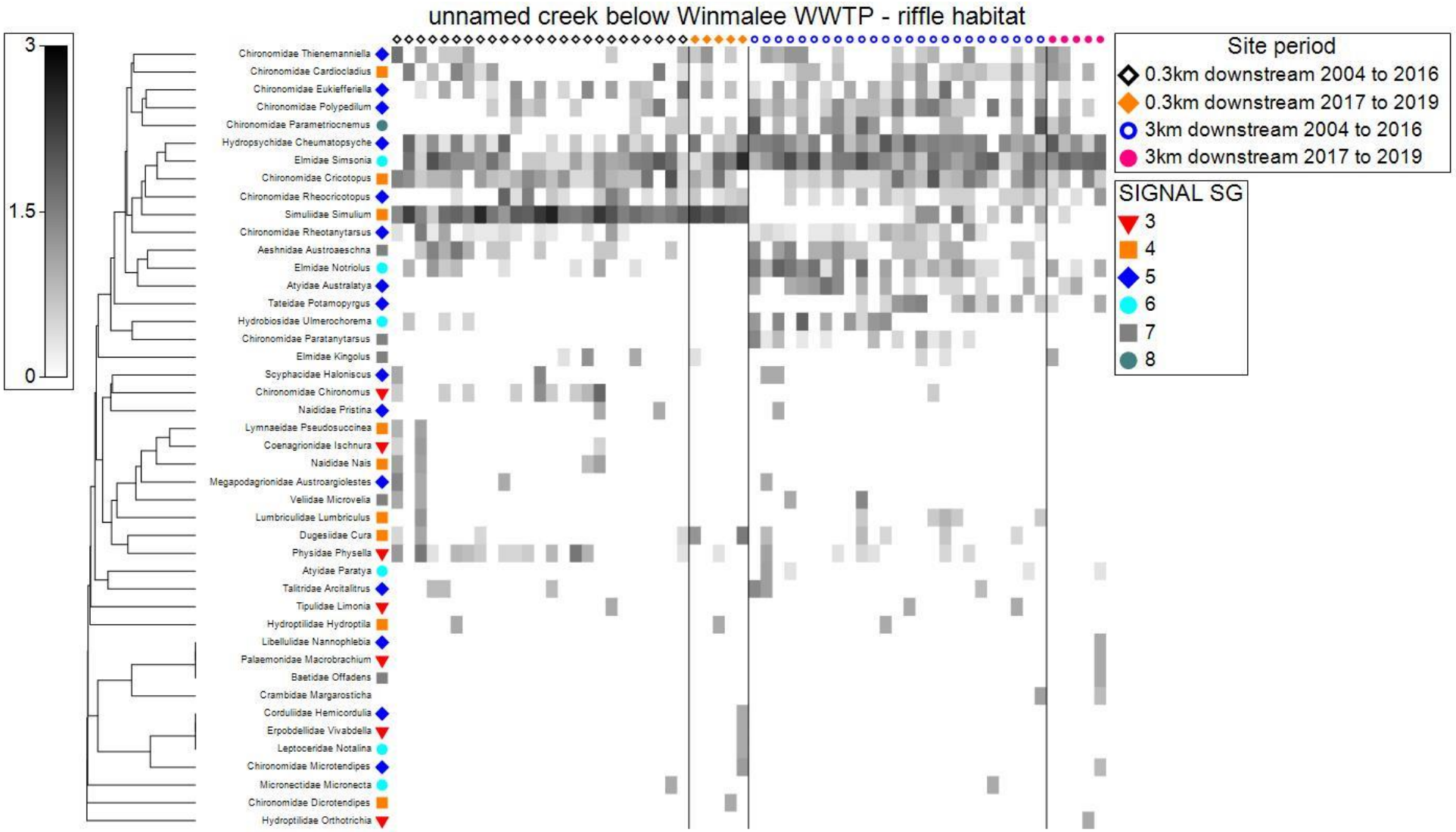


Figure N-20 Shade plot of freshwater macroinvertebrate riffle habitat community structure of both downstream sites of unnamed creek below Winmalee WWTP

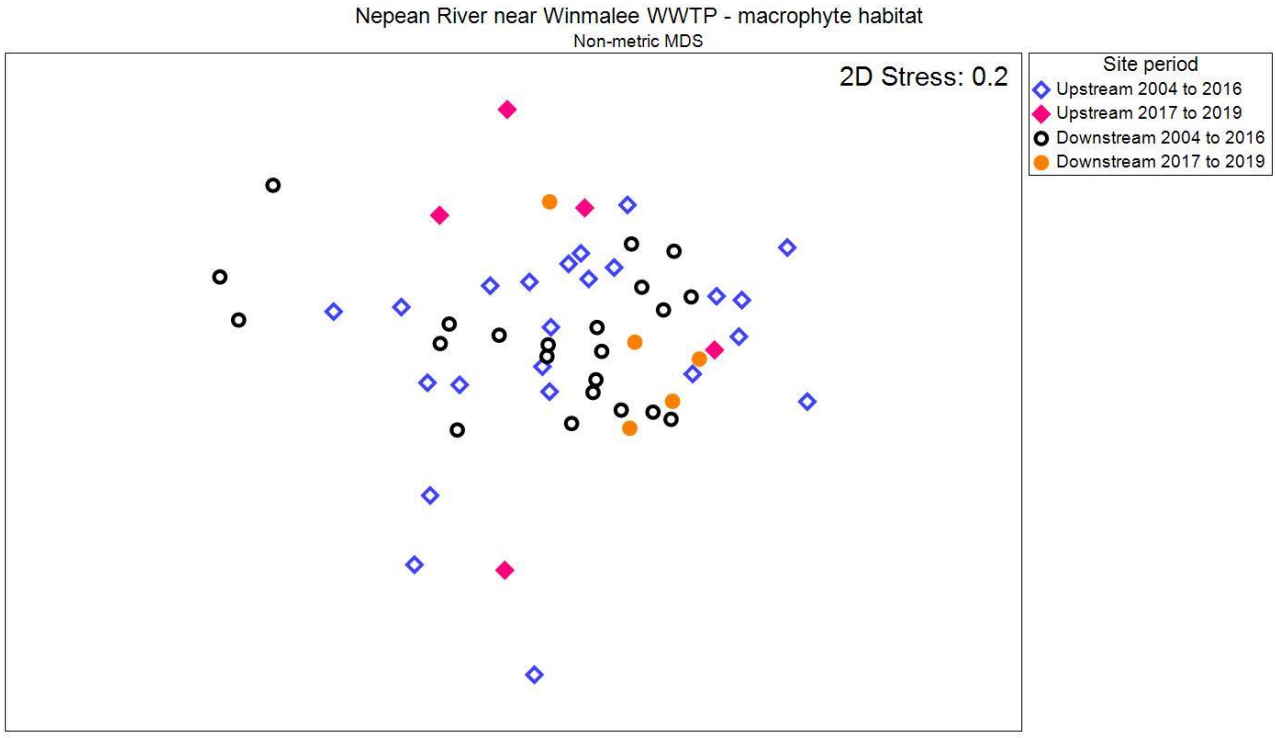


Figure N-21 Two-dimensional nMDS ordination plot of freshwater macroinvertebrate macrophyte habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

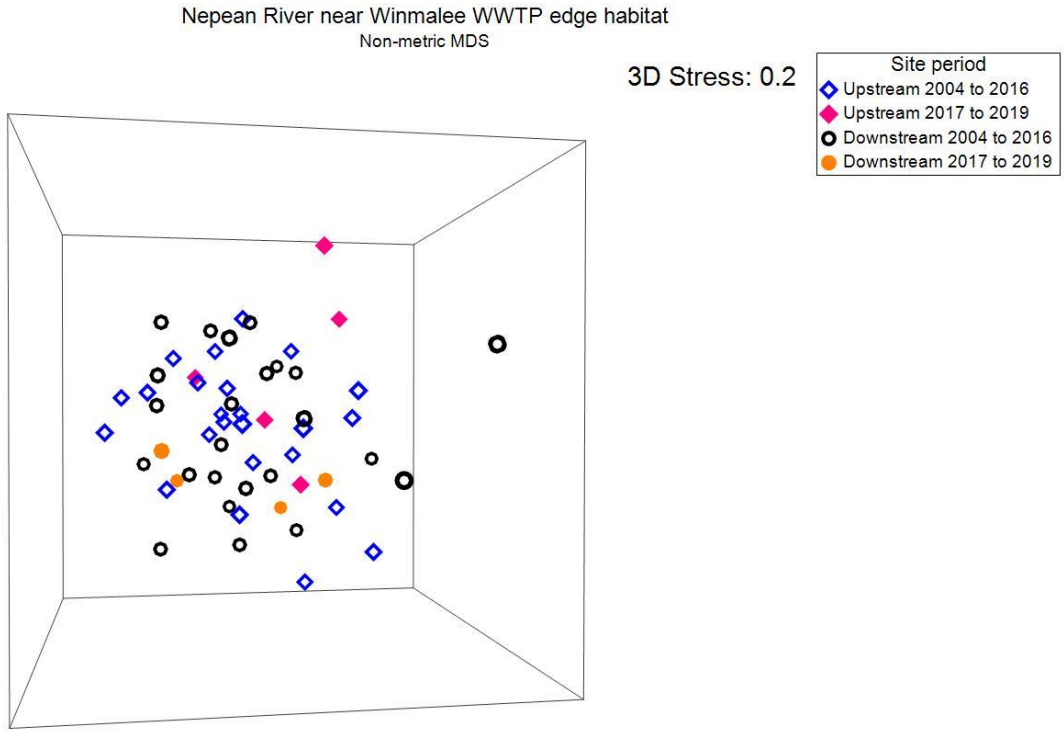


Figure N-22 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

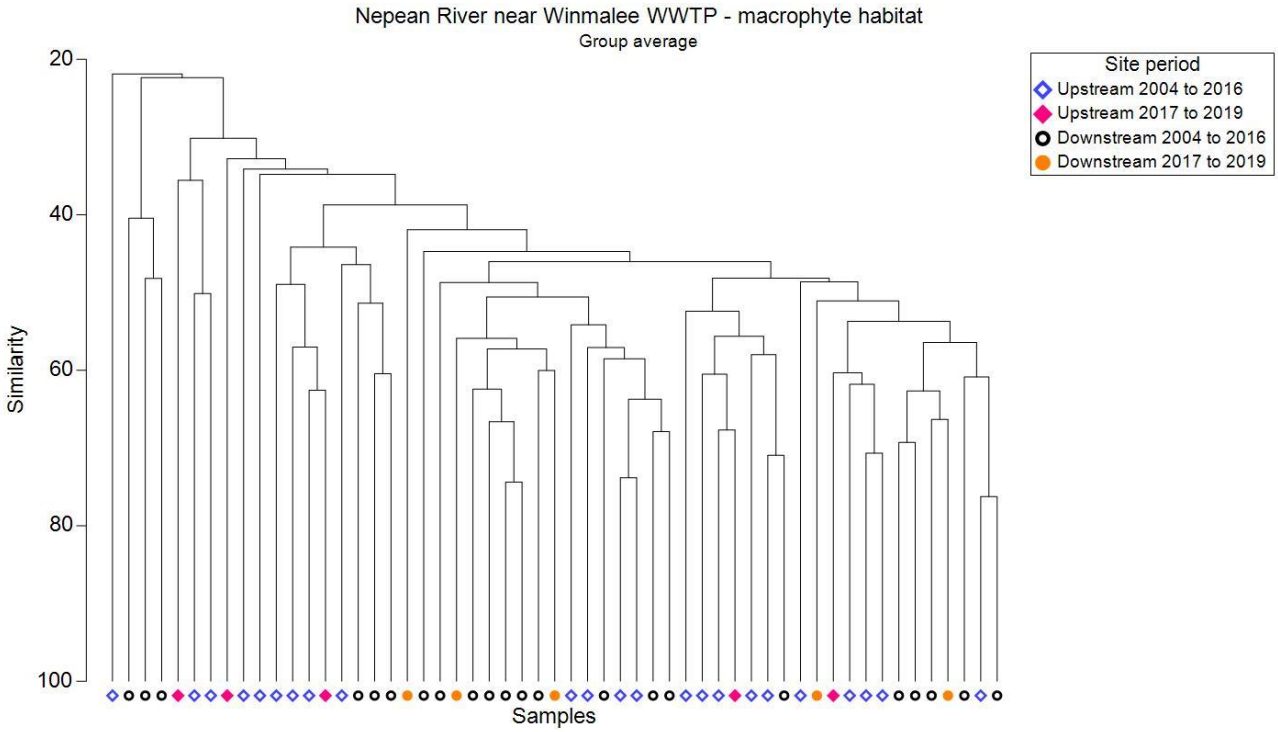


Figure N-23 Tree diagram of freshwater macroinvertebrate macrophyte habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

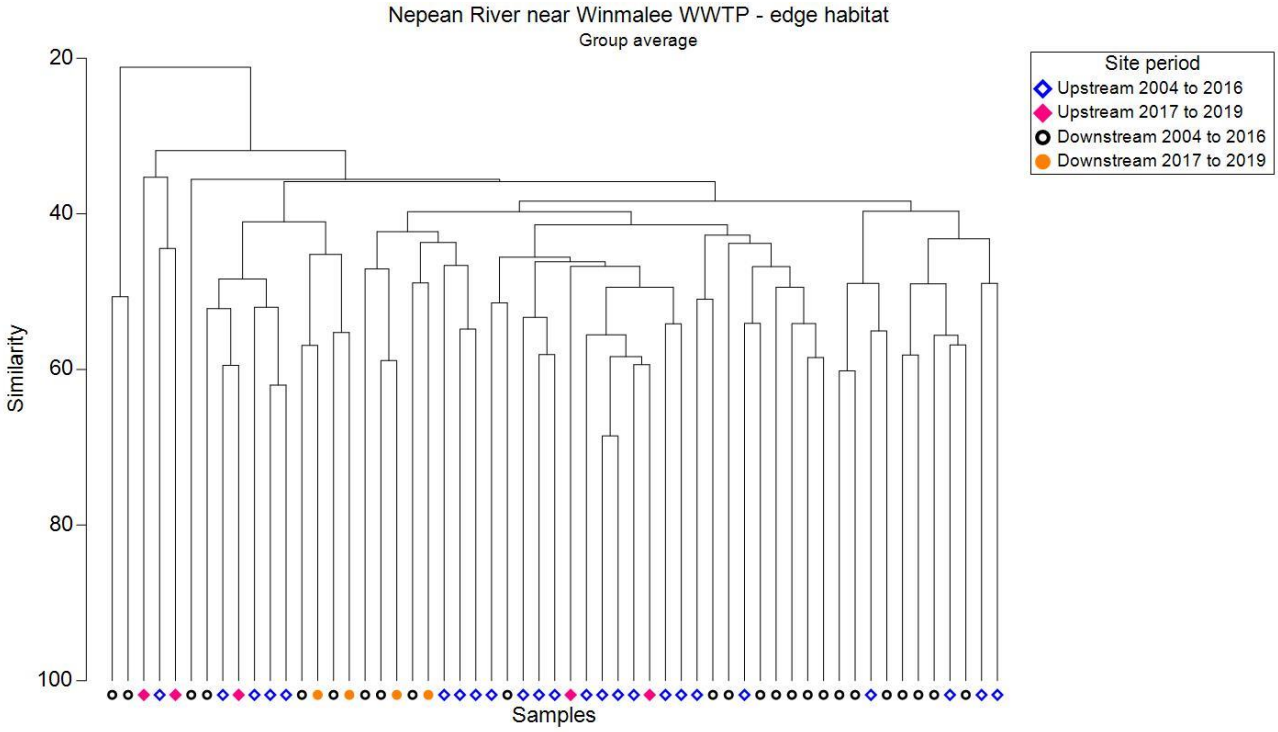


Figure N-24 Tree diagram of freshwater macroinvertebrate edge habitat community structure of sites upstream-downstream of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Table N-29 ANOSIM test of Site for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Analysis of Similarities
Site levels
Upstream
Downstream

Global Test
Sample statistic (R): 0.066
Significance level of sample statistic: 0.9%
Number of permutations: 999 (Random sample from a large number)

Table N-30 ANOSIM test of Site for edge habitat Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Analysis of Similarities
Site levels
Upstream
Downstream

Global Test
Sample statistic (R): 0.124
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-31 PERMANOVA test of Site and Year factors for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

WWTP discharges
Permutational MANOVA

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	16

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	3254.7	3254.7	1.9576	0.0352	9925
Year	15	38230	2548.6	1.5329	0.0013	9804
SitexYear	15	21605	1440.3	0.86629	0.8562	9793
Res	23	38240	1662.6			
Total	54	1.0237E+05				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	63.745	7.9841
S(Year)	260.47	16.139
S(SitexYear)	-130.7	-11.433
V(Res)	1662.6	40.775

Table N-32 PERMANOVA test of Site and Year factors for edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Permutational MANOVA

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	16

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	4202.3	4202.3	2.4799	0.0027	9916
Year	15	38068	2537.9	1.4977	0.0001	9689
SitexYear	15	26496	1766.4	1.0424	0.3449	9713
Res	25	42363	1694.5			
Total	56	1.1215E+05				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	95.509	9.7729
S(Year)	238.96	15.458
S(SitexYear)	40.75	6.3835
V(Res)	1694.5	41.164

Table N-33 PERMDISP test of Site for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Distance-based test for homogeneity of multivariate dispersions

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 999
Number of groups: 2
Number of samples: 55

DEVIATIONS FROM CENTROID
F: 3.4614 df1: 1 df2: 53
P(perm): 0.097

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Upstream	28	43.557	1.511
Downstream	27	38.883	2.0225

Table N-34 PERMDISP test of Site for edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Distance-based test for homogeneity of multivariate dispersions

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999
Number of groups: 2
Number of samples: 57

DEVIATIONS FROM CENTROID
F: 0.60341 df1: 1 df2: 55
P(perm): 0.4744

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Upstream	29	42.251	1.1039
Downstream	28	43.552	1.2641

Table N-35 ANOSIM test of Site period for macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Analysis of Similarities
Global Test
Sample statistic (R): 0.069
Significance level of sample statistic: 10.1%
Number of permutations: 999 (Random sample from a large number)
No pairwise comparisons are shown as a non-significant global test outcome was recorded

