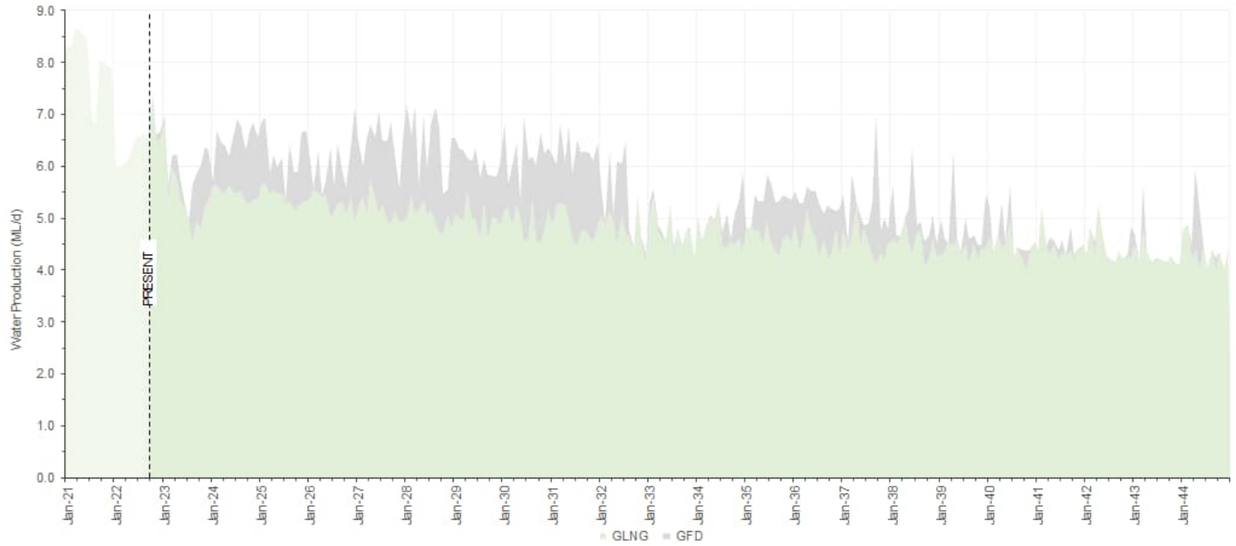
Appendix C-2 IESC Comments and Response

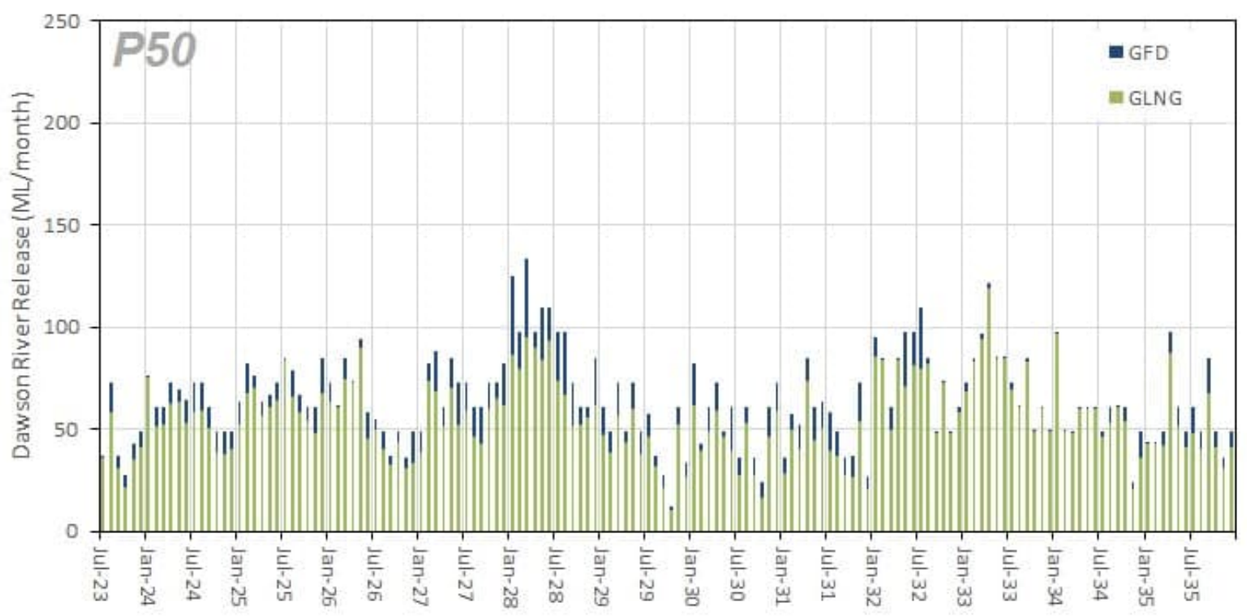
Appendix C-2 - Responses and Clarifications to IESC Questions

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
Question 1: Noting the relevant water quality objectives, water management information and requirements associated with the environmental Authority, can the Committee provide comment on likely scale and extent of potential downstream impacts to the waterhole and Dawson River water resources resulting from the proposed water releases?			
1	The project includes two different proposed releases: the event-based release of untreated produced water directly to the Dawson River, and the release of reverse osmosis (RO)-treated produced water to the Dawson River via the waterhole. The two planned releases will differ in the scale and extent of their potential impacts on the waterhole and other Dawson River water resources.	Following initial Preliminary Documentation (PD) development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. The event-based releases no longer form a component of the proposed action. The proposed ongoing release of desalinated water is a continuation under the Santos water management strategy as described in the 2021 referral (AECOM 2021). Discharge of treated desalinated coal seam gas (CSG) water to the Dawson River via the waterhole is a continuation of the pre-existing GLNG treated desalinated discharge that has been occurring under the GLNG Project since 2015. The proposed action has been assessed and authorised under the State EA (EPPG00928713) following submission and review of supporting technical documents in line with the Department of Environment and Science (DES) Technical Guideline: *Licensing – Wastewater Releases to Queensland Waters and the Coals Seam Gas Water Management Policy* (2012) including potential impacts to environmental values and sensitive species listed as Matters of State Environmental Significance (MSES). The State EA has specific limits approval requirements for conditions under which discharges may be made, and monitoring is required at specific compliance points for the desalinated water release to establish compliance with State EA requirements that are protective of environmental values and sensitive species in the receiving environment as well as drinking water values. These requirements are incorporated into the Receiving Environment Monitoring Program (REMP), presented in the PD Appendices. The REMP monitoring requirements, local trigger (LT) values and sub-regional water quality objectives (WQO) recognise that generic National default guideline values may not represent incumbent conditions at the sub-regional level and have locally derived water quality objectives as listed in the State EA compliance requirements. The current application for the managed release of desalinated water from the Santos GLNG Gas Field Development (GFD) Project has been assessed for potential impacts based on the *Commonwealth Significant Impact Guidelines* (SIG) 1.3. The SIG 1.3 identify that a 'significant impact' is based on the impact is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the water resource, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. The precautionary principle is applied to assess if an action may have a "significant impact" if there are threats of serious or irreversible environmental damage when full scientific certainty is absent.	Section 1.1 Section 1.2 Section 1.3
	a. The event-based releases of untreated produced water are likely to impact an approximately 12-km reach of the Dawson River that is not currently subject to any produced water releases. This reach is between the event-based release point and the monitoring location DRR1 (AECOM 2022, Figure 5.1, p. 70). Impacts are also likely downstream beyond DRR1, including areas where surface water enters bed and bank sediments (e.g., where the Dawson River changes from gaining to losing, see Paragraph 30).	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2 Section 2.1
	b. The treated water releases will potentially impact the tributary, waterhole and Dawson River downstream. The potentially impacted area extends from the desalinated water release point (blue dot in Figure 5.1, AECOM 2022, p. 70) to the confluence with the Dawson River just upstream of DRMP1 (AECOM 2022, Figure 5.1, p. 70) and downstream.	Desalinated water releases proposed for the Gas Field Development (GFD) Project are an extension of existing water releases for the Gladstone Liquefied Natural Gas (GLNG) Project (EPBC 2008/4059) as described in Section 1.1 of the PD. Desalinated water releases to the waterhole and subsequently the Dawson River have occurred since 2015 and have been monitored and assessed under the existing REMP since that time. Water generation from the Fairview gas field is dynamic and variable depending on CSG well numbers and production rate. Water management of coal seam gas water prioritises beneficial reuse of water consistent with the Queensland Government Coal Seam Gas Water Management Policy (DEHP, 2012). Beneficial use data for 2021 indicates produced water end uses are: • 60% is used irrigation • 10% for operational activities such as dust suppression, construction, drilling etc) • 5% is lost to net evaporation • 5% as stored water including brine and • 20% released as desalinated water to the Dawson River. Produced water is treated at the Hub Compressor Station 04 (HCS04) water treatment plant via reverse osmosis (RO) to reduce salinity and chemicals. Water treatment is designed to meet EA prescribed pre-release "contaminant limits (CL) for protecting the Environmental Values (EV) for Drinking Water" (see below). The treatment process is described in Section 2.2.1.4 of the PD and summarized in the response to Question 13. Treated desalinated water is discharged to an ephemeral gully to bring it into equilibrium with ambient temperature and dissolved oxygen conditions prior to entering the waterhole and subsequently entering the Dawson River. Schedule B of the EA defines maximum contaminant limits for treated water that are: a) below acute toxicity limits prior to discharge at the head of gully release point – Schedule B Table 4; and b) protection of the drinking water EV at the compliance point S4 at Yebna Crossing – Schedule B Table 5 Predicted P50 desalinated water inflow to the ROP plant for both the GLNG and GFD projects and the forecast Dawson River discharge requirements are provided in Section 2.3.2 of the PD document and are presented in the following graph.	Section 2.2 Section 9.0

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD



P50 model for ROP2 inflow from GLNG (green) and GFD (grey) projects



P50 Forecast Monthly Dawson River release plot to 2035

The REMP program presented in Appendix J (and reported in Appendix F) of the PD is required by the State EA (Condition B36 to B41) to monitor the receiving environment for potential impact and where required, implement actions and responses triggered by REMP data. REMP monitoring has included ecosystem health monitoring based on SIGNAL 2 scoring (Stream Invertebrate. Grade Number - Average Level1 - scoring system) for both the waterhole and Dawson River upstream and downstream of the desalinated water confluence. Ongoing desalinated releases in accordance with State EA condition requirements under the GFD Project have been found unlikely to significantly change the existing condition of the receiving environment that has been receiving treated desalinated water from the GLNG Project since 2015.

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		Potential impacts of the proposed action have been assessed against the SIG 1.3: as summarized in the PD document. The assessment of potential impacts against the SIG 1.3 have not identified a significant impact to MNES from the release of treated desalinated water.	
2	The IESC considers that untreated produced CSG water should not be released into any surface waters, even during high flows, because of the risks of short- and long-term impacts of mixtures of chemical contaminants on downstream aquatic, riparian and shallow subterranean ecosystems. Legacy impacts of some of these contaminants are unlikely to be resolved merely by dilution, especially as the releases of untreated water are projected to potentially continue until 2066.	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2 Section 2.1
3	For 12 km downstream of the proposed release point, the Dawson River has not been previously subject to releases of produced water. This reach provides aquatic, riparian and subterranean habitats for a range of biota including EPBC Act-listed turtles (see response to Question 2). It also includes GDEs [groundwater dependent ecosystem] such as groundwater-dependent riparian vegetation and watercourse springs, some of which are listed as a TEC ('The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin' – GAB spring).	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2 Section 2.1
4	The release of untreated produced water to this reach could result in a range of impacts on biota including impaired survival, growth, recruitment and reproduction. Impacts could arise through:	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2 Section 2.1
	a. contact with contaminants, either directly via contact with contaminated water and/or sediments or indirectly (e.g., consuming contaminated plants or prey);		
	b. changes to habitat availability from altered flow regimes, altered and variable water levels and channel erosion and sedimentation; and/or		
	c. altered rates of ecosystem processes (e.g., instream nutrient cycling) mediated by microbial assemblages that have been impacted by contaminants.		
5	An assessment of the scale and extent of the impacts requires further local-scale studies, using appropriate field data to provide baseline information on the current conditions (e.g., sediment and water quality, habitat types, aquatic and riparian biota, predominant ecological processes and their rates) including ecohydrological conceptual modelling to examine potential impact pathways and their materiality. These are discussed in more detail in Paragraphs 8, 15, 18b, 20-21, 23-28 and 30.	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2 Section 2.1
6	The proponent is relying on dilution of the untreated produced water to minimise impacts. However, without appropriate DTA, it is not possible to know whether the proposed dilution will be sufficient to prevent impacts associated with direct contact with the contaminant mixtures present in the untreated water releases. Previous studies have shown that for CSG produced water, dilutions of approximately 260:1 (Hydrobiology, 2018) can be needed whereas for shale gas produced water, 'safe' dilutions may be as high as 1140:1 (Golding et al., 2022). 'Safe' dilutions vary greatly depending on pre-release dilutions and local and operational conditions and should be determined for each produced water source (e.g., target formation, initial flowback and produced water).	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2 Section 2.1
7	If untreated releases are permitted, potential impacts should be monitored regularly. Monitoring should include:	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2 Section 2.1
	a. a DTA-based approach to monitoring before and during releases such as described in Golding et al., (2022) to ensure 'safe' dilutions are being achieved;		

<table>
<tr><th>No</th><th>IESC COMMENT</th><th>Response and /or Clarification</th><th>Clarification location in PD</th></tr>
<tr><td></td><td>b. continuous monitoring of electrical conductivity during untreated water releases within both the produced water management system and the Dawson River (upstream and downstream of the release locations) as an early warning of potential water quality issues; and</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td></td><td>c. daily monitoring at the downstream extent of the mixing zone permitted under the Queensland EA, for metals and nutrients during releases, to confirm WQOs are being met. (As it is plausible that WQOs may be exceeded beyond the mixing zone, monitoring should include a site approximately 1 km downstream from the release point as part of a longitudinal series of sampling sites to detect any potential contamination gradient).</td></tr>
<tr><td>8</td><td>The IESC notes that insufficient information has been provided to characterise the current baseline condition of the reach of the Dawson River that may be impacted by the release of untreated water if releases are permitted. Further information is needed on baseline water and sediment quality, flow regime, geomorphological and ecological conditions at additional sites within the reach. Baseline condition measurements for the 12-km reach downstream of the proposed release point must reflect current conditions, that is, conditions prior to exposure to any produced water releases given that this reach has not been previously subject to produced water releases. This information is needed to document existing conditions, allow detection of impacts through comparison with future monitoring data and guide development of a TARP [triggered action response plan] to manage potential impacts.</td><td>Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan.

