Table 1: Proposed RQOs – IUA 5: Orange Estuary

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure
5.1 Orange River Estuary (8.5 km upstream)	Hydrology	Low Flows	Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality.	Base flows	Range: 2- 5 m³/s. Duration: 2 - 3 months at a time during the low flow period. Frequency: 2 - 4 years out of 10.
	Hydrodynamics	Mouth Condition	Maintain a mouth state to create the required habitat for birds, fish, macrophytes, microalgae and water quality. Increase retention time in winter	Mouth condition – Closure	2 > closure < 4 times in 10 years. Closed period 4 to 6 weeks
		Water Level	Maintain a mouth state to create the required habitat for birds, fish, macrophytes, microalgae and water quality. Increase retention time in winter. Maintain a seasonally variable water level regime that supports the recommended mouth breaching and closure cycles.	Water Level	Water level during closed state <2.5 m MSL.
	Quality	Salinity	Salinity intrusion should maintain biotic state (fish, invertebrates, macrophytes and microalgae)	River inflow (drought flows = 10% of the time)	25 > salinity < 40 lower reaches (0 - 6 km) 0 > salinity < 10 upper reaches (6 - 12 km) 0 > salinity < 5 backflooding zone (12 - 18 km)
				River inflow low flows	20 > salinity < 30 lower reaches for 5 > months < 7 of the year. 0 > salinity < 5 upper reaches for 5 > months < 7 of the year.
				River inflow high flows	Salinity > 1 for < 7 months of the year.
		Nutrients	Inorganic nutrient concentrations should maintain biotic state (fish, invertebrates, macrophytes and microalgae).	DIN + DIP: River inflow at Ernst Oppenheimer Bridge (D8H012Q01) or Sendelings Drift (low flows):	Maximum DIN consistently <100 µg/ℓ (e.g. two consecutive surveys) Maximum DIP consistently < 10 µg/ℓ

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure
			Reduce nutrient input in lower Orange River.	DIN + DIP: River inflow at Ernst Oppenheimer Bridge (D8H012Q01) or Sendelings Drift (high flows):	Maximum DIN consistently < 150 µg/ℓ Maximum DIP consistently < 20 µg/ℓ
				DIN + DIP: Estuary (low flows - except during upwelling when concentrations in saline areas can be higher):	Maximum DIN consistently >100 µg/ℓ Maximum DIP consistently >10 µg/ℓ
				DIN + DIP: Estuary (high flows)	Maximum DIN consistently >150 µg/ℓ Maximum DIP consistently >20 µg/ℓ
		System variables	System variables (pH, DO and turbidity) should maintain biotic state (fish, invertebrates, macrophytes and microalgae)	River inflow at Ernst Oppenheimer Bridge (D8H012Q01) or Sendelings Drift (low flows)	6.5 > pH < 8.5 DO >5 mg/ℓ Maximum Turbidity consistently <30 NTU (e.g. two consecutive surveys)
				River inflow at Ernst Oppenheimer Bridge (D8H012Q01) or Sendelings Drift (high flows)	6.5 > pH < 8.5 DO >5 mg/ℓ Turbidity: Naturally turbid (can be <200 NTU).
				Estuary (low flows):	6.5 > pH < 8.5 DO >5 mg/ℓ Turbidity variable, dictated by river inflow
				Estuary (high flows):	6.5 > pH < 8.5 DO >5 mg/ℓ Turbidity variable, dictated by river inflow
		Toxic substances	Presence of toxic substances not to cause exceedance of limits for biota. Should maintain biotic state (fish, invertebrates, macrophytes and microalgae)	Water column toxic substances: River inflow (at Ernst Oppenheimer Bridge (D8H012Q01) / Sendelings Drift) and estuary:	Concentrations must not exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995 or future updates).
				River inflow (at Ernst Oppenheimer Bridge (D8H012Q01) / Sendelings Drift) and estuary: (Sediment toxic substance/ parameters not covered in SA guidelines)	Concentrations not to exceed targets as per Western Indian Ocean: Guidelines for Setting Water and Sediment Quality Targets for Coastal and Marine areas (UNEP *et al*. 2022)
	Physical Habitat	Sediment dynamics	Flood regime to maintain the sediment distribution patterns and	Suspended sediments Bathymetric surveys	Average clay content of suspended sediments in river upstream of estuary <65%.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure
			aquatic habitat (instream physical habitat) so as not to exceed limits for biota.	LiDAR of EFZ	
	Biota	Microalgae	Phytoplankton biomass and cell density should not exceed prescribed limits. Median phytoplankton and microphytobenthos (MPB) biomasses should not exceed prescribed limits (TPC of 'very high' biomass). Decrease nutrient input and reduce base flows in winter where possible under current configuration.	Biomass using chlorophyll-*a* as an index. Community structure using phytoplankton groups and benthic diatoms.	Median phytoplankton *chl-a* should be > 8 µg/ℓ under 'normal flows'. Phytoplankton should be < 20 µg/ℓ and cell density should be < 10 000 cells/ml 'normal flows' (typical of blooms) Maintain median subtidal and intertidal benthic *chl-a* < 8 µg/ℓ and 42 mg/m². A 5% decrease in phytoplankton *chl-a* will relate to a 5% increase in microalgal score. This is mostly related to flow (low flow = higher residence time) and nutrients.
		Macrophytes	Maintain the diversity of macrophyte habitats in the estuary. Improve reeds and sedges covering Maintain submerged macrophyte *Stuckenia pectinata* (pondweed) in sheltered areas Macroalgae cover less than 1 ha. Increase vegetation cover in desertified marsh area by removal of causeway and improvement of tidal and flood channels. More than 50% of this area vegetated (approximately 250 ha).	Community structure using botanical survey and mapping (including alien invasive species).	Prevent further sedimentation in main channel and colonisation by vegetation. <50 % loss of reed and sedge habitats in non-flood year (due to salinity changes). > 300 ha of Reeds and sedges area cover. Presence of pondweed in non-flood years. Macroalgae cover < 1 ha in the estuary. > 200 ha vegetation cover in the desertified marsh area.
		Invertebrates	Retain Present State species richness and mix (low species abundance, high dominance).	Macrobenthos, Zooplankton and Macrocrustacea Community structure.	Species richness < 20 for zooplankton and macroinvertebrates respectively.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure
			Indicator species such as *Capitella capitata*, should not dominate benthic species abundance at the majority of sampling sites since their presence indicates anoxia conditions in the sediment. However, *Capitella* will naturally occur in high abundance in stagnant or poorly drained backwater areas.		*C. capitata* does not numerically dominate benthic species abundance at more than five of sampled sites in the Orange River estuary.
		Fish	Maintain species composition of estuary-associated marine species, non-dependent marine species and indigenous freshwater species. All numerically dominant species are represented by juveniles. The overall biomass of the dominant species *Chelon richardsonii* should not drop below the limit as prescribed.	Fish Recruitment Index (FRI) Community structure	Composition of estuary-associated marine species - 35 - 40%, Composition of non-dependent marine species - 20%, Composition of indigenous freshwater species - 45 - 50%, Non estuary associated marine or freshwater species become proportionally dominant. 0+ juveniles recruitment. *C. richardsonii* biomass > 90%.
		Birds	The estuary should contain a rich avifaunal community that includes representatives of all the original groups, significant numbers of migratory waders and terns, as well as a healthy breeding population of resident waders. The estuary should support over 8 000 waterbirds in summer and over 6 000 birds in winter.	Winter and summer bird counts	Bird numbers should not continue on a downward trajectory. The five-year average numbers of the 14 species for which the estuary supports more than 1% of the southern African or global population should not fall to below half of the average numbers reported by Anderson et al. (2003): Blacknecked Grebe 125 Great White Pelican 473 Cape Cormorant 984

