Biodiversity and Conservation Science

Swan Canning Estuary - Indicators and Targets

Supporting document to the Swan Canning River Protection Strategy Five Year Review – 2022.

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Reporting on Indicators and Targets

1 Background and overview

Under the Swan and Canning Rivers Management Act 2006, the Swan River Trust is required to monitor and report to the Minister of Environment on a series of performance indicators as part of a five-yearly review of the River Protection Strategy (RPS; 2015). One of those indicators is that 75% of monitored ecosystem health data meets respective targets required for a healthy and functioning ecosystem. Consistent with the biennial review of the RPS (Swan River Trust, 2018), the ecosystem health targets were comprised of both biophysical and ecological indicators, which included:

- catchment water quality
- estuarine water quality
- conditions in the oxygenation zones; and
- the fish community index.

In addition, the five-year review includes an additional indicator, seagrass health, which was added following the development of a health index collaboration with the Department of Water and Environmental Regulation (DWER, 2018).

The performance indicator for ecological health in 2020 was determined by comparing data collected between 2015 and 2020 against prescribed targets and pooling those to arrive at an overall score (Table 1). Thereby in 2020 it was determined that 72% of ecosystem health data met the target for a healthy and functioning ecosystem.

Information in this report underpins the RPS five year review (SRT, 2022).

Table 1 Summary of overall ecosystem health within the Swan-Canning Estuary.

Ecosystem Health Indicators		Maximum Score	Actual Score
Catchment Water Quality	Total Nitrogen and Total Phosphorus meets Short Term and Long Term targets specified by the Swan Canning Cleanup Program (Swan River Trust, 2001)	296	224
Estuary Water Quality	For each Ecological Management Zone, chlorophyll a and dissolved oxygen meet targets prescribed by Swan Canning Cleanup Program (Swan River Trust, 2001)	40	5
Oxygenation Conditions	> 80% of all individual DO measurements (data points) collected for each Oxygenation Zone during the oxygenation season to be above 4 mg/L	10	10
Seagrass Health	Seagrass performance index is 2.25 or better in each seagrass zone	6	6
Fish Communities	Fish Community Index score is “fair” or better for each ecological management zone.	80	67
TOTAL		**432**	**312**
			72.2%

The derivation of these scores are described in the sections below.

2 Catchment Water Quality

2.1 Method for target calculation

The Swan-Canning Catchment water quality targets for total nitrogen (TN) and total phosphorus (TP) were established by Donohue et al. (2001; Table 2) and the methodology for calculating the compliance of the TN and TP concentrations against these short- and long-term targets follow those of the same report and of the Swan River Trust' (2001) Swan-Canning Clean-up Program report. These apply a binomial method to account for variability in analyte concentrations and sampling method.

Table 2 Swan-Canning Catchment targets for total nitrogen (TN (mg L-1) and total phosphorus (TP (mg L-1) for the 2016-2020 reporting period.

Analyte	Short-term target	Long-term target
TN (mg L-1)	2.0	1.0
TP (mg L-1)	0.2	0.1

This approach uses the number of sampling events (*n*) to establish a maximum number of allowable exceedances (*eMax*) to both the short- and long-term catchment nutrient targets, with this value influenced by past Key Performance Indicator (KPI) assessments (see Appendix 1)

In any one year, the KPI is evaluated using data on analyte concentration collected in weeks 22-43 for the previous three years. Thus, to establish the KPI status of 2020, data collected in weeks 22-43 of years 2017-2019 was used.

2.2 Compliance summary for 5 years and application to RPS

For each KPI year, a pass or fail status was dependent on the assessment of the count of exceedances (*e*) against the *eMax* value, with the long-term targets only being able to be assessed if the short-term targets were first passed (see Appendix 1). KPI status against TN and TP targets in any one year was then summarized for each catchment (Table 3 and Table 4).

Table 3 KPI status based on exceedances of TN targets (as shown in Appendix 1*). ND= no data.*

Catchment	2016		2017		2018		2019		2020	
	Total Nitrogen		Total Nitrogen		Total Nitrogen		Total Nitrogen		Total Nitrogen	
	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target
Avon River	pass	pass	pass	pass	pass	fail	pass	fail	pass	fail
Bannister Creek	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail
Bayswater Brook	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail
Bennett Brook	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail
Bickley Brook	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail
Blackadder Creek	pass	pass	pass	fail	pass	fail	pass	fail	pass	fail
Canning River	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Ellen Brook	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail
Helena River	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Jane Brook	pass	pass	pass	pass	pass	pass	pass	fail	pass	pass
Mills Street Main Drain	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail
South Belmont Main Drain	pass	pass	pass	pass	nd	nd	pass	fail	pass	fail
Southern River	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail
Susannah Brook	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Yule Brook	pass	pass	pass	pass	pass	fail	pass	fail	pass	fail

Table 4 KPI status based on exceedances of TP targets (as shown in Appendix 1*). ND= no data.*

Catchment	2016		2017		2018		2019		2020	
	Total Phosphorus		Total Phosphorus		Total Phosphorus		Total Phosphorus		Total Phosphorus	
	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target
Avon River	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Bannister Creek	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Bayswater Brook	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Bennett Brook	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Bickley Brook	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Blackadder Creek	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Canning River	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Ellen Brook	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail
Helena River	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Jane Brook	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass

Catchment	2016		2017		2018		2019		2020	
	Total Phosphorus		Total Phosphorus		Total Phosphorus		Total Phosphorus		Total Phosphorus	
	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target	Short Term Target	Long Term Target
Mills Street Main Drain	pass	pass	pass	pass	pass	pass	pass	fail	pass	fail
South Belmont Main Drain	pass	pass	pass	pass	nd	nd	pass	fail	pass	fail
Southern River	pass	fail	pass	fail	pass	fail	pass	fail	pass	fail
Susannah Brook	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Yule Brook	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass

The KPI determination for catchment water quality is determined by the information contained in Table 3 and Table 4. Of the potential total KPI score of 296, there were 224 pass scores. The information was summarized for reporting on the River Protection Strategy as shown in Table 5.Trend determination for TN and TP in sub-catchments was assessed as not significant over the 5 years (see Appendix 3)

Table 5 Swan-Canning Catchment KPI compliance summary for 2016-2020. Trend over time was determined as not significant (ns) for all catchments.

Catchment Water Quality												
Catchment	Total Nitrogen (TN)						Total Phosphorus (TP)					
	2016	2017	2018	2019	2020	Trend	2016	2017	2018	2019	2020	Trend
Avon River						ns						ns
Bannister Creek						ns						ns
Bayswater Brook						ns						ns
Bennett Brook						ns						ns
Bickley Brook						ns						ns
Blackadder Creek						ns						ns
Canning River						ns						ns
Ellen Brook						ns						ns
Helena River						ns						ns
Jane Brook						ns						ns
Mills Street Main Drain						ns						ns
South Belmont Main Drain			ND			ns			ND			ns
Southern River						ns						ns
Susannah Brook						ns						ns
Yule Brook						ns						ns

No available data	ND
Met all targets	
Met short-term but not long-term targets	
Did not meet targets	

3 Estuarine Water Quality

The performance of the Swan-Canning Estuary water quality is determined for each Ecological Management Zone (EMZ) within the estuary from compliance data (2016-2020).

3.1 Method for target calculation

The Swan-Canning Estuary water quality targets chlorophyll-a (Chl-a) and dissolved oxygen (DO) were established in the Swan River Trust (2001) “Swan-Canning Clean-up Program”. The methodology for calculating the estuary targets and for calculating the compliance against these targets follow those of the same report using a binomial approach to account for not just the variability in analyte concentrations, but also the sampling methodology associated with data collection.

Table 6 Swan-Canning Estuary targets for surface chlorophyll a (Chl-a (ug L-1)) and dissolved oxygen (DO (%)) for the 2016-2020 reporting period.

Ecological Management Zone	Chl-a (ug L-1)	DO (%)
Lower Swan-Canning Estuary	3.55	82.1
Middle Swan Estuary	8.75	75.1
Upper Swan Estuary	1.982	81.2
Canning Estuary	1.167	49.1

This approach uses the number of sampling events (*n*) to establish a maximum number of allowable exceedances (*eMax*) of the estuary targets. The Key Performance Indicator (KPI) status (pass or fail) for each EMZ is dependent on the assessment of the count of target exceedances (*e*) against the *eMax* value. This assessment uses water quality data (surface DO (%), surface Chl-a (mg L^{-1}) collected between the target period of January and May of each year comprising each KPI period and assesses each concentration value from randomly selected sites within each EMZ against the targets detailed in Table 6.

3.2 Dissolved oxygen and chlorophyll a KPI compliance summary and application to five-year report on the River Protection Strategy.

For each KPI year, a pass or fail status was dependent on the assessment of the count of exceedances (*e*) of targets against the *eMax* values. The raw data used to comprise Table 7 are detailed within Appendix 2 (Table - Table). The KPI status for each EMZ for the KPI periods between 2016 and 2020 are detailed within *Table 7*. Of the potential total KPI score of 40, there were 5 pass scores.

Table 7 The number of acceptable exceedances (eMax) and the number of actual exceedances (e) of targets for and surface dissolved oxygen (DO (%)) and chlorophyll a (Chl-a ((mg L-1)) for the 2016-2020 reporting period. KPIs were passed where e<eMax.

Surface DO (%)	2016			2017			2018			2019			2020		
Ecological Management Zone	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*
Lower Swan-Canning Estuary	63	6(0)	pass	64	6(3)	pass	66	6(3)	3	66	6(3)	pass	66	6(1)	pass
Middle Swan Estuary	64	1(3)	fail	65	1(6)	fail	66	1(11)	11	66	1(9)	fail	66	1(8)	fail
Upper Swan Estuary	64	1(20)	fail	65	1(18)	fail	65	1(19)	19	65	1(15)	fail	63	1(18)	fail
Canning Estuary	64	1(11)	fail	65	1(13)	fail	66	1(11)	11	56	0(9)	fail	45	0(5)	fail

Surface Chl-a	2016			2017			2018			2019			2020		
Ecological Management Zone	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*	*n*	*eMax (e)*	*KPI*
Lower Swan-Canning Estuary	63	3 (10)	fail	64	3 (21)	fail	64	3 (22)	fail	64	3 (15)	fail	64	3(4)	fail
Middle Swan Estuary	62	3 (27)	fail	63	3 (38)	fail	65	3 (49)	fail	66	3 (47)	fail	66	3 (45)	fail
Upper Swan Estuary	64	3 (14)	fail	65	3 (25)	fail	65	3 (34)	fail	65	3 (35)	fail	65	3 (26)	fail
Canning Estuary	64	3 (29)	fail	65	3 (29)	fail	66	3 (30)	fail	56	2 (21)	fail	45	2 (10)	fail

The information was summarized for reporting on the River Protection Strategy as shown in Table 8. There was no significant trend in dissolved oxygen and chlorophyll-a collected over a 5 year period (July 2015-June 2020; see Appendix 2).

Table 8 Compliance summary of the Swan-Canning Estuary KPI status for each Ecological Management Zone. Trend in parameters over time were shown as not significant (ns).

Estuarine Water Quality Targets												
Ecological Management Zone	**Dissolved Oxygen**						**Chlorophyll-a**					
	2016	**2017**	**2018**	**2019**	**2020**	**Trend**	**2016**	**2017**	**2018**	**2019**	**2020**	**Trend**
Lower Swan						ns						ns
Middle Swan						ns						ns
Upper Swan						ns						ns
Canning Estuary						ns						ns
Met target												
Did not meet target												

4 Conditions in oxygenation zone

4.1 Method for target calculation

Four oxygenation plants operate in the Swan Canning. The effectiveness of these plants at maintaining suitable dissolved oxygen in the Upper Swan River and the Lower Canning River is evaluated annually in accordance with parameters outlined in Table 9 and management of the oxygenation plants is adjusted accordingly.

Table 9 Operational targets for management of oxygenation zone and parameters for calculation

Oxygenation targets	Lower Canning River	Upper Swan River
Target zone	All standard profiling sites in the Kent St weir pool, ie KEN to ELL inclusive.	All standard profiling sites from Kingsley Drive (KIN) to Reg Bond Reserve (REG) inclusive.
Calculation period	Oxygenation season – when Kent Street Weir gates are operational, typically October to August.	All year
Method	Dissolved oxygen data (mg/L) is collected as part of a routine weekly water quality monitoring, with a vertical profile at each nominated site using a multiprobe sonde. The target is produced by pooling all data points within the target zone for the calculation period to determine the proportion of data above the threshold as a percentage of the pool of data.	
Annual management targets	2mg/L threshold -Cumulative annual target: requires >90% of all dissolved oxygen measurements from the target zone during the oxygenation season to be above 2 mg/L (>90% = Good; >80% = acceptable; ≤80% = review of operational strategy required); and 4mg/L threshold Cumulative annual target: requires > 80% of all dissolved oxygen measurements from the target zone during the oxygenation season to be above 4 mg/L (>80% = Good; >70% = acceptable; ≤70% = review of operational strategy required).	

The KPI target for the River Protection Strategy requires that > 80% of all individual dissolved oxygen measurements collected for each Oxygenation Zone during the oxygenation season to be above 4 mg/L.

4.2 Dissolved oxygen and chlorophyll a KPI compliance summary and application to five -year report on the River Protection Strategy.

Results for the oxygenation targets are shown in

Table 10 and shows that the majority of measurements were above 2mg/L and >80% of data measurements were above 4mg/L. Therefore, the KPI target was met for both zones in all years and the maximum KPI score of 10 was achieved. The information was summarized for reporting on the River Protection Strategy as shown in Table 11.

Table 10 Percentage of data in any one oxygenation season/year that was above thresholds in the two oxygenation zones.

Year	Lower Canning River		Upper Swan River	
	2 mg/L	4 mg/L	2 mg/L	4 mg/L
2015-16	97.15	94.24	94.54	82.54
2016-17	96.75	86.69	94.77	86.86
2017-18	98.93	94.41	93.65	81.50
2018-19	98.26	95.86	98.53	88.90
2019-20	98.93	96.81	97.50	87.90

Table 11 Compliance summary of KPI status for each Oxygenation Zone.

Oxygenation Zone Conditions					
Oxygenation Zone	**2016**	**2017**	**2018**	**2019**	**2020**
Upper Swan Estuary					
Lower Canning River					
Met target					
Did not meet target					

6 Seagrass Health

6.1 Method for target calculation

The health of seagrass in the lower Swan and Canning estuaries is assessed based on a range of seagrass metrics including seagrass presence, % cover, productivity and reproduction (see Kilminster et.al 2018) that are combined to generate a seagrass performance index. Due to the intensive nature of monitoring for all metrics in any one year, full assessment and determination of the performance index occurs once every 5 years. Full assessment occurred during the first year 2015-16 (DWER, 2018) and is reported here. Seagrass performance was graded poor, low, fair or good for each of 6 sites (poor: <2, low: 2-2.5, fair: >2.5-3, good: >3) for each of six sites. The seagrass performance (KPI) target is set at 2.25.

6.2 Seagrass performance KPI compliance summary and application to five-year report on the River Protection Strategy

All sites achieved or exceeded the target, with the lowest seagrass performance scores (3.0) being recorded at the Lucky Bay and Canning sites and the highest (3.75) at the Rocky Bay and Heathcote sites (Table 12). Therefore, the maximum KPI score of 6 was achieved and the information was summarized for 5-year reporting on the River Protection Strategy as shown in Table 13.

Table 12 Seagrass health index values based on seagrass performance in 2015-16.

Sites	2015-16	KPI status
Rocky Bay	3.75	pass
Dalkeith	3.5	pass
Lucky Bay	3	pass
Pelican Point	3.25	pass
Heathcote	3.75	pass
Canning	3	pass

Table 13 Swan-Canning Estuary seagrass health from 2015-2016.

Seagrass Health	
Sites	**2015-16**
Rocky Bay	
Dalkeith	
Lucky Bay	
Pelican Point	
Heathcote	
Canning	
Met target	
Did not meet target	

7 Fish Communities

7.1 Method for target calculation

The Fish Community Index provide an ecological indicator of estuary condition that complements existing water quality monitoring and evaluation. The index has been applied annually since 2012 as part of an on-going monitoring effort in collaboration between Murdoch University. The index is calculated separately for shallow nearshore and deeper offshore waters, with condition graded based on criteria in Table 14. Index condition grade criteria differ for the nearshore and offshore indices

Table 14 Fish Community Index scores for shallow and deep areas of four ecological management zones in the Swan Canning estuary. Scores are shown for both summer (S) and autumn (A) in each year 2016-2020.

Condition grade	Nearshore FCI scores	Offshore FCI scores
A (very good)	>74.5	>70.7
B (good)	64.6-74.5	58.4-70.7
C (fair)	57.1-64.6	50.6-58.4
D (poor)	45.5-57.1	36.8-50.6
E (very poor)	<45.5	<36.8

Results for nearshore and offshore waters for the period 2016-2020 are shown in *Table 15* with a full reports found in Hallett 2016, 2017, 2018, 2019 and Tweedley et.al, 2020.

Table 15 Fish Community Index scores for shallow and deep areas of four ecological management zones in the Swan Canning estuary. Scores are shown for both summer (S) and autumn (A) in each year 2016-2020. Shading shows the condition grade based on Table 14

Ecological Management Zone	2016				2017				2018			
	Shallow nearshore waters		Deeper offshore waters		Shallow nearshore waters		Deeper offshore waters		Shallow nearshore waters		Deeper offshore waters	
	S	A	S	A	S	A	S	A	S	A	S	A
Lower Swan Canning estuary	69	66	54	57	62	70	61	64	59	67	64	53
Middle Swan estuary	62	65	60	43	61	65	62	43	62	55	63	46
Upper Swan estuary	76	77	70	55	60	68	51	49	68	68	69	62
Canning estuary	68	63	51	56	60	63	45	39	68	72	49	53

Ecological Management Zone	2019				2020			
	Shallow nearshore waters		Deeper offshore waters		Shallow nearshore waters		Deeper offshore waters	
	S	A	S	A	S	A	S	A
Lower Swan Canning estuary	62	60	64	61	53	67	64	59
Middle Swan estuary	59	64	57	49	64	62	69	58
Upper Swan estuary	70	62	63	61	76	66	69	61
Canning estuary	63	64	50	44	58	67	49	53

7.2 Compliance for 5 year and application to RPS

Achievement of the KPI target was determined by whether the fish community index scores achieved a grade of Fair or better. Scores that were poor or very poor were determined to have not met the KPI. Therefore, based on the scores and grades show in Table 2 the KPI status are shown in Table 16. Of a possible total score of 80 there were 67 occasions when the KPI was met and 13 occasions when it was not met. Scores were summarized in the RPS 5-year report document as shown in Table *17*.

Table 16 Fish Community Index scores for shallow and deep areas of four ecological management zones in the Swan Canning estuary. Scores are shown for both summer (S) and autumn (A) in each year 2016-2020.

Ecological Management Zone	2016				2017				2018			
	Shallow nearshore waters		Deeper offshore waters		Shallow nearshore waters		Deeper offshore waters		Shallow nearshore waters		Deeper offshore waters	
	S	A	S	A	S	A	S	A	S	A	S	A
Lower Swan Canning estuary	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Middle Swan estuary	pass	pass	pass	fail	pass	pass	pass	fail	pass	fail	pass	fail
Upper Swan estuary	pass	pass	pass	pass	pass	pass	pass	fail	pass	pass	pass	pass
Canning estuary	pass	pass	pass	pass	pass	pass	fail	fail	pass	pass	fail	pass

Ecological Management Zone	2019				2020			
	Shallow nearshore waters		Deeper offshore waters		Shallow nearshore waters		Deeper offshore waters	
	S	A	S	A	S	A	S	A
Lower Swan Canning estuary	pass	pass	pass	pass	fail	pass	pass	pass
Middle Swan estuary	pass	pass	pass	pass	pass	pass	pass	pass
Upper Swan estuary	pass	pass	pass	pass	pass	pass	pass	pass
Canning estuary	pass	pas	fail	fail	pass	pass	fail	pass

Table 17 Fish community index performance for nearshore and offshore communities within the Swan-Canning Estuary between 2016 and 2020.

Fish Communities										
Ecological Management Zone	2016		2017		2018		2019		2020	
	Shallow nearshore waters	Deeper offshore waters	Shallow nearshore waters	Deeper offshore waters	Shallow nearshore waters	Deeper offshore waters	Shallow nearshore waters	Deeper offshore waters	Shallow nearshore waters	Deeper offshore waters
Lower Swan										
Middle Swan										
Upper Swan										
Canning Estuary										

Met target in both seasons	
Met target in one season	
Did not meet targets	

8 References

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Appendix 1: Catchment compliance

The KPI assessment of catchment water quality data for total nitrogen and total phosphorus is conducted by assessing the number of exceedances (e) against the number of allowable exceedances (eMax) of the short- and long-term KPI targets (Table 2) for each analyte. The table of eMax values used in the assessment (Table A1.1) was previously generated by the Department of Water and Swan River Trust and detailed in Donohue et al. (2001). Each catchment is initially assessed against the more conservative fail-safe (FS) eMax value based on the number of sample events for each KPI period (n). To calculate e for each catchment the count of analyte concentrations exceeding their respective short- and long-term targets for each sampling events that fall within weeks 22-43 of the previous three years is to be established.