Event-based releases no longer form a component of the proposed action.

Baseline water and sediment quality, flow regime, geomorphological and ecological conditions appropriate for the desalinated water release are covered in Section 5.2 (Hydrology), Section 5.3 (Water Quality) and Section 5.4 (Sediment Quality) of the PD.</td><td>Section 1.2
Section 2.1
Section 5.2
Section 5.3
Section 5.4</td></tr>
<tr><td>9</td><td>The mixing zone modelling results for event-based releases show that water quality objectives cannot be achieved within the mixing zone as defined by the Queensland Government. Mixing is required to be complete within three stream widths from the release point or 300 m, whichever is smaller (AECOM 2016, p. 56). This would require WQOs to be met within 70 m of the event-based release point under high flows and 50 m for medium flows (AECOM 2016, pp. 56-57). Results of the modelling are summarised in Tables 25-27 and Figures 21-32 (AECOM 2016, pp. 58-72) and show that some WQOs may not be achieved until almost 1 km downstream. Alternative release scenarios, such as blending with produced water from wells that have not been hydraulically stimulated, although briefly discussed, require further consideration to ensure WQOs are met within the required distance downstream so that Matters of National Environmental Significance (MNES) are adequately protected.</td><td>Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan.

Event-based releases no longer form a component of the proposed action.</td><td>Section 1.2
Section 2.1</td></tr>
<tr><td>10</td><td>The treated water releases have been occurring at a maximum rate of 13.5 ML/day since July 2015 (AECOM 2022, p. 77). The releases have raised the depth of water in the waterhole (AECOM 2022, Figure 5.3, p. 77) so it is now permanently inundated to a depth of approximately 1 m. The waterhole is likely to remain permanently inundated while regular releases from the project occur. Should releases under the project be 18 ML/day, water depth may remain higher for longer and spilling to the Dawson River could increase in frequency.</td><td>Water releases have predominantly occurred at 13.5 ML/day. Releases at 18 ML/day have also occurred at 18 ML/day in 2016, 2017 and 2022 as presented Figure 2-3 in the PD).

Water levels within the waterhole under the current discharge regime are presented in Figure 5-5 of the PD and are based on gauging at the REMP WLMP1 monitoring location, the discharge location of the gulley to the waterhole. Change in water depth at WLMP1 ranges between a maximum of +0.4 to -0.5 and more typically varies between ±0.2 m depending on the duration of the discharge.

Overall management of produced water has been revised during 2021 by increasing areas of irrigation and to reduce overall water discharge requirements. This has resulted in a 39% decrease in release days and 41% decrease in total annual release volume compared to 2020 period as indicated in the Table below.
<table>
<tr><th>Year</th><th>Total No. of Release Days in Year</th><th>Release Rate (ML/day)</th><th>Annual Release (ML)</th><th>State EA Approved Annual Release (ML)</th></tr>
<tr><td>2015</td><td>22</td><td>13.5</td><td>262.7</td><td rowspan="5">6,570[a]</td></tr>
<tr><td>2016</td><td>87</td><td>13.5 to 18 ML/day</td><td>1,106.1</td></tr>
<tr><td>2017</td><td>97</td><td>13.5 to 18 ML/day</td><td>1,248.9</td></tr>
<tr><td>2018</td><td>111</td><td>13.5</td><td>1,433.6</td></tr>
<tr><td>2019</td><td>143</td><td>13.5</td><td>1,874.0</td></tr>
</table></td><td>Section 2.2
Section 5.2.2.2</td></tr>
</table>

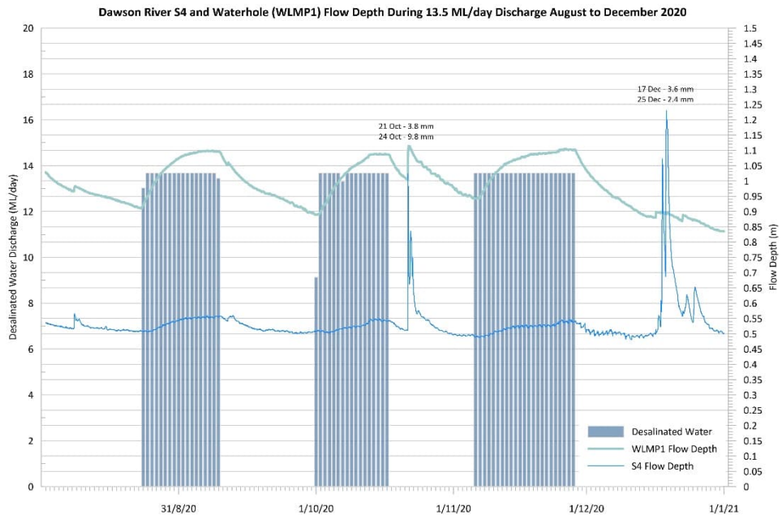
No	IESC COMMENT	Response and /or Clarification	Clarification location in PD

2020	156	13.5	2,077.5	
2021	95[b]	13.5	1,223.8	
Average [c]	**114.8**	**-**	**1,494.0**	

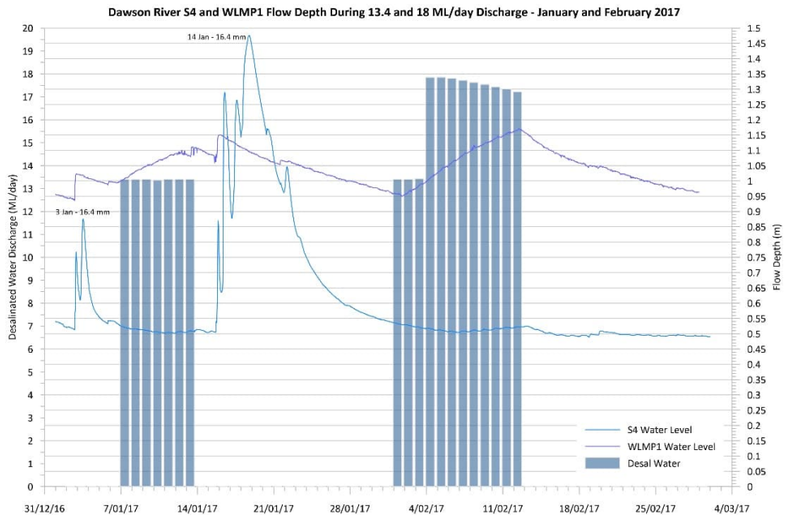
a – State EA approved annual release based on 18 ML/day x 365 days
b - Reduced 2021 release days is due to revised water management procedures directing more water to beneficial reuse via irrigation.
C – Excluding 2015 as discharges commenced mid-way through the year

The revised water management regime will be used for the GFD project with a predicted P50 annual desalinated water release volume of 900 ML over a similar 70 days duration or less based on a desalinated water pond discharge trigger of 90-95% capacity (excluding freeboard) and cessation of discharge at 50% capacity (excluding freeboard). Forecast P50 desalinated water discharges are predicted to be well below the State EA approved limit of 547 ML/Month (6,570 ML/Year / 12 Months) with all predicted desalinated water releases to 2035 being less than 150 ML/month; less than 30% of the EA approved limit.

Water depth in the waterhole is governed by the waterhole outlet elevation of between 259 mAHD and 250 mAHD. Monitoring records of historical desalinated water release include a single period of 18 ML/day discharge in February 2017. The total increase in waterhole water level during an 18 ML/day is 0.23 m, marginally increased from a 0.20 m water level increase with a 13.5 ML/day discharge event in the 5-month period indicated below under base-flow conditions. The data for the 18 ML/day increase does not indicate a significant change in either magnitude or duration of flow depth in the waterhole or Dawson River.



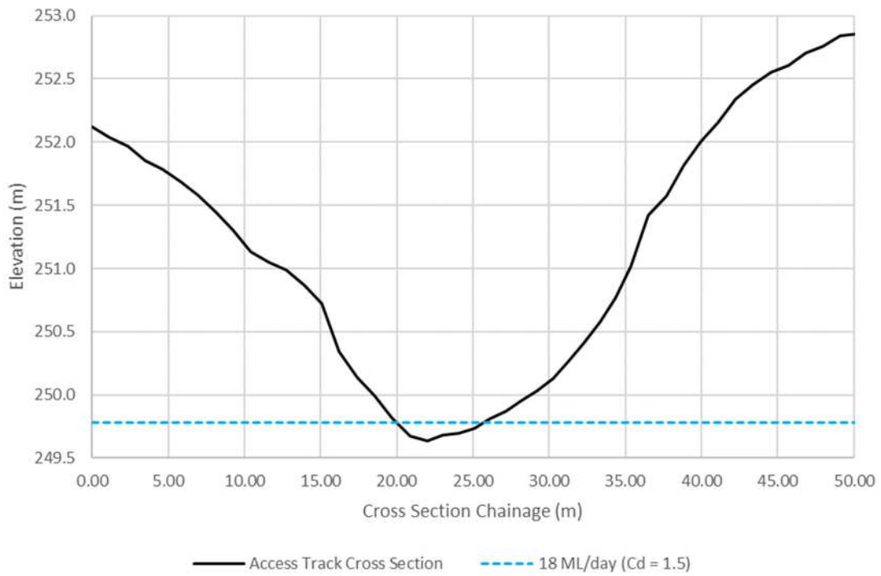
13.5 ML/day Desalinated Water Discharge

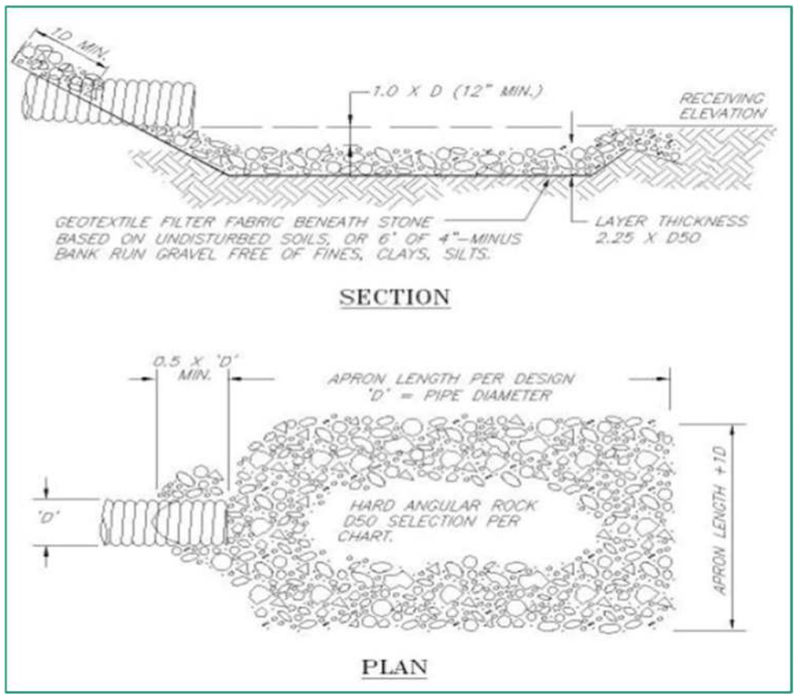


18 ML/day Desalinated Water Discharge

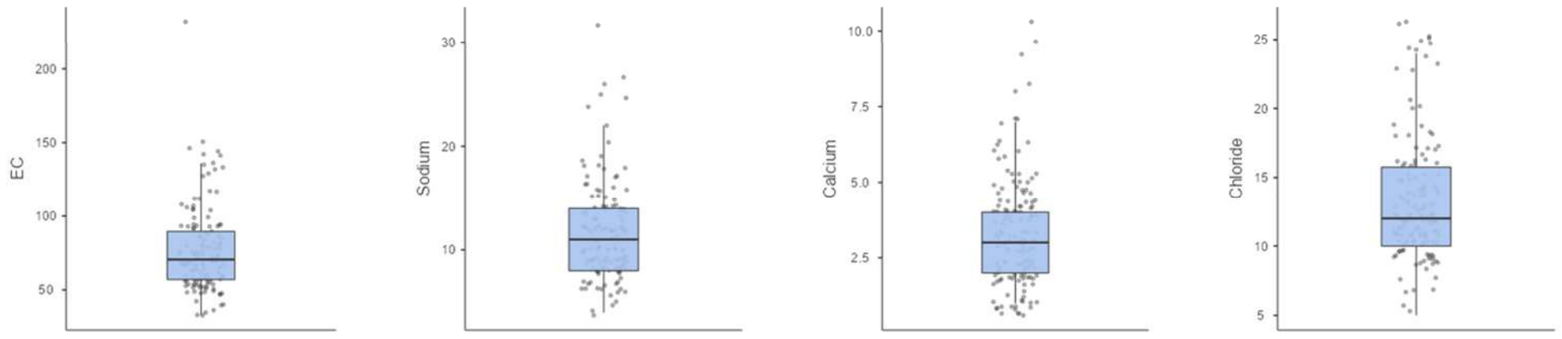
As indicated in the plots above, once pumping to the waterhole ceases water levels in the waterhole and Dawson River decrease gradually over a number of days. In the absence of recent rainfall within the waterhole catchment, and ceased desalinated water discharge, the waterhole outlet does not flow.