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	
					Lesser Flamingo	1 031
					Greater Flamingo	700
					South African Shelduck	516
					Cape Shoveller	373
					Chestnutbanded Plover	97
					Pied Avocet	891
					Curlew Sandpiper	1 666
					Kelp Gull	1 098
					Hartlaub's Gull	707
					Caspian Tern	165
					Swift Tern	344
					Damara Tern	58

Table 2: Draft Estuaries RQOs and Numerical Limits — IUA 8: Coastal Areas - Buffels Estuary

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
8.2 Buffels Estuarry	Flow	Low Flows	Flows should not exceed natural, and seasonal distribution should not be compromised. Current baseflows into the estuary should be upheld to maintain present mouth state and salinity regime.	Base flows	Long term monitoring should be implemented to inform numerical limits.	Desktop simulations of the surface hydrology indicate little change in the surface water flows, however this does not take into consideration the impact of road infrastructure throughout the catchment, and specifically just above the estuary that acts as instream “farm dams”. DWS, 2017
		High Flows (floods)	The distribution patterns of the flood components differ by no more than 10% in terms of magnitude, timing and variability from that Floods need to reach the estuary.	High Flows (floods)	Long term monitoring should be implemented to inform numerical limits.	
		Groundwater	Groundwater to be maintained at present levels.	Groundwater discharge	Long term monitoring should be implemented to inform numerical limits.	Groundwater is estimated to be significantly modified with ground water use far exceeding the recharge of the aquifer.
	Hydrodynamics	Mouth Condition	Mouth open conditions to be maintained within the current range. Rate at which mouth breaches to be increase.	Mouth condition	Long term monitoring should be implemented to inform numerical limits.	Very little information is available on the hydrodynamics of the small Lower Orange Estuarine Systems. If an estuary is very sensitive to flow modification (e.g. very small or shallow), and/or in an A or B Category, a ±5% variation is allowed for over a 5-year period. Buffels estuary is very seldom connected to the sea. Natural breaching by flood waters estimated to have occurred every 3 to 7. Open mouth conditions would only prevail for short periods (days to a week or two) as flood peaks in arid catchments

