Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC 2018/8319

Decision on validity of Request for Reconsideration of Referral Decision: Browse to North West Shelf Development, Indian Ocean, WA (EPBC 2018/8319)

To: Kylie Calhoun, Branch Head, Environment Assessments West Branch

Action required: For Decision

Timing: DATE. There is no statutory timeframe for this decision, however, must be made as soon as practicable. The request was received on 18 February 2026.

Recommendations:

1. Consider the information in this brief, the letter and supporting documents from Environmental Justice Australia requesting reconsideration of the decision of the Minister's delegate relating to EPBC 2018/8319 (Attachment A).

Considered/Please discuss

2. Agree that the letter and supporting documents at Attachment A meet the requirements of s 78A(2) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and regulation 4AA.01 of the *Environment Protection and Biodiversity Conservation Regulations 2025* (EPBC Regulations) and is therefore a valid request for reconsideration under s 78A.

Agreed/Not agreed/Please discuss

3. If you agree to Recommendation 2, accept the reasoning in the departmental briefing package as the basis for your decision.

Accepted/Please discuss

4. If you agree to Recommendation 2, note that the decision that the Browse to North West Shelf Development Project is a controlled action will be reconsidered under s 78C of the EPBC Act after the letter and supporting documents at Attachment A have been published on the internet for public comment, relevant parties have been consulted, and consultation has finished.

Acknowledged/Please discuss

5. If you agree to Recommendation 2, sign the letters to the requestor, proponent and appropriate Commonwealth and State Ministers at Attachment B1 to Attachment B7.

Signed/Please discuss

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6. If you agree with Recommendation 2, please read and agree to publish Attachment C, the Invitation for Public Comment on the Reconsideration of Referral Determination: S78A Reconsideration Request document.

Agreed/Not agreed/Please discuss

Signature of delegate:



Branch Head
Environment assessments West

Date: 19 June 2026

Comments:

Key issues:

1) On 18 February 2026, Inshani Ward from Environmental Justice Australia (**EJA**) on behalf of the Australian Conservation Foundation (**ACF**), sent a letter with supporting documents (**Attachments A1-A3**), requesting reconsideration under section 78A of the EPBC Act of the controlled action decision for Browse to North West Shelf Development Project (**the proposed action**) (EPBC 2018/8319).

2) The request related to the decision of the Minister's delegate of 22 February 2019, under section 75 of the EPBC Act, that the proposed action is a controlled action, and that National Heritage places (sections 15B & 15C), Listed threatened species and ecological communities (sections 18 & 18A), Listed migratory species (sections 20 & 20A) and Commonwealth marine areas (sections 23 & 24A) are the controlling provisions (**the referral decision**). See the referral decision notice at **Attachment D**.

3) EJA contends that it has provided substantial new information about the impacts the proposed action will have, or is likely to have, on matters of national environmental significance (**MNES**).

4) EJA states that this new information demonstrates that the proposed action's release of scope 1 and scope 3 greenhouse gas (**GHG**) emissions will likely lead to measurable climate impacts, including a loss of coral colonies during future mass bleaching events on the Great Barrier Reef and a measurable increase in global warming attributable to the project. EJA considers the following additional controlling provisions are likely to be significantly impacted by the proposed action:

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a) World Heritage properties (ss 12 & 15A)

b) Great Barrier Reef Marine Park (ss 24B & 24C) (**GBRMP**)

(collectively, the **GBRMP controlling provisions**)

5) The department has assessed EJA's request against the requirements under the EPBC Act and EPBC Regulations. The department considers that the request meets the requirements as set out in the EPBC Act and EPBC Regulations and is therefore a valid request.

Description of the referral decision:

6) A valid referral was received on 15 November 2018 from Woodside Energy Ltd who stated their belief that the proposed action was a controlled action for the purposes of the EPBC Act in relation to the environment in a Commonwealth marine area.

7) On 22 February 2019, the Minister's delegate determined under section 75 that the proposed action is a controlled action (**Attachments C & D**), with likely significant impacts on:

a) National Heritage (sections 15B & 15C),

b) Listed threatened species and ecological communities (sections 18 & 18A),

c) Listed migratory species (sections 20 & 20A), and

d) Commonwealth marine areas (**CMA**) (sections 23 & 24A).

8) As the proposed action will be taken *in* a CMA, the protected matter for the purposes of sections 23 and 24A is the environment generally. The 'environment' is defined in section 528 to relevantly include 'ecosystems and their constituent parts', 'natural and physical resources', 'the qualities and characteristics of locations, places and areas' (which would include the atmosphere).

9) The referral decision brief states that the proposed action includes:

a) The development and extraction of hydrocarbons from Brecknock, Calliance and Torosa hydrocarbon reservoirs,

b) The installations and operation of two floating production and storage offloading (FPSO) facilities, and

c) The installation and transportation of hydrocarbons from the FPSO facilities via a 900 km trunkline to existing pipeline infrastructure.

10) The department notes that the proposed action does not include the following:

a) The processing of the Browse gas – extracted from Brecknock, Calliance and Torosa hydrocarbon reservoirs – and third-party gas at Karratha gas plant. This is approved under a separate action (EPBC 2018/8335).

b) The combustion of gas extracted from the Brecknock, Calliance and Torosa hydrocarbon reservoirs.

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c) The use of carbon capture and storage (CCS) technology. Woodside's separate referral (EPBC 2024/10028) for the Browse CCS Project was withdrawn on 24 March 2026. On 30 March 2026, Woodside applied to Minister Watt for a s146N determination under the amended EPBC Act so that the whole Browse CCS Project can be referred under the EPBC Act (rather than split across the NOPSEMA Part 10 approval). The department is currently considering this application.

Impacts of GHG emissions on the environment generally

11) The referral decision brief included consideration of GHG emissions with respect to the environment generally, for the purposes of the CMA controlling provisions. The brief considered two potentially relevant sources of GHG emissions:

a) Direct GHG emissions as a result of extracting hydrocarbons and processing at the FPSO facilities; and

b) Indirect GHG emissions resulting from processing the extracted gas at Karratha Gas Plant (part of (EPBC 2018/8335) above) and the transport to and combustion overseas of the extracted gas.

12) At the referral decision stage, the Minister's delegate agreed with the department's recommendation that there is a real chance or possibility that the GHG emissions as a direct or indirect result of the proposed action may result in a significant impact to the environment generally within the Australian jurisdiction.

Impacts of GHG emissions on other MNES

13) The referral decision brief considered that GHG emissions from the proposed action were unlikely to result in an identifiable significant impact on the specific listed threatened or migratory species.

14) The referral decision brief did not consider GHG emissions in relation to any other MNES.

Regulatory requirements for reconsiderations:

15) There is no statutory timeframe for making a reconsideration decision under section 78 of the EPBC Act, but a referral decision cannot be revoked once an action has been approved, refused or taken under the Act.

16) The proposed action has not been taken. Nor has a decision been made on whether to approve or refuse the taking of the action. As the proposed action was the subject of a referral decision, it cannot be taken without an approval.

17) The department's policy is that it will not recommend an approval or refusal decision before a decision has been made on whether a reconsideration request is valid and, if applicable, the referral decision has been reconsidered.

18) Reconsideration requests do not attract a cost recovery fee unless made by the proponent or person proposing to take the action. Therefore, there would be no associated cost recovery fee if the request were accepted as valid.

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19) Under section 78A(1) of the EPBC Act, a person (other than a State or Territory Minister) may request that the Minister reconsider a decision made under section 75(1) of the EPBC Act, on the basis of any matter referred to in sections 78(1)(a) to (ca).

20) A request for reconsideration by such a person must meet the requirements of section 78A of the EPBC Act and regulation 4AA.01 of the EPBC Regulations to be valid. If a request is valid, the Minister must then consult on the request in accordance with section 78B of the EPBC Act and reconsider the referral decision under section 78C of the EPBC Act.

21) The department considers that the request meets the requirements of section 78A of the EPBC Act and regulation 4AA.01 of the EPBC Regulations as outlined below:

The request must:	Reference	Notes	Met/Not Met
be made in writing	Section 78A(2)(a)	The request was made in writing and received on 18 February 2026.	Met
set out the basis for reconsideration	Section 78A(2)(b)	The request identifies that the decision should be reconsidered on the basis that there is substantial new information that has become available about the impacts of the proposed action.	Met
comply with the requirements in the regulations	Section 78A(2)(c)	Discussed below.	Met
identify the legislative grounds for reconsideration	Regulation 4AA.01(2)(a)	The request specifies subsection 78(1)(a) (availability of substantial new information).	Met
include the sources of any information provided	Regulation 4AA.01(2)(b)	The request (**Attachment A1**) refers to new information regarding possible significant impacts of the project on the Great Barrier Reef from emissions of the project.	Met
provide details of when the information became available	Regulation 4AA.01(2)(c)	The request identifies the following sources of information and the dates they became available: • Professor Sarah Perkins-Kilpatrick, 'Independent Expert Report – End-to-End Attribution of the 'Browse to North West Shelf' Project and Impacts on Coral Loss in the Great Barrier Reef', 12 February 2026 (**Attachment A2**). This information is an independent report making the claim that emissions from the proposed action are likely to have quantifiable physical effects on the environment in the GBRMP. It uses the methodology set out in the article explained below to model these casual links between the emissions (scope 1 and 3) and the measurable climate impacts and impacts on the GBRMP. • Nerilie J Abram *et al*, 'Quantifying the Regional to Global Climate Impacts of Individual Fossil Fuel Projects to Inform Decision-Making', npj Climate Action (Nature) journal, October 2025 (**Attachment A3**). Professor Perkins- Kilpatrick is a contributing author on this article. This article shows how socioeconomic and environmental consequences can be attributed to CO_2	Met

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The request must:	Reference	Notes	Met/Not Met
		emissions from individual projects. Furthermore, it states that emissions from projects may end up dominating a country's emissions and therefore impact its ability to meet their Nationally Determined Contributions – as determined for the Paris Agreement. The article demonstrates a methodology to link emissions from a project and the impact on the Great Barrier Reef through colony losses during future warming events and the impact of emissions on global warming.	
contain any new information not considered when the original decision was made	Regulation 4AA.01(3)(a)	The information contained in the request was not before the Minister's delegate at the referral decision stage and so is considered new information.	Met
contain information that demonstrates that a change in the potential impacts of the action is likely to happen with a high degree of certainty	Regulation 4AA.01(3)(b)	The request outlines a likely impact range in global temperature increase and quantity of lost coral colonies in their request. They have also provided a confidence level, demonstrating that regardless of the extent of impact there will be an impact on the global temperature and the reef. To the extent the decision-maker for the referral decision did not consider that GHG emissions were a potential impact of the proposed action on the GBRMP controlling provisions, the request contains information which (taken on its own, assuming it is accurate, and without the benefit of any comments from the designated proponent, Commonwealth or State Ministers and members of the public) appears to meet the requirement in reg 4AA.01(3)(b).	Met

22) The department makes its recommendation in relation to regulation 4AA.01(3)(b) having considered the information contained in the request on its own, assuming it is accurate, and without the benefit of any comments from the designated proponent, Commonwealth or State Ministers and members of the public.

23) The department did not assess, and has not formed a view on, the accuracy and completeness of the information, nor how it should be considered at the reconsideration decision stage.

Conclusion

24) The department considers that the request is consistent with the requirements of the EPBC Act and EPBC Regulations. Accordingly, the department considers that the request is valid and the referral decision should be reconsidered.

25) If you agree with the department's recommendations, the department will write to the requestor notifying them their request is valid (**Attachment B1**). In accordance with section 78B(2), the proponent will also be provided with a letter notifying them of the request and allowing 20

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business days to provide comments (**Attachment B2**). If required, the department will seek further information from the proponent in the subsequent process.

26) In accordance with section 78B(6), the department will publish the request and a notification for public comment period (**Attachment C**) for a period of 20 business days. In accordance with sections 78B(4) and (5), the department will notify relevant Commonwealth and State Ministers of the request (**Attachments B3-B7**) and will provide them with 20 business days to supply any further information and provide comment.

Consultation

27) The Legal Division were consulted in the preparation of this brief.

Cleared by

Name: s. 22(1)(a)(ii)
Position: Director, North WA Section
Branch: Environment Assessments West
Phone: s. 22(1)(a)(ii)
Date: 18 June 2026

Contact officer

Name: s. 22(1)(a)(ii)
Section: North WA
Phone: s. 22(1)(a)(ii)

Attachments

A: Consolidated request for reconsideration

- A1: Letter to Minister from EJA with request dated 18 February 2026
- A2: Independent Expert Report
- A3: Journal article: Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making

B: Letters to relevant parties – FOR SIGNATURE

- B1: Letter to requestor
- B2: Letter to proponent
- B3: Letter to State
- B4: Letter to Minister for Climate Change and Energy
- B5: Letter to Minister for Resources and Northern Australia
- B6: Letter to Minister for Indigenous Australians

C: Notice for requesting public comment

D: Referral decision notice dated 22 February 2019

E: Referral decision brief dated 22 February 2019

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Australian Government
Department of Climate Change, Energy, the Environment and Water

EPBC 2018/8319

Ms Inshani Ward
Special Counsel
Environmental Justice Australia
PO Box 12123
A'BECKETT ST VIC 8006

inshani.ward@envirojustice.org.au

Dear Ms Ward

Validity of reconsideration request – Browse to North West Shelf Project, Indian Ocean, WA (EPBC 2018/8319)

Thank you for your letter, on behalf of the Australian Conservation Foundation (ACF) of 18 February 2026 to the Minister for the Environment and Water, requesting under section 78A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the Minister reconsider the controlled action decision for the Browse to North West Shelf Project, Indian Ocean, WA (EPBC 2018/8319), revoke that decision, and substitute a new decision under section 75(1) that includes the controlling provisions for World Heritage properties (sections 12 and 15A) and the Great Barrier Reef Marine Park (sections 24B and 24C). The Minister for the Environment and Water, Senator the Hon Murray Watt, has asked me to reply to your correspondence on his behalf.

I have determined that your reconsideration request meets the requirements of section 78A(2) of the EPBC Act and regulation 4AA.01 of the *Environment Protection and Biodiversity Conservation Regulations 2025* (EPBC Regulations) and, as such, it will proceed. In accordance with the requirements of the EPBC Act, the department has written to the proponent and the relevant Commonwealth and State Ministers inviting comments and will publish the request for reconsideration on the department's website to allow public comment. The proponent, Ministers and public will have 20 business days to provide a comment.

Following the consultation period, the Minister, or a delegate of the Minister, will consider all relevant information and reconsider the controlled action decision under section 78C(1). This will result in a decision to either confirm the original decision, or to revoke the original decision and substitute it with a new decision.

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If you have any questions about the reconsideration request or the assessment please contact s. 22(1)(a)(ii) by email to s. 22(1)(a)(ii) @dcceew.gov.au (cc'ing NorthWA.Section@dcceew.gov.au). Please quote the EPBC reference number shown at the beginning of this letter.

Thank you for your correspondence.

Yours sincerely



Kylie Calhoun
Branch Head
Environment Assessments West

19 June 2026

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Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC 2018/8319

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Mr Alistair Jones
Director General
Department of Water and Environmental Regulation
Locked Bag 10
JOONDALUP WA 6919

Invitation to comment on reconsideration request – Browse to North West Shelf Development, Indian Ocean, WA (proposed action)

Dear Mr Jones

I am writing to you in relation to the above proposed action.

On 22 February 2019, a delegate of the then Minister for the Environment and Water (the Minister), decided, under section 75(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), that the proposed action is a controlled action and the controlling provisions are:

- National Heritage places (section 15B & section 15C)
- Listed threatened species and ecological communities (section 18 & section 18A)
- Listed migratory species (section 20 & section 20A)
- Commonwealth marine areas (section 23 & section 24A)

(the original decision).

On 18 February 2026, the Minister received a request under section 78A of the EPBC Act to reconsider the original decision on the basis of the matter referred to in section 78(1)(a) of the EPBC Act.

The request and associated documents are available via the department's EPBC Act Public Portal webpage: https://epbcpublicportal.environment.gov.au/open-for-comments/ (using EPBC reference 2018/8319).

The request was submitted under section 78A of the EPBC Act on the basis of substantial new information about the impacts that the proposed action has or will have, or is likely to have, on a matter protected by a provision of Part 3, as prescribed under section 78(1)(a) of the EPBC Act.

As this action is proposed to be taken in Western Australia and I think it may impact on a matter of national environmental significance, I invite you under section 78B(5) of the EPBC Act to provide within 20 business days of the date of this letter:

- comments on whether a matter referred to in any of sections 78(1)(a) to (ca) of the EPBC Act is applicable in relation to the proposed action; and
- any other information you consider relevant to the reconsideration.

The current version of the EPBC Act can be accessed via the department's website: https://www.dcceew.gov.au/environment/epbc.

Please provide comment using the following contact details:

By email:
s. 22(1)(a)(ii)
Director, North WA Assessments Section
s. 22(1)(a)(ii) @dcceew.gov.au (cc northwa.section@dcceew.gov.au)

Following the consultation period, the Minister, or a delegate of the Minister, will consider all relevant information and reconsider the original decision under section 78C(1). This will result in a decision either to confirm the original decision, or to revoke the original decision and substitute it with a new decision.

If you have any questions about the reconsideration request or the assessment please contact s. 22(1)(a)(ii), by email to s. 22(1)(a)(ii)@dcceew.gov.au (cc'ing NorthWA.Section@dcceew.gov.au). Please quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

Kylie Calhoun
Branch Head
Environment Assessments West

19 June 2026

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Australian Government
Department of Climate Change, Energy, the Environment and Water

EPBC 2018/8319

The Hon. Chris Bowen MP
Minister for Climate Change and Energy
Parliament House
CANBERRA ACT 2600

Invitation to provide information on reconsideration request – Browse to North West Shelf Development, Indian Ocean, WA (proposed action)

Dear Minister

I am writing to you in relation to the above proposed action.

On 22 February 2019, a delegate of the then Minister for the Environment and Water (the Minister), decided, under section 75(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), that the proposed action is a controlled action and the controlling provisions are:

- National Heritage places (section 15B & section 15C)
- Listed threatened species and ecological communities (section 18 & section 18A)
- Listed migratory species (section 20 & section 20A)
- Commonwealth marine areas (section 23 & section 24A)

(the original decision).

On 18 February 2026, the Minister received a request under section 78A of the EPBC Act to reconsider the original decision on the basis of the matter referred to in section 78(1)(a) of the EPBC Act.

The request and associated documents are available via the department's EPBC Act Public Portal webpage: https://epbcpublicportal.environment.gov.au/open-for-comments/ (using EPBC reference 2018/8319).

The request was submitted under section 78A of the EPBC Act on the basis of substantial new information about the impacts that the proposed action has or will have, or is likely to have, on a matter protected by a provision of Part 3, as prescribed under section 78(1)(a) of the EPBC Act.

As you have administrative responsibilities relating to the proposed action, I invite you under section 78B(4)(b) of the EPBC Act to provide, within 20 business days of the date of this letter, information about whether a matter referred to in any of sections 78(1)(a) to (ca) of the EPBC Act is applicable in relation to the proposed action. If you would like to see those matters, the current

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version of the EPBC Act can be accessed via the department's website: https://www.dcceew.gov.au/environment/epbc.

Please provide the information using the following contact details:

By email:
s. 22(1)(a)(ii)
Director, North WA Assessments Section
s. 22(1)(a)(ii) @dcceew.gov.au (cc northwa.section@dcceew.gov.au)

Following the consultation period, the Minister, or a delegate of the Minister, will consider all relevant information and reconsider the original decision under section 78C(1). This will result in a decision either to confirm the original decision, or to revoke the original decision and substitute it with a new decision.

If you have any questions about the reconsideration request or the assessment please contact s. 22(1)(a)(ii) by email to s. 22(1)(a)(ii) @dcceew.gov.au (cc'ing NorthWA.Section@dcceew.gov.au). Please quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely



Kylie Calhoun
Branch Head
Environment Assessments West

19 June 2026

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Australian Government
Department of Climate Change, Energy, the Environment and Water

EPBC 2018/8319

The Hon Madeleine King MP
Minister for Resources and
Minister for Northern Australia
Parliament House
CANBERRA ACT 2600

Invitation to provide information on reconsideration request – Browse to North West Shelf Development, Indian Ocean, WA (proposed action)

Dear Minister

I am writing to you in relation to the above proposed action.

On 22 February 2019, a delegate of the then Minister for the Environment and Water (the Minister), decided, under section 75(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), that the proposed action is a controlled action and the controlling provisions are:

- National Heritage places (section 15B & section 15C)
- Listed threatened species and ecological communities (section 18 & section 18A)
- Listed migratory species (section 20 & section 20A)
- Commonwealth marine areas (section 23 & section 24A)

(the original decision).

On 18 February 2026, the Minister received a request under section 78A of the EPBC Act to reconsider the original decision on the basis of the matter referred to in section 78(1)(a) of the EPBC Act.

The request and associated documents are available via the department's EPBC Act Public Portal webpage: https://epbcpublicportal.environment.gov.au/open-for-comments/ (using EPBC reference 2018/8319).

The request was submitted under section 78A of the EPBC Act on the basis of substantial new information about the impacts that the proposed action has or will have, or is likely to have, on a matter protected by a provision of Part 3, as prescribed under section 78(1)(a) of the EPBC Act.

As you have administrative responsibilities relating to the proposed action, I invite you under section 78B(4)(b) of the EPBC Act to provide, within 20 business days of the date of this letter, information about whether a matter referred to in any of sections 78(1)(a) to (ca) of the EPBC Act is

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applicable in relation to the proposed action. If you would like to see those matters, the current version of the EPBC Act can be accessed via the department's website: https://www.dcceew.gov.au/environment/epbc.

Please provide the information using the following contact details:

By email:
s. 22(1)(a)(ii)
Director, North WA Assessments Section
s. 22(1)(a)(ii) @dcceew.gov.au (cc northwa.section@dcceew.gov.au)

Following the consultation period, the Minister, or a delegate of the Minister, will consider all relevant information and reconsider the original decision under section 78C(1). This will result in a decision either to confirm the original decision, or to revoke the original decision and substitute it with a new decision.

If you have any questions about the reconsideration request or the assessment please contact s. 22(1)(a)(ii) by email to s. 22(1)(a)(ii) @dcceew.gov.au (cc'ing NorthWA.Section@dcceew.gov.au). Please quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely



Kylie Calhoun
Branch Head
Environment Assessments West

19 June 2026

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Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC 2018/8319

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Senator the Hon Malarndirri McCarthy
Minister for Indigenous Australians
Parliament House
CANBERRA ACT 2600

Invitation to provide information on reconsideration request – Browse to North West Shelf Development, Indian Ocean, WA (proposed action)

Dear Minister

I am writing to you in relation to the above proposed action.

On 22 February 2019, a delegate of the then Minister for the Environment and Water (the Minister), decided, under section 75(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), that the proposed action is a controlled action and the controlling provisions are:

- National Heritage places (section 15B & section 15C)
- Listed threatened species and ecological communities (section 18 & section 18A)
- Listed migratory species (section 20 & section 20A)
- Commonwealth marine areas (section 23 & section 24A)

(the original decision).

On 18 February 2026, the Minister received a request under section 78A of the EPBC Act to reconsider the original decision on the basis of the matter referred to in section 78(1)(a) of the EPBC Act.

The request and associated documents are available via the department's EPBC Act Public Portal webpage: https://epbcpublicportal.environment.gov.au/open-for-comments/ (using EPBC reference 2018/8319).

The request was submitted under section 78A of the EPBC Act on the basis of substantial new information about the impacts that the proposed action has or will have, or is likely to have, on a matter protected by a provision of Part 3, as prescribed under section 78(1)(a) of the EPBC Act.

As you have administrative responsibilities relating to the proposed action, I invite you under section 78B(4)(b) of the EPBC Act to provide, within 20 business days of the date of this letter, information about whether a matter referred to in any of sections 78(1)(a) to (ca) of the EPBC Act is applicable in relation to the proposed action. If you would like to see those matters, the current

version of the EPBC Act can be accessed via the department's website: https://www.dcceew.gov.au/environment/epbc.

Please provide the information using the following contact details:

By email:
s. 22(1)(a)(ii)
Director, North WA Assessments Section
s. 22(1)(a)(ii) @dcceew.gov.au (cc northwa.section@dcceew.gov.au)

Following the consultation period, the Minister, or a delegate of the Minister, will consider all relevant information and reconsider the original decision under section 78C(1). This will result in a decision either to confirm the original decision, or to revoke the original decision and substitute it with a new decision.

If you have any questions about the reconsideration request or the assessment please contact s. 22(1)(a)(ii) by email to s. 22(1)(a)(ii) @dcceew.gov.au (cc'ing NorthWA.Section@dcceew.gov.au). Please quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely



Kylie Calhoun
Branch Head
Environment Assessments West

19 June 2026

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Australian Government
Department of Climate Change, Energy, the Environment and Water

Opportunity for Public Comment

Browse to North West Shelf Development, Indian Ocean, WA (EPBC ref 2018/8319)

Request for a reconsideration of the decision under section 78 of the *Environment Protection and Biodiversity Conservation Act 1999*

Interested members of the public are invited to comment on a request for a reconsideration of the decision made section 75(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (**the EPBC Act**) for the proposed action – to develop and extract hydrocarbons from the Brecknock, Calliance and Torosa reservoirs; install and operate two floating production storage and offloading (FPSO) facilities without the TRE well centre infrastructure, all approximately 425 km north of Broome; and install and transport hydrocarbons from the FPSO facilities via a 900 km trunkline to existing pipeline infrastructure near North Rankin Platform, 120 km northwest of Karratha [see EPBC Act referral 2018/8319 and variation requests dated 7 July 2022 and 23 May 2025].

The Minister for the Environment and Water has received a request under section 78A of the EPBC Act to reconsider the controlled action decision made under section 75(1) for the proposed action, on the basis of the matter referred to in section 78(1)(a). The request and its attachments are available via the department's EPBC Act Public Portal webpage: https://epbcpublicportal.environment.gov.au/open-for-comments/ using EPBC reference 2018/8319.

Members of the public are invited under section 78B(6) of the EPBC Act to provide comments in writing on this request, including whether a matter referred to in any of sections 78(1)(a) to (ca) is applicable in relation to the proposed action. To see those matters, the current version of the EPBC Act can be found on the department's website: https://www.dcceew.gov.au/environment/epbc.

Submissions must be received no later than **20 business days from the date this notice was published**.

Please provide your comments by searching for and selecting EPBC Number 2018/8319 through the 'Open for comments' tab of the department's EPBC Act Public Portal webpages at: https://epbcpublicportal.environment.gov.au/open-for-comments/ and clicking 'Make Comment'.