If *e* remains below the FS *eMax* value for the short-term targets the catchment being assessed will pass the short-term target KPI assessment. Conversely, if *e* exceeds the FS *eMax* value then the catchment will fail the assessment. If the catchment passes the short-term KPI target assessment it can then be assessed against the long-term target FS *eMax* value. If *e* remains below the long-term FS *eMax* value then the catchment will pass the long-term KPI assessment. Any exceedances to this FS *eMax* value will cause the catchment to fail the assessment.

Where a catchment passes an assessment against the FS *eMax* value, the benefit of the doubt (BoD) *eMax* value can be used as a less-conservative maintenance value during the subsequent year's assessment. If the catchment passes the assessment using this BoD *eMax* value then it can be used for the following assessments unless a fail occurs. If the catchment fails the assessment against this BoD *eMax* value the assessment must revert to using the FS *eMax* value.

Allowable exceedances

Table A1.1: Allowable exceedances (eMaxs) to the catchment nutrient targets for total nitrogen (TN) and total phosphorus (TP). The eMax value used is determined by the sample size (n) and the previous KPI status (Pass or Fail). For catchments where they have continued to fail meeting the short and long term targets the fail-safe (FS) value is used and where they have previously passed these targets the benefit of the doubt (BoD) value is to be used.

n	BoD	FS	*n*	BoD	FS
12	9	3	37	23	14
13	9	4	38	24	14
14	10	4	39	25	14
15	11	4	40	25	15
16	11	5	41	26	15
17	12	5	42	26	16
18	12	6	43	27	16
19	13	6	44	27	17
20	14	6	45	28	17
21	14	7	46	29	17
22	15	7	47	29	18
23	15	8	48	30	18
24	16	8	49	30	19
25	17	8	50	31	19
26	17	9	51	31	20
27	18	9	52	32	20
28	18	10	53	32	21
29	19	10	54	33	21
30	19	11	55	34	21
31	20	11	56	34	22
32	21	11	57	35	22
33	21	12	58	35	23
34	22	12	59	36	23
35	22	13	60	36	24

Appendix 2: Estuarine compliance

Calculating KPI assessment

The KPI assessment of estuarine water quality data for chlorophyll a and dissolved oxygen is conducted by assessing *e* against the FS *eMax* values of the KPI targets (Table 6) for each analyte within each EMZ. The table of *eMax* values used in the assessment (Table and Table was previously generated by the Department of Water and Swan River Trust and detailed in Donohue *et al.* (2001).

Similarly to the catchment KPI assessment, if an EMZ passes the assessment of the subsequent year is assessed against the BoD *eMax* value.

The assessment of estuarine water quality data is dependent on data from one site per EMZ per sample event. The process of achieving each site has been modified with following changes to the monitoring routine overtime.

Until 2016, the compliance project SG-E-SWANCOMP was used to pre-determine a list of randomly selected additional monitoring sites (site names prefixed with “SWL”) to be sampled weekly within the Lower Swan-Canning Estuary over the KPI target period between January and May. Within the Middle and Upper Swan Estuary analyte data from randomly selected SG-E-SWANEST sites were used for the same purpose, and within the Canning Estuary data from the SG-E-CANEST site RIV was used.

After the termination of the SG-E-SWANCOMP in 2016, between 2016 and 2018 the same site selection process was applied within the Lower Swan-Canning Estuary to that of the Middle and Upper Swan Estuary. At the end of 2018 the weekly nutrient sampling across both the SG-E-SWANEST and SG-E-CANEST projects was reduced to fortnightly sampling.

Following the termination of SG-E-SWANCOMP and the reduction in sampling frequency there is the requirement to use two randomly selected SG-E-SWANEST sites from each EMZ to ensure that the sample size (*n*) is large enough to fall within the range of the list of allowable exceedances detailed in Table and Table .

The random selection of sites is achieved the using the Random Number Generation (RNG) tool in Microsoft Excel. To run the RNG a table listing the four sites that comprise each EMZ is to be created. Each site is to be allocated a Site number of 1-4 (Figure) and probability score of 0.25 (25%). The RNG tool can then be run. The Number of Variables equates to the number of weeks between January and May (for example 11 between January 2019 and May 2019 due to the fortnightly sampling), the amount of Random Numbers is 4 (one for each of the comprising sites) and the Parameters is the value and probability input range. Once ran a matrix of 11 x 4 values is created.

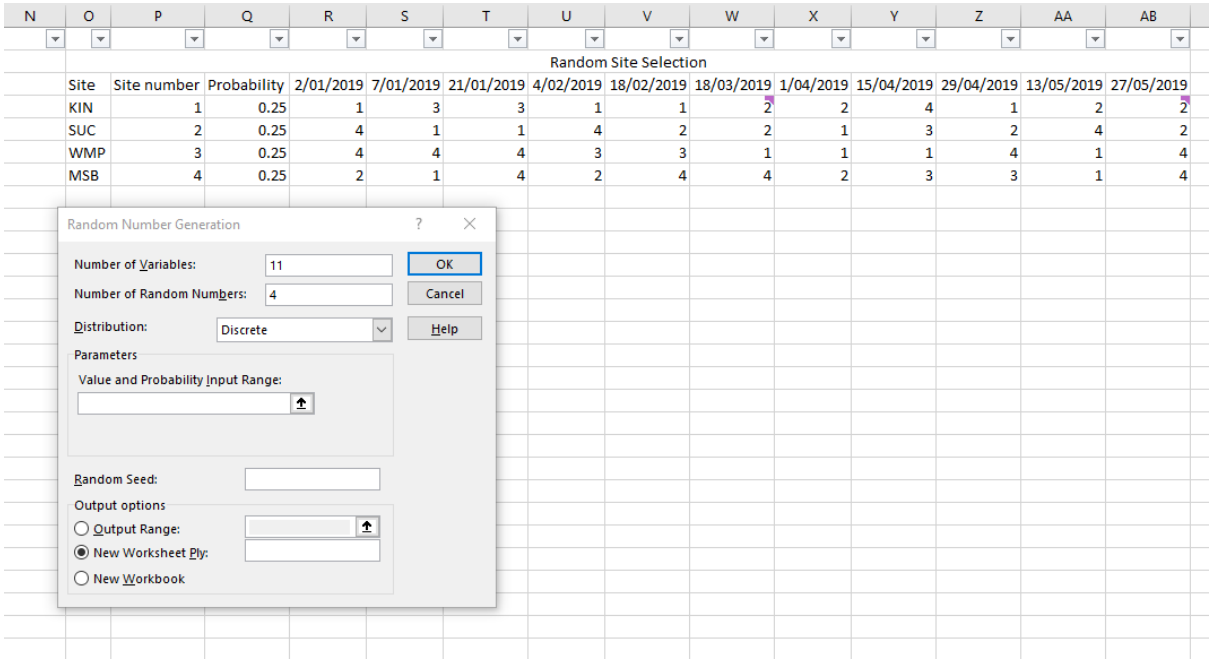

Figure A2.1: Using the Random Number Generation tool in Microsoft Excel to randomly select sites used for the KPI assessment process.

To make the allocation of sites easier the dates of the unique sample events can be transposed along the top of the matrix. For this example, where fortnightly sampling has occurred, the top two site numbers are selected. On the 02/01/2019 sites 1 and 4 (KIN and MSB) are the two random sites used. Where the top two numbers are the same, the next different number down the list is to be used. This has occurred on the 18/03/2019, in this instance SUC (2) and KIN (1) were used. Should all four of the numbers be the same then the top number from the previous column (or next in the case of the first column) is to be used to ensure that the two sites being used remain unique.

An additional column (in this case, “Use data”) is added to the end of the original data set (Figure A2.1). In this column, an identifier “Y” is placed into the cells for each of the corresponding randomly selected sites at each sample event from the Random Site Selection table (Figure).

A	B	C	D	E	F	G	H	I	J	K	L
Site	Site Numb	Date	Ye	Mon	chla	TN	SatD	DO	TP	EMZ	Use da
KIN	1	2/01/2019	2019	1	0.036	1.3	126	9.23	0.14	Upper Swan Estuary	Y
MSB	4	2/01/2019	2019	1	0.0015	0.71	50.2	3.84	0.025	Upper Swan Estuary	Y
SUC	2	2/01/2019	2019	1	0.038	1.2	106.9	7.94	0.11	Upper Swan Estuary	
WMP	3	2/01/2019	2019	1	0.016	0.91	104.1	7.86	0.049	Upper Swan Estuary	
KIN	1	7/01/2019	2019	1	0.017	1.1	123.1	8.81	0.098	Upper Swan Estuary	Y
MSB	4	7/01/2019	2019	1	0.0033	0.76	62.5	4.79	0.027	Upper Swan Estuary	
SUC	2	7/01/2019	2019	1	0.012	0.87	105.5	7.73	0.05	Upper Swan Estuary	
WMP	3	7/01/2019	2019	1	0.0058	0.8	107.7	8.16	0.037	Upper Swan Estuary	Y
KIN	1	21/01/2019	2019	1	0.016	0.98	103.8	7.17	0.096	Upper Swan Estuary	Y
MSB	4	21/01/2019	2019	1	0.0029	0.71	59.2	4.41	0.019	Upper Swan Estuary	
SUC	2	21/01/2019	2019	1	0.02	0.98	88.7	6.27	0.069	Upper Swan Estuary	
WMP	3	21/01/2019	2019	1	0.025	0.95	111.3	8.04	0.051	Upper Swan Estuary	Y
KIN	1	4/02/2019	2019	2	0.053	1.2	130.3	9.47	0.14	Upper Swan Estuary	Y
MSB	4	4/02/2019	2019	2	0.0025	0.6	63.2	4.98	0.017	Upper Swan Estuary	Y
SUC	2	4/02/2019	2019	2	0.0086	0.94	73	5.41	0.076	Upper Swan Estuary	
WMP	3	4/02/2019	2019	2	0.027	0.96	104.1	7.86	0.056	Upper Swan Estuary	
KIN	1	18/02/2019	2019	2	0.02	1.1	141	9.94	0.094	Upper Swan Estuary	Y

Figure A2.1 Using an identifier to select the data for the randomly selected sites within each EMZ and for each unique sample event.

The filter tool is then used to select the cells marked “Y” and the data for the three years is to be copied into a separate table which comprises the data for that specific KPI period.

The number of samples (*n*) can then be calculated (using the COUNT function: =COUNT(E2:E67)) along with the number of exceedances (*e*) of the targets for each analyte concentration (using the COUNTIF function: =COUNTIF(E2:E67,E70)). The COUNT function requires numeric values within the chosen cells and fails to count non-numeric symbols, thus where required concentrations that fell below the limit of reporting (LoR) were halved for analysis (for example a chlorophyll a concentration of <0.001 mg/L would be halved to 0.0005 mg/L). Subsequently the KPI status of “Pass” or “Fail” can be determined by assessing *e* against the maximum number of allowable exceedances (*eMax*) for each analyte (using the IF function: =IF(E71>E72,"Fail","Pass")) (Figure A2.2). Where a KPI status has passed for a particular period *e* for the following period(s) should be then assessed against the BoD which is a more conservative value designed to help maintain the KPI status.

	A	B	C	D	E	F	G	H
1	Location	Sample date	Site Code	Surface/Bottom	%DO (% sat)	CHLA (mg/L)	TN (mg/L)	TP (mg/L)
46	Lower	6/01/2020	HEA	S	101.6	0.0015	0.26	0.026
47	Lower	6/01/2020	NAR	S	95.9	0.0014	0.3	0.037
48	Lower	20/01/2020	ARM	S	97.4	0.0017	0.24	0.013
49	Lower	20/01/2020	BLA	S	100.3	0.0025	0.18	NA
50	Lower	3/02/2020	ARM	S	94.3	0.0021	0.26	0.025
51	Lower	3/02/2020	BLA	S	96	0.0018	0.23	0.02
52	Lower	17/02/2020	BLA	S	91	0.0029	0.23	0.022
53	Lower	17/02/2020	NAR	S	88.4	0.0027	0.36	0.055
54	Lower	3/03/2020	HEA	S	94.7	0.0021	0.28	0.036
55	Lower	3/03/2020	NAR	S	92.8	0.0023	0.51	0.063
56	Lower	16/03/2020	BLA	S	86.7	0.0015	0.18	0.016
57	Lower	16/03/2020	HEA	S	92.3	0.0023	0.27	0.036
58	Lower	30/03/2020	ARM	S	95.7	0.0032	0.28	0.027
59	Lower	30/03/2020	BLA	S	80.5	0.0031	0.25	0.023
60	Lower	14/04/2020	ARM	S	98.6	0.0017	0.2	0.017
61	Lower	14/04/2020	BLA	S	84.3	0.0017	0.2	0.02
62	Lower	28/04/2020	HEA	S	93.9	0.0029	0.23	0.027
63	Lower	28/04/2020	NAR	S	88.9	0.0019	0.22	0.026
64	Lower	11/05/2020	HEA	S	94.8	0.0025	0.28	0.029
65	Lower	11/05/2020	NAR	S	89.3	0.0022	0.3	0.034
66	Lower	26/05/2020	BLA	S	92.3	0.0012	0.25	0.014
67	Lower	26/05/2020	HEA	S	92.1	0.0007	0.27	0.025
68								
69				number of samples (*n*)	66	64	66	65
70				Analyte Target	<82.1	>0.00355	>0.509	>0.058
71				Number of exceedences (*e*)	1	4	1	1
72				Maximum allowable number of exceedances (*eMax*)	6	3	3	3
73				KPI Status (Pass/Fail)	Pass	Fail	Pass	Pass
74								

Figure A2.2 Using the COUNT, COUNTIF and IF functions in Microsoft Excel to calculate the number of samples (n), Number of exceedances (e) and the KPI Status by assessing e against the maximum number of allowable exceedances (eMax).

Allowable exceedances

Table A2.1: Allowable exceedances (eMaxs) to the estuarine nutrient targets for chlorophyll a (Chl-a). The eMax value used is determined by the sample size (n) and the previous KPI status (Pass or Fail). For EMZs where they have continued to fail the fail-safe (FS) value is used and where they have previously passed the benefit of the doubt (BoD) value is to be used.

n		BoD	FV	FS	*n*	BoD	FV	FS
50		9	5	2	60	10	6	2
51		9	5	2	61	10	6	3
52		9	5	2	62	10	6	3
53		9	5	2	63	10	6	3
54		9	5	2	64	11	6	3
55		9	6	2	65	11	7	3
56		9	6	2	66	11	7	3
57		10	6	2	67	11	7	3
58		10	6	2	68	11	7	3
59		10	6	2	69	11	7	3
60		10	6	2	70	11	7	3

Table A2.2: Allowable exceedances (eMaxs) to the estuarine targets for dissolved oxygen (DO). The eMax value used is determined by the sample size (n) and the previous KPI status (Pass or Fail). For EMZs where they have continued to fail the fail-safe (FS) value is used and where they have previously passed the benefit of the doubt (BoD) value is to be used.

n	BoD	FV	FS	*n*	BoD	FV	FS
50	5	3	0	60	6	3	1
51	5	3	0	61	6	3	1
52	5	3	0	62	6	3	1
53	5	3	0	63	6	3	1
54	6	3	0	64	6	3	1
55	6	3	0	65	6	3	1
56	6	3	0	66	6	3	1
57	6	3	0	67	6	3	1
58	6	3	0	68	7	3	1
59	6	3	1	69	7	3	1
60	6	3	1	70	7	4	1

Raw estuarine compliance data

Table A2.3: Raw surface chlorophyll-a (Chl-a (mg L-1)) and surface dissolved oxygen (DO (%)) compliance data for the 2016 KPI period for the Lower-Swan Canning (Lower), Middle (Middle) and Upper Swan Estuary (Upper).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Lower	6/01/2014	SWL055	96.9	0.0005	Middle	6/01/2014	NIL	95.1	0.0026	Upper	6/01/2014	SUC	88.1	0.019
Lower	13/01/2014	SWL139	96.9	0.002	Middle	13/01/2014	NIL	94	0.0026	Upper	13/01/2014	SUC	83.3	0.012
Lower	20/01/2014	SWL156	96.5	0.002	Middle	20/01/2014	MAY	89.2	0.0025	Upper	20/01/2014	KIN	135.6	0.014
Lower	28/01/2014	SWL192	95.5	0.003	Middle	28/01/2014	STJ	90.7	0.0036	Upper	28/01/2014	SUC	85.8	0.016
Lower	3/02/2014	SWL182	94.5	0.002	Middle	3/02/2014	MAY	86	0.003	Upper	3/02/2014	SUC	72	0.018
Lower	10/02/2014	SWL121	98	0.003	Middle	10/02/2014	NIL	99.7	0.0035	Upper	10/02/2014	SUC	106.1	0.021
Lower	17/02/2014	SWL157	95.1	0.002	Middle	17/02/2014	NIL	85.6	0.0035	Upper	17/02/2014	SUC	86.2	0.0066
Lower	24/02/2014	SWL025	96.4	0.002	Middle	24/02/2014	NIL	102	0.0052	Upper	24/02/2014	SUC	102.7	0.013
Lower	4/03/2014	SWL154	96.9	0.001	Middle	4/03/2014	NIL	91.4	0.0059	Upper	4/03/2014	KIN	94.6	0.018
Lower	10/03/2014	SWL148	96.6	0.002	Middle	10/03/2014	MAY	96.7	0.0056	Upper	10/03/2014	KIN	76.7	0.0058
Lower	17/03/2014	SWL156	95.9	0.0005	Middle	17/03/2014	NIL	93.4	0.0041	Upper	17/03/2014	RON	89.3	0.02
Lower	24/03/2014	SWL156	96.3	0.003	Middle	24/03/2014	NIL	100.3	0.0034	Upper	24/03/2014	RON	109.3	0.021
Lower	31/03/2014	SWL256	92.8	0.003	Middle	31/03/2014	MAY	73.2	0.0047	Upper	31/03/2014	KIN	56.2	0.0068
Lower	7/04/2014	SWL259	100.6	0.001	Middle	7/04/2014	MAY	100.6	0.01	Upper	7/04/2014	SUC	84.8	0.011
Lower	14/04/2014	SWL046	91.5	0.0005	Middle	14/04/2014	STJ	99.8	0.0019	Upper	14/04/2014	SUC	129.9	0.0067
Lower	23/04/2014	SWL121	93.7	0.0005	Middle	23/04/2014	STJ	98.4	0.0075	Upper	23/04/2014	RON	81.6	0.009
Lower	29/04/2014	SWL222	87.6	0.002	Middle	29/04/2014	STJ	93.7	0.014	Upper	29/04/2014	KIN	79.5	0.009
Lower	5/05/2014	SWL176	98.9	0.003	Middle	5/05/2014	STJ	104.3	0.015	Upper	5/05/2014	KIN	74.9	0.01
Lower	12/05/2014	SWL262	103.2	0.002	Middle	12/05/2014	NIL	109.5	0.0087	Upper	12/05/2014	RON	84.6	0.012
Lower	19/05/2014	SWL073	92.5	0.002	Middle	19/05/2014	MAY	104.9	0.028	Upper	19/05/2014	KIN	74.3	0.015
Lower	26/05/2014	SWL150	90.5	0.002	Middle	26/05/2014	MAY	93.2	0.084	Upper	26/05/2014	KIN	59.7	0.0072
Lower	5/01/2015	SWL065	96.8	0.0005	Middle	5/01/2015	MAY	94.8	0.011	Upper	5/01/2015	KIN	92	0.0099
Lower	12/01/2015	SWL113	93.7	0.0005	Middle	12/01/2015	MAY	100.1	0.005	Upper	12/01/2015	KIN	147.2	0.036
Lower	19/01/2015	SWL065	95.5	0.002	Middle	19/01/2015	NIL	90.2	0.0033	Upper	19/01/2015	SUC	103.7	0.015
Lower	27/01/2015	SWL012	95.3	0.003	Middle	27/01/2015	STJ	94.9	0.0066	Upper	27/01/2015	SUC	120.8	0.021
Lower	9/02/2015	SWL236	106.8	0.002	Middle	2/02/2015	NIL	87.2	0.0042	Upper	2/02/2015	SUC	80.4	0.022
Lower	16/02/2015	SWL012	88.7	0.003	Middle	9/02/2015	STJ	99.4	0.004	Upper	9/02/2015	RON	113.8	0.013
Lower	3/03/2015	SWL254	94.2	0.0005	Middle	16/02/2015	NIL	85	0.0032	Upper	16/02/2015	KIN	84.8	0.0087
Lower	9/03/2015	SWL222	98.3	0.003	Middle	23/02/2015	NIL	92	0.0039	Upper	23/02/2015	SUC	90	0.01
Lower	16/03/2015	SWL148	96.5	0.002	Middle	3/03/2015	STJ	86.6	0.012	Upper	3/03/2015	SUC	91.8	0.0056
Lower	23/03/2015	SWL171	95.4	0.004	Middle	9/03/2015	MAY	94.7	0.0062	Upper	9/03/2015	SUC	70.7	0.011
Lower	30/03/2015	SWL045	91.3	0.001	Middle	16/03/2015	STJ	100.7	0.019	Upper	16/03/2015	SUC	95.6	0.02
Lower	7/04/2015	SWL282	95	0.003	Middle	23/03/2015	STJ	89.9	0.004	Upper	23/03/2015	SUC	88.2	0.0078
Lower	13/04/2015	SWL284	100	0.002	Middle	30/03/2015	MAY	108.8	0.012	Upper	30/03/2015	KIN	135.2	0.032
Lower	16/04/2015	SWL133	92.6	0.005	Middle	7/04/2015	NIL	90.5	0.0046	Upper	7/04/2015	SUC	78.7	0.0088
Lower	20/04/2015	SWL259	101.2	0.002	Middle	13/04/2015	STJ	109.7	0.018	Upper	13/04/2015	KIN	99.8	0.018
Lower	28/04/2015	SWL201	97.1	0.001	Middle	20/04/2015	STJ	105.4	0.014	Upper	20/04/2015	SUC	92.7	0.011
Lower	4/05/2015	SWL284	99.5	0.0005	Middle	28/04/2015	STJ	88.1	0.0045	Upper	28/04/2015	KIN	94.5	0.0062
Lower	11/05/2015	SWL221	98.2	0.002	Middle	4/05/2015	MAY	79.1	0.00025	Upper	4/05/2015	SUC	82.8	0.0055