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
						generally is a matter of hours with little follow up flow.
		Sediment distribution patterns	Flood regime to maintain sediment distribution patterns and associated aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five-year average.	Sediment composition (sediment particle size, organic content)	Long term monitoring should be implemented to inform numerical limits.	Sediment distribution patterns are impacted by impacts on connectivity in the estuary. The shifts in the hydrodynamics are largely due to structures (culverts, remnants of roads) and reduce groundwater input to the system. With estuarine connectivity being severely reduce, both within the system and to the catchment and marine environment.
	Quality	Salinity	Maintain variability in salinity regime. Measurable increase in salinity in the upper and middle reaches during the winter season	Salinity	Upper reaches: <5 PSU. Lower reaches: <20 PSU.	Salinity limits were derived from measured data or extrapolated for similar systems. Key determining estuarine features used in setting the salinity limits were estuary size, estuary depth, % mouth open and mouth position (*i.e.* perched/not perched). Data sets used include observations and field data.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Dissolved inorganic nitrogen (DIN)	Instream concentration of nutrients as specified must be maintained to protect the aquatic ecosystem health and ensure the prescribed ecological category is met.	DIN	Entire estuary: average <0.3 mg/l (aim for Category C).	Available data on the water quality of the Buffels Estuary is limited. Based on a general understanding of water quality characteristics in estuaries along this part of the coast, as well as expert knowledge, target ranges were proposed for various water quality health categories, where the condition of any parameter had to be improved. Otherwise, the present (measured) water quality concentration is specified.
		Dissolved inorganic phosphorus (DIP)		DIP	Entire estuary: average >0.025 mg/l (aim for Category C).	
		Turbidity	Lower turbidity levels in estuary.	Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter	Entire estuary: average <20 NTU except during floods	Very limited data is available ion turbidity in the estuary. Available data suggest that turbidity in the estuary is high. Harrison (1998) attributed the high turbidity measured in the lower reaches during September 1993 to high concentrations of suspended algae concentrations occurring at the time.
		Dissolved Oxygen	Estuary should be well-oxygenated throughout	Dissolved oxygen (mg/L)	Entire estuary: average ≥4 mg/l	Dissolved oxygen is an essential for most aquatic life. Anthropogenic sources that may influence dissolved oxygen concentration are those with high oxygen demand such as high organic content, biochemical oxygen demand or chemical oxygen demand. These include stormwater run-off, sewage discharge and certain industrial wastes. A frequently used threshold of hypoxia proposed in the literature is 4 mg-O_2/litre.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Toxic substances	Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per Western Indian Ocean (WIO) Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Organic and inorganic constituents, and pathogens.	Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009). Long term monitoring should be implemented to inform numerical limits.	Various water quality constituents can stimulate algal growth or affect biological health. These are classified into organic and inorganic constituents, and pathogens. No data on toxic substances were available. It was assumed that diffuse runoff golf course and adjacent mining activities have contributed to some toxic contamination in the system.
	Biota	Microalgae	Maintain the distribution of different phytoplankton groups (diverse community composition). Control nutrient input from golf course to prevent microalgal blooms.	Biomass using chlorophyll-*a* as an index. Community structure using phytoplankton groups and benthic diatoms.	Long term monitoring should be implemented to inform numerical limits. Phytoplankton chl-a > 20 µg/L represents blooms and should not occur in this system.	Microalgae are an important carbon source for zooplankton and benthic invertebrates. Diversity and abundance typically highest in fresh upper reaches of estuary. Reduced flow and greater salinity intrusion increase microalgal biomass and diversity. Extended mouth closure likely to result in loss in diversity and phytoplankton biomass and increase in benthic microalgal biomass.
		Macrophytes	Maintain the distribution of current macrophyte habitats.	Community structure using	<20% change in the area covered by different macrophyte	The limits are set based on available data and field surveys (DWS, 2017). Macrophyte limits

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			Maintain habitat diversity including some freshwater wetland with reeds and rushes and submerged macrophytes such as pondweed (*Stukenia pectinata*). Growth of natural vegetation in areas where rooikrans is being removed.	botanical survey and mapping, including alien invasive species.	habitats (accounts for natural changes due to the dynamic nature of estuaries).	are based on historical data and descriptions and are considered to be of low confidence. Expert opinion and Google images were used to make the assessments.
		Invertebrates	Invertebrate community structure to be maintained.	Community structure: As sampled by plankton net, grab and dip nets/traps (as appropriate)	Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 25% at any point in the opening and closure cycle.	
		Fish	Maintain current community structure. No alien fish species should occur. Fish should be free of lesions and other anomalies related to water quality. No fish kills should occur.	Community structure: As sampled by seine in open waters	2 to 3 species should occur and include estuarine resident and estuarine dependant marine fishes. Long term monitoring should be implemented to inform numerical limits.	Based on analysis of available data and expert opinion informed by first-hand knowledge of small west coast estuaries. Estuaries sampled by the researchers were categorised according to their salinity regime. Preliminary fish lists (% abundance and frequency of occurrence) were based on available information.
		Birds	Should be dominated by waders and water birds that comprise. Verify occurrence and cause of bird mortalities.	Winter and summer bird counts	Waders and water birds comprise: >15 species and >100 individuals. Long term monitoring should be implemented to inform numerical limits.	Changes in habitat, food availability and human disturbance affect community composition and species abundance. RQOs set for based on analysis of available data and expert opinion informed by first-hand knowledge of small west coast estuaries.

Table 3: Draft Estuaries RQOs and Numerical Limits — IUA 8: Coastal Areas - Swartlintjies Estuary