Table N-36 ANOSIM test of Site period for edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Analysis of Similarities
Global Test
Sample statistic (R): 0.139
Significance level of sample statistic: 0.4%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Upstream 2004 to 2016, Upstream 2017 to 2019	0.207	7.1	118755	999	70
Upstream 2004 to 2016, Downstream 2004 to 2016	0.106	0.2	Very large	999	1
Upstream 2004 to 2016, Downstream 2017 to 2019	0.309	1	20475	999	9
Upstream 2017 to 2019, Downstream 2004 to 2016	0.209	8.5	118755	999	84
Upstream 2017 to 2019, Downstream 2017 to 2019	0.281	9.5	126	126	12
Downstream 2004 to 2016, Downstream 2017 to 2019	-0.02	49.6	20475	999	495

Table N-37 Genera subset whose multivariate pattern matches full genera set of the macrophyte habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Subset of 27 (correlation 0.951) genera from macrophyte habitat whose pattern matches that of the full set of 77 genera identified with the same subset found on 13 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:
Chironomidae *Cricotopus*, Chironomidae *Rheotanytarsus*, Atyidae *Paratya*, Leptoceridae *Triplectides*, Physidae *Physella*, Chironomidae *Dicrotendipes*, Leptoceridae *Oecetis*, Baetidae *Offadens*, Planorbidae *Ferrissia*, Simuliidae *Simulium*, Baetidae *Cloeon* ,Chironomidae *Polypedilum*, Ecnomidae *Ecnomus*, Caenidae *Tasmanocoenis*, Coenagrionidae *Ischnura*, Libellulidae *Nannophlebia*, Coenagrionidae *Pseudagrion*, Ceratopogonidae *Bezzia*, Chironomidae *Ablabesmyia*, Lymnaeidae *Pseudosuccinea*, Chironomidae *Tanytarsus*, Libellulidae *Diplacodes*, Corbiculidae *Corbicula*, Hebridae *Merragata*, Chironomidae *Cryptochironomus*, Isostictidae *Rhadinosticta*, Unionicolidae *Recifella*

Table N-38 Genera subset whose multivariate pattern matches full genera set of the edge habitat of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Subset of 45 (correlation 0.951) genera from edge habitat whose pattern matches that of the full set of 110 genera identified with the same subset found on 26 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:
Leptoceridae *Triplectides*, Atyidae *Paratya*, Chironomidae *Cricotopus,* Leptoceridae *Oecetis*, Baetidae *Cloeon,* Leptoceridae *Notalina*, Physidae *Physella*, Chironomidae *Rheotanytarsus*, Chironomidae *Dicrotendipes*, Veliidae *Microvelia*, Caenidae *Tasmanocoenis*, Simuliidae *Simulium*, Corixidae *Micronecta*, Coenagrionidae *Ischnura*, Libellulidae *Nannophlebia*, Hydrophilidae *Berosus*, Chironomidae *Chironomus*, Chironomidae *Procladius*, Platycnemididae *Nosoticta*, Dugesiidae *Cura*, Baetidae *Offadens*, Coenagrionidae *Pseudagrion*, Hydroptilidae *Hellyethira*, Lymnaeidae *Pseudosuccinea*, Chironomidae *Ablabesmyia*, Chironomidae *Microtendipes*, Planorbidae *Ferrissia*, Chironomidae *Tanytarsus*, Coenagrionidae *Austroagrion,* Corbiculidae *Corbicula*, Naididae *Nais*, Calamoceratidae *Anisocentropus*, Chironomidae *Rheocricotopus,* Ecnomidae *Ecnomus*, Hydropsychidae *Cheumatopsyche*, Libellulidae *Orthetrum,* Ceratopogonidae *Bezzia*, Mesoveliidae *Mesovelia*, Oxidae *Oxus*, Chironomidae *Larsia*, Hydrophilidae *Helochares*, Glossiphoniidae *Helobdella*, Naididae *Stylaria*, Naucoridae *Naucoris*, Micronectidae *Micronecta*.

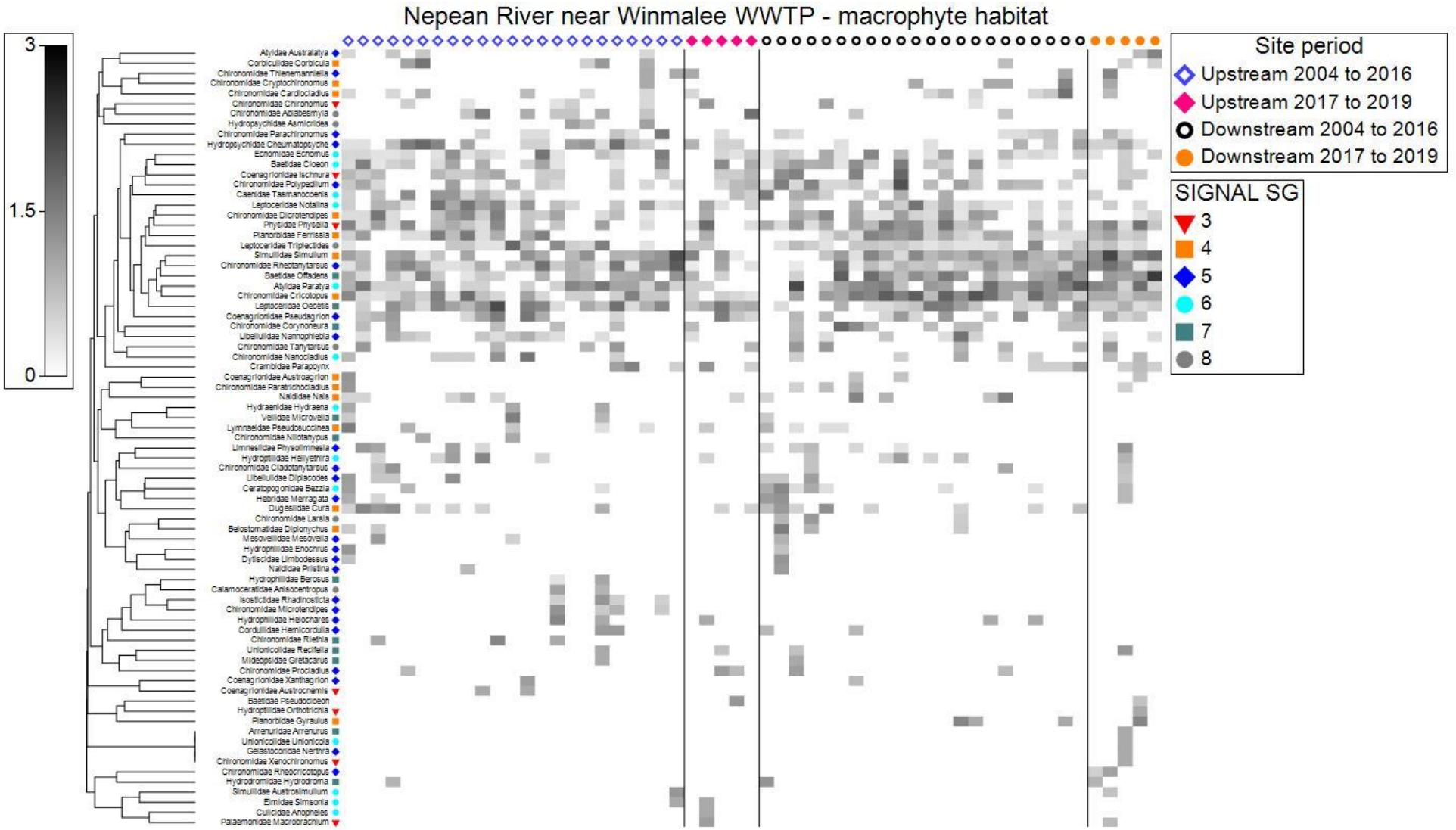


Figure N-25 Shade plot of freshwater macroinvertebrate macrophyte habitat community structure of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

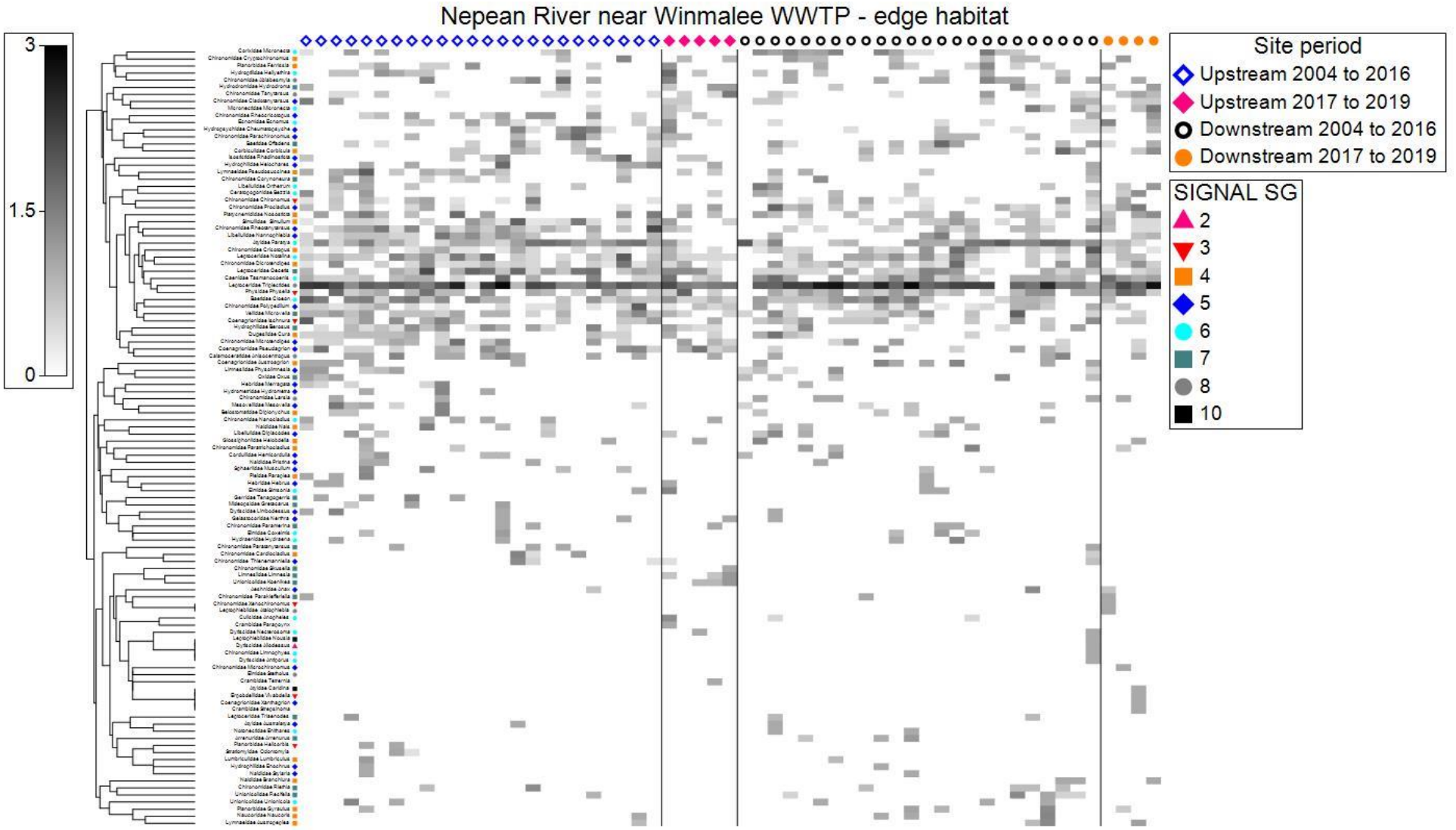


Figure N-26 Shade plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Nepean River at the confluence of the unnamed creek into which Winmalee WWTP discharges

Stream health and community structure near North Richmond WWTP

The SIGNAL-SG plots provided assessments of stream health for both Redbank Creek near North Richmond WWTP and in the Hawkesbury River upstream-downstream of the confluence with Redbank Creek. These plots were based upon macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 2004 to 2019 for Redbank Creek and 1995 to 2019 for the Hawkesbury River. These visual comparisons suggest that the wastewater discharges from the North Richmond WWTP did not have a measurable negative impact on stream health of the Hawkesbury River over 1995 to 2019 (Figure N-27), however, a decline in stream health is seen for Redbank Creek in 2018-19 (Figure N-28).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under t-tests returned a non-significant outcome for the Hawkesbury River, while a just significant test outcome (Table N-39 and Table N-40) for Redbank Creek was returned and confirmed the visual trend for 2018-19.

As a measurable localised negative impact on downstream stream health in Redbank Creek was detected further data analysis was undertaken.

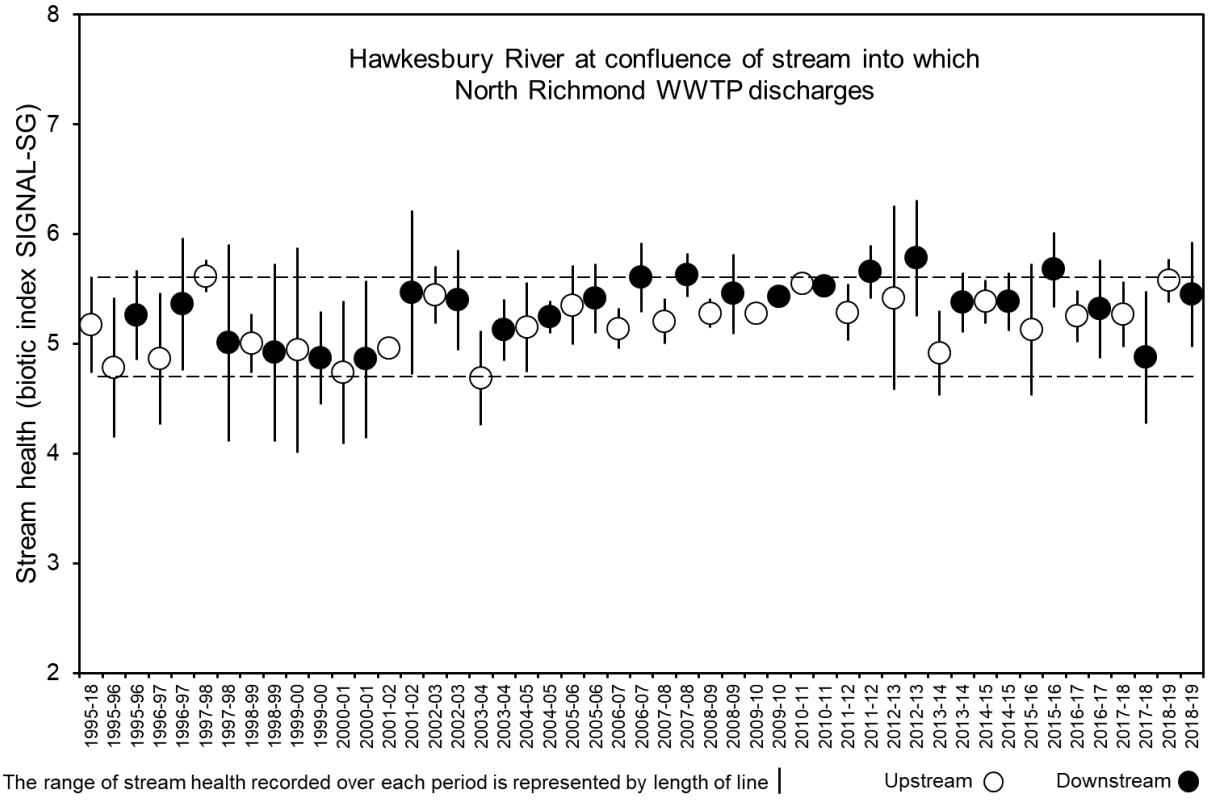


Figure N-27 Stream health of Hawkesbury River upstream-downstream of the confluence of Redbank Creek near North Richmond WWTP

Table N-39 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from the Hawkesbury River near North Richmond WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	-0.60	0.5593

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	5.89	0.0740

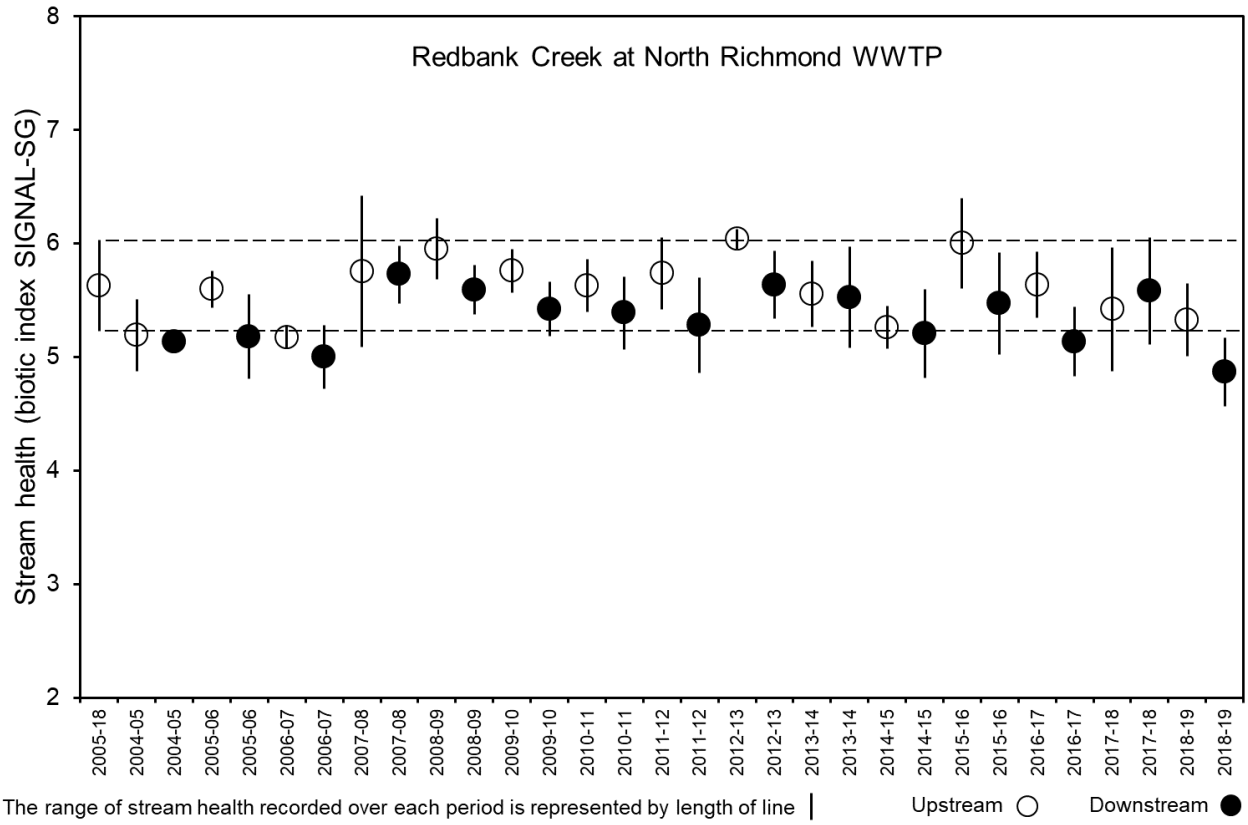


Figure N-28 Stream health of Redbank Creek near North Richmond WWTP

Table N-40 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Redbank Creek near North Richmond WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	-2.53	0.0301

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	1.11	0.9087

Macrophyte habitat samples were collected consistently enough from Redbank Creek and Nepean River locations to allow multivariate analysis for the monitoring period 2005 to 2019. Somewhat slightly distinct groups of site samples were evident for Redbank Creek in the three-dimensional ordination plot (Figure N-29).