Lower	18/05/2015	SWL260	95.5	0.002	Middle	11/05/2015	MAY	84.1	0.0041	Upper	11/05/2015	KIN	74.1	0.0021
Lower	25/05/2015	SWL026	101.9	0.003	Middle	18/05/2015	NIL	93.4	0.0062	Upper	18/05/2015	KIN	77	0.0028
Lower	4/01/2016	SWL161	94.3	0.0005	Middle	25/05/2015	STJ	91.4	0.0087	Upper	25/05/2015	KIN	127.8	0.0086
Lower	13/01/2016	SWL157	94.6	0.007	Middle	4/01/2016	MAY	92.6	0.019	Upper	4/01/2016	KIN	123.3	0.031
Lower	18/01/2016	SWL184	90.9	0.002	Middle	13/01/2016	STJ	92.3	0.0051	Upper	13/01/2016	SUC	84.3	0.016
Lower	25/01/2016	SWL135	93.3	0.003	Middle	18/01/2016	STJ	84.9	0.012	Upper	18/01/2016	SUC	110.3	0.016
Lower	1/02/2016	SWL229	93.4	0.003	Middle	25/01/2016	NIL	87.7	0.01	Upper	25/01/2016	SUC	89.2	0.015
Lower	8/02/2016	SWL054	93.5	0.002	Middle	1/02/2016	MAY	85.1	0.0098	Upper	1/02/2016	RON	72.6	0.0074
Lower	15/02/2016	SWL135	85.7	0.0005	Middle	8/02/2016	NIL	98	0.0059	Upper	8/02/2016	RON	95.5	0.011
Lower	22/02/2016	SWL102	92.8	0.003	Middle	15/02/2016	MAY	90.7	0.0072	Upper	15/02/2016	SUC	107.7	0.018
Lower	29/02/2016	SWL033	89.8	0.003	Middle	22/02/2016	STJ	84.8	0.0085	Upper	22/02/2016	SUC	84.3	0.021
Lower	8/03/2016	SWL120	94.7	0.002	Middle	29/02/2016	NIL	96.2	0.0086	Upper	29/02/2016	SUC	92.2	0.016
Lower	14/03/2016	SWL043	88.4	0.002	Middle	8/03/2016	STJ	95.2	0.0099	Upper	8/03/2016	SUC	91	0.0098
Lower	21/03/2016	SWL261	102.3	0.002	Middle	14/03/2016	MAY	96.3	0.011	Upper	14/03/2016	RON	93	0.013
Lower	30/03/2016	SWL046	94.4	0.004	Middle	21/03/2016	STJ	125	0.015	Upper	21/03/2016	RON	133.1	0.018
Lower	4/04/2016	SWL120	109.8	0.008	Middle	30/03/2016	MAY	54.8	0.017	Upper	30/03/2016	RON	29.3	0.053
Lower	11/04/2016	SWL300	93.3	0.003	Middle	4/04/2016	MAY	57.3	0.018	Upper	4/04/2016	SUC	45	0.0053
Lower	18/04/2016	SWL181	100.2	0.004	Middle	11/04/2016	NIL	90.7	0.015	Upper	11/04/2016	SUC	82.4	0.015
Lower	26/04/2016	SWL181	99.5	0.002	Middle	18/04/2016	NIL	110.1	0.024	Upper	18/04/2016	SUC	68.5	0.017
Lower	2/05/2016	SWL228	117.4	0.013	Middle	26/04/2016	STJ	79.4	0.021	Upper	26/04/2016	SUC	110.4	0.085
Lower	9/05/2016	SWL259	90.3	0.008	Middle	2/05/2016	STJ	155.8	0.075	Upper	2/05/2016	KIN	110.5	0.059
Lower	16/05/2016	SWL134	98.1	0.003	Middle	9/05/2016	NIL	97.6	0.023	Upper	9/05/2016	KIN	56.8	0.0083
Lower	23/05/2016	SWL274	92.1	0.004	Middle	16/05/2016	NIL	197.9	0.046	Upper	16/05/2016	KIN	71.9	0.01
Lower	30/05/2016	SWL279	101.7	0.093	Middle	23/05/2016	NIL	89.2	NS	Upper	23/05/2016	SUC	78.6	0.026
					Middle	30/05/2016	MAY	75.2	0.011	Upper	30/05/2016	KIN	74.4	0.0021

Table A2.4: Raw surface chlorophyll-a (Chl-a (mg L-1)) and surface dissolved oxygen (DO (%)) compliance data for the 2016 KPI period for the Canning Estuary (Canning)

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Canning	7/01/2014	RIV	91.8	0.012	Canning	24/03/2015	RIV	65.3	0.012
Canning	14/01/2014	RIV	85.3	0.014	Canning	31/03/2015	RIV	46	0.006
Canning	21/01/2014	RIV	97.5	0.013	Canning	8/04/2015	RIV	65.2	0.0049
Canning	29/01/2014	RIV	103	0.011	Canning	14/04/2015	RIV	43.5	0.034
Canning	4/02/2014	RIV	111.9	0.019	Canning	21/04/2015	RIV	73	0.032
Canning	11/02/2014	RIV	94	0.013	Canning	29/04/2015	RIV	68.2	0.0069
Canning	18/02/2014	RIV	94.3	0.0091	Canning	5/05/2015	RIV	48.5	0.0082
Canning	25/02/2014	RIV	72.8	0.011	Canning	12/05/2015	RIV	58.7	0.0013
Canning	5/03/2014	RIV	91.6	0.0098	Canning	19/05/2015	RIV	48.2	0.0023
Canning	11/03/2014	RIV	86.8	0.012	Canning	26/05/2015	RIV	42.8	0.0024
Canning	18/03/2014	RIV	93.5	0.011	Canning	5/01/2016	RIV	54.7	0.012
Canning	25/03/2014	RIV	70.4	0.004	Canning	12/01/2016	RIV	81.4	0.012
Canning	1/04/2014	RIV	85.3	0.035	Canning	19/01/2016	RIV	89.1	0.02
Canning	8/04/2014	RIV	82.1	0.009	Canning	27/01/2016	RIV	78.4	0.013
Canning	15/04/2014	RIV	101.8	0.0021	Canning	2/02/2016	RIV	66.5	0.0032
Canning	22/04/2014	RIV	91	0.0098	Canning	9/02/2016	RIV	87.7	0.013
Canning	28/04/2014	RIV	71.4	0.034	Canning	16/02/2016	RIV	81.4	0.0074
Canning	6/05/2014	RIV	39.3	0.012	Canning	23/02/2016	RIV	65.5	0.015
Canning	13/05/2014	RIV	86.5	0.048	Canning	1/03/2016	RIV	56.7	0.0099
Canning	20/05/2014	RIV	42.4	0.012	Canning	9/03/2016	RIV	81.2	0.0077
Canning	27/05/2014	RIV	59.8	0.0021	Canning	15/03/2016	RIV	56.3	0.0052
Canning	6/01/2015	RIV	75.6	0.0077	Canning	22/03/2016	RIV	52.5	0.014
Canning	13/01/2015	RIV	52.2	0.0083	Canning	29/03/2016	RIV	64.4	0.014
Canning	20/01/2015	RIV	56.8	0.012	Canning	5/04/2016	RIV	62.3	0.011
Canning	28/01/2015	RIV	50.6	0.011	Canning	12/04/2016	RIV	55.2	0.0037
Canning	3/02/2015	RIV	36.8	0.0028	Canning	19/04/2016	RIV	42.7	0.02
Canning	10/02/2015	RIV	54.1	0.011	Canning	27/04/2016	RIV	44.2	0.011
Canning	17/02/2015	RIV	66.8	0.0096	Canning	3/05/2016	RIV	70.6	0.015
Canning	24/02/2015	RIV	63.5	0.01	Canning	10/05/2016	RIV	55.3	0.0081
Canning	4/03/2015	RIV	66.1	0.016	Canning	17/05/2016	RIV	58.8	0.0053
Canning	10/03/2015	RIV	58.4	0.012	Canning	24/05/2016	RIV	50.6	0.064
Canning	17/03/2015	RIV	33.8	0.0085	Canning	31/05/2016	RIV	63.6	0.012

Table A2.5: Raw surface chlorophyll-a (Chl-a (mg L-1)) and surface dissolved oxygen (DO (%)) compliance data for the 2017 KPI period for the Lower-Swan Canning (Lower), Middle (Middle) and Upper Swan Estuary (Upper).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg/L)	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Lower	5/01/2015	SWL065	96.8	0.0005	Middle	5/01/2015	MAY	94.8	0.011	Upper	5/01/2015	KIN	92	0.0099
Lower	12/01/2015	SWL113	93.7	0.0005	Middle	12/01/2015	MAY	100.1	0.005	Upper	12/01/2015	KIN	147.2	0.036
Lower	19/01/2015	SWL065	95.5	0.002	Middle	19/01/2015	NIL	90.2	0.0033	Upper	19/01/2015	SUC	103.7	0.015
Lower	27/01/2015	SWL012	95.3	0.003	Middle	27/01/2015	STJ	94.9	0.0066	Upper	27/01/2015	SUC	120.8	0.021
Lower	9/02/2015	SWL236	106.8	0.002	Middle	2/02/2015	NIL	87.2	0.0042	Upper	2/02/2015	SUC	80.4	0.022
Lower	16/02/2015	SWL012	88.7	0.003	Middle	9/02/2015	STJ	99.4	0.004	Upper	9/02/2015	RON	113.8	0.013
Lower	3/03/2015	SWL254	94.2	0.0005	Middle	16/02/2015	NIL	85	0.0032	Upper	16/02/2015	KIN	84.8	0.0087
Lower	9/03/2015	SWL222	98.3	0.003	Middle	23/02/2015	NIL	92	0.0039	Upper	23/02/2015	SUC	90	0.01
Lower	16/03/2015	SWL148	96.5	0.002	Middle	3/03/2015	STJ	86.6	0.012	Upper	3/03/2015	SUC	91.8	0.0056
Lower	23/03/2015	SWL171	95.4	0.004	Middle	9/03/2015	MAY	94.7	0.0062	Upper	9/03/2015	SUC	70.7	0.011
Lower	30/03/2015	SWL045	91.3	0.001	Middle	16/03/2015	STJ	100.7	0.019	Upper	16/03/2015	SUC	95.6	0.02
Lower	7/04/2015	SWL282	95	0.003	Middle	23/03/2015	STJ	89.9	0.004	Upper	23/03/2015	SUC	88.2	0.0078
Lower	13/04/2015	SWL284	100	0.002	Middle	30/03/2015	MAY	108.8	0.012	Upper	30/03/2015	KIN	135.2	0.032
Lower	16/04/2015	SWL133	92.6	0.005	Middle	7/04/2015	NIL	90.5	0.0046	Upper	7/04/2015	SUC	78.7	0.0088
Lower	20/04/2015	SWL259	101.2	0.002	Middle	13/04/2015	STJ	109.7	0.018	Upper	13/04/2015	KIN	99.8	0.018
Lower	28/04/2015	SWL201	97.1	0.001	Middle	20/04/2015	STJ	105.4	0.014	Upper	20/04/2015	SUC	92.7	0.011
Lower	4/05/2015	SWL284	99.5	0.0005	Middle	28/04/2015	STJ	88.1	0.0045	Upper	28/04/2015	KIN	94.5	0.0062
Lower	11/05/2015	SWL221	98.2	0.002	Middle	4/05/2015	MAY	79.1	0.00025	Upper	4/05/2015	SUC	82.8	0.0055
Lower	18/05/2015	SWL260	95.5	0.002	Middle	11/05/2015	MAY	84.1	0.0041	Upper	11/05/2015	KIN	74.1	0.0021
Lower	25/05/2015	SWL026	101.9	0.003	Middle	18/05/2015	NIL	93.4	0.0062	Upper	18/05/2015	KIN	77	0.0028
Lower	4/01/2016	SWL161	94.3	0.0005	Middle	25/05/2015	STJ	91.4	0.0087	Upper	25/05/2015	KIN	127.8	0.0086
Lower	13/01/2016	SWL157	94.6	0.007	Middle	4/01/2016	MAY	92.6	0.019	Upper	4/01/2016	KIN	123.3	0.031
Lower	18/01/2016	SWL184	90.9	0.002	Middle	13/01/2016	STJ	92.3	0.0051	Upper	13/01/2016	SUC	84.3	0.016
Lower	25/01/2016	SWL135	93.3	0.003	Middle	18/01/2016	STJ	84.9	0.012	Upper	18/01/2016	SUC	110.3	0.016
Lower	1/02/2016	SWL229	93.4	0.003	Middle	25/01/2016	NIL	87.7	0.01	Upper	25/01/2016	SUC	89.2	0.015
Lower	8/02/2016	SWL054	93.5	0.002	Middle	1/02/2016	MAY	85.1	0.0098	Upper	1/02/2016	RON	72.6	0.0074
Lower	15/02/2016	SWL135	85.7	0.0005	Middle	8/02/2016	NIL	98	0.0059	Upper	8/02/2016	RON	95.5	0.011
Lower	22/02/2016	SWL102	92.8	0.003	Middle	15/02/2016	MAY	90.7	0.0072	Upper	15/02/2016	SUC	107.7	0.018
Lower	29/02/2016	SWL033	89.8	0.003	Middle	22/02/2016	STJ	84.8	0.0085	Upper	22/02/2016	SUC	84.3	0.021
Lower	8/03/2016	SWL120	94.7	0.002	Middle	29/02/2016	NIL	96.2	0.0086	Upper	29/02/2016	SUC	92.2	0.016
Lower	14/03/2016	SWL043	88.4	0.002	Middle	8/03/2016	STJ	95.2	0.0099	Upper	8/03/2016	SUC	91	0.0098
Lower	21/03/2016	SWL261	102.3	0.002	Middle	14/03/2016	MAY	96.3	0.011	Upper	14/03/2016	RON	93	0.013
Lower	30/03/2016	SWL046	94.4	0.004	Middle	21/03/2016	STJ	125	0.015	Upper	21/03/2016	RON	133.1	0.018
Lower	4/04/2016	SWL120	109.8	0.008	Middle	30/03/2016	MAY	54.8	0.017	Upper	30/03/2016	RON	29.3	0.053
Lower	11/04/2016	SWL300	93.3	0.003	Middle	4/04/2016	MAY	57.3	0.018	Upper	4/04/2016	SUC	45	0.0053
Lower	18/04/2016	SWL181	100.2	0.004	Middle	11/04/2016	NIL	90.7	0.015	Upper	11/04/2016	SUC	82.4	0.015
Lower	26/04/2016	SWL181	99.5	0.002	Middle	18/04/2016	NIL	110.1	0.024	Upper	18/04/2016	SUC	68.5	0.017
Lower	2/05/2016	SWL228	117.4	0.013	Middle	26/04/2016	STJ	79.4	0.021	Upper	26/04/2016	SUC	110.4	0.085
Lower	9/05/2016	SWL259	90.3	0.008	Middle	2/05/2016	STJ	155.8	0.075	Upper	2/05/2016	KIN	110.5	0.059
Lower	16/05/2016	SWL134	98.1	0.003	Middle	9/05/2016	NIL	97.6	0.023	Upper	9/05/2016	KIN	56.8	0.0083
Lower	23/05/2016	SWL274	92.1	0.004	Middle	16/05/2016	NIL	197.9	0.046	Upper	16/05/2016	KIN	71.9	0.01

Lower	30/05/2016	SWL279	101.7	0.093	Middle	23/05/2016	NIL	89.2	NS	Upper	23/05/2016	SUC	78.6	0.026
Lower	03/01/2017	SWL276	99.8	0.0005	Middle	30/05/2016	MAY	75.2	0.011	Upper	30/05/2016	KIN	74.4	0.0021
Lower	09/01/2017	SWL300	97	0.003	Middle	3/01/2017	NIL	99.4	0.0047	Upper	03/01/2017	SUC	97.8	0.011
Lower	16/01/2017	SWL301	90.3	0.002	Middle	9/01/2017	NIL	105.3	0.0036	Upper	09/01/2017	RON	98.6	0.013
Lower	23/01/2017	SWL270	109.2	0.001	Middle	16/01/2017	STJ	85.1	0.019	Upper	16/01/2017	SUC	83.1	0.013
Lower	30/01/2017	SWL140	90.1	0.004	Middle	23/01/2017	STJ	105.9	0.021	Upper	23/01/2017	RON	96.2	0.017
Lower	06/02/2017	SWL182	94	0.013	Middle	30/01/2017	NIL	85.7	0.013	Upper	30/01/2017	SUC	74.8	0.036
Lower	15/02/2017	SWL177	66.4	0.003	Middle	6/02/2017	MAY	51.1	0.0007	Upper	06/02/2017	SUC	90.1	0.0024
Lower	20/02/2017	SWL192	80.3	0.004	Middle	15/02/2017	NIL	57.1	0.0032	Upper	15/02/2017	SUC	68	0.0048
Lower	27/02/2017	SWL284	95.1	0.025	Middle	20/02/2017	STJ	62.9	0.0083	Upper	20/02/2017	RON	76.8	0.007
Lower	07/03/2017	SWL257	125.9	0.039	Middle	27/02/2017	STJ	79.1	0.022	Upper	27/02/2017	SUC	77.6	0.023
Lower	13/03/2017	SWL258	84.5	0.006	Middle	7/03/2017	MAY	104.9	0.063	Upper	07/03/2017	KIN	157	0.052
Lower	20/03/2017	SWL153	116.7	0.03	Middle	13/03/2017	MAY	107.3	0.027	Upper	13/03/2017	KIN	88.9	0.042
Lower	27/03/2017	SWL139	74.1	0.025	Middle	20/03/2017	STJ	87	0.022	Upper	20/03/2017	RON	114.7	0.028
Lower	03/04/2017	SWL053	97.6	0.003	Middle	27/03/2017	STJ	72.9	0.027	Upper	27/03/2017	RON	164.6	0.057
Lower	10/04/2017	SWL204	84.4	0.002	Middle	3/04/2017	MAY	151.8	0.041	Upper	03/04/2017	RON	95.9	0.028
Lower	18/04/2017	SWL149	90.2	0.002	Middle	10/04/2017	MAY	127.4	0.036	Upper	10/04/2017	SUC	75	0.036
Lower	24/04/2017	SWL247	103.3	0.002	Middle	18/04/2017	MAY	98.6	0.065	Upper	18/04/2017	KIN	148.4	0.051
Lower	01/05/2017	SWL170	94.9	0.003	Middle	24/04/2017	NIL	85.5	0.018	Upper	24/04/2017	SUC	99.6	0.03
Lower	08/05/2017	SWL252	111.4	0.006	Middle	1/05/2017	NIL	75.2	0.0043	Upper	01/05/2017	RON	90.9	0.027
Lower	15/05/2017	SWL153	99.2	0.005	Middle	8/05/2017	STJ	102.3	0.022	Upper	08/05/2017	KIN	138.5	0.3
Lower	22/05/2017	SWL252	91.2	0.001	Middle	15/05/2017	NIL	91.2	0.011	Upper	15/05/2017	KIN	92.5	0.045
Lower	29/05/2017	SWL278	103.4	0.004	Middle	22/05/2017	NIL	93.8	0.015	Upper	22/05/2017	KIN	84.4	0.019
					Middle	29/05/2017	NIL	117.7	0.041	Upper	29/05/2017	KIN	90.1	0.031