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
8.3 Swartlintjies Estuary	Flow	Low Flows	Flows should not exceed natural, and seasonal distribution should not be compromised. Current baseflows into the estuary should be upheld to maintain present mouth state and salinity regime.	Base flows	Long term monitoring should be implemented to inform numerical limits.	Desktop simulations of the surface hydrology indicate little change in the surface water flows; however, this does not take into consideration the impact of road infrastructure throughout the catchment, and specifically just above the estuary that acts as instream “farm dams”. DWS, 2017
		High Flows (floods)	The distribution patterns of the flood components differ by no more than 10% in terms of magnitude, timing and variability Floods need to reach the estuary.	High Flows (floods)	Long term monitoring should be implemented to inform numerical limits.	
		Groundwater	Groundwater to be maintained at present levels.	Groundwater recharge	Long term monitoring should be implemented to inform numerical limits.	Groundwater is estimated to be significantly modified with ground water use far exceeding the recharge of the aquafer.
	Hydrodynamics	Mouth Condition	Mouth open conditions to be maintained within the current range.	Mouth condition	Long term monitoring should be implemented to inform numerical limits.	Very little information is available on the hydrodynamics of the small Lower Orange Systems. If an estuary is very sensitive to flow modification (e.g. very small or shallow), and/or in an A or B Category, a ±5% variation was allowed for over a 5-year period. Estuary very seldom connected to the sea. Natural breaching by flood waters estimated to have occurred every 3 to 7. Open mouth conditions would only prevail for short periods (days to a week or two) as flood peaks in arid catchments generally is a matter of hours with little follow up flow.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Sediment distribution patterns	Flood regime to maintain sediment distribution patterns and associated aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five-year average.	Sediment composition (sediment particle size, organic content)	Long term monitoring should be implemented to inform numerical limits.	Sediment distribution patterns are impacted by impacts on connectivity in the estuary. The shifts in the hydrodynamics are largely due to structures (culverts, remnants of roads) and reduce groundwater input to the system. With estuarine connectivity being severely reduce, both within the system and to the catchment and marine environment.
	Quality	Salinity	Maintain variability in salinity regime.	Salinity	Average salinity: <150 PSU.	Salinity limit derived from measured data or extrapolated for similar systems. Key determining estuarine features used in setting the salinity – including estuary size, estuary depth, % mouth open and mouth position (i.e. perched/not perched). Data sets used include Harrison, 1998 observations and field data.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Dissolved inorganic nitrogen (DIN)	Instream concentration of nutrients as specified maintained to protect the aquatic ecosystem health and ensure the prescribed ecological category is met.	DIN	Entire estuary: average <0.1 mg/l.	Available data on the water quality of the Estuary is limited. Based on a general understanding of water quality characteristics in estuaries along this part of the coast, as well as expert knowledge, target ranges were proposed for various water quality health categories, where the condition of any parameter had to be improved. Otherwise, the present (measured) water quality concentration was set limits.
		Dissolved inorganic phosphorus (DIP)		DIP	Entire estuary: average >0.01 mg/l.	
		Turbidity	Lower turbidity levels in estuary.	Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter	Entire estuary: average <10 NTU except during floods	Very limited data ius available ion turbidity in the estuary. Available data suggest that turbidity in the estuary is high. Harrison (1998) attributed the high turbidity measured in the lower reaches during September 1993 to high concentrations of suspended algae concentrations occurring at the time.
		Dissolved Oxygen	Estuary should be well-oxygenated throughout	Dissolved oxygen (mg/L)	Entire estuary: average: ≥6 mg/l	Dissolved oxygen is an essential for most aquatic life. Anthropogenic sources that may influence dissolved oxygen concentration are those with high oxygen demand such as high organic content, biochemical oxygen demand or chemical oxygen demand. These include stormwater run-off, sewage discharge and certain industrial wastes. A frequently used threshold of hypoxia proposed in the literature is 4 mg-O_2/litre.
		Toxic substances	Substance concentrations in estuarine waters not to exceed	Organic and inorganic	Substance concentrations in	Various water quality constituents can stimulate algal growth or affect

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	constituents, and pathogens.	estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009). Long term monitoring should be implemented to inform numerical limits.	biological health. These are classified into organic and inorganic constituents, and pathogens. No data on toxic substances were available. It was assumed that diffuse runoff golf course and adjacent mining activities have contributed to some toxic contamination in the system.
	Biota	Microalgae	Maintain the distribution of different phytoplankton groups and low biomass.	Biomass using chlorophyll-*a* as an index. Community structure using phytoplankton groups and benthic diatoms.	Median phytoplankton chl-*a* should be <5 µg/ℓ under normal flows. Phytoplankton chl-*a* > 20 µg/L represents blooms and should not occur in this system.	Microalgae are an important carbon source for zooplankton and benthic invertebrates. Diversity and abundance typically highest in fresh upper reaches of estuary. Reduced flow and greater salinity intrusion increase microalgal biomass and diversity. Extended mouth closure likely to result in loss in diversity and phytoplankton biomass and increase in benthic microalgal biomass.
		Macrophytes	Maintain the distribution of current macrophyte habitats. Water column salinity not greater than 150 PSU to limit salt accumulation and dieback of salt marsh (*Sarcocornia pillansii*).	Community structure using botanical survey and mapping, including alien	<20% change in the area covered by different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries).	The limits are set based on available data and field surveys. Macrophyte specifications are based on historical data and descriptions and are considered to be of low confidence. Expert opinion and Google images were

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			Investigate historical slime dams input to ensure no salt input. Prevent further disturbance and development in the salt marsh and floodplain habitat.	invasive species.		used to make the assessments. Limits generally set to maintain the distribution of current macrophyte habitats (<20% change in the area), maintain the integrity of the riparian zone and floodplain habitat.
		Invertebrates	Invertebrate community structure to be maintained.	Community structure: As sampled by plankton net, grab and dip nets/traps (as appropriate)	Unincysted Brine shrimp should be present in the system for 75% of the time.	RQOs set to maintain the diversity, abundance and cyclicity of invertebrate communities, in particular the brine shrimp populations.
		Fish	Not applicable. Hyper saline system.			
		Birds	Including flamingos, > 10 species of waders and water birds that feed on brine shrimp should be present 75% of the time (during 40 – 150 PSU and brine shrimp available). Verify occurrence and cause of bird mortalities.	Winter and summer bird counts	Waders and water birds comprise: >10 species present 75% of the time. Long term monitoring should be implemented to inform numerical limits.	Changes in habitat, food availability and human disturbance affect community composition and species abundance. The specifications were set based on analysis of available data and expert opinion informed by first-hand knowledge of small west coast estuaries.