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Australian Government
Department of the Environment and Energy

Notification of
REFERRAL DECISION AND DESIGNATED PROPONENT – controlled action
DECISION ON ASSESSMENT APPROACH – environmental impact statement

Browse to North West Shelf Development, Indian Ocean, WA [EPBC 2018/8319]

This decision is made under section 75 and section 87 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

proposed action	To: develop and extract hydrocarbons from the Brecknock, Calliance and Torosa reservoirs; install and operate two floating production storage and offloading (FPSO) facilities, all approximately 425 km north of Broome; and install and transport hydrocarbons from the FPSO facilities via a 900 km trunkline to existing pipeline infrastructure near North Rankin Platform, 120 km northwest of Karratha [see EPBC Act referral 2018/8319].
decision on proposed action	The proposed action is a controlled action. The project will require assessment and approval under the EPBC Act before it can proceed.
relevant controlling provisions	• National heritage values of a National Heritage place (sections (s15B & s15C) • Listed threatened species and communities (sections 18 & 18A) • Listed migratory species (sections 20 & 20A) • Commonwealth marine area, the protected matter being the environment generally (sections 23 & 24A)
designated proponent	Woodside Energy Ltd ACN 005 482 986
assessment approach	The project will be assessed by environmental impact statement.
Decision-maker	
Name and position	Declan O'Connor-Cox Acting Assistant Secretary Assessments (WA, SA, NT) and Post Approvals Branch
Signature	
date of decision	22/02/2019

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DEPARTMENT OF THE ENVIRONMENT AND ENERGY

To: Declan O'Connor-Cox, Acting Assistant Secretary, Assessments (WA, SA, NT) and Post Approvals Branch (for decision)

Referral Decision Brief – Browse to North West Shelf Development, Indian Ocean, Western Australia (EPBC 2018/8319)

Timing: As soon as possible - statutory timeframe expired 13 December 2018

Recommended Decision	**NCA** ☐ **NCA(pm)** ☐ **CA** ☒
Designated Proponent	Woodside Energy Ltd ACN 005 482 986
Controlling Provisions triggered or matters protected by particular manner	World Heritage (s12 & s15A) Yes ☐ No ☒ No if PM ☐ National Heritage (s15B & s15C) Yes ☒ No ☐ No if PM ☐ Ramsar wetland (s16 & s17B) Yes ☐ No ☒ No if PM ☐ Threatened Species & Communities (s18 & s18A) Yes ☒ No ☐ No if PM ☐ Migratory Species (s20 & s20A) Yes ☒ No ☐ No if PM ☐ C'wealth marine (s23 & s24A) Yes ☒ No ☐ No if PM ☐ Nuclear actions (s21 & 22A) Yes ☐ No ☒ No if PM ☐ C'wealth land (s26 & s27A) Yes ☐ No ☒ No if PM ☐ C'wealth actions (s28) Yes ☐ No ☒ No if PM ☐ GBRMP (s24B & s24C) Yes ☐ No ☒ No if PM ☐ A water resource – large coal mines and CSG (s24D & s24E) Yes ☐ No ☒ No if PM ☐ C'wealth heritage o/s (s27B & s27C) Yes ☐ No ☒ No if PM ☐
Public Comments	Yes ☐ No ☒
Ministerial Comments	Yes ☒ No ☐ Who: WA Department of Water and Environmental Regulation (DWER), Department of Industry, Innovation and Science (including Geoscience Australia), Austrade, Attorney-General. See Attachments C1–C4.
Assessment Approach Decision	Yes ☒ No ☐ What: Environmental Impact Statement Bilateral Applies ☐

Recommendation/s:

1. Consider the information in this brief, the referral (Attachment D) and other attachments.

Considered / Please discuss

2. Agree with the recommended decision.

Agreed / Not agreed

3. Agree to the designated proponent.

Agreed / Not agreed

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4. Agree the action be assessed by Environmental Impact Statement.

Agreed / Not agreed

5. If you agree to 2 and 4, indicate that you accept the reasoning in the Departmental briefing package as the basis for your decision, including: that you accept the referral is part of a larger action identified by the proponent as its 'Burrup Hub project'; and, you have decided not to reject the referral.

Accepted / Please discuss

6. Agree to the fee schedule and justifications (Attachment F1), and that the fee schedule without justifications (Attachment F2) be sent to the proponent.

Agreed / Not agreed

7. If you agree to 4 and 6, note that an invoice will be provided to the person proposing to take the action for Stage 1 of the assessment, for the preparation of the EIS Guidelines.

Noted / Please discuss

8. Sign the notice at Attachment A, which will be published if you make the recommended decision.

Signed / Not signed

9. Sign the letters at Attachments B1-B4, which will be sent if you make the recommended decision.

Signed / Not signed

10. If you agree to 2 and 4, agree that the work order in Attachment G accurately reflects the work required to be undertaken by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Agreed / Not agreed

11. If you agree to 10, note that your approval in the Department's Procure to Pay system will be required before the Department can send the work order in Attachment G to NOPSEMA, and thereby enter into the contract.

Noted / Please discuss

Declan O'Connor-Cox
Acting Assistant Secretary
Assessments (WA, SA, NT) and Post Approvals Branch

Date: 22 February 2019

Comments:

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BACKGROUND

Description of the referral

A referral was received on 15 November 2018. The action was referred by Woodside Energy Limited (ACN 005 482 986) (proponent), on behalf of the Browse Joint Venture (BJV). The BJV comprises the following parties:

- Woodside Browse Pty Limited (ACN 120 237 381);
- Shell Australia Pty Limited (ACN 009 663 576);
- BP Developments Australia Pty Limited (ACN 081 102 856);
- Japan Australia LNG (MIMI Browse) Pty Limited (ACN 157 922 211);
- PetroChina International Investment (Australia) Pty Limited (ACN 152 953 529).

The proponent has stated its belief that the proposal is not a controlled action for the purposes of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), except in relation to the environment in the Commonwealth marine area (section 5.1.6 of Attachment D1).

Description of the proposal (including location)

The proponent proposes to develop the Brecknock, Calliance and Torosa reservoirs, located approximately 425 km north of Broome, and approximately 260 km off the Kimberley coastline (Attachment D). The hydrocarbon resources in these reservoirs is predominately gas, with contingent resources of 13.9 trillion cubic feet of dry gas, and approximately 390 million barrels of condensate (Attachment D2). The end date for the activity proposed by the proponent is October 2068 (Attachment D1). The proposed action involves the following (Attachment D2):

In the 'Browse Development Area'

- Installation and operation of two floating production storage and offloading (FPSO) facilities, one at Torosa and one at Calliance/Brecknock, each with up to 1100 million cubic feet per day export capacity.
- Drilling up to 49 wells over field life, and extraction of fluids from each well.
- Installation and management of subsea infrastructure connecting the wells to the FPSO facilities.
- Laying and utilising approximately 85 km of 36" inter-field spur line to connect the Torosa FPSO facility to the 42" trunkline near the Calliance/Brecknock FPSO.
- Decommissioning at end of life, including well suspension and plug and abandoning wells.

The 'trunkline'

- Laying and utilising (to transport fluids) approximately 900 km of 42" carbon steel trunkline from the Calliance/Brecknock FPSO facility to the tie-in at North Rankin (Trunkline Area), approximately 135 km north-north-west of Dampier.

Related activities that are components of the proposed action

- Approximately 12-24 tanker movements per year per FPSO to transport condensate produced.
- Up to two personnel transfers by helicopter a week per FPSO facility during normal operations, to two or three flights or equivalent vessel transfers per day per FPSO at times

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of high activity (e.g. crew changes, shutdowns, major maintenance). The proponent has not specified which mainland airports will be used.

Maps of the proposed action area are provided in Figures 1 and 2 of Attachment D2. The 'proposed action area' includes all areas where the proposed action will occur. Where it makes sense to do so, the brief also uses the labels Browse Development Area and Trunkline Area to refer to those discreet areas within the proposed action area.

Four related proposals (not part of the proposed action)

From the tie-in at North Rankin, the gas will be transported through existing infrastructure owned by a separate Woodside joint venture, the North West Shelf Joint Venture (NWS JV), to the Karratha Gas Plant (KGP) on the Burrup Peninsula, WA, for processing. The KGP is currently approved for operation until 2030.

1. The Department has received a separate referral from the proponent on behalf of the NWS JV (EPBC 2018/8335; North West Shelf Project Extension, Carnarvon Basin, WA) in relation to the extension of life of the KGP until 2070 to accommodate the expected 50 years of production from the Torosa, Brecknock and Calliance development.

As part of the Burrup Hub Vision, Woodside also proposes to develop the Scarborough gas reservoir using new offshore facilities connected to an expansion of the existing Pluto LNG facility.

The offshore Scarborough development occurs in Commonwealth waters and includes up to 12 subsea wells feeding to a semi-submergible floating production unit. A 430 km pipeline line will transport the dry gas to shore, to the Pluto LNG facility.

2. The proponent has advised informally that they expect the activities included in the 'offshore component' of the Scarborough development to be submitted as an Offshore Project Proposal to the National Offshore Petroleum and Safety Management Authority (NOPSEMA) in early 2019.
3. The Department has received a separate referral from the proponent on behalf another joint venture partnership with BHP Billiton Petroleum (North West Shelf) Pty Ltd (BHP) (EPBC 2018/8362; Scarborough Development nearshore component) to duplicate and operate a gas pipeline from the limit of State (WA) Waters to the Pluto LNG facility, also on the Burrup Peninsula, WA.

You should note that the expansion of the existing Pluto LNG facility has already been provided for in the EPBC Act approval of the development on two sites (EPBC 2006/2968; the Consolidated Approval Notice for this development is at Attachment E35), only one of which has been developed and is operating to date.

The nearshore component of the Scarborough development (EPBC 2018/8362) occurs wholly in State Waters. It includes the construction and laying of a section of pipeline and a shore crossing site to create connection at the Pluto LNG facility. Approximately 32.7 km of the 430 km pipeline will occur in State Waters.

The installation of the whole of the pipeline, including dredging and disposal of spoil, will be considered as part of the application for a permit under the *Environment Protection (Sea Dumping) Act 1981* (Cth).

The Department considers that accepting a split referral which breaks the two components of the Scarborough development component at the Commonwealth/ State waters boundary may create a public perception that the impact of the whole of the pipeline installation is not being considered in its entirety.

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The Department notes that the impacts from the pipeline installation in State waters, including increases in turbidity and sedimentation plumes in State and Commonwealth waters, will be considered separately from similar environmental impacts that may occur in State and Commonwealth waters from pipeline construction in Commonwealth waters. Impacts from both components of the one action will be assessed. The Department considers that the split nature of the referral at the jurisdictional boundary will not affect the assessment of the possible significant impacts of the proposal as a whole.

4. A contractor under contract with the proponent has proposed the construction of a pipeline to connect the KGP and the Pluto LNG facility (EPBC 2018/8353).

Taken together, this brief refers to the five related projects–the four outlined in this section plus the proposed action discussed in this brief–as the 'Burrup Hub project'.

The Department has given particular consideration to the split referral question in relation to the assessment of the impacts of greenhouse gas (GHG) emissions from the Burrup Hub Project as a whole. There is additional discussion in support of accepting (that is, of not refusing to accept) the split referral in the section headed Contribution of proposed action to climate change.

Under s.74A of the EPBC Act, the Minister (and you as a delegate) have a discretion to refuse to accept a 'split referral'. The Department's *Policy Statement: Staged Developments—Split referrals: Section 74A of the EPBC Act* provides guidance on such decisions (Attachment E33).

The proponent acknowledges the four separate referrals and the Scarborough offshore component that will be submitted to NOPSEMA are in effect a split referral. They argue the separate referrals should be accepted so they can structure the separate individual projects according to specific commercial requirements. While each will be operated by the proponent, each project is owned by different sets of joint venture partners. Having regard to the proponent's:

- efforts to publicise their approach on their 'Burrup Hub' project (Attachment E5); and
- commitment to account for all relevant impacts of each action, and ensure each impact can be considered in a timely, effective and efficient manner,

the Department considers there has been an opportunity for the public to consider all components of the Burrup Hub project, at this referral stage, in its entirety. The Department can and will ensure through this referral and any subsequent assessment and approval process that the objects of the EPBC Act are not frustrated by the separate submission of the Burrup Hub project referrals.

Description of the environment

The proposed action area is in the North-West Marine Region, and traverses the Timor Province Bioregion, North-West Transition Bioregion and the North-West Shelf Province Bioregion (Figure 10 of Attachment D2). The FPSOs and subsea infrastructure are proposed to lie on the Ashmore Terrace within the Timor Province Bioregion (Attachment D2). This region is shallow, with water depths less than 500 m over more than 50 per cent of the area. The continental shelf is located in the northern-most part of the bioregion, and is a unique feature that comprises a number of coral reefs, including Ashmore, Cartier, Scott and Seringapatam Reefs (Attachment E1). The majority of the Trunkline Area runs through the North-West Bioregion, along the south-eastern boundary at depths of between 280 m and 400 m, before turning towards the mainland and the North Rankin tie-in at a depth of approximately 125 m (Attachment D2).

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Scott Reef comprises two emergent shelf atolls separated by a deep channel (Figure 1; Attachment E2). North Scott Reef is an annular reef, approximately 17 km long and 16 km wide, and encloses a shallow lagoon approximately 20 m deep. South Scott Reef is a crescent shaped reef, approximately 20 km wide, with a lagoon 20-70 m deep. The Torosa FPSO is proposed to be located approximately 8 km to the east of Scott Reef, and infrastructure is proposed to lie in the channel between North and South Scott Reef (Attachment D2). The Brecknock/Calliance FPSO will be approximately 40 km to the south-south-west of Scott Reef.

Seringapatam Reef is a shelf atoll located approximately 23 km north of Scott Reef. Scott and Seringapatam Reefs are located in the south-west corner of the Australia-Indonesia MoU Box (1974) (Attachment E3; in the attachment, the Australia-Indonesia MoU Box is depicted as 'An area permitted to traditional Indonesian fishermen').

A large proportion of the Torosa reservoir lies under Scott Reef which is part of Western Australia. State waters extend three nautical miles (approximately 5.5 km) around Scott Reef (Figure 1 of Attachment D2). Up to an estimated 21 of the production wells will be located within State waters (Attachment D2).

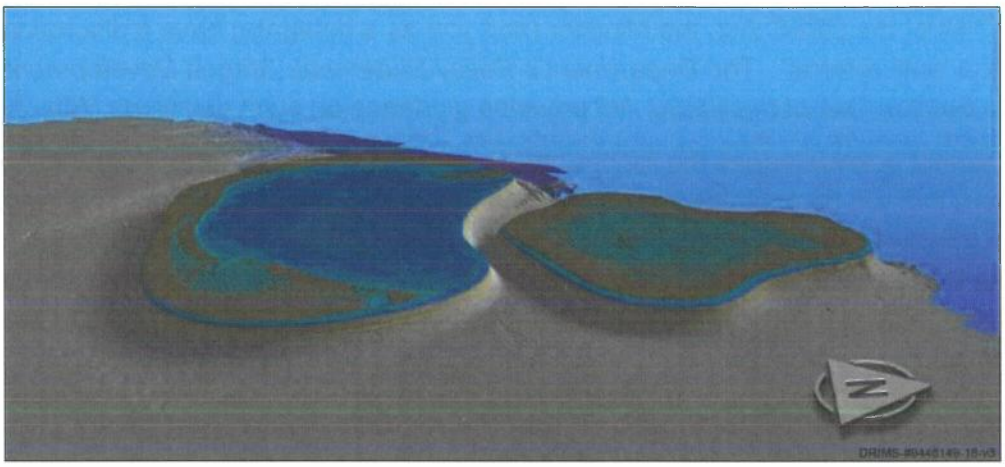


Figure 1: Three-dimensional merged bathymetric data set for Scott Reef, illustrating North and South Scott Reef separated by a deep channel

The Rowley Shoals are a series of three isolated, reef-rimmed platforms (Mermaid, Clerke, and Imperieuse Reefs) along a north-south orientation that rise vertically to the surface from water depths of about 400 m (Attachment E1). The Trunkline Area is expected to pass close to the Rowley Shoals: approximately 23 km from Mermaid Reef, 24 km from Clerke Reef, and 11 km from Imperieuse Reef (Attachment D2).

The proposed action area intersects or is within 100 km of the following Key Ecological Features of the North-West Marine Bioregion:

- Seringapatam Reef and Commonwealth waters in the Scott Reef Complex;
- Continental Slope Demersal Fish Communities;
- Mermaid Reef and Commonwealth waters surrounding Rowley Shoals;
- Ancient coastline at 125 m depth contour;
- Glomar Shoals.

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KEY ISSUES

- Interference with listed threatened and migratory species, including biologically important activities of cetaceans, turtles and birds, as a result of noise, light, discharges to the environment, vessel and helicopter movements and infrastructure installation, operation and presence.
- Risk of hydrocarbon spill, and consequent impacts on listed threatened and migratory species, and the marine environment.
- Contribution of the proposed action to climate change, with consequent impacts on listed threatened and migratory species, and the environment generally.

RECOMMENDED DECISION

Under section 75 of the EPBC Act you must decide whether the action that is the subject of the proposal referred is a controlled action, and which provisions of Part 3 (if any) are controlling provisions for the action. In making your decision you must consider all adverse impacts the action has, will have, or is likely to have, on the matter protected by each provision of Part 3. You must not consider any beneficial impacts the action has, will have or is likely to have on the matter protected by each provision of Part 3.

The Department recommends that you decide that the proposal is a controlled action, because there are likely to be significant impacts on the following controlling provisions:

- National heritage values of a National Heritage place (section s15B & section 15C);
- Listed threatened species and communities (section 18 & section 18A);
- Listed migratory species (section 20 & section 20A);
- Commonwealth marine area, the protected matter being the environment generally (section 23 & section 24A).

As the proposed action will be taken *in* a Commonwealth marine area, the protected matter for the purposes of the controlling provisions in section 23 and 24A is the environment generally (see s 23(1) and ss 24A(1) and (2) of the EPBC Act). The 'environment' is defined in section 528 to relevantly include 'ecosystems and their constituent parts', 'natural and physical resources', 'the qualities and characteristics of locations, places and areas' (which would include the atmosphere) and heritage values of places.

These impacts are discussed respectively below.

Listed threatened species and communities

Migratory species

The environment generally

The Department's Environment Reporting Tool (ERT) Report dated 14 January 2019 (Attachments E4) indicate that listed threatened, migratory and marine species (or their habitat) are known or likely to occur in or within 20 km of the proposed action.

The EPBC Species and Ecological Communities Update dated 14 January 2019 (Attachment E6) has been reviewed to check for recent or upcoming decisions relating to listed species and communities, approved conservation advices, recovery plans, or threat abatement plans that may be of relevance to the proposal. There are no relevant changes.

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Based on the location of the proposed action, likely habitat present at the site, and scope of the proposed action, the Department considers that impacts potentially arise in relation to species, including birds, cetaceans, fish and turtles that are listed as threatened, migratory and/or marine, and that are part of the marine environment, as a result of the following activities associated with the proposal:

- Acoustic disturbance;
- Light emissions;
- Discharges to the sea;
- Vessel and helicopter use;
- Installation and management of seafloor infrastructure;
- Subsidence;
- Potential for significant hydrocarbon spill;
- Contribution of proposed action to climate change.

The listed threatened and migratory species at most risk of significant impact as a result of the proposed action are listed in Attachment E7, and the impacts on them are discussed below.

Acoustic disturbance

Proposed action

The proposed action will generate noise as a result of the following:

- Drilling and completion and installation activities:
    - Mobile Offshore Drilling Units (MODUs) – Noise associated with a moored MODU is likely to be 100-190 dB re 1 µPa at 1 m during drilling and 85-135 dB re 1 µPa at 1 m when not actively drilling (Attachment D2).
    - Vertical Seismic Profiling (VSP) – VSP utilises a sound source suspended deep in the water column and recorders located down hole to provide a high-resolution seismic image of the immediate vicinity of the well. VSP will be undertaken by up to three 250 cu.in airguns discharging in a pattern of five bursts in quick succession with 20 second gaps. VSP would typically be undertaken for approximately 2 to 6 hours per well, however it is dependent on well design and the open hole length, and an upper limit of 10 hours per well has been included in the referral (Attachment D2; Attachment E8). Sound levels will be approximately 238 dB re 1 µPa at 1 m, with dominant frequencies less than 200 Hz (Attachment D2).
    - Mooring installation – The MODU is most likely to use anchor moorings at most drill centre locations. However, piling may be required. Suction piling is the preferred option for piling, and the proponent considers this is likely to be feasible (Attachment D2). Suction piling produces low levels of noise emitted from the pump. If driven piles are required, significant levels of underwater noise will be generated. Predicted sound levels range from 200 to 250 dB re 1 µPa at 1 m for a broad range of piles up to 5 m in diameter, with most energy occurring at frequencies below 2 kHz (Attachment D2). The proponent expects that, if pile driving is required, one pile would be installed at a time, at a rate of approximately one pile per day, with active driving time for each pile expected to take between one and six hours within a 24-hour period (Attachment D2). If piling is required to secure the MODUs, 8–12 piles would be installed per MODU (Attachment E8).

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- Seabed preparation – Noise generated through direct interaction with the seabed is likely to be a mixture of broadband noise and tones, with noise levels dependent on the physical properties of the seabed (Attachment D2). The proponent advises that trenching noise has been measured at 178 dB re 1 µPa at 1 m, while measurement of rock placement using a fall pipe in 60 to 80 m water depth found noise levels generated to be below ambient (Attachment D2).
- Vessel movements – The main source of noise from support vessels, both platform support and subsea support vessels, relates to the use of thrusters. Thruster noise is typically high intensity and broadband in nature, and the proponent expects that noise levels up to 182 dB re 1 µPa at 1 m could be generated by vessels using thrusters (Attachment D2).
- Inspection, Maintenance and Repair (IMR) – Acoustic survey may be undertaken as part of IMR activities, including Side Scan Sonar (SSS) and Multi-Beam Echo Sounders (MBES). However, the proponent advises that these methods are typically used infrequently and are not constantly active during these infrequent IMR activities (Attachment D2).
- Helicopter movements – Noise associated with helicopter movements will be emitted to the atmosphere during all phases of the proposed development. The proponent advises that expected noise levels from routine helicopter use may be in the vicinity of 90.6 dB at 150 m, with no detectable noise at 4.6 km (Attachment D2), but has not indicated the noise levels expected to be generated underwater as a result of helicopter use. The Department notes received levels of sound have been recorded from helicopter use of up to 111 dB re 1 µPa at 9 m depth directly under a helicopter flying at 305 m altitude, and the same level at a lateral distance of 50 m from a different model flying at 152 m altitude (Attachment E9).

- Commissioning and operational activities:
  - FPSO facilities – During normal operations, underwater noise generated by each FPSO facility is expected to be dominated by the noise and vibration generated by on-board machinery within the hull and topsides process equipment, with the highest level of noise predicted to be generated during offloading condensate (Attachment D2). This is expected to occur 12-24 times a year per FPSO. Noise levels during these periods could be 188 dB re 1 µPa at 1 m at frequencies between 20 and 2500 Hz (Attachment D2).
  - Wells – Noise generated at subsea wellheads is due to the pressure difference between the input and the output pressure of the choke valve and the reservoir fluids flowing through the wellhead (Attachment D2). The potential pressure difference, and therefore the potential noise level, is highest early in reservoir life and will diminish with time (Attachment D2). The noise level, and frequency of noise emitted- at choke valves is not specified in the referral. The proponent has subsequently noted that, in an assessment of the earlier Browse Floating Liquefied Natural Gas proposal (EPBC 2013/7079), modelling was presented based on measured noise levels from the Cossack Pioneer FPSO (Attachment E8). The modelling indicates that noise will: be approximately 159 dB re 1 µPa at 1 m; be less than 120 dB re 1 µPa at 500 m from the wellheads; and is not expected to propagate more than 1 km under optimal conditions. It was noted that the operating state of the Cossack Pioneer FPSO wellhead was not known at the time of measurement.

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- Installation of the trunkline: Noise emissions associated with works to install the 900 km trunkline do not appear to have been considered. The Department notes that installation works will involve the following activities, which are likely to have noise implications:
    - Vessel use;
    - On-vessel welding of sections of pipe;
    - Use of a crane to lower pipe to place directly onto seafloor;
    - Installation of up to 20 piles to secure the riser bases.

Potential impacts

Numerous marine animal species, from small invertebrates to large cetaceans, make extensive use of underwater sounds for important biological activities, including intraspecific communication, predator avoidance, navigation, larval orientation, foraging and reproduction (Attachment E10). Anthropogenic noise pollution in the aquatic environment interferes with the ability of marine animals to utilise their usual auditory and acoustic processes.

Low pressure frequencies are within the detectable hearing range of most fish and cetacean species, and is physiologically detected by cephalopod (e.g. squid, octopus, cuttlefish) and decapod (crayfish, crab, lobster, prawn) species (Attachment E10).

Many species have been shown to be affected physically (even mortally) by pressure waves emitted close to their location (Attachments E10 and E11):

- Physiological damage to hearing systems, such as irreversible damage to cochlear cells;
- Auditory masking constraining communication and reducing auditory sensitivity;
- Statocyst and organ damage, including lesions, hair cell loss and damage, and neuron swelling, in cephalopods;
- Noise exposure during larval development can result in body malformations in scallops;
- Physiological stress responses, such as increased metabolism, decreased immunity, increased nervous activity, and release of neurotransmitters and stress hormones.

Prolonged exposure to pulses of sound, such as during seismic surveys and pile driving activities, increases the effects of pulsed noise over time. Both pulsed and continuous noise can result in affected species avoiding an impacted area, or continuing to occupy it (such as to feed) for periods that could cause physical impacts.

Impacts from noise vary between species, and different species are susceptible to impacts at different frequencies and intensities. For example, gas bladders, and their anatomical location within the body, makes fish more susceptible to pressure-mediated injury to the ears and general body tissue than species lacking gas bladders (Attachment E10). Larger fish are more likely to be injured than smaller fish, presumably due to the difference in swim bladder resonance (Attachment E10). Baleen whales are more susceptible to impacts from low frequency sounds (below 100 Hz), while Bottlenose Dolphins (*Tursiops truncatus*) are vulnerable to high frequency sounds (especially above 50 kHz) (Attachment E9). Cetaceans experience permanent impacts to hearing at lower intensity levels than pinnipeds (Attachment E9).

If you agree with the recommendations in this brief, the Department will specify via the EIS Guidelines that information be included in the assessment documentation sufficient to ensure the public can understand clearly, by species (or grouping of species), the intensity and frequency ranges of sound to be emitted from the various noise sources, tabulated against hearing ranges and known (or, where there is uncertainty, likely) noise thresholds.

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As distance from the source increases, the sound level decreases (attenuates), and physical impacts are reduced. However, many marine species continue to exhibit behavioural impacts, such as startle and alarm responses, avoidance or attraction behaviours, and changes in schooling patterns, water column positions, and swimming speeds, as a result of sound waves emitted by seismic surveys conducted at distance from their location (Attachments E10 and E11). Physical impacts can include:

- Turtles can show a dive response;
- Crustaceans' predator-reaction time can increase;
- Whales have been observed to modify sound-producing behaviour, including courtship calls, and surfacing behaviour;
- Disruption in foraging behaviour, including exposure to harms that increase with the period of exposure;
- Emigration;
- Modified diving, which can induce gas-bubble lesions and fat embolisms in the vessels and parenchyma of vital organs, cause intolerable nitrogen supersaturation, and lead to death.

Mass stranding events of squid, turtles and cetaceans have also been linked to anthropogenic noise exposure (Attachment E11).

Avoidance and mitigation

The proponent has committed to the following avoidance and mitigation measures to address the impacts of underwater noise emissions:

- Suction piling will be selected as the preferred anchoring method where practicable;
- Support vessels and helicopters will operate in accordance with Part 8 of the *Environment Protection and Biodiversity Conservation Regulations 2000* (EPBC Regulations; Attachment E23) and the *Australian National Guidelines for Whale and Dolphin Watching 2017* (Attachment E12);
- Scheduled helicopter flight paths will avoid seabird roosting areas such as Sandy Islet;
- If VSP is conducted at a drill centre, pre-start marine fauna observations will be undertaken to ensure sensitive fauna are not in the vicinity, in accordance with *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* (Attachment E13; Seismic Guidelines);
- If impact piling is required for installation of moorings, noise management procedures will be developed and implemented, and detailed in the relevant EPs for submission and acceptance by NOPSEMA (the Department notes that, if impact piling is required in State waters, similar (or the same, complementary) plans can be required by the relevant State minister and the (federal) Minister);
- Preparation of a Cetacean Management Plan to minimise impacts associated with construction and operation.

The Department notes that the location(s) on the coast from/to which helicopters may come and go have not been specified. If you agree to the recommendations in this brief, this information will be sought via the EIS Guidelines.

The Department considers that the above measures are otherwise appropriate and will reduce potential impacts arising from noise emissions. However, the Department does not consider

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that these measures are sufficient to avoid significant impacts, and that additional mitigation measures may be available that the proponent does not appear to have considered. If you agree with the recommendations in this brief, the Department will seek additional information from the proponent via the EIS Guidelines regarding the avoidance and mitigation measures that could be undertaken to further reduce impacts from noise generation.

Potential impacts on matters of national environmental significance

There are fundamental knowledge gaps that limit understanding of the potential impacts of anthropogenic noise pollution on underwater species (Attachment E10). Despite this uncertainty, from the noise levels specified in the referral, and considering physical impact thresholds (where known, discussed below), it is clear that individuals of at least some marine species in the immediate vicinity of an acoustic source may be physically, even mortally, impacted. Individuals of marine species further away from the source may experience behavioural impacts (noting that some noise-induced behavioural changes can also result in lethal and sub-lethal impacts; see above examples). Physical and behavioural impacts can be reduced by mitigation measures such as soft start approaches, which can encourage mobile marine species to exit the area before harmful levels of sound are emitted, or the use of noise absorption systems such as air bubble curtains, hydro sound dampers, cofferdams, noise mitigation screens or BEKA shells (Attachment E9). However, the proponent has not indicated in its referral that any of these mitigation measures will be used, or that any have been considered (Attachment D).