Table A.6: Raw surface chlorophyll-a (Chl-a (mg L^{-1})) and surface dissolved oxygen (DO (%)) compliance data for the 2017 KPI period for the Canning Estuary (Canning).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Canning	6/01/2015	RIV	75.6	0.0077	Canning	29/03/2016	RIV	64.4	0.014
Canning	13/01/2015	RIV	52.2	0.0083	Canning	5/04/2016	RIV	62.3	0.011
Canning	20/01/2015	RIV	56.8	0.012	Canning	12/04/2016	RIV	55.2	0.0037
Canning	28/01/2015	RIV	50.6	0.011	Canning	19/04/2016	RIV	42.7	0.02
Canning	3/02/2015	RIV	36.8	0.0028	Canning	27/04/2016	RIV	44.2	0.011
Canning	10/02/2015	RIV	54.1	0.011	Canning	3/05/2016	RIV	70.6	0.015
Canning	17/02/2015	RIV	66.8	0.0096	Canning	10/05/2016	RIV	55.3	0.0081
Canning	24/02/2015	RIV	63.5	0.01	Canning	17/05/2016	RIV	58.8	0.0053
Canning	4/03/2015	RIV	66.1	0.016	Canning	24/05/2016	RIV	50.6	0.064
Canning	10/03/2015	RIV	58.4	0.012	Canning	31/05/2016	RIV	63.6	0.012
Canning	17/03/2015	RIV	33.8	0.0085	Canning	4/01/2017	RIV	108.6	0.0097
Canning	24/03/2015	RIV	65.3	0.012	Canning	10/01/2017	RIV	107.9	0.02
Canning	31/03/2015	RIV	46	0.006	Canning	17/01/2017	RIV	126.2	0.018
Canning	8/04/2015	RIV	65.2	0.0049	Canning	24/01/2017	RIV	82.1	0.0076
Canning	14/04/2015	RIV	43.5	0.034	Canning	31/01/2017	RIV	58.9	0.029
Canning	21/04/2015	RIV	73	0.032	Canning	7/02/2017	RIV	100.2	0.0094
Canning	29/04/2015	RIV	68.2	0.0069	Canning	14/02/2017	RIV	45.4	0.0024
Canning	5/05/2015	RIV	48.5	0.0082	Canning	21/02/2017	RIV	70.8	0.011
Canning	12/05/2015	RIV	58.7	0.0013	Canning	28/02/2017	RIV	83.6	0.0078
Canning	19/05/2015	RIV	48.2	0.0023	Canning	8/03/2017	RIV	70.1	0.013
Canning	26/05/2015	RIV	42.8	0.0024	Canning	14/03/2017	RIV	66.8	0.042
Canning	5/01/2016	RIV	54.7	0.012	Canning	21/03/2017	RIV	75.7	0.056
Canning	12/01/2016	RIV	81.4	0.012	Canning	28/03/2017	RIV	55.2	0.012
Canning	19/01/2016	RIV	89.1	0.02	Canning	4/04/2017	RIV	76.2	0.011
Canning	27/01/2016	RIV	78.4	0.013	Canning	11/04/2017	RIV	68.2	0.0041
Canning	2/02/2016	RIV	66.5	0.0032	Canning	19/04/2017	RIV	68.8	0.0074
Canning	9/02/2016	RIV	87.7	0.013	Canning	26/04/2017	RIV	78.1	0.013
Canning	16/02/2016	RIV	81.4	0.0074	Canning	2/05/2017	RIV	66.8	0.0033
Canning	23/02/2016	RIV	65.5	0.015	Canning	9/05/2017	RIV	41.7	0.011
Canning	1/03/2016	RIV	56.7	0.0099	Canning	16/05/2017	RIV	38.4	0.014
Canning	9/03/2016	RIV	81.2	0.0077	Canning	23/05/2017	RIV	51.8	0.033
Canning	15/03/2016	RIV	56.3	0.0052	Canning	30/05/2017	RIV	41.8	0.019
Canning	22/03/2016	RIV	52.5	0.014					

Table A2.7: Raw surface chlorophyll-a (Chl-a (mg L^{-1})) and surface dissolved oxygen (DO (%)) compliance data for the 2018 KPI period for the Lower-Swan Canning (Lower), Middle (Middle) and Upper Swan Estuary (Upper).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg/L)	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Lower	4/01/2016	SWL161	94.3	0.0005	Middle	4/01/2016	MAY	92.6	0.019	Upper	4/01/2016	KIN	123.3	0.031
Lower	13/01/2016	SWL157	94.6	0.007	Middle	13/01/2016	STJ	92.3	0.0051	Upper	13/01/2016	SUC	84.3	0.016
Lower	18/01/2016	SWL184	90.9	0.002	Middle	18/01/2016	STJ	84.9	0.012	Upper	18/01/2016	SUC	110.3	0.016
Lower	25/01/2016	SWL135	93.3	0.003	Middle	25/01/2016	NIL	87.7	0.01	Upper	25/01/2016	SUC	89.2	0.015
Lower	1/02/2016	SWL229	93.4	0.003	Middle	1/02/2016	MAY	85.1	0.0098	Upper	1/02/2016	RON	72.6	0.0074
Lower	8/02/2016	SWL054	93.5	0.002	Middle	8/02/2016	NIL	98	0.0059	Upper	8/02/2016	RON	95.5	0.011
Lower	15/02/2016	SWL135	85.7	0.0005	Middle	15/02/2016	MAY	90.7	0.0072	Upper	15/02/2016	SUC	107.7	0.018
Lower	22/02/2016	SWL102	92.8	0.003	Middle	22/02/2016	STJ	84.8	0.0085	Upper	22/02/2016	SUC	84.3	0.021
Lower	29/02/2016	SWL033	89.8	0.003	Middle	29/02/2016	NIL	96.2	0.0086	Upper	29/02/2016	SUC	92.2	0.016
Lower	8/03/2016	SWL120	94.7	0.002	Middle	8/03/2016	STJ	95.2	0.0099	Upper	8/03/2016	SUC	91	0.0098
Lower	14/03/2016	SWL043	88.4	0.002	Middle	14/03/2016	MAY	96.3	0.011	Upper	14/03/2016	RON	93	0.013
Lower	21/03/2016	SWL261	102.3	0.002	Middle	21/03/2016	STJ	125	0.015	Upper	21/03/2016	RON	133.1	0.018
Lower	30/03/2016	SWL046	94.4	0.004	Middle	30/03/2016	MAY	54.8	0.017	Upper	30/03/2016	RON	29.3	0.053
Lower	4/04/2016	SWL120	109.8	0.008	Middle	4/04/2016	MAY	57.3	0.018	Upper	4/04/2016	SUC	45	0.0053
Lower	11/04/2016	SWL300	93.3	0.003	Middle	11/04/2016	NIL	90.7	0.015	Upper	11/04/2016	SUC	82.4	0.015
Lower	18/04/2016	SWL181	100.2	0.004	Middle	18/04/2016	NIL	110.1	0.024	Upper	18/04/2016	SUC	68.5	0.017
Lower	26/04/2016	SWL181	99.5	0.002	Middle	26/04/2016	STJ	79.4	0.021	Upper	26/04/2016	SUC	110.4	0.085
Lower	2/05/2016	SWL228	117.4	0.013	Middle	2/05/2016	STJ	155.8	0.075	Upper	2/05/2016	KIN	110.5	0.059
Lower	9/05/2016	SWL259	90.3	0.008	Middle	9/05/2016	NIL	97.6	0.023	Upper	9/05/2016	KIN	56.8	0.0083
Lower	16/05/2016	SWL134	98.1	0.003	Middle	16/05/2016	NIL	197.9	0.046	Upper	16/05/2016	KIN	71.9	0.01
Lower	23/05/2016	SWL274	92.1	0.004	Middle	23/05/2016	NIL	89.2	**no data**	Upper	23/05/2016	SUC	78.6	0.026
Lower	30/05/2016	SWL279	101.7	0.093	Middle	30/05/2016	MAY	75.2	0.011	Upper	30/05/2016	KIN	74.4	0.0021
Lower	3/01/2017	SWL276	99.8	0.0005	Middle	3/01/2017	NIL	99.4	0.0047	Upper	03/01/2017	SUC	97.8	0.011
Lower	9/01/2017	SWL300	97	0.003	Middle	9/01/2017	NIL	105.3	0.0036	Upper	09/01/2017	RON	98.6	0.013
Lower	16/01/2017	SWL301	90.3	0.002	Middle	16/01/2017	STJ	85.1	0.019	Upper	16/01/2017	SUC	83.1	0.013
Lower	23/01/2017	SWL270	109.2	0.001	Middle	23/01/2017	STJ	105.9	0.021	Upper	23/01/2017	RON	96.2	0.017
Lower	30/01/2017	SWL140	90.1	0.004	Middle	30/01/2017	NIL	85.7	0.013	Upper	30/01/2017	SUC	74.8	0.036
Lower	6/02/2017	SWL182	94	0.013	Middle	6/02/2017	MAY	51.1	0.0007	Upper	06/02/2017	SUC	90.1	0.0024
Lower	15/02/2017	SWL177	66.4	0.003	Middle	15/02/2017	NIL	57.1	0.0032	Upper	15/02/2017	SUC	68	0.0048
Lower	20/02/2017	SWL192	80.3	0.004	Middle	20/02/2017	STJ	62.9	0.0083	Upper	20/02/2017	RON	76.8	0.007
Lower	27/02/2017	SWL284	95.1	0.025	Middle	27/02/2017	STJ	79.1	0.022	Upper	27/02/2017	SUC	77.6	0.023
Lower	7/03/2017	SWL257	125.9	0.039	Middle	7/03/2017	MAY	104.9	0.063	Upper	07/03/2017	KIN	157	0.052
Lower	13/03/2017	SWL258	84.5	0.006	Middle	13/03/2017	MAY	107.3	0.027	Upper	13/03/2017	KIN	88.9	0.042
Lower	20/03/2017	SWL153	116.7	0.03	Middle	20/03/2017	STJ	87	0.022	Upper	20/03/2017	RON	114.7	0.028
Lower	27/03/2017	SWL139	74.1	0.025	Middle	27/03/2017	STJ	72.9	0.027	Upper	27/03/2017	RON	164.6	0.057
Lower	3/04/2017	SWL053	97.6	0.003	Middle	3/04/2017	MAY	151.8	0.041	Upper	03/04/2017	RON	95.9	0.028
Lower	10/04/2017	SWL204	84.4	0.002	Middle	10/04/2017	MAY	127.4	0.036	Upper	10/04/2017	SUC	75	0.036
Lower	18/04/2017	SWL149	90.2	0.002	Middle	18/04/2017	MAY	98.6	0.065	Upper	18/04/2017	KIN	148.4	0.051
Lower	24/04/2017	SWL247	103.3	0.002	Middle	24/04/2017	NIL	85.5	0.018	Upper	24/04/2017	SUC	99.6	0.03
Lower	1/05/2017	SWL170	94.9	0.003	Middle	1/05/2017	NIL	75.2	0.0043	Upper	01/05/2017	RON	90.9	0.027
Lower	8/05/2017	SWL252	111.4	0.006	Middle	8/05/2017	STJ	102.3	0.022	Upper	08/05/2017	KIN	138.5	0.3
Lower	15/05/2017	SWL153	99.2	0.005	Middle	15/05/2017	NIL	91.2	0.011	Upper	15/05/2017	KIN	92.5	0.045
Lower	22/05/2017	SWL252	91.2	0.001	Middle	22/05/2017	NIL	93.8	0.015	Upper	22/05/2017	KIN	84.4	0.019
Lower	29/05/2017	SWL278	103.4	0.004	Middle	29/05/2017	NIL	117.7	0.041	Upper	29/05/2017	KIN	90.1	0.031
Lower	2/01/2018	SWL113	83.5	0.0005	Middle	02/01/2018	MAY	96.1	0.012	Upper	02/01/2018	KIN	127.2	0.005
Lower	8/01/2018	SWL284	95.5	0.002	Middle	08/01/2018	MAY	96	0.011	Upper	08/01/2018	SUC	106.5	0.041
Lower	15/01/2018	SWL055	88.6	0.004	Middle	15/01/2018	STJ	73.6	0.0073	Upper	22/01/2018	SUC	137.6	0.019
Lower	22/01/2018	SWL233	98.8	0.002	Middle	22/01/2018	STJ	60	0.0057	Upper	29/01/2018	SUC	103.4	0.033

Lower	29/01/2018	SWL161	87.9	0.003	Middle	29/01/2018	STJ	88.3	0.027	Upper	05/02/2018	RON	88.8	0.028
Lower	5/02/2018	SWL225	106.2	0.001	Middle	05/02/2018	STJ	89.4	0.02	Upper	12/02/2018	KIN	114.9	0.024
Lower	12/02/2018	SWL232	96	0.003	Middle	12/02/2018	STJ	85.2	0.013	Upper	19/02/2018	RON	101.3	0.03
Lower	19/02/2018	SWL262	96.8	0.003	Middle	19/02/2018	STJ	83.5	0.013	Upper	26/02/2018	SUC	73.5	0.02
Lower	26/02/2018	SWL183	90.4	0.003	Middle	26/02/2018	MAY	87.6	0.015	Upper	06/03/2018	KIN	109.7	0.021
Lower	6/03/2018	SWL227	101.6	0.003	Middle	06/03/2018	STJ	129.2	0.025	Upper	12/03/2018	KIN	109.2	0.0078
Lower	12/03/2018	SWL301	91	0.002	Middle	12/03/2018	NIL	107.9	0.022	Upper	19/03/2018	RON	103.3	0.034
Lower	19/03/2018	SWL142	94.8	0.003	Middle	19/03/2018	STJ	82.3	0.012	Upper	26/03/2018	KIN	79.9	0.021
Lower	26/03/2018	SWL221	98.5	0.002	Middle	26/03/2018	NIL	87	0.011	Upper	03/04/2018	KIN	121.2	0.032
Lower	3/04/2018	SWL043	98.8	0.001	Middle	03/04/2018	NIL	101.5	0.008	Upper	09/04/2018	KIN	82.7	0.031
Lower	9/04/2018	SWL253	93.4	0.001	Middle	09/04/2018	NIL	126.8	0.056	Upper	16/04/2018	SUC	102.9	0.031
Lower	16/04/2018	SWL276	89.7	0.012	Middle	16/04/2018	MAY	124.3	0.026	Upper	23/04/2018	SUC	100.5	0.032
Lower	23/04/2018	SWL299	92.2	0.003	Middle	23/04/2018	MAY	69.8	0.017	Upper	30/04/2018	RON	68.1	0.0077
Lower	30/04/2018	SWL024	98.8	0.003	Middle	30/04/2018	STJ	98.3	0.012	Upper	07/05/2018	SUC	71.8	0.0064
Lower	7/05/2018	SWL201	93.1	0.003	Middle	07/05/2018	MAY	92.8	0.028	Upper	14/05/2018	SUC	95.6	0.025
Lower	14/05/2018	SWL035	88	0.0005	Middle	14/05/2018	NIL	119.3	0.017	Upper	21/05/2018	KIN	61.4	0.0011
Lower	21/05/2018	SWL053	85.1	0.002	Middle	21/05/2018	MAY	54.6	0.002	Upper	28/05/2018	RON	79.9	0.017
Lower	28/05/2018	SWL221	93.6	0.013	Middle	28/05/2018	STJ	69.9	0.007					

Table A2.8: Raw surface chlorophyll-a (Chl-a (mg L^{-1})) and surface dissolved oxygen (DO (%)) compliance data for the 2018 KPI period for the Canning Estuary (Canning).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Canning	5/01/2016	RIV	54.7	0.012	Canning	21/03/2017	RIV	75.7	0.056
Canning	12/01/2016	RIV	81.4	0.012	Canning	28/03/2017	RIV	55.2	0.012
Canning	19/01/2016	RIV	89.1	0.02	Canning	04/04/2017	RIV	76.2	0.011
Canning	27/01/2016	RIV	78.4	0.013	Canning	11/04/2017	RIV	68.2	0.0041
Canning	2/02/2016	RIV	66.5	0.0032	Canning	19/04/2017	RIV	68.8	0.0074
Canning	9/02/2016	RIV	87.7	0.013	Canning	26/04/2017	RIV	78.1	0.013
Canning	16/02/2016	RIV	81.4	0.0074	Canning	02/05/2017	RIV	66.8	0.0033
Canning	23/02/2016	RIV	65.5	0.015	Canning	09/05/2017	RIV	41.7	0.011
Canning	1/03/2016	RIV	56.7	0.0099	Canning	16/05/2017	RIV	38.4	0.014
Canning	9/03/2016	RIV	81.2	0.0077	Canning	23/05/2017	RIV	51.8	0.033
Canning	15/03/2016	RIV	56.3	0.0052	Canning	30/05/2017	RIV	41.8	0.019
Canning	22/03/2016	RIV	52.5	0.014	Canning	03/01/2018	RIV	79	0.012
Canning	29/03/2016	RIV	64.4	0.014	Canning	09/01/2018	RIV	88.3	0.01
Canning	5/04/2016	RIV	62.3	0.011	Canning	16/01/2018	RIV	56.5	0.023
Canning	12/04/2016	RIV	55.2	0.0037	Canning	23/01/2018	RIV	72.8	0.013
Canning	19/04/2016	RIV	42.7	0.02	Canning	30/01/2018	RIV	82.8	0.015
Canning	27/04/2016	RIV	44.2	0.011	Canning	06/02/2018	RIV	73.4	0.0046
Canning	3/05/2016	RIV	70.6	0.015	Canning	13/02/2018	RIV	85.7	0.022
Canning	10/05/2016	RIV	55.3	0.0081	Canning	20/02/2018	RIV	36.2	0.0084
Canning	17/05/2016	RIV	58.8	0.0053	Canning	27/02/2018	RIV	52.5	0.0055
Canning	24/05/2016	RIV	50.6	0.064	Canning	07/03/2018	RIV	43.5	0.0086
Canning	31/05/2016	RIV	63.6	0.012	Canning	13/03/2018	RIV	71.8	0.0059
Canning	04/01/2017	RIV	108.6	0.0097	Canning	20/03/2018	RIV	81.5	0.011
Canning	10/01/2017	RIV	107.9	0.02	Canning	27/03/2018	RIV	42.7	0.0075
Canning	17/01/2017	RIV	126.2	0.018	Canning	04/04/2018	RIV	69.5	0.0091
Canning	24/01/2017	RIV	82.1	0.0076	Canning	10/04/2018	RIV	68.6	0.0068
Canning	31/01/2017	RIV	58.9	0.029	Canning	17/04/2018	RIV	80.8	0.027
Canning	07/02/2017	RIV	100.2	0.0094	Canning	24/04/2018	RIV	45.5	0.0036
Canning	14/02/2017	RIV	45.4	0.0024	Canning	01/05/2018	RIV	50	0.016
Canning	21/02/2017	RIV	70.8	0.011	Canning	08/05/2018	RIV	58.9	0.0078
Canning	28/02/2017	RIV	83.6	0.0078	Canning	15/05/2018	RIV	56.3	0.0061
Canning	08/03/2017	RIV	70.1	0.013	Canning	22/05/2018	RIV	50.7	0.0052
Canning	14/03/2017	RIV	66.8	0.042	Canning	29/05/2018	RIV	41.6	0.0068

Table A2.9: Raw surface chlorophyll-a (Chl-a (mg L^{-1})) and surface dissolved oxygen (DO (%)) compliance data for the 2019 KPI period for the Lower-Swan Canning (Lower), Middle (Middle) and Upper Swan Estuary (Upper).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg/L)	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Lower	03/01/2017	SWL276	99.8	0.0005	Middle	3/01/2017	NIL	99.4	0.0047	Upper	03/01/2017	SUC	97.8	0.011
Lower	09/01/2017	SWL300	97	0.003	Middle	9/01/2017	NIL	105.3	0.0036	Upper	09/01/2017	RON	98.6	0.013
Lower	16/01/2017	SWL301	90.3	0.002	Middle	16/01/2017	STJ	85.1	0.019	Upper	16/01/2017	SUC	83.1	0.013
Lower	23/01/2017	SWL270	109.2	0.001	Middle	23/01/2017	STJ	105.9	0.021	Upper	23/01/2017	RON	96.2	0.017
Lower	30/01/2017	SWL140	90.1	0.004	Middle	30/01/2017	NIL	85.7	0.013	Upper	30/01/2017	SUC	74.8	0.036
Lower	06/02/2017	SWL182	94	0.013	Middle	6/02/2017	MAY	51.1	0.0007	Upper	06/02/2017	SUC	90.1	0.0024
Lower	15/02/2017	SWL177	66.4	0.003	Middle	15/02/2017	NIL	57.1	0.0032	Upper	15/02/2017	SUC	68	0.0048
Lower	20/02/2017	SWL192	80.3	0.004	Middle	20/02/2017	STJ	62.9	0.0083	Upper	20/02/2017	RON	76.8	0.007
Lower	27/02/2017	SWL284	95.1	0.025	Middle	27/02/2017	STJ	79.1	0.022	Upper	27/02/2017	SUC	77.6	0.023
Lower	07/03/2017	SWL257	125.9	0.039	Middle	7/03/2017	MAY	104.9	0.063	Upper	07/03/2017	KIN	157	0.052
Lower	13/03/2017	SWL258	84.5	0.006	Middle	13/03/2017	MAY	107.3	0.027	Upper	13/03/2017	KIN	88.9	0.042
Lower	20/03/2017	SWL153	116.7	0.03	Middle	20/03/2017	STJ	87	0.022	Upper	20/03/2017	RON	114.7	0.028
Lower	27/03/2017	SWL139	74.1	0.025	Middle	27/03/2017	STJ	72.9	0.027	Upper	27/03/2017	RON	164.6	0.057
Lower	03/04/2017	SWL053	97.6	0.003	Middle	3/04/2017	MAY	151.8	0.041	Upper	03/04/2017	RON	95.9	0.028
Lower	10/04/2017	SWL204	84.4	0.002	Middle	10/04/2017	MAY	127.4	0.036	Upper	10/04/2017	SUC	75	0.036
Lower	18/04/2017	SWL149	90.2	0.002	Middle	18/04/2017	MAY	98.6	0.065	Upper	18/04/2017	KIN	148.4	0.051
Lower	24/04/2017	SWL247	103.3	0.002	Middle	24/04/2017	NIL	85.5	0.018	Upper	24/04/2017	SUC	99.6	0.03
Lower	01/05/2017	SWL170	94.9	0.003	Middle	1/05/2017	NIL	75.2	0.0043	Upper	01/05/2017	RON	90.9	0.027
Lower	08/05/2017	SWL252	111.4	0.006	Middle	8/05/2017	STJ	102.3	0.022	Upper	08/05/2017	KIN	138.5	0.3
Lower	15/05/2017	SWL153	99.2	0.005	Middle	15/05/2017	NIL	91.2	0.011	Upper	15/05/2017	KIN	92.5	0.045
Lower	22/05/2017	SWL252	91.2	0.001	Middle	22/05/2017	NIL	93.8	0.015	Upper	22/05/2017	KIN	84.4	0.019
Lower	29/05/2017	SWL278	103.4	0.004	Middle	29/05/2017	NIL	117.7	0.041	Upper	29/05/2017	KIN	90.1	0.031
Lower	02/01/2018	SWL113	83.5	<0.001	Middle	02/01/2018	MAY	96.1	0.012	Upper	02/01/2018	KIN	127.2	0.005
Lower	08/01/2018	SWL284	95.5	0.002	Middle	08/01/2018	MAY	96	0.011	Upper	08/01/2018	SUC	106.5	0.041
Lower	15/01/2018	SWL055	88.6	0.004	Middle	15/01/2018	STJ	73.6	0.0073	Upper	22/01/2018	SUC	137.6	0.019
Lower	22/01/2018	SWL233	98.8	0.002	Middle	22/01/2018	STJ	60	0.0057	Upper	29/01/2018	SUC	103.4	0.033
Lower	29/01/2018	SWL161	87.9	0.003	Middle	29/01/2018	STJ	88.3	0.027	Upper	05/02/2018	RON	88.8	0.028
Lower	05/02/2018	SWL225	106.2	0.001	Middle	05/02/2018	STJ	89.4	0.02	Upper	12/02/2018	KIN	114.9	0.024
Lower	12/02/2018	SWL232	96	0.003	Middle	12/02/2018	STJ	85.2	0.013	Upper	19/02/2018	RON	101.3	0.03
Lower	19/02/2018	SWL262	96.8	0.003	Middle	19/02/2018	STJ	83.5	0.013	Upper	26/02/2018	SUC	73.5	0.02
Lower	26/02/2018	SWL183	90.4	0.003	Middle	26/02/2018	MAY	87.6	0.015	Upper	06/03/2018	KIN	109.7	0.021
Lower	06/03/2018	SWL227	101.6	0.003	Middle	06/03/2018	STJ	129.2	0.025	Upper	12/03/2018	KIN	109.2	0.0078
Lower	12/03/2018	SWL301	91	0.002	Middle	12/03/2018	NIL	107.9	0.022	Upper	19/03/2018	RON	103.3	0.034
Lower	19/03/2018	SWL142	94.8	0.003	Middle	19/03/2018	STJ	82.3	0.012	Upper	26/03/2018	KIN	79.9	0.021
Lower	26/03/2018	SWL221	98.5	0.002	Middle	26/03/2018	NIL	87	0.011	Upper	03/04/2018	KIN	121.2	0.032
Lower	03/04/2018	SWL043	98.8	0.001	Middle	03/04/2018	NIL	101.5	0.008	Upper	09/04/2018	KIN	82.7	0.031
Lower	09/04/2018	SWL253	93.4	0.001	Middle	09/04/2018	NIL	126.8	0.056	Upper	16/04/2018	SUC	102.9	0.031
Lower	16/04/2018	SWL276	89.7	0.012	Middle	16/04/2018	MAY	124.3	0.026	Upper	23/04/2018	SUC	100.5	0.032
Lower	23/04/2018	SWL299	92.2	0.003	Middle	23/04/2018	MAY	69.8	0.017	Upper	30/04/2018	RON	68.1	0.0077
Lower	30/04/2018	SWL024	98.8	0.003	Middle	30/04/2018	STJ	98.3	0.012	Upper	07/05/2018	SUC	71.8	0.0064
Lower	07/05/2018	SWL201	93.1	0.003	Middle	07/05/2018	MAY	92.8	0.028	Upper	14/05/2018	SUC	95.6	0.025