The ordination pattern was not as apparent in the corresponding tree diagram (dendrogram) from the classification analysis as the initial divisions did not show a clear site separation (Figure N-30). An even less distinct site pattern was shown in the corresponding Nepean River sites two-dimensional ordination plot which showed both interspersed site samples and periods (Figure N-32).

The corresponding shade plot for Redbank Creek (Figure N-31) displayed a number of both tolerant taxon such as the freshwater snail Physidae Physella (SIGNAL-SG grade 3) and sensitive taxon such as the caddisfly larvae Leptoceridae Triplectides (SIGNAL-SG grade 8) which were consistent through both locations. This overall pattern was mirrored in the shade plot produced for the Nepean River locations with both tolerant and sensitive taxa collected consistently at both upstream and downstream sites (Figure N-34). The shade plot for Redbank Creek indicated lower numbers of overall taxa may have be collected from the Redbank Creek downstream location during the 2017 to 2019 period, which is explored further below.

The PERMDISP analysis for Redbank Creek sites indicated a just significant pattern of dispersion (spacing between same-site samples) for the two sites (Table N-41). This outcome suggests a variability in taxonomic make-up of samples collected over time through the period tested (Table N-41). This may be a result of the lower numbers of taxa collected during the recent period of 2017 to 2019, as can be seen in the Redbank Creek shade plot (Figure N-31). This result implies both temporal (within site) and between site differences occur in the community structure at Redbank Creek. In contrast, PERMDISP analysis of the corresponding Nepean River sites indicated a strong non-significant pattern of dispersion for the two locations (Table N-47). This outcome suggests the variability in taxonomic make-up of samples collected over time was at similar levels for both sites in the Nepean River through the period tested (2005 to 2019).

The ANOSIM test run on the factor ‘Site’ within Redbank Creek returned a low to mid range value ($R = 0.329$; $P = 0.001$) confirming community structure was somewhat similar at each site (Table N-42). Similarly, an ANOSIM test run on the factor ‘Period’ within Redbank Creek returned a mid range value ($R = 0.434$; $P = 0.001$) confirming community structure was somewhat different between the periods of 2005 to 2016 and 2017 to 2019 (Table N-43) which confirms the pattern observed in the corresponding shade plot. The corresponding ANOSIM test run on the factor ‘Site’ within the Nepean River returned a low ($R = 0.106$; $P = 0.002$) confirming community structure was similar at each site (Table N-48).

To further explore community structure, hypothesis testing was conducted with using PERMANOVA for both Redbank Creek and Nepean River sites. The PERMANOVA model comprised the fixed factors ‘Site’ and ‘Year’. ‘Year’ represented samples collected in years between 2005 and 2019. ‘Site’ had two levels, upstream and downstream. For Redbank Creek, a statistically non-significant ‘Site x Year’ interaction was returned (Table N-44). This non-significant result allowed us to view the ‘Site’ and ‘Year’ results. Both “Site” and “Year” returned statistically significant results indicating both spatial and temporal differences exist. Similarly, the corresponding PERMANOVA analysis on Nepean River sites displayed a non-significant ‘Site x Year’ interaction with significant results for both ‘Year’ and ‘Site’ (Table N-49).

A second run of ANOSIM was performed for both Redbank Creek and Nepean River sites based on Site-period sample groups displayed in above ordination plots. Redbank Creek samples returned a mid range global R-value of 0.455 (Table N-45). Pairwise tests indicated only one

upstream versus downstream comparisons had a high level R-value (close to or equalling the maximum R-value of 1). This comparison was for the most recent downstream samples (2017 to 2019) to longer term upstream samples (2005 to 2016). In contrast, the most recent 2017 to 2019 upstream and downstream sample compaisons returned an R-value of 0.4, suggesting less obvious differences in community structure for this same collection period. This perhaps reflects differences in abundance observed in the shade plots (Figure N-31 and Figure N-34). Nepean River samples returned a very low range global R-value of 0.093 (Table N-50). Pairwise tests indicated all six comparisons had very low level R-values (close to the minimum R-value of 0, with 5 of the 6 test results non-significant). These pairwise test results indicate there are no clear differences in assemblage structure between upstream and downstream sites within the Nepean River locations.

A BVSTEP routine was used to find a subset of taxa whose multivariate pattern matched that of the full dataset within both Redbank Creek and Nepean River locations. For Redbank Creek, 34 taxa were identified (Table N-46) out of 145 taxa while for Nepean River locations 24 taxa were identified (Table N-51) out of 96 taxa. These taxa reflected those taxa which formed the main patterns within the shade plots (Figure N-31 and Figure N-34).

These results suggested downstream community structure in Redbank Creek was potentially altered by wastewater discharge from North Richmond WWTP in recent years however this is shown largely in abundance differences as both tolerant and sensitive taxa have been consistently collected across all years. North Richmond WWTP discharge concentration limits have not shown marked changes to pollution levels and implies the change in Redbank Creek may potentially be a result of the decreasing creek flow from low rainfall causing WWTP flows to be more pronounced. Despite this apparent localised impact, macroinvertebrate communities within the Nepean River do not shown evidence of an impact from the wastewater transported in the flows from Redbank Creek.

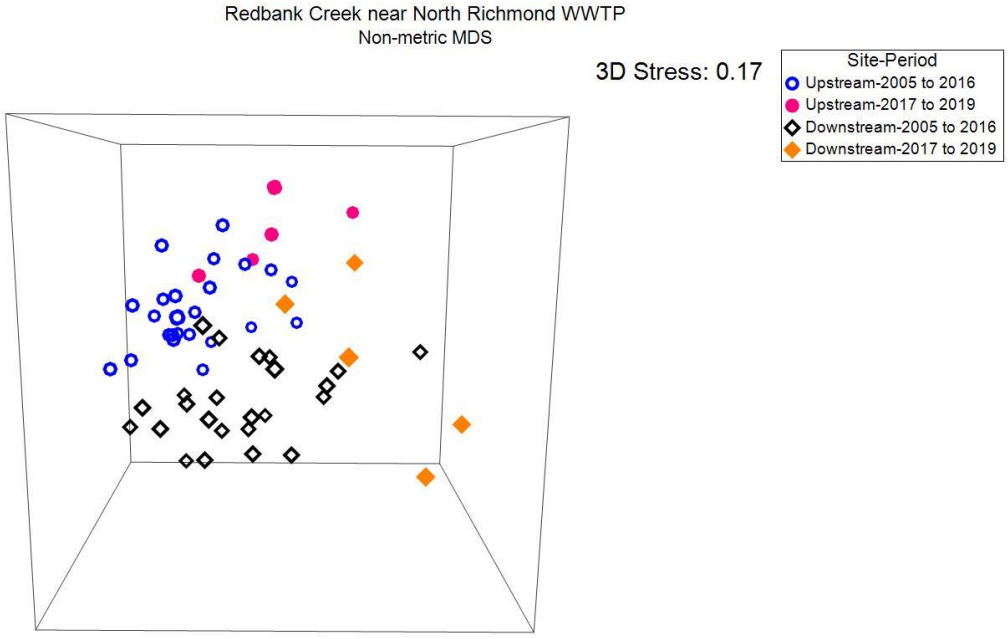


Figure N-29 Three-dimensional ordination plot of freshwater macroinvertebrate macrophyte habitat community structure of Redbank Creek upstream and downstream sites of North Richmond WWTP

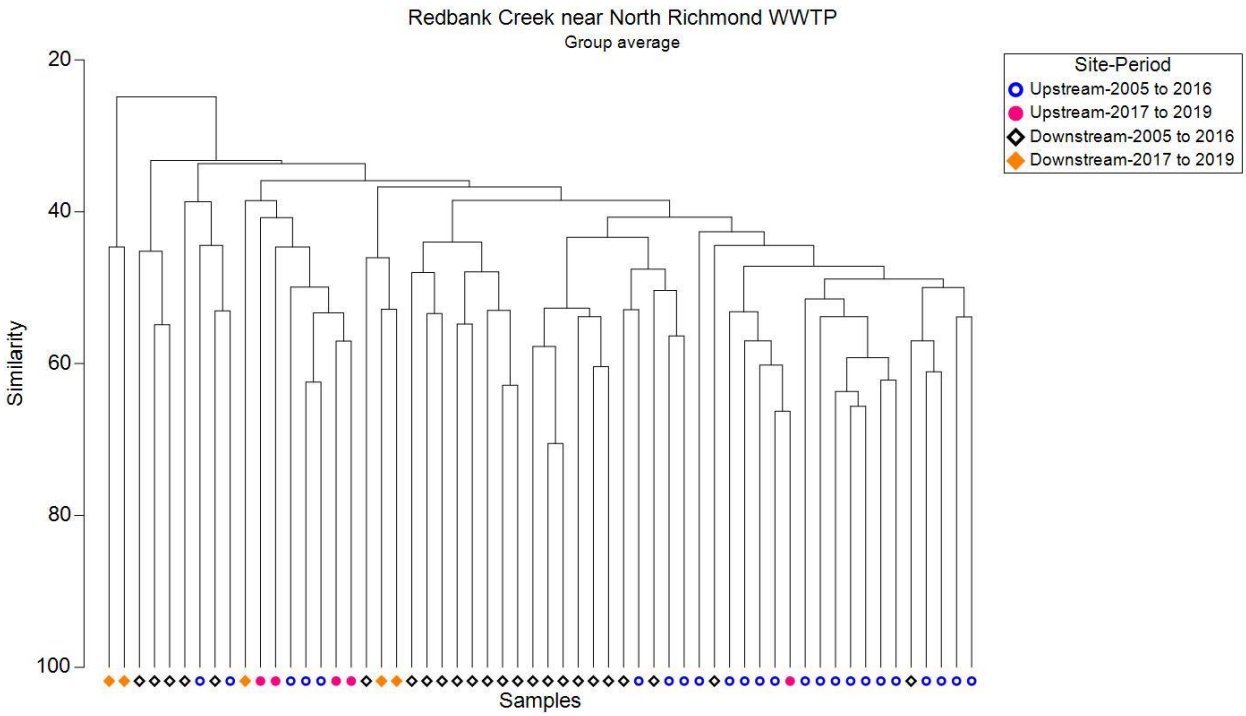


Figure N-30 Tree diagram of freshwater macroinvertebrate macrophyte habitat community structure of Redbank Creek upstream and downstream sites of North Richmond WWTP

Table N-41 PERMDISP test of 'Site' factor for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP

Distance-based test for homogeneity of multivariate dispersions
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999

Number of groups: 2
Number of samples: 58

DEVIATIONS FROM CENTROID
F: 4.9624 df1: 1 df2: 56
P(perm): 0.0442

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Downstream	29	43.158	1.165
Upstream	29	39.566	1.1152

Table N-42 ANOSIM test of 'Site' factor for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP

Analysis of Similarities
Site levels
Downstream
Upstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.329
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-43 ANOSIM test of 'Period' factor for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP

Analysis of Similarities
Site levels
Downstream
Upstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.434
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-44 PERMANOVA test of 'Site' and 'Year' factors for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP

Permutational MANOVA
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	15

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	10978	10978	7.6079	0.0001	9916
Year	14	43101	3078.6	2.1336	0.0001	9730
SitexYear	14	18024	1287.4	0.89224	0.8776	9715
Res	28	40402	1442.9			
Total	57	1.1253E+05				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	339.01	18.412
S(Year)	423.52	20.58
S(SitexYear)	-80.519	-8.9732
V(Res)	1442.9	37.986

Table N-45 ANOSIM test of 'Site period' samples for macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP

Analysis of Similarities
Global Test
Sample statistic (R): 0.455
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Downstream-2005 to 2016, Downstream-2017 to 2019	0.556	0.2	118755	999	1
Downstream-2005 to 2016, Upstream-2005 to 2016	0.369	0.1	Very large	999	0
Downstream-2005 to 2016, Upstream-2017 to 2019	0.603	0.2	118755	999	1
Downstream-2017 to 2019, Upstream-2005 to 2016	0.81	0.1	118755	999	0
Downstream-2017 to 2019, Upstream-2017 to 2019	0.404	1.6	126	126	2
Upstream-2005 to 2016, Upstream-2017 to 2019	0.305	1.2	118755	999	11

Table N-46 Genera subset whose multivariate pattern matches full genera set of the macrophyte habitat of Redbank Creek upstream and downstream sites of North Richmond WWTP

Subset of 34 (correlation 0.950) genera from edge habitat whose pattern matches that of the full set of 145 genera identified with the same subset found on 14 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:
Hydrophilidae *Berosus*, Chironomidae *Polypedilum*, Corduliidae *Hemicordulia*, Leptoceridae *Triplectides*, Physidae *Physella*, Isostictidae *Rhadinosticta*, Sphaeriidae *Musculium*, Dugesiidae *Cura*, Atyidae *Paratya*, Chironomidae *Chironomus*, Argiolestidae *Austroargiolestes*, Chironomidae *Ablabesmyia*, Lymnaeidae *Pseudosuccinea*, Chironomidae *Procladius*, Chironomidae *Dicrotendipes*, Veliidae *Microvelia*, Chironomidae *Tanytarsus*, Coenagrionidae *Ischnura*, Planorbidae *Glyptophysa*, Oxidae *Oxus*, Ceratopogonidae *Bezzia*, Baetidae *Cloeon,* Dytiscidae *Necterosoma*, Ecnomidae *Ecnomus*, Leptophlebiidae *Atalophlebia* ,Leptoceridae *Oecetis*, Pleidae *Paraplea*, Gelastocoridae *Nerthra*, Chironomidae *Riethia*, Libellulidae *Diplacodes*, Dytiscidae *Antiporus*, Dytiscidae *Chostonectes*, Chironomidae *Paratanytarsus*, Naididae *Nais*.

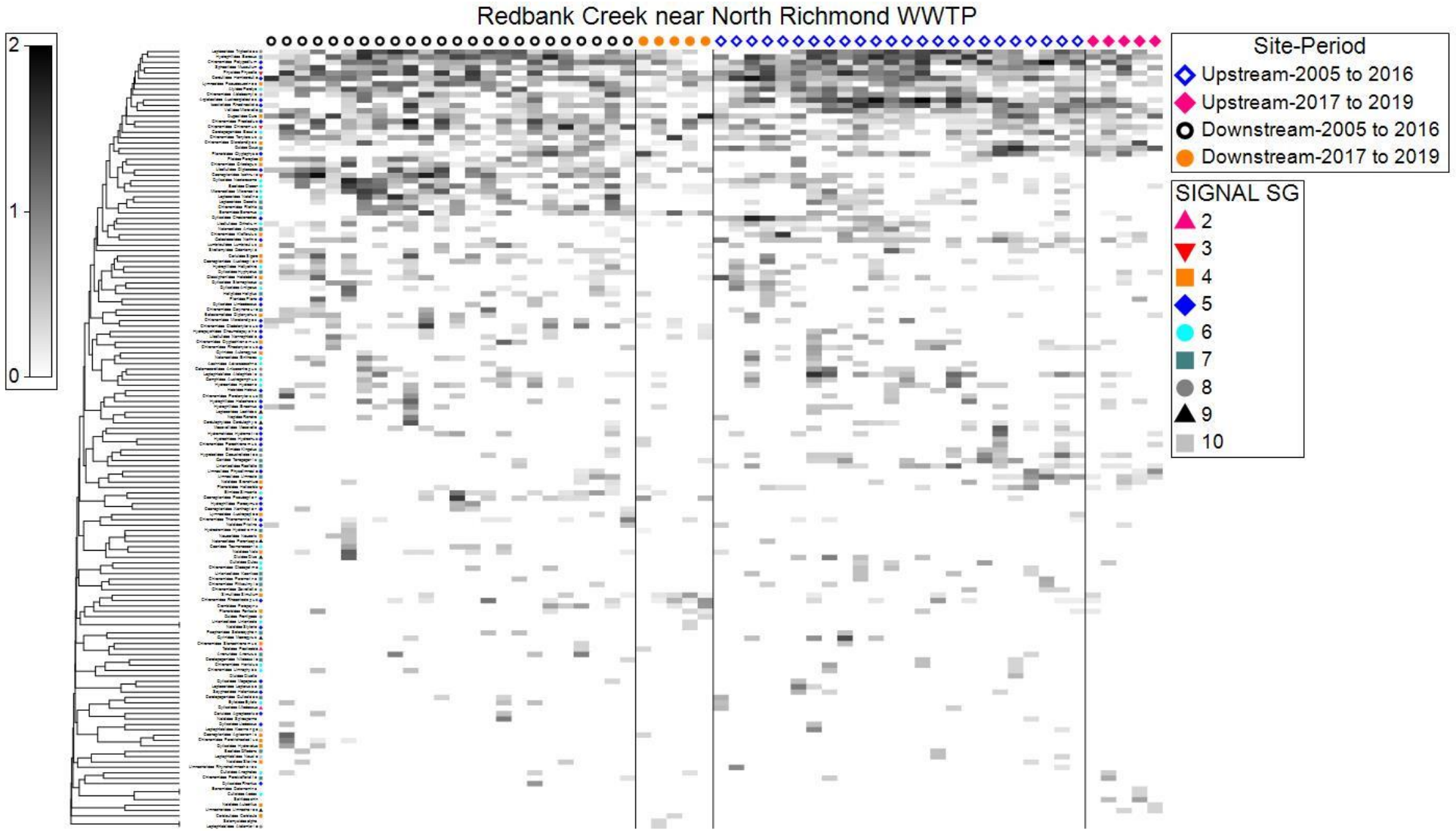


Figure N-31 Shade plot of freshwater macroinvertebrate macrophyte habitat community structure of Redbank Creek upstream and downstream sites of North Richmond WWTP