Table 4: Draft Estuaries RQOs and Numerical Limits — IUA 8: Coastal Areas - Spoeg Estuary

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
8.4: Spoeg Estuary	Flow	Low Flows	Flows should not exceed natural, and seasonal distribution should not be compromised. Current baseflows into the estuary should be upheld to maintain present mouth state and salinity regime.	Base flows	Long term monitoring should be implemented to inform numerical limits.	Desktop simulations of the surface hydrology indicate little change in the surface water flows, however this does not take into consideration the impact of road infrastructure throughout the catchment, and specifically just above the estuary that acts as instream “farm dams”. DWS, 2017
		High Flows (floods)	The distribution patterns of the flood components differ by no more than 10% in terms of magnitude, timing and variability Floods need to reach the estuary.	High Flows (floods)	Long term monitoring should be implemented to inform numerical limits.	
		Groundwater	Groundwater to be maintained at present levels.	Groundwater recharge	Long term monitoring should be implemented to inform numerical limits.	Groundwater is estimated to be significantly modified with ground water use far exceeding the recharge of the aquifer.
	Hydrodynamics	Mouth Condition	Maintain current connectivity with the marine environment.	Mouth condition	Long term monitoring should be implemented to inform numerical limits.	Very little information is available on the hydrodynamics of the small Lower Orange Systems. If an estuary is very sensitive to flow modification (e.g. very small or shallow), and/or in an A or B Category, a ±5% variation was allowed for over a 5-year period.
		Sediment distribution patterns	Flood regime to maintain sediment distribution patterns and associated aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ	Sediment composition (sediment particle size, organic content)	Long term monitoring should be implemented to inform numerical limits.	Sediment distribution patterns are impacted by impacts on connectivity in the estuary. The shifts in the hydrodynamics are largely due to structures (culverts, remnants of roads) and reduce groundwater input to the system. With estuarine connectivity being severely reduce, both within the system and to the catchment and marine environment.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			significantly from present (± 0.5 m) (to be determined). Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five-year average.			
	Quality	Salinity	Maintain variability in salinity regime, with measurable increase in salinity in the upper and middle reaches during the winter season	Salinity	Average Salinity: <35 PSU.	Salinity specifications derived from measured data or extrapolated for similar systems. Key determining estuarine features included estuary size, estuary depth, % mouth open and mouth position (i.e. perched/not perched). Data sets used include Harrison, 1998 observations and recent field data.
		Dissolved inorganic nitrogen (DIN)	Instream concentration of nutrients as specified maintained to protect the aquatic ecosystem health and ensure the prescribed ecological category is met.	DIN	Entire estuary: average <0.1 mg/l (aim for Category C).	Available data on the water quality of the Spoeg Estuary is limited. Based on a general understanding of water quality characteristics in estuaries along this part of the coast, as well as expert knowledge, target ranges were proposed for various water quality health categories, where the condition of any parameter had to be improved. Otherwise, the present (measured) water quality concentration was set as the RQO.
		Dissolved inorganic phosphorus (DIP)		DIP	Entire estuary: average >0.01 mg/l (aim for Category C).	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Turbidity	Lower turbidity levels in estuary.	Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter	Entire estuary: average <10 NTU except during floods	Very limited data ius available ion turbidity in the estuary. Available data suggest that turbidity in the estuary is high. Harrison (1998) attributed the high turbidity measured in the lower reaches during September 1993 to high concentrations of suspended algae concentrations occurring at the time.
		Dissolved Oxygen	Estuary should be well-oxygenated throughout	Dissolved oxygen (mg/L)	Entire estuary: average: ≥6 mg/l	Dissolved oxygen is an essential for most aquatic life. Anthropogenic sources that may influence dissolved oxygen concentration are those with high oxygen demand such as high organic content, biochemical oxygen demand or chemical oxygen demand. These include stormwater run-off, sewage discharge and certain industrial wastes. A frequently used threshold of hypoxia proposed in the literature is 4 mg-O_2/litre.
		Toxic substances	Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Organic and inorganic constituents, and pathogens.	Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi	Various water quality constituents can stimulate algal growth or affect biological health. These are classified into organic and inorganic constituents, and pathogens. No data on toxic substances were available. It was assumed that diffuse runoff golf course and adjacent mining activities have contributed to some toxic contamination in the system.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
					Convention Secretariat and CSIR, 2009). Long term monitoring should be implemented to inform numerical limits.	
	Biota	Microalgae	Maintain the distribution of different phytoplankton groups and low biomass in the lower reaches.	Biomass using chlorophyll-*a* as an index. Community structure using phytoplankton groups and benthic diatoms.	Median phytoplankton chl-*a* in lower reaches: <10 µg/ℓ under normal flows. Long term monitoring should be implemented to inform numerical limits.	Microalgae are an important carbon source for zooplankton and benthic invertebrates. Diversity and abundance typically highest in fresh upper reaches of estuary. Reduced flow and greater salinity intrusion increase microalgal biomass and diversity. Extended mouth closure likely to result in loss in diversity and phytoplankton biomass and increase in benthic microalgal biomass. Phytoplankton chl-a > 20 µg/L represents blooms and should not occur in this system.
		Macrophytes	Maintain the distribution of current macrophyte habitats. Maintain the salinity gradient to ensure habitat diversity including some freshwater wetland with reeds upstream and submerged macrophytes such as *Ruppia cirrhosa*. Prevent any further groundwater abstraction and increase in salinity that will lead to die-back of reeds and increase in dry bare saline areas in the salt marsh.	Community structure using botanical survey and mapping, including alien invasive species.	<20% change in the area covered by different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries).	Specifications are based on historical data and descriptions and are considered to be of low confidence. Expert opinion and Google images were used to make the assessments. RQO set to maintain the distribution of current macrophyte habitats and maintain the integrity of the riparian zone and floodplain habitat.
		Invertebrates	Invertebrate community structure to be maintained.	Community structure: As sampled by plankton net,	Population abundances of plankton and benthic assemblages	RQO set based on analysis of available data and expert opinion informed by first-hand knowledge of the small west coast estuaries.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			Invasive alien species should not occur.	grab and dip nets/traps (as appropriate)	(baselines to be set) should not deviate by more than 25% at any point in the opening and closure cycle.	Estuaries sampled by the researchers were roughly grouped into the two brackish and the three systems characterised by cycles of hypersalinity. Specifications set to maintain the diversity, abundance and cyclicity of invertebrate communities, in particular the brine shrimp populations (DWS, 2017)
		Fish	Maintain current community structure. No alien fish species should occur. Fish should be free of lesions and other anomalies related to water quality. No fish kills should occur.	Community structure: As sampled by seine in open waters	2 to 4 species should occur and include estuarine resident and estuarine dependant marine fishes. Long term monitoring should be implemented to inform numerical limits.	Based on analysis of available data and expert opinion informed by first-hand knowledge of small west coast estuaries. Estuaries sampled by the researchers were categorised according to their salinity regime (DWS, 2017).
		Birds	Should be dominated by waders and water birds. Verify occurrence and cause of bird mortalities.	Winter and summer bird counts	Waders and water birds comprise: >15 species and >50 individuals. Long term monitoring should be implemented to inform numerical limits.	Changes in habitat, food availability and human disturbance affect community composition and species abundance. Based on analysis of available data and expert opinion informed by first-hand knowledge of small west coast estuaries.