Lower	14/05/2018	SWL035	88	<0.001	Middle	14/05/2018	NIL	119.3	0.017	Upper	21/05/2018	KIN	61.4	0.0011
Lower	21/05/2018	SWL053	85.1	0.002	Middle	21/05/2018	MAY	54.6	0.002	Upper	28/05/2018	RON	79.9	0.017
Lower	28/05/2018	SWL221	93.6	0.013	Middle	28/05/2018	STJ	69.9	0.007	Upper	02/01/2019	KIN	126	0.036
Lower	2/01/2019	BLA	96.5	0.0021	Middle	02/01/2019	MAY	96.7	0.027	Upper	02/01/2019	MSB	50.2	0.0015
Lower	2/01/2019	HEA	96.1	0.0027	Middle	02/01/2019	NIL	93.7	0.0054	Upper	07/01/2019	KIN	123.1	0.017
Lower	7/01/2019	ARM	99.3	0.001	Middle	07/01/2019	NIL	93.7	0.0038	Upper	07/01/2019	WMP	107.7	0.0058
Lower	7/01/2019	HEA	96.4	0.0013	Middle	07/01/2019	STJ	106.9	0.017	Upper	21/01/2019	KIN	103.8	0.016
Lower	21/01/2019	ARM	100.6	0.0011	Middle	21/01/2019	MAY	135.8	0.026	Upper	21/01/2019	WMP	111.3	0.025
Lower	21/01/2019	BLA	98.9	0.0015	Middle	21/01/2019	NIL	105.8	0.0017	Upper	04/02/2019	KIN	130.3	0.053
Lower	4/02/2019	ARM	93.7	0.0022	Middle	04/02/2019	MAY	90.1	0.013	Upper	04/02/2019	MSB	63.2	0.0025
Lower	4/02/2019	BLA	97.9	0.0026	Middle	04/02/2019	RON	113.1	0.0036	Upper	18/02/2019	KIN	141	0.02
Lower	18/02/2019	ARM	92.8	0.0015	Middle	18/02/2019	MAY	92.7	0.015	Upper	18/02/2019	SUC	85.6	0.0061
Lower	18/02/2019	NAR	93.8	0.0031	Middle	18/02/2019	STJ	111.5	0.025	Upper	18/03/2019	KIN	149.8	0.045
Lower	18/03/2019	ARM	96	0.0024	Middle	18/03/2019	MAY	113.2	0.017	Upper	18/03/2019	SUC	102	0.018
Lower	18/03/2019	HEA	94.2	0.0008	Middle	18/03/2019	NIL	97	0.0048	Upper	01/04/2019	KIN	122.8	0.016
Lower	1/04/2019	ARM	99.2	0.0077	Middle	01/04/2019	NIL	105.2	0.0087	Upper	01/04/2019	SUC	97.7	0.013
Lower	1/04/2019	NAR	88.8	0.0022	Middle	01/04/2019	RON	107.9	0.011	Upper	15/04/2019	MSB	82.3	0.032
Lower	15/04/2019	HEA	92.2	0.0021	Middle	15/04/2019	RON	103.4	0.013	Upper	15/04/2019	WMP	124.1	0.02
Lower	15/04/2019	NAR	90.7	0.0005	Middle	15/04/2019	STJ	89.2	0.025	Upper	29/04/2019	KIN	78.7	0.013
Lower	29/04/2019	ARM	99	0.0021	Middle	29/04/2019	NIL	103.6	0.011	Upper	29/04/2019	SUC	79.4	0.015
Lower	29/04/2019	HEA	95.9	0.0022	Middle	29/04/2019	STJ	109.8	0.017	Upper	13/05/2019	MSB	83.1	0.016
Lower	13/05/2019	ARM	102.3	0.001	Middle	13/05/2019	MAY	76.7	0.0029	Upper	13/05/2019	SUC	105.7	0.012
Lower	13/05/2019	BLA	95.3	0.0008	Middle	13/05/2019	NIL	86.5	0.0033	Upper	27/05/2019	MSB	82	0.019
Lower	27/05/2019	ARM	96	0.0033	Middle	27/05/2019	MAY	141.1	0.039	Upper	27/05/2019	SUC	87.4	0.0093
Lower	27/05/2019	NAR	91.7	0.002	Middle	27/05/2019	STJ	108.8	0.022					

Table A2.10: Raw surface chlorophyll-a (Chl-a (mg L^{-1})) and surface dissolved oxygen (DO (%)) compliance data for the 2019 KPI period for the Canning Estuary (Canning).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Canning	04/01/2017	RIV	108.6	0.0097	Canning	13/02/2018	RIV	85.7	0.022
Canning	10/01/2017	RIV	107.9	0.02	Canning	20/02/2018	RIV	36.2	0.0084
Canning	17/01/2017	RIV	126.2	0.018	Canning	27/02/2018	RIV	52.5	0.0055
Canning	24/01/2017	RIV	82.1	0.0076	Canning	07/03/2018	RIV	43.5	0.0086
Canning	31/01/2017	RIV	58.9	0.029	Canning	13/03/2018	RIV	71.8	0.0059
Canning	07/02/2017	RIV	100.2	0.0094	Canning	20/03/2018	RIV	81.5	0.011
Canning	14/02/2017	RIV	45.4	0.0024	Canning	27/03/2018	RIV	42.7	0.0075
Canning	21/02/2017	RIV	70.8	0.011	Canning	04/04/2018	RIV	69.5	0.0091
Canning	28/02/2017	RIV	83.6	0.0078	Canning	10/04/2018	RIV	68.6	0.0068
Canning	08/03/2017	RIV	70.1	0.013	Canning	17/04/2018	RIV	80.8	0.027
Canning	14/03/2017	RIV	66.8	0.042	Canning	24/04/2018	RIV	45.5	0.0036
Canning	21/03/2017	RIV	75.7	0.056	Canning	01/05/2018	RIV	50	0.016
Canning	28/03/2017	RIV	55.2	0.012	Canning	08/05/2018	RIV	58.9	0.0078
Canning	04/04/2017	RIV	76.2	0.011	Canning	15/05/2018	RIV	56.3	0.0061
Canning	11/04/2017	RIV	68.2	0.0041	Canning	22/05/2018	RIV	50.7	0.0052
Canning	19/04/2017	RIV	68.8	0.0074	Canning	29/05/2018	RIV	41.6	0.0068
Canning	26/04/2017	RIV	78.1	0.013	Canning	3/01/2019	RIV	54.6	0.0063
Canning	02/05/2017	RIV	66.8	0.0033	Canning	8/01/2019	RIV	82.5	0.0099
Canning	09/05/2017	RIV	41.7	0.011	Canning	22/01/2019	RIV	54.9	0.014
Canning	16/05/2017	RIV	38.4	0.014	Canning	5/02/2019	RIV	86.5	0.0086
Canning	23/05/2017	RIV	51.8	0.033	Canning	19/02/2019	RIV	80.2	0.0052
Canning	30/05/2017	RIV	41.8	0.019	Canning	6/03/2019	RIV	75.9	0.014
Canning	03/01/2018	RIV	79	0.012	Canning	19/03/2019	RIV	57.2	0.007
Canning	09/01/2018	RIV	88.3	0.01	Canning	2/04/2019	RIV	51.3	0.0093
Canning	16/01/2018	RIV	56.5	0.023	Canning	16/04/2019	RIV	52.6	0.011
Canning	23/01/2018	RIV	72.8	0.013	Canning	30/04/2019	RIV	56.8	0.0079
Canning	30/01/2018	RIV	82.8	0.015	Canning	14/05/2019	RIV	71.2	0.0097
Canning	06/02/2018	RIV	73.4	0.0046	Canning	28/05/2019	RIV	61.5	0.019

Table 18: Raw surface chlorophyll-a (Chl-a (mg L^{-1})) and surface dissolved oxygen (DO (%)) compliance data for the 2020 KPI period for the Lower-Swan Canning (Lower), Middle (Middle) and Upper Swan Estuary (Upper).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg/L)	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Lower	02/01/2018	SWL113	83.5	<0.001	Middle	02/01/2018	MAY	96.1	0.012	Upper	02/01/2018	KIN	127.2	0.005
Lower	08/01/2018	SWL284	95.5	0.002	Middle	08/01/2018	MAY	96	0.011	Upper	08/01/2018	SUC	106.5	0.041
Lower	15/01/2018	SWL055	88.6	0.004	Middle	15/01/2018	STJ	73.6	0.0073	Upper	22/01/2018	SUC	137.6	0.019
Lower	22/01/2018	SWL233	98.8	0.002	Middle	22/01/2018	STJ	60	0.0057	Upper	29/01/2018	SUC	103.4	0.033
Lower	29/01/2018	SWL161	87.9	0.003	Middle	29/01/2018	STJ	88.3	0.027	Upper	05/02/2018	RON	88.8	0.028
Lower	05/02/2018	SWL225	106.2	0.001	Middle	05/02/2018	STJ	89.4	0.02	Upper	12/02/2018	KIN	114.9	0.024
Lower	12/02/2018	SWL232	96	0.003	Middle	12/02/2018	STJ	85.2	0.013	Upper	19/02/2018	RON	101.3	0.03
Lower	19/02/2018	SWL262	96.8	0.003	Middle	19/02/2018	STJ	83.5	0.013	Upper	26/02/2018	SUC	73.5	0.02
Lower	26/02/2018	SWL183	90.4	0.003	Middle	26/02/2018	MAY	87.6	0.015	Upper	06/03/2018	KIN	109.7	0.021
Lower	06/03/2018	SWL227	101.6	0.003	Middle	06/03/2018	STJ	129.2	0.025	Upper	12/03/2018	KIN	109.2	0.0078
Lower	12/03/2018	SWL301	91	0.002	Middle	12/03/2018	NIL	107.9	0.022	Upper	19/03/2018	RON	103.3	0.034
Lower	19/03/2018	SWL142	94.8	0.003	Middle	19/03/2018	STJ	82.3	0.012	Upper	26/03/2018	KIN	79.9	0.021
Lower	26/03/2018	SWL221	98.5	0.002	Middle	26/03/2018	NIL	87	0.011	Upper	03/04/2018	KIN	121.2	0.032
Lower	03/04/2018	SWL043	98.8	0.001	Middle	03/04/2018	NIL	101.5	0.008	Upper	09/04/2018	KIN	82.7	0.031
Lower	09/04/2018	SWL253	93.4	0.001	Middle	09/04/2018	NIL	126.8	0.056	Upper	16/04/2018	SUC	102.9	0.031
Lower	16/04/2018	SWL276	89.7	0.012	Middle	16/04/2018	MAY	124.3	0.026	Upper	23/04/2018	SUC	100.5	0.032
Lower	23/04/2018	SWL299	92.2	0.003	Middle	23/04/2018	MAY	69.8	0.017	Upper	30/04/2018	RON	68.1	0.0077
Lower	30/04/2018	SWL024	98.8	0.003	Middle	30/04/2018	STJ	98.3	0.012	Upper	07/05/2018	SUC	71.8	0.0064
Lower	07/05/2018	SWL201	93.1	0.003	Middle	07/05/2018	MAY	92.8	0.028	Upper	14/05/2018	SUC	95.6	0.025
Lower	14/05/2018	SWL035	88	<0.001	Middle	14/05/2018	NIL	119.3	0.017	Upper	21/05/2018	KIN	61.4	0.0011
Lower	21/05/2018	SWL053	85.1	0.002	Middle	21/05/2018	MAY	54.6	0.002	Upper	28/05/2018	RON	79.9	0.017
Lower	28/05/2018	SWL221	93.6	0.013	Middle	28/05/2018	STJ	69.9	0.007	Upper	02/01/2019	KIN	126	0.036
Lower	2/01/2019	BLA	96.5	0.0021	Middle	02/01/2019	MAY	96.7	0.027	Upper	02/01/2019	MSB	50.2	0.0015
Lower	2/01/2019	HEA	96.1	0.0027	Middle	02/01/2019	NIL	93.7	0.0054	Upper	07/01/2019	KIN	123.1	0.017
Lower	7/01/2019	ARM	99.3	0.001	Middle	07/01/2019	NIL	93.7	0.0038	Upper	07/01/2019	WMP	107.7	0.0058
Lower	7/01/2019	HEA	96.4	0.0013	Middle	07/01/2019	STJ	106.9	0.017	Upper	21/01/2019	KIN	103.8	0.016
Lower	21/01/2019	ARM	100.6	0.0011	Middle	21/01/2019	MAY	135.8	0.026	Upper	21/01/2019	WMP	111.3	0.025
Lower	21/01/2019	BLA	98.9	0.0015	Middle	21/01/2019	NIL	105.8	0.0017	Upper	04/02/2019	KIN	130.3	0.053
Lower	4/02/2019	ARM	93.7	0.0022	Middle	04/02/2019	MAY	90.1	0.013	Upper	04/02/2019	MSB	63.2	0.0025
Lower	4/02/2019	BLA	97.9	0.0026	Middle	04/02/2019	RON	113.1	0.0036	Upper	18/02/2019	KIN	141	0.02
Lower	18/02/2019	ARM	92.8	0.0015	Middle	18/02/2019	MAY	92.7	0.015	Upper	18/02/2019	SUC	85.6	0.0061
Lower	18/02/2019	NAR	93.8	0.0031	Middle	18/02/2019	STJ	111.5	0.025	Upper	18/03/2019	KIN	149.8	0.045
Lower	18/03/2019	ARM	96	0.0024	Middle	18/03/2019	MAY	113.2	0.017	Upper	18/03/2019	SUC	102	0.018
Lower	18/03/2019	HEA	94.2	0.0008	Middle	18/03/2019	NIL	97	0.0048	Upper	01/04/2019	KIN	122.8	0.016
Lower	1/04/2019	ARM	99.2	0.0077	Middle	01/04/2019	NIL	105.2	0.0087	Upper	01/04/2019	SUC	97.7	0.013
Lower	1/04/2019	NAR	88.8	0.0022	Middle	01/04/2019	RON	107.9	0.011	Upper	15/04/2019	MSB	82.3	0.032
Lower	15/04/2019	HEA	92.2	0.0021	Middle	15/04/2019	RON	103.4	0.013	Upper	15/04/2019	WMP	124.1	0.02
Lower	15/04/2019	NAR	90.7	0.0005	Middle	15/04/2019	STJ	89.2	0.025	Upper	29/04/2019	KIN	78.7	0.013
Lower	29/04/2019	ARM	99	0.0021	Middle	29/04/2019	NIL	103.6	0.011	Upper	29/04/2019	SUC	79.4	0.015
Lower	29/04/2019	HEA	95.9	0.0022	Middle	29/04/2019	STJ	109.8	0.017	Upper	13/05/2019	MSB	83.1	0.016
Lower	13/05/2019	ARM	102.3	0.001	Middle	13/05/2019	MAY	76.7	0.0029	Upper	13/05/2019	SUC	105.7	0.012

Lower	13/05/2019	BLA	95.3	0.0008	Middle	13/05/2019	NIL	86.5	0.0033	Upper	27/05/2019	MSB	82	0.019
Lower	27/05/2019	ARM	96	0.0033	Middle	27/05/2019	MAY	141.1	0.039	Upper	27/05/2019	SUC	87.4	0.0093
Lower	27/05/2019	NAR	91.7	0.002	Middle	27/05/2019	STJ	108.8	0.022	Upper	6/01/2020	KIN	130.5	0.01
Lower	6/01/2020	HEA	101.6	0.0015	Middle	6/01/2020	NIL	110.3	0.0041	Upper	6/01/2020	SUC	132.6	0.013
Lower	6/01/2020	NAR	95.9	0.0014	Middle	6/01/2020	STJ	108.6	0.009	Upper	20/01/2020	SUC	141	0.015
Lower	20/01/2020	ARM	97.4	0.0017	Middle	20/01/2020	MAY	107.4	0.024	Upper	20/01/2020	WMP	157.1	0.05
Lower	20/01/2020	BLA	100.3	0.0025	Middle	20/01/2020	RON	98.6	0.017	Upper	3/02/2020	KIN	122	0.016
Lower	3/02/2020	ARM	94.3	0.0021	Middle	3/02/2020	NIL	104.2	0.0055	Upper	3/02/2020	WMP	121.6	0.017
Lower	3/02/2020	BLA	96	0.0018	Middle	3/02/2020	STJ	102	0.0083	Upper	17/02/2020	KIN	109.9	0.016
Lower	17/02/2020	BLA	91	0.0029	Middle	17/02/2020	MAY	106.5	0.0084	Upper	17/02/2020	SUC	110	0.01
Lower	17/02/2020	NAR	88.4	0.0027	Middle	17/02/2020	NIL	117.2	0.0035	Upper	3/03/2020	MSB	69.3	0.012
Lower	3/03/2020	HEA	94.7	0.0021	Middle	3/03/2020	MAY	119.7	0.016	Upper	3/03/2020	WMP	132.6	0.015
Lower	3/03/2020	NAR	92.8	0.0023	Middle	3/03/2020	NIL	134.9	0.013	Upper	16/03/2020	KIN	101.9	0.033
Lower	16/03/2020	BLA	86.7	0.0015	Middle	16/03/2020	NIL	146.8	0.022	Upper	16/03/2020	WMP	93.3	0.01
Lower	16/03/2020	HEA	92.3	0.0023	Middle	16/03/2020	RON	115.5	0.026	Upper	30/03/2020	MSB	44.7	0.0046
Lower	30/03/2020	ARM	95.7	0.0032	Middle	30/03/2020	MAY	124.8	0.072	Upper	30/03/2020	SUC	102.9	0.021
Lower	30/03/2020	BLA	80.5	0.0031	Middle	30/03/2020	STJ	119.2	0.015	Upper	14/04/2020	MSB	NS	0.029
Lower	14/04/2020	ARM	98.6	0.0017	Middle	14/04/2020	MAY	68.1	0.015	Upper	14/04/2020	SUC	NS	0.045
Lower	14/04/2020	BLA	84.3	0.0017	Middle	14/04/2020	NIL	83.7	0.0069	Upper	28/04/2020	KIN	43.9	0.0036
Lower	28/04/2020	HEA	93.9	0.0029	Middle	28/04/2020	NIL	96.9	0.0098	Upper	28/04/2020	SUC	62.8	0.0033
Lower	28/04/2020	NAR	88.9	0.0019	Middle	28/04/2020	RON	71.8	0.017	Upper	11/05/2020	MSB	77.1	0.011
Lower	11/05/2020	HEA	94.8	0.0025	Middle	11/05/2020	NIL	103.9	0.011	Upper	11/05/2020	WMP	41.5	0.0017
Lower	11/05/2020	NAR	89.3	0.0022	Middle	11/05/2020	STJ	102.4	0.016	Upper	26/05/2020	SUC	72.5	0.0027
Lower	26/05/2020	BLA	92.3	0.0012	Middle	26/05/2020	MAY	73.8	0.0072	Upper	26/05/2020	WMP	61.5	0.0021
Lower	26/05/2020	HEA	92.1	0.0007	Middle	26/05/2020	STJ	80.1	0.0046					

Table A2.12: Raw surface chlorophyll-a (Chl-a (mg L^{-1})) and surface dissolved oxygen (DO (%)) compliance data for the 2020 KPI period for the Canning Estuary (Canning).

EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})	EMZ	Date	Site	DO (%)	Chl-a (mg L^{-1})
Canning	03/01/2018	RIV	79	0.012	Canning	8/01/2019	RIV	82.5	0.0099
Canning	09/01/2018	RIV	88.3	0.01	Canning	22/01/2019	RIV	54.9	0.014
Canning	16/01/2018	RIV	56.5	0.023	Canning	5/02/2019	RIV	86.5	0.0086
Canning	23/01/2018	RIV	72.8	0.013	Canning	19/02/2019	RIV	80.2	0.0052
Canning	30/01/2018	RIV	82.8	0.015	Canning	6/03/2019	RIV	75.9	0.014
Canning	06/02/2018	RIV	73.4	0.0046	Canning	19/03/2019	RIV	57.2	0.007
Canning	13/02/2018	RIV	85.7	0.022	Canning	2/04/2019	RIV	51.3	0.0093
Canning	20/02/2018	RIV	36.2	0.0084	Canning	16/04/2019	RIV	52.6	0.011
Canning	27/02/2018	RIV	52.5	0.0055	Canning	30/04/2019	RIV	56.8	0.0079
Canning	07/03/2018	RIV	43.5	0.0086	Canning	14/05/2019	RIV	71.2	0.0097
Canning	13/03/2018	RIV	71.8	0.0059	Canning	28/05/2019	RIV	61.5	0.019
Canning	20/03/2018	RIV	81.5	0.011	Canning	7/01/2020	RIV	67.5	0.022
Canning	27/03/2018	RIV	42.7	0.0075	Canning	21/01/2020	RIV	58.6	0.02
Canning	04/04/2018	RIV	69.5	0.0091	Canning	4/02/2020	RIV	73.9	0.0084
Canning	10/04/2018	RIV	68.6	0.0068	Canning	18/02/2020	RIV	165.8	0.0092
Canning	17/04/2018	RIV	80.8	0.027	Canning	4/03/2020	RIV	60.6	0.0042
Canning	24/04/2018	RIV	45.5	0.0036	Canning	17/03/2020	RIV	34.6	0.0048
Canning	01/05/2018	RIV	50	0.016	Canning	31/03/2020	RIV	59.2	0.012
Canning	08/05/2018	RIV	58.9	0.0078	Canning	15/04/2020	RIV	40.9	0.0095
Canning	15/05/2018	RIV	56.3	0.0061	Canning	29/04/2020	RIV	48.7	0.0033
Canning	22/05/2018	RIV	50.7	0.0052	Canning	12/05/2020	RIV	38.1	0.0039
Canning	29/05/2018	RIV	41.6	0.0068	Canning	27/05/2020	RIV	50	0.0044
Canning	3/01/2019	RIV	54.6	0.0063					

Appendix 3: Swan Canning catchment trend analyses

Trend analyses was performed each catchment analyte using the package *mgcv* in the statistical software R. The following generalised additive model (GAM) was fitted to the total nitrogen (TN) and total phosphorus (TP) data for each of catchment site during the peak-flow period from June to November of each year between 01/06/2015-30/11/2019:

Gam (analyte concentration ~ Year + s(Month, bs = 'tp', k = 6), family = 'gaussian', method = 'REML')

gam = generalised additive model applied through *mgcv* package

s = smoothing term set up to model spline-based smooths

bs = smoothing basis used within *s* and set to *'cp'*

tp = thin plate regression spline – low rank isotropic smoother

k = knots, the internal breakpoints that define the spline. With 6 being the number of months (covariates) analysed.

family = object specifying the distribution and link to use in fitting. Set to *'gaussian'*

gaussian = assuming normal distribution of data

method = smoothing parameter estimation method set to *'REML'*

REML= restricted maximum likelihood

Peak-flow period was selected to reduce the effect of inconsistencies in the number of sampling events across the ephemeral catchment sites, which generally cease to flow in summer months.

Estimated marginal means (EMMs) for each year with upper and lower 95% confidence intervals were then calculated for each site using month as a factor in the package *emmeans*. Simultaneous tests for general linear hypotheses were subsequently conducted and overlain on the EMMs using Compact Letter Display (CLD) to assess and illustrate the significance in difference between years at each site (EMMs with the same letter are not significantly different between periods) with an overall trend determined based on these findings. See Figures A3.1 to A3.6 for TN and A4.7 to A4.13 for TP.

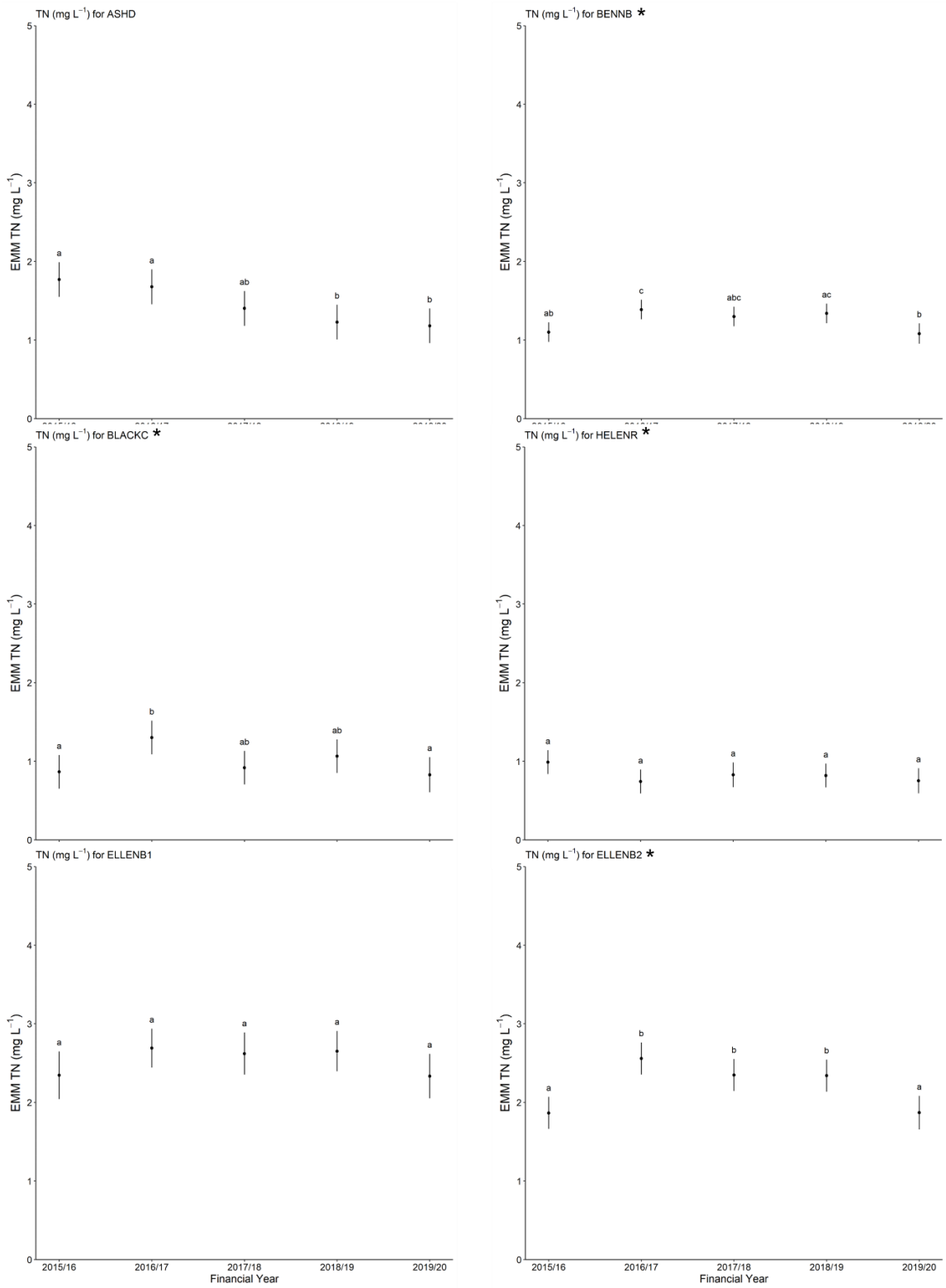

Figure A3.1: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total nitrogen (TN mg L-1) at Ashfield Drain (ASHD), Bennett Brook (BENNB), Blackadder Creek (BLACKC), Helena River (HELENR), and Ellen Brook (ELLENB1 and ELLENB2) within the Upper Swan Catchment with 95% confidence intervals between 2015/16 – 2019/20.

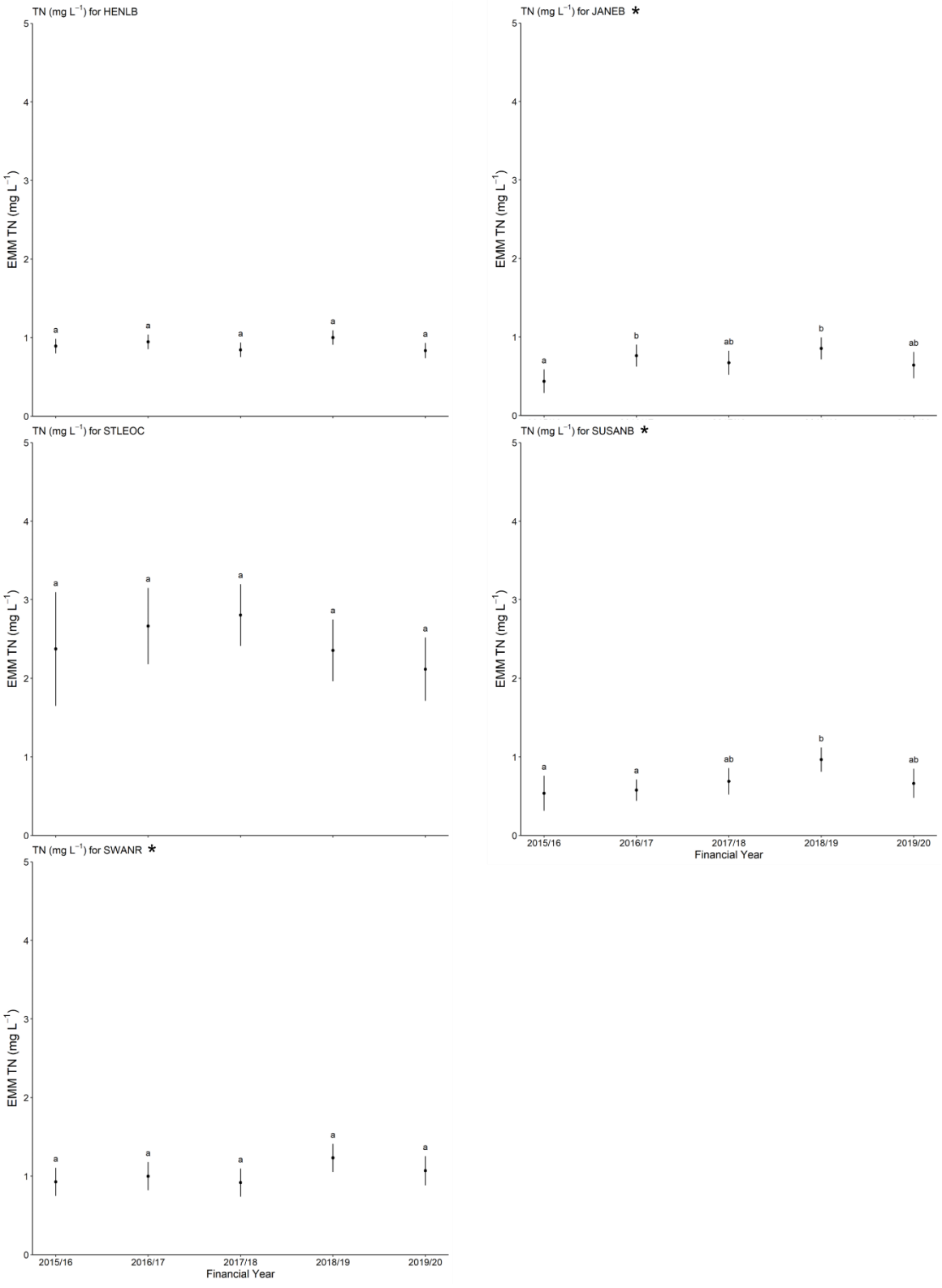

Figure A3.2 Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total nitrogen (TN mg L-1) at Henley Brook (HENLB), Jane Brook (JANEB), St. Leonards Creek (STLEOC), Susannah Brook (SUSANB), and Avon River (SWANR) within the Upper Swan Catchment with 95% confidence intervals between 2015/16 – 2019/20.

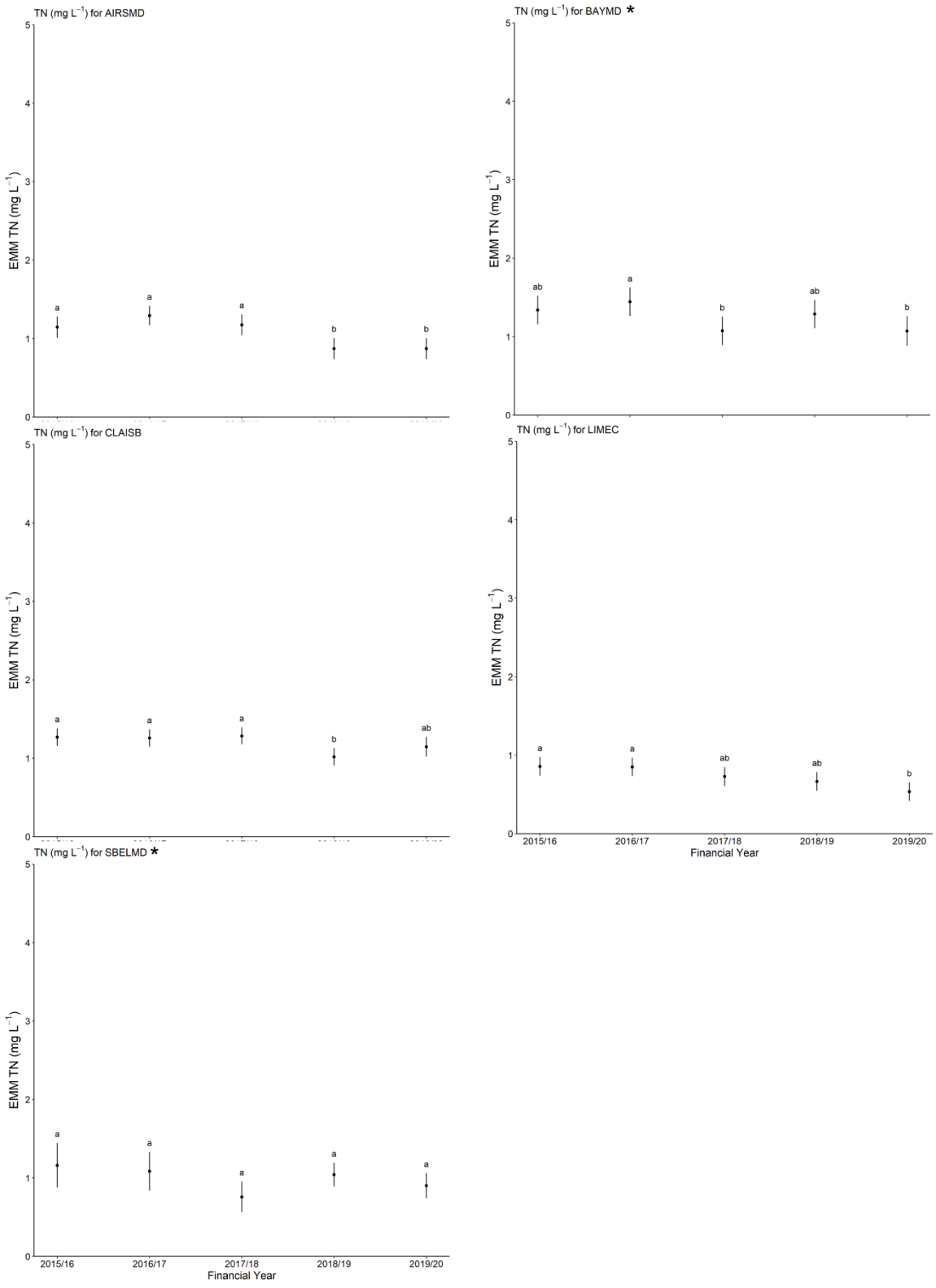

Figure A3.3: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total nitrogen (TN mg L-1) at Perth Airport South Main Drain (AIRSMD), Bayswater Brook Main Drain (BAYMD), Claise Brook (CLAISB), Limestone Creek (LIMEC) and at South Belmont Main Drain (SBELMD) within the Middle Swan Catchment with 95% confidence intervals between 2015/16 – 2019/20.

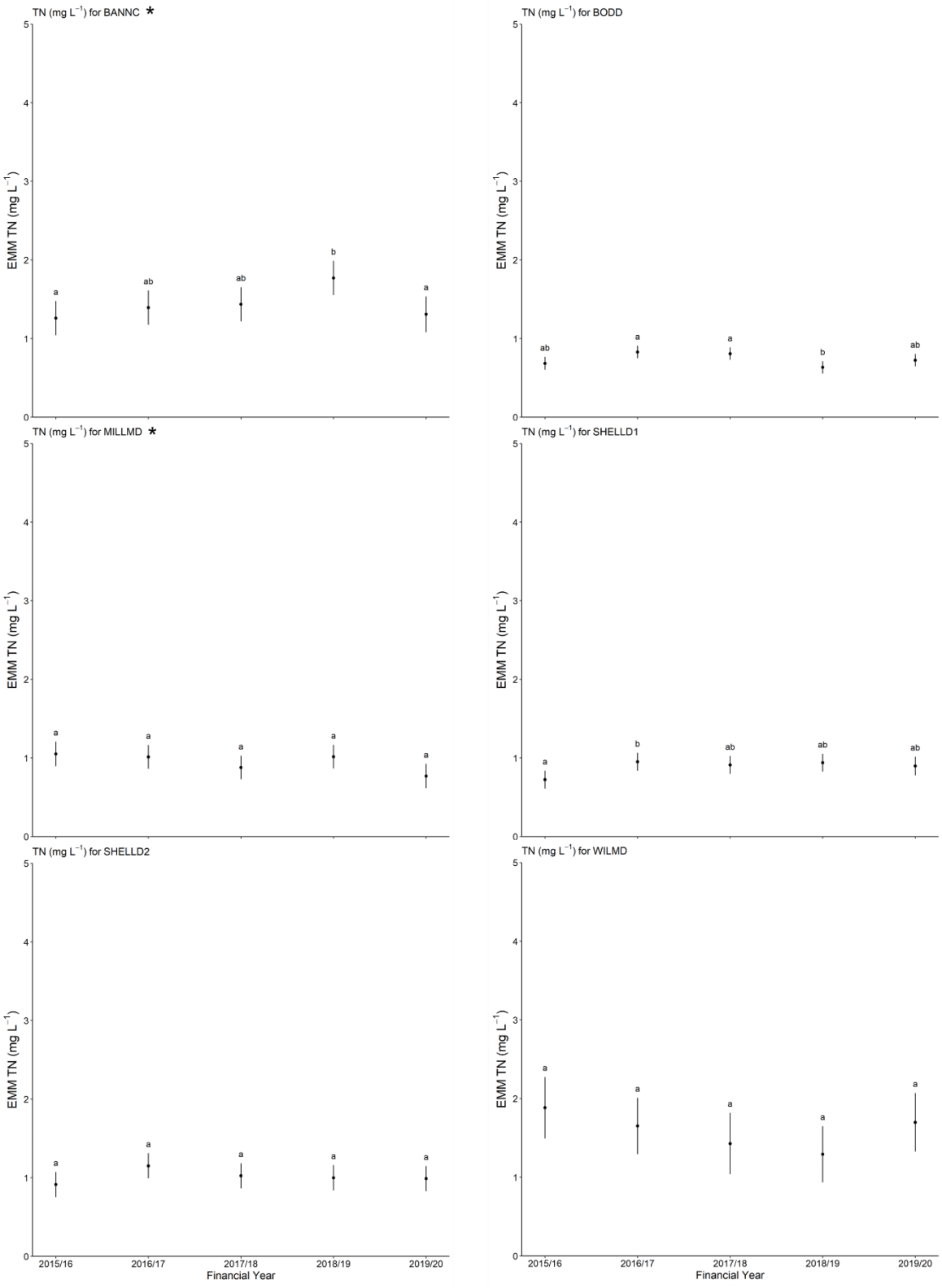

Figure A3.4: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total nitrogen (TN mg L-1) at Bannister Creek (BANNC), South Perth (BODD), Mills Street Main Drain (MILLMD), Bullcreek (SHELLD1 and SHELLD2) and Wilson Main Drain (WILMD) within the Canning Estuary Catchment with 95% confidence intervals between 2015/16 – 2019/20.