Outflow from the waterhole is constrained by the channel morphology of the waterhole outlet spill point located at the track crossing point (refer to pictures below). Additional flow depths under 18 ML/day are not expected to increase flow depth significantly at the waterhole outlet shown in the images below and currently calculated to be 0.14 m water depth at the invert point (Section 5.2.2.2 – Table 5-3).

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		 View Upstream  View South  View Downstream  **waterhole outlet watercourse – access track – cross section and weir flow estimate (at 18 ML/day)**	
11	The IESC considers that increasing depth could favour further establishment and potential dominance of non-native invasive species using the waterhole as a dry-season refuge. For example, increased spilling may allow invasive fish species such as goldfish (*Carassius auratus*) and mosquitofish (*Gambusia holbrooki*) that are already in the waterhole to disperse repeatedly into the Dawson River. The proponent should assess the risk of the predicted changes to the waterhole's water regime in facilitating the spread of invasive species in the Dawson River and propose suitable mitigation or remediation strategies if undesired changes occur.	The waterhole is isolated from potential anthropogenic sources of non-native species within the waterhole catchment. The waterhole catchment is entirely pasture, cropping and woodland. REMP monitoring completed between 2015 and 2022 is summarized in Section 5.3.4 of the PD and attached in the Appendices includes monitoring for non-native species. REMP monitoring has identified goldfish (Carassius auratus) in the waterhole in 2015, 2016, and 2017. No record of mosquitofish (*Gambusia holbrooki*) has occurred in REMP monitoring of the waterhole or Dawson River since the commencement of fish sampling in 2015. No non-native species have been recorded in the waterhole since 2017. No record of non-native species has been recorded since 2015 in the Dawson River during REMP monitoring. Mosquitofish (*Gambusia holbrooki*) were identified in the Dawson River during baseline surveys between 2013 and 2015. Reference to the Queensland Government Wetland*Info* table for identified ray-finned fish in the Dawson River drainage sub-basin (https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/wildlife/?AreaID=sub-basin-dawson-river&Kingdom=animals&Class=ray-finned%20fishes) identifies 39 species of fish to be present including goldfish (*Carassius auratus*) and mosquitofish (*Gambusia holbrooki*) and the European Carp (*Cyprinus carpio*).	Section 5.3.4

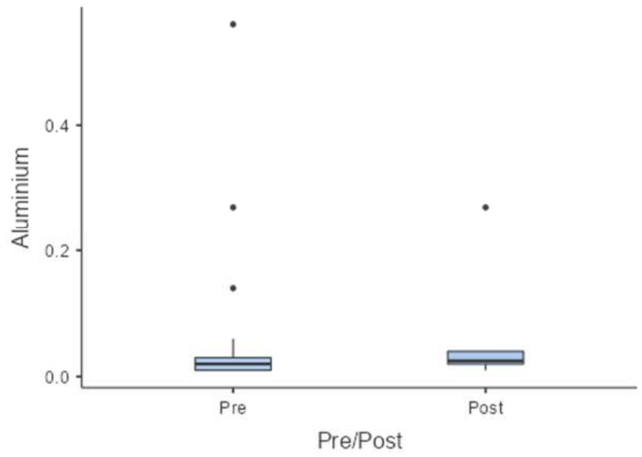
No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		Queensland Government data indicates the referenced species are already present in the Dawson River sub-catchment. Dispersion of exotic species from the waterhole is not a proposed action risk but rather a preexisting issue for the Upper Dawson River catchment.	
12	Increased release rates could also affect erosion and bank stability upstream of the waterhole and where the tributary enters the waterhole. Although the proponent considers that the current armouring upstream of the waterhole is sufficient to prevent this, monitoring data have not been provided to demonstrate that this is the case under current flow conditions. Thus, it is unclear whether the current armouring is sufficient or will be at releases of up to 18 ML/day.	As IESC has noted in the comment, armouring is already in place in the areas most prone to erosion (as illustrated in the below diagram for the release outfall). A detailed soils assessment was undertaken in 2012 (Alluvium, 2012) to inform design and placement of management controls including armouring within the drainage feature. Monitoring and inspections were undertaken by Santos post-commissioning (inclusive of post the 2016 and 2017 18 ML/day discharges) to verify stabilization outcomes and regrowth of vegetation. No significant increased presence of erosion was identified within the drainage feature during the post commissioning monitoring period. Monitoring within the receiving environment (for potential erosion under bed and bank stability assessment) is carried out biannually as part of REMP The REMP implementation will continue under the proposed action, and include assessment of water turbidity, bed and banks stability in the waterhole (including WLMP1 at the drainage feature outlet as an indicator of upstream erosion.   Example of the heavily armoured bed in a confined valley setting. .	Section 5.2.1
13	Impacts to water quality of the Dawson River are also possible from treated water releases, with the greatest potential for impacts occurring when low river flows coincide with peak treated water releases (frc environmental 2021, pp. 15-16). The scale and extent of potential impacts are unclear with further information needed on:		
	a. the type of RO treatment used;	a) Water treatment applied at the HCS04 treatment plant is described in the revised PD and summarised below • The reverse osmosis plant (ROP) ROP 2 at HCS04 utilises RO to produce high-quality treated water suitable for irrigation or release to the Dawson River meeting the drinking water EV. The ROP utilises a combination of physical (filtration) and chemical treatment processes including coagulation/clarification, oxidation, micro-filtration, high-recovery reverse osmosis, and finally adjustment of sodium adsorption ratio (SAR). The treated water produced by RO is referred to as desalinated water. The by-products of the treatment process include a concentrated saltwater stream ("brine") and a concentrated solids stream ("sludge"). For every 1,000 parts of water processed, approximately 890 parts are converted to desalinated water, 109 parts of brine, and one part of sludge. The brine is sent to storage ponds, while the sludge is sent to landfill. • **Coagulation/Clarification** The first step of the RO process involves the removal of large particles (suspended solids) and dissolved organic material. This is done through coagulation and clarification. Coagulation involves adding small amounts of chemical coagulants to promote the agglomeration of smaller suspended matter into larger particles. Clarification is the process of allowing these coagulated particles to settle to the bottom of a specially engineered clarification basin. Treated water following coagulation and clarification overflows the top of the clarification basin and is collected for further treatment. • **Oxidation** The clarified water from the clarification basin is sent through an oxidation treatment step to separate out any dissolved inorganic compounds (such as iron, manganese, and arsenic). Through oxidation, these are converted into filterable forms. Oxidation is done using chlorine in the form of sodium-hypochlorite. The oxidation step also removes any remaining organics not removed through the clarification step. • **Filtration**	Section 2.2.1

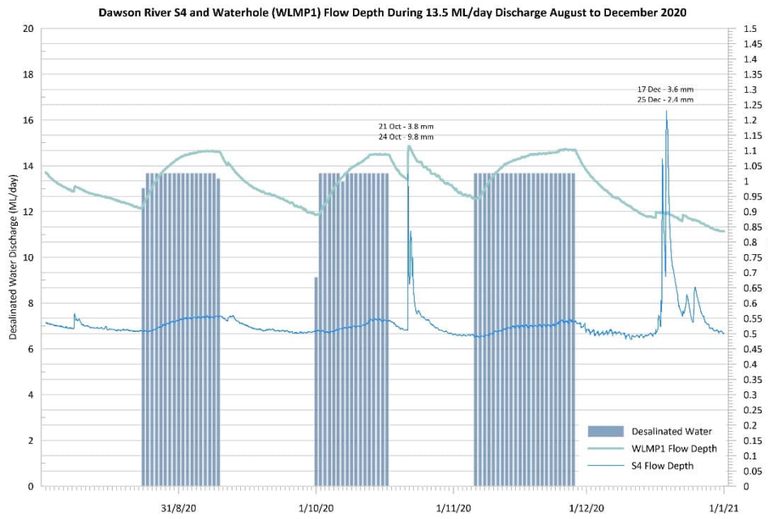
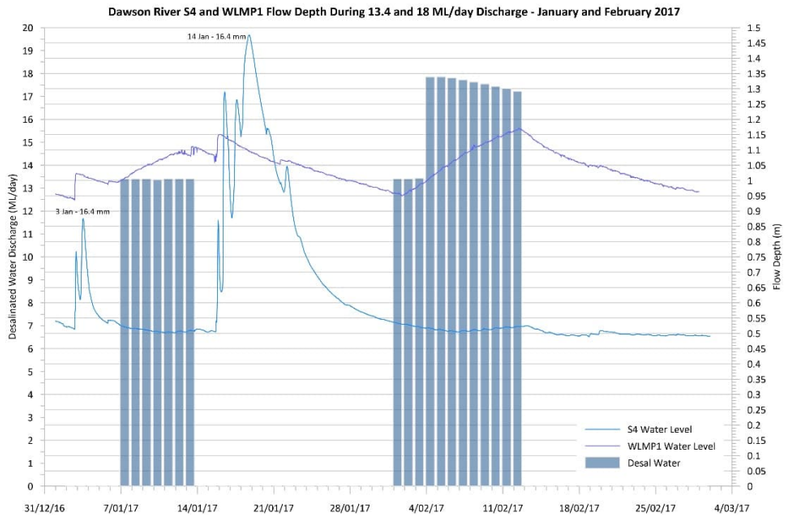
<table>
<tr><th>No</th><th>IESC COMMENT</th><th>Response and /or Clarification</th><th>Clarification location in PD</th></tr>
<tr><td></td><td></td><td>Filtration uses multi-media filters. These contain three specific media layers:
• Anthracite (a coarse pre-filter media)
• Sand (for fine filtration)
• Garnet (as a base layer polishing?)
The filtration step is used to remove the solids created during the oxidation step as well as remove any fine particulate that is carried over from the clarification step.
• Reverse Osmosis
Multiple stages of RO units are used to remove dissolved salts. The concentration of dissolved salts is quantified through the measurement of Electrical Conductivity (EC). The RO units use membranes that allow water molecules to pass through, but limit the passage of salts, resulting in desalinated water. The robust upstream pre-treatment processes allows for approximately 90% of desalinated water.
The concentrated salt solution (brine) is collected and transferred to the brine collection system.
• Adjustment of SAR
Calcium chloride dehydrate is added to the desalinated water to reach a target Ca-Cl concentration of 5–18 mg/L and a range of SAR of between 2 and 20.
• Waste Return System
Many of the above systems require regular flushing operations to maintain their performance:
• the filtration system requires backwashing to remove accumulated particles
• the softening process requires a non-chemical flush after resin regeneration
The wash water from the flushing processes is collected and sent to the waste return tank where it is collected and recycled to the head of the plant for re-treatment. This recycling improves the overall efficiency of the ROP.
• Regeneration Waste System
The RO processes require regular chemical cleanings to remove accumulated unwanted materials within the membranes.
The chemical wastewater from these processes is collected and directed to the Regeneration Waste Tank; from there it can be transferred to the brine collection system.</td><td></td></tr>
<tr><td></td><td>b. the chemical composition of the permeate and how it varies, including its ionic strength and how this is managed. Ionic matching of the treated release water to the receiving environment may be needed; and</td><td>b) Statistical water quality data for major ions sodium, chloride, and calcium together with EC in desalinated water within the HCS04 desalinated water pond is summarised in the following boxplots to demonstrate the range, median and percentiles within desalinated water