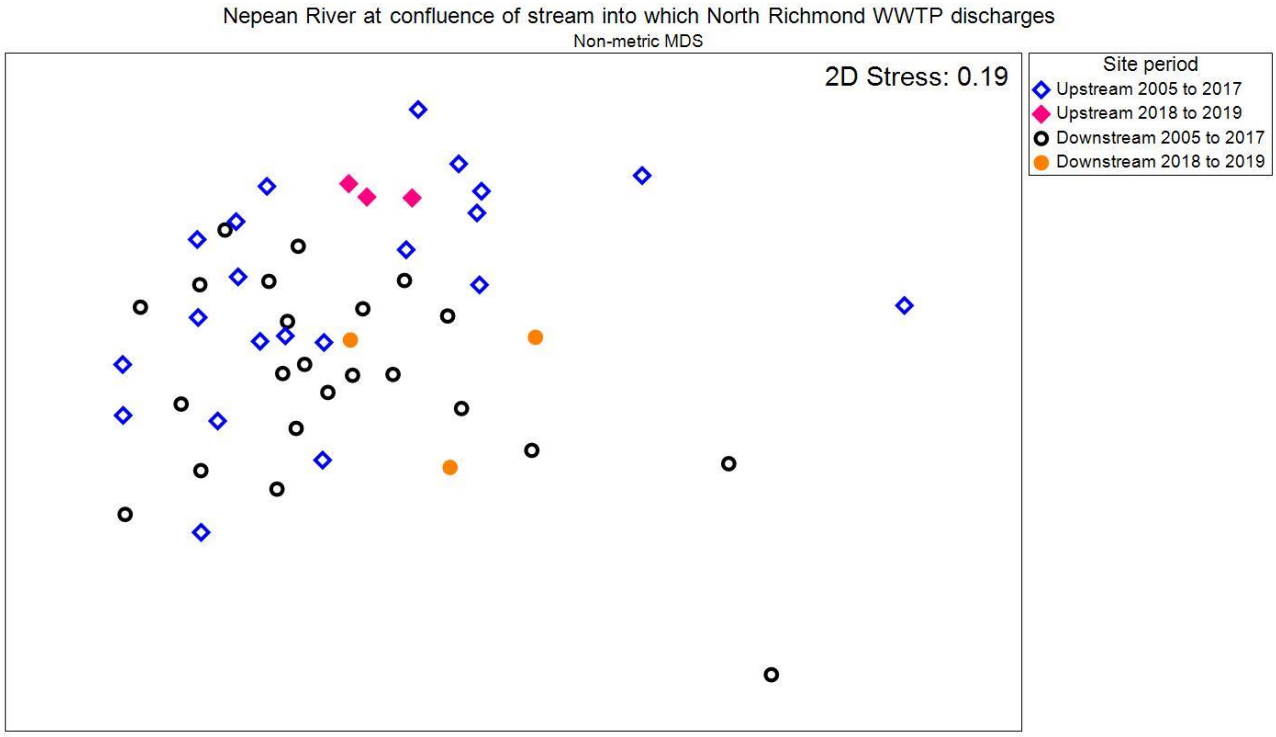


Figure N-32 Two-dimensional ordination plot of freshwater macroinvertebrate macrophyte habitat community structure of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

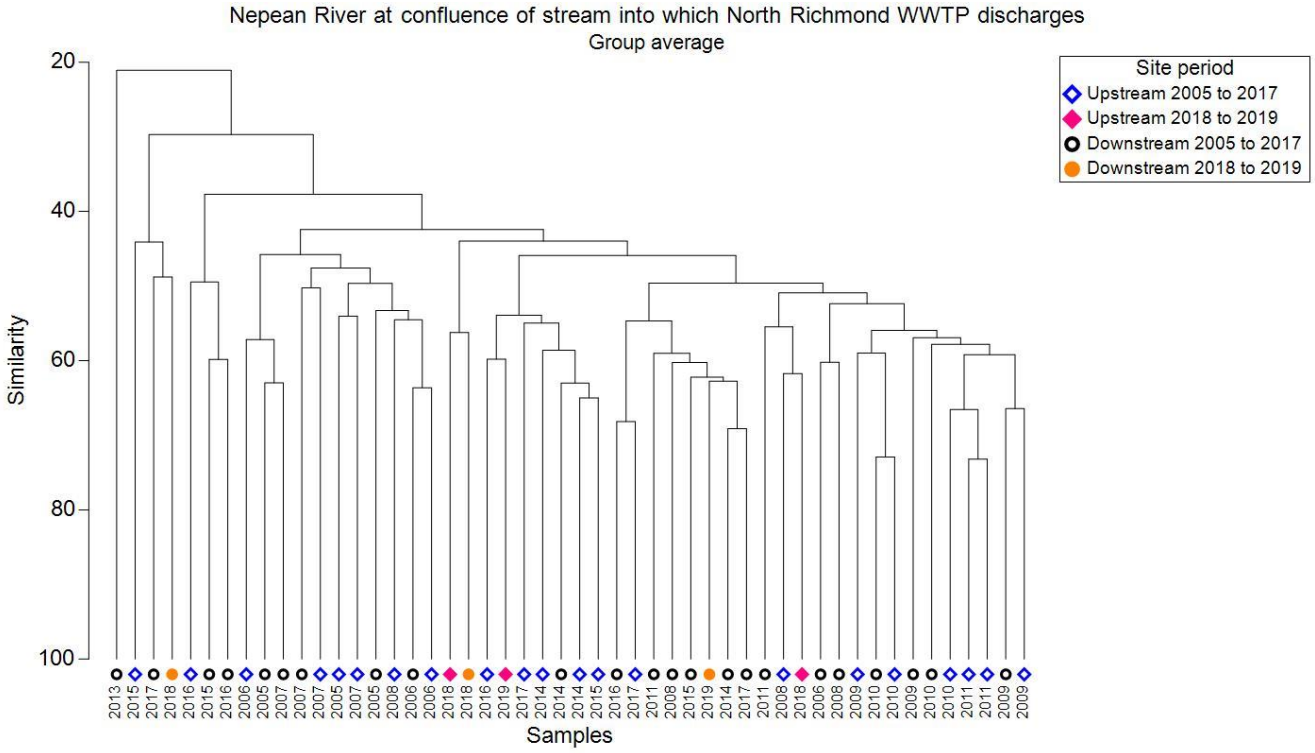


Figure N-33 Tree diagram of freshwater macroinvertebrate macrophyte habitat community structure of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

Table N-47 PERMDISP test of 'Site' factor for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

Distance-based test for homogeneity of multivariate dispersions
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999

Number of groups: 2
Number of samples: 50

DEVIATIONS FROM CENTROID
F: 0.32102 df1: 1 df2: 48
P(perm): 0.6108

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Downstream	26	38.302	1.6277
Upstream	24	39.582	1.5559

Table N-48 ANOSIM test of 'Site' factor for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

Analysis of Similarities
Site levels
Downstream
Upstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.106
Significance level of sample statistic: 0.2%
Number of permutations: 999 (Random sample from a large number)

Table N-49 PERMANOVA test of Site and Year factors for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

Permutational MANOVA
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	14

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	3850.9	3850.9	2.9954	0.0019	9921
Year	13	35205	2708	2.1064	0.0001	9807
SitexYear**	12	13825	1152	0.89611	0.7974	9816
Res	23	29569	1285.6			
Total	49	83146				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	110.05	10.49
S(Year)	403.24	20.081
S(SitexYear)	-71.519	-8.4569
V(Res)	1285.6	35.855

Table N-50 ANOSIM test of Site period for macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

Analysis of Similarities
Global Test
Sample statistic (R): 0.093
Significance level of sample statistic: 4.6%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Downstream 2005 to 2017, Upstream 2005 to 2017	0.088	0.8	Very large	999	7
Downstream 2005 to 2017, Upstream 2018 to 2019	0.193	18.1	2600	999	180
Downstream 2005 to 2017, Downstream 2018 to 2019	0.133	25.7	2600	999	256
Upstream 2005 to 2017, Upstream 2018 to 2019	-0.115	71	2024	999	709
Upstream 2005 to 2017, Downstream 2018 to 2019	0.159	19.2	2024	999	191
Upstream 2018 to 2019, Downstream 2018 to 2019	0.333	20	10	10	2

Table N-51 Genera subset whose multivariate pattern matches full genera set of the macrophyte habitat of Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

Subset of 24 (correlation 0.952) genera from edge habitat whose pattern matches that of the full set of 96 genera identified with the same subset found on 14 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:

Chironomidae *Polypedilum*,Baetidae *Cloeon*,Atyidae *Paratya,*Limnesiidae *Physolimnesia*,Leptoceridae *Oecetis*,Leptoceridae *Notalina*,Coenagrionidae *Pseudagrion*,Coenagrionidae *Austroagrion,*Coenagrionidae *Ischnura*,Chironomidae *Cricotopus*,Hydroptilidae *Hellyethira*,Physidae *Physella,*Planorbidae *Ferrissia*,Leptoceridae *Triplectides,*Ecnomidae *Ecnomus,*Sphaeromatidae *Cymodetta*,Ceratopogonidae *Bezzia*,Hydrodromidae *Hydrodroma*,Caenidae *Tasmanocoenis*,Dugesiidae *Cura*,Coenagrionidae *Austrocnemis*,Chironomidae *Nanocladius*,Corduliidae *Hemicordulia*,Hebridae *Merragata*

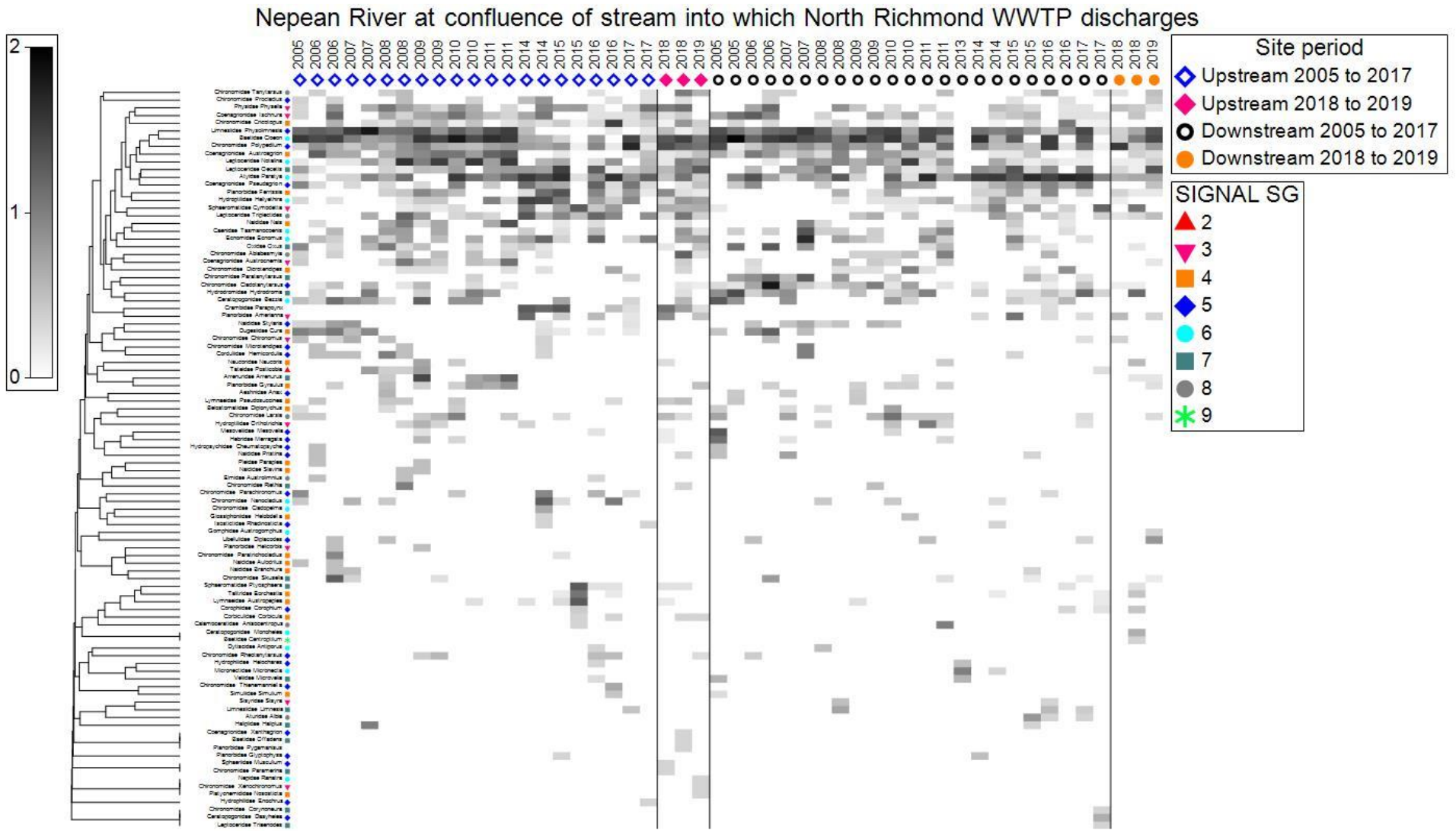


Figure N-34 Shade plot of freshwater macroinvertebrate macrophyte habitat of the Nepean River upstream and downstream sites of the confluence of stream into which North Richmond discharges

Stream health near St Mary's WWTP

The SIGNAL-SG plot for South Creek provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1995 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site indicating wastewater discharge from St Mary's WWTP did not have a measurable impact on stream health during 2018-19 (Figure N-35). When viewing historical aerial maps on Nearmap, it is noted there was a reduction in land clearing activities immediately north of the upstream site in 2017-18 and 2018-19. This may be contributing to the overall improved stream health.

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a non-significant test outcome (Table N-52) and confirmed the visual Signal-SG plot.

As no measurable negative impact on downstream stream health was detected, no further data analysis was undertaken.

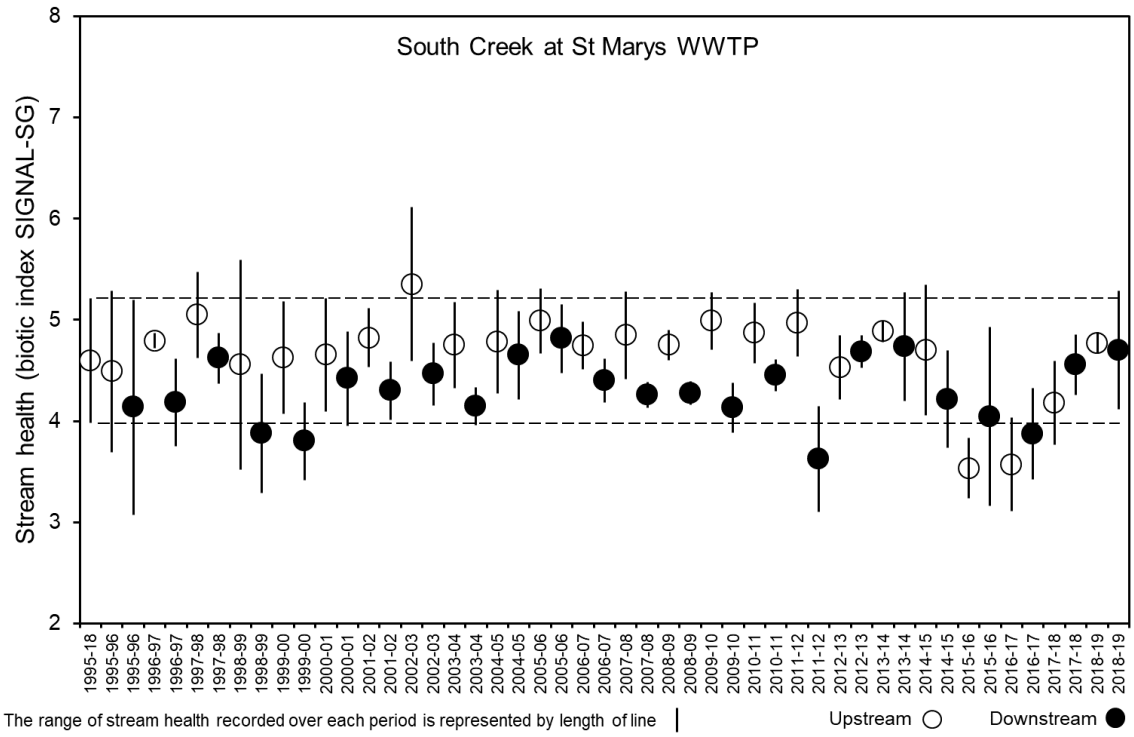


Figure N-35 Stream health of South Creek near St Mary's WWTP

Table N-52 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from South Creek near St Mary's WWTP

Method	Variances	DF	t Value	Pr > |t|
Satterthwaite	Unequal	5.2963	-0.30	0.7727

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	33.71	0.0015

Stream health near Quakers Hill WWTP

The SIGNAL-SG plot for Breakfast Creek provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1995 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site indicating wastewater discharge from Quakers Hill WWTP did not have a measurable impact on stream health during 2018-19 (Figure N-36).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a non-significant test outcome (Table N-53) and confirmed the visual Signal-SG plot.

As no measurable impact on downstream stream health was detected, no further data analysis was undertaken.