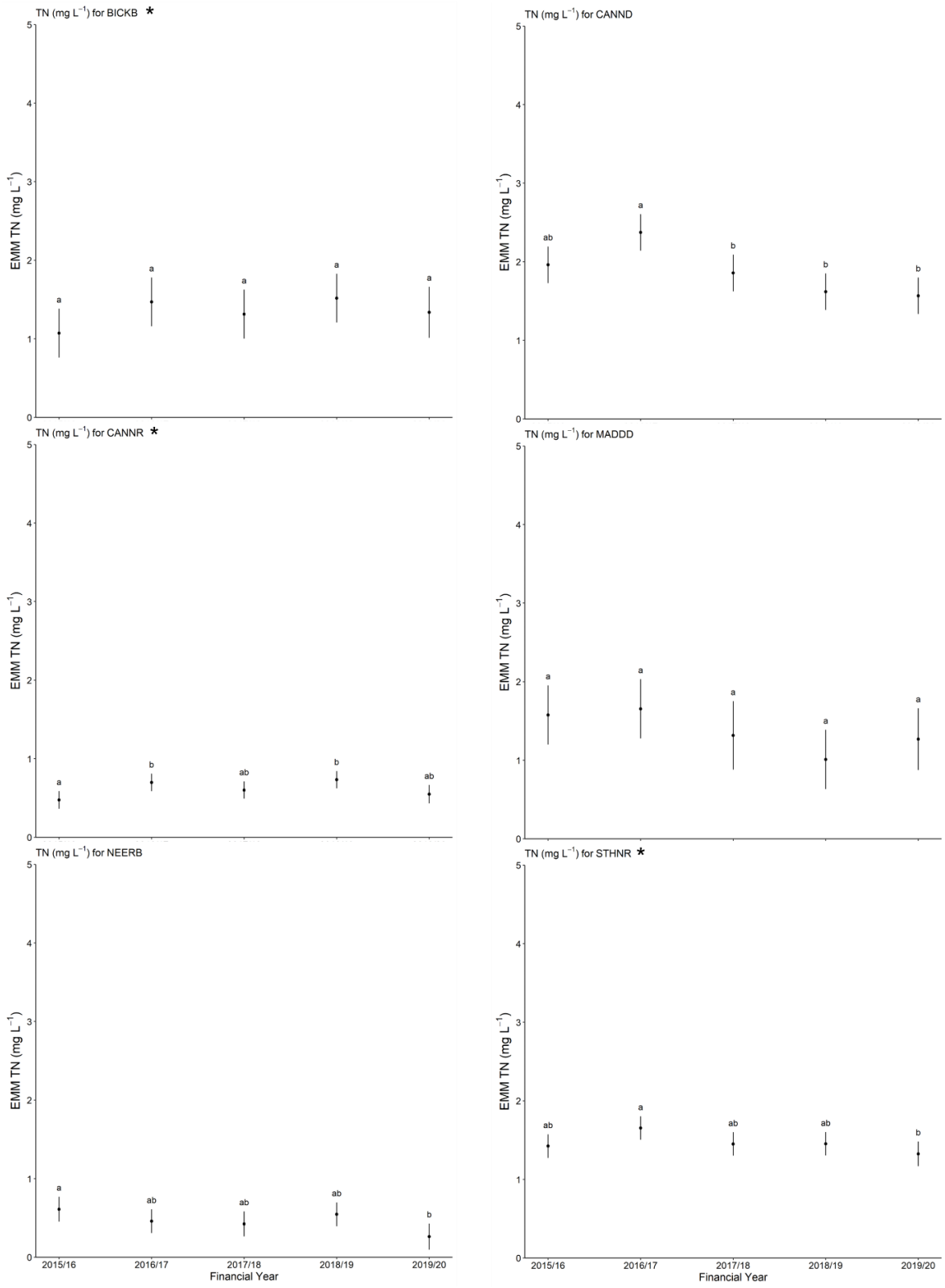

Figure A3.5: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total nitrogen (TN mg L-1) at Bickley Brook (BICKB), Cannington Drain (CANND), Canning River (CANNR), Maddington Main Drain (MADDD), Neerigen Brook (NEERB) and at Southern River (STHNR) within the Canning River Catchment with 95% confidence intervals between 2015/16 – 2019/20.

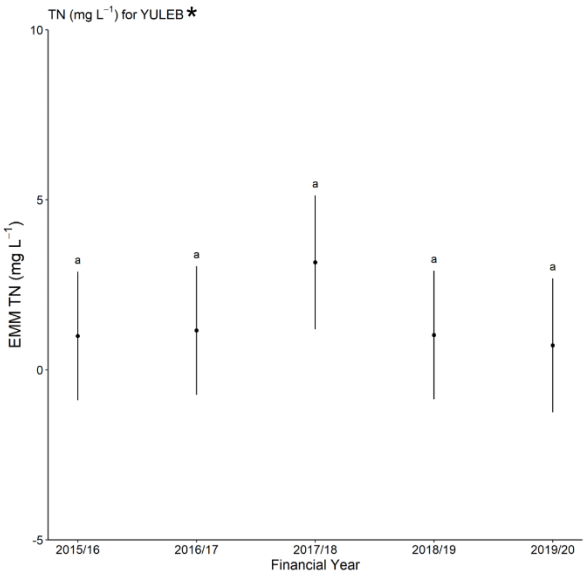

Figure A3.6: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total nitrogen (TN mg L-1) at Yule Brook (YULEB) within the Canning River Catchment with 95% confidence intervals between 2015/16 – 2019/20. Note y-axis scaling differs for YULEB due to increased TN concentrations at this site sites.

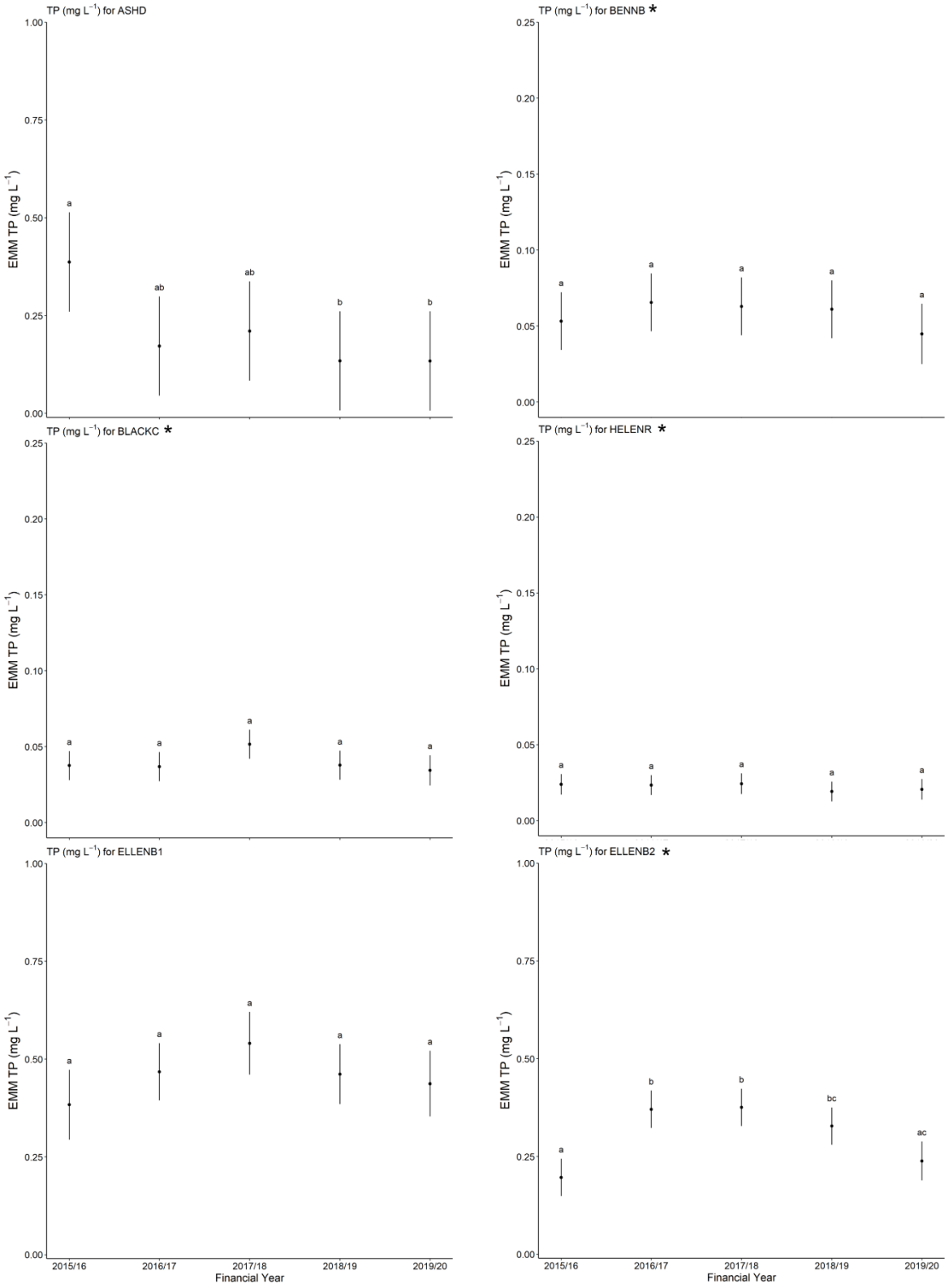

Figure A3.7: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total phosphorus (TP mg L-1) at Ashfield Drain (ASHD), Bennett Brook (BENNB), Blackadder Creek (BLACKC), Helena River (HELENR), and Ellen Brook (ELLENB1 and ELLENB2) within the Upper Swan Catchment with 95% confidence intervals between 2015/16 – 2019/20. Note y-axis scaling differs for ASHD, ELLENB1 and ELLENB2 due to increased TP concentrations at these sites.

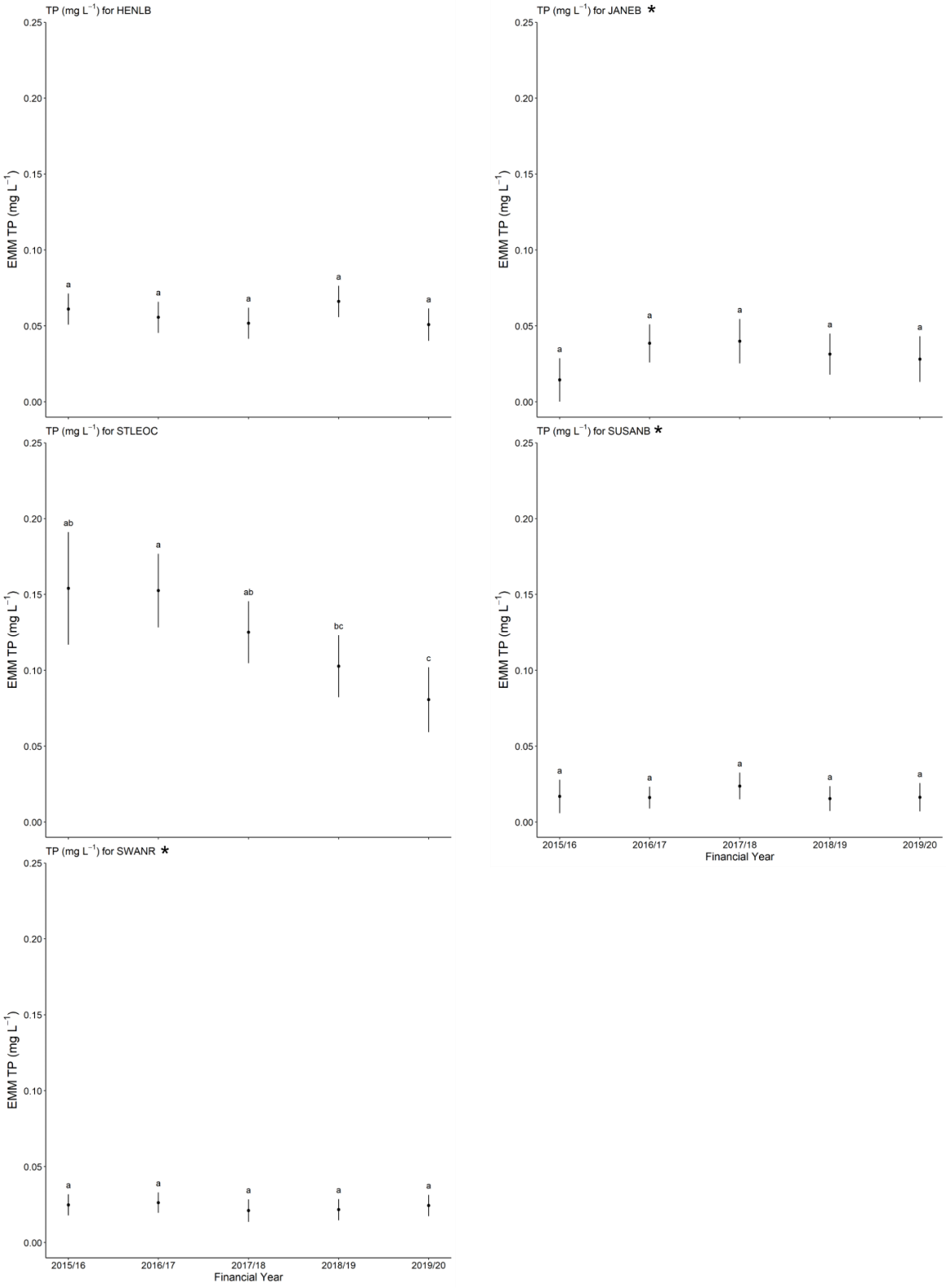

Figure A3.8: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total phosphorus (TP mg L-1) at Henley Brook (HENLB), Jane Brook (JANEB), St. Leonards Creek (STLEOC), Susannah Brook (SUSANB), and Avon River (SWANR) within the Upper Swan Catchment with 95% confidence intervals between 2015/16 – 2019/20.

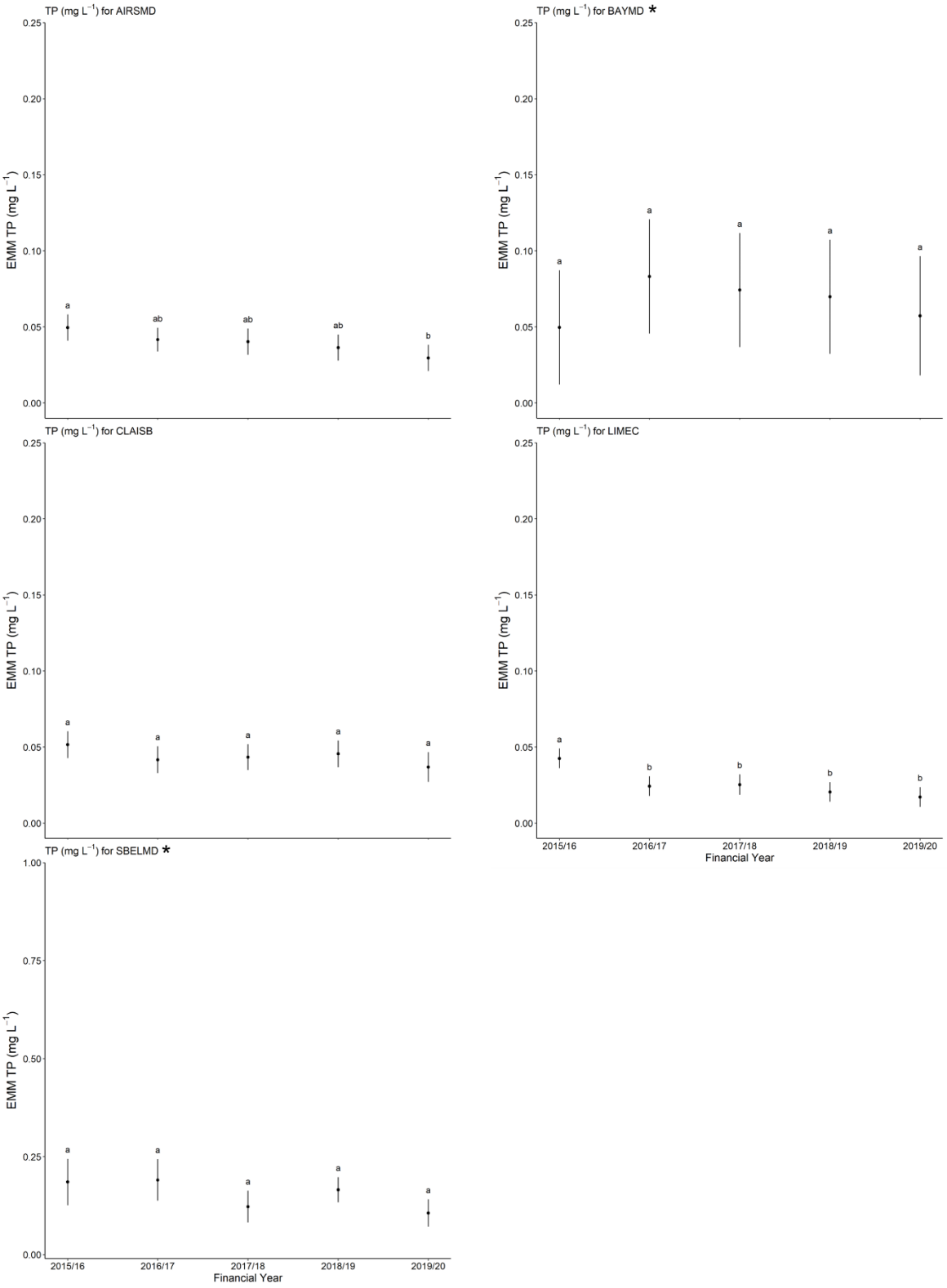

Figure A3.9: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total phosphorus (TP mg L-1) at Perth Airport South Main Drain (AIRSMD), Bayswater Brook Main Drain (BAYMD), Claise Brook (CLAISB), Limestone Creek (LIMEC) and at South Belmont Main Drain (SBELMD) within the Middle Swan Catchment with 95% confidence intervals between 2015/16 – 2019/20. Note y-axis scaling differs for SBELMD due to increased TP concentrations at this site.

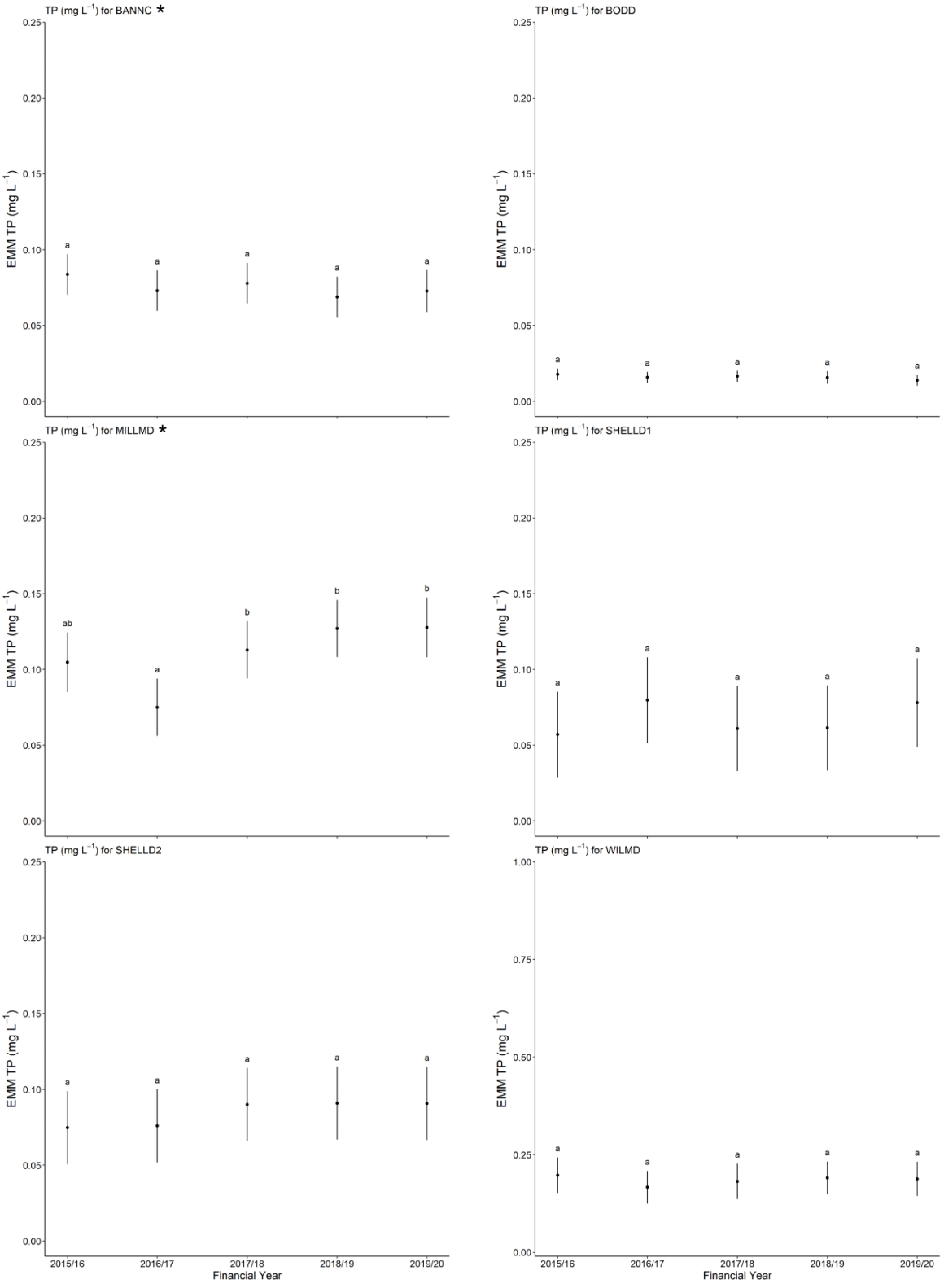

Figure A3.10: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total phosphorus (TP mg L-1) at Bannister Creek (BANNC), South Perth (BODD), Mills Street Main Drain (MILLMD), Bullcreek (SHELLD1 and SHELLD2) and Wilson Main Drain (WILMD) within the Canning Estuary Catchment with 95% confidence intervals between 2015/16 – 2019/20. Note y-axis scaling differs for WILLMD due to increased TP concentrations at this site.