Box and whisker plots of EC and major ions
 

Median values of EC and major ions based on REMP data from 2015 to 2022
<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">WQO</th><th rowspan="2">Units</th><th>HCS04 DWB</th><th>WLMP5</th><th>DRR1</th><th>DRMP1</th><th>S4</th></tr>
<tr><th>Median</th><th>Median</th><th>Median</th><th>Median</th><th>Median</th></tr>
<tr><td>Electrical Conductivity @ 25°C</td><td>370 (base flow)
210 (high flow)</td><td>µS/cm</td><td>91</td><td>160</td><td>273</td><td>275</td><td>273</td></tr>
<tr><td>Calcium - dissolved</td><td>-</td><td>mg/L</td><td>3.0</td><td>13.0</td><td>15.5</td><td>16.00</td><td>16.5</td></tr>
<tr><td>Magnesium - dissolved</td><td></td><td>mg/L</td><td><1[1]</td><td>2.0</td><td>6.5</td><td>6.0</td><td>6.5</td></tr>
<tr><td>Sodium- dissolved</td><td>-</td><td>mg/L</td><td>12.0</td><td>12.0</td><td>2.0</td><td>29.0</td><td>30.5</td></tr>
<tr><td>Potassium - dissolved</td><td></td><td>mg/L</td><td>4.0[2]</td><td>5.0</td><td>4.0</td><td>4.0</td><td>3.5</td></tr>
</table></td><td>Section 5.3.1</td></tr>
</table>

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		<table><tr><td>Chloride - dissolved</td><td></td><td>mg/L</td><td>13.0</td><td>11.5</td><td>23.0</td><td>29.0</td><td>31.0</td></tr><tr><td>Sulfate – dissolved</td><td></td><td>mg/L</td><td>4.0</td><td><1.0[1]</td><td>2.0</td><td>4.0</td><td>2.0</td></tr><tr><td colspan="8">Notes 1 – Not detected above the limit of reporting (LOR) 2 – Maximum valuer reported due to low rate of detection above the LOR NA – Not analysed</td></tr></table> Review of the median desalinated water, waterhole (WLMP5), upstream (DRR1) and median downstream (DRMP1 and S4) display minimal change from desalinated water releases. It is recognized that desalinated water (permeate) is low in calcium. As described in the response to question 13 Calcium is added at the end of the treatment train to adjust calcium levels prior to release. These findings are supported by data visualisations, tabulations and statistical analyses now presented in Section 5.3.3	
	c. the variability of background water quality at times of no releases.	The REMP monitoring location DRR1 is located upstream of the waterhole discharge point and represents the background water quality of the Dawson River prior to the confluence with the waterhole discharge channel (refer to Attachment 3). Water quality from DRR1 represents the variability of the Dawson River prior to receiving desalinated water discharge and is representative of the background variability in water quality. Variability in background water has been statistically evaluated for both the waterhole (Appendix E-1) and the Dawson River (Appendix E-2 via the upstream location DRR1) and is presented in AECOM 2022, Section 5.3 and Appendix E. This has been updated to include water quality data to June 2022 and provides the variability in the upstream data based on the Min, 20th percentile, median, 80th percentile 95th percentile, and maximum.	Section 5.3.5
14	The provided water quality summaries, show existing exceedances of WQOs for several analytes including suspended solids, aluminum, ammonia, boron, copper, nitrogen and zinc. The proponent has not discussed what the potential impacts of further increasing the concentrations and loads of these analytes may be, nor have they proposed management actions specifically to reduce the concentrations other than dilution which is not effective when WQOs are already exceeded.	The water quality summary tables previously presented overly conservative values. All values <LOR were disregarded in these summaries, which is a higher level of conservatism than advised for non-detects as required by the Australia and New Zealand Guidelines (ANZG 2018) for fresh and marine water quality. The revised tables adopt a standard approach of substituting <LOR values with the LOR value (i.e. the most conservative treatment for non-detects advised under ANZG). Parameters with <3 detects are assumed to have a 'true' median or 95th percentile <LOR and only the maximum value are reported in the revised statistical water quality assessment of REMP data in Appendix E-1 and Appendix E-2 of the PD. The revised water quality summaries in Appendix E-1 and Appendix E-2 of the revised PD reveal that: • For the waterhole (PD, Appendix E-1): The following 'pre-existing' water quality median or 95th percentile are either outside the range or above the above the sub-regional WQO were observed in pre-2015 baseline data in the waterhole based on data from WLMP5: - Dissolved oxygen (DO) - Electrical conductivity (EC) - Suspended solids - Aluminium - Copper - Zinc - Ammonia as N - Nitrite + nitrate as N - Total nitrogen as N Post 2015 REMP data indicates that bar dissolved aluminium, ammonia, nitrate+nitrite and Total Nitrogen, no median value is outside the required range or 95th percentile above the sub-regional WQO. Nutrients display a distinct decrease in concentration in the waterhole following the start of desalinated water release. Dissolved aluminium displays a slight increase that is statistically non-significant from baseline (P > 0.05).	Section 5.3

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		 • For the Dawson River (Appendix E-2): based on the DRR1 located upstream of the waterhole – Dawson River confluence there are pre-existing (upstream) recorded concentrations above the sub-regional WQO for: - pH - EC (conservatively assuming the high flow trigger value) - Dissolved aluminium - Dissolved zinc - Ammonia as N - Nitrite + Nitrate as N - Total nitrogen as N In all cases except nitrate+nitrite however, WQ improves downstream of the waterhole confluence with the Dawson River. For nitrate+nitrite, the downstream median remains below the upstream 80th percentile, indicating a non-significant departure from baseline conditions (ANZG, 2018; DEHP, 2013). Overall baseline and downstream data do not demonstrate an increase in load for these parameters.	
15	Changes to stream levels in the Dawson River when treated water is released are stated to be small (approximately 0.30 m at Yebna Crossing, AECOM 2022, p. 73). Changes to daily release rates at the project site are less clear as this has been discussed for Utopia Downs some 60 km downstream (AECOM 2022, p. 82). Rapid and frequent rises and falls in water levels can impact streamside vegetation and bank stability, damage stream edge habitats, and affect stream edge groundwater seeps. To allow an assessment of the scale and extent of potential impacts of rapid fluctuations in water level and flow, further local-scale mapping of receiving waters (the waterhole and the Dawson River) should be provided to identify habitats and biota that could be impacted by these changes so that the proponent can modify release strategies accordingly.	The following graph of the August 2020 to January 2021 period, as a period representing baseflow with minimal rainfall events, indicates the increase in flow depth at S4 during desalinated water release events at 13.5 ML/day is no more than 0.05 m over the 5-month period under baseflow conditions. Review of the 18 ML/day release during January 2017 indicates the increase in flow depth at S4 is no more than 0.05 m under baseflow conditions.	Section 5.2.2.3

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		 **13.5 ML/day Desalinated Water Discharge**  **18 ML/day Desalinated Water Discharge** During the August 2020 to December 2020 period observed increases in flow depth at S4 in the Dawson River and WLMP1 in the waterhole following commencement of treated desalinated water release is observed to increase gradually over 11 or more days. This gradual increase in water elevation in both the waterhole and Dawson River is consistent across all desalinated water discharge events where no concurrent rainfall event occurs. Following cessation of treated desalinated water discharges the decrease in flow depth at S4 in the Dawson River and WLMP1 in the waterhole occurs gradually over the entire period. Comparison to the three rainfall events recorded between the treated desalinated water release in the above graphs indicates that natural water depth increases as a result of rainfall events are rapid in both the waterhole (where rainfall falls within the catchment) and Dawson River, occurring over the same day as the rainfall event. Other smaller rainfall events recorded at the Injune post office of similar or greater magnitude did not result in a measurable response at S5 either during or between desalinated water releases. Increases and decreases in water depth for both the waterhole and Dawson River are not rapid and are gradual as observed in the gauging data. Rapid water level changes in both the waterhole and Dawson River do occur naturally following rainfall events with observed increases in flow depth occurring over a much shorter duration than observed for the release of treated water in isolation. The 2021 Boobook survey recorded turtle nests at 0.6 m to 5 m heights within the Dawson River. Turtle nests placed on the slope or crest of lower banks remain above the measured and modelled increased water level at S4 and are not considered to be impacted by desalinated water releases. Desalinated water releases do not intersect observed MNES turtle nest elevations recorded in the Dawson River. Natural river flow increases to relatively small rainfall events do increase Dawson River water levels more rapidly and to a greater degree than discharges.	
16	Released produced waters, both treated and untreated, will contain chemicals used in CSG operations (including chemicals used in hydraulic fracturing, drilling, water treatment) as well as geogenics that may adversely impact EPBC Act-listed turtles and other biota. The proponent has provided a Chemical Risk Assessment Framework (CRAF) assessing 34 chemicals that may be found in the produced water being managed by this project (Santos, 2022). The IESC notes several issues with the assessment as outlined below.	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action. The below responses relate to the desalinated water release only.	Section 1.2
	a. Drilling chemicals, potentially present in the produced water (e.g., barium), have not been identified or assessed in the chemicals risk assessment (CRA). Thus, the likely concentrations of these chemicals in the releases and their potential impact cannot be determined.	Santos has routinely monitored produced water quality from the GLNG Project since 2008 and has completed CRA for all chemicals used in drilling, hydraulic fracturing and water treatment together with naturally occurring geogenic chemicals from target formations. This information is made publicly available on Santos' website. As detailed in Section 8.3 of the PD, drilling chemicals (plus hydraulic fracturing and water treatment chemicals) have been assessed as part of the proposed action.	Section 8.3
	b. The CRA makes multiple assumptions about dilution of chemicals in produced water. The dilutions are not always clearly justified and initial concentrations that may be present in the untreated water to be released in the Dawson River are also unclear. Initial concentrations and assumed dilution factors should be clearly shown so that	This question refers to untreated water. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan.	Section 1.2 Section 8.3

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
	predicted concentrations relied upon in the assessment can be justified.	Event-based releases no longer form a component of the proposed action. **The following items are applicable for treated desalinated water discharges only.** Assumptions regarding initial concentrations and dilution factors for desalinated water are described within the qualitative assessments conducted for each Tier 2 chemical and quantitative assessments conducted for each Tier 3 chemical provided within Appendix I of the PD. Quantitative mass balance estimates were described and provided for each chemical. These conservative estimates were then used to estimate potential exposure point concentrations (EPCs) for the evaluation of releases of treated water to the Dawson River. The EPC for treated water discharge assumes the following factors: 1) biodegradation; 2) treatment system effectiveness; and, 3) dilution into the river. EPCs were first adjusted based on biodegradation rates to calculate theoretical EPCs for two exposure time periods (0 and 30 days) which represent no storage/no degradation (Day 0) and a bounding estimate (Day 30) which considers degradation during storage at the HCS04 ROP (also called the water management facility in the CRAF). The EPC was then reduced by a factor of 100 to account for 99% treatment efficiency by water treatment through the ROP. The 99% treatment efficiency of the ROP system has been long used and approved by DAWE (now DCCEEW) for multiple chemical risk assessments. Finally, a dilution factor of 50 was used to account for dilution into the Dawson River receiving water body. As referenced in the assessments, this factor was based on the mixing zone described in the Santos 2013 report Dawson River Release Scheme – Environmental Authority Amendment Application –Supporting Information and subsequently approved in the State EA. This dilution factor is far less than the dilution that would occur (>1,500 fold) based on a maximum release rate of 18 ML/day and a Dawson River average low flow of 28,000 ML/day. These EPCs are considered conservative as they do not include additional degradation due to other mechanisms (e.g., photolysis) or storage times (such as within the produced water management pond and/or desalinated water pond) that facilitate further mass reductions of organic constituents prior to conveyance. See also response to 16c.	
	c. The CRA of Tier 2 and Tier 3 chemicals assumed a dilution of 50-fold for the untreated produced water releases and 5000-fold for the treated produced water releases for the calculation of Predicted Environmental Concentrations (PECs) (or EPCs as the proponent refers to these). If the PEC exceeded the Predicted No-Effect Concentration (PNEC), chemicals were then often excluded from further risk assessment on the basis that they lacked persistence (i.e., that they would dissociate or degrade in the water management system or the receiving environment). This has meant that some chemicals, for example, the surfactant cocamidopropylbetaine, which in the untreated releases is estimated to have a PNEC of 78 (well above the target level of 1) have not been adequately assessed. The proponent considers that cocamidopropylbetaine will readily biodegrade and has a short half-life of 15 days. Despite the relatively short half-life, 15 days is still a considerable time for a chemical to be present at potentially toxic levels. If dilutions are inadequate, this chemical may cause impacts to the aquatic ecosystem.	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action. **The following responds to the treated desalinated water discharge component of the question.** Of the 37 Tier 2 and Tier 3 chemicals evaluated in the CRA, none had EPCs for treated produced water greater than PNECs. Chemicals that are readily biodegradable, such as cocoamidopropylbetaine, are not persistent and may only be present in the aquatic compartment for a short period of time. The CRAF is guided by the CSG risk assessment guidance issued by the Australian Industrial Chemicals Introduction Scheme (AICIS) (formerly National Industrial Chemicals Notifications and Assessment Scheme (NICNAS) and DoEE (now DCCEEW) Environmental Risk Assessment Guidance Manual for Industrial Chemicals (2009) amongst other Australian guidance documents. Based on the NICNA and DCCEEW (2009) guidance the minimum default half-life is 15 days. This is a default conservative assumption as biodegradation studies detailed in the CRAF dossier indicated greater degradation in less time (i.e., >80% after 7 days). In addition, this chemical is also subject to photolytic degradation (half-life of <10 hours) as well as dissociation in aqueous systems. Based on these factors, further assessment of treated water discharge for this chemical is not warranted and the justification provided in the Tier 2 assessment is sufficient. TTPC is discussed further in the response to comment 16d.	Section 1.2 Section 8.3
	d. Tributyl Tetradecyl Phosphonium Chloride (TTPC) was identified by the proponent as a chemical of concern given the calculated risk ratio. TTPC is acutely toxic in aquatic environments; however, the proponent has concluded that since untreated releases will be infrequent, and TTPC is not expected to bioaccumulate, but rather will strongly absorb to soil and sediments, it will not be an unacceptable risk (AECOM 2022, p. 183). The assessment considered risk via ingestion in non-aquatic species only and did not fully consider the risk from TTPC through exposure to sediment due to a lack of available data. This exposure pathway is important given TTPC is expected to accumulate in the sediment. Given that TTPC is toxic and persistent, the proponent should investigate the effect of TTPC on sediment-dwelling biota (e.g., native bivalve species).	This question refers to untreated water. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action. **The following responds to the treated desalinated water discharge component of the question.** TTPC had risk ratios greater than 1 for untreated water releases. These releases are no longer proposed. The DCCEEW (2009) Environmental Risk Assessment Guidance Manual for Industrial Chemicals states that "…*A substance is considered bioaccumulative if it has a BCF or BAF of greater than 2000 or, in the absence of BCF or BAF measurements, if the log Kow is greater than 4.2." The CRAF Part 2 finds that the Know for TTPC is 2.45 and is below the DCCEEW threshold for the chemical to be bioaccumulative.* As indicated in the quantitative risk assessment for TTPC in the CRA Part 2, EPCs for surface water were less than PNECs. In regard to sediment, the equilibrium partitioning method that was used to derive the PNEC for sediment can also be used to derive a PEC (or EPC) for sediment. As provided in the revised quantitative risk assessment for TTPC, EPCs for sediment were also less than PNECs. Thus, no further evaluation of TTPC in treated water discharge is warranted under the DCCEEW (2009) CRAF process.	Section 1.2 Section 8.3
	e. A screening risk assessment of geogenics based on previous produced water maximum concentrations only considered a limited range of chemicals. The screening process identified that risk ratios for several geogenics were greater than the target value of 1, including aluminium (up to 1100), barium (870), arsenic (38) and chromium (16). The proponent has assumed that geogenics will be	This question refers to untreated water. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action. **The following responds to the treated desalinated water discharge component of the question.**	Section 8.3.5