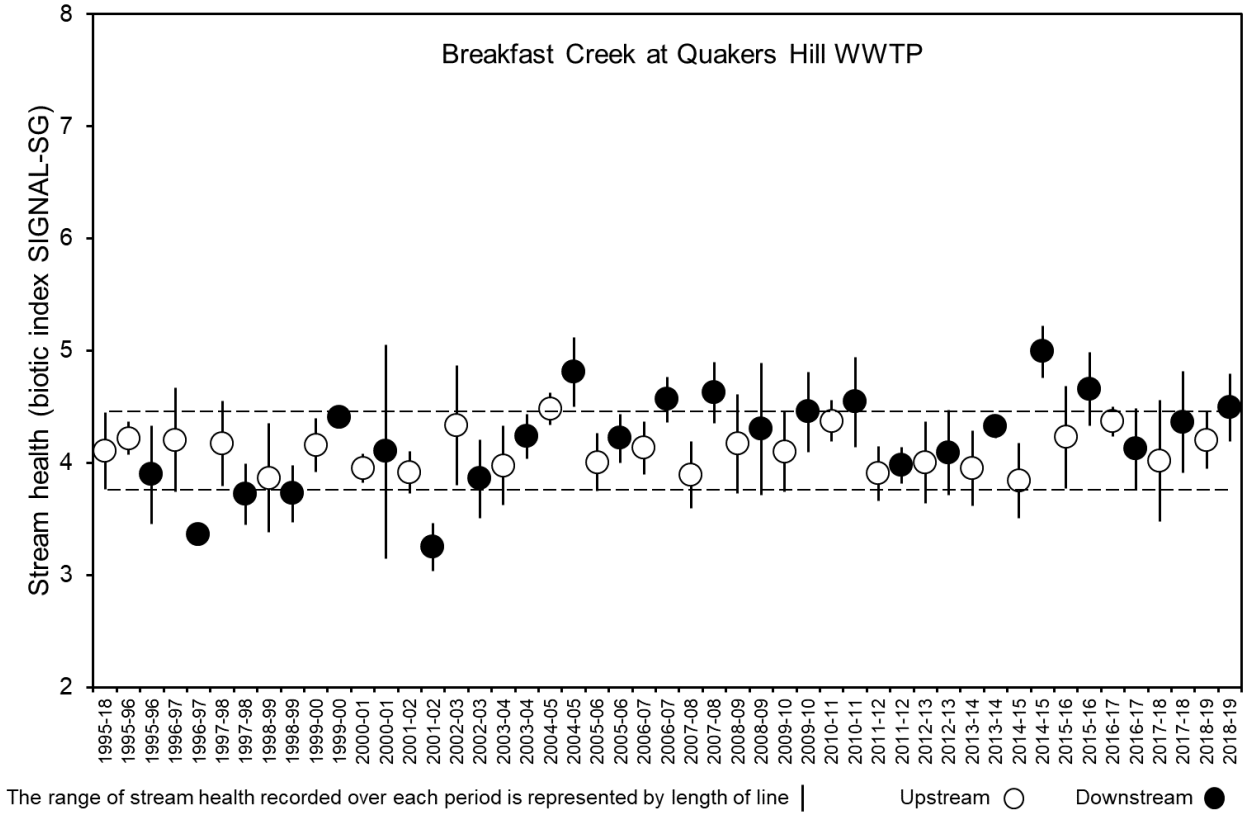


Figure N-36 Stream health of Breakfast Creek near Quakers Hill WWTP

Table N-53 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Breakfast Creek near Quakers Hill WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	1.79	0.1042

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	1.44	0.6968

Stream health near Riverstone WWTP

The SIGNAL-SG plot for Eastern Creek provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1995 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site indicating wastewater discharge from Riverstone WWTP did not have a measurable impact on stream health during 2018-19 (Figure N-37). Compared to previous years, both the upstream and downstream sites experienced a decline in stream health during 2018-19.

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a non-significant test outcome (Table N-54) and confirmed the visual trend.

As no measurable negative impact on downstream stream health was detected, no further data analysis was undertaken.

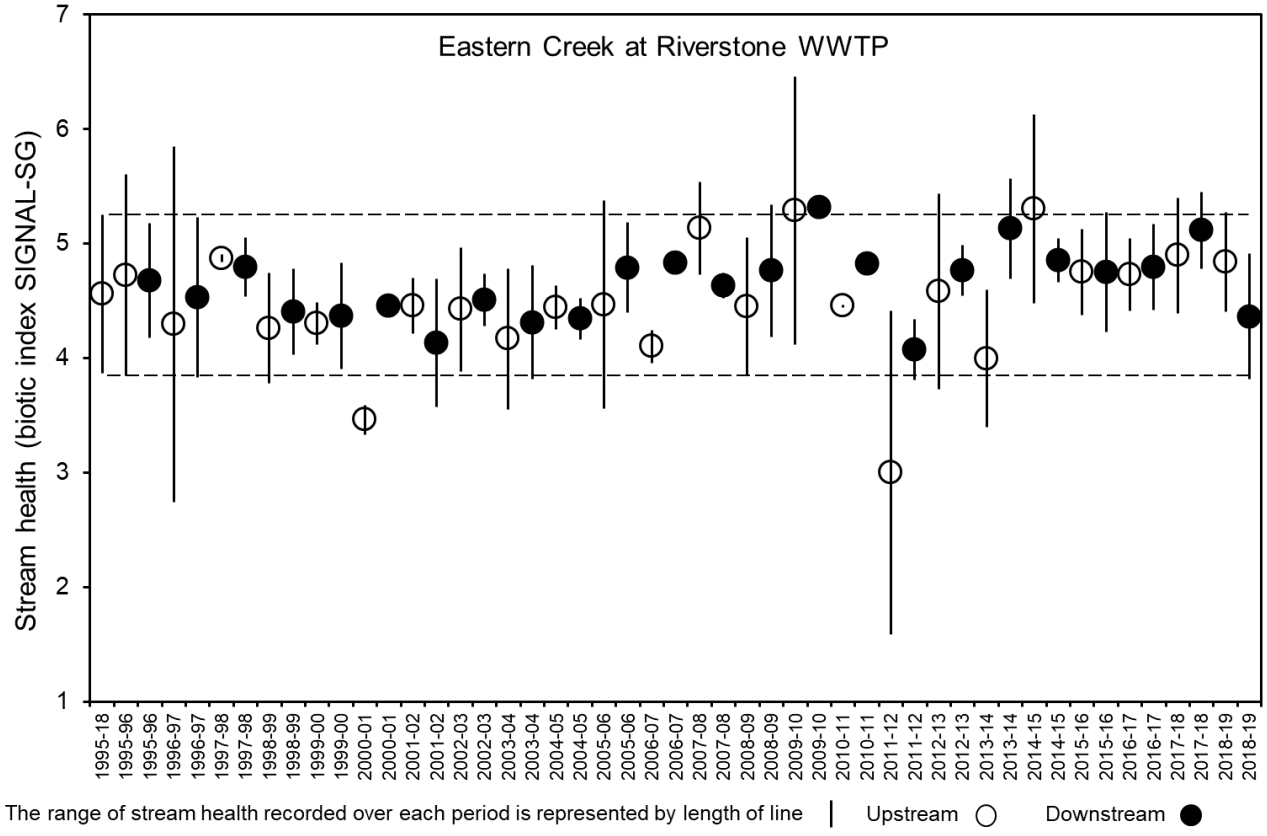


Figure N-37 Stream health of Eastern Creek near Riverstone WWTP

Table N-54 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Eastern Creek near Riverstone WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	14	-1.93	0.0748

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	7	7	1.56	0.5710

Stream health near Castle Hill WWTP

The SIGNAL-SG plot for Cattai Creek provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1995 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site indicating wastewater discharge from Castle Hill WWTP did not have a measurable impact on stream health during 2018-19 (Figure N-38).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a non-significant test outcome (Table N-55) and confirmed the visual trend.

As no measurable impact on downstream stream health was detected, no further data analysis was undertaken.

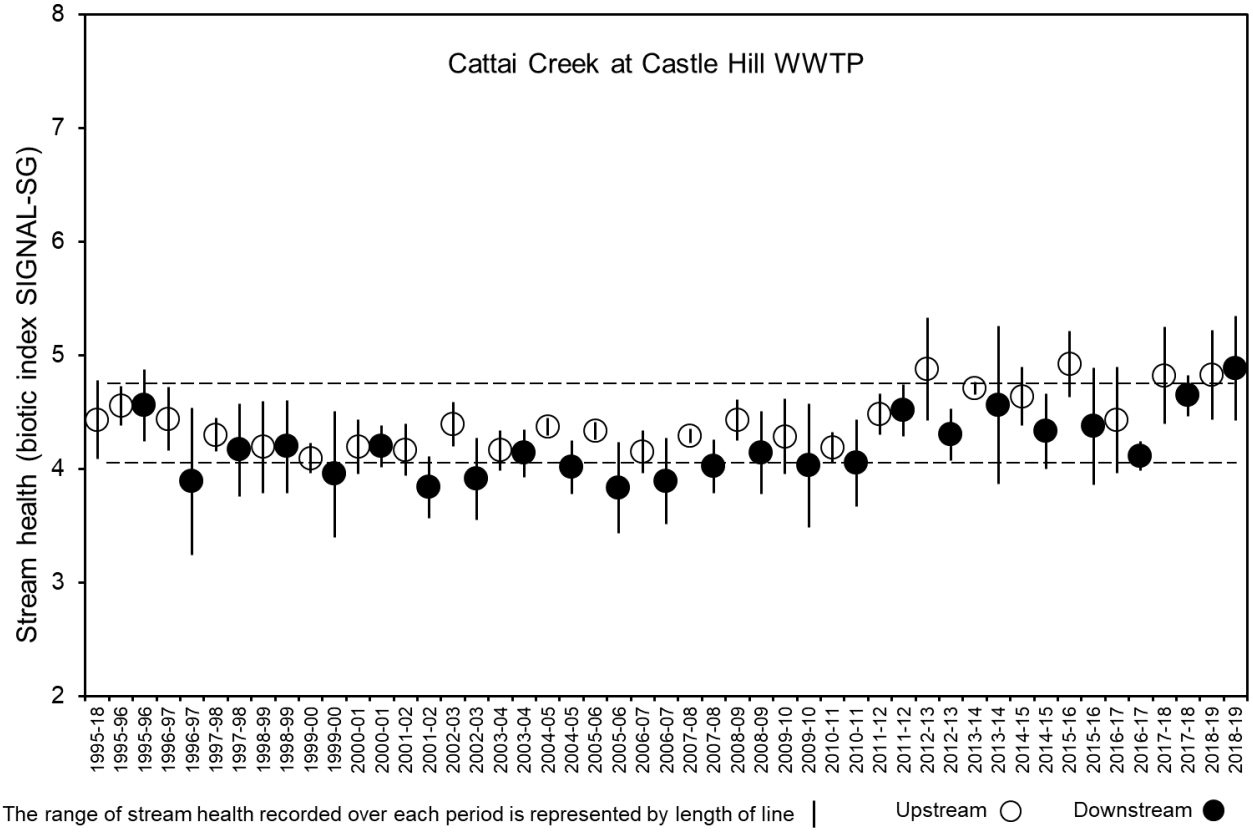


Figure N-38 Stream health of Cattai Creek near Castle Hill WWTP

Table N-55 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Cattai Creek near Castle Hill WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	0.22	0.8281

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	1.37	0.7373

Stream health near Rouse Hill WWTP

The SIGNAL-SG plot for Second Ponds Creek provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1995 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site indicating wastewater discharge from Rouse Hill WWTP did not have a measurable impact on stream health during 2018-19 (Figure N-39).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a non-significant test outcome (Table N-56) and confirmed the visual trend. Downstream stream health returned to within the long term health range after being at its highest observed level in 2017-18.

As no measurable negative impact on downstream stream health was detected, no further data analysis was undertaken.

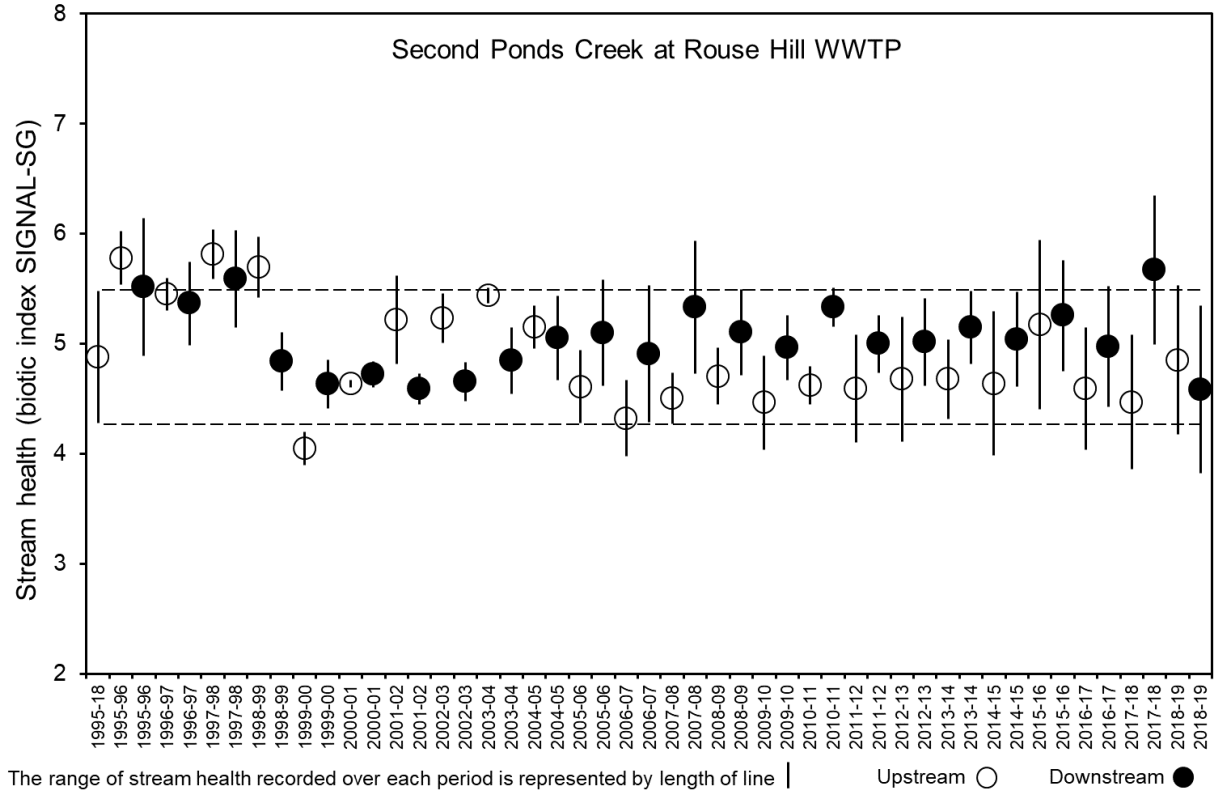


Figure N-39 Stream health of Second Ponds Creek near Rouse Hill WWTP

Table N-56 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Second Ponds Creek near Rouse Hill WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	-0.65	0.5332

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	1.26	0.8047

Stream health and community structure near Hornsby Heights WWTP

The SIGNAL-SG plot for Calna Creek provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1996 and 2018. This comparison suggests downstream stream health has not been maintained at a level comparable to that of the upstream site, indicating wastewater discharge from the Hornsby Heights WWTP did have a measurable persistent impact on stream health during over the last eight financial years (Figure N-40).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a significant test outcome (Table N-57).

As a measurable negative impact on downstream stream health was detected, further analysis of the macroinvertebrate community data was undertaken to explore for trends not revealed in the SIGNAL-SG analysis.

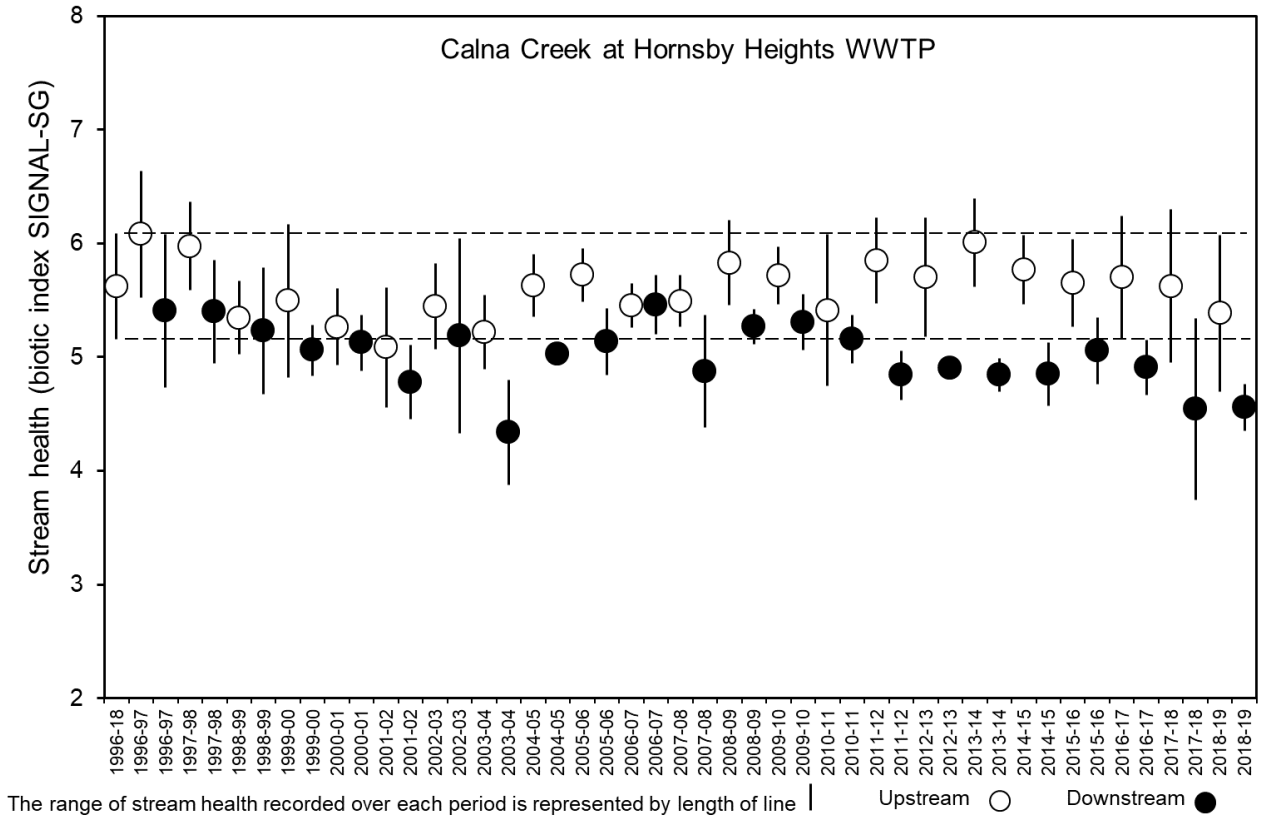


Figure N-40 Stream health of Calna Creek near Hornsby Heights WWTP

Table N-57 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Calna Creek near Hornsby Heights WWTP

Method	Variances	DF	t Value	Pr > |t|
Satterthwaite	Unequal	5.8972	-2.83	0.0304

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	11.06	0.0196

Both edge and riffle habitats were collected consistently enough at upstream-downstream sites on the same sampling occasions to allow a multivariate analysis for the monitoring period of 1996 to 2019. Each habitat (edge and riffle) was analysed separately with comparisons assessed with upstream-downstream sites.