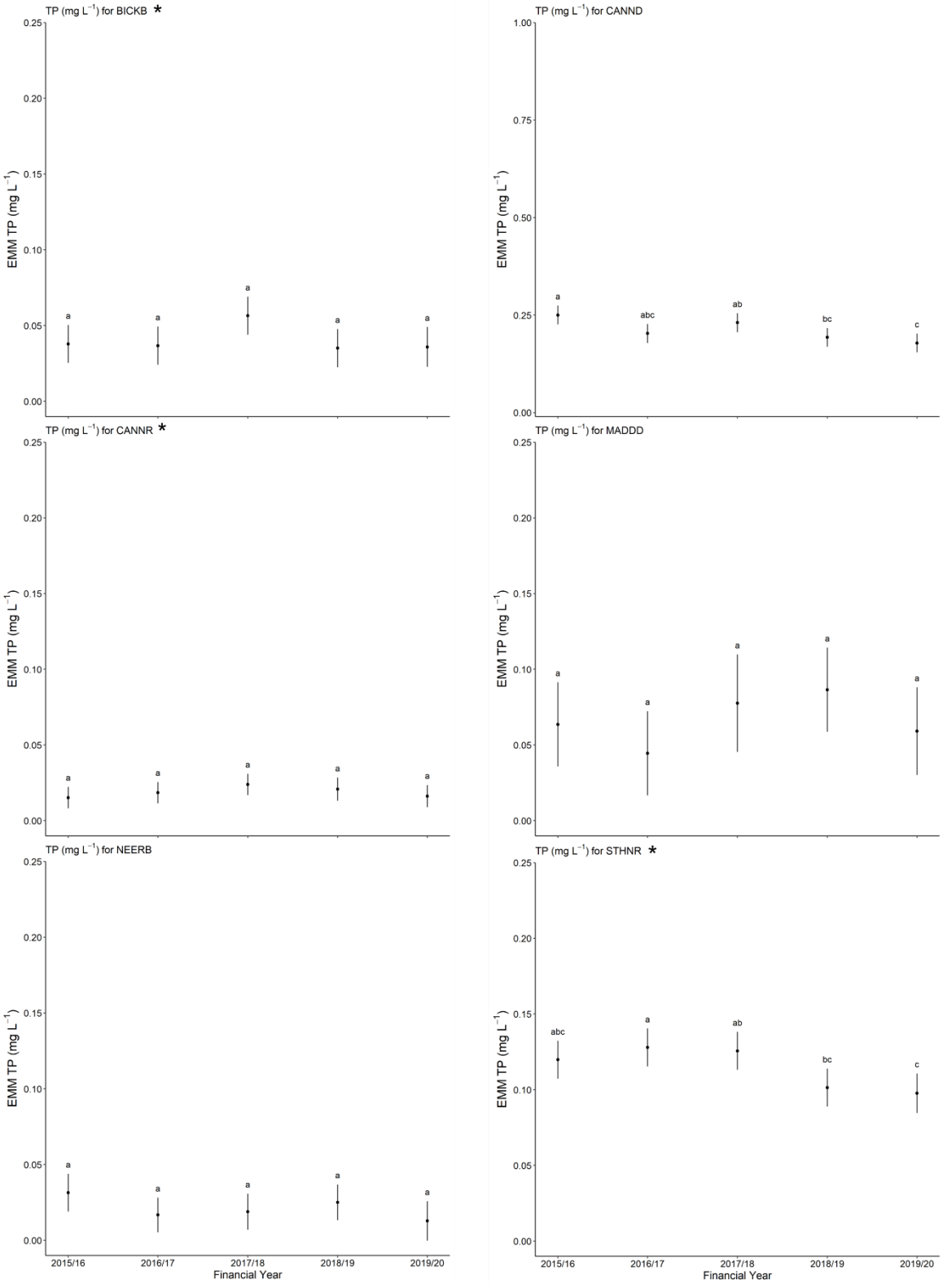

Figure A3.11: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total phosphorus (TP mg L-1) at Bickley Brook (BICKB), Cannington Drain (CANND), Canning River (CANNR), Maddington Main Drain (MADDD), Neerigen Brook (NEERB) and at Southern River (STHNR) within the Canning River Catchment with 95% confidence intervals between 2015/16 – 2019/20. Note y-axis scaling differs for CANND due to increased TP concentrations at this site.

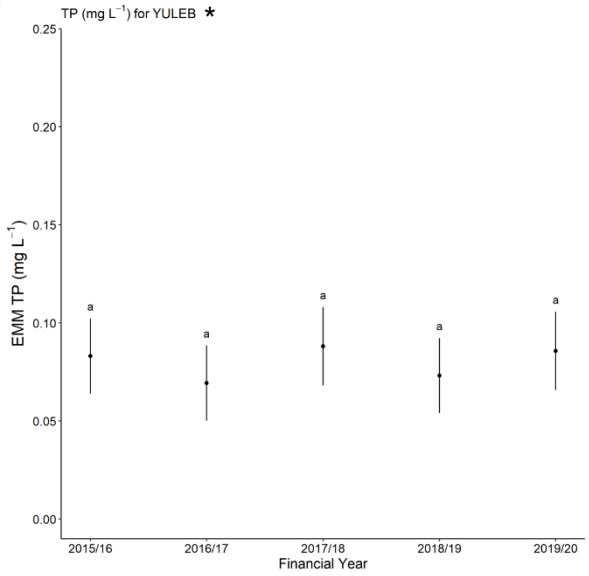

Figure A3.12: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of total phosphorus (TP mg L-1) at Yule Brook (YULEB) within the Canning River Catchment with 95% confidence intervals between 2015/16 – 2019/20.

Appendix 4: Swan-Canning estuarine data trend analysis

Trend analyses was performed on each analytes sampled using the package *mgcv* in the statistical software R. The following generalised additive model (GAM) was fitted to the five-year dissolved oxygen (DO), chlorophyll-a (Chl-a) data (01/07/2015-30/06/2020) for each ecological management zone (EMZ):

gam(analyte concentration ~ Year + s(Month, bs = 'cp') + Site, family = 'gaussian', method = 'REML')

gam = generalised additive model applied through *mgcv* package

s = smoothing term set up to model spline-based smooths

bs = smoothing basis used within *s* and set to *'cp'*

cp = cyclical P-spline

family = object specifying the distribution and link to use in fitting. Set to *'gaussian'*

gaussian = assuming normal distribution of data

method = smoothing parameter estimation method set to *'REML'*

REML= restricted maximum likelihood

Estimated marginal means (EMMs) for each year with upper and lower 95% confidence intervals were then calculated for each EMZ, using site and month as factors in the package *emmeans*. Simultaneous tests for general linear hypotheses were subsequently conducted and overlain on the EMMs using CLD to assess and illustrate the significance in difference between years (EMMs with the same letter are not significantly different between years) at each EMZ with an overall trend determined based on the level of these findings. See Figures A4.1 and A4.2 for chla and A4.3 and A4.4 for dissolved oxygen.

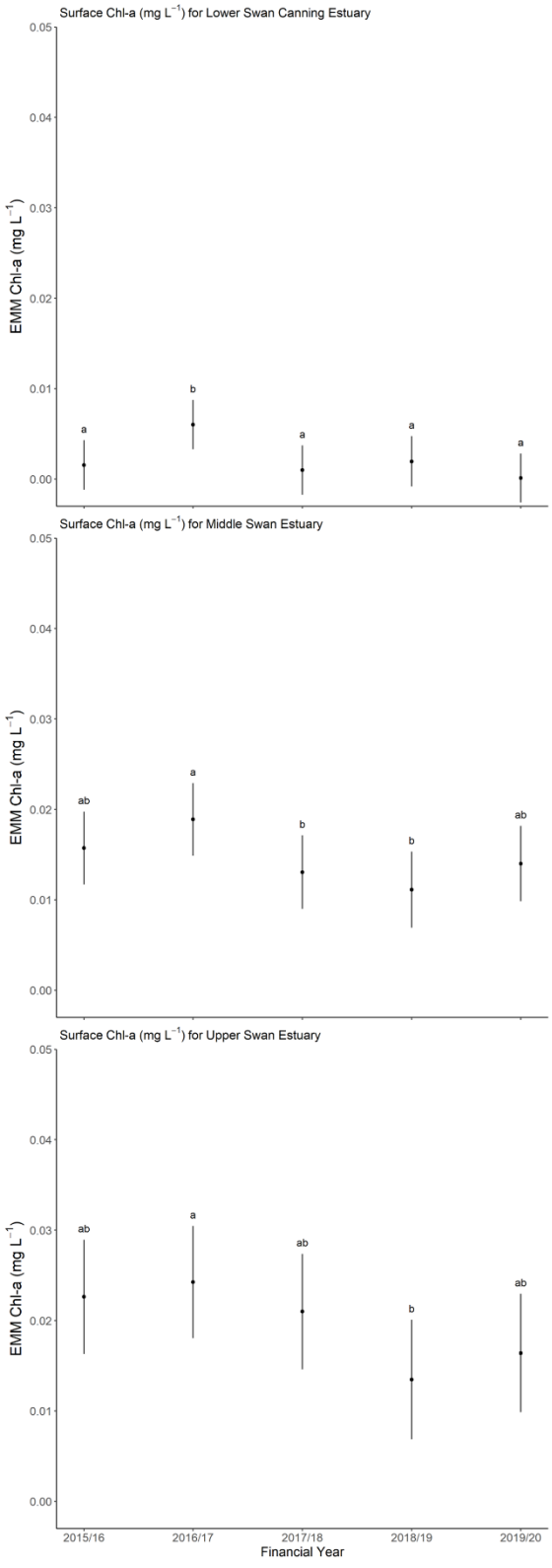

Figure A4.1 Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of chlorophyll a (Chl-a mg L-1) within surface waters of the Lower Swan-Canning Estuary, Middle Swan Estuary and the Upper Swan Estuary with 95% confidence intervals between 2015/16 – 2019/20.

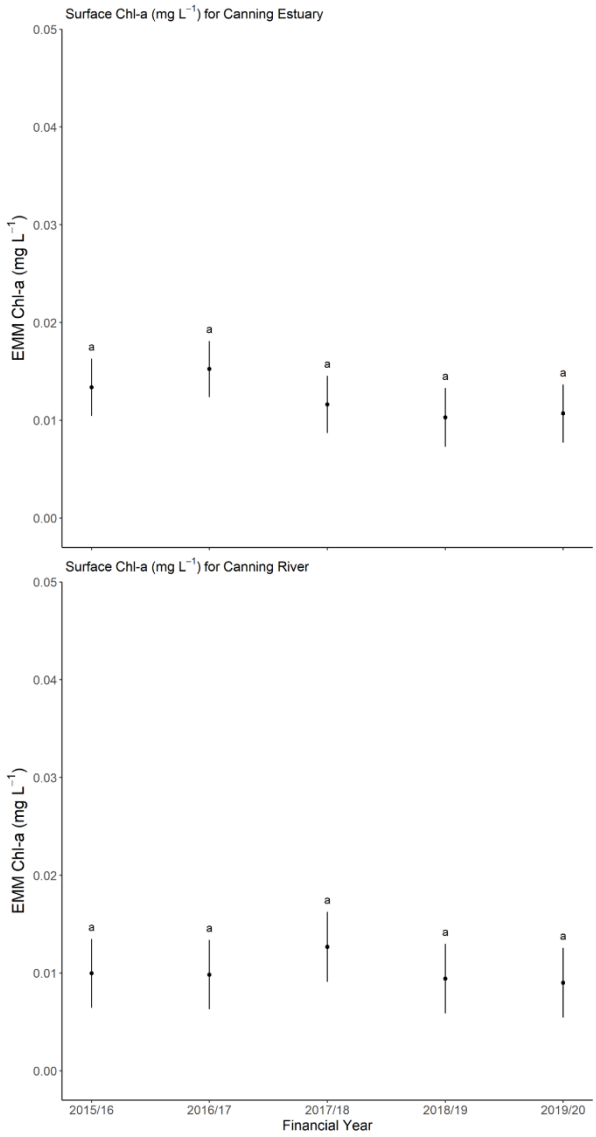

Figure A4.2 Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of chlorophyll a (Chl-a mg L-1) within surface waters of the Canning Estuary and Canning River with 95% confidence intervals between 2015/16 – 2019/20.

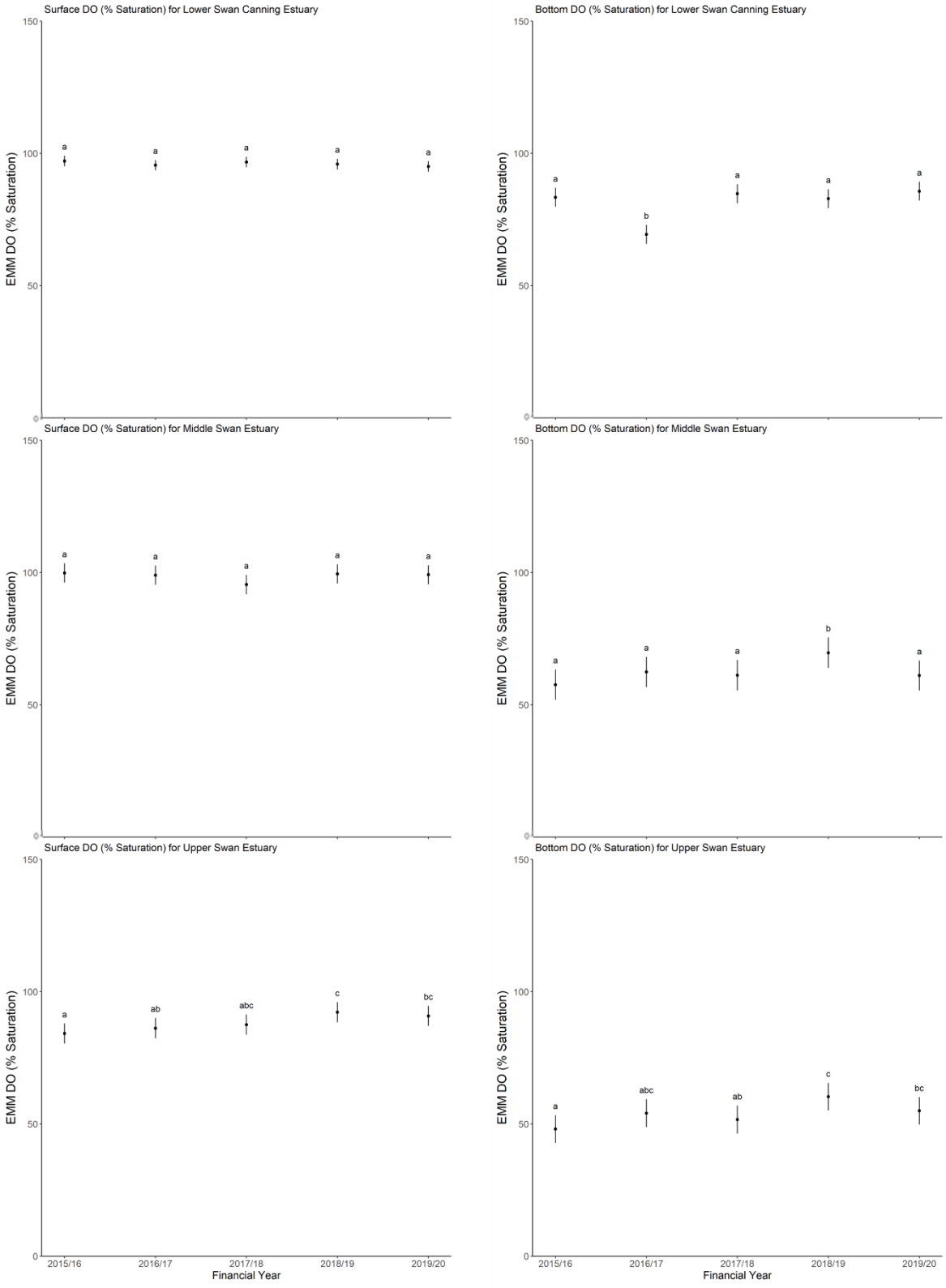

Figure A4.3 Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of dissolved oxygen (% saturation) within surface and bottom waters of the Lower Swan-Canning Estuary, Middle Swan Estuary and the Upper Swan Estuary with 95% confidence intervals between 2015/16 – 2019/20.

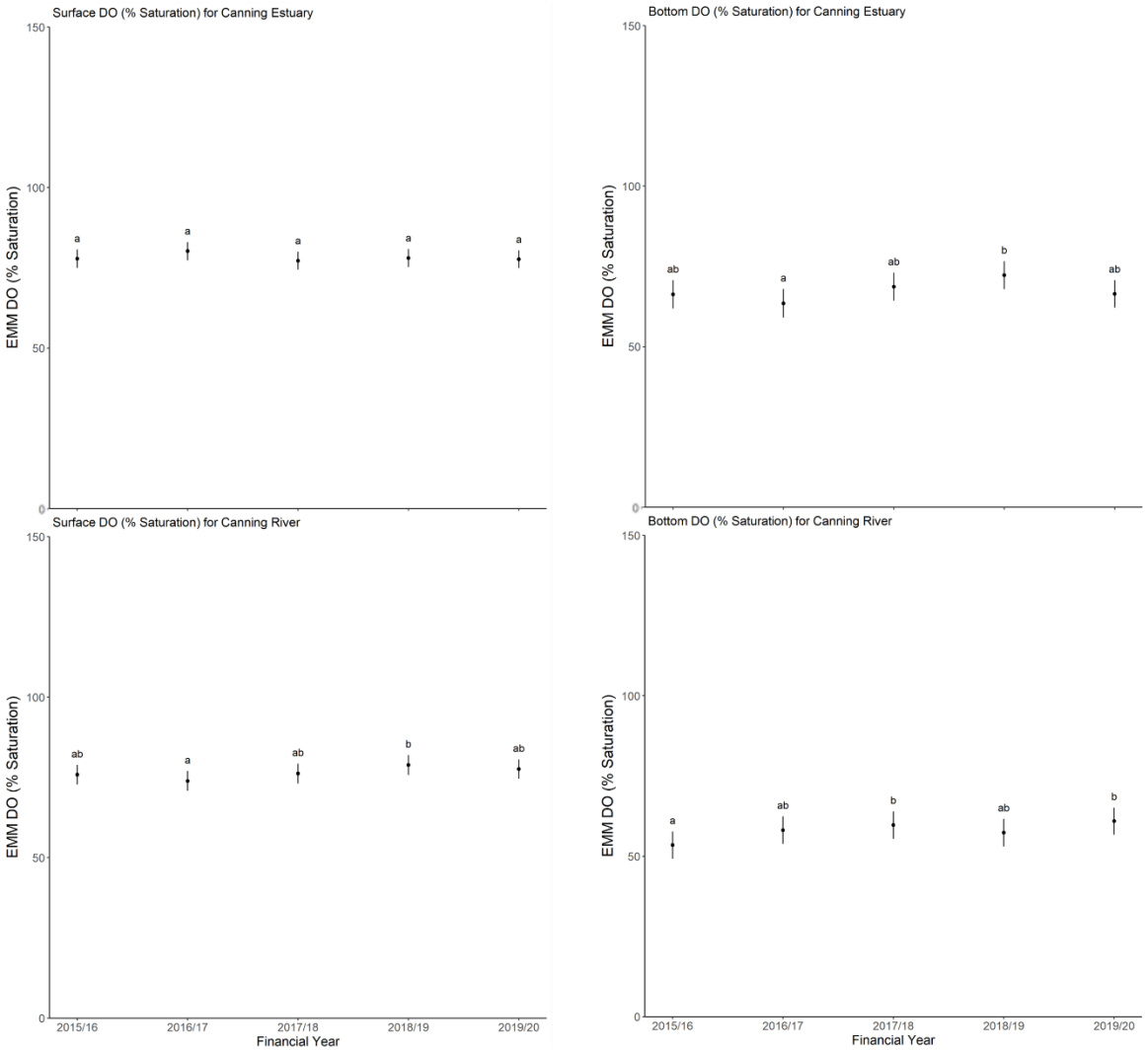

Figure A4.4: Estimated marginal means overlain with a simultaneous test for general linear hypothesis shown as the Compact Letter Display (CLD) of dissolved oxygen (% saturation) within surface and bottom waters of the Canning Estuary and Canning River with 95% confidence intervals between 2015/16 – 2019/20.