While there remains scientific uncertainty regarding noise-level thresholds for impacts to marine fauna, Departmental policy recognises 160 dB re 1 µPa as a physical impact threshold for whales (Attachment E13). The Department considers that physical impacts to whales are likely to be experienced above this level; implicit in this is the understanding behavioural impacts are also likely below it. This is consistent with some other jurisdictions; for example, Germany has regulated that underwater sound levels must not exceed 160 dB re 1 µPa at 750 m, which would limit sound levels to 140 dB re 1 µPa at 8 km (Attachment E9). The thresholds for impacts to other marine species are likely to be different. There is insufficient evidence to be confident of such thresholds for many species, though the Department notes it is likely that the threshold for turtles is higher, likely to be around 178 dB re 1 µPa.

The Seismic Guidelines stipulate that all seismic survey proposals should have a shutdown zone around the sound source of 500 m and a precaution (otherwise known as low power) zone of 2 km. In other words, if a cetacean is detected within 500 m of the seismic source, the source must be shut down; if a cetacean is detected within the precaution zone, the seismic source must be reduced to low power. Where the proponent of a seismic survey proposal can demonstrate–through sound modelling or empirical measurements–that the received sound exposure level for each shot will not likely exceed 160dB re 1µPa2·s for 95 per cent of seismic shots at 1 km range, a precaution zone of 1 km around the sound source is recommended (Attachment E13). In the absence of such evidence, a precaution zone of 2 km is recommended. For this proposal, no location-specific real-time acoustic modelling or testing has been undertaken.

The proponent has indicated that it expects that noise generated during the construction phase will significantly exceed 160 dB re 1 µPa over prolonged periods as a result of several different activities, as outlined above (Attachment D2). The proponent has stated that sound levels up to 250 dB re 1 µPa at 1 m may be generated during construction (Attachment D2).

The Endangered, Migratory Pygmy Blue Whale (*Balaenoptera musculus brevicauda*) is known to forage in the proposed action area, especially around Scott Reef. Individuals generally

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migrate along the continental margin of the north-west shelf during their annual migration (Attachment E14). However, the Migratory Species Section advises that the importance to the Pygmy Blue Whale of the waters around Scott Reef and the broader area is unclear, and spatial information regarding their presence in this area is required, including regarding the number of individuals likely to utilise the impacted area, and the nature of the habitat use (e.g. whether it is used for breeding as well as foraging and migration) (Attachment E14).

The Trunkline Area and the expected route for vessel movements between Scott Reef and towns along the WA coast each intersect the annual migration route of the Vulnerable, Migratory Humpback Whale (*Megoptera novaeangliae*). The Migratory Species Section advises that updated mapping describing this habitat use should be provided (Attachment E14).
As stated above, the proponent does not appear to have considered the noise that will be generated during the installation of the trunkline. If you agree to the recommendations in this brief, both matters will be addressed by seeking clarifications in assessment documents via the EIS Guidelines.

The ERT Reports dated 14 January 2019 also identifies Vulnerable, Migratory Sei and Fin Whales (*Balaenoptera borealis* and *Balaenoptera physalus* respectively) as likely to forage, and Migratory Bryde's Whales (*Balaenoptera edeni*) as likely to occur, in or within 20 km of the proposed action area (Attachments E4 and E5).

Anthropogenic noise resulting from industrial, shipping and aircraft operations is a key threat to Pygmy Blue and Humpback whales (Attachments E15 and E16). The Migratory Species Section considers that the proponent has not adequately considered sound thresholds and potential impacts to cetacean physiology and behaviour, and that further information is required to be provided by the proponent regarding whale usage of the impacted area, predicted noise levels, shipping lanes, vessel numbers and aircraft movements (Attachment E14).

Sandy Islet, and the waters around Scott Reef, are biologically important areas for the Vulnerable, Migratory Hawksbill Turtle (*Eretmochelys imbricata*) and Green Turtle (*Chelonia mydas*), both of which are known to nest and inter-nest in these areas (Attachment E14). Vulnerable, Migratory Flatback Turtles (*Natator depressus*) are also known to occur in these waters, and the other three listed Endangered, Migratory marine turtles, Loggerhead Turtle (*Caretta caretta*), Leatherback Turtle (*Dermochelys coriacea*) and Olive Ridley Turtle (*Lepidochelys olivacea*), are likely to occur (Attachment E14).

Green Turtles are distributed across nine genetically distinct stocks, each of which represents a unique evolutionary history (Attachment E17). Sandy Islet provides habitat critical to the survival for internesting and nesting Green Turtles from one of these stocks, which does not nest at any other location. If the genetic stock of Green Turtles that nest at Scott Reef – Browse Island is lost, it cannot be replaced (Attachment E14). The proponent has not addressed this issue, instead comparing the number of turtles likely to nest at Sandy Islet (population currently unknown) with that of other nesting locations in WA and finds that it is "not large" (Attachment D2). The Migratory Species Section advises that this comparison is irrelevant, as turtles nesting at other locations cannot replace the Scott Reef – Browse Island genetic stock if it is lost, and the fact that the population is likely to be small and geographically limited to nesting on Sandy Islet and Browse Island means that protection of these sites is imperative to ensure the genetic diversity of Green Turtles in Australia (Attachment E14).

Hawksbill Turtles utilising the proposed action area for nesting, internesting and foraging are likely to be part of the Western Australian Hawksbill stock, and are expected to represent only a small proportion of this stock (Attachment E14).

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Individual turtles in the vicinity of the construction work are likely to be impacted by the noise generated. With wells located in the Scott Reef Channel and one of the FPSOs proposed 8 km from Scott Reef, and the potential for the high levels of low to mid frequency noise close to Scott Reef could cause physical injury to marine turtles, and mortalities are possible. It is possible that a population-significant number of turtles may be impacted, especially as regards the Green Turtle population that nests at Sandy Islet. The Migratory Species Section advises that no assessment of sound levels (single and cumulative doses) has been included in the referral documentation, and potential impacts to marine turtle physiology and behaviour do not appear to have been considered (Attachment E14).

The Migratory Species Section advice (Attachment E14) does not expressly consider several additional listed threatened or migratory (or both) species identified in the ERT Reports dated 14 January 2019 (Attachments E4 and E5) as known or likely to occur within 5 km of the proposed action area. The species potentially impacted are listed in Attachment E7. The Department considers, given the above discussion, that individuals of these species near construction work may suffer physical impacts, including potential mortality. However, the Short-nosed Seasnake (*Aipysurus apraefrontalis*) is not likely to be impacted, as the only known population is located at Ashmore and Hibernia Reefs, 250 km to the north-north-east (Attachment E18). Also, the four fish species are not listed as threatened, only migratory, and no ecologically significant populations are known to occur in the vicinity of the proposed action area.

The Department considers that high levels of sound will be generated during installation of the trunkline. However, the expected level of noise is unknown and does not appear to have been considered by the proponent. The 900 km Trunkline Area lies approximately 9 km from the Mermaid Reef Marine Park, and through the Argo-Rowley Terrace Marine Park and Kimberley Marine Park (Figure 11 of Attachment D2). These areas are a migratory pathway for the Pygmy Blue Whale, and the Kimberley Marine Park includes calving and nursing habitat, as well as migratory pathway, for the Humpback Whale (Attachment E19). The ERT Report dated 14 January 2019 (Attachment E4) also identifies the following species as known or likely to occur in or within 20 km of the Trunkline Area:

- Vulnerable, Migratory Whale Shark (*Rhincodon typus*) – Foraging known;
- Vulnerable, Migratory Green Sawfish (*Pristis zijsron*) – Known to occur;
- Vulnerable, Migratory Largetooth Sawfish (*Pristis pristis*) – Known to occur;
- Migratory Knifetooth Sawfish (*Anoxypristis cuspidata*) – Known to occur;
- Migratory Shortfin Mako (*Isurus oxyrinchus*) – Likely to occur;
- Migratory Longfin Mako (*Isurus paucus*) – Likely to occur;
- Migratory Reef Manta Ray (*Manta alfredi*) – Known to occur;
- Migratory Giant Manta Ray (*Manta birostris*) – Likely to occur;
- Migratory White-tailed Tropicbird (*Phaethon lepturus*) – Breeding likely.

The installation of the trunkline involves piling, and the Department assumes the noise levels will be similar to those considered above in relation to piling to be undertaken at Scott Reef; that is, up to 250 dB re 1 µPa at 1 m. While the proponent has advised that only 20 piles will be required across the 900 km length (Attachment D2), the sound generated may have lethal and sub-lethal impacts to individuals of the above species, and behavioural impacts over a larger area. The Department expects the noise management procedures the proponent has undertaken to develop and implement to manage noise impacts from piling at Scott Reef

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(discussed above) would also be applied to control the impacts of the piling required for the trunkline, which would mitigate impacts on noise-sensitive species including Whale Shark.

Given that the White-tailed Tropicbird does not spend a lot of time underwater, the Department considers that it is unlikely to be significantly impacted by the noise generated by installation of the trunkline. The Knifetooth Sawfish, Shortfin Mako, Longfin Mako, Reef Manta Ray and Giant Manta Ray are not listed as threatened, only migratory, and no ecologically significant populations are known to occur in the vicinity of the proposed action area. Given the short-term nature of the piling, the Department considers that the noise generated during installation of the trunkline is not likely to substantially modify the habitat of these species.

Green Sawfish and Largetooth Sawfish, while heavily reliant on inshore coastal areas, are also known to utilise deepwater habitats. All areas where biologically important behaviour is known to occur are considered critical to the survival of the species, and all populations are considered to be of high conservation value (Attachment E20). However, there is a lack of detailed information on adult habitat use, and little is known about the species' growth rates and breeding ecology (Attachment E20). It is presumed that, like other large elasmobranch species, sawfish have slow growth rates, are long lived, and have low reproductive capacity (Attachment E20). These life history characteristics limit their ability to recover once populations have been depleted (Attachment E20). The noise generated by piling to install the trunkline is likely to have lethal, sub-lethal, and behavioural impacts on any sawfish individuals and the species' prey present within a very large area. It is likely that sawfish individuals occurring in the area would be adults, as juveniles are known to occur only in estuarine and inshore areas and freshwater streams (Attachment E20). The loss of adult individuals of breeding age could have a significant long-term impact on the populations of the species.

The proposed action area intersects Commonwealth and State- managed fisheries, including fish, prawn, abalone and oyster fisheries (Attachment D2). Noise generated may also impact fisheries in the vicinity of the proposed action area, through death, sub-lethal physical and physiological impacts, modifications of behaviour (including avoidance), and changes to juvenile development (Attachments E10 and E11).

Conclusion

The noise generated during construction will be high intensity and within the frequency detected or used by several species of listed threatened and migratory cetaceans, turtles and fish that are known to rely on the proposed action area for biologically important activities, including breeding, migration and foraging. The Department predicts that, as a result, individuals of these and numerous other marine species are likely to suffer physical and behavioural impacts from the various noises generated by the proposed action. Mortalities are possible. The Department considers that there is a real chance or possibility that the noise generated by the proposed action during all phases of the proposed action will adversely affect habitat critical to the survival of the Pygmy Blue Whale, Humpback Whale, Sei Whale, Fin Whale, Whale Shark, Green Turtle, Hawksbill Turtle, Flatback Turtle, Loggerhead Turtle, Leatherback Turtle, Olive Ridley Turtle, Green Sawfish and Largetooth Sawfish. The Department also considers that the proposed action could interfere substantially with the recovery of, and lead to a long-term decrease in the size of an important population of, the Green Sawfish and Largetooth Sawfish. Therefore, the Department considers that the noise generated by the proposed action is **likely** to have a significant impact on these species, as well as on the environment generally.

Light emissions

Functional lighting is required on vessels, FPSO facilities and MODUs at levels to provide a safe working environment for personnel (Attachment D2). The majority of lighting is expected to be

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fluorescent, with a small number of high pressure sodium floodlights; illumination levels of approximately 200 Lux will be used in operational areas (Attachment D2).

Intermittent flaring from the FPSOs and MODUs will create additional light emissions, which will vary in duration and intensity (Attachment D2). The proponent has advised that there will be no continuous flaring during normal operations, with the exception of purge gas (inert gas used to purge the flare line to avoid ingress of air) and pilot gas (fuel gas supplied to keep the flare alight) (Attachment D2).

The Migratory Species Section advises (Attachment E14) that flaring, navigational and operational lighting used during construction and ongoing operation is likely to disrupt critical turtle behaviours, as turtles use light as an orientation cue during nesting, and hatchling and adult sea-finding behaviour. It is essential that artificial light within or adjacent to habitat critical to the survival of marine turtles is managed such that turtles are not displaced (Attachment E17). The Migratory Species Section considers the proposed management of light to be insufficient given the importance of Sandy Islet to the Scott Reef – Browse Island Green Turtle stock, and notes that the proponent does not appear to have considered the impact of light on hatchlings (Attachment E14). Given the low profile of the island and the lack of other light sources in the region, it is likely that turtle hatchlings will be attracted to construction and operational lighting, as this light will be low to the horizon (Attachment E14). This may mean that hatchlings do not take the shortest route to the deep water and ocean currents where they live their 'lost years', wasting critical energy reserves and spending longer in the high predation zones east of Sandy Islet, within (not off) Scott Reef (Attachment E21). Intermittent flaring will further increase this risk (Attachment E14). The approach to light management should be natural darkness except where navigation or human safety requirements necessitate artificial light, and then light is to be managed such that: turtles are not displaced from critical habitat; and biologically important behaviour can continue (Attachment E17).

Seabirds and migratory shorebirds listed as migratory or threatened (or both) are known or likely to occur within the proposed action area. The ERT Report dated 14 January 2019 identifies the Common Noddy (*Anous stolidus*), Streaked Shearwater (*Calonectris leucomelas*), Lesser Frigatebird (*Fregata ariel*), Little Tern (*Sternula albifrons*), Barn Swallow (*Hirundo rustica*) and Common Sandpiper (*Actitus hypoleucos*) as known or likely to occur in or within 20 km of the proposed action area. Flight paths are known to traverse the proposed action area, and Scott Reef is an ecologically significant area due to its location between Indonesia and the Rowley Shoals, in a region in which coral reefs are sparsely distributed (Attachment E14). In particular, Scott Reef is a biologically important area for the Migratory Lesser Frigatebird (*Fregata ariel*) (breeding and foraging) and Little Tern (*Sternula albifrons*) (congregation, resting and breeding) (Attachment E14). While the proponent notes that seabirds and migratory shorebirds may be impacted by artificial light (Attachment D2), there is no consideration of light management to ensure there is no significant impact to relevant avian species. The Migratory Species Section advises (Attachment E14) that the proposed minimisation of continuous flaring to purge gas, pilot light and waste gas is insufficient to ensure seabirds and migratory shorebirds are not impacted, and that other measures should be taken, including flaring only during daylight hours and shielding flares. Similarly, the proponent does not appear to have considered the risk of seabirds being attracted to flares and incinerated, even where flaring is intermittent and of short duration (Attachment E14). If you agree with the recommendations in this brief, the Department will explore with the proponent during the assessment phase whether it would be safe to flare only during daylight hours.

The Department considers that there is a real chance or possibility that light emissions as a result of the proposed action will adversely affect habitat critical to the survival of Green Turtles, disrupt the breeding cycle of an important population of Green Turtles, and substantially modify an area of important habitat for migratory bird species. Therefore, the Department considers

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that light emitted by the proposed action is **likely** to have a significant impact on the Green Turtle, Common Noddy, Streaked Shearwater, Lesser Frigatebird, Little Tern, Barn Swallow, Common Sandpiper, and the environment generally.

Discharges to the sea

Routine discharges will include a combination of liquid discharges, underwater emissions, and solid waste discharges at various stages of the proposed action (Attachment D2):

	Development Drilling and Completion	**Installation and Commissioning**	**Operation**	**Decommissioning**
Hydrotest fluids		✓	✓	
Produced water	✓	✓	✓	✓
Cooling water	✓	✓	✓	✓
Subsea control fluids	✓	✓	✓	
Desalination brine	✓	✓	✓	✓
Drain discharges	✓	✓	✓	✓
Sewage and sullage	✓	✓	✓	✓
Drill cuttings and fluids	✓			
Non-hazardous inorganic wastes	✓	✓	✓	✓
Putrescible wastes	✓	✓	✓	✓
Hazardous wastes	✓	✓	✓	✓
Ballast water and biofouling	✓	✓	✓	✓

The nature and impacts of these discharges are summarised below:

- Hydrotest fluid
  - Hydrostatic testing is used to check strength in and leaks from pipelines. Once laid, pipes are filled with hydrotest fluid and tested. Once testing is complete, hydrotest fluid is expected to remain in the pipelines until hydrocarbon production is ready to commence.

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- This is because hydrotest fluid is also required over a longer period to protect pipelines from corrosion. Hydrotest fluid contains additives such as mono-ethylene glycol (MEG), necessary to extend the useful life of the hydrotest fluid. Up to 1 million cubic metres (1 billion litres) of hydrotest fluid will be required to be used in the trunkline and inter-field spur line hydro testing. A further 115 cubic metres (115,000 litres) of MEG will be required per production riser. The proponent has not specified how many risers will be installed.

- Hydrotest fluid discharges may consist of a combination of biocides, corrosion inhibitor, oxygen scavenger (e.g. ammonium bisulphate), scale inhibitor, MEG, fluorescein dye, and nitrogen. The proponent has not specified the exact components that will be used in the hydrotest fluid.

- The proponent has committed to selecting the lowest toxicity chemicals possible, minimising the requirement for discharge and refill, and discharging hydrotest fluid in a controlled manner to ensure adequate dilution (Attachment D2).

- The proponent has assessed the impacts of discharge of hydrotest fluid as negligible (the receptor will essentially not be affected) due to negligible, temporary and localised contamination of surrounding waters occurring only once during commissioning (Attachment D2). Given the mitigation measures proposed, and the fact that hydrotest fluid discharge will be regulated by NOPSEMA in the Environment Plan, the Department considers the proponent's assessment is most-likely accurate. At the same time, if you agree with the recommendations in this brief, the Department will specify via the EIS Guidelines that information is included in the assessment documentation sufficient to ensure the public can understand clearly the impacts expected from the discharge of hydrotest fluid.

- Produced water

  - Produced water may consist of a combination of formation water (water that occurs naturally within the hydrocarbon-bearing geological formations; expected to be saline) and condensed water (water vapour contained in the gaseous phase of the reservoir fluids that condenses out of the gas as the pressure and temperate is reduced; fresh). Up to 5,723 cubic metres (5.7 million litres) of produced water will be processed per day per FPSO facility (Attachment D2).

  - The exact components in the produced water that will result from the proposed action are unknown, but may contain inorganic salts, dissolved organic compounds, dissolved gases (including hydrogen sulphide and carbon dioxide), dissolved and dispersed hydrocarbons, metals, production chemicals, and naturally occurring radioactive materials (NORMs).

  - Produced water will be treated to meet defined specifications, which the proponent believes, based on studies of currents and dilutions, will disperse to below toxicity threshold concentrations, ensuring a 99% species protection level, more than three nautical miles from Scott Reef (Attachment D2). The proponent has committed to using chemicals with the lowest environmental toxicity rating possible.

  - The proponent is proposing to use active heating as the hydrate management strategy, rather than continuous MEG (Attachment D2). Thus, there will be no continuous injection of MEG during operations. However, MEG will be injected into subsea infrastructure when bringing new wells online, and for start-ups and shutdowns

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(Attachment D2). This MEG will be returned to the FPSO and discharged in the produced water stream.

- The proponent has assessed the impacts of discharge of produced water and MEG as minor (impact magnitude is within applicable standards but is considered to have significance) due to "near-field contamination to surrounding waters above relevant guidance / background levels for the duration of the activity" (Attachment D2). Given the potential for lethal and sub-lethal impacts to individuals of a range of marine species in the surrounding waters at the time of discharge, and the possibility that metals and other substances in the discharged produced water may bio-accumulate, the Department agrees with this assessment. At the same time, if you agree to the recommendations in this brief, the Department will carefully consider the information to be required for the assessment via the EIS Guidelines, having regard to the long-term nature of the discharges and the potential for bio-accumulation of metals and other substances in marine species.

- Cooling water

  - Cooling water will be required for vessels and MODUs involved with drilling and completion, and for commissioning and operation of the FPSO facilities. The largest requirement for cooling water will be from operation of the FPSO facilities for process cooling (Attachment D2).

    - The FPSO facilities are proposed to utilise an indirect cooling water system, where seawater is pumped up to the facility, treated with hypochlorite (an ion with the chemical formula ClO−, used to induce reactions involving chlorine), and passed through the heat exchangers prior to discharge overboard (Attachment D2). The discharge temperature of this water will be above the average ambient seawater temperature at the site, but the proponent has not indicated by how much. However, the proponent predicts that temperatures would return to within 3 degrees of ambient temperature within 190 m of the discharge point in winter, and 110 m in summer (Attachment D2). Seawater demand for cooling will be approximately 20,500 cubic metres per hour per FPSO (Attachment D2).

  - The hypochlorite system will inject chlorine into the seawater to prevent biofouling (Attachment D2). Residual chlorine will be discharged overboard in the cooling water stream, at levels not to exceed 0.2 parts per million during routine operations (may be up to 0.5 ppm if shock dosing is required) (Attachment D2). The proponent predicts that residual chlorine concentrations will reduce to 0.002 parts per million within 1.4 km in winter, and shorter distances in summer and transitional seasons 95 per cent of the time (Attachment D2). The Department notes that the chlorine will be highly reactive for a period following its release to the marine environment and can react with other substances in the marine environment to produce compounds that may be of very high environmental concern. The proponent has not considered this in its referral and has not proposed any management measures. If you agree to the recommendations in this brief, management and mitigation measures will be required in the EIS Guidelines.

  - The proponent has assessed the impacts of discharge of cooling water to be minor (impact magnitude is within applicable standards but is considered to have significance) due to "near-field contamination to surrounding waters above relevant guidance / background levels for the duration of the activity" (Attachment D2). Given the potential for lethal and sub-lethal impacts to individuals of a range of marine species in the

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surrounding waters at the time of discharge, and the potential impacts arising from discharge of chlorine, the Department agrees with this assessment.

- Subsea control fluids
  - Subsea control fluids are discharged during valve operation in open loop systems (approximately 0.1 L of intermittent hydraulic fluid discharges). In closed loop systems, control fluids are returned back to the FPSO facility.
  - The content of the control fluid that will be used is not currently defined but the proponent has committed to ensuring the selected fluid has an Offshore Chemical Notification Scheme rating of Group D or better (Attachment D2). Group A represents chemicals with the greatest hazard potential, and Group E the least.
  - The proponent has assessed the impacts of discharge of subsea control fluids to be negligible (the receptor will essentially not be affected) due to negligible, temporary and localised contamination of surrounding waters occurring sporadically (Attachment D2). Given the small amount of fluid to be discharged in intermittent bursts, the Department agrees with this assessment.
- Desalination brine
  - MODUs, installation vessels and operational support vessels may produce fresh water on-board using reverse osmosis or thermal desalination of seawater. The desalination process will result in a desalination brine discharge, typically 20-50 percent higher in salinity than the intake seawater, and may contain low concentrations of anti-scale chemicals (Attachment D2).
  - The proponent has assessed the impacts of discharge of desalination brine to be negligible (the receptor will essentially not be affected) due to temporary localised contamination of surrounding waters (Attachment D2). Given the proponent's commitment to using biocides and anti-scaling agents suitable for use in potable water systems (low toxicity), the Department agrees with this assessment.
- Drain discharges
  - Bunds on the FPSO facilities will capture and contain discharges and liquid spills, which will be collected and routed through drain collection tanks to slops tanks for treatment (Attachment D2). Oil will be recovered and treated water containing less than 15 mg per litre oil-in-water will be discharged overboard. During heavy rains, operation of the fire deluge system, or during a major liquid spill where there is a life safety imperative, large volumes of collected fluids may flow directly overboard, without treatment (Attachment D2).
  - The proponent has assessed the impacts of discharge of drain discharges to be negligible (the receptor will essentially not be affected) due to temporary localised contamination of surrounding waters (Attachment D2). Given the treatment measures to be undertaken, the Department agrees with this assessment.
- Sewage and sullage
  - Sewage and sullage (grey water generated from domestic processes such as dishwashing, laundry and showers) will be generated on the MODU, support vessels, and FPSO facilities. Sewage volumes will depend on the number of personnel on board

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and are expected to range from 10-30 cubic metres per day per facility. Sewage will be treated prior to discharge in accordance with international and Australian standards.

- The proponent has assessed the impacts of discharge of sewage and sullage to be slight (the receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and well within acceptable standards) due to slight nutrient enrichment of surrounding waters (Attachment D2). Given the proponent's commitments to compliance with international and Australian standards for treatment and discharge of sewage at sea (Attachment D2), and to not discharge untreated sewage within Scott Reef lagoon (Attachment E8) or within 3 nautical miles of Scott Reef (Attachment D2), the Department agrees with this assessment.

- Drill cuttings and fluids

  - Cuttings generated during drilling of wells are expected to range in size from very fine to very coarse particles (Attachment D2). Approximately 750-850 cubic metres of cuttings are anticipated to be produced per well, and there will be 49 wells (Attachment D2). Minor amounts of drilling fluid may adhere to cuttings, with small sized cuttings more difficult than larger cuttings to separate from drilling fluid. Drilling fluids may be water based or non-water-based, and may or may not contain toxic chemicals (Attachment D2).

  - Disposal options for drill cuttings will be assessed at each drill location using a risk based framework to evaluate different discharge options and scenarios.

    Where no impact to sensitive receptors is demonstrated, drill cutting will be discharged overboard at the sea surface. Where an impact to Scott Reef is predicted, alternative drill cutting disposal techniques will be used. These may include:

    - Discharge from the MODU at a sufficient depth to allow acceptable dispersion to occur
    - Retain cuttings, store and ship to an offshore location away from the reef for offshore disposal
    - Retain cuttings, store and transfer to shore for disposal (Attachment E8).

  - Lethal and sub-lethal impacts to benthic marine organisms are possible, for example through smothering, resulting in temporary loss of benthic communities and potentially long-lasting altered community structure and composition (Attachment D2). However, these impacts will be highly localised to the drilling locations, benthic infauna and epifauna are known to recover relatively quickly, affected areas of the seabed support a low density of common and widespread benthic fauna that are well represented in the region, and ecologically significant food sources are unlikely to be present due to the depth of water.

  - The proponent has assessed the impacts of discharge of drill cuttings and fluids to be slight (the receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and well within acceptable standards) due to slight short-term decrease in water quality on near field scale and permanent slight localised impact on benthic habitat (Attachment D2). The Department notes the proponent's commitments not to discharge non water based drilling fluids at sea, and to develop and implement an adaptive management strategy for the disposal of drill cuttings from wells close to Scott Reef (including relocation away from the reef). The Department considers there is a **real**

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and not remote possibility of significant impacts to listed threatened and migratory species, and the environment generally, from the disposal of drill cuttings.