In the three-dimensional nMDS ordination plot of the Calna Creek edge habitat, a relatively interspersed pattern of upstream and downstream samples were observed (Figure N-41). This pattern was confirmed in the corresponding tree diagram from cluster analysis as the first division did not separate a group of upstream samples from another group of downstream samples (Figure N-43). The riffle habitat pattern displayed less overlap of upstream-downstream samples in the Calna Creek ordination plot (Figure N-42) and tree diagram (Figure N-44) compared to the edge habitat.

The PERMDISP analysis indicated a similar pattern of dispersion (spacing between same samples) for the upstream and downstream sites of the riffle habitat (Table N-63). This suggests the variability in taxonomic composition of samples collected over time was similar for upstream and downstream riffle sites through the period 1995 to 2019. As such, the subsequent riffle habitat results of ANOSIM tests were focused on community structure differences between sites. In contrast, significant dispersion was shown for the edge habitat samples (Table N-62). This outcome suggests subsequent edge habitat results of ANOSIM tests are describing both the variability in taxonomic composition of samples over time as well as community composition variability between the upstream and downstream sites.

An ANOSIM test was run on the factor ‘Site’. The returned R-values were at a low-range level for edge (Table N-58) and at a mid-range level for riffle (Table N-59). These R-value results suggest site specific assemblages were more distinguishable for the riffle habitat and less distinguishable for the edge habitat. This pattern is reinforced by the shade plots that show a clear difference in sites within the riffle habitat (Figure N-46) and a less distinct pattern within the edge habitat (Figure N-45). These shade plots also show the riffle habitat has a smaller set of taxa (57) compared with the more diverse edge habitat (104 taxa). The BVSTEP routine was used to find a subset of taxa whose multivariate pattern matched that of the full dataset with 19 taxa identified for the riffle habitat (Table N-67) and 34 taxa for the edge habitat (Table N-66). These subsets of taxa reflect those taxa which formed the main visual patterns in the respective shade plots.

To further explore community structure, hypothesis testing was conducted with a PERMANOVA model. This model comprised the fixed factors ‘Site’ and ‘Year’ with ‘Year’ representing samples collected between 1996 and 2019 and ‘Site’ having two levels, upstream and downstream. A statistically significant ‘Site x Year’ interaction was returned for both the edge and the riffle habitats (Table N-60 and Table N-61) suggesting a change through time at least at one site.

A second run of ANOSIM based on ‘Site-Period’ groups in the 3D ordination plots (Figure N-41 and Figure N-42) returned a significant global low-range R-value (0.342) for the edge habitat. Under subsequent upstream-downstream pairwise comparisons, two tests returned an R-value at a level (R = 0.921 and 0.917) (Table N-64) that can be expected from natural differences between groups from variation in the substratum composition of the habitats between sites. Besley and Chessman (2008) found R-values up to 0.66 for sites on the same near-pristine stream. A mid-range global R-value (0.625) was returned for the riffle habitat and three of the upstream and downstream pairwise comparisons returned R-values (0.967, 0.71 and 0.928) (Table N-65) that were at a level that implied more than natural substratum differences between sites.

In summary, the SIGNAL-SG control chart plot showed clear differences between the upstream-downstream sites consistently over the last eight financial years. Variability in the range of stream health levels were also evident for upstream-downstream sites in this SIGNAL-SG control chart. This variability and difference in assemblage structure suggested by SIGNAL-SG results was also evident in multivariate analysis. Both SIGNAL-SG and multivariate results suggest downstream community structure in Calna Creek has been consistently altered by wastewater discharge from the Hornsby Heights WWTP through the 2011 to 2019 monitoring period.

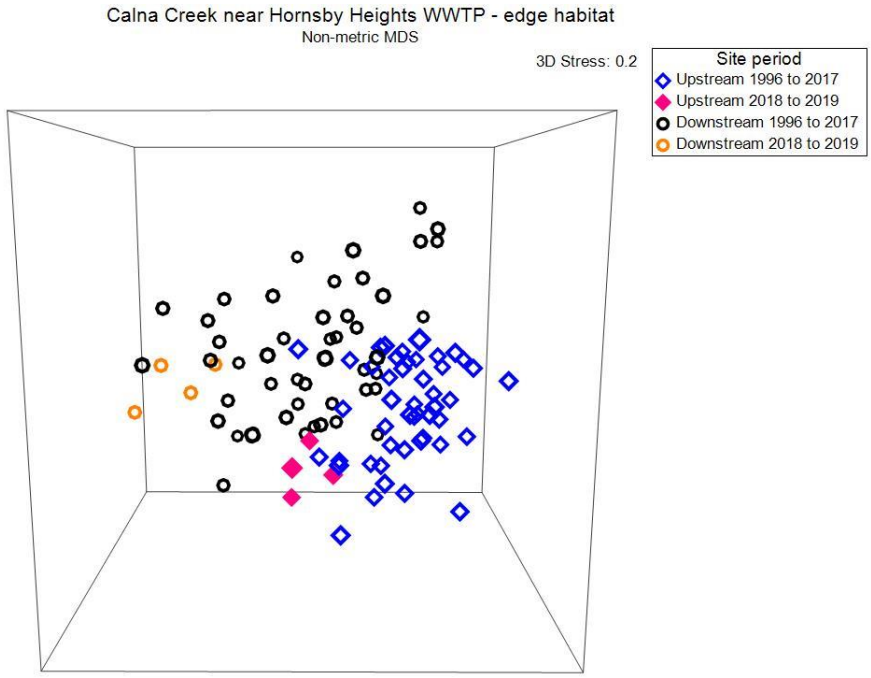


Figure N-41 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP

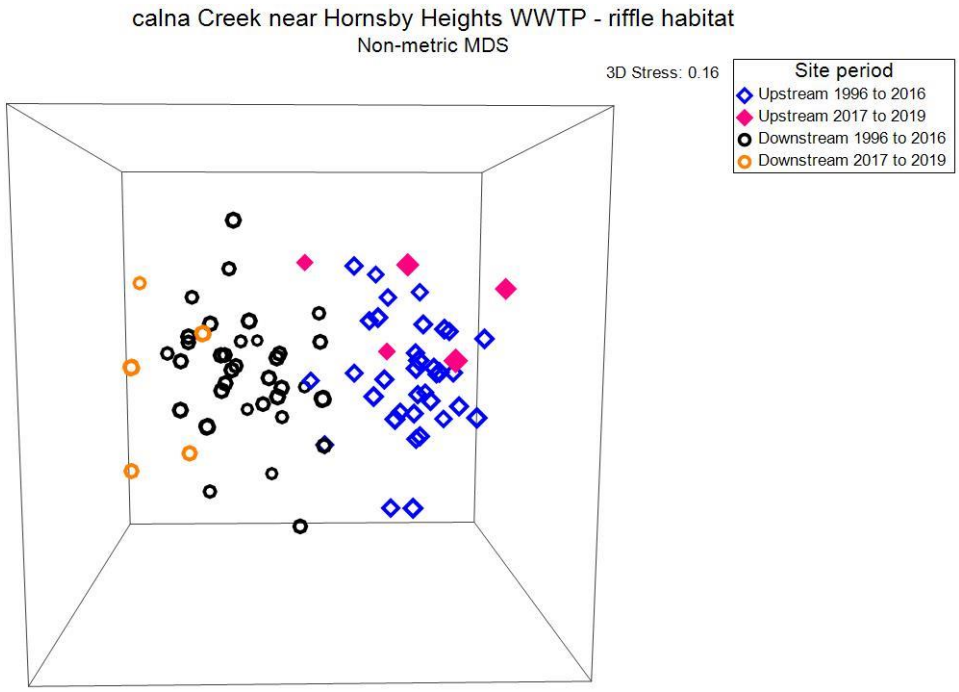


Figure N-42 Two-dimensional ordination plot of freshwater macroinvertebrate riffle habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP

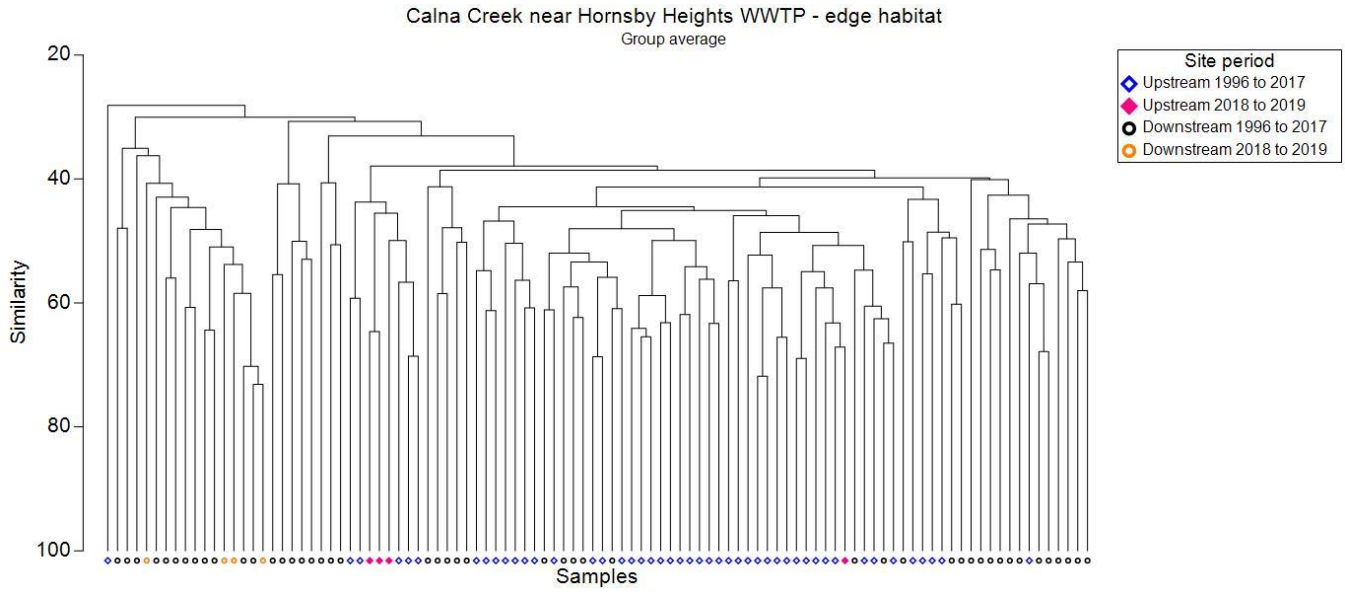


Figure N-43 Tree diagram of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP

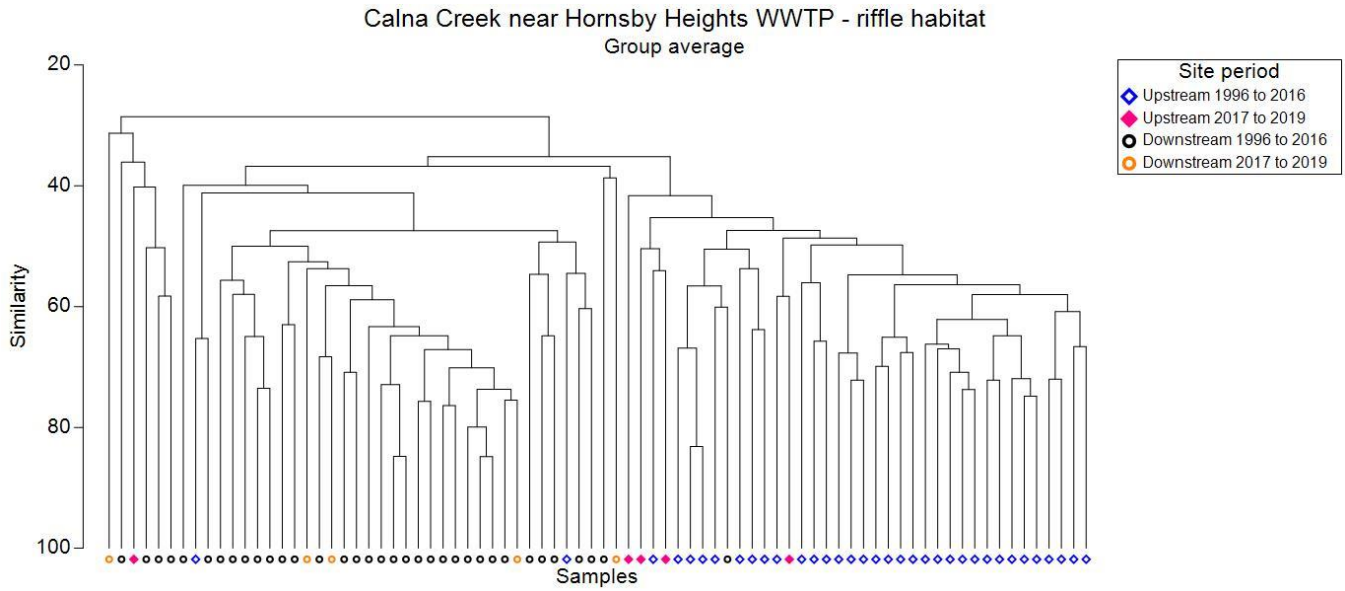


Figure N-44 Tree diagram of freshwater macroinvertebrate riffle habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP

Table N-58 ANOSIM test of 'Site' factor for edge habitat of Calna Creek near Hornsby Heights WWTP

Analysis of Similarities
Site levels
Downstream
Upstream

Tests for differences between unordered Site groups
Global Test

Sample statistic (R): 0.327
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-59 ANOSIM test of 'Site' factor for riffle habitat of Calna Creek near Hornsby Heights WWTP

Analysis of Similarities
Site levels
Upstream
Downstream

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.609
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Table N-60 PERMANOVA test of 'Site' and 'Year' factors for edge habitat of Calna Creek near Hornsby Heights WWTP

Hornsby Heights WWTP
Permutational MANOVA

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	24

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	15976	15976	10.994	0.0001	9927
Year	23	62406	2713.3	1.8671	0.0001	9699
SitexYear	23	42752	1858.8	1.2791	0.0005	9655
Res	54	78473	1453.2			
Total	101	2.0293E+05				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	310.97	17.634
S(Year)	297.76	17.256
S(SitexYear)	191.69	13.845
V(Res)	1453.2	38.121

Table N-61 PERMANOVA test of 'Site' and 'Year' factors for riffle habitat of Calna Creek near Hornsby Heights WWTP

Permutational MANOVA

Resemblance worksheet
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Site	Fixed	2
Year	Fixed	24

PERMANOVA table of results

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Site	1	30406	30406	26.531	0.0001	9942
Year	23	42302	1839.2	1.6048	0.0001	9730
SitexYear	23	33508	1456.9	1.2712	0.0141	9776
Res	32	36673	1146			
Total	79	1.4575E+05				

Estimates of components of variation

Source	Estimate	Sq.root
S(Site)	812.78	28.509
S(Year)	208.68	14.446
S(SitexYear)	187.14	13.68
V(Res)	1146	33.853

Table N-62 PERMDISP test of 'Site' factor for edge habitat of Calna Creek near Hornsby Heights WWTP

Heights WWTP
Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999

Number of groups: 2
Number of samples: 102

DEVIATIONS FROM CENTROID
F: 24.313 df1: 1 df2: 100
P(perm): 0.0001

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Downstream	51	44.711	0.8141
Upstream	51	39.243	0.75317

Table N-63 PERMDISP test of 'Site' riffle habitat of Calna Creek near Hornsby Heights WWTP

Dispersion weighting
Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

Group factor: Site
Number of permutations: 9999

Number of groups: 2
Number of samples: 80

DEVIATIONS FROM CENTROID
F: 1.6958 df1: 1 df2: 78
P(perm): 0.2367

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Upstream	40	35.107	1.2047
Downstream	40	37.719	1.6037

Table N-64 ANOSIM test of 'Site period' for edge habitat of Calna Creek near Hornsby Heights WWTP

Analysis of Similarities
Global Test
Sample statistic (R): 0.342
Significance level of sample statistic: 0.1%
Number of permutations: 999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Downstream 1996 to 2017, Upstream 1996 to 2017	0.323	0.1	Very large	999	0
Downstream 1996 to 2017, Downstream 2018 to 2019	0.117	20	249900	999	199
Downstream 1996 to 2017, Upstream 2018 to 2019	0.064	30.4	249900	999	303
Upstream 1996 to 2017, Downstream 2018 to 2019	0.921	0.1	249900	999	0
Upstream 1996 to 2017, Upstream 2018 to 2019	0.369	0.9	249900	999	8
Downstream 2018 to 2019, Upstream 2018 to 2019	0.917	2.9	35	35	1

Table N-65 ANOSIM test of 'Site period' for riffle habitat of Calna Creek near Hornsby Heights WWTP

Analysis of Similarities
Global Test
Sample statistic (R): 0.625
Significance level of sample statistic: 0.1%
Number of permutations: 9999 (Random sample from a large number)