<table>
<tr><th>No</th><th>IESC COMMENT</th><th>Response and /or Clarification</th><th>Clarification location in PD</th></tr>
<tr><td></td><td>removed during RO treatment but given the untreated releases will not undergo RO treatment, dilution will be relied upon to manage geogenics in untreated releases. Substantial dilutions will be required to manage some of these geogenic chemicals, and this can be determined by using DTA [direct toxicity assessment].</td><td>Analytical data for dissolved metals in desalinated water from the HCS04 DWB pond consists of up to 158 samples collected between April 2015 and September 2022 (7 years). The HCS04 DWB pond water quality data presented in Appendix E-1 does not identify any 95th percentile value of a geogenic parameter (where sufficient detections above the limit of reporting (LOR) occur) above the respective sub-regional WQO. Other than aluminium (53% detections) and boron (100% detections) all other analysed metals in desalinated water have less than 10% of detections above its respective LOR. Concentrations of aluminium and boron do not exceed the respective State EA CL / Local Trigger value, sub-regional WQO, or SSTL.

The geogenic screening conservatively compared maximum concentrations (worst-case scenario) in produced water to risk-based human health and ecological screening criteria. As discussed in Section 8.3.5, whilst a number of maximum concentration risk ratios are greater than the target risk ratio (of one), the potential for exposure of sensitive receptors including MNES to geogenic chemicals in produced water is low. Further, only two chemicals (total aluminium and total barium) had risk quotients (RQs) greater than 57, the minimum dilution ratio identified to achieve water quality objectives under baseline conditions. The RQ for arsenic was less than 1 (a value of 0.38 and not 38 as the comment states).

Further evaluation of the geogenic screening using the arithmetic mean rather than the maximum detection yielded an RQ of 29 for total aluminium. In addition, the ecological screening criteria for total barium was also updated from the 1996 Suter value referenced by USEPA Region 3 to a more recent 2013 and robust derivation from the Great Lakes Initiative (GLI) Clearinghouse resources Tier II criteria. This updated value along with the arithmetic mean resulted in an RQ of 7.8.

Based on this revised evaluation and desalinated water quality data, substantial dilutions do not appear to be required to manage geogenic chemicals in desalinated water including boron. Section 8.3.5 and Table 8.7 of the PD have been revised to provide this supporting information</td><td></td></tr>
<tr><td></td><td>f. The chemical risk assessment has only considered individual chemicals, and management primarily through dilution for untreated produced water, similarly only considered individual chemicals. Interactive effects are not considered. DTA is needed to ensure that the potential impacts arising from the combination of chemicals (both known and unknown) present in produced water are adequately assessed and managed. Additionally, limited consideration of cumulative impacts has been undertaken as the proponent has not identified any chemicals being used as persistent, bioaccumulative and toxic. Further consideration is needed of potential cumulative impacts as some chemicals are toxic and may persist in sediments. Biota within the aquatic environment can be directly exposed to the sediments while foraging.</td><td>This question refers to untreated water. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan.

Event-based releases no longer form a component of the proposed action.

The following responds to the treated desalinated water discharge component of the question.

Consistent with the CRAF, cumulative effects are assessed for Tier 3 chemicals which are persistent and/or bioaccumulative. Of the 12 chemicals identified as Tier 3, 4 (TTPC, glutaraldehyde, CMIT/MIT mixture, and cocoalkyl dimethylbenzyl ammonium chloride) were further assessed in treated water discharge (the other 8 were determined not to be present). None are bioaccumulative and only two hydraulic fracturing chemicals (TTPC and cocoalkyl dimethylbenzyl ammonium chloride) have the potential to adsorb to sediments. Of these, 1 chemical (TTPC) meets the criteria for persistence. None of the 4 chemicals had individual EPCs in treated water above water PNECs. Likewise, none of the 4 chemicals had individual EPCs in sediment above sediment PNECs. Furthermore, as shown below, the cumulative risk ratio was less than 1 in each media. Based on these findings, no further evaluation is warranted.
<table>
<tr><th>Chemical</th><th>PEC water</th><th>PNEC water</th><th>RQ</th><th>PEC sed</th><th>PNEC sed</th><th>RQ</th></tr>
<tr><td>Tributyl tetradecyl phosphonium chloride</td><td>7.5E-07</td><td>1.9E-05</td><td>4.0E-02</td><td>5.1E-01</td><td>1.3E+01</td><td>4.0E-02</td></tr>
<tr><td>Cocoalkyl dimethylbenzyl ammonium chloride</td><td>1.4E-13</td><td>4.2E-04</td><td>3.4E-10</td><td>3.5E-09</td><td>3.6E+00</td><td>9.7E-10</td></tr>
<tr><td>Glutaraldehyde</td><td>2.1E-09</td><td>2.5E-03</td><td>8.5E-07</td><td>5.2E-09</td><td>6.0E-03</td><td>8.6E-07</td></tr>
<tr><td>Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)</td><td>1.4E-07</td><td>1.4E-04</td><td>1.0E-03</td><td>9.0E-08</td><td>5.4E-03</td><td>1.7E-05</td></tr>
<tr><td></td><td></td><td>Total</td><td>4.1E-02</td><td></td><td>Total</td><td>4.0E-02</td></tr>
</table></td><td>Section 8.3</td></tr>
<tr><td>17</td><td>The Receiving Environment Management Plan (REMP) is unclear on the sampling regime. It contains many qualifiers with statements such as “where a parameter records an exceedance within 2 hours of the release at site S1a then the parameter will also be monitored at all Dawson River sites twice in the following year, adhering to a pre-wet and post-wet schedule.” (frc environmental 2021, p. 45). This would correspond to sampling on the currently proposed, highly limited schedule so it is unclear how this is a timely response to an exceedance. The monitoring schedule in the REMP requires clarification to clearly commit to:

a. a spatially- and temporally-thorough monitoring schedule covering appropriate unimpacted (reference) and impact sites with sampling occurring at a frequency that will allow rapid detection of potential impacts;

b. monitoring that includes a DTA-based approach for untreated water releases (see Paragraph 7a); and

c. implementing a TARP that will allow early detection of impacts, and actions that will prevent further impacts from occurring.</td><td>Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan.

Event-based releases no longer form a component of the proposed action.</td><td>Not applicable</td></tr>
<tr><td>18</td><td>While sediment sampling is undertaken, the purpose of this sampling is unclear as there appears to be no corrective actions to prevent further potential impacts if the proponent-defined ‘trigger values’ are exceeded. The sampling program is limited in spatial extent, has no sampling at unimpacted sites, and sampling only occurs twice-yearly.</td><td>The REMP is a requirement of the State EA with locations and monitoring program defined under Requirement B36 to B41. The State EA defines the locations, and monitoring requirements, including sediments.

REMP monitoring locations for sediment quality include DRR1 located upstream of the confluence of the waterhole and represents background conditions for the Dawson River within the reaches that are subject to long term agricultural land-use as a moderately disturbed catchment.</td><td>Section 9.0
Appendix I</td></tr>
</table>

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		Existing bi-annual sampling is completed in accordance with the State EA requirements and is representative of the existing climate of the region that is dominated by monsoonal conditions via a wet season and dry season conditions.	
	a. The sediment sampling program needs to be continued for the life of the project and developed further to better understand the potential for contaminant accumulation in sediments: i. in the waterhole where sediment type (greater amounts of silt) may make it more likely (frc environmental 2021, p. 25) during backflushing at high flows ii. within the event-based mixing zone where higher concentrations due to the release of untreated produced water will occur; and iii. further downstream of the project area where contaminated surface water potentially infiltrates alluvial sediments.	a.i - Sediment sampling to date does not indicate contaminant/parameter accumulation within the waterhole. On-going REMP monitoring will continue to monitor for potential change in sediment quality. a.i, a.ii and a.iii – refer to event based releases. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 5.4 Section 5.5.4 Appendix E-3
	b. Further analysis of whether contaminants accumulate in the sediment and could enter the food chain providing a pathway to impacting water resources including EPBC-listed turtles (see response to Question 2) should also be provided, including consideration of how far downstream contaminated sediments could travel and whether there is lateral movement into the riparian zone.	Refer to response to Question 16 c. sediment partitioning. As discussed in AECOM 2022, Section 4.4.1 of the PD regional scale mapping does not include any alluvium upstream or within the proposed action area (OGIA, 2021). This is considered related to the fluvial transport of sediments within the Dawson River channel in the proposed action area. Within the Dawson River alluvium is regularly flushed downstream during high-flow events. Based on the transient nature of the unconsolidated material contaminants are not expected to accumulate in the sediment.	Section 4.4.1 Section 5.4 Section 5.5.4 Appendix E-3
Question 2: Can the Committee provide comment on likely scale and extent of potential impacts on the White-throated Snapping Turtle and Fitzroy River Turtle as a result of changes to hydrological regime and water quality associated with the proposed water releases?			
19	The IESC considers that impacts to hydrological regimes and water quality in the Dawson River at the project area must be avoided because this reach of the river provides critical habitat (Boobook Ecological Consulting 2022b, p. 15) for the critically endangered White-throated snapping turtle and the vulnerable Fitzroy River turtle. Furthermore, populations of White-throated snapping turtles in the Dawson River are of substantial phylogeographic significance to conservation of the species in north-eastern Australia (e.g., Todd et al., 2013) and deserve particular protection. In the project area, turtle recruitment appears to be almost zero because of nest predation and trampling (Boobook Ecological Consulting 2022b, p. 21) which indicates that the local populations are already severely stressed. Additional stresses, even seemingly minor, to these two species from the project should be avoided and a precautionary approach is essential. Although recent research has provided new information about these species' ecology and conservation significance (e.g., Micheli-Campbell et al., 2017), specific knowledge of the requirements of turtle populations occupying the dryland waterholes of the Dawson River is very limited.	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action. The following items are developed in response to the general comments raised and applicable elements for desalinated water releases. The Dawson River provides critical habitat for white-throated snapping turtle (WTST) and Fitzroy River turtle (FRT), noting that critical habitat for both species extends well-beyond the Dawson River. For WTST critical habitat occurs widely throughout the range of the species elsewhere in the Fitzroy River basin, and in the Burnett and Mary Rivers (DAWE 2020). Within the Fitzroy River Basin, critical habitat for WTST occurs from the lower Fitzroy River from the barrage impoundment to the upper Dawson River, Callide Dam, lower Nogoa River, upper Connor River, and lower Isaac River in the Tartus Weir impoundment (Limpus et al. 2011), with a key nesting aggregation reported in the upper reaches of the Fitzroy River barrage impoundment (DAWE 2020). For FRT, which is endemic to the Fitzroy Basin, critical habitat occurs from the Fitzroy Barrage to the upper Dawson River, the Mackenzie River and lower reaches of the Nogoa River, and to the Upper Connors River (Limpus et al. 2011). Critical habitat for the species is not limited to the Dawson River. It is noted also that the principal threat to both turtle species is nest predation by native and introduced predators and trampling of nests by cattle. These threats are almost ubiquitous throughout the respective ranges of both WTST and FRT, including the reach of the Dawson River relevant for the Project. The phylogeographic study by Todd (2013) indicated that the population of WTST from the Fitzroy Basin (as a whole) was distinct from the populations in the Mary and Burnett Rivers, but WTST from the Dawson River were not genetically distinct from elsewhere in the Fitzroy River Basin. While phylogeographic patterns in FRT have not been studied / published, at least two other turtle species (WTST and Krefft's river turtle) have no phylogeographic subdivision between the Dawson River and other sub-catchments of the Fitzroy Basin (Todd 2013); thus, it is parsimonious to consider FRT across the whole basin as a single phylogroup. Therefore, populations of WTST and FRT in the Dawson River are not phylogeographically distinct from populations elsewhere in the Fitzroy River basin. IESC raised concern that the desalinated releases will cause hydrological alteration and / or water quality impacts that could adversely impact WTST and FRT in the reach of the Dawson River relevant to the Project With respect to water quality, cloacal respiring turtles likely have higher sensitivity to contaminants than lung-breathing turtles, although specific toxicity thresholds for turtles are unknown / unassessed (see discussion in Boobook 2022). In the absence of species-specific water quality thresholds, baseline (i.e. pre-release) water quality data was used to develop water quality guidelines for water quality monitoring in the Waterbody and the Dawson River for the REMP, with toxicity studies used to derive guidelines for some parameters (e.g. boron). The approach to water quality guideline development was based on the Queensland Water Quality Guidelines (2009) which is the same approach as described in the current National Water Quality Guidelines (ANZG 2018). Where water quality monitoring data indicates concentrations above a sub-regional WQO, then the monitoring data is further assessed by compared to both reference site data (i.e., data collected upstream of the waterhole confluence with the Dawson River) and the full range (i.e. minimum to maximum) of baseline data, and spatial and temporal water quality patterns are assessed. To date, water quality monitoring data collected from the receiving environment for the REMP has indicated that reference site or baseline water quality conditions have typically been achieved, with further assessment of occasional parameters that are above a sub-regional WQO indicating they were not related to the release and are consistent with or lower than upstream water quality (Section 5.3 of the PD) . Biological (i.e. macroinvertebrate and fish) monitoring data has supported water quality monitoring in showing a healthy aquatic ecosystem in the desalinated release receiving environment. Furthermore, turtle monitoring data collected in conjunction with REMP monitoring has indicated the presence of healthy WTST and FRT in the receiving environment as similar frequencies to those recorded during the baseline studies. Therefore, the available monitoring data indicated that water quality risks of the desalinated release has low risk for turtles. With respect to flow, measured water level increases under 18 ML/day discharge (refer to Question 15) indicated that water level of the Dawson River at Yebna Crossing is increased by no more than 0.05 m under base-flow conditions (noting turtle nesting seasons are predominantly within low flow periods). Calculated changes in water depth and velocity at DRMP1, immediately downstream of the waterhole confluence with the Dawson River indicates an average water depth increase of 0.06 m and velocity increase of 0.07 m/s under an 18 ML/day release, consistent with measured water depth and discharge	Section 7.1.1 Section 7.2.1 Section 7.2.2 Section 5.3