- Solid waste
  - Non-hazardous solid waste may include scrap metal, packaging, wood, cardboard, paper and empty containers (Attachment D2). The proponent will, "where a net environmental benefit is likely", segregate this waste into recyclable and non-recyclable containers for transport onshore (Attachment D2). Soft plastics will be transported onshore for recycling or disposal at an appropriate facility (Attachment E8).
  - Food scraps and other putrescible waste will be produced from all FPSO facilities, MODUs and support vessels (approximately 1 litre per person per day) during all phases of the proposed action (Attachment D2). This waste will be discharged directly into the marine environment.
  - Hazardous waste generated during the proposed action may include recovered solvents, excess or spent chemicals, hydrocarbon contaminated materials (e.g. sorbents, filters and rags), batteries, biological wastes from medical facilities, mercury- or NORM-contaminated materials and lubricating oils (Attachment D2). The proponent will, "where a net environmental benefit is likely", segregate general hazardous waste into recyclable and non-recyclable containers for transport onshore (Attachment D2). Precautions will be taken where materials may contain mercury or NORMs (Attachment D2). All hazardous waste will be shipped onshore for appropriate handling and disposal at a licensed facility (Attachment D2).
  - The proponent has assessed the impacts of discharge of solid wastes to be negligible (the receptor will essentially not be affected) due to the localised impacts and the proponent's commitments to store and transport inorganic waste to licensed disposal facilities on shore (Attachment D2). Given these measures, the Department agrees with this assessment in relation to inorganic waste. However, the Department considers that the discharge of putrescible waste, including food scraps, into the water is likely to attract birds and marine animals, which will increase the magnitude of impacts resulting from other aspects of the activity, such as lethal and sub-lethal impacts from noise, vessel strike, flares, and fluid discharges, and is therefore more significant.
- Ballast water and biofouling
  - Installation and support vessels will discharge ballast water (if required) prior to entering waters within 12 nautical miles from land (including Scott Reef) (Attachment D2). Vessels and FPSO facilities will be treated with antifouling paint to prevent marine growth (Attachment D2). The proponent will comply with international and Australian standards in relation to ballast water and anti-fouling measures.
  - The proponent has not undertaken an assessment of the impacts of discharge of ballast water and biofouling chemicals. Discharge of ballast water could introduce and spread invasive marine species and disease. The Department considers that the proponent's mitigation measures are appropriate and sufficient to reduce this risk.

Based on the above, and noting the proponent's assessment that the discharge of produced water and cooling water is likely to have a significant impact on the marine environment, the Department considers that there is a real chance or possibility that the proposed action will result in a substantial change in water quality that may adversely impact on biodiversity and ecological integrity, and substantially modify important habitat for migratory birds.

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The Department also notes that coral reefs are sensitive to pollution and sediments, which can cause growth of excess plants such as seaweed and smother corals. Therefore, the Department considers that the discharges proposed as part of the proposed action are **likely** to have a significant impact on the environment generally. The Department considers it is **unlikely** the discharges from the proposed action have a significant impact on specific listed threatened species or specific listed migratory species.

Helicopter, vessel and infrastructure presence

The presence of helicopters, vessels and infrastructure may have impacts beyond those discussed above in relation to noise, light and discharges and below in relation to hydrocarbon spills. The proponent advises that, currently, shipping activity in and around the Scott Reef and Brecknock/Calliance areas is sparse, with the main commercial shipping routes located approximately 50 to 100 km west of Scott Reef (Attachment D2). Vessel presence will increase significantly as a result of the proposed action: The drilling, completion, installation and commissioning phases will be supported by barges, tugs, survey vessels, supply vessels, and installation and pipelay vessels (Attachment D2). Ongoing operations will require a small number of vessels to transport personnel, stores and equipment on a routine basis (Attachment D2).

Increased vessel presence in the proposed action area will increase the risk of vessel strikes and introduction and spread of invasive marine species and diseases, including to sensitive receptors such as Scott Reef. The proponent has committed (Attachment D2) to meeting Commonwealth and State ballast water and biofouling legislation and guidelines, and to complying with the *Whale shark management with particular reference to Ningaloo Marine Park* (WA) (Attachment E22), EPBC Regulations Part 8 Division 8.1 (Attachment E23), and the *Australian National Guidelines for Whale and Dolphin Watching* (Attachment E12).
The Department considers that these measures are appropriate and sufficient to mitigate the risk of vessel strike in most locations; however, the Scott Reef Channel between North and South Scott Reef is a confined channel and hence a particularly sensitive area.

Upwellings generated by Scott Reef are an important part of the biological process at Scott Reef, as they bring nutrient rich waters from below the pycnocline to near the surface, where the nutrients can be used by corals and other organisms (Attachment E25), including Pygmy Blue Whales.

Given the confined nature of Scott Reef Channel, and given the potential for use of the channel by cetaceans likely to occur in the vicinity, it is **likely** that vessel use could disturb or result in vessel strike and have a significant impact on the Pygmy Blue Whale, and on the environment generally.

Part 8 Division 8.1 of the EPBC Regulations (Attachment E23) provides protection against impacts to cetaceans arising from aircraft use. These provisions would apply to helicopters transporting personnel to and from the mainland, which are likely to pass over migrating whales on occasion. The proponent has not clearly identified the airport(s) on the WA coast that would be used for transporting people by helicopter to and from the FPSOs.

In the absence of information about the flight paths of helicopters that will travel regularly between the WA coast and the FPSOs, there is a **real and not remote possibility** that the helicopter use that is part of the proposed action could disturb and have a significant impact on the following migratory birds: Common Noddy, Streaked Shearwater, Lesser Frigatebird, Little Tern, Barn Swallow, Common Sandpiper, and on the environment generally.

Given the proponent's commitment to implement EPBC Regulations Part 8 Division 8.1, it is **unlikely** the helicopter use included in the proposed action will have a significant impact on listed threatened species or listed migratory species not mentioned in the previous paragraph.

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The proponent intends that subsea infrastructure will be installed permanently (Attachment D2). Offshore infrastructure can create artificial habitat and result in the introduction or expansion of species that would otherwise not be able to colonise the area, and thereby result in a shift in faunal and floral assemblages. It also introduces permanent disturbance to the seabed, and could increase risks to users of the proposed action area in the future, such as for tourism, research, transport and fishing.

The installation, servicing and (if later found necessary) removal of offshore infrastructure may obstruct the movement of marine fauna, and mooring lines and risers present an entanglement risk to cetaceans and other fauna. Placement of infrastructure in the channel between North and South Scott Reef, as proposed, is likely to pose a greater impediment to fauna movements given the confined nature of the corridor. Approximately half of the Pygmy Blue Whales that migrate near Scott Reef pass through the channel (Attachment E24).

It is likely that the installation, servicing and (if later found necessary) removal of offshore infrastructure could obstruct cetaceans, limiting feeding opportunities for species such as the Pygmy Blue Whale, and/or result in entanglements. As a result, it is **likely** the management of infrastructure included in the proposed action will have a significant impact on threatened and migratory cetaceans including the Pygmy Blue Whale, Humpback Whale, Sei Whale, Fin Whale, and on the environment generally.

Seabed disturbance and subsidence

The proposed action will disturb approximately 1192 ha of seafloor due to subsea infrastructure, including FPSOs, moorings, wells, and pipelines (including the trunkline). In addition, the intended disposal of drill cuttings in currently unknown areas away from Scott Reef will cause disturbance of the seabed at those locations (discussed separately in detail, above). All these disturbances are likely to have highly localised lethal and sub-lethal impacts to benthic marine organisms, temporary and permanent loss of benthic communities, and potentially long-lasting altered community structure and composition (Attachment D2). Benthic infauna and epifauna are known to recover relatively quickly, and affected areas of the seabed support a low density of common and widespread benthic fauna that are well represented in the region. The proponent advises that seafloor communities in deeper (more than 100 m) waters receive insufficient light to sustain ecologically sensitive primary producers such as seagrasses, macroalgae and zooxanthellate scleractinian corals will not occur (Attachment D2). Given the depth of water in which subsea infrastructure will be situated (mostly more than 400 m) benthic primary producer groups are unlikely to be impacted. Given this, the Department considers that the proposed extent of seabed disturbance is **unlikely** to have a significant impact on listed threatened or migratory species, or on the environment generally.

Extraction of hydrocarbons will result in subsidence of the seabed above the reservoir. This will result in communities currently inhabiting those areas, including the highly biologically diverse Scott Reef, being situated lower in the water column. Species in those communities may not be capable of tolerating changes in water depth or temperature or other conditions such as currents and sedimentation, and these ecosystems could be impacted. For example, coral reefs exist only within narrow parameters of depth, salinity, and temperature. Sandy Islet is already small, at just 700 m long, with approximately 400 m^2 remaining above water at extreme high tide. The coral communities at Scott Reef play a key role in maintaining the species richness and subsequent aggregations of marine life identified as conservation values for the key ecological feature (Attachment E1). If the area of Sandy Islet is decreased, competition for turtle nesting space will increase; if Sandy Islet is entirely submerged, Green and Hawksbill Turtles will no longer be able to nest there.

The proponent's modelling predicts subsidence as a result of the proposed action to be 2.6 to 8.9 cm over 40 years (Attachment D2). The proponent contends this is not significant given the

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magnitude of sea level change predicted to occur as a result of climate change (Attachment D2).

The Department does not consider the subsidence expected to result from the proposed action to be negligible. Global sea levels are predicted to rise by 5-15 cm by 2030 as a result of climate change (Attachment E1). The proposed action is likely to result in an additional increase in water depth at Scott Reef.

Given Sandy Islet is low-lying, even a reasonably small magnitude of subsidence could submerge a significant additional portion of its sand. Research funded by the proponent has found that space is already at such a premium on Sandy Islet that turtles often accidentally excavate an existing nest while digging their own, which results in the death of the exposed eggs (Attachment D2). Similarly, a decrease in the extent of Sandy Islet would reduce the area available for migratory birds, in a region in which coral reefs are already sparsely distributed, and a biologically important area for the Lesser Frigatebird (breeding and foraging) and Little Tern (congregation, resting and breeding) (Attachment E14). The *Recovery Plan for Marine Turtles in Australia* (Marine Turtles RP) notes that Sandy Islet is extremely vulnerable, and "is further in doubt with the subsidence and compaction of rock strata underlying the reef as the oil and gas reserves of the Torosa Field are extracted" (Attachment E17).

Coral reefs at depths of more than 30-40 m are highly unlikely to be able to grow at sufficient rates to match sea level rise (Attachment E1). Large areas of Scott Reef are threatened by sea level rise, and subsidence will only exacerbate the issue placing a larger area of the ecologically significant coral communities in this key ecological feature at risk of loss.

The proponent states that it does not propose to take any management measures to reduce the risk of environmental impact associated with subsidence (Attachment D2). The Department considers that, if the action proceeds, the impact of subsidence, including the potential loss of Sandy Islet and the Green Turtle population that relies on it, will be unavoidable.

South Scott Reef includes an area of Commonwealth waters (Attachment E2 viewed alongside Figure 1 in Attachment D2). Given that a change in water depth is likely to reduce the suitability of Scott Reef for at least part of the existing, important coral communities, and decrease the area available for nesting by threatened turtle species (including the unique Scott Reef – Browse Island genetic stock of Green Turtle (Attachment E14), the Department considers that there is a real chance or possibility that the subsidence caused or contributed to by the proposed action will lead to a long-term decline in the size of an important population of Green Turtle, reduce the area of occupancy of an important population of Green Turtle, adversely affect habitat critical to the survival of Green and Hawksbill Turtles, disrupt the breeding cycle of an important population of Green Turtle, substantially modify or destroy an area of important habitat for migratory birds, and have a substantial adverse effect on a population of Green Turtles. Therefore, the Department considers that the subsidence caused by the proposed action is **likely** to have a significant impact on the Green Turtle, Hawksbill Turtle, Common Noddy, Streaked Shearwater, Lesser Frigatebird, Little Tern, Barn Swallow, Common Sandpiper, and the environment generally.

Potential for significant hydrocarbon spill

A significant hydrocarbon release is likely to have lethal and sub-lethal impacts on numerous listed threatened and migratory species, including turtles, cetaceans and birds, and on the environment generally. Impacts will not be limited to the proposed action area, but could be far reaching and impact matters of national environmental significance that have not been considered elsewhere in this brief. The release of hydrocarbons could have a catastrophic impact on the local breeding population of Green Turtles, in particular, and could lead to both an

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immediate and long-term decrease in the size of the unique Scott Reef – Browse Island genetic stock, especially if the spill also reached Browse Island (mapped at Attachment E3); the proponent's modelling indicates this is possible (Attachment D2). Release of hydrocarbons from the trunkline would, depending on the location, be likely to impact at least one Australian Marine Park and Key Ecological Features of the North-west Marine Bioregion.

The proponent's objective is to manage to prevent accidental hydrocarbon releases (Attachment D2). To that end, the proponent has committed to implementing measures to minimise the risk of a hydrocarbon spill (Attachment D2).

The proponent has identified (Attachment D2) six ways in which a hydrocarbon spill could occur:

- Loss of well controls;
- Subsea loss of control;
- Loss of hydrocarbons from topsides;
- Loss of control from substructure (storage of condensate or diesel);
- Loss of containment from the trunkline (gas only);
- Loss of containment from vessel collision.

The Department understands that the potential for a hydrocarbon spill during transfer of condensate from FPSO facilities to tankers is included (it would be a loss of hydrocarbons from topsides).

As noted in the Marine Turtles RP (Attachment E17), "[w]hile the risk of an oil spill is generally considered low, the consequences would be substantial due to the small range and localised nature of [the Scott Reef – Browse Island Green Turtle] stock, and the risk increases with each new activity. The consequences of an oil spill have implications for the immediate health of marine turtles and their nesting, future nesting activities, water quality and general turtle health". The Department considers that, even if the likelihood of a spill is low, it is more than a remote chance or possibility, and that, if a significant spill occurs, the likelihood of significant impacts to listed threatened and migratory species, and the environment generally, is almost certain. Given the severity of impacts that would result from a significant hydrocarbon spill, the Department considers that the proposed action is **likely** to have a significant impact on listed threatened and migratory species and the environment generally.

Contribution of proposed action to climate change

As set out above, section 75(2) requires you to consider all adverse impacts the proposed action has, will have or is likely to have on the matters protected by each provision of Part 3.

The Department considers that impacts from greenhouse gas (GHG) emissions are an adverse impact that the proposed action is likely to have on listed threatened species, listed migratory species and the environment generally.

For this reason, the Department recommends that you consider GHG impacts of the proposed action when deciding whether the following provisions are controlling provisions for the proposed action:

a. sections 18 and 18A (listed threatened species and communities)
b. sections 20 and 20A (listed migratory species)
c. sections 23 and 24A (Commonwealth marine area, the protected matter being the environment generally)

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The Department's analysis of GHG impacts on listed threatened species, listed migratory species and the environment generally is set out below for your consideration.

Climate change threatens all life on earth, including threatened and migratory species and the environment generally. Increasing temperatures are known to change the sex ratio of many marine species, including Green Turtles, and kill coral reefs and kelp forests on which hundreds of marine species rely. Increasing sea temperatures cause an increase in the acidity of the oceans (carbonic acid), leading in time to the dissolution of reefs such as Scott Reef. These changes will impact threatened and migratory species, and the marine environment generally, including via reduction in extent of habitat and loss of food sources.

The impacts of GHG emissions are not limited to impacts on the marine environment. The Department's website explains "[o]ur climate is changing. Observed changes over the 20th century include increases in global average air and ocean temperature, rising global sea levels, long-term sustained widespread reduction of snow and ice cover, and changes in atmospheric and ocean circulation and regional weather patterns, which influence seasonal rainfall conditions" (Attachment E40).

Impacts on the 'environment' from greenhouse gas emissions

The Department's *Significant impact guidelines 1.2 - Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (Attachment E32) indicate that an action is likely to have a significant impact on the environment if there is a real chance or possibility that the action will have certain effects.

As discussed above, given that the proposed action will be taken *in* a Commonwealth marine area, the protected matter for the purposes of the controlling provisions in section 23 and 24A is the environment generally (see s 23(1) and ss 24A(1) and (2) of the EPBC Act). The 'environment' is defined in section 528 to relevantly include 'ecosystems and their constituent parts', 'natural and physical resources', 'the qualities and characteristics of locations, places and areas' (which would include the atmosphere) and heritage values of places.

Having regard to the statement in the Significant Impact Guidelines that a 'significant impact' is an impact which is important, notable or of consequence, having regard to its context or intensity, the Department considers the relevant significance thresholds in the context of 'the environment' are whether there is a real chance or possibility that the GHG emissions resulting from the action will, at *any location*:

- reduce biological diversity or change species composition on reefs, seamounts or in other sensitive marine environments or
- substantially damage or modify large areas of the seafloor or ocean habitat, such as sea grass.

The Department considers that there are three relevant sources of GHG emissions that can be characterised as 'impacts' of the proposed action.

Source 1 - GHG emissions from the action itself

The first are 'direct emissions', being the GHG emissions from the action itself (ie the emissions occurring in the Commonwealth marine area at Scott Reef where the action is being taken. Atmospheric and GHG emissions will occur throughout all phases of the proposed action, for example, through combustion, flaring, venting and fugitive emissions (Attachment D2).
Up to 7 Mt of CO_2-e will be emitted over Commonwealth waters each year as part of the proposed action, with average annual emissions estimated to be 4 Mt CO_2-e over the 50 years of hydrocarbon extraction (Attachments D2 and D7). These figures relate only to the extraction of hydrocarbons and processing at the FPSO facilities.

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Sources 2 and 3

The second and third sources of emissions can be characterised as 'indirect impacts' of the proposed action (ie impacts from a secondary/consequential action). The legal test for indirect impacts is set out in section 527E(1) and (2) of the EPBC Act and, relevantly for these purposes, differs depending on whether it is Woodside or a third party taking the secondary action).

Source 2 - GHG emissions as a result of processing the gas at the Karratha Gas Plant

Once extracted and processed at the FPSOs, the hydrocarbons will be transported via the trunkline to the Karratha Gas Plant (KGP) for processing.

Section 527E(1) and (2), when read together, provide that an event or circumstance is an indirect impact of an action if the action is a substantial cause of that event or circumstance. The exception is where the event or circumstance is the result of an action by a third party independently of the proponent (in that situation, there is a different legal test which is discussed below in relation to the third source of emissions). This exception is not applicable to emissions from the KGP, as Woodside will also be the person taking the (separate) action that covers processing the gas at KGP (see EPBC 2018-8335); there is no relevant third party.

The Department considers that environmental impacts from the proposed processing of the gas from the Brecknock, Calliance and Torosa reservoirs at the KGP are indirect impacts of the referred action, and, therefore, the GHG emissions from the KGP as a result of processing that gas must be considered when assessing the impacts of the proposed action. This is because the proposed action is a substantial cause of the GHG emissions coming out of the KGP as a result of processing the gas from Scott Reef. This is on the basis that the proposed action will directly result in the gas in question being extracted from Scott Reef and transported to the KGP for processing; without the proposed action, the gas from Scott Reef would not be processed at the KGP and the GHG emissions resulting from that processing would not occur. In other words, the proposed action will facilitate the environmental impacts associated with processing the gas at KGP, including from GHG emissions.

The Department also notes the following information regarding the GHG emissions from the KGP:

- LNG processing is an extremely energy-intensive process. KGP currently consumes seven per cent of the gas it receives from offshore to generate the power required to run its liquefaction operations; to date, this creates 70 per cent of the KGP's carbon emissions (Attachment E26).
- As mentioned above, via the separate referral of the North West Shelf Project Extension (EPBC 2018-8335), the proponent seeks to continue GHG and other emissions from the KGP until the end of November 2068. The KGP was originally commissioned in 1984 and is accepting gas for processing from sources throughout the Carnarvon Basin. While the information provided in the referral for EPBC 2018-8335 (Attachment E27) does not indicate the current expiry date for the operation of the KGP, that date is understood to be around 2030. The same referral also does not indicate the level of GHG and other emissions expected up until the end of November 2068. What is indicated is there will be "[c]ontinued emissions and discharges to the environment … that could result in a staged decrease in emissions over time" because of process upgrades planned at the KGP. As part of EPBC 2018/8335, the proponent intends to implement measures to make its operations more efficient and reduce emissions (both total emissions and per unit of LNG produced).
- The Department has subsequently sought and obtained clarification from the proponent: The processing of the gas from the Brecknock, Calliance and Torosa reservoirs at the KGP

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will result in annual average GHG emissions of 4 Mt CO_2-e/annum from the KGP (Attachment D7).

- The Department notes above that the proponent intends to duplicate a gas pipeline from the limit of State (WA) Waters to the Pluto LNG facility on the Burrup Peninsula, WA (another Burrup Hub Project, Scarborough Development nearshore component, WA; EPBC 2018/8362), and to connect the Pluto LNG facility to the KGP (another Burrup Hub project, Pluto-North West Shelf Interconnector, Burrup Peninsula, WA; EPBC 2018/8353).

  For the purposes of the proposed action, the Department considers any increase in GHG emissions from KGP due to these or any other activities is not an indirect impact of *this* proposed action. The Department expects NOPSEMA will consider the direct and indirect GHG emissions from the Scarborough offshore development when it considers the Offshore Project Proposal and (assuming it proceeds to this stage) the Environment Plan for the Scarborough Development offshore component.

Source 3 – GHG emissions as a result of the extracted gas being exported and used overseas

Following processing of the gas from the Brecknock, Calliance and Torosa reservoirs at the KGP, the proponent intends to export that LNG overseas. The GHG emissions from: shipping that LNG to other countries; and combustion of that LNG overseas, have not been included in the referral. The Department subsequently sought and obtained clarification from the proponent: It is estimated the combustion of the gas from the Brecknock, Calliance and Torosa reservoirs overseas will result in annual average GHG emissions of 48 Mt CO_2-e/annum overseas (Attachment D7).

As mentioned above, the legal test for indirect impacts is found in section 527E(1) and (2). For impacts resulting from an action taken by an independent third party to be 'indirect impacts' of the proposed action, the following four things need to be satisfied:

1. the primary action (being the proposed action) must be a substantial cause of the impact; and
2. the primary action must facilitate, to a major extent, the secondary action (being the action of the third party); and
3. the secondary action must have been within the contemplation of the proponent and a reasonably foreseeable consequence of the primary action; and
4. the consequence on the relevant protected matter, in this case being the environment in any location (discussed above), must have been within the contemplation of the proponent and a reasonably foreseeable consequence of the third party's action.

Considering the test set out in s 527E(1)(b) and (2) of the EPBC Act, the Department considers the proposed transport to and combustion overseas of the gas extracted from the Brecknock, Calliance and Torosa reservoirs (after liquefaction at the KGP) is an indirect result of the referred action that must be considered as part of the proposed action.

The Department considers that environmental impacts from the GHG emissions produced from the proposed transport to and combustion overseas of the gas extracted from the Brecknock, Calliance and Torosa reservoirs, are indirect impacts of the referred action; therefore, the GHG emissions from the transport to and combustion of that gas overseas must be considered when assessing the impacts of the proposed action.

The proposed action is a substantial cause of the GHG emitted from the transport to and combustion overseas of the gas extracted from the Brecknock, Calliance and Torosa reservoirs. The proposed action will directly result in the gas in question being extracted being (processed

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then) transported and combusted overseas; without the proposed action, the gas from the Brecknock, Calliance and Torosa reservoirs would not be (processed at the KGP nor) transported nor combusted overseas and the GHG emissions resulting from that transport and combustion would not occur. In other words, the proposed action will facilitate the environmental impacts associated with transport to and combustion overseas, including from GHG emissions.

Woodside would have contemplated: the need to transport the gas overseas; that the gas would be acquired by third parties and combusted overseas; and that the emissions from the transport and the combustion would result in increased GHG emissions with consequential environmental impacts.

Assessment of impacts of GHG emissions resulting from the proposed action on the environment

The GHG emissions from the proposed action (both direct and indirect) will be considered in the context of Australia's framework for managing such emissions:

- Australia has made an international commitment to reduce emissions of carbon dioxide by 26-28 per cent of 2005 levels (that is, to no more than 437 Mt) by 2030. The Safeguard Mechanism provides a framework for Australia's largest emitters to measure, report and manage their emissions. It places emissions limits (known as baselines) on Australia's largest emitters. It gives covered businesses a legislated obligation to keep net emissions below their baseline. Businesses must manage their emissions and keep to this limit (Attachment E28).
- Baselines are set by the Clean Energy Regulator and must be made in accordance with the *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015* (Safeguard Rule). In accordance with section 38 of the Safeguard Rule, new facilities commencing after 1 July 2020, have a baseline set using a Government-determined emissions intensity benchmark. These emissions intensity benchmarks have not yet been made but they are intended to represent leading practice with respect to emissions intensity in each sector (Attachment E28).

While no individual emission source can be linked to a specific consequence of climate change, it is appropriate to consider the contribution of projects to the cumulative impacts of climate change on the environment. The proposed action will increase Australia's (and the world's) total GHG emissions by, in the proponent's words (Attachment D2), a "moderate" amount, and reduce the likelihood that Australia will be able to meet its commitments.

Climate Change Policy Branch have advised that, based on the June 2018 quarterly inventory, Australia's current annual emissions were 534 Mt CO2-e for the year to June 2018 and average annual emissions over the period 1990-2016 were 550 Mt CO_2-e. So, 8 Mt CO_2-e per year, being the amount of GHG emissions that will be emitted in Australia as a result of the project, is 1.5 per cent of current emissions and 1.5 per cent of annual average emissions (Attachment E37). The same advice explains annual global emissions are currently approximately 50,000 Mt CO2-e per year. So, 56 Mt CO_2-e, being the amount of GHG emissions that will be emitted in the world as a result of the project, is 0.1 per cent of global emissions (Attachment E37).

Climate Change Division has further advised that global emissions of GHG have an impact on the marine environment through the impacts of ocean warming, sea level rise and ocean acidification. They indicate these impacts are driven by global emissions of GHG gases (Attachment E37).

The direct and indirect consequential GHG emissions associated with the proposed action will be managed and mitigated through national and international emissions control frameworks

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operating in Australia and within countries that are the import market for the LNG from the project.

At the same time, the Department considers that emitting 56 Mt CO_2-e per annum to the atmosphere between around 2026 (when production from the Brecknock, Calliance and Torosa reservoirs is expected to commence) and the end of October 2068, as a direct and indirect result of the proposed action, results in a **real chance or possibility** that this increase in global GHG emissions will adversely affect the environment by causing impacts including (but not limited to):

- reduced biological diversity or change species composition on reefs, seamounts or in other sensitive marine environments or
- substantial damage or modification to large areas of the seafloor or ocean habitat.

On this basis, the Department considers there is a **real chance or possibility** that GHG emissions from the proposed action may itself result in a significant impact on the environment.

When combined with the other likely impacts to the environment from the proposed action discussed in this brief (ie impacts from acoustic disturbance, light emissions, discharges – liquid, gaseous, drill cuttings and fluid, putrescible solid wastes, vessel and infrastructure presence, seabed disturbance and subsidence and the (albeit low) potential for significant hydrocarbon spill, the Department's view is that a significant impact on the environment as a result of the proposed action is **likely**. The Department therefore considers that sections 23 and 24A should be controlling provisions for the proposed action.

Impacts on listed threatened species and listed migratory species from greenhouse gas emissions

The Department considers it is not possible to demonstrate a sufficient relationship between the consequences of the increase in GHG emissions and impacts on any species. The Department therefore considers it is **unlikely** that GHG emissions from the proposed action would result in an identifiable significant impact on specific listed threatened or migratory species.

Other issues regarding impacts from greenhouse gas emissions

If you agree to the recommendations in this brief, the Department will require a detailed estimate of the total and annual average GHG emissions expected from the proposed action, including from liquefaction of the gas extracted from the Brecknock, Calliance and Torosa reservoirs at KGP, from shipping LNG overseas, and from combustion of the LNG overseas, be included in the assessment documentation for the proposed action, via the EIS Guidelines.

The Department expects that the direct and indirect GHG emissions from the Scarborough reservoir, and the impacts of those emissions, will be taken into account by NOPSEMA in assessing that separate action.

The Department considers that, by regarding the GHG emissions from the liquefaction of gas onshore and the combustion of liquefied gas overseas as indirect impacts of upstream extraction projects such as the referred action, there is no issue in not refusing to accept the split referral of Burrup Hub projects; that is, the objects of the EPBC Act are not frustrated.

Heritage

There are also known and potentially unknown shipwrecks in the proposed action area or surrounds. All shipwrecks, whether known or unknown, are protected under the *Historic Shipwrecks Act 1976*. The *Historic Shipwrecks Act 1976* will be replaced by the *Underwater Cultural Heritage Act 2018*, when it comes into force on a day to be fixed by Proclamation, or 12 months after Royal Assent. The *Underwater Cultural Heritage Act 2018* also provides protection for shipwrecks.

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The Heritage Section advises that the proponent should be required to implement measures to mitigate potential damage to historic shipwrecks (Attachment E29). The proponent is aware of known shipwrecks in the vicinity of the proposed action, including the Yarra, the Lively and the Haw Kiet (Attachment D2). If any additional shipwrecks are identified during surveys or installation activities, the proponent has committed to avoiding them and reporting their discovery to the Department (Attachment D2).