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
Upstream 1996 to 2016, Upstream 2017 to 2019	0.615	0.1	658008	999	0
Upstream 1996 to 2016, Downstream 1996 to 2016	0.624	0.1	Very large	999	0
Upstream 1996 to 2016, Downstream 2017 to 2019	0.967	0.1	658008	999	0
Upstream 2017 to 2019, Downstream 1996 to 2016	0.71	0.1	658008	999	0
Upstream 2017 to 2019, Downstream 2017 to 2019	0.928	0.8	126	126	1
Downstream 1996 to 2016, Downstream 2017 to 2019	0.197	12.1	658008	999	120

Table N-66 Genera subset whose multivariate pattern matches full genera set of the edge habitat Calna Creek near Hornsby Heights WWTP

Subset of 34 (correlation 0.951) genera from edge habitat whose pattern matches that of the full set of 104 genera identified with same subset found on 32 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:

Ceratopogonidae *Bezzia*,Chironomidae *Chironomus*,Chironomidae *Cryptochironomus*,Chironomidae *Dicrotendipes*,Chironomidae *Microtendipes*,Chironomidae *Polypedilum*,Chironomidae *Procladius*,Chironomidae *Rheocricotopus*,Chironomidae *Rheotanytarsus*,Chironomidae *Riethia*,Chironomidae *Tanytarsus*,Coenagrionidae *Austroagrion*,Corduliidae *Hemicordulia*,Corydalidae *Archichauliodes*,Dugesiidae *Cura*,Elmidae *Kingolus*,Elmidae *Notriolus*,Gerridae *Tenagogerris*,Glossiphoniidae *Helobdella*,Gomphidae *Austrogomphus*,Hydroptilidae *Hellyethira*,Limnesiidae *Limnesia*,Lumbriculidae *Lumbriculus*,Lymnaeidae *Pseudosuccinea*,Megapodagrionidae *Austroargiolestes*,Naididae *Branchiura*,Notonectidae *Anisops*,Notonectidae *Enithares*,Physidae *Physella*,Psephenidae *Sclerocyphon*,Stratiomyidae *Odontomyia*,Tateidae *Potamopyrgus*,Veliidae *Microvelia*,Argiolestidae *Austroargiolestes*

Table N-67 Genera subset whose multivariate pattern matches full genera set of the riffle habitat Calna Creek near Hornsby Heights WWTP

Subset of 19 (correlation 0.950) genera from riffle habitat whose pattern matches that of the full set of 57 genera identified with same subset found on 40 runs from 50 random start runs. Each run was based 3 randomly selected genera. Genera were:

Elmidae *Simsonia*,Tateidae *Potamopyrgus*,Physidae *Physella*,Elmidae *Notriolus*,Hydropsychidae *Cheumatopsyche*,Chironomidae *Cricotopus*,Simuliidae *Simulium*,Elmidae *Kingolus*,Philopotamidae *Chimarra*,Psephenidae *Sclerocyphon*,Chironomidae *Polypedilum*,Corydalidae *Archichauliodes*,Chironomidae *Rheotanytarsus*,Dugesiidae *Cura*,Gomphidae *Hemigomphus*,Chironomidae *Parakiefferiella*,Chironomidae *Thienemanniella*,Megapodagrionidae *Austroargiolestes*,Gelastocoridae *Nerthra*

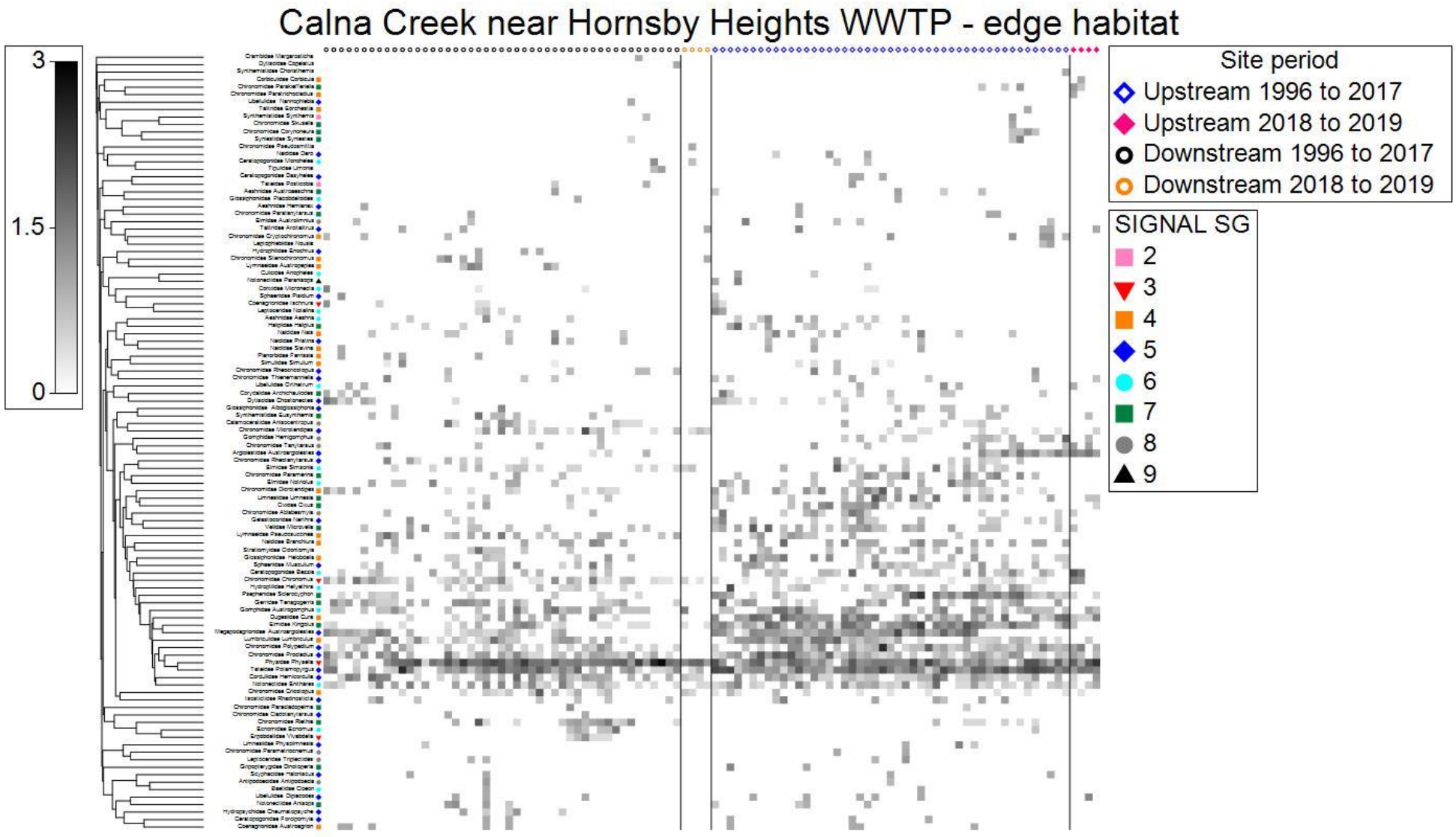


Figure N-45 Shade plot of freshwater macroinvertebrate edge habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP

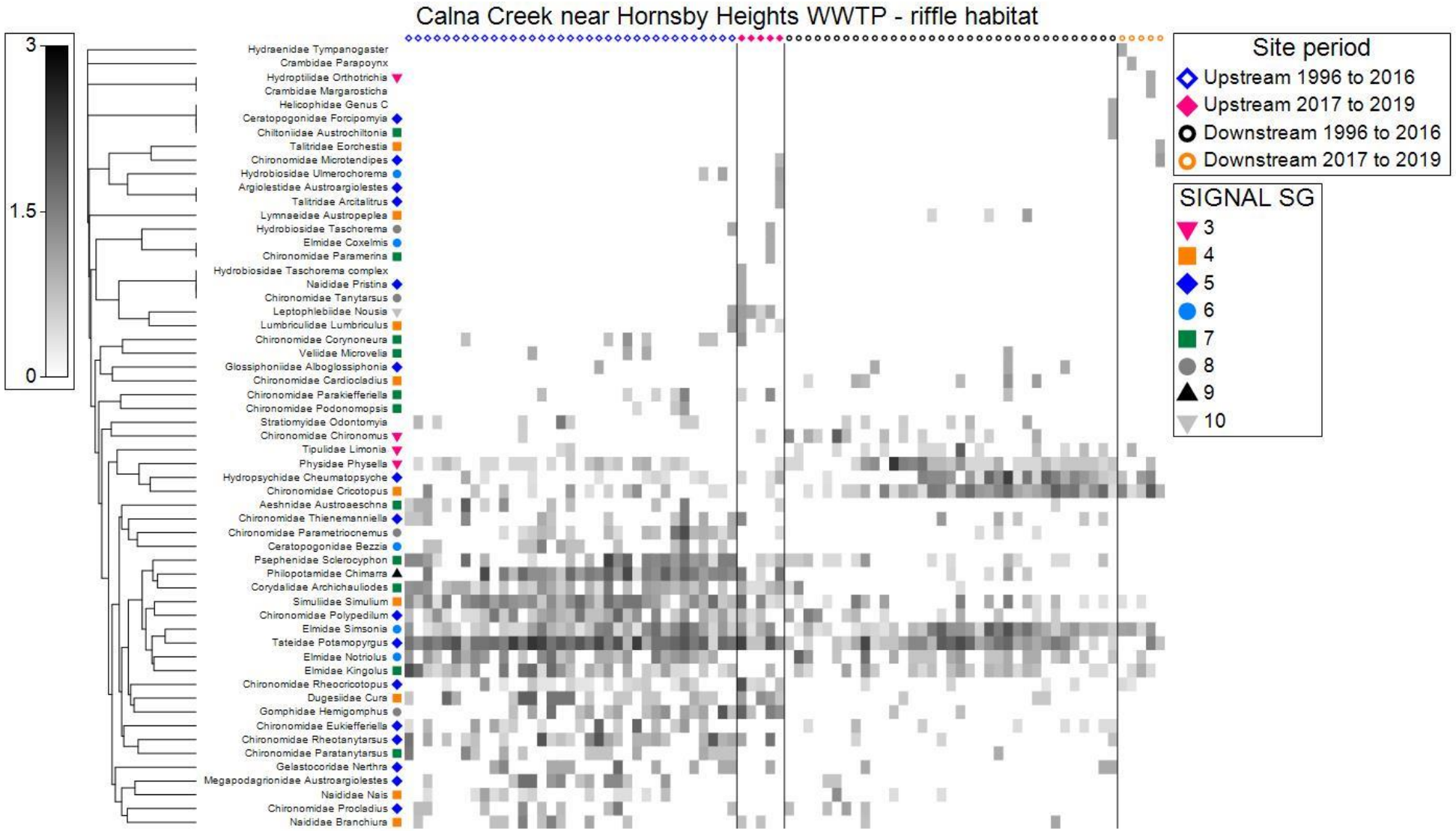


Figure N-46 Shade plot of freshwater macroinvertebrate riffle habitat community structure of upstream-downstream sites of Calna Creek near Hornsby Heights WWTP

Stream health near West Hornsby WWTP

The SIGNAL-SG plot for Waitara Creek provided an assessment of stream health. This plot was based on macroinvertebrate identification and counting results expressed as SIGNAL-SG scores and allows a visual comparison of data collected from 2018–19 against that collected between 1996 and 2018. This comparison suggests downstream stream health was maintained at a level comparable to that of the upstream site indicating wastewater discharge from West Hornsby WWTP did not have a measurable impact on stream health during 2018-19 (Figure N-47).

A comparison of the upstream-downstream SIGNAL-SG scores for 2018-19 samples under a t-test returned a non-significant test outcome (Table N-68) and confirmed the visual trend.

As no measurable negative impact on downstream stream health was detected, no further data analysis was undertaken.

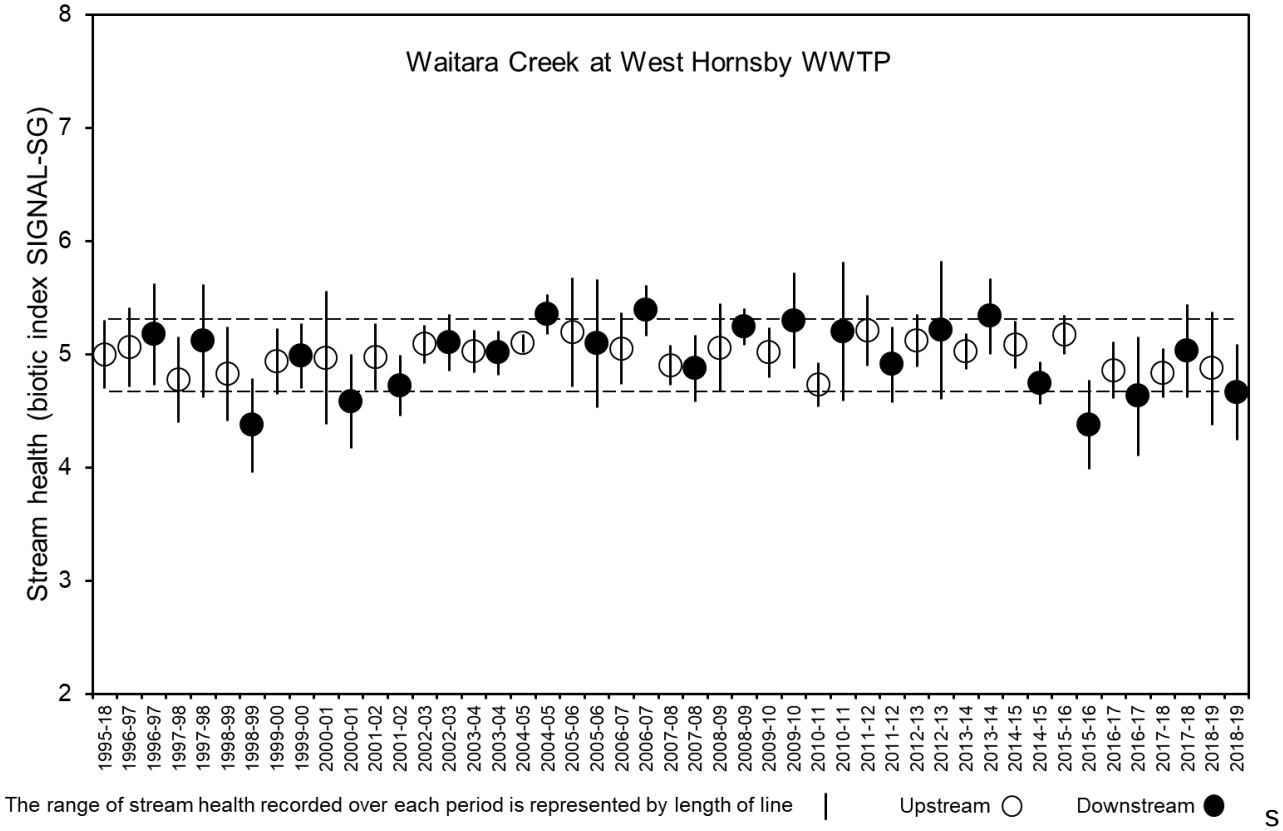


Figure N-47 Stream health of Waitara Creek near West Hornsby WWTP

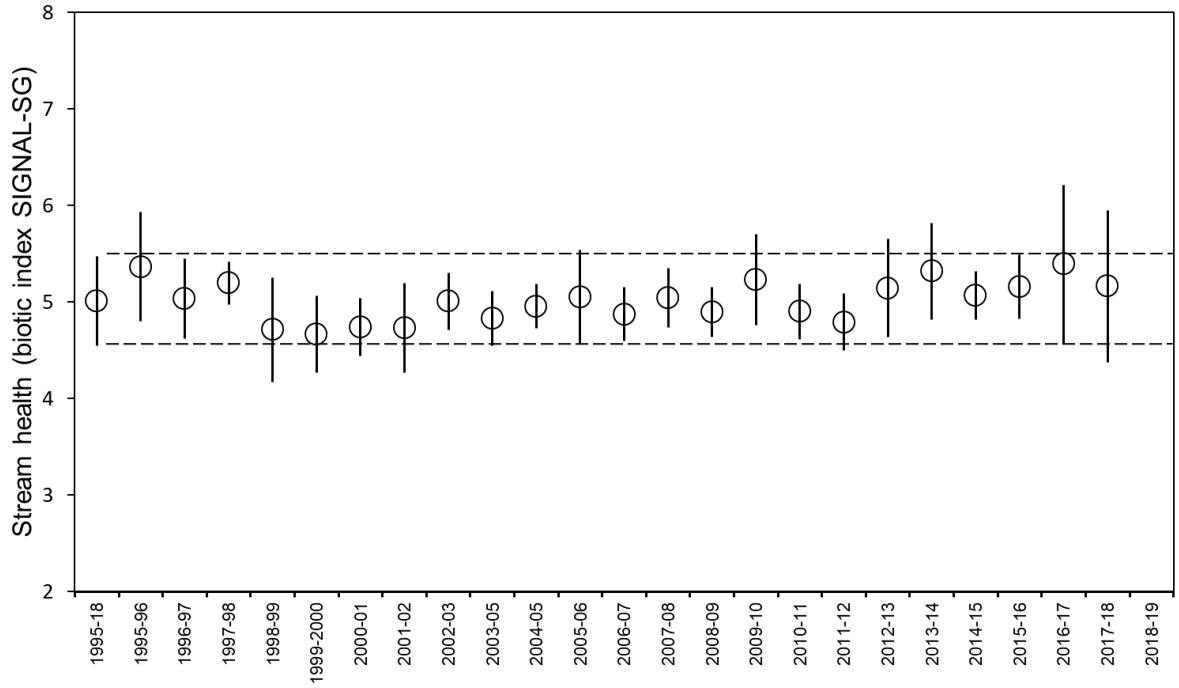
Table N-68 t-test of upstream-downstream SIGNAL-SG scores of 2018-19 samples from Waitara Creek near West Hornsby WWTP

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	10	-0.78	0.4510

Equality of Variances				
Method	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Folded F	5	5	1.38	0.7316

Other sites of the Hawkesbury-Nepean River system that are only assessed under the macroinvertebrate indicator and not directly related to WWTP discharges follow.