Table 5: Draft Estuaries RQOs and Numerical Limits — IUA 8: Coastal Areas - Groen Estuary

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
8.5: Groen Estuary	Flow	Low Flows	Flows should not exceed natural, and seasonal distribution should not be compromised. Current baseflows into the estuary should be upheld to maintain present mouth state and salinity regime.	Base flows	Long term monitoring should be implemented to inform numerical limits.	Desktop simulations of the surface hydrology indicate little change in the surface water flows, however this does not take into consideration the impact of road infrastructure throughout the catchment, and specifically just above the estuary that acts as instream "farm dams". (DWS, 2017).
		High Flows (floods)	The distribution patterns of the flood components differ by no more than 10% in terms of magnitude, timing and variability Floods need to reach the estuary.	High Flows (floods)	Long term monitoring should be implemented to inform numerical limits.	
		Groundwater	Groundwater to be maintained at present levels.	Groundwater recharge	Long term monitoring should be implemented to inform numerical limits.	Groundwater is estimated to be significantly modified with ground water use far exceeding the recharge of the aquafer.
	Hydrodynamics	Mouth Condition	Mouth open conditions to be maintained within the current range.	Mouth condition	Long term monitoring should be implemented to inform numerical limits.	Very little information is available on the hydrodynamics of the small Lower Orange Systems. If an estuary is very sensitive to flow modification (e.g. very small or shallow), and/or in an A or B Category, a ±5% variation was allowed for over a 5-year period.
		Sediment distribution patterns	Flood regime to maintain sediment distribution patterns and associated aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly	Sediment composition (sediment particle size, organic content)	Long term monitoring should be implemented to inform numerical limits.	Sediment distribution patterns are impacted by impacts on connectivity in the estuary. The shifts in the hydrodynamics are largely due to structures (culverts, remnants of roads) and reduce groundwater input to the system. With estuarine connectivity being severely reduce, both within the system and to the catchment and marine environment.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			from present (± 0.5 m) (to be determined). Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five-year average.			
	Quality	Salinity	Maintain variability in salinity regime.	Salinity	Upper reaches: <80 PSU (hyper salinity). Middle reaches: <100 PSU (hyper salinity). Lower reaches: <150 PSU (hyper salinity).	Limits derived from measured data or extrapolated for similar systems. Key determining estuarine features used include estuary size, estuary depth, % mouth open and mouth position (i.e. perched/not perched). Data sets used include Harrison, 1998 observations and recent field data.
		Dissolved inorganic nitrogen (DIN)	Instream concentration of nutrients as specified maintained to protect the aquatic ecosystem health and ensure the prescribed ecological category is met.	DIN	Entire estuary: average <0.1 mg/l	Available water quality data is limited. Based on a general understanding of water quality characteristics in estuaries along this part of the coast, as well as expert knowledge, target ranges were proposed for various water quality health categories, where the condition of any parameter had to be improved. Otherwise, the present (measured) water quality concentration was set (DWS, 2017)
		Dissolved inorganic phosphorus (DIP)		DIP	Entire estuary: average >0.01 mg/l	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Turbidity	Lower turbidity levels in estuary.	Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter	Entire estuary: average <15 NTU except during floods	Very limited data is available on turbidity in the estuary. Available data suggest that turbidity in the estuary is high. Harrison (1998) attributed the high turbidity measured in the lower reaches during September 1993 to high concentrations of suspended algae concentrations occurring at the time.
		Dissolved Oxygen	Estuary should be well-oxygenated throughout	Dissolved oxygen (mg/L)	Entire estuary: average ≥6 mg/l	Dissolved oxygen is an essential for most aquatic life. Anthropogenic sources that may influence dissolved oxygen concentration are those with high oxygen demand such as high organic content, biochemical oxygen demand or chemical oxygen demand. These include stormwater run-off, sewage discharge and certain industrial wastes. A frequently used threshold of hypoxia proposed in the literature is 4 mg-O_2/litre.
		Toxic substances	Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Organic and inorganic constituents, and pathogens.	Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets	Various water quality constituents can stimulate algal growth or affect biological health. These are classified into organic and inorganic constituents, and pathogens. No data on toxic substances were available. It was assumed that diffuse runoff golf course and adjacent mining activities have contributed to some toxic contamination in the system.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
					as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009). Long term monitoring should be implemented to inform numerical limits.	