The Scott Reef and Surrounds Commonwealth Heritage place (Place ID 10548) was listed for its significant heritage value because of the place's importance in the course or pattern of Australia's natural or cultural history, its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history, and its potential to yield information that will contribute to an understanding of Australia's natural or cultural history (Attachment E29). The proposed action area is, at its closest, approximately 4 km from the Scott Reef and Surrounds Commonwealth Heritage place, which lies directly above the Torosa reservoir. The Heritage Section advises (Attachment E29) that the proposed action has the potential to impact the heritage values of the Scott Reef and Surrounds Commonwealth Heritage place, in particular the deep coral ecosystem of the southern atoll, which is considered a global coral refugia. However, the Heritage Section considers the proponent's proposed avoidance and mitigation measures to be appropriate, and sufficient to effectively mitigate the potential impacts (Attachment E29).

The Mermaid Reef – Rowley Shoals Commonwealth Heritage place (Place ID 105255) was listed for its significant heritage values because of the place's importance in the course or pattern of Australia's natural or cultural history, its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history, its potential to yield information that will contribute to an understanding of Australia's natural or cultural history, and its importance in demonstrating the principal characteristics of a class of Australia's natural or cultural places or environments (Attachment E29). The trunkline is proposed to lie approximately 9.5 km from the Mermaid Reef – Rowley Shoals Commonwealth Heritage place. The Heritage Section considers that the proximity of the Trunkline Area to this place causes concern regarding the long-term impact on heritage values of a potential hydrocarbon spill (Attachment E29). However, the Heritage Section considers the proponent's proposed avoidance and mitigation measures to be appropriate, and sufficient to effectively mitigate the potential impacts (Attachment E29).

Given the proposed mitigation measures and the Heritage Section's advice that implementation of these strategies will effectively mitigate the potential impacts of the proposed action on Commonwealth Heritage places (Attachment E29), the Department considers that the proposed action is **unlikely** to have a significant impact on a Commonwealth Heritage place.

Indonesian Traditional Fishers

Under a Memorandum of Understanding between Australia and Indonesia, Indonesian traditional fishers are allowed to fish in Scott Reef and to collect trochus shell and trepang (sea cucumber) (Class *Holothuroidea*) (see map of MoU Box in Attachment E3). Potential impacts to traditional fishermen include collision with traditional fishing vessels, exclusion of traditional fishermen from their fishing grounds, and acoustic disturbance to Indonesian fishermen swimming or breath-hold diving for trepang.

Given that the FPSO facilities will be located away from approach and exit paths to Scott Reef that are likely to be used by Indonesian traditional fishers (Attachment D2), and the exclusion zone to be applied around those facilities, the Department considers that significant impacts to Indonesian traditional fishers are **unlikely**.

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Key Ecological Features

The proposed action will intersect two key ecological features (KEFs), the Continental slope demersal fish communities, and Seringapatam Reef and Commonwealth waters in the Scott Reef complex (Figure 10 in Attachment D2); the trunkline will traverse the former for approximately 250 km (Attachment D2). Based on the above discussion of the impacts of the proposed action, the Department considers that the proposed action is **likely** to have a significant impact on these key ecological features, and therefore on the environment generally.

Conclusions on impacts to: listed threatened species and communities; migratory species; and the environment generally

The Department considers that the proposed action is likely to have a significant impact on listed threatened species and communities because of:

- Acoustic disturbance
- Light emissions
- Vessel disturbance
- Subsidence of Scott Reef
- Management of seafloor infrastructure
- Potential for significant hydrocarbon spill.

On this basis, the Department recommends that that you decide that ss 18 and 18A are controlling provisions for the proposed action.

The Department considers that the proposed action is likely to have a significant impact on listed migratory species because of:

- Acoustic disturbance
- Light emissions
- Helicopter use
- Subsidence of Scott Reef
- Management of seafloor infrastructure
- Potential for significant hydrocarbon spill.

On this basis, the Department recommends that that you decide that ss 20 and 20A are controlling provisions for the proposed action.

The Department considers that the proposed action is likely to have a significant impact on the environment because of:

- Acoustic disturbance;
- Light emissions;
- Discharges and emissions to the sea and atmosphere;
- Vessel and helicopter use;
- Subsidence;
- Management of seafloor infrastructure;
- Potential for significant hydrocarbon spill;
- Contribution of proposed action to climate change.

On this basis, the Department recommends that that you decide that ss 23 and 24A are controlling provisions for the proposed action.

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National Heritage places

The ERT (Attachment E4) did not identify any National Heritage places located within or adjacent to the proposed action area; however, Heritage Division advice (Attachment E36) notes that the Dampier Archipelago (including the Burrup Peninsula) (Place ID 105727), which was included in the list of National Heritage Places on 3 July 2007, is likely to be indirectly impacted by the proposed action.

As set out above, section 75(2) requires you to consider all adverse impacts the proposed action has, will have or is likely to have on the matters protected by each provision of Part 3.

The Department considers that impacts from emissions of NOx, CO_2 and volatile organic compounds (noxious emissions) are an indirect, adverse impact that the proposed action is likely to have on the national heritage values of the Dampier Archipelago National Heritage Place.

For this reason, the Department recommends that you consider the indirect impacts from the proposed action's noxious emissions when deciding whether the following provision is controlling provisions for the proposed action:

- section s15B & section 15C (National heritage values of a National Heritage place)

The Department's analysis of impacts from noxious emissions on the Dampier Archipelago (including the Burrup Peninsula) National Heritage Place is set out below for your consideration.

The Dampier Archipelago (including the Burrup Peninsula) National Heritage Place borders the lease boundary of the Karratha Gas Plant (KGP) near Dampier on the WA coast. The place contains one of the richest and diverse collections of rock art (referred to as petroglyphs) in Australia; the petroglyphs are among the national heritage values for which the place is listed. The art features a range of motif types including anthropomorphic and zoomorphic figures and geometric and amorphous designs. The petroglyphs range considerably in their motif subject content, technique, antiquity and distribution across the landscape.

Potential impacts

Having regard to the statement in the Significant Impact Guidelines that a 'significant impact' is an impact which is important, notable or of consequence, having regard to its context or intensity, the Department considers the relevant significance threshold in the context of 'national heritage' is whether there is a real chance or possibility that the noxious emissions resulting from the action will:

- one or more of the National Heritage values to be degraded or damaged, or
- one or more of the National Heritage values to be notably altered, modified, obscured or diminished.

Advice from the Heritage Branch on EPBC 2018/8335 noted the evidence presented at the 2018 *Senate Inquiry into the Protection of Aboriginal rock art of the Burrup Peninsula* (Attachment E39). The Inquiry noted there is significant uncertainty about what might be a safe or acceptable emission threshold for maintaining the integrity of the petroglyphs, and the ongoing cumulative effects of third party emissions on the integrity and condition of the rock art values (Attachment E39). This uncertainty includes airborne emissions from existing and future industrial uses on the Burrup Peninsula including the KGP.

The Heritage Branch has also raised concerns about the lack of information on the consultation undertaken by Woodside with traditional owners on the Karratha Gas Plant extension and sought additional information that demonstrates, amongst other things, that the relevant

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Indigenous people understand the proposal and assessment processes and the potential impacts on their heritage values and places (Attachment E39).

If the proposed action is approved and proceeds, it will offer a potential supply of gas for processing (liquefaction) at the KGP. If the North West Shelf Project Extension proposal (EPBC 2018/8335) is also approved and proceeds, extending the operating life of the Karratha Gas Plant until 2068, then:

- The noxious emissions from the KGP to the atmosphere will continue beyond 2030 (the facility is currently only authorised to operate until that time). The proposed action could also lead to a change in the composition of noxious emissions. The continuation of, and the change in composition of the noxious emissions may each have impacts on the petroglyphs by contributing to an acceleration in the weathering of the petroglyphs.
- The availability of useable LNG from the KGP (and/or the adjacent Pluto LNG Facility which is already approved under the EPBC Act (EPBC 2006/2968; Attachment E35) may catalyse additional third party development on the Burrup Peninsula, including the Perdaman Urea proposal (EPBC 2018/8383) and other imminent referrals from the Mitsubishi/Wesfarmers/Coogee Chemicals Methanol project (Attachment E36). These proposals could facilitate amplified, cumulative noxious emissions from the Burrup Peninsula resulting in an increasingly adverse impact on the petroglyphs.

As mentioned above, the legal test for indirect impacts is found in section 527E(1) and (2). For impacts resulting from an action taken by an independent third party to be 'indirect impacts' of the proposed action, the action must be a substantial cause of that event or circumstance. The exception is where the event or circumstance is the result of an action by a third party independently of the proponent (in that situation, there is a different legal test which is discussed below in relation to the third source of emissions). As set out above, this exception is not applicable to emissions from the KGP, as Woodside will also be the person taking the (separate) action that covers processing the gas at KGP (see EPBC 2018-8335); there is no relevant third party.

Considering the test set out in s 527E(1)(b) and (2) of the EPBC Act, the Department considers the proposed liquefaction of the gas extracted from the Brecknock, Calliance and Torosa reservoirs at the KGP is an indirect result of the referred action, with the effect that impacts from the liquefaction must be considered when assessing the impacts of the proposed action on the national heritage values of the Dampier Archipelago national heritage place.

This is because the proposed action is a substantial cause of the noxious emissions from liquefaction of the gas extracted from the Brecknock, Calliance and Torosa reservoirs. The proposed action will directly result in the gas in question being extracted being liquefied; without the proposed action, the gas from the Brecknock, Calliance and Torosa reservoirs would not be liquefied at the KGP and the noxious emissions resulting would not occur. In other words, the proposed action will facilitate the environmental impacts resulting from the liquefaction and noxious emissions.

Woodside would have contemplated the need to liquefy the gas at KGP, and that the noxious emissions may result in increased impacts on the petroglyphs.

Avoidance and mitigation measures

In the referral for EPBC 2018/8335, Woodside advise they expect atmospheric emissions from that proposal will be in line with current permitted levels and Woodside, as operator of the Karratha Gas Plant, will continue to assess emission reduction opportunities that could result in a staged decrease in emissions over time (Attachment E38).

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Assessment and conclusion about impacts of noxious emissions resulting from the proposed action on the national heritage values

Assuming the continuation of, and a change in composition of emissions from the KGP, and assuming the availability of useable LNG for an extended period may catalyse additional third party development on the Burrup Peninsula, the Department considers the proposed action is likely to result in indirect, cumulative impacts on the petroglyphs of the Burrup Peninsula. The proponent has not demonstrated that significant impacts could be avoided or mitigated effectively.

You should note the proponent has written to the Department presenting reasons why the controlling provision: National heritage values of a National Heritage place, should not be triggered (Attachment E43). For the reasons set out above, the Department disagrees.

The Department considers that the proposed action is likely to have a significant impact on the national heritage values of the Dampier Archipelago (including the Burrup Peninsula) National Heritage Place, specifically, the likely acceleration in the weathering of the petroglyphs. On this basis, the Department recommends that that you decide that ss 15B and 15C are controlling provisions for the proposed action.

PROTECTED MATTERS THAT ARE NOT CONTROLLING PROVISIONS

Ramsar Wetlands	The ERT (Attachment E4) did not identify any Ramsar listed wetland of international importance within or adjacent to the proposed action area, therefore this controlling provision does not apply.
World Heritage properties	The ERT (Attachment E4) did not identify any World Heritage properties located within or adjacent to the proposed action area, therefore this controlling provision does not apply.
Commonwealth action	The referring party is not a Commonwealth agency, therefore this controlling provision does not apply.
Commonwealth land	The proposed action is not being undertaken on Commonwealth land, therefore this controlling provision does not apply.
Nuclear action	The proposed action does not meet the definition of a nuclear action as defined in the EPBC Act, therefore this controlling provision does not apply.
Great Barrier Reef Marine Park	The proposed action is located off the coast of Western Australia, therefore this controlling provision does not apply.
Commonwealth Heritage places overseas	The proposed action is not located overseas, therefore this controlling provision does not apply.
A water resource, in relation to coal seam gas development and large coal mining development	The proposed action is not a coal seam gas or a large coal mining development, therefore this controlling provision does not apply.

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SUBMISSIONS

Public submissions

The proposal was published on the Department's website on 16 November 2018 and public comments were invited until 30 November 2018. No public submissions were received.

Comments from Commonwealth Ministers

By letter dated 16 November 2018, the following ministers were invited to comment on the referral:

- The Hon David Littleproud MP, Minister for Agriculture and Water Resources;
- The Hon Christian Porter MP, Attorney-General;
- The Hon Angus Taylor MP, Minister for Energy;
- Senator the Hon Mathias Cormann, Minister for Finance, via his nominated delegate, Mr Andrew Smith, Assistant Secretary, Property Portfolio Operations Branch, Department of Finance;
- Senator the Hon Nigel Scullion, Minister for Indigenous Affairs;
- The Hon Karen Andrews MP, Minister for Industry, Science and Technology;
- The Hon Michael McCormack MP, Minister for Infrastructure, Transport and Regional Development;
- Senator the Hon Matt Canavan, Minister for Resources and Northern Australia;
- Senator the Hon Simon Birmingham, Minister for Trade, Tourism and Investment.

The Department received the following responses:

- s. 22(1)(a)(ii), Senior Investment Specialist responded on behalf of Austrade on 20 November 2018 (Attachment C2) and advised that Austrade has no issues to raise.
- s. 22(1)(a)(ii), Assistant Manager, Mining and Investment responded on behalf of the Department of Industry, Innovation and Science (DIIS) on 30 November 2018 (Attachment C3) and noted that DIIS supports the proposed development and NOPSEMA's role in the assessment process. The response also advised that Geoscience Australia agrees that the proposed action is not a nuclear action, nor a water issue related to coal seam gas or coal mining.
- The Hon Christian Porter MP, Attorney-General, responded on 7 December 2018 (Attachment C4) and noted that the referral recognises that further work and assessment is required to confirm possible impacts and to finalise mitigation measures. Therefore, the Attorney-General requests that his Department continue to be consulted as the proposal progresses. The Attorney-General's Department advises that there are currently no native title claims or applications over the proposed development area, but that in the unlikely event of a native title claim being brought, the development would need to comply with the future acts regime in the *Native Title Act 1993*.
- s. 22(1)(a)(ii), Acting Assistant Secretary, Climate and Resilience Policy Branch, Department of Agriculture and Water Resources (DAWR), responded on 18 December 2018 (Attachment C5), on behalf of the Minister for Agriculture and Water Resources, and stated that DAWR had no comments from a portfolio perspective on whether the proposed action may have significant impacts on a matter of national environment significance.

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DAWR encourages the proponent to maintain open communication and consultation with stakeholders, including NOPSEMA, the Australian Fisheries Management Authority, Seafood Industry Australia, Australian Recreational Fishing Foundation, Commonwealth Fisheries Association, Western Australian Fishing Industry Council, North West Slope Trawl Fishery, Western Tuna and Billfish Fishery, Southern Bluefin Tuna Fishery, and Western Skipjack Tuna Fishery, throughout the project's life.

Comments from State Ministers

By letter dated 16 November 2018, the following State minister was invited to comment on the referral:

- Mr Mike Rowe, Director General, Department of Water and Environmental Regulation (DWER), as the nominated delegate for Mr Stephen Dawson MLC, Minister for Environment and Disability Services, and the Hon Bill Johnston MLA, Minister for Mines and Petroleum.

Mr Rowe responded on 28 November 2018 and noted that the EPA has received a referral for the State waters component of the proposed action, but had not yet made a decision on whether or not to assess the proposal (Attachment C1).

A decision on assessment approach was subsequently made by the EPA. On 24 January 2019, the EPA published a notice stating the proposal will be assessed at the level of Public Environment Review because of the:

- high environmental values of Scott Reef (where the proposal is located);
- proposed installation and production of subsea wells in State waters; and
- extent of the proposal's direct and indirect impacts (Attachment E31).

ASSESSMENT APPROACH

If you agree that the action is a controlled action, you must decide on the approach for assessment in accordance with section 87 of the EPBC Act. Although there is some overlap between this referral and a parallel proposal submitted to DWER, accredited assessment is not possible in this case due to the significant development proposed to be undertaken in Commonwealth waters. The Department recommends that this proposal be assessed by an environmental impact statement under Part 8 of the EPBC Act.

Given the location of matters of national environmental significance, the number of matters likely to be impacted, the scale of the action, and potential impacts from the proposal, that form of assessment represents an appropriate method that will ensure that impacts on the controlling provisions are appropriately assessed.

Under section 87(3)(b) of the EPBC Act, you must consider any other relevant information available about the relevant impacts of the action, including information in a report on the impacts of actions under a policy, plan or program under which the action is to be taken that was given to the Minister under an agreement under Part 10 (about strategic assessments).

In 2013-2014 a strategic assessment was undertaken to create a sole regulator for offshore petroleum and greenhouse gas activities in Commonwealth waters. Since 2014, NOPSEMA has been the primary Commonwealth regulator for all offshore oil and gas activities. Ordinarily, assessment and regulation of actions undertaken in Commonwealth waters would be undertaken by NOPSEMA. However, the proponent requested, and the Department and

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NOPSEMA have agreed due to the complex cross-jurisdictional issues (Attachment E30), that the Department should accept the proponent's referral which will, subject to the approval of the proposed action under Part 9 of the EPBC Act, enable them to submit an Environment Plan to NOPSEMA for their activity (in accordance with regulation 9(3)(b)(iii) of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations* 2009).

The Department considers that the services of NOPSEMA are required during the assessment process, given their specialist expertise in offshore petroleum and greenhouse gas activities. If you agree to Recommendation 10 of this brief, and approve the procurement of NOPSEMA's services in the Department's Procure to Pay system, the Department will send NOPSEMA the work order (Attachment G; consistent with a Deed by which such services may be obtained, Attachment H), at which point a contract will be formed. The Department and NOPSEMA will cooperate with DWER with a view to streamlining the process.

In making your decision you must consider the matters summarised in the table below:

Matter to be considered	**Comment**
Any other information about the impacts of the action considered relevant - s87(3)(b)	Relevant information is discussed in the Department's advice on relevant impacts contained in the referral decision brief.
Any comments received from a State or Territory minister relevant to deciding the appropriate assessment approach – s87(3)(c)	DWER stated (Attachment C1) that it cannot comment on whether the proposed action was suitable for an accredited assessment. The Department notes that an accredited assessment is not possible, as the proposed action area referred to the Department includes Commonwealth waters, whereas the referral to the State is limited to State waters. No other comments were received relating to the assessment approach.
Minister may decide on an Accredited Assessment if certain requirements are met – s87(4)	Assessment by an accredited assessment process is not possible. The Department and NOPSEMA will cooperate with DWER as appropriate.

OTHER MATTERS FOR DECISION-MAKING

Significant impact guidelines

The Department has reviewed the information in the referral against the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance* (December 2013) and other relevant material. While this material is not binding or exhaustive, the factors identified are considered adequate for decision-making in the circumstances of this referral. Adequate information is available for decision-making for this proposal.

Precautionary principle

In making your decision under section 75, you are required to take account of the precautionary principle (section 391). The precautionary principle is that a lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage.

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Bioregional Plans

In accordance with section 176(5), you are required to have regard to a bioregional plan in making any decision under the Act to which the plan is relevant.

The Department has had regard to the *Marine bioregional plan for the North-west Marine Region* (Attachment E1) in making its recommendation (see discussion above).

Cost Recovery

The fee schedule (with justifications) for your consideration is at Attachment F1. Before you agree with the Recommendation 6 in this brief, you should note that the Department recommends (at row P of Attachment F1) that the 'exceptional circumstances' criteria are met for the purposes of the assessment of this proposed action. The 'exceptional circumstances' criteria, found in the *Cost Recovery Implementation Statement: Cost Recovery For Environmental Assessments under the Environment Protection and Biodiversity Conservation Act 1999 (2016-17)* (Attachment E34) are:

> Novel scope of work/ action/ process or location, and potential impacts are unclear.
>
> OR
>
> Action is understood, but environmental consequences are very high and carry the potential for severe/ irreversible/ long-term impacts.

In this instance, having regard to the Department's need to contract NOPSEMA to draft a recommendation report, and the complex cross-jurisdictional issues involved in the proposed action, the Department considers the assessment of the proposed action will be considering a novel scope of work. The fee schedule (without justifications) at Attachment F2, and an invoice for Stage 1, will be sent to the person taking the action, seeking payment of fees prior to the commencement of any further activity.

s. 22(1)(a)(ii)

Acting Director
Major Projects West Section
Assessments (WA, NT, SA) and Post Approvals Branch
Ph: s. 22(1)(a)(ii)

February 2019

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ATTACHMENTS

A:	Decision Notice FOR SIGNATURE	v1.0
B:	Letters FOR SIGNATURE	
B1:	Proponent	v1.0
B2:	Delegate of WA Minister for Environment and Disability Services and the WA Minister for Mines and Petroleum	v1.0
B3:	Delegate of the Minister for Industry	v1.0
B4:	Attorney-General	v1.0
C:	Comments received	
C1:	WA Department of Water and Environmental Regulation	v1.0
C2:	Austrade	v1.0
C3:	Department of Industry, Innovation and Science (including Geoscience Australia)	v1.0
C4:	Attorney-General	v1.0
C5:	Department of Agriculture	v1.0
D:	Referral	
D1:	*Referral form*	v1.0
D2:	*Supporting Document*	v1.0
D3:	*Climate Change Policy*	v1.0
D4:	*Health, Safety, Environment and Quality Policy*	v1.0
D5:	*Protected Matters Report*	v1.0
D6:	*Browse Shapefiles*	v1.0
D7:	Email from the proponent (received 13 February 2019)	v1.0
E:	References	
E1:	*Marine bioregional plan for the North-west Marine Region*	v1.0
E2:	Map of Scott Reef	v1.0
E3:	Australia-Indonesia MoU Box (1974)	v1.0
E4:	Environment Report Tool: 20 February 2019, 20 km buffer	v1.0
E5:	Burrup Hub Information (saved webpage)	v1.0
E6:	EPBC Act Species and Ecological Communities Weekly Report 18 February 2019	v1.0
E7:	Threatened and Migratory species potentially impacted by the proposed action	v1.0
E8:	Additional Information from the proponent (18 December 2018)	v1.0
E9:	*Great Barrier Reef Underwater Noise Guidelines* (Discussion Paper, August 2017)	v1.0

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E10: *A critical review of the potential impacts of marine seismic surveys on fish and invertebrates*	v1.0
E11: *Noise in the Sea and Its Impacts on Marine Organisms*	v1.0
E12: *Australian National Guidelines for Whale and Dolphin Watching 2017*	v1.0
E13: *EPBC Act Policy Statement 2.1 - Interaction between offshore seismic exploration and whales: Industry guidelines*	v1.0
E14: Migratory Species Section advice (29 November 2018)	v1.0
E15: *Conservation Management Plan for the Blue Whale* (2015)	v1.0
E16: *Conservation Advice* Megaptera novaeangliae *(humpback whale)* (2015)	v1.0
E17: *Recovery Plan for Marine Turtles in Australia* (2017)	v1.0
E18: *Approved Conservation Advice for* Aipysurus apraefrontalis *(Short-nosed Sea Snake)* (2010)	v1.0
E19: Parks Australia Division advice	v1.0
E20: *Sawfish and River Sharks Multispecies Recovery Plan* (2015)	v1.0
E21: *Green turtle nesting sites on Sandy Islet Jan-Feb 2010* [extract from Guinea, ML 2010, Long Term Monitoring of the Marine Turtles of Scott Reef February 2010, Field Survey Report produced for the proponent (from EIS for EPBC 2013-7079, Appendix F26)	v1.0
E22: *Whale shark management with particular reference to Ningaloo Marine Park* (WA DPAW) (2013)	v1.0
E23: *EPBC Regulations*, Part 8	v1.0
E24: *Woodside Kimberley Sea Noise Logger Program, Sept-2006 to June-2009: Whales, Fish and Man-made Noise* (2011, from EIS for EPBC 2013-7079, Appendix F29)	v1.0
E25: *A Three Dimensional Hydrodynamic Model of Scott Reef*	v1.0
E26: Gas giants look to renewables to cut energy (*The West Australian* 5 June 2018)	v1.0
E27: Referral of the North West Shelf Project Extension, Carnarvon Basin, WA (EPBC 2018-8335)	v1.0
E28: Climate Change Division advice (20 December 2018)	v1.0
E29: Heritage Division advice (3 December 2018)	v1.0
E30: Letter to Proponent (29 March 2018)	v1.0
E31: EPA Notice (24 January 2019)	v1.0
E32: *EPBC Act* Significant *Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies*	v1.0
E33: *EPBC Act Policy Statement: Staged Developments—Split referrals*	v1.0
E34: *Cost Recovery Implementation Statement*	v1.0
E35: *Consolidated Approval Notice for EPBC 2006/2968*	v1.0

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E36: Heritage Division advice (15 February 2019)	v2.0
E37: Climate Change Division advice (18 February 2019)	v2.0
E38: EPBC 2018/8335 referral	v1.0
E39: Heritage Branch Advice on EPBC 2018/8335	v2.0
E40: Department's website: *Understanding Climate Change*	v1.0
E41: Legal Section advice (22 February 2019a)	v1.0
E42: Legal Section advice (22 February 2019a)	v1.0
E43: Additional Information from the proponent (22 February 2019)	v1.0
F: Fee Schedules	
F1: Fee schedule (with justifications)	v1.0
F2: Fee schedule (without justifications)	v1.0
G: Work order to be sent to NOPSEMA	
G1: Work Order	v1.0
G2: NOPSEMA's Cost estimate (20 December 2018)	v1.0
H: Deed of Standing Offer (November 2018)	v1.0

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Archived: Tuesday, 4 August 2026 10:14:47 AM
From: s. 22(1)(a)(ii)
Mail received time: Tue, 23 Jun 2026 06:35:17 +0000
Subject: Re: Update on the Browse to North West Shelf Development Project (EPBC 2018/8319): Reconsideration Request Validity Determination
Attachments:
Attachment 1 - Letter from EJA.pdf; Attachment 2 - independent expert report.pdf; Attachment 3 - Climate action journal article.pdf;

OFFICIAL

Hi s. 22(1)(a)(ii),

Please find the 3 attachments. Sorry for not including this initially and the confusion. Please let us know if you require anything else.

Kind regards,

s. 22(1)(a)(ii) **(she/her)**
Senior Assessment Officer

Environment Regulation Division | Environment Assessments West Branch | North WA Section
Department of Climate Change, Energy, the Environment and Water
**Please note that I am located on the country of the Yirrganydji people, Far North Queensland*

OFFICIAL

From: s. 22(1)(a)(ii) @woodside.com>
Sent: Tuesday, 23 June 2026 4:26 PM
To: s. 22(1)(a)(ii) @dcceew.gov.au>; s. 22(1)(a)(ii) @dcceew.gov.au>
Cc: s. 22(1)(a)(ii) @dcceew.gov.au>; North WA section <NorthWA.Section@dcceew.gov.au>; BrowseNotices <BrowseNotices@woodside.com.au>; s. 22(1)(a)(ii) @woodside.com>
Subject: RE: Update on the Browse to North West Shelf Development Project (EPBC 2018/8319): Reconsideration Request Validity Determination

Dear s. 22(1)(a)(ii) and s. 22(1)(a)(ii),

Thank you for your email.

It appears the attachments were not included with the letter. Could you please resend the email with the attachments?

Many thanks,

s. 22(1)(a)(ii)

Environment Lead - Browse Project | HSE

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Woodside Energy
Mia Yellagonga
Karlak, 11 Mount Street
Perth WA 6000
Australia

T: +s. 22(1)(a)(ii)
M:+s. 22(1)(a)(ii)
E: s. 22(1)(a)(ii) @woodside.com
www.woodside.com

Please note I?m currently working school hours on Monday, Tuesday, Thursday and Friday. If you email outside of these hourse and the matter is urgent please contact me on my mobile s. 22(1)(a)(ii) *).*

I acknow ledge the Whadjuk Noongar people as the traditional custodians of the land on w hich I choose to live and w ork.
Creating a safe and inclusive w orking environment is everyone?s responsibility.