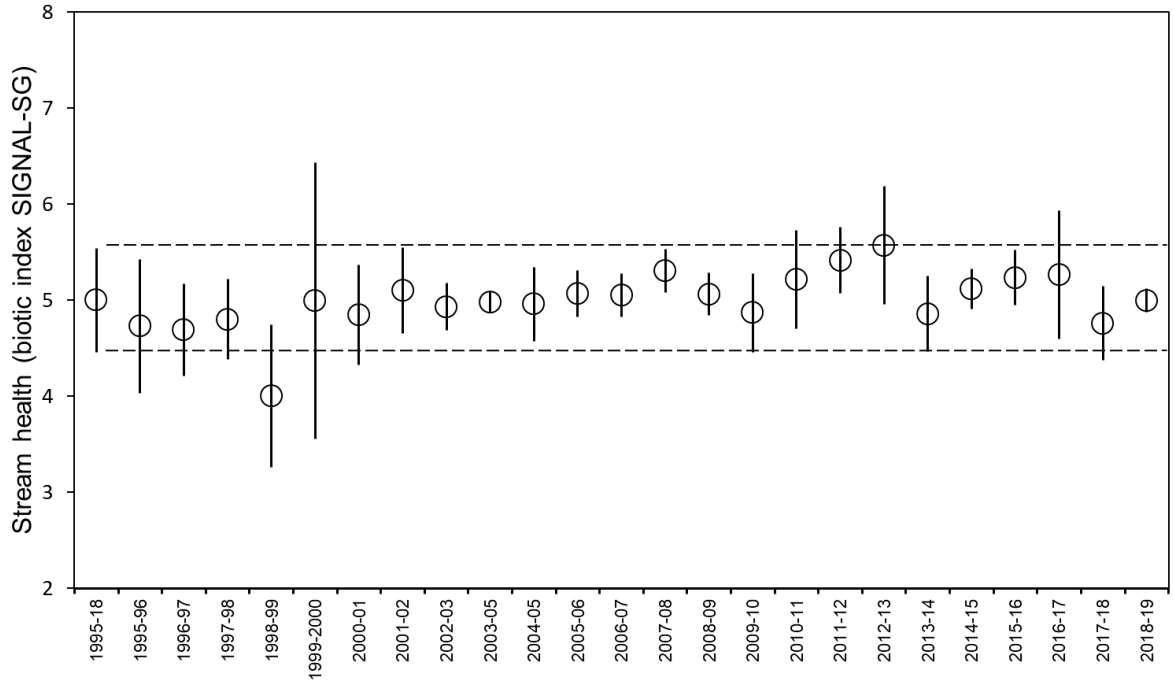
Cattai Creek at Annangrove Road, d/s of both Rouse Hill and Castle Hill plants



The range of stream health recorded over each period is represented by length of line |

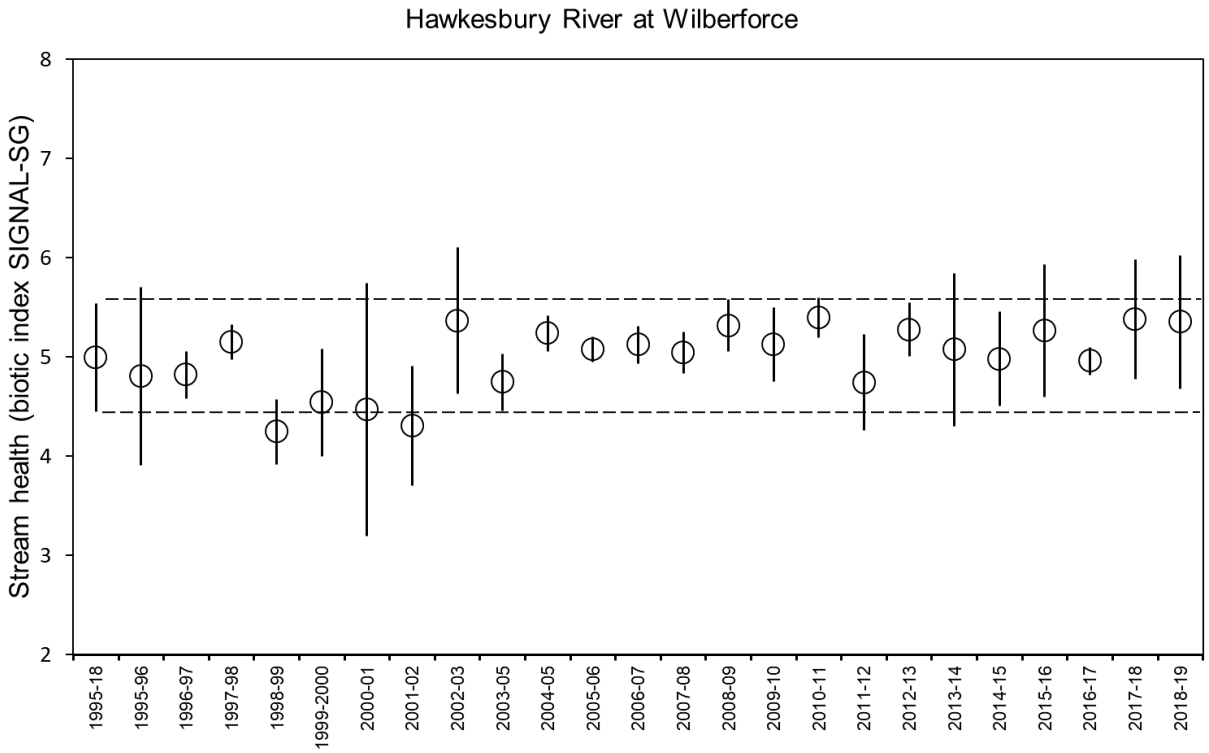
No samples were taken at NC5 in 2018-19 due to safety concerns associated with illegal dumping of as952ear the sampling site.

Hawkesbury River at Windsor Bridge, u/s South Creek

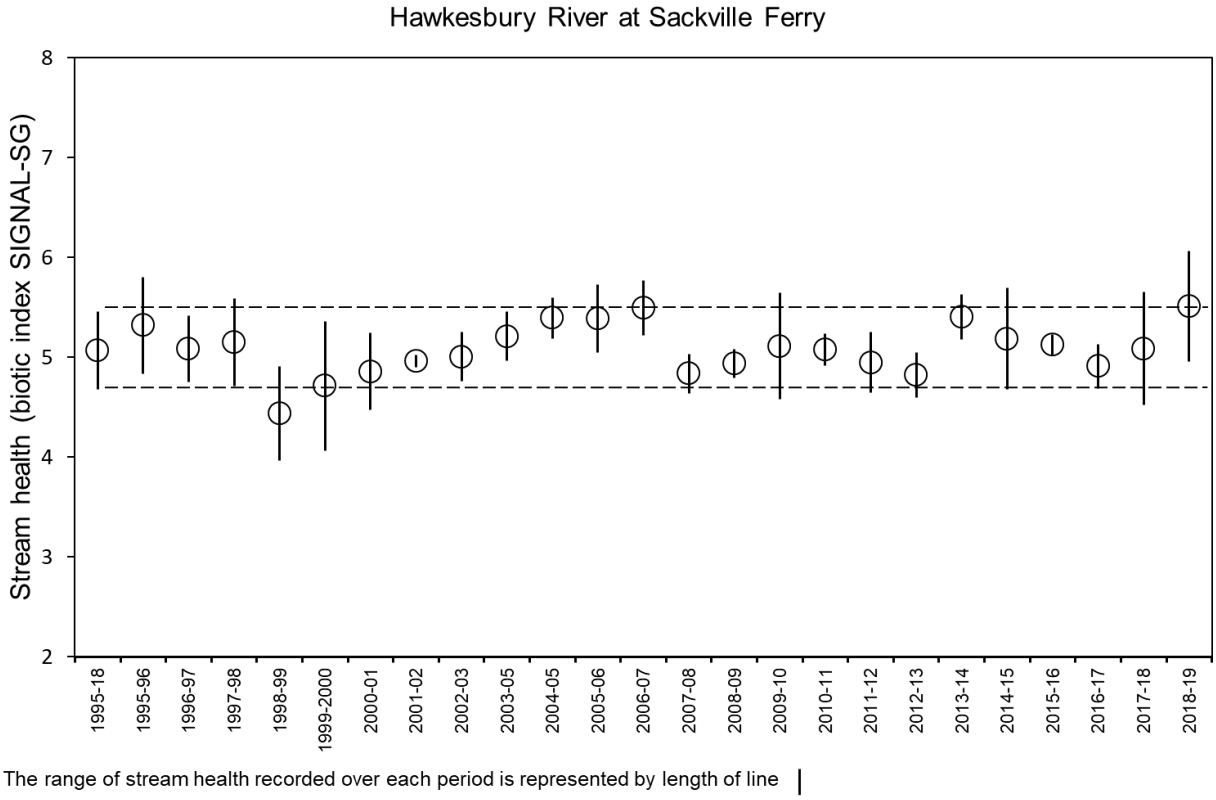


The range of stream health recorded over each period is represented by length of line |

Mean stream health in 2018-19 was within the range recorded over the period back to 1995.



Mean stream health in 2018-19 was within the range recorded over the period back to 1995.



Mean stream health in 2018-19 was within the range recorded over longer period back to 1995.

Appendix O Stream health of other Sydney rivers

Sites monitored for the macroinvertebrate indicator in freshwater streams assessed the general condition of stream health in urban areas. Among these, four are control sites located upstream of any likely impact from urban areas. Three out of four urban sites are situated in areas just upstream of estuarine limits of the Parramatta River (PJPR), Lane Cove River (PJLC) and Georges River (GR22). The fourth urban site is situated about 5 km further up in the Georges River (GR23). The control sites were Lynch's Creek (N451) a tributary of Hawkesbury-Nepean River, Hacking River at McKell Avenue in Royal National Park (PH22), the upper Georges River system at O'Hares Creek (GE510) and Georges River at Ingleburn Reserve (GR24).

Results from 2018-19 indicate stream health for one of the four control sites (N451) was typical of natural water quality in bushland areas that do not receive urban stormwater runoff or sewer overflows (Figure O-1 and Figure O-2). The mean stream health for the Hacking River at Mckell Avenue fell within the 'mild water pollution' category (Figure O-1). Additionally, mean stream health for the Georges River at Ingleburn Reserve (GR24 - control site) and O'Hares Creek were within the 'mild water pollution' category (Figure O-2).

Urban sites within the Port Jackson Rivers upstream of Lane Cove Weir (PJLC) and Parramatta Weir (PJPR) fell into the 'Moderate water pollution' category (Figure O-1). Additionally, urban sites within the Georges River for 2018-19 fell around the boundary of mild to moderate impaired stream health (Figure O-2). These results were near the upper part of the range of stream health that has been recorded for these urban sites over the previous 1995 to 2018 period.

Results from these test sites represent the ambient condition of the combined impact of urban stormwater runoff and sewer overflows. These two influences cannot be teased apart. Pilot studies are being designed under Sydney Water's wet weather overflow program to model a stormwater control condition, which may then better define the impact of sewer overflows on urban streams than these current single site assessments.

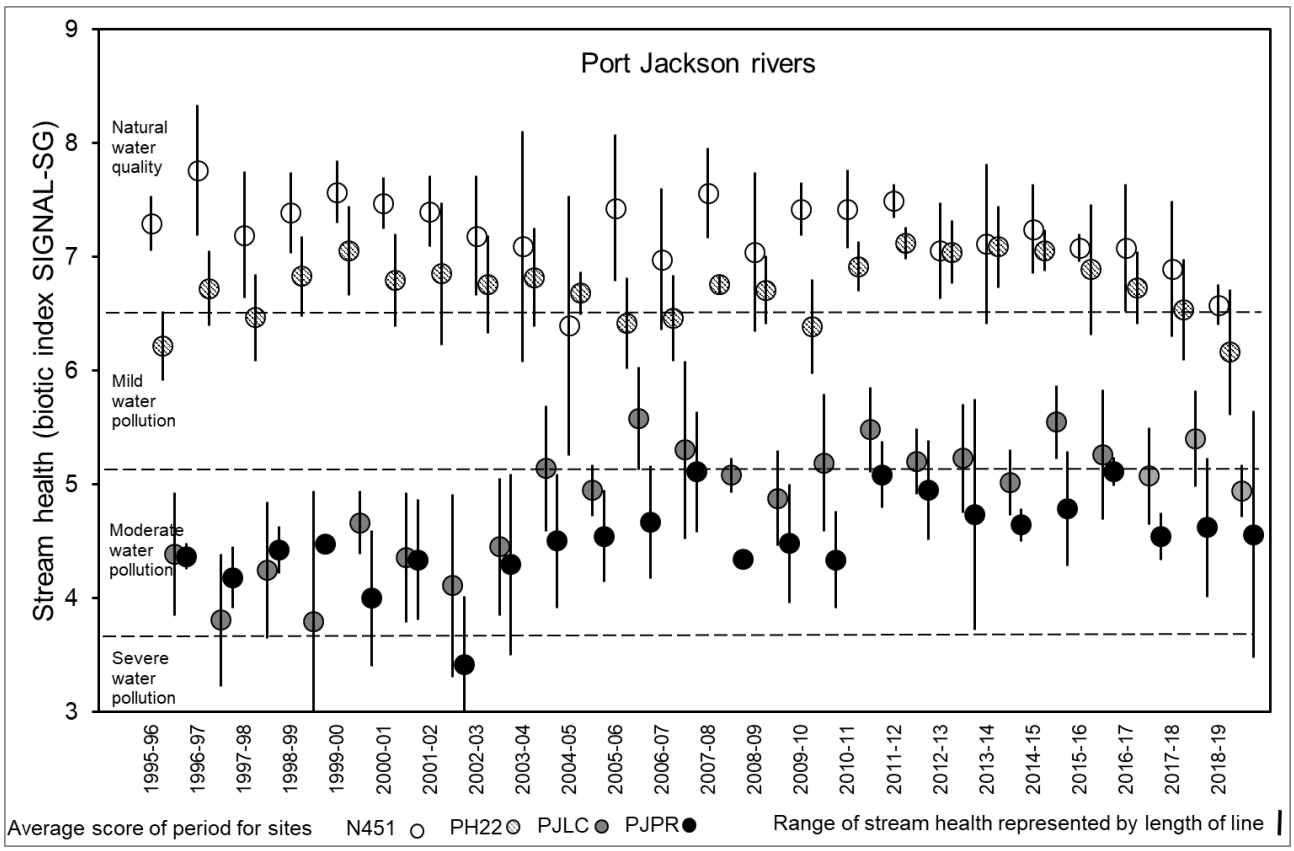


Figure O-1 Stream health of Lane Cove and Parramatta rivers in comparison to control sites

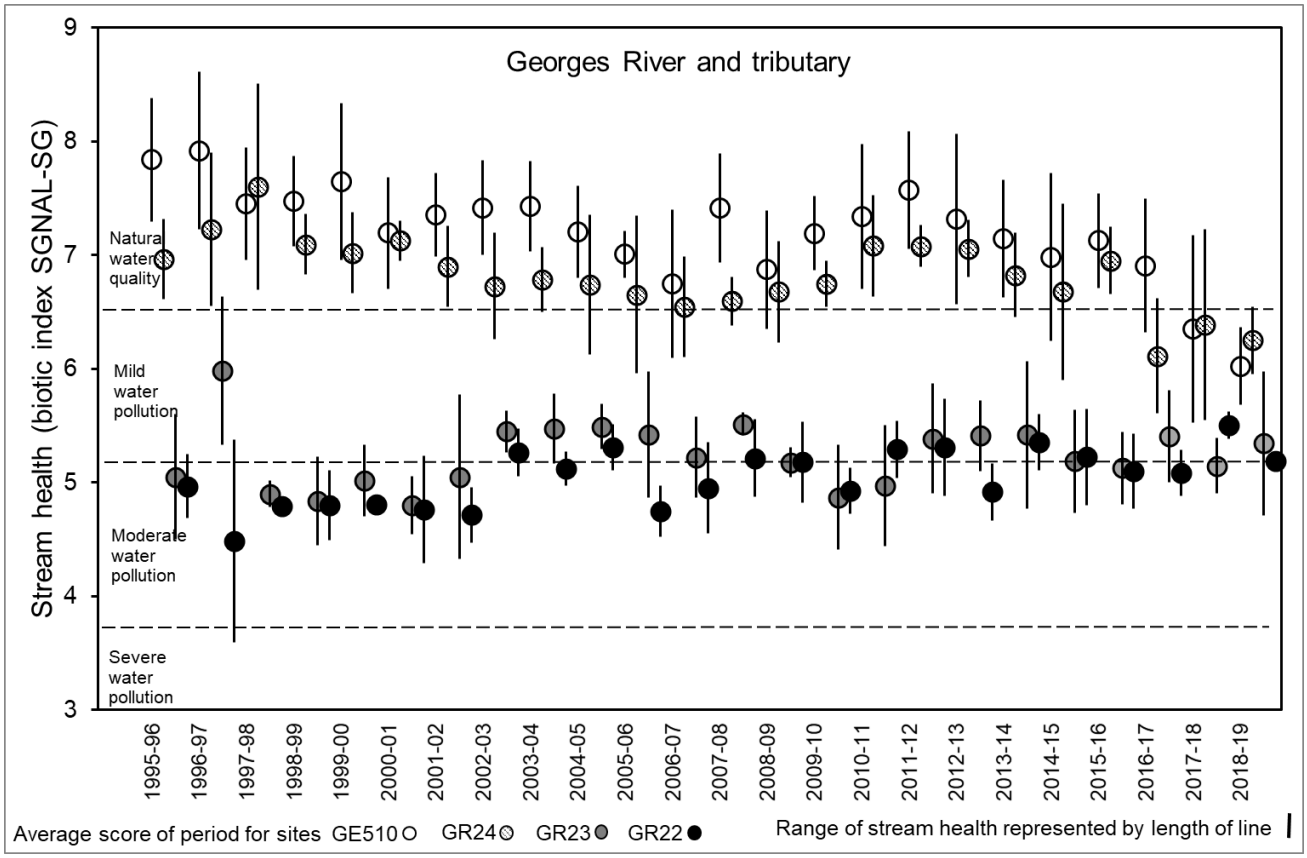


Figure O-2 Stream health of lower freshwater Georges River sites compared to control sites in the upper Georges River system