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		increases at S4 (Section 5.2.2.3). WTST and FRT nests are approximately 1.2 –2.5 m above natural water level; thus, the 0.05 m increases in baseline water depth have low risk of intercepting turtle nesting sites, and the slight increase in average water velocity would have negligible influence on erosion and deposition processes of the Dawson River (i.e. negligible influence on nesting bank formation processes). Finally, it is noted that the Dawson River base-flow in the proposed action areas is spring-fed and has near-perennial flow (the long-term flow duration curve for Utopia Downs indicates flows 1.0 ML/day or more occur 98% of the time) and thus is not a dryland system. Long-term monitoring data indicates that WTST and FRT do not generally occur in the waterhole (oxbow lake within the receiving environment, with a single record of WTST in 2017 presumed a vagrant), although WTST have been reported from dryland waterholes on the Burnett River and elsewhere in the Fitzroy River system (main river channel) (Limpus et al. 2011). The Project does not propose any activity that would increase the occurrence of dryland waterholes on the Dawson River.	
20	Project-specific impacts to EPBC Act-listed turtles in the Dawson River are possible via changes to water quality, flow regimes, habitat (e.g., through erosion and/or sedimentation reducing the occurrence or suitability of riffle habitat), and/or accumulation of contaminants in sediments or food (e.g., invertebrate prey, filamentous algae) ingested by the two turtle species. Potential impact pathways and their materiality should be portrayed using an ecohydrological conceptual model (ECM) to illustrate how changes to hydrological regimes and water quality associated with the proposed water releases may interact to affect the two species at different stages of their life cycle in the project area. This ECM should include a narrative for each pathway that specifies its uncertainty, justifies its inclusion with reliable evidence (e.g., site-specific data, relevant supporting literature) and describes appropriate mitigation options to reduce the risk of impacts on the two turtle species.	The potential impact pathways of desalinated releases on WTST and FRT are: • **Inundation of nest sites by increased water level**. Measured water levels under an 18 ML/day release of desalinated water (refer to Question 15 response) increased the water level of the Dawson River at Yebna Crossing by no more than 0.05 m under base-flow conditions, WTST and FRT nests are approximately 1.2 –2.5 m above natural water level; thus, the measured 0.05 m increase in water level has a low risk of intercepting nesting sites for either species. • **Inundation of residential and foraging habitat by increased water level**. Measured water levels under an 18 ML/day release of desalinated water (refer to Question 15 response) increased the water level of the Dawson River at Yebna Crossing by 0.05 m under base-flow conditions. This slight increase in water level is not large enough to effect drown-out of riffle or pool margin habitats (both of which are reported as high-productivity habitats that support turtle foraging), and indeed have the potential to slightly expand the proportion of riffle habitat under low, noting this would be a very temporary beneficial change. There will be no risk of impact to turtle habitat by inundation. Measured water level responses to natural rain events in Yebna crossing (refer to question 15 responses) generates faster and larger changes in water levels for events of 3 mm to 16 mm rainfall events, based on at Injune Post Office rainfall. • **Increased scour and deposition of bed and bank substrate**. Calculations indicate that a constant release rate of 18 ML/day of desalinated water would increase average water velocity by 0.07 m/s at DRMP1 and are indistinguishable under higher flow conditions (0.05 m/s at 10% AEP and 0.01 m/s at 2% AEP). Sandy banks provide turtle nesting habitat, and cobbles in riffle zones a key foraging substrate. Large (flood) flow events often cause significant geomorphic changes to bed and back substrates via scour and deposition. Generally, such changes are natural and important for habitat rejuvenation, but in the context of threatened turtle species may present a risk if sandy banks (nest sites) are scoured and cobbly riffles (foraging habitat) are smother by deposited sediment. The desalinated release will increase average water velocity under baseflow conditions by 0.07 m/s and have negligible influence on water velocity during higher flows in the Dawson River (0.05 m/s at 10% AEP and 0.01 m/s at 2% AEP). The influence of the desalinated release on geomorphic processes that are important for turtles nesting bank formation is negligible. • **Direct exposure to contaminants in the water column**. In the absence of species-specific water quality thresholds, baseline (i.e., pre-release) water quality data was used to develop water quality guidelines for water quality monitoring in the Waterbody and the Dawson River for the REMP, with toxicity studies used to derive guidelines for some parameters (e.g., boron). The approach to water quality guideline development was based on the Queensland Water Quality Guidelines (2009) which is the same approach as described in the current National Water Quality Guidelines (ANZG 2018). Where water quality monitoring data indicates a concentration above a local water quality guideline, then the monitoring data is further assessed by compared to both reference site data (i.e., data collected upstream of the release point) and the full range (i.e. minimum to maximum) of baseline data, and spatial and temporal water quality patterns are assessed. To date, water quality monitoring data collected from the receiving environment for the REMP has indicated that reference site or baseline water quality conditions have typically been achieved, with further assessment of occasional parameters that are above a sub-regional WQO indicating they were not related to the release and are consistent with or lower than upstream water quality. Biological (i.e. macroinvertebrate and fish) monitoring data has supported water quality monitoring in showing a healthy aquatic ecosystem in the desalinated release receiving environment. Furthermore, turtle monitoring data collected in conjunction with REMP monitoring has indicated the presence of healthy WTST and FRT in the receiving environment as similar frequencies to those recorded during the baseline studies. Therefore, the available monitoring data indicated that water quality risks of the desalinated release has low risk for turtles. • **Indirect exposure to contaminants via accumulation in benthic sediments**. As for water quality, there are no species-specific sediment quality guidelines relating to WTST and FRT. In the absence of such guidelines, baseline sediment quality data was used to development sediment quality guidelines (using same approach as water quality for guideline development). REMP monitoring data to date has found that the desalinated release is unlikely to have caused any effects in sediment quality in the receiving environment. Therefore, the available monitoring data indicated that sediment quality risks of the desalinated release for turtles is low. • **Indirect exposure to contaminants via accumulation in food resources**. Juveniles of most turtle species have a high proportion of aquatic macroinvertebrates in their diet, with adult FRT maintaining a high proportion of benthic invertebrates in their diet but adult WTST having a higher proportion of filamentous algae (Limpus et al. 2011). The above description of water quality and sediment quality indicate low direct risk to turtles, but also to food resources of turtles (e.g., benthic macroinvertebrate monitoring has indicated no adverse impacts of the desalinated release). Because water quality and sediment quality parameters are generally within baseline range, or within toxicity thresholds (e.g., boron), there is low risk that a higher rate of accumulation of potential toxicants would accumulate in food resources compared to baseline condition. Risk is low.	Section 7.2.1 Section 7.2.2
	a. Changes to water quality were discussed in the response to Question 1. These changes, especially those associated with untreated water releases, are particularly relevant to both species of EPBC Act-listed turtle because of their inferred high sensitivity to contaminants (AECOM 2022, pp. 162-164).	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action. **The following items are developed in response to the general comments raised and applicable elements for desalinated water releases** With respect to water quality, cloacal respiring turtles may have a higher sensitivity to contaminants than lung-breathing turtles, although specific toxicity thresholds for turtles are unknown/unassessed (see discussion in Boobook 2022). In the absence of species-specific water quality thresholds, the REMP water quality data and State EA CL for the protection of the drinking water EV are referenced together with sub-regional WQO and toxicity studies used to derive guidelines for some parameters (e.g. boron). Water quality parameters collected in the HCS04 DWB pond are not above the respective State EA CL or sub-regional WQO. The approach to water quality guideline development was based on the Queensland Water Quality Guidelines (2009) which is the same approach as described in the current National Water Quality Guidelines (ANZG 2018). Where water quality monitoring data indicates a concentration above a local water quality guideline, then the monitoring data is further assessed by compared to both reference site data (i.e., data collected upstream of the release point) and the full range (i.e., minimum to maximum) of baseline data, and spatial and temporal water quality patterns are assessed. To date, water quality monitoring data collected from the receiving environment for the REMP has indicated that reference site or baseline water quality conditions have typically been achieved, with further assessment of occasional parameters that are above a sub-regional WQO indicating they were not related to the release and are consistent with or lower than upstream water quality (refer to responses to Questions 13 and 14).	Section 1.2 Section 7.2.2