From: s. 22(1)(a)(ii) @dcceew.gov.au>
Sent: Tuesday, 23 June 2026 2:07 PM
To: s. 22(1)(a)(ii) @woodside.com>
Cc: s. 22(1)(a)(ii) <Candace.Cooke@dcceew.gov.au>; s. 22(1)(a)(ii) @dcceew.gov.au>; North WA section <NorthWA.Section@dcceew.gov.au>; s. 22(1)(a)(ii) @woodside.com>; BrowseNotices <BrowseNotices@woodside.com.au>
Subject: Update on the Browse to North West Shelf Development Project (EPBC 2018/8319): Reconsideration Request Validity Determination

OFFICIAL

Dear s. 22(1)(a)(ii)

Please find attached a letter for Woodside Energy Ltd regarding a reconsideration request received in February 2026 for the Browse to North West Shelf Development Project (EPBC 2018/8319). This outlines the determination of validity and next steps.

If you have any questions or concerns, please contact s. 22(1)(a)(ii), Director, North WA Assessment Section on s. 22(1)(a)(ii) or at s. 22(1)(a)(ii) @dcceew.gov.au.

Kind regards,

s. 22(1)(a)(ii) **(she/her)**
Senior Assessment Officer

Environment Regulation Division | Environment Assessments West Branch | North WA Section
Department of Climate Change, Energy, the Environment and Water
E s. 22(1)(a)(ii) @dcceew.gov.au
**Please note that I am located on the country of the Yirrganydji people, Far North Queensland*

DCCEEW.gov.au ABN 63 573 932 849

We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past and present.

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Our ref: A54157

ENVIRONMENTAL JUSTICE AUSTRALIA

18 February 2026

Senator the Hon Murray Watt
Minister for the Environment and Water
PO Box 6100
Senate
Parliament House

By email: minister.watt@dcceew.gov.au

Dear Minister Watt

Request for reconsideration of decision under s 78A of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth): Browse to North West Shelf Development (EPBC No. 2018/8319)

A. Introduction and summary

1. We are instructed by the Australian Conservation Foundation (**ACF**) to request, pursuant to s 78A of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (**EPBC Act**), that you reconsider the decision of the Minister's delegate made under s 75(1) of that Act, in respect of the Browse to North West Shelf Development (EPBC No. 2018/8319) (the **Browse project**), dated 22 February 2019 (the **controlled action decision**).

2. ACF is Australia's national environmental organisation, representing a community of more than 700,000 people who are committed to achieving a healthy environment for all Australians. For more than 50 years, ACF has been a strong advocate for Australia's forests, rivers, people and wildlife. ACF promotes awareness, lobbies government and is committed to taking advantage of any lawful right or privilege to raise awareness of environmental issues.

3. This reconsideration request is made on the basis of substantial new information which identifies the impacts that the Browse project will, or is likely to, have on the environment in the Great Barrier Reef Marine Park (**GBRMP**) and its protected values as a declared World Heritage property –matters protected under Part 3 of the EPBC Act.[1]

4. As you are already aware, there are several controlling provisions attached to the project including: National heritage places (ss 15B and 15C), listed threatened species and

[1] We note that the Great Barrier Reef Marine Park comprises approximately 99% of the Great Barrier Reef World Heritage Property. For reference, our reference to the Great Barrier Reef Marine Park in this reconsideration request also includes a reference to the Great Barrier Reef World Heritage Property.

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communities (ss 18 and 18A), listed migratory species (ss 20 and 20A) and Commonwealth marine area (ss 23 and 24A).[2] Neither the environment of the GBRMP nor its protected values are listed as controlling provisions (ss 24B and 24C and ss 12 and 15A).

5. The substantial new information enclosed as **Annexure A** with this request comprises a report from Professor Sarah Perkins-Kirkpatrick dated 12 February 2026 (**Report**) which demonstrates that the emissions from the Browse project are likely to have significant physical effects on the environment in the GBRMP and its protected values, namely the additional loss of approximately 29.35 million individual coral colonies on the GBRMP during each future mass bleaching event.

6. The Report at Annexure A is novel. It draws on established principles of attribution science but extends them in a significant and new direction, providing a scientifically grounded causal chain linking project emissions to measurable climate impacts. It uses the detailed methodology set out in the 2025 publication by Abrams et. Al, *Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making*.[3] A copy of this publication is enclosed as **Annexure B**.

7. For the reasons set out in this reconsideration request, you should be satisfied that the conditions in s 78(1)(a) are met and that you would:

    a. Revoke, in accordance with s 78(1)(a) of the EPBC Act, the controlled action decision by the Minister's delegate setting out the controlling provisions for the Browse project.

    b. Substitute, in accordance with 75(1) of the EPBC Act, a new decision which includes ss 24B and 24C and ss 12 and 15A of the EPBC Act as controlling provisions (the **GBRMP controlling provisions**).

8. This reconsideration request is structured as follows:

    a. **Part B** addresses, by way of background, the details of the Browse project (see [9] below), the relevant controlled action decision (see [11] below) and the legislative context (see [18] below).

    b. **Part C** provides an overview of the request, including the materials provided with this request, namely the report of Professor Perkins-Kirkpatrick enclosed as **Annexure A**. It also addresses why this is a valid request for reconsideration which you, as the responsible Minister, are now bound to determine (see [32] below).

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[2] Australian Government Department of the Environment and Energy, *Notification of Referral Decision and Designated Proponent – controlled action and Decision on Assessment approach – environmental impact statement: Browse to North West Shelf Development, Indian Ocean, WA [EPBC 2018/8319]* (22 February 2019) < https://epbcpublicportal.environment.gov.au/all-referrals/project-referral-summary/project-decision/?id=06ce8ddd-26e9-e811-a978-005056ba00a8> (the **controlled action decision**).

[3] Abrams et al, *Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making* (2025) npj Climate Action 4(1) (**Annexure B**).

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c. **Part D** addresses the relationship between this reconsideration request and the approval of the Browse project (see [52] below).

B. Background

B.1 *The Browse Project*

9. The Browse project proposes to develop and extract gas from the Browse Basin until 2068. The proposal seeks to extract LNG from the Browse reservoir and transport the extracted gas via a 900km pipeline to the Karratha Gas Plant for processing. The designated proponent is Woodside Energy Ltd (ACN: 005 482 986).

10. The proponent estimates that the lifetime scope 1 and 3 greenhouse gas emissions (**GHG**) resulting from the Browse project will total 1,602 Mt CO_2-e.[4]

B.2 *The controlled action decision*

11. On 22 February 2019, a delegate of the Federal Minister for the Environment and Water determined that the Browse project was a controlled action under s 75 of the EPBC Act. At that time, the decision-maker determined that the controlling provisions for the Browse project were:

    a. National heritage places (ss 15B and 15C).

    b. Listed threatened species and communities (ss 18 and 18A).

    c. Listed migratory species (ss 20 and 20A).

    d. Commonwealth marine area (ss 23 and 24A).[5]

12. At the time the decision-maker determined the controlling provisions for Browse, the delegate's referral brief noted that the protected matters in ss 24B and 24C as well as ss 12 and 15A were not controlling provisions because "[t]he proposed action is located off the coast of Western Australia, therefore this controlling provision [being, the GBRMP controlling provision] does not apply"[6] and that no identified "World Heritage properties [were] located within or adjacent to the proposed action area, therefore this controlling provision does not apply."[7]

13. Furthermore, following the controlled action decision, the proponent published its final Environmental Impact Statement (**EIS**) [8] consisting of the Environmental Impact Assessment (published December 2019)[9] and the Supplement to the EIS (published July

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[4] *Proposed Browse to NWS Project, Draft Environmental Impact Statement* (Woodside Energy Ltd., 2019) (Table 7-5 (Scope 1) and Table 7-9 (Scope 3)), pp. 686-688: estimates that the lifetime Scope 1 emissions will total approximately 272 Mt CO_2-e and lifetime Scope 3 emissions will total approximately 1,330 Mt CO_2-e. Together, this amounts to 1,602 Mt CO_2-e or around 1.6 billion tonnes Mt CO_2-e.

[5] The controlled action decision, above n 1, p 1.

[6] Department of Environment and Energy, Referral Decision Brief – Browse to North West Shelf Development, Indian Ocean, Western Australia (EPBC 2018/8319), p 36.

[7] Ibid.

[8] Publication of final Environmental Impact Statement under s 104(4) of the EPBC Act.

[9] Woodside Energy, Proposed Browse to North West Shelf Project Draft Environmental Impact Statement/Environmental Review Document (EPBC 2018/8319).

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2022).[10] In the Supplement to the EIS, the proponent noted that "It is important to acknowledge that anthropogenic climate change impacts cannot be directly attributable to any one project…"[11]

14. As outlined above at paragraphs [5]-[6] of this request, the Report relies on methodology published in October 2025 which represents a significant and novel expansion of established climate attribution science and disproves the assertion that it is not possible to attribute anthropogenic climate change impacts to individual fossil fuel projects.

15. The Report establishes that it is now scientifically possible to link GHG emissions from individual fossil fuel projects (like the Browse project) with additional global warming and quantify the ecological and human impacts of that warming at global and regional scales.[12] This is possible regardless of the location of the proposed action.

16. The Report demonstrates that there are real, quantifiable and significant impacts to the environment and values of the GBRMP associated with the additional warming attributable to the Browse project.

17. The existence of this new evidence warrants the revocation of the original controlled action decision and the substitution of a new controlled action decision which includes the GBRMP controlling provisions because it demonstrates that there are real, quantifiable and significant impacts to the environment and values of the GBRMP associated with the additional warming attributable to the Browse project.

B.3 *Legislative framework*

18. Section 78A(1) provides that a person may request that you reconsider a decision made under s 75(1) on the basis of a matter in s 78(1)(a) to (ca). The requirements for a valid request under s 78A(1) are set out in s 78A(2) and Pt 4A of the *Environment Protection and Biodiversity Conservation Regulations 2025* (Cth) (**EPBC Regulations**).

19. Section 78C provides that, upon receipt of a request under s 78A and following you taking steps to seek information and comment as required by s 78B, you must:

    a. reconsider the controlled action decision; and
    b. either:
        i. confirm the decision; or
        ii. revoke the decision in accordance with s 78(1), and substitute a new decision for it.

20. Section 78(1)(a) provides that you may revoke a controlled action decision under s 75(1) and substitute a new decision if you are satisfied that the revocation and substitution is warranted by the availability of substantial new information about the impacts that the

[10] Woodside Energy, Proposed Browse to North West Shelf Project Supplement Report to the Draft Environmental Impact Statement (EPBC 2018/8319) (**Supplement EIS**).
[11] Supplement EIS, p 110.
[12] Expert Report of Professor Sarah Perkins-Kirkpatrick dated 12 February 2026, [51] (**Annexure A**).

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action has or will have, or is likely to have, on a matter protected by a provision of Pt 3 of the EPBC Act.[13]

21. "Substantial information" is information that is real or of substance, and not trivial or inconsequential.[14] Information is "new" if it was not before the Minister (or the Minister's delegate) at the time of the making of the controlled action decision, even if it was in existence at the time.[15]

22. A controlled action decision under s 75(1) is made on the basis of whether the proposed action, if taken without relevant approval, would be prohibited by a provision of Pt 3 — namely, whether the action "has", "will have" or "is likely to have" a significant (adverse) impact on any of the matters protected by Pt 3. Whether revocation and substitution of the controlled action decision is warranted by substantial new information, for the purposes of s 78(1), should therefore also be determined by reference to the same test (in light of the substantial new information). One consequence of the fact that decision-making under s 78(1) involves asking the same question as under s 75(1) — namely, whether the action has, will have or is likely to have a significant (adverse) impact on any of the matters protected by Pt 3 — is that you are required to have regard to the precautionary principle in making a decision under s 78(1).[16]

23. An "impact" of an action can include an event or circumstance that is an indirect consequence of the action, provided the action is a substantial cause of that event or circumstance and, where relevant, the requirements in s 527E(2) are met.[17] As the Department's Policy Statement acknowledges, an impact that evidence strongly suggests might manifest itself many years later, or occurs at a substantial geographic distance from the location of the original action, may still be an indirect consequence that is substantial enough to be considered an impact.[18]

24. A "significant" impact is an impact that is important, notable or of consequence, having regard to its context or intensity.[19] A significant impact is "likely" if it is a real or not remote chance or possibility.[20]

25. If you receive a valid request for reconsideration, the steps prescribed by ss 78B (concerning informing the proponent and inviting comments and other information) and 78C (which requires you to reconsider the relevant s 75 decision) apply.

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[13] The Department's policy provides that the original decision will be revoked if any of the grounds in s 78(1) are satisfied: Department of Environment and Energy, *Environment Protection and Biodiversity Conservation Act 1999* (Cth) Policy Statement — Reconsideration: Implementing the requirements of sections 78, 78A, 78B and 78C of the EPBC Act, 4, 6, 9.
[14] EPBC Act Policy Statement for Reconsideration Requests, 6.
[15] EPBC Act Policy Statement for Reconsideration Requests, 6.
[16] EPBC Act, s 391.
[17] EPBC Act, s 527E(1)(b).
[18] EPBC Act Policy Statement on "Indirect Consequences" of an Action, 2.
[19] *VicForests v Friends of Leadbeater's Possum Inc* [2021] FCAFC 66; 389 ALR 552 at [62]; Significant Impact Guidelines 1.1, 3.
[20] *Polaris Coomera Pty Ltd v Minister for the Environment* [2021] FCA 254, [212]-[226]; Significant Impact Guidelines 1.1, 3.

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26. The matters protected by Pt 3, and the relevant controlling provision for each MNES, are listed in tabular form in s 34 of the EPBC Act. With respect to the GBRMP controlling provisions, we note the following:

27. Sections 24B(2) and 24C(5) prohibit a person from taking an action (in the Australian jurisdiction) that has or will have or is likely to have a significant impact on the environment in the GBRMP.

28. Section 528 of the EPBC Act defines 'environment' as 'includ[ing]':
    (a) ecosystems and their constituent parts, including people and communities; and
    (b) natural and physical resources; and
    (c) the qualities and characteristics of locations, places and areas; and
    (d) heritage values of places; and
    (e) the social, economic and cultural aspects of a thing mentioned in paragraph (a), (b), (c) or (d).

29. 'Ecosystem' is further defined to mean a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. The GBRMP has been recognised as the largest coral reef ecosystem in the world.[21] Accordingly, it is our submission that the environment in the GBRMP includes corals.

30. The definition of environment also includes the heritage values of a place which is defined to include the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians. Furthermore, ss 12 and 15A of the EPBC Act protects the World Heritage values of the GBRMP. Section 12(3) of the EPBC Act defines World Heritage values as 'the natural heritage and cultural heritage contained in the property' which have the meaning given by the World Heritage Convention.[22] As you are aware, almost the entire ecosystem of the GBRMP, including its coral reefs, is included on the World Heritage List, having been recognised as having Outstanding Universal Value in all four natural criteria.[23] In that regard, the collection of coral reefs within the GBRMP are central to the protection and fulfillment of its identified World Heritage values. For example, these values include the recognition of the GBRMP as the largest single collection of coral reefs in the world[24] of which the heterogeneity and interconnectivity of the reef assemblage[25] and the abundance and diversity of shape, size and colour of marine fauna and flora in the coral reef [26] encompasses the "fullest possible representation of marine environmental processes."[27]

31. An identified significant impact on the coral reef ecosystems in the GBRMP will encompass a significant impact on both the heritage values and the World Heritage

[21] Great Barrier Reef Marine Park Authority, Great Barrier Reef Outlook Report (2024), p 22 (**GBR Outlook Report**).
[22] EPBC Act, s 12(4).
[23] Department of Environment, 'EPBC Act referral guidelines for the Outstanding Universal Value of the Great Barrier Reef World Heritage Area' (May 2014) pp 9, 31-36.
[24] UNESCO, Statement of Outstanding Universal Value (1981), criterion (VIII).
[25] Ibid, criterion (IX).
[26] Ibid,criterion (VII).
[27] Ibid, criterion (IX).

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values of the GBRMP. In light of this, if you were satisfied that there was substantial new information available about the impacts that an action has or will have or is likely to have on the GBRMP and its protected values, it is our submission that ss 24B and 24C, and ss 12 and 15A would be relevantly engaged as controlling provisions. Where there are identified impacts to the coral reef ecosystems of the GBRMP, you should consider the consequential effects on other values in the GBRMP given the significance of coral reef ecosystems to the broader marine environmental processes of the GBRMP.

C. Request for reconsideration

32. This request relies on the independent expert report of Professor Sarah Perkins-Kirkpatrick dated 12 February 2026 (**Annexure A**) and the underlying methodology of the Report set out in the 2025 publication by Abrams et. al (**Annexure B**). In summary, the Report confirms that:

    a. It is now scientifically possible to link GHG emissions from the Browse project (and other fossil fuel projects) with additional global warming and quantify the ecological and human impacts of that warming at global and regional scales.[28]

    b. The CO_2-only emissions of the Browse project are estimated to be a total of 1,597.41 Mt CO_2 over the extended field life of the project.[29]

    c. The best estimate of additional global warming attributable to the emissions of the Browse project is 0.00072°C.[30]

    d. The additional warming attributable to the Browse project is estimated to produce the following impacts on the GBRMP:

        i. **an incremental increase in accumulated thermal exposure in the GBRMP of 0.003165°C-weeks** (likely range 5–95%: 0.0012–0.0067 °C-weeks) during marine heatwave events; and

        ii. a corresponding incremental **coral cover loss of 0.0111%** (likely range 0.0034–0.0252%) during each future mass bleaching event, equivalent to the **loss of approximately 29.35 million individual coral colonies** (likely range 9.04–66.78 million colonies) across the 1.06 million hectares of shallow (0-20 m) coral habitat in the GBRMP.[31]

    e. Other stressors such as ocean acidification, extreme weather events, and ecological shifts are not included in this calculation. Consequently, the **estimates of the impacts on the GBRMP represent the incremental impact of the**

[28] Annexure A, paragraph [51].
[29] Annexure A, paragraphs [19]-[20].
[30] Annexure A, paragraphs [21]-[22].
[31] Annexure A, paragraph [24].

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Browse project's emissions alone on coral loss during marine heatwave events.[32]

The Report is substantial new information about the impacts that the Browse project will have or is likely to have on the GBRMP

33. This material satisfies the statutory requirement of "substantial new information" because: 1) it was not before the decision-maker, the Minister's delegate, at the time the s 75 decision for the Project was made, and is novel for the reasons set out at [6] above (that is, it is "new"); and 2) it addresses, in a detailed and authoritative manner, matters relevant to decision-making under ss 75 and 78 (that is, it is "real" and "of substance") with respect to the Browse project.

34. The methodology underlying the Report, from the peer-reviewed Abrams et. al publication, makes a significant contribution to the field of climate attribution science. Previous attribution studies have tended to be retrospective and high-level in nature, focused on attributing extreme weather events to anthropogenic climate change as a general phenomenon. This Report develops a method of analysis that is both forward-looking and granular. It establishes the causal relationship between project-level emissions and projected ecological and human impacts. Because of its use of novel methodology and its implications for decision-making, the Report is information that is real and of substance, not trivial or inconsequential.

35. We note that in the assessment of other fossil fuel projects, you and your Department have previously reasoned on the basis that the physical effects of climate change are, if anything, an indirect consequence of the action pursuant to s 527E(1)(b).[33]

36. This is not necessarily the case, since the Report establishes a clear causal relationship (with no intervening factors) between the emissions from the Browse project and the ultimate environmental consequences to the GBRMP, which can be characterised as a direct impact of the Browse project pursuant to s 527E(1)(a). In our submission, the chain of causation can be characterised as follows:

    a. The action proposed by the Browse project is the processing of gas, primarily LNG, for sale.

    b. The only possible use for the gas is that it is burned to produce energy, which results in greenhouse gas emissions.

    c. Increased concentrations of greenhouse gas emissions result in an increase in global temperature (a phenomenon known as climate change or global warming). In the case of the Browse project, the likely range of additional global warming

[32] Annexure A, paragraph [26].
[33] For example, the Minister recently deployed this type of reasoning when making a decision pursuant to ss 78 and 78C(1) of the EPBC Act with respect to the North West Shelf Project < https://epbcpublicportal.environment.gov.au/all-referrals/project-referral-summary/project-decision/?id=b2b05d5f-d79c-f011-bbd2-6045bdc274b1>.

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attributable to its emissions is 0.0005 – 0.0010°C, with the best estimate being 0.00072°C.

d. The additional global warming attributable to the Browse project is estimated to impact the GBRMP by producing changes in thermal stress in the GBRMP and corresponding coral mortality during future mass bleaching events.

37. Therefore, the identified environmental impacts, including the additional loss of approximately 29.35 million coral colonies in the GBRMP during each future mass bleaching are a **direct impact** or consequence of the emissions from the Browse project.

38. In light of this, in your determination of this reconsideration request we urge you to determine that the additional loss of millions of coral colonies on the GBRMP during each future mass bleaching event is properly characterised as a "direct impact" of the action pursuant to s 527E(1)(a).

39. Alternatively, if you determine that the identified impacts are an indirect consequence of the Browse project pursuant to s 527E(1)(b) of the EPBC Act, the distinction between "direct" and "indirect" impacts does not matter as both types of impacts must be assessed by you and your Department. What is important is that the Report provides a clear and scientifically grounded link between the Browse project's emissions and their real-world consequences on the GBRMP, which warrants the reconsideration of the original decision for the Browse project and the making of a new decision which includes the GBRMP controlling provisions.

40. We also note that the impacts identified in the Report are "significant" and "likely" to occur.

41. The impacts of climate change on the GBRMP are extensively documented, including by your Department, with scientific consensus identifying it as the most significant threat to the ecosystem's long-term survival.[34] The GBRMP *Outlook Report 2024* (**GBR Outlook Report**) identifies that most of the outcomes of steadily rising GHG concentrations are experienced as extreme events in the GBRMP: the most pressing and inevitable of these being widespread marine heatwaves that can cause mass bleaching and death of corals on a Region-wide scale.[35] The occurrence of a mass bleaching event has been identified as severely affecting the GBRMP ecosystem, including coral reef habitats.[36] These mass bleaching events are expected to increase in frequency and intensity. The Intergovernmental Panel on Climate Change (**IPCC**) Sixth Assessment Report predicts that it is virtually certain that ocean warming will continue over the 21st century resulting in increasingly frequent and intense marine heatwaves along with corresponding mass coral bleaching events.[37] The Browse project's contribution to increased coral mortality during each future mass bleaching event represents an impact that is significant and of consequence to the GBRMP.

42. The impact is also "likely", in the sense that there is a real and not remote chance of it occurring. The Report gives a probabilistic range of likely outcomes in order to account for the uncertainty in predicting future outcomes. The best estimate is that an additional

[34] For example, see: GBR Outlook Report, 295 and 503.
[35] GBR Outlook Report, p 503.
[36] GBR Outlook Report, pp 37, 103, 105, 287, 448.
[37] GBR Outlook Report, p 105 and Intergovernmental Panel on Climate Change, Sixth Assessment Report, *Climate Change 2022: Impacts, Adaptation and Vulnerability* (28 February 2022), 3.2 Observed Trends and Projections of Climatic Impact-Drivers in the Global Ocean, p. 393 – 412.

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29.35 million coral colonies will be lost in each future mass bleaching event, but the likely range is from 9.04 million to 66.78 million.[38] "Likely ranges"[39] as defined in the report represent the central 90% of the probability distribution, meaning there is a 90% chance that the outcomes will fall within that range. This is a much higher degree of certainty than the legal test for "likely". We note that even at the lower end of the range, there is a measurable and significant impact on the GBRMP caused by the emissions of the Browse project.

43. Accordingly, it is our submission that the Report is substantial new information that would satisfy you, in accordance with s 78(1)(a), that the Browse project will have, or is likely to have, a significant impact on the GBRMP.

The Report has implications for how your Department is able to reason with respect to the climate impacts of fossil fuel projects

44. This Report also has consequences for the way in which you or your Department is able to reason with respect to climate impacts. In assessing fossil fuel projects to date, your reasoning has typically relied on two limbs for finding that the physical effects of climate change are not "impacts" of the action:

    a. the information does not demonstrate that the proposed action will cause any net increase in global GHG emissions and global average temperature (because the net increase is subject to multiple variables); and

    b. any contribution from the proposed action to global average temperature would be very small and that it is therefore not possible to say that the proposed action is a substantial cause of the physical effects of climate change.

45. The methodology in the Abrams et. al. paper represents a scientific development with significant implications for policy and decision-making. It is now possible to draw a clear and scientifically-grounded link between project-level emissions and their real-world consequences.

46. The "no net increase" limb of your previous reasoning reflects a concern with the uncertainty inherent in predicting future scenarios. Your use of "variables" in previous reasoning was an attempt to determine whether the proposed action was a "substantial cause" of the event or circumstance. The information contained in this request demonstrates that the action is a direct or, if indirect, substantial cause of the event or circumstance. The methodology in the Abrams et. al. paper, as used in the Report, now allows you to understand the consequences of the Browse project's emissions. As outlined above, the paper's methodology makes use of multiple and independent lines of high-quality evidence, together with confidence intervals, to account for uncertainty. It uses the simple but robust Transient Climate Response to CO_2 Emissions (**TCRE**) metric, which is accepted by the Intergovernmental Panel on Climate Change (**IPCC**) and is used for scenario modelling and to calculate global carbon budgets. The TCRE connects CO_2 emissions to increases in global surface temperature. The paper notes that the metric

[38] Annexure A, paragraph [24] and diagram at [26].
[39] Annexure A, paragraph [43].

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holds regardless of the intensity of future emissions, and includes emissions reduction pathways required to limit warming to well-below 2 degrees. The paper also notes that even in future zero-emission scenarios, the global warming caused by past CO_2 emissions persists over many centuries. Therefore, it is not possible to avoid the consequences of the emissions of a project by relying on future emissions-reduction or carbon offset claims. The confidence intervals used in the paper allow for the residual uncertainty inherent in predicting future emissions scenarios and global warming. This is the same uncertainty which forms the basis of the "variables" used in your previous reasoning. Confidence intervals allow uncertainty to be addressed by providing a range of possible outcomes. The methodology in the Abrams et. al. paper, and in the Report, now provides you with a clear indication of the range of outcomes resulting from the emissions attributable to the Browse project. We note that even at the lower end of the range, there is still a measurable effect from the Browse project on the GBRMP. The causal chain is transparent and scientifically grounded. It would not be rational, in light of this development, to selectively choose "variables" which sidestep the causal chain.

47. It would also not be appropriate to reason by reference to a world in which the project does not go ahead. As noted by Justice Horan in *Environment Council of Central Queensland Inc v Minister for the Environment and Water*, "the Minister was required to identify the direct and indirect consequences of the proposed action, and not to hypothesise what might happen in a future "world" in which the proposed action is not taken".[40] Although the Court in that case accepted that it was permissible to have regard to "variables" as part of the predictive exercise of determining which climate effects would be caused by the proposed action, the information now provided makes the use of those variables redundant. It is irrelevant to hypothesise about what might happen if the Browse project does not proceed. The information and methodology provided in the Report simplifies the predictive exercise you are required to undertake.

48. In relation to the "very small contribution" limb of your previous reasoning, this Report makes it clear that even marginal additions to warming translate into quantifiable increases in coral mortality. It is now no longer possible to sustain the proposition that project-level emissions cannot be linked to measurable climate impacts.

49. As evidenced by the 2025 Abrams paper and the Report, the field of attribution science has changed. We submit that it will now be necessary for the Department's reasoning to change with it. The Report demonstrates that there are real, quantifiable consequences associated with the additional warming attributable to a single fossil fuel project.

50. The precautionary principle requires that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation. As noted above at [40], your Department has already extensively documented the very serious threat that climate change poses to the GBRMP ecosystem and its heritage values.[41] The 2024 GBR Outlook Report identifies that current and predicted climate change impacts will have far-

[40] *Environment Council of Central Queensland Inc v Minister for the Environment and Water* [2024] FCAFC 56 at [175].
[41] GBR Outlook Report, p 477.