	Biota	Microalgae	Maintain the distribution of different phytoplankton groups along the salinity gradient. Limit algal blooms in this system	Biomass using chlorophyll-*a* as an index. Community structure using phytoplankton groups and benthic diatoms.	Long term monitoring should be implemented to inform numerical limits. Phytoplankton chl-a < 20 µg/L	Microalgae are an important carbon source for zooplankton and benthic invertebrates. Diversity and abundance typically highest in fresh upper reaches of estuary. Reduced flow and greater salinity intrusion increase microalgal biomass and diversity. Extended mouth closure likely to result in loss in diversity and phytoplankton biomass and increase in benthic microalgal biomass.
		Macrophytes	Maintain the distribution of current macrophyte habitats. Maintain the salinity gradient to ensure habitat diversity including the upstream freshwater seepage area where salinity should be less than 10 PSU. Prevent any further groundwater abstraction and increase in salinity that will lead to die-back of reeds and increase in dry bare saline areas in the salt marsh.	Community structure using botanical survey and mapping, including alien invasive species.	<20% change in the area covered by different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries).	RQO based on available data and field surveys - based on historical data and descriptions and are considered to be of low confidence. Expert opinion and Google images were used to make the assessments (DWS, 2017). RQO set to maintain the distribution of current macrophyte habitats (<20% change in the area), maintain the integrity of the riparian zone and floodplain habitat.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Invertebrates	Invertebrate community structure to be maintained.	Community structure: As sampled by plankton net, grab and dip nets/traps (as appropriate)	Unincysted Brine shrimp should be present in the system for 75% of the time.	RQO based on analysis of available data and expert opinion informed by first-hand knowledge of the small west coast estuaries. Estuaries sampled by the researchers were roughly grouped into the two brackish and the three systems characterised by cycles of hypersalinity. RQOs set to maintain the diversity, abundance and cyclicity of invertebrate communities, in particular the brine shrimp populations (DWS, 2017).
		Fish	Maintain current community structure. No alien fish species should occur. Fish should be free of lesions and other anomalies related to water quality. No fish kills should occur.	Community structure: As sampled by seine in open waters	2 species (M. *cephalus, L. richardsonii*) occur when salinities are less than 50 PSU in the salinity cycle. Long term monitoring should be implemented to inform numerical limits.	RQO based on analysis of available data and expert opinion informed by first-hand knowledge of small west coast estuaries. Estuaries sampled by the researchers were categorised according to their salinity regime. Preliminary fish lists (% abundance and frequency of occurrence) were based on available information (DWS, 2017)
		Birds	Including flamingos, > 10 species of waders and water birds that feed on brine shrimp should be present 75% of the time (during 40 – 150 PSU and brine shrimp available). Verify occurrence and cause of bird mortalities.	Winter and summer bird counts	Waders and water birds comprise: >10 species present 75% of the time Long term monitoring should be implemented to inform numerical limits.	Changes in habitat, food availability and human disturbance affect community composition and species abundance. RQO based on analysis of available data and expert opinion informed by first-hand knowledge of small west coast estuaries.

Table 6: Draft Estuaries RQOs and Numerical Limits — IUA 8: Coastal Areas - Sout Estuary

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
8.6: Sout Estuary	Flow	Low Flows	Flows should not exceed natural, and seasonal distribution should not be compromised. Current baseflows into the estuary should be upheld to maintain present mouth state and salinity regime.	Base flows	Long term monitoring should be implemented to inform numerical limits.	Desktop simulations of the surface hydrology indicate little change in the surface water flows, however this does not take into consideration the impact of road infrastructure throughout the catchment, and specifically just above the estuary that acts as instream “farm dams”.
		High Flows (floods)	The distribution patterns of the flood components differ by no more than 10% in terms of magnitude, timing and variability from that reported in 2015 (DWS, 2017). Floods need to reach the estuary (at present significantly reduced by weir above estuary	High Flows (floods)	Long term monitoring should be implemented to inform numerical limits.	
		Groundwater	Groundwater to be maintained at present levels.	Groundwater recharge	Long term monitoring should be implemented to inform numerical limits.	Groundwater is estimated to be significantly modified with ground water use far exceeding the recharge of the aquifer.
	Hydrodynamics	Mouth Condition	Improve connectivity with the different water bodies and restored connectivity with the catchment through removal/ modification of weir at the head of the estuary.	Mouth condition	Long term monitoring should be implemented to inform numerical limits.	Very little information is available on the hydrodynamics of the small Lower Orange Systems. If an estuary is very sensitive to flow modification (e.g. very small or shallow), and/or in an A or B Category, a ±5% variation was allowed for over a 5-year period.
		Sediment distribution patterns	Flood regime to maintain sediment distribution patterns and associated aquatic habitat (instream physical habitat).	Sediment composition (sediment particle size, organic content)	Long term monitoring should be implemented to inform numerical limits.	Sediment distribution patterns are impacted by impacts on connectivity in the estuary. The shifts in the hydrodynamics are largely due to structures (culverts,