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		Biological (i.e., macroinvertebrate and fish) monitoring data has supported water quality monitoring in showing a healthy aquatic ecosystem in the desalinated release receiving environment. Furthermore, turtle monitoring data collected in conjunction with REMP monitoring has indicated the presence of healthy WTST and FRT in the receiving environment at similar frequencies to those recorded during the baseline studies. Therefore, the available monitoring data indicated that water quality risk of the desalinated water release has low risk for turtles.	
	b. Given the significance of the Dawson River as habitat for the two EPBC Act-listed turtle species, further site-specific assessment of habitat requirements, including for foraging, nesting and dry-season refuge, should be undertaken at different hydrological phases to assess how hydraulic changes arising from the releases might reduce their survival, especially over the long term (decades). This assessment should focus on sections of the Dawson River and waterhole where local-scale flow behaviour (e.g., within riffles) may be especially likely to be altered by the proposed releases.	The Dawson River provides critical habitat for white-throated snapping turtle (WTST) and Fitzroy River turtle (FRT), noting that critical habitat for both species extends well-beyond the Dawson River. For WTST critical habitat occurs widely throughout the range of the species elsewhere in the Fitzroy River basin, and in the Burnett and Mary Rivers (DAWE 2020). Within the Fitzroy River Basin, critical habitat for WTST occurs from the lower Fitzroy River from the barrage impoundment to the upper Dawson River, Callide Dam, lower Nogoa River, upper Connor River, and lower Isaac River in the Tartus Weir impoundment (Limpus et al. 2011), with a key nesting aggregation reported in the upper reaches of the Fitzroy River barrage impoundment (DAWE 2020). For FRT, which is endemic to the Fitzroy Basin, critical habitat occurs from the Fitzroy Barrage to the upper Dawson River, the Mackenzie River and lower reaches of the Nogoa River, and to the Upper Connors River (Limpus et al. 2011). Critical habitat for the species is not limited to the Dawson River. It is noted also that the principal threat to both turtle species is nest predation by native and introduced predators and trampling of nests by cattle. These threats are almost ubiquitous throughout the respective ranges of both WTST and FRT, including the reach of the Dawson River relevant for the Project. Habitat assessment completed to date under baseline studies (2013 to 2015) and the REMP program (2015 to 2022), a total of 9 years monitoring, indicate that key habitat for WTST and FRT (e.g., sandy nesting banks, pools (including vegetated pool margins) and riffles occur in the Dawson River. Sandy banks provide turtle nesting habitat, and cobbles in riffle zones a key foraging substrate. Large (flood) flow events often cause significant geomorphic changes to bed and back substrates via scour and deposition. Generally, such changes are natural and important for habitat rejuvenation, but in the context of threatened turtle species may present a risk if sandy banks (nest sites) are scoured and cobbly riffles (foraging habitat) are smother by deposited sediment. Desalinated water releases at both 18 ML/day and 13.5 ML/day result in no more than a 0.05 m increase in measured water levels at S4 (noting turtle nesting seasons are predominantly within low flow periods) (see Question 20 responses for additional detail). WTST and FRT nests are approximately 1.2 –2.5 m above natural water level; thus, the slight increases in low-flow water level have low risk of intercepting turtle nesting sites, and the slight reduction in average water velocity would have negligible influence on erosion and deposition processes of the Dawson River (i.e. negligible influence on nesting bank formation processes). The influence of the releases on geomorphic processes under base flow is not considered significant and under higher flow events is indistinguishable from natural flow conditions; thus, risk is negligible. It is not likely that further habitat survey work would increase understanding of the habitats present in the Dawson River or increase understanding of the (negligible) level of risk to aquatic habitat due to the releases.	Section 7.1 Section 7.2.1
	c. Further work is needed to understand the potential for contaminants to be present in the food resources of the two species of EPBC Act-listed turtles, and/or to accumulate in sediments. As the adults of the two species have different diets (Boobook Ecological Consulting 2022b, p. 10), assessment of the potential for bioaccumulation of contaminants in the food chain must include filamentous algae and aquatic invertebrates. Work needed on contaminant accumulation in sediments is discussed in Paragraph 18.	Juveniles of most turtle species have a high proportion of aquatic macroinvertebrates in their diet, with adult FRT maintaining a high proportion of benthic invertebrates in their diet but adult WTST having a higher proportion of filamentous algae (Limpus et al. 2011)(cross-reference the Micheli-Campbell et al. 2017 study that indicated that WTST have distinct food resources compared to Mary River turtles despite having overlapping home ranges in the Mary River, specifically with WTST consuming greater proportions of filamentous algae and crustaceans foraged from muddy and vegetated shallow margins of pool habitat). The above description of water quality and sediment quality indicate low direct risk to turtles, but also to food resources of turtles (e.g., benthic macroinvertebrate monitoring has indicated no adverse impacts of the desalinated release). Because water quality and sediment quality parameters are generally within baseline range, or within toxicity thresholds (e.g., boron), there is low risk that a higher rate of accumulation of potential toxicants would accumulate in food resources compared to baseline condition. Risk is low. Desalinated water quality (refer to Q16 response) does not exceed the State EA CL / LT (as the primary catchment specific reference) ammonia that appears to be associated with wildlife utilizing the DWB Pond. Ammonia is not bioaccumulative, therefore, the risk of bioaccumulation and transfer of contaminants to higher trophic levels (primary consumers such as macroinvertebrates and adult WTST, and secondary consumers such as juvenile turtles and adult FRT) is not significant. As for water quality, there are no species-specific sediment quality guidelines relating to WTST and FRT. In the absence of such guidelines, baseline sediment quality data was used to development sediment quality guidelines (using same approach as water quality for guideline development). REMP monitoring data to date has found that the desalinated release is unlikely to have caused any effects in sediment quality in the receiving environment and the risk of contaminant accumulation in sediment is low (refer to response to Question 16). Therefore, the available monitoring data indicated that sediment quality risks of the desalinated release for turtles is low.	Section 7.2.2
	d. Assessing the vulnerability and sensitivity of hatchlings is particularly important because of their heavy reliance on cloacal respiration and greater potential susceptibility to contaminated water (AECOM 2022, p. 164). The proponent should provide more details about the risks of impacts to hatchlings from water contamination and altered habitat availability and describe mitigation measures to protect any hatchlings that survive nest trampling and egg predation.	Refer to the response to Question 20. a	Section 1.2 Section 7.2.2
21	Limited monitoring has been proposed for both water quality (as discussed in Paragraph 7) and ecological features and processes of the Dawson River to enable rapid detection of potential impacts.	REMP monitoring of water quality, sediment quality, aquatic habitat, aquatic plants, macroinvertebrates, fish and zooplankton occurs at three sites within the waterhole (WLMP4, WLMP1 and WLMP5) and two sites on the Dawson River within the receiving environment (DRMP1 and S4), as well as reference sites upstream of the desalinated release (Dawson River site DRR1). This monitoring is undertaken in the pre-wet and post-wet seasons each year and is designed to enable detection of adverse changes to the aquatic ecology of the receiving environment that may be related to the desalinated release as required under the State EA. Monitoring to date has not indicated an adverse impact of the desalinated release on the aquatic ecology of either the waterhole or the Dawson River. While turtle monitoring is not indicated by the current REMP Design Report, turtle monitoring has been undertaken in conjunction with REMP monitoring at all above listed sites, and it is noted this monitoring has indicated the presence of healthy WTST and FRT in the receiving environment at similar frequencies to those recorded during the baseline studies. The REMP has been revised to include additional an additional turtle survey method via snorkeling (where safe flow conditions are present) to increase the robustness of survey methods in line with current practices.	Section 7.2 Section 9.1 Appendix J

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
	a. No plans (e.g., suitable TARPs) in response to potential impacts on the two EPBC Act-listed turtle species are provided to ensure that there are appropriate actions to prevent further impacts within a suitable timeframe.	This question relates to event-based releases that are no longer part of the proposed action. For desalinated releases the REMP required under the State EA includes actions and responses and are summarized in Section 9.0 of the REMP. Schedule K of the State EA provides notification requirements for environmental incidents including exceedances of authorized release limits for water quality parameters in desalinated water and at the Yebna Crossing S4 compliance point. A duty to notify of environmental harm is also an obligation under the *Environmental Protection Act, 1994* (QLD) in addition to notification requirements required under the State EA.	Section 9.0
	b. Monitoring in the waterhole is located mainly on the upstream side which is unlikely to provide favourable habitat for either turtle species; sampling locations (especially for aquatic macroinvertebrates) should include preferred foraging sites such as riffles and backwaters.	Current REMP monitoring locations in the waterhole include three locations as follows: - WLMP4 – located at the western end of the waterhole (upstream) - WLMP1 – located in the central southern bend of the waterhole at the discharge location from the Gully (middle) - WLMP5 - located at the eastern downstream end of the waterhole prior to the exit to the watercourse connecting the waterhole with the Dawson River (downstream). The above locations cover the extent of habitat in the waterhole both “upstream” middle and “downstream”. Section 7.1.3 of the PD identifies the waterhole as non-critical habitat for either of the MNES turtle species though may be used by both the WTST or the FRT but may be used by opportunistically. REMP monitoring completed to date has identified one sighting of a white-throated snapping turtle in the waterhole in 2017 over the 6 years of REMP monitoring completed to date.	Section 5.0 Figure 5-1
	c. Additional ecological monitoring is needed closer to the event-based release location because the IESC considers that the risk of impacts to the two turtle species is greater from the untreated water releases.	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2
22	The population of White-throated snapping turtles at the project site is isolated from downstream populations by substantial distance and waterway barriers. Should project-related impacts to the White-throated snapping turtle substantially reduce its population size and/or reproductive success, then there is a high chance that the population at the project site will become locally extinct as the downstream population will not be able to access and repopulate the area. The IESC is very concerned about the risks of this project, especially the potential long-term impacts of event-based releases of untreated produced water, on the persistence of this critically endangered species.	WTST is distributed throughout the Dawson River and Fitzroy River including downstream of the Glebe Weir where treated CSG water is released for the Glebe Beneficial Use Scheme (GBUS) (including coal seam gas water treated at the Northern Water Treatment Plant) for use by irrigators. The home range of the white-throated snapping turtle is now considered to be over 30 km and the distribution observed under REMP surveys is more likely a product of survey effort rather than actual distribution within the proposed action area; i.e. it is likely present in greater numbers than captured under current REMP surveys. Phylogeographic and population genetic analyses (Todd 2013) indicate that WTST in the Dawson River is genetically connected with WTST elsewhere in the Fitzroy River basin, indicating that at least some individuals move larger distances within the basin. These longer-range dispersal events often exceed the distance of flowing riverine habitat between dams and weirs (indicating that dams and weirs can adversely impact movement). However, as some individuals may move over or around such infrastructure, and only a few individuals take such long-range movement, the extent to which WTST in the Dawson River is artificially isolated from populations elsewhere is likely limited. As discussed above, the hydrological and water quality risks of the proposed desalinated water releases for WTST are low to negligible. There will be no risk of impact to reproductive success or local population size due to the releases. It is well-established that the principal threat to reproductive success in WTST is nest predation and trampling, neither of which will be increased due to the project.	Section 7.1
Question 3: Can the Committee provide comment on the likely scale and extent of impacts to downstream GDEs as a result of changes to hydrological regime and water quality associated with the proposed water releases?			
23	Subterranean, aquatic and terrestrial GDEs are all present or highly likely at the project site and downstream of the proposed release points. However, their exact distribution and groundwater-dependence need to be ground-truthed and mapped at a local scale to enable a full assessment of potential impacts as a result of changes to the hydrological regime and water quality associated with the proposed water releases.	The CSM described in the 2022 AECOM report provides a reasoned assessment of low-impact risk to the three types of GDEs based on State mapping, ground-truthing by Boobook, and then a precautionary assessment of GDE distribution based on where uncertainty exists, particularly for subterranean GDEs which are not mapped as present but assumed to be present by the assessment. As such, there seems little point in attempting to precisely map GDEs. Event-based releases are no longer part of the proposed action. Rather than attempt to map the exact (which is difficult and rarely can be achieved) distribution of GDEs it is proposed that the REMP monitoring includes Limits of Acceptable Change for general indicators of GDE health such as vegetation health indices, using multi-spectral satellite imagery methods as described below, beyond which mitigating actions can be applied. The current identified terrestrial GDES would be the focus of noted monitoring, with the inclusion of appropriate reference sites to gauge seasonal and interannual variation. With respect to the hydraulic impact on the Dawson River of the proposed release of desalinated water the proposed activity will result in minimal if any incremental change to the existing hydraulic and frequency-duration characteristics of the Dawson River when compared with the existing release regime which has been operating since 2015. Reference to responses to Question 15 indicates that previous 18 ML/day desalinated water releases and current 13.5 ML/day desalinated water releases result in less than 0.05 m response in downstream water levels at S4 on the Dawson River. Observed increases in the Dawson River flow depths at S4 take 2 to 3 days to be observable in gauged data and subsequently increase slowly to the peak increase in flow depth of 0.05 m over the duration of the discharge period, up to 10 days. Decreases after cessation of desalinated releases occur equally slowly. In comparison, natural rain events manifest as rapid increases in flow depth in the Dawson River as indicated in Question 15. The provided information in the PD does not dispute the presence of GDEs. The presented GDEs represent an overestimation of GDEs, particularly terrestrial GDEs, where three regional ecosystems are determined to be known or likely terrestrial GDEs. It is unlikely that the entire regional ecosystem is reliant on groundwater as part of its water balance, and only individual stands would utilize groundwater. The presence of aquatic (surface expression) GDEs for the Dawson River are also acknowledged and these are considered to be high-value GDEs as they support the conservation significant fauna (FRT and WTST). Only desalinated water releases are proposed which is consistent with the current scenario in terms of water quality. The REMP (2017 to 2021) which monitors the potential impacts of treated water releases on the aquatic ecosystem values indicated that there has been no influence on the aquatic ecology of the receiving environment. This is likely a result of the low-risk nature (protection of 99% of species) of the released desalinated water quality. The presence of stygofauna in aquifers and hyporheic habitat is not disputed. Typical to the Surat Basin, stygofauna are generally present in low diversity and abundance and commonly consist of nematodes and copepods from a variety of families. Given the connectivity across the Dawson River both in the hyporheos and aquifers there are unlikely to be any present short-range endemics. Despite this, the	Section 6.3.3 Section 5.2.2