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reaching and irreversible consequences to the GBRMP with "every increment of additional global warming…further compromis[ing] the Reef's unique biodiversity, with continuing consequences for cultural heritage, social and economic benefits, and the broader ecosystem services of the Reef." [42]

51. In light of the compelling link drawn by the new information in this request between the Browse project's emissions and increased coral mortality on the GBRMP, it is our submission that the precautionary principle is engaged in this instance and requires that you, at minimum, assess the impact of the project on the environment and the protected values of the GBRMP. To the extent that there is uncertainty in the extent of the threat identified in the Report (i.e. coral mortality in future bleaching events), a precautionary approach requires that you do not use this to avoid taking measures to prevent that harm.

D. Consideration of the relationship between this reconsideration request and approval of the Browse Project

52. For the avoidance of doubt, it is submitted that this request meets each of the statutory requirements for a valid reconsideration request, because:

    a. It is in writing.[43]

    b. It explains the basis on which the controlled action decision should be reconsidered,[44] and identifies s 78(1)(a) as the ground relied upon to make the request.[45]

    c. It includes the sources of information provided and the details of when that information became available: Professor Perkins-Kirkpatrick's report was finalised on 12 February 2026. Further, the methodology relied upon in the report of Professor Perkins-Kirkpatrick was published in October 2025.[46]

    d. It contains new information that was not considered when the controlled action decision was made because that information did not exist at the time the decision was made by the Minister's delegate.[47]

    e. As outlined above and detailed in the Report, the new information demonstrates that a change in the potential impacts of the action is likely to happen with a high degree of certainty.[48]

53. Consequently, upon receipt of this request, you will be required to take the steps required by ss 78B and 78C of the EPBC Act.

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[42] GBR Outlook Report, pp v, 344, 416.
[43] EPBC Act, s 78A(2)(a).
[44] EPBC Act, s 78A(2)(b).
[45] EPBC Regulations, reg 4AA.01(2)(a).
[46] EPBC Regulations, reg 4AA.01(2)(b)-(c).
[47] EPBC Regulations, reg 4AA.01(3)(a).
[48] EPBC Regulations, reg 4AA.01(3)(b).

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54. Finally, and in relation to how this reconsideration request impacts on the approval process for the Browse project, we draw your attention to the Department's Policy Statement. In particular, we highlight the Department's Policy Statement wherein it provides that in circumstances where a reconsideration request is made and the approval decision has not yet been made:[49]

    a. the reconsideration request will be dealt with **before** the approval decision; and

    b. such a situation may involve the Minister extending the time for making the approval decision in accordance with the EPBC Act.

55. Consequently, you will be required to take all of the steps required by ss 78B and 78C of the EPBC Act **before** you proceed to taking any step required by Pt 9 of the EPBC Act, relating to the approval of the Browse project.

56. Should you proceed to the approval decision of the Browse project, contrary to the above requirements, we request you provide us with **10 days written notice** of your intention to approve the Browse project.

57. Should you require further information in respect of this request for reconsideration please contact Hannah White, hannah.white@envirojustice.org.au, Cecile Bester, cecile.bester@envirojustice.org.au or Inshani Ward, inshani.ward@envirojustice.org.au.

Yours sincerely,

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[49] EPBC Act Policy Statement on 'Other considerations', 11.

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Independent Expert Report
End-to-End Attribution of the 'Browse to North West Shelf' Project and Impacts on Coral Loss in the Great Barrier Reef

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Compiled in accordance with the Federal Court of Australia Expert Evidence Practice Note (GPN-EXPT) and Expert Witness Code of Conduct

Prepared by:
Prof Sarah Perkins-Kirkpatrick
Fenner School of Environment and Society (ANU)

Date: 12 February 2026

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1. INTRODUCTION AND INSTRUCTIONS

[1] I have been instructed to provide an independent expert opinion in relation to end-to-end attribution science in the context of the Browse to North West Shelf Development (Browse Project), namely the attribution of project-level greenhouse gas (GHG) emissions to thermal stress and coral loss in the Great Barrier Reef (GBR).

[2] The specific questions I have been asked to address are set out in Sections 6 – 10 and concern:

- The quantification of additional global warming attributable to the Browse Project;
- Whether, and to what extent, that additional warming will have or is likely to have impacts on coral loss in the GBR; and
- Specifications concerning the underlying methodology of the respective analysis.

[3] I understand that my duty is to the Court and not to any party, in accordance with the Federal Court of Australia's Expert Evidence Practice Note and the Expert Witness Code of Conduct.

[4] I confirm that I have complied with, and will continue to comply with, that duty.

[5] I confirm that the opinions expressed in this report are wholly or substantially based on my specialised knowledge derived from my training, study and experience.

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2. GENERAL SCOPE OF REPORT

[6] This report addresses:

- The translation of cumulative CO_2 emissions from the Browse Project into additional global mean surface temperature (GMST) change;
- The attribution of that additional global warming to changes in thermal stress in the Great Barrier Reef Marine Park (GBRMP);
- The relationship between thermal stress and coral loss on the GBR;
- The assumptions, data, models, uncertainty ranges, and confidence levels used; and
- The relationship between the methods applied and prior attribution science.

[7] This report does not assess legal causation, liability, or policy considerations.

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3. QUALIFICATIONS, EXPERTISE AND APPOINTMENTS

3.1 Academic Qualifications

[8] I am a Professor of Climate Science in the Fenner School of Environment and Society at the Australian National University (ANU) with expertise in climate change, extreme heat, detection and attribution, extreme event attribution, impact attribution, climate observations and physical climate models.

[9] I hold the following qualifications:

- Bachelor of Science from Macquarie University (2005)
- Postgraduate Certificate in Research Preparation from Macquarie University (2005)
- PhD in Climate Science from UNSW (2010)

3.2 Professional Experience and Appointments

[10] My professional experience includes:

- 2024-present, Professor in climate science, Fenner School of Environment & Society, The Australian National University
- 2021-2024, Senior Lecturer/Associate Professor & Australian Research Council Future Fellow, School of Science, UNSW Canberra
- 2018– 2021, Senior Lecturer & Australian Research Council Future Fellow, Climate Change Research Centre, UNSW Sydney
- 2014-2017, Australian Research Council Discovery Early Career Researcher Award Fellow, Climate Change Research Centre, UNSW Sydney
- 2011-14, ARC Centre of Excellence for Climate System Science, Post-doctoral Researcher, UNSW Sydney
- 2009-11 CSIRO, Postdoctoral researcher (Pacific Climate Change Science Program)

[11] I currently hold the following appointment:

Professor of Climate Science, Fenner School of Environment and Society, Australian National University.

President, Australian Meteorological and Oceanographic Organisation

Deputy Director and lead of Engagement & Impact Portfolio, ARC Centre of Excellence for the Weather of the 21st Century

Co-ordinating Lead Author, Working Group I, Intergovernmental Panel of Climate Change 7th Assessment Report

3.3 Relevant Publications

[12] My relevant peer-reviewed publications include:

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1. Perkins-Kirkpatrick, S., Gregory, C., Vanos, J., Baldwin, J., Staudmeyer, H., Guzman-Echavarria, G. and Jay, O., 2025. non-survivable heat stress conditions are already occurring. Nature Communications, accepted.

2. Undorf, S., Dimitrova, A., Harrington, L.J., Hegerl, G.C., Jézéquel, A., Kimutai, J., Lo, E., Mengel, M., Perkins-Kirkpatrick, S., Pietroiusti, R. and Pinto, I., 2026. Approaches and challenges in attributing climate change impacts. Nature Reviews Earth & Environment, accepted.

3. Wehner, M., Perkins-Kirkpatrick, S., Simpson, I. and Singh, D., 2025. Detection and attribution of the human influence on extreme weather and climate events. Environmental Research: Climate, 4(4), p.040203.

4. Mora, C.J., Malik, A., Alexander, L.V., Stuart-Smith, R.F., King, A.D., Perkins-Kirkpatrick, S. and Schinko, T., 2025. Attributing global impacts of local extremes to climate change for improving loss and damage estimates. Environmental Research Letters, 20(3), p.e031009.

5. **Abram, N.J., Maher, N., Perkins-Kirkpatrick, S., Falster, G.M., Hughes, T.P., Meissner, K.J., Slater, L.J., King, A.D., Pitman, A.J., Moon, G. and Morgan, W., 2025. Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making. npj Climate Action, 4(1), p.92.**

6. Perkins-Kirkpatrick, S., Palmer, L., King, A. and Ziehn, T., 2025. Heatwaves in a net zero World. Environmental Research: Climate, 4(4), p.045015.

7. Grose, M., Hope, P., Risbey, J., Mora, C.J., Perkins-Kirkpatrick, S., King, A., Harrington, L.J., Rosier, S., Matear, R., Black, M. and Stone, D., 2024. Processes and principles for producing credible climate change attribution messages: lessons from Australia and New Zealand. Environmental Research: Climate, 3(3), p.035009.

8. Perkins-Kirkpatrick, S.E., Selvey, L., Aglas-Leitner, P., Lansbury, N., Hundessa, S., Stone, D., Ebi, K.L. and Osborne, N.J., 2025. Attributing heatwave-related mortality to climate change: a case study of the 2009 Victorian heatwave in Australia. Environmental Research: Climate, 4(1), p.015004.

9. Perkins-Kirkpatrick, S. E., Alexander, L. V., King, A. D., Kew, S. F., Philip, S. Y., Barnes, C., ... & Zscheischler, J. (2024). Frontiers in attributing climate extremes and associated impacts. Frontiers in Climate, 6, 1455023.

10. Perkins-Kirkpatrick, S., Barriopedro, D., Jha, R., Wang, L., Mondal, A., Libonati, R., & Kornhuber, K. (2024). Extreme terrestrial heat in 2023. Nature Reviews Earth & Environment, 5(4), 244-246.

11. Perkins-Kirkpatrick, S. E., Stone, D. A., Mitchell, D. M., Rosier, S., King, A. D., Lo, Y. T. E., ... & Wehner, M. (2022). On the attribution of the impacts of extreme weather events to anthropogenic climate change. Environmental Research Letters, 17(2), 024009.

12. Perkins-Kirkpatrick, S. E., & Lewis, S. C. (2020). Increasing trends in regional heatwaves. Nature communications, 11(1), 3357.

13. Lewis, S.C., Perkins-Kirkpatrick, S.E., Althor, G., King, A.D. and Kemp, L., 2019. Assessing contributions of major emitters' Paris-era decisions to future temperature extremes. Geophysical Research Letters, 46(7), pp.3936-3943.

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14. Harrington, L.J., Lewis, S., Perkins-Kirkpatrick, S.E., King, A.D. and Otto, F.E., 2019. Embracing the complexity of extreme weather events when quantifying their likelihood of recurrence in a warming world. Environmental Research Letters, 14(2), p.024018.

15. Lewis, S.C., Blake, S.A., Trewin, B., Black, M.T., Dowdy, A.J., Perkins-Kirkpatrick, S.E., King, A.D. and Sharples, J.J., 2020. Deconstructing factors contributing to the 2018 fire weather in Queensland, Australia. Bulletin of the American Meteorological Society, 101(1), pp.S115-S122.

16. Lewis, S.C., King, A.D., Perkins-Kirkpatrick, S.E. and Wehner, M.F., 2019. Toward calibrated language for effectively communicating the results of extreme event attribution studies. Earth's Future, 7(9), pp.1020-1026.

17. Perkins-Kirkpatrick, S.E. and Gibson, P.B., 2017. Changes in regional heatwave characteristics as a function of increasing global temperature. Scientific Reports, 7(1), p.12256.

18. Oliver, E.C., Benthuysen, J.A., Bindoff, N.L., Hobday, A.J., Holbrook, N.J., Mundy, C.N. and Perkins-Kirkpatrick, S.E., 2017. The unprecedented 2015/16 Tasman Sea marine heatwave. Nature communications, 8(1), p.16101.

19. Perkins, S.E. and Gibson, P.B., 2015. 31. INCREASED RISK OF THE 2014 AUSTRALIAN MAY HEATWAVE DUE TO ANTHROPOGENIC ACTIVITY. Bulletin of the American Meteorological Society, 96(12), pp.S154-S157.

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4. MATERIALS AND SOURCES OF INFORMATION

[13] In preparing this report, I have relied upon the following sources of information:

- The letter of instruction dated 22 January 2026 (Environmental Justice Australia, EJA)
- Lifetime GHG emissions estimates for the Browse Project (scope 1 and scope 3) extracted from the document titled *PROPOSED BROWSE TO NWS PROJECT - DRAFT EIS/ERD* (Woodside Energy Ltd., 2019);
- The 'Department of Climate Change, Energy, the Environment and Water' document titled *Australian National Greenhouse Accounts Factors – For individuals and organisations estimating greenhouse gas emissions* (DCCEEW, 2025);
- Peer-reviewed attribution and climate impact literature, specifically *Global warming transforms coral reef assemblages* (Hughes et al., 2018), *Reef-scale thermal stress monitoring of coral ecosystems: New 5-km global products from NOAA Coral Reef Watch* (Liu et al., 2014) and *Warming Trends and Bleaching Stress of the World's Coral Reefs 1985–2012* (Heron et al., 2016);
- The publication *Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making* (Abram et al., 2025a);
- The code used for analysis, which is publicly available on Zenodo in Matlab (Abram et al., 2025b) and Python (Stepin & Abram, 2025);

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- The Sixth Assessment Report of the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC AR6, 2021);
- The Berkeley Earth global temperature record (monthly resolution) (Rohde & Hausfather, 2020);
- The NOAA Coral Reef Watch (CRW) Degree Heating Week (DHW)* product (daily resolution) – specifically the 5km-resolved DHW dataset (Heron et al., 2016; Liu et al., 2014)

  * DHW / °C-weeks: a measure of thermal exposure. In reef environments this leads to thermal stress and bleaching of corals (Liu et al., 2014).

[14] A full bibliography is provided in Section 13

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5. OVERVIEW OF END-TO-END ATTRIBUTION SCIENCE

[15] The end-to-end attribution framework applied in this report is based on the peer-reviewed methodological approach set out in the recent publication by Abram et al. (2025a) ***"Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making"***. The study develops a detailed risk-assessment and attribution framework linking project-level GHG emissions to changes in GMST and various downstream global and regional consequences based on established climate-impact relationships.

[16] For the Browse Project, the framework has been adapted only where necessary to reflect project-specific characteristics. Application to the GBR follows the Abram et al. (2025a) publication without alteration to the underlying scientific assumptions or uncertainty treatment.

[17] Specifically for the quantification of GBR coral loss, the framework is applied through four linked steps as follows:

a) Estimation of cumulative project-level CO_2 emissions and translation of those emissions into additional GMST change (addressed in Part A);
b) Scaling of the additional warming to regional thermal stress in the GBRMP and application of empirically observed relationships between thermal stress and coral loss in the GBR (addressed in Part B).

The implementation of this framework, including data sources, assumptions, spatial treatment, timescale, and uncertainty, is described in Part C.

PART A – GLOBAL WARMING ATTRIBUTABLE TO THE BROWSE PROJECT

[18] The IPCC AR6 (2021, Summary for Policymakers D.1.1) states that global warming increases in direct proportion to cumulative CO_2 emissions, as described by the Transient

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Climate Response to CO_2 Emissions (TCRE) with a best estimate of 0.45°C per 1,000 $GtCO_2$ and a 66–100% likelihood that warming lies between 0.27°C and 0.63°C. This well-established, approximately linear relationship underpins estimates of remaining carbon budgets and climate targets such as limiting warming to 1.5°C or well below 2°C. No assessed minimum CO_2 threshold exists below which the TCRE relationship fails (Canadell et al., 2021).

6. Question 1: Additional Global Warming Attributable to the Project

[19] Following the framework laid out in Section 5, paragraph [17 a], cumulative scope 1 and scope 3 CO_2-equivalent (CO_2-e) emissions were extracted from the *Proposed Browse to NWS Project, Draft Environmental Impact Statement* (Woodside Energy Ltd., 2019) (Table 7-5 (Scope 1) and Table 7-9 (Scope 3)), adopting the extended field life scenario (44 years), which reports **total project emissions of 1,602 Mt CO_2-e**.

[20] Conversion from CO_2-e to CO_2-only mass was undertaken using category-specific assumptions regarding gas composition, ensuring compatibility with the TCRE framework ([18]). For combustion-related sources (including installation activities using heavy-duty diesel), CO_2 fractions were derived from emissions factors reported in Table 7-3 (Woodside Energy Ltd., 2019) and the *Australian Government National Greenhouse Accounts Factors* (DCCEEW, 2025), while reservoir emissions were treated as CO_2-only in accordance with the project methodology. Applying these gas-specific conversion assumptions yields a **total of 1,597.41 Mt CO_2** over the extended field life, indicating that CO_2 accounts for virtually all reported project GHG emissions.

Emissions source (Scopes 1 & 3)	*CO_2-equivalent emissions [Mt]*	*CO_2 fraction [%]*	*CO_2 [Mt]*
Installation	1.0	99.3	0.99
Fuel combustion	53.0	99.7	52.84
Flaring	3.0	95.4	2.86
Upstream reservoir	93	100	93
Processing	98	99.7	97.71
Downstream reservoir	24	100	24
Third-party consumption	1,330	99.7	1326.01
Total	**1,602**		**1,597.41**

[21] To **quantify the additional global warming attributable to these emissions**, this report applies the TCRE best estimate of 0.45°C per 1000 Gt CO_2 (IPCC AR6, 2021), which yields an estimate of additional global mean surface warming attributable to the CO_2-only emissions from the Browse Project of:

- **Best estimate: 0.00072°C**;
- Likely range: 0.0005 – 0.0010°C, reflecting combined uncertainty in climate sensitivity and carbon-cycle response.

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[22] These values represent the incremental contribution of the Browse Project's emissions to global warming and were calculated using the following equation from Abram et al. (2025a, p.3):

$$Additional\ warming\ (°C) = Emissions\ (Mt\ CO_2) \times \frac{0.45\ (°C)}{1{,}000{,}000\ (Mt\ CO_2)}$$

PART B – CORAL LOSS ON THE GREAT BARRIER REEF

7. Question 2: Impact of Additional Global Warming on GBR Coral Loss

[23] Building on the results from Part A, this assessment further applies the framework described in Section 5, paragraph [17 b] to quantify impacts on coral loss in the GBR. This is done by linking the additional global warming attributable to the Browse Project to changes in thermal stress in the GBRMP, measured using degree heating weeks (DHW*), and ultimately to observed empirical relationships between DHW and coral mortality on the GBR.

*DHW (°C-weeks) is a metric of cumulative thermal exposure, combining the intensity and duration of marine heatwaves (positive sea temperature anomalies relative to the local bleaching threshold), and is strongly associated with the severity of coral bleaching** and mortality (Liu et al., 2014).

**Bleaching is a heat-stress response in which corals expel their symbiotic algae and become physiologically weakened; if thermal stress is severe or prolonged, bleaching can lead to high coral mortality (Hughes et al., 2018).

[24] Applying this analytical approach, the additional warming attributable to the Browse Project is estimated to produce:

- **An incremental increase in accumulated thermal exposure in the GBRMP of 0.003165 °C-weeks** (likely range 5–95%: 0.0012–0.0067 °C-weeks) during marine heatwave events; and
- A corresponding incremental **coral cover loss of 0.0111%** (likely range 0.0034–0.0252%) during each future mass bleaching event*, equivalent to the **loss of approximately 29.35 million individual coral colonies** (likely range 9.04–66.78 million colonies), across the 1.06 million hectares of shallow (0-20 m) coral habitat in the GBRMP.**

  *A mass bleaching event occurs when elevated sea temperatures cause most corals in a region to lose their symbiotic algae, leading to widespread paling and elevated mortality risk (Henley et al., 2024).

  **The mortality relationship is derived from observed bleaching events, which quantify how elevated heat stress (DHW) increases event-specific coral mortality (Hughes et al., 2018). The Browse Project's additional warming (ΔGMST) represents an incremental and persistent increase in GMST that would intensify DHW during future mass bleaching events. The resulting estimate therefore represents the additional coral mortality attributable to the Project per event, rather than total mortality or a cumulative one-off loss.

[25] These estimates are probabilistic, reflecting uncertainty in:

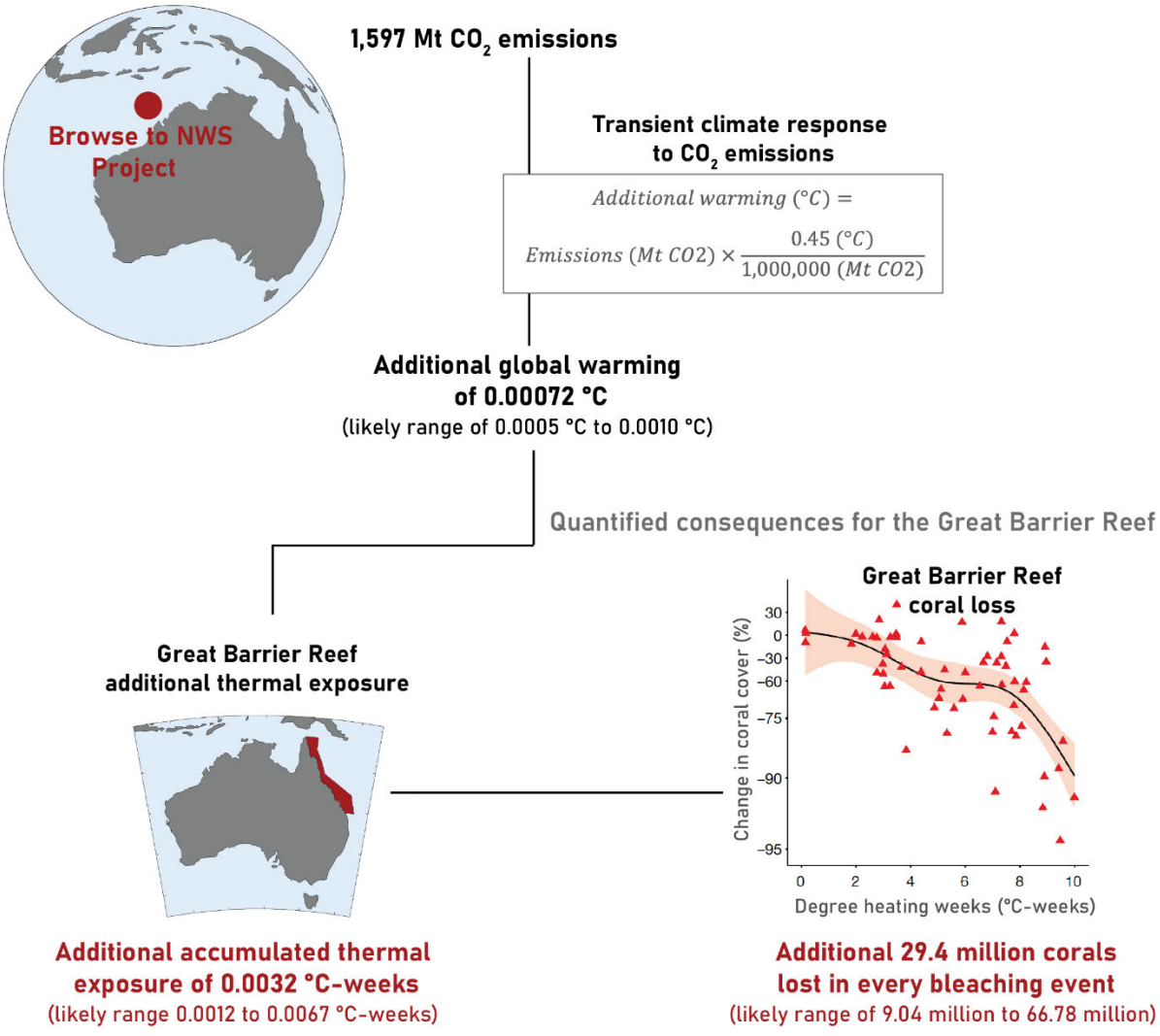
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- Spatial variability of DHW responses across the GBRMP; and
- The empirical relationship between DHW and coral cover loss.

The total area of coral reef habitat is treated as a fixed, conservative estimate (1.06 million hectares of shallow reef), and coral density is similarly fixed (0.25 million colonies per hectare). Neither reef area nor coral density is included as a source of probabilistic uncertainty in the analysis. Consequently, total coral losses may be underestimated if additional reef habitats are affected or if coral density varies spatially across different reef regions.

[26] The quantified impacts assume that:

- The relationship between DHW and coral mortality remains consistent in the future; and
- Other stressors such as ocean acidification, extreme weather events, and ecological shifts are not included in this calculation. Consequently, the **estimates represent the incremental impact of the Browse Project's emissions alone** on coral loss during marine heatwave events.



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PART C – MODEL, DATA, AND ASSUMPTIONS

8. Question 3: Methodology and Assumptions

8.1 Overview of Model Implementation

[27] This section addresses Question 3 by explaining how the attribution framework described in Section 5 was implemented to quantify the impacts of additional global warming on coral loss in the GBR. It describes the model structure, data sources, and key assumptions used to translate GMST change into regional thermal stress and coral mortality.

[28] The subsections below respond directly to the subquestions in Question 3 by setting out:
(a) how impacts on the GBR are treated spatially;
(b) how additional atmospheric warming is related to ocean thermal stress;
(c) the appropriateness of the model for the project's operational lifetime; and
(d) the treatment of uncertainty, confidence levels, and likelihood statements.

8.2 Question 3(a): Spatial Treatment of Impacts on the Great Barrier Reef

[29] Thermal stress impacts on the GBR are quantified using DHW averaged across the entire GBRMP.

[30] The relationship between GMST and DHW is derived from:

a) Monthly GMST anomalies* from Berkeley Earth global temperature record (Rohde & Hausfather, 2020); and

b) Daily, 5-km resolution DHW data covering 12,222 individual grid cells across the GBRMP from NOAA Coral Reef Watch over 39 years (1986-2024) (Heron et al., 2016; Liu et al., 2014).

*GMST anomaly refers to the deviation of annual global mean temperature from the long-term austral summer average; the Browse Project's additional warming (ΔGMST) represents a projected temperature anomaly due to its estimated CO_2 emissions.

[31] For each grid cell, a linear model was fit relating summer-centred annual maximum DHW values to summer-centred annual GMST anomalies (summer-centred = July-June). The resulting cell-level slopes capture spatial heterogeneity across the reef and follow a lognormal distribution, which is used to characterise spatial uncertainty in the DHW–GMST relationship within the attribution analysis. The primary attribution analysis fits a linear regression between annual maximum GBR-wide DHW and summer-centred annual GMST anomalies and uses the resulting reef-wide slope (°C-weeks per °C) to estimate changes in DHW from small increments of additional warming. This linear approximation is appropriate for the tiny magnitudes of warming attributable to the Browse Project. For larger magnitudes of additional warming, the GMST–DHW relationship is expected to become non-linear,

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consistent with the observed heterogeneity in cell-level responses. All downstream calculations of DHW change, coral cover loss, and coral colony mortality are based on this single reef-wide relationship.

[32] Spatial heterogeneity in the DHW–GMST relationship is propagated probabilistically through Monte Carlo sampling (Cox et al., 2003, provides background on Monte Carlo uncertainty propagation). The lognormal distribution of cell-level DHW–GMST slopes described in [31] is sampled 100,000 times to produce 5–95% confidence bounds for projected DHW increases. This approach ensures that the reef-wide mean projection is used for impact calculations while fully accounting for uncertainty arising from variation in cell-level relationships.

8.3 Question 3(b): Translation from Atmospheric Warming to Ocean Thermal Stress

[33] The model does not simulate ocean temperatures using a physical ocean model. Instead, it estimates ocean thermal stress empirically by relating GMST anomalies to accumulated thermal stress in reef waters, expressed as DHW.

[34] This relationship is quantified using linear regression, in which annual, summer-centred GMST anomalies [30 a] are regressed against summer-centred annual maximum DHW values across the GBRMP [30 b], based on historical observations. Summer-centring (July-June) avoids splitting the GBR coral bleaching season across annual boundaries.

The resulting relationship takes the form: *DHW = intercept + slope × GMST.*

[35] Daily DHW values across the GBRMP are first averaged to produce a daily reef-wide mean. For each of the data set's 39 summer-centred years, the annual maximum is calculated from these daily means. This approach provides a representative measure of reef-wide thermal exposure during the bleaching season, aligns with empirical coral mortality relationships (Hughes et al., 2018), and avoids bias from isolated thermal hotspots. Linear regression of these summer-centred annual maxima against corresponding summer-centred annual GMST anomalies yields an aggregate scaling relationship of 4.4 °C-weeks per 1 °C warming, which is used to estimate changes in thermal stress for small increments of additional warming such as that attributable to the Browse Project.

[36] A linear approximation is appropriate for the small additional warming attributable to an individual project. Based on 39 years of historical data, the GMST–DHW relationship is approximately linear over such marginal increases.

[37] Empirical observations from mass bleaching events on the Great Barrier Reef indicate that each additional 1 °C-week of accumulated thermal stress is associated with an average loss of approximately 2–5% of coral cover. This relationship provides the empirical basis for translating projected increases in DHW into estimates of coral cover loss and coral colony mortality.

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8.4 Question 3(c): Appropriateness for a 40-Year Project Lifetime

[38] The Browse Project is expected to operate over a period of approximately 40 years (expected field life: 31 years, extended field life: 44 years) (Woodside Energy Ltd., 2019).

[39] The attribution framework is appropriate for this timescale because:

- CO_2 is a long-lived greenhouse gas, with atmospheric residence times extending over decades to centuries;
- Global warming depends primarily on cumulative CO_2 emissions rather than the precise timing of emissions, such that emissions in earlier years contribute alongside later emissions;
- The climate system responds over decadal to centennial timescales, as heat is absorbed and redistributed by the oceans and the atmosphere; and
- Coral bleaching impacts depend on incremental increases in background warming, which intensify the frequency and severity of marine heatwave events over time.

[40] The quantified coral losses represent the incremental mortality attributable to the Browse Project's emissions during each future mass bleaching event, added to the background warming trajectory represented by the Berkeley Earth GMST data, rather than as a one-off impact.

8.5 Question 3(d): Confidence Levels and Likelihood Statements

[41] Uncertainty in the attribution of Browse Project emissions to coral loss on the Great Barrier Reef is quantified at each stage of the attribution chain:

- Climate sensitivity (TCRE);
- DHW-GMST relationship (including spatial heterogeneity across the reef); and
- Empirical relationship between thermal stress and coral mortality.

Reef area and coral density are treated as fixed parameters and do not contribute to uncertainty in the reported ranges.

[42] Probabilistic uncertainty is propagated through the attribution chain using 100,000 Monte Carlo draws, capturing both parameter uncertainty and spatial variability across GBRMP grid cells (characterised by a lognormal distribution as described in Section 8.2). Potential non-linearity at higher levels of warming is acknowledged as a limitation of the linear approximation, consistent with observed spatial variability in cell-level responses.

[43] Likelihood statements are expressed using calibrated probabilistic language consistent with established climate science practice:

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- Best estimates correspond to the mean of each parameter distribution; and
- Likely ranges represent the central 90% of the distribution, approximated as the 5–95% confidence interval of the Monte Carlo distribution.

[44] The framework propagates the uncertainties listed in [41] throughout the attribution chain, distinguishing between physical climate uncertainties (TCRE and the DHW-GMST relationship) and empirical uncertainties (DHW-coral mortality), while holding other environmental and ecological factors constant. The reported range therefore reflects climate-driven coral loss specifically.

[45] Using this framework, the projected additional coral loss from the Browse Project during future mass bleaching events can be reported as probabilistic estimates without relying on single deterministic values, enabling transparent communication of the range of possible outcomes.

PART D — OVERALL IMPACTS ON THE GREAT BARRIER REEF

9. Question 4: Impacts of the Browse Project

[46] Based on the attribution framework analysis above, the Browse Project will have the following impacts on the GBR (respective quantification is provided in Section 6):

- A quantifiable, though very small, increase in GMST (0.00072°C*);
- A corresponding incremental increase in thermal stress (DHW) across the GBRMP during marine heatwaves (0.0032 °C-weeks*); and
- Additional coral mortality during each future mass bleaching event (29.4 million individual coral colonies*).

*best estimate

[47] These probabilistic projections form the basis for assessing the Browse Project's impacts on the GBR. While the absolute contribution to global warming is small, the Monte Carlo analysis demonstrates that even marginal additional warming translates into quantifiable increases in DHW across the GBRMP and, in turn, additional coral mortality.

[48] The analysis conservatively excludes compounding and interacting effects, including:

- Reduced recovery time between successive bleaching events (Hughes et al., 2017);
- Ocean acidification; and
- Other climate-driven stressors affecting reef ecosystems.

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PART E — NOVELTY OF THE ABRAM et. al (2025) ARTICLE

10. Question 5: Relationship to Existing Attribution Science

[49] The methods applied in Abram et al. (2025a) draw on established attribution science but extend it in a significant and novel direction.

[50] Earlier attribution studies have generally been retrospective in nature and have typically either:

- Attributed observed climate change or impacts to historic aggregate emissions at global, national, or sectoral scales; or
- Focused on attributing observed extreme events to anthropogenic climate change, without tracing responsibility back to discrete sources such as individual projects.

[51] By contrast, the analysis in Abram et al. (2025a) is prospective and decision-focused. The novelty does not lie in new physical climate science, but in the integration of established emissions–warming–impact relationships into a project-level framework designed to inform decision-making. It is distinct in that it:

- Enables attribution of additional warming expected to result from the emissions of individual fossil fuel projects, rather than to aggregated emitters;
- Establishes a transparent and scientifically grounded causal chain linking project-level emissions to global temperature change and onward to projected ecological and human impacts at global and regional scales; and
- Quantifies those impacts in probabilistic and policy-relevant terms that are directly applicable to project approval and risk assessment processes.

[52] In my opinion, this constitutes a material extension of prior attribution science. Rather than restating existing methods, the article repurposes and integrates them into a new framework designed explicitly to inform real-world decision-making at the point of project approval.

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11. Statement of Independence and Duty to the Court

[53] I confirm that:

- I have made all inquiries that I consider necessary and appropriate;
- No matters of significance have been withheld; and
- The opinions expressed are honestly held and based on my specialised knowledge.

[54] I reacknowledge that my paramount duty is to the Court, not to any party.

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12. Limitations and Assumptions

[55] The assessment treats the total area of coral reef habitat as a fixed estimate of 1.06 million hectares, which may underestimate total reef extent, particularly at greater depths. Estimates of coral colony loss further rely on a fixed average density of 250,000 coral colonies per hectare, consistent with published field counts of colonies above minimum size thresholds. Coral abundance is poorly constrained at reef-wide scales because it is typically measured as percent cover rather than colony counts, and because juvenile corals are too small to be feasibly counted. The adopted density excludes many billions of juvenile corals and therefore represents a conservative assumption.

[56] This assessment assumes that the empirical relationships between thermal stress (DHW) and coral loss observed historically will remain broadly applicable in the future.

[57] This assessment is limited to quantifying incremental coral loss and does not evaluate impacts on other climate-sensitive species in the GBRMP or the potential secondary consequences for species and ecosystems that depend on corals. Coral mortality rates may also increase if reef composition shifts toward more heat-susceptible species.

[58] Consequently, the quantified impacts reported should be regarded as conservative estimates of the Browse Project's incremental contribution to coral loss on the GBR.

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Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making

Check for updates

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Every additional tonne of carbon dioxide emissions adds to global warming[1]. This means that decisions to approve new fossil fuel projects represent pivotal moments in shaping Earth's future climate trajectory. Yet, the specific additional global warming caused by project-level CO_2 emissions, and the impacts of that warming, are rarely incorporated into decision-making on the acceptability of new fossil fuel projects. Here, we show how quantifying this additional warming enables concrete, foreseeable consequences to be identified and evaluated in a formal risk assessment framework. This approach reveals that major socioeconomic and environmental consequences can be attributed to CO_2 emissions associated with individual fossil fuel projects, contrary to the pervasive unquantified claims of negligible risks by project proponents. Furthermore, as countries pursue rapid decarbonisation aligned to their Nationally Determined Contributions, the CO_2 emissions from individual fossil fuel projects can, within decades, dominate and even exceed legislated national emission limits. The practical, future-focused approaches demonstrated here offer a critical bridge between climate science and decision-making, with immediate relevance to choices that will shape Earth's climate for decades to centuries to come.

Earth's climate over the coming decades to centuries will be determined by cumulative global emissions of carbon dioxide (CO_2)[1] (Fig.1a). Limiting global CO_2 emissions, and thereby limiting global warming, relies on cooperation, commitments and actions towards emission reductions that are implemented at national and sub-national scales[2]. Within these jurisdictions, the approval/permitting of new or extended fossil fuel extraction occurs on a project-by-project basis. This means that decisions with long-term commitments to future CO_2 emissions and their consequences are made at a project-level, which on their own can appear to be too small to significantly influence global climate change. This raises a fundamental question in the nexus between science and decision-making: if every project is considered too small to matter, does that imply that no individual project bears responsibility for any climate change consequences?

Approval of new or extended fossil fuel projects considers many factors, including their anticipated greenhouse gas emissions. For example, in Australia, one of the world's major fossil fuel producers[3], the proponents of new fossil fuel projects are required to submit project proposals that detail their anticipated greenhouse gas emissions and associated impacts. There are established protocols for calculating and reporting greenhouse gas emissions of fossil fuel production and use[4]. However, there is no required or best-practice framework for quantifying the consequences of these anticipated emissions. Across a range of project proposals under various

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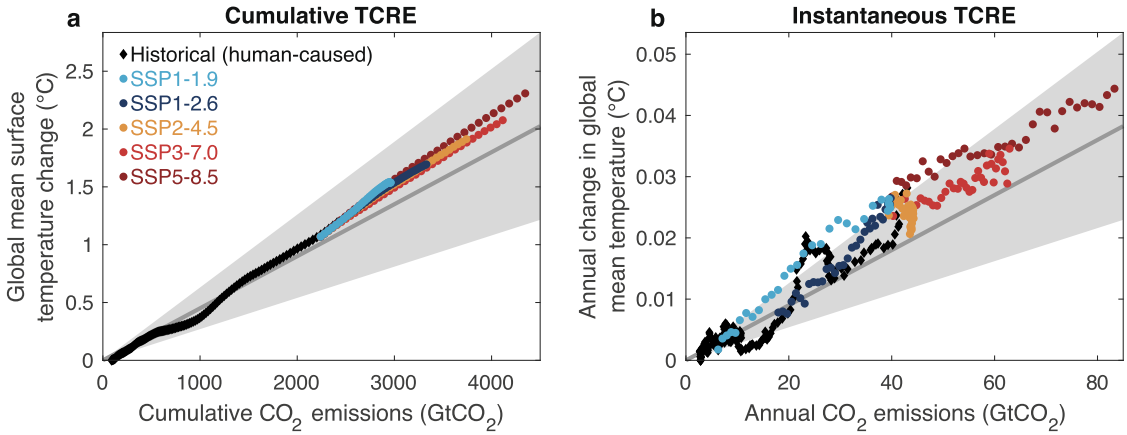


Fig. 1 | The transient climate response to CO_2 emissions (TCRE). a The near-linear relationship between cumulative CO_2 emissions and human-caused global warming demonstrated for historical data (1850–2019) and future emission scenarios synthesised across the multi-model mean of CMIP6 simulations (2014–2050). Future scenarios are based on Shared Socioeconomic Pathways (SSPs) ranging from very low emissions (SSP1-1.9) to very high emissions (SSP5-8.5) futures. Data are from Fig. SPM.10 of ref. 1. **b** The same near-linear relationship is also evident for annual CO_2 emissions and the additional human-caused warming each year, derived from the same datasets. Grey line in both panels shows the IPCC best estimate of the TCRE (0.45 °C of warming caused by 1000 $GtCO_2$) and grey shading shows the 66–100% likelihood range of the TCRE (0.27 °C to 0.63 °C of warming caused by 1000 $GtCO_2$).

Australian jurisdictions, and multiple proponents including global carbon majors[5,6], we demonstrate three pervasive areas where a climate-science basis is currently lacking in fossil fuel project proposal documents (Supplementary Table 1). Firstly, proponents consistently describe their project-level greenhouse gas emissions as negligible in the context of global emissions and as having an unquantifiable contribution to global warming. Secondly, because their global warming contribution is unquantified and assumed negligible, the climate change impacts of individual projects are also unquantified and assumed to be inconsequential. And thirdly, descriptions of project contributions to national or global emissions inventories fail to incorporate committed decarbonisation trajectories over the lifecycle of the proposed projects. Given the immediate risks of climate change, and the deep emission reductions required to meet national and international climate mitigation commitments, there is an urgent need for science-based tools that can support decision-making. Specifically, science-based approaches are needed to quantify the context and consequences of new fossil fuel projects at the point of their approval.

Bridging the divide between scientific evidence and decision-making requires frameworks that link greenhouse gas emissions to tangible consequences. The historical responsibility for climate warming, and its economic damages, has been established for nations[7] and major fossil fuel companies[6]. The economic costs of future climate warming and associated changes in climate variability and extremes have also been projected[8,9], and are expected to disproportionately impact poorer, low-latitude countries that are also often the least responsible for climate change. Scientific progress in quantifying and attributing climate change consequences is underpinning litigation claims worldwide[6,10]. But there remains a divide in bringing actionable scientific evidence into decision-making at a level that can play a role in reducing future climate harms. Using a case study approach, we demonstrate a simple and robust method for quantifying the additional global warming that can be anticipated from the CO_2 emissions of individual fossil fuel projects. This is a critical step that then enables the specific, tangible consequences of a project to be quantified, which in turn can be used to assess whether the project's risks are acceptable. We further illustrate the time-evolving context of project-level CO_2 emissions with respect to Nationally Determined Contributions (NDC) to climate change mitigation, which enables proposals for new or extended fossil fuel projects to be evaluated alongside concurrent commitments to rapid emission reductions. The novelty and potential impact of our future-focused, project-level framework is that it brings the best-available scientific evidence into decision-making at the point where decisions are being made now that will commit future CO_2 emissions for many decades to come. These are the decision points that will be critical to setting the world's future climate trajectory.

Results

Quantifying CO_2-induced warming

The IPCC 6th Assessment Report states that *every additional tonne of CO_2 emissions adds to global warming*[1]. Following IPCC protocols, this statement in the Summary for Policymakers has been approved by all 195 IPCC member governments as an accurate representation of the scientific evidence assessed by the IPCC[11]. The statement is made in the context of evidence for the 'Transient Climate Response to CO_2 Emissions' (TCRE); a simple yet robust metric that connects the primary cause of climate change (CO_2 emissions) to its principal measure (the change in global mean surface temperature)[12] (Fig. 1a). The IPCC assesses that the best estimate of the TCRE is that every 1000 billion tonnes (gigatonnes; Gt) of CO_2 emissions causes 0.45 °C of additional warming, with a 66–100% likelihood of warming between 0.27 °C to 0.63 °C[1]. The robust evidence for this TCRE relationship spans process understanding, direct observations and climate model simulations[11]. The TCRE has been defined based on global cumulative CO_2 emissions since 1850. It is the primary basis for determining the remaining carbon budgets that must not be exceeded if global warming is to be limited to particular policy relevant thresholds[2,13,14], including the 1.5 °C ambition and the well-below 2 °C goal of the Paris Agreement[15].

The near-linear increase in global temperatures due to ongoing CO_2 emissions is expected (with high confidence) to continue over this century and for global warming up to at least 2 °C[11]. This is regardless of the intensity of future emissions, and includes the emission reduction pathways required to limit warming to well-below 2 °C (e.g., SSP1-1.9 and SSP1-2.6 emission scenarios; Fig. 1a). CO_2 is well-mixed and long-lived in the atmosphere (Methods), and zero-CO_2 emission scenarios demonstrate that the global warming caused by past CO_2 emissions persists over many centuries, even after net CO_2 emissions cease entirely[16–19]. The TCRE reflects the near-immediate climate warming response to CO_2 emissions that persists for centuries, while over millennial and longer timescales the equilibrium response of the climate to elevated atmospheric CO_2 concentrations results in further atmospheric surface warming as the energy budget balances across different parts of the Earth system, including the ocean[20]. In the future, the TCRE could become higher than current assessments if positive feedbacks within the Earth system are activated, amplifying the warming caused by anthropogenic CO_2 emissions. For example, if human-generated CO_2 emissions cause enough warming to exceed the tipping point for rapid permafrost thaw[21], releasing large quantities of additional greenhouse gases

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into the atmosphere, then the resulting global warming would exceed expectations based solely on the TCRE relationship for anthropogenic CO_2 emissions[11]. The TCRE is applied indiscriminately to all human-caused CO_2 emissions, however in reality the relationship is more nuanced for CO_2 emissions associated with land use change as these also involve associated changes in the land carbon sink and planetary surface albedo[7].

The TCRE relationship provides a simple approach, based on robust scientific evidence, to quantify the additional global warming that can be anticipated due to individual fossil fuel projects. There is no assessed minimum emissions level where the TCRE relationship ceases to persist between CO_2 emissions and the global warming they cause[11]. Process-based understanding of how CO_2 acts as a greenhouse gas to cause climate warming extends down to the molecular level[22–26]. This implies that the near-linear relationship quantified for cumulative global CO_2 emissions and total global warming should apply to any level of CO_2 emissions that are made within the context where there is high confidence in the TCRE (i.e., fossil CO_2 emissions made this century, and for global warming up to at least 2°C). Indeed, an equivalent near-linear relationship exists between annual anthropogenic CO_2 emissions and additional human-caused warming each year[14] (Fig. 1b). The TCRE has been used to quantify the annual and total contributions to historical global warming attributable to individual nations[7]. The application to quantify the additional warming caused by CO_2 emissions from individual fossil fuel projects is equivalent in method and scale to this previously established use. This is consistent with the IPCC assessment that every additional tonne of CO_2 emissions adds to global warming, and underpins the application of the TCRE at emission levels far smaller than the gigatonne scale used to quantify cumulative global CO_2 emissions.

Additional warming from project-level emissions

Quantification of the additional warming caused by individual fossil fuel projects is a critical evaluation tool. To illustrate this, we use a case study of the Scarborough gas project that has recently been approved for development offshore of northwest Australia[27] (Fig. 2). Liquified Natural Gas (LNG) production from the Scarborough and North Scarborough fields is currently expected to start in 2026 and continue for 31 years, with potential for further expansion or extension to other gas fields in the Greater Scarborough resource. The Scarborough Offshore Project Proposal[27] defined the anticipated scope and environmental outcomes of the project as part of the regulatory approval process. This included estimates for routine greenhouse gas emissions related to the production, processing and consumption of Scarborough LNG. In its detailed impact evaluation, the report states that "*it is not possible to link greenhouse gas emissions from Scarborough with climate change or any particular climate-related impact given that the estimated emissions associated with Scarborough are negligible in the context of existing and future predicted global greenhouse gas concentrations*" (Supplementary Table 1)[27]. The consequence of greenhouse gas emissions from the Scarborough project was therefore evaluated by the project proponents as "*negligible for all receptors*".

The estimated greenhouse gas emissions from the Scarborough project total 876 million tonnes (Mt) of CO_2 emissions over the anticipated lifetime of the project[27]. This incorporates CO_2 emissions associated with offshore production, onshore processing and domestic and international use of Scarborough gas (Methods). Equation 1 quantifies the best estimate of the additional global warming caused by CO_2 emissions from this project, based on the TCRE, as:

$$Additional\ warming(^{\circ}C) = Emissions(Mt\ CO2) \times \frac{0.45\,(^{\circ}C)}{1,000,000\,(Mt\ CO2)} \quad (1)$$

The best estimate is that the 876 Mt of CO_2 emissions from this project will cause 0.00039 °C of additional global warming, with a 66–100% likelihood of causing global warming of between 0.00024 °C and 0.00055 °C (Fig. 2; Methods). While direct measurement of global mean temperature changes is not possible with this level of precision, the agreement across multiple, consistent and independent lines of high-quality evidence (i.e., robust evidence using IPCC calibrated language[28]) gives high confidence in the near-linear relationship between CO_2 emissions and global warming that is quantified through the TCRE[11]. Thus, the additional warming that will be caused by CO_2 emissions from the Scarborough project (or any other fossil fuel project) is knowable and can be quantified based on the anticipated CO_2 emissions of the project.

Quantifying consequences

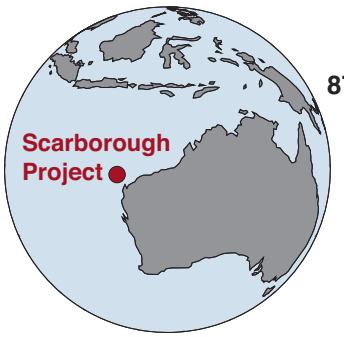
Quantification of the additional warming caused by individual fossil fuel projects enables tangible consequences of this additional warming to be quantified and evaluated in a risk assessment framework. A range of human, environmental and economic impacts are attributable to human-caused global warming. This includes evidence for severe impacts on human and natural systems that have already occurred at current levels of global warming[29,30], and projected future warming that will continue to worsen the frequency and intensity of many climate change-related hazards[1]. These regional consequences in many cases scale with global warming levels, and hence, with CO_2 emissions. They can therefore provide more relatable and relevant measures of climate change risks for decision-makers than quantification of additional global warming alone[31]. Here, we use examples of impacts that are known to be strongly associated with global warming to demonstrate a framework for quantifying tangible consequences of the additional warming caused by an individual fossil fuel project.

The human cost of global warming can be quantified by considering the number of people who will be left outside of the "human climate niche"[32]. The human climate niche describes the climate conditions in which human societies have historically thrived and is defined by the distribution of the human population with respect to mean annual temperature. This distribution is shaped by the effects of climate on people, and on the species and resources that sustain or challenge us, and has been highly consistent for millennia[32,33]. Unlike economic impact measures, the human climate niche framework for quantifying the human cost of global warming considers all lives as equal, regardless of wealth and is inclusive of those already alive and yet to be born[32]. The anticipated global population by the mid-21st century under middle-of-the-road socioeconomic pathways is around 9.5 billion people[34]. In a world with 9.5 billion people, every 1 °C of additional global warming is projected to cause a 13.8 ± 1.6% increase in the global population exposed to a local climate shift where the mean annual temperature exceeds 29 °C and is beyond the hot edge of the human climate niche[32] (Fig. 2a; Supplementary Fig. 1a). Considering the full cold-to-hot distribution of the climate niche, as well as anticipated demographic change, allows for further quantification that 9.5 ± 1.0% of the global population will be left outside of the human climate niche for every 1 °C of additional global warming[32]. Based on these relationships, the 0.00039 °C (0.00024 °C–0.00055 °C likely range) of additional global warming caused by CO_2 emissions from the Scarborough project will result in a best estimate of 516,000 people (308,000–732,000 likely range) being exposed to unprecedented heat, and 356,000 people (213,000–504,000 likely range) being left outside of the human climate niche (Fig. 2a; Methods).

One of the many consequences of exposure outside the human climate niche is increased mortality. At current levels of human-caused global warming, there has already been an observable and rapidly escalating rise in heat-related excess deaths[35–37], including mass mortality events[38]. In many of the worst-affected regions of the world, principally developing nations with tropical (hot and humid) climates, robust data to quantify the human mortality burden of global warming is not yet available. In Europe, where suitable health data is available across 854 cities[36], recent work has quantified that under a low mitigation and low adaptation scenario (SSP3-7.0), the death burden of climate change will increase by 49% this century[39]. Using the middle-of-the-road emissions and demographic scenario (SSP2-4.5) for projected European deaths (Fig. 2b, Supplementary Fig. 2a), it can be estimated that in Europe alone the additional climate warming caused by the Scarborough project will result in an additional 484 heat-related deaths by

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876 Mt CO_2 emissions

Transient climate response to CO_2 emissions

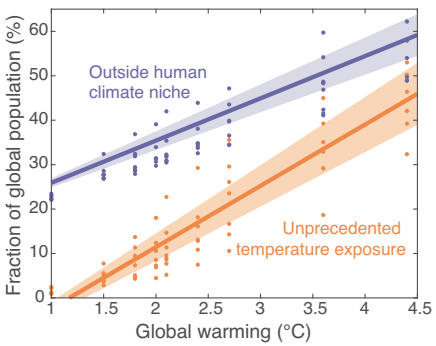
$$\text{Additional warming } (°C) = \text{Emissions } (Mt\ CO2) \times \frac{0.45\ (°C)}{1{,}000{,}000\ (Mt\ CO2)}$$

Additional global warming of 0.00039°C
(likely range of 0.00024°C to 0.00055°C)

Examples of quantified consequences

a

Human climate niche

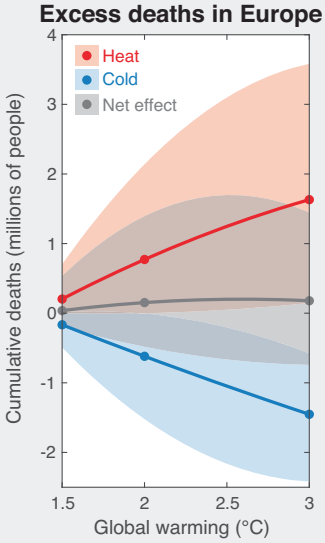


516,000 additional people exposed to unprecedented heat
(likely range of 308,000 to 732,000 people)

356,000 additional people left outside human climate niche
(likely range of 213,000 to 504,000 people)

b

Excess deaths in Europe



Additional 484 heat-related deaths in Europe
(likely range of 88 to 1324)

Additional 118 lives lost in Europe
(likely range of –161 to 851)

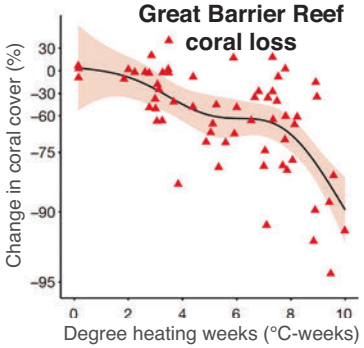
c

Great Barrier Reef additional thermal exposure



Additional accumulated thermal exposure of 0.0017°C-weeks
(likely range 0.00060 to 0.0037°C-weeks)

Great Barrier Reef coral loss



Additional 16 million corals lost in every bleaching event
(likely range of 4.7 million to 37 million)

Fig. 2 | Example of the quantification of the consequences of project-level CO_2 emissions. The approach is illustrated using the Scarborough offshore gas project as a case study but is applicable to any fossil fuel project. Emissions from the Scarborough project of 876 Mt CO_2 can be anticipated (based on the TCRE) to cause a best estimate of 0.00039 °C of additional global warming. The consequences of this additional warming are expected to result in best estimates of, **a** an additional 516,000 people globally exposed to unprecedented heat and 356,000 left outside the human climate niche in a world with 9.5 billion people[32] (Supplementary Fig. 1 also quantifies impacts for global populations of 6.9 billion and 11.2 billion people); **b** an additional 484 heat-related deaths in Europe, and a total of 118 additional lives lost in Europe (net effect) by the end of this century under a middle-of-the-road emissions pathway (SSP2-4.5)[39] (Supplementary Fig. 2 also quantifies impacts under the high emissions SSP3-7.0 scenario); and, **c** additional thermal exposure in the Great Barrier Reef Marine Park (Supplementary Fig. 3) that results in an additional 16 million coral colonies lost in every future bleaching event on the Great Barrier Reef (lower panel after ref. 43). See Methods for calculation details, and text in the "quantifying consequences" section for more detailed descriptions of the examples illustrated in this figure.

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the end of this century (with a likely range of 88 to 1324 additional heat-related deaths; Methods). Heat-related excess deaths in Europe are projected to be most common in southern regions[39], and when taking into account reduced cold-related deaths primarily in northern Europe, the net effect of additional warming caused by Scarborough project emissions is estimated to cost 118 lost lives (−161 to 851 likely range) in Europe alone.

Human-caused climate warming is also having detrimental consequences for natural systems that people value and depend upon. The Great Barrier Reef (GBR) is a UNESCO World Heritage site that is protected under Australian environmental laws[40]. The severe impact of human-caused global warming on coral reefs is evident in the newly emerging phenomenon of mass coral bleaching and mortality events[41]. The GBR has experienced six mass bleaching events during the last decade (2016, 2017, 2020, 2022, 2024, and 2025), caused by heat extremes that are beyond the range of natural climate variability[42]. These repeated bleaching events mean that the existential threat to the GBR ecosystem from human-caused climate warming is now being realised[41–44]. Back-to-back mass bleaching events have already occurred twice