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five-year average.			remnants of roads) and reduce groundwater input to the system. With estuarine connectivity being severely reduce, both within the system and to the catchment and marine environment.
	Quality	Salinity	Maintain variability in salinity regime.	Salinity	Upper reaches: <120 PSU (hyper salinity). Middle reaches: <80 PSU (hyper salinity). Lower reaches: <60 PSU (hyper salinity).	Salinity limits derived from measured data or extrapolated for similar systems. Key determining estuarine features included estuary size, estuary depth, % mouth open and mouth position (i.e. perched/not perched). Data sets used include Harrison, 1998 observations and recent field data.
		Dissolved inorganic nitrogen (DIN)	Instream concentration of nutrients as specified maintained to protect the aquatic ecosystem health and ensure the prescribed ecological category is met.	DIN	Entire estuary: average <0.1 mg/l	Available water quality data is limited. Based on a general understanding of water quality characteristics in estuaries along this part of

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Dissolved inorganic phosphorus (DIP)		DIP	Entire estuary: average >0.01 mg/l	the coast, as well as expert knowledge, target ranges are proposed for water quality health, where the condition of any parameter had to be improved. Otherwise, the present (measured) water quality concentration was set.
		Turbidity	Lower turbidity levels in estuary.	Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter	Entire estuary: average <10 NTU except during floods	Very limited data is available on turbidity in the estuary. Available data suggest that turbidity in the estuary is high. Harrison (1998) attributed the high turbidity measured in the lower reaches during September 1993 to high concentrations of suspended algae concentrations occurring at the time.
		Dissolved Oxygen	Estuary should be well-oxygenated throughout	Dissolved oxygen (mg/L)	Entire estuary: average: ≥6 mg/l	Dissolved oxygen is an essential for most aquatic life. Anthropogenic sources that may influence dissolved oxygen concentration are those with high oxygen demand such as high organic content, biochemical oxygen demand or chemical oxygen demand. These include stormwater run-off, sewage discharge and certain industrial wastes. A frequently used threshold of hypoxia proposed in the literature is 4 mg-O_2/litre.
		Toxic substances	Substance concentrations in estuarine waters not to exceed	Organic and inorganic	Substance concentrations in	Various water quality constituents can stimulate

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	constituents, and pathogens.	estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009). Long term monitoring should be implemented to inform numerical limits.	algal growth or affect biological health. These are classified into organic and inorganic constituents, and pathogens. No data on toxic substances were available. It was assumed that diffuse runoff golf course and adjacent mining activities have contributed to some toxic contamination in the system.
	Biota	Microalgae	Maintain the distribution of different phytoplankton groups and low biomass in the lower reaches. Phytoplankton chl-a > 20 µg/L represents blooms and should not occur in this system.	Biomass using chlorophyll-*a* as an index. Community structure using phytoplankton groups and benthic diatoms.	Median phytoplankton chl-a in lower reaches: <10 µg/ℓ under normal flows. Long term monitoring should be implemented to inform numerical limits.	Microalgae are an important carbon source for zooplankton and benthic invertebrates. Diversity and abundance typically highest in fresh upper reaches of estuary. Reduced flow and greater salinity intrusion increase microalgal biomass and diversity. Extended mouth closure likely to result in loss in diversity and phytoplankton biomass and increase in benthic microalgal biomass.
		Macrophytes	Maintain the distribution of current macrophyte habitats.	Community structure using	<20% change in the area covered by	RQO based on historical data and descriptions and are

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			Water column salinity not greater than 50 PSU in the lower reaches to limit salt accumulation and dieback of salt marsh (*Sarcocornia pillansii*). Prevent further disturbance and development in the salt marsh and floodplain habitat through salt works activities.	botanical survey and mapping, including alien invasive species.	different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries).	considered to be of low confidence. Expert opinion and Google images were used to make the assessments (DWS, 2017). EcoSpecs were generally set to maintain the distribution of current macrophyte habitats (<20% change in the area), maintain the integrity of the riparian zone and floodplain habitat.
		Invertebrates	Invertebrate community structure to be maintained.	Community structure: As sampled by plankton net, grab and dip nets/traps (as appropriate)	Unincysted Brine shrimp should be present in the system for 75% of the time.	RQO based on analysis of available data and expert opinion informed by first-hand knowledge of the small west coast estuaries. Estuaries sampled by the researchers were roughly grouped into the two brackish and the three systems characterised by cycles of hypersalinity (DWS, 2017). RQO set to maintain the diversity, abundance and cyclicity of invertebrate communities, in particular the brine shrimp populations.
		Fish	Not applicable. Hyper saline system.			
		Birds	Including flamingos, > 10 species of waders and water birds that feed on brine shrimp should be present 75% of the time (during 40 – 150 PSU and brine shrimp available). Verify occurrence and cause of bird mortalities.	Winter and summer bird counts	Waders and water birds comprise: >10 species present 75% of the time Long term monitoring should be implemented to inform numerical limits.	Changes in habitat, food availability and human disturbance affect community composition and species abundance. The EcoSpecs were set for each estuary based on analysis of available data and

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
						expert opinion informed by first-hand knowledge of small west coast estuaries.