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
		desalinated water releases present a low risk to such fauna as the releases are unlikely to contribute to these habitats. If there is any contribution, the desalinated water quality is treated to a high quality and will be highly attenuated by background flows of the Dawson River. Current information investigating the toxicity of contaminants to stygofauna (Canivet et al., 2001; Hose et al., 2016, 2019; Reboleira et al. 2013) have shown that stygofauna are more tolerant to acute and chronic exposure and therefore guidelines used for surface-dwelling aquatic species are also likely to protect stygofauna.	
24	Subterranean GDEs (e.g., stygofauna, hyporheic fauna) are acknowledged as potentially present in aquifers and the hyporheic zone in the project area where discharging aquifer water enters the river channel (Boobook Ecological Consulting 2022a, p. 5). However, this GDE has not been sampled which prevents reliable assessment of potential impacts from, for example, inflows of contaminated water in zones into shallow alluvial aquifers. Baseline data are needed on stygofauna and hyporheic fauna, especially in alluvial sediments of the reach immediately downstream of the release point of untreated water and areas where infiltration may occur (e.g., parafluvial zones of unconfined channels, bed sediments where the Dawson River changes from gaining to losing). Field surveys and sampling should follow the guidelines outlined in DSITI (2015) and Doody et al. (2019), focussing on shallow alluvial sediments along the bank and in the riverbed, and including suitable unimpacted reference sites for comparison.	The presence of stygofauna in aquifers and hyporheic habitat is not disputed. Typical to the Surat Basin, stygofauna are generally present in low diversity and abundances and commonly consist of nematodes and copepods from a variety of families. Unpublished data collected by Hydrobiology in 2018 from the Precipices Sandstone approximately 10 km downstream of the proposed action along the Dawson River indicated that stygofauna are generally present in low diversity and abundances and commonly consist of nematodes and copepods from a variety of families. Given the connectivity across the Dawson River both in the hyporheos and aquifers there are unlikely to be any present short-range endemics. Despite this, the proposed treated water releases present a low risk to such fauna as the releases are unlikely contribute to these habitats (few gaining periods) and if there is any contribution, the release water quality achieves the respective sub-regional WQO or is lower than upstream reference water quality. We also note that current information, investigating the toxicity of contaminants to stygofauna (Canivet et al., 2001; Hose et al., 2016, 2019; Reboleira et al. 2013) have shown that stygofauna are more tolerant to acute and chronic exposure and therefore guidelines used for surface dwelling species are also likely to protect stygofauna. If general indicators for stygofauna health were introduced into the REMP, pore-water quality is suggested for monitoring along with groundwater quality.	Section 6.3. Section 6.4.3
25	Field surveys are also needed to determine if the critically endangered Boggomoss snail (Adclarkia dawsonensis), which occurs at the downstream GAB spring Boggomoss Spring and within riparian areas, is present at the project site. Aquatic snails can be highly susceptible to impacts from contaminated water and are good ecotoxicological bioindicators (review in Chen et al., 2021)	Communication with Dr John Stanisic (Hon. Research Fellow, Queensland Museum; author of the National Recovery Plan for the Boggomoss snail; Adclarkia dawsonensis) has indicated that the Boggomoss Snail does not occur around Injune in the Upper Dawson River catchment and is known only from localities downstream of Taroom >150 km downstream of S4, the downstream boundary of the proposed action area. The proposed action area is occupied by another genus of large land snail viz. Pallidelix that are not listed under the EPBC or QLD DES as threatened fauna. The Boggomoss occurs in the riparian environments of the Dawson below Taroom and some boggomosses where the GAB aquifer provides moist conditions for the establishment of 'pseudo-riparian' environments. Dr Stanisic notes that the Boggomoss Snail is a land snail, not an aquatic snail.	Not applicable
26	Aquatic GDEs within and downstream of the project area may be impacted through several mechanisms outlined below. The expected scale and extent of impacts to these GDEs varies and is dependent on their distribution, water source and vulnerability to change.		
	a. GDEs supported wholly or partly by shallow aquifers, including colluvial and alluvial aquifers underlying the Dawson River and the waterhole, may be impacted. i. Impacts are most likely in the hyporheic zone where localised infiltration of surface water occurs and can transport contaminants into these shallow systems. ii. Impacts can also arise from changes to the hydrological regime such as transient changes to hydraulic gradients that may be induced by elevated surface water levels from water releases. iii. In the hyporheic zone, changes to hydraulic gradients can alter subsurface redox conditions and affect biogeochemical processes such as nutrient cycling in these GDEs (review in Boulton et al., 2010). These GDEs are particularly poorly characterised in the provided assessment yet are potentially vulnerable to sustained changes to the hydrological regime and water quality, especially where river water infiltrates shallow aquifers.	REMP monitoring data for the waterhole and Dawson River does not identify exceedance of State EA CL / Local Trigger (as the primary screening reference),and limited 95th percentile concentrations above the sub-regional WQO (aluminium, ammonia, and total nitrogen that are all present at similar or higher concentrations upstream of the proposed action area, therefore water quality is not considered likely to be an issue for desalinated water discharges. The chemical risk assessment (CRA) conducted for the project should hold for both surface water and groundwater/hyporheic species (GDEs). Monitoring of surface water consistent with the REMP, with the addition of porewater specific to the hyporheos will assist in determining any changes to such receptors. Measured hydrologic changes associated with desalinated water releases in the waterhole (as measured at site WLMP1) are between a maximum of +0.4 m to -0.5 m and typically range between ±0.2 m at 18 ML/day, which is less than inferred changes before 2015. Water level changes in the Dawson River (as measured at site S4 / Yebna Crossing) is no more 0.05 m at 18 ML/day with increases to that level occurring over many days. Measured water level increases are well below rainfall-induced flow level changes (refer to Q15 response) and similar to the tail flows from peak events. Therefore, it is considered that hydrologic changes from desalinated water releases are within background ranges and unlikely to cause significant water quality and ecological changes or impacts.	Section 5.2.2 Section 5.3 Section 6.4.2
	b. It **is recommended that the proponent map these GDEs in the project area and assess their potential vulnerability to altered**	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan.	Section 1.2

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
	water regimes and water quality resulting from the proposed releases (see Paragraph 23). This is especially relevant if the predicted cumulative drawdown reduces hydraulic gradients and discharges within the project area. The Underground Water Impact Report (OGIA, 2021) predicts cumulative long-term impacts on groundwater levels for the Precipice Sandstone at springs adjacent to the proposed action area of up to 0.7 m within 38-39 years (AECOM 2022, Table 4.16, p. 67). The proponent asserts that this drawdown is 'not sufficient to alter vertical groundwater gradients within the proposed action area' (AECOM 2022, p. 67) **yet presents no supporting evidence**. Even if hydraulic gradients driving surface water-groundwater interactions in the project area are weakened rather than reversed, there are likely to be implications for surrounding groundwater resources and the river's baseflow.	Event-based releases no longer form a component of the proposed action. The reference area is now outside and upstream of the proposed action area	
	c. Riverbank seeps at the project site, other than GAB springs, may be impacted by both types of water releases depending on their location. The seeps are likely reliant on the alluvial aquifers and could be exposed to contaminants. This can occur directly from the releases, or potentially could also arise as high flows recede and contaminated water discharges from the alluvial sediments. It is possible that contaminated water from the untreated releases may be temporarily stored within the alluvial aquifers as bank storage. When the surface water level recedes, this stored water is released back into the surface water system possibly resulting in a second pulse of contaminants that could impact downstream GDEs and aquatic biota. **A vulnerability assessment should be done for each seep, and its water quality and biota should be monitored as part of the REMP to confirm the proponent's predictions that no significant impacts will occur from the project**.	This comment refers to event-based releases. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2
	d. The IESC agrees with the proponent that most GDEs supported by deeper aquifers such as the Precipice Sandstone are unlikely to be impacted by the proposed water releases, especially where there are no feasible pathways for movement of contaminants into the groundwater.	No comment response required	Not applicable
27	Terrestrial GDEs occur in the project area and include the TEC 'Eucalyptus populnea Woodland on Alluvial Plains' (AECOM 2022, p. 129). It is not clear whether contaminants from untreated releases may be transported laterally into the riparian zone during high flows and, over time, infiltrate into the shallow groundwater used by groundwater-dependent vegetation. If this pathway is feasible (see Paragraph 18b), the **proponent should ground-truth likely sites in the project area and assess the distribution and groundwater-dependence of terrestrial GDEs in potentially affected locations**. These may be useful monitoring sites for assessing long-term (decadal) legacy effects of contaminants from untreated releases on downstream terrestrial GDEs. The health of these GDEs should be monitored in vulnerable locations as part of the REMP, especially for potential long-term impacts of deposited contaminants.	This comment refers to event-based releases. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2
Question 4: Can the Committee provide comment on likely scale and extent of potential impacts to surrounding groundwater resources resulting from the proposed water releases through interactions between surface water and groundwater resources?			
28	The proponent's assessment that impacts from produced water releases will have a limited impact on regional groundwater is based on the maintenance of groundwater pressures above the base of the Dawson River (i.e., gaining conditions occurring within the Dawson River prevent recharge of the regional aquifer). From the information provided, it is not possible to determine the current and future likelihood of hydraulic gradient weakening or reversal. Further work to support their assessment is needed that considers:	This comment refers to event-based releases that are no longer part of the proposed action. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2

No	IESC COMMENT	Response and /or Clarification	Clarification location in PD
	a. whether predicted drawdown (noting that uncertainty in drawdown predictions can be up to one order of magnitude) from CSG operations in the area could result in any reaches of the Dawson River potentially impacted by produced water releases from the project becoming losing reaches which may facilitate aquifer recharge with contaminated water (see Paragraph 26b); and	This comment refers to event-based releases that are no longer part of the proposed action. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2
	b. if a decrease in gaining conditions (e.g., not a full reversal to losing conditions) could occur and cause impacts in the hyporheic zone (e.g., altered rates or types of biogeochemical processes) or affect spring discharge.	Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2
29	Direct impacts from the water releases to the regional groundwater system, the Precipice Sandstone, are unlikely. This is because the pressure head in the Precipice Sandstone in the area close to the proposed untreated release point is above the level of the Dawson River streambed making substantial recharge of the Precipice Sandstone aquifer by contaminated water unlikely. In times of high surface water flows, some recharge to the stream bed and banks will occur, but this recharge is unlikely to infiltrate into the Precipice Sandstone aquifer. Additionally, this localised recharge and storage is typically temporary and is expected to discharge back to the downstream surface water system as water levels recede. The effects will most likely occur in the alluvial sediment overlying the Precipice Sandstone aquifer. See Paragraph 26c for discussion of potential impacts arising from this process.	This comment refers to event-based releases that are no longer part of the proposed action. Following initial PD development and submission Santos made the decision that event-based releases are no longer required as a contingency measure for water management. No infrastructure is in place and the event-based release is not incorporated into any current or future water management plan. Event-based releases no longer form a component of the proposed action.	Section 1.2
30	Shallow groundwater systems at the project site may be impacted by the releases of treated ~~and untreated~~ water. The scale and extent of the impacts are likely to be localised; however, the importance and significance of the impacts is unclear from the information provided. For example, treated water releases, especially at low flows, are very likely to alter hyporheic water chemistry (assuming hyporheic water is chemically different from the released water) because of advective exchange in the riverbed in places where groundwater inputs are weak or absent, and this will potentially occur for a considerable distance downstream if the releases continue for years to decades. Assessing the scale and extent of these potential impacts depends on mapping these areas and their vertical hydraulic gradients at various flows and then inferring the likelihood that impacts to groundwater resources may arise from contamination and, to a lesser degree and in much more localised areas, changes and even reversals in surface water-groundwater exchange. Impacts to GDEs supported by shallow groundwater systems are discussed in the response to Question 3.	Response to 1 and 2 paragraphs: Assessment of impact at and within the waterhole has been completed in the PD. Additional evaluation of localised impact, identified as unlikely by the IESC, will be added to the groundwater section. Additional assessment will include: - No proposed changes to the existing hydrological regimes or water quality than what has happened to date - Conceptualisation of the possible impact - Overtopping and water quality entering the Dawson River – hyporheic zone in the non-perennial creek - There is no impact pathway for shallow groundwater systems. - Desalinated water entering the Dawson River – a temporary increase in flow (minor compared to baseflow) and water level (no more than 5 cm), indicating limited advection flow area and timing - Alluvium conceptualisation, non-continuous and migratory, indicates limited potential for accumulation of dissolved substances (advection) from the treated water due to limited effective storage - any possible dissolved substances introduced from the treated water discharge would be readily flushed from the alluvium (assuming it remains in place) during higher than baseflow flow rates (river water level rises several meters) – any such shallow groundwater systems are wholly dependent on permanent flows in the watercourse because the alluvial material is very poorly developed in this steep landscape adjacent to the watercourse – Assuming hyporheic water is chemically different from the released water noting that the water entering the Dawson River – pre-2015 and post-2015 water quality comparison Third paragraph – relates to Dawson River where Precipice Sandstone discharge, as the proposed action relates to the waterhole and downstream of Dawson River confluence with waterhole, which are all underlain by the Evergreen Formation aquitard. The aquitard is detailed in the report to have no groundwater contribution. This comment only relates to event based which is no longer part of the project Fourth Paragraph – refer to responses to IESC Question 23, Question 24, and Question 26	Section 4.2.2 Section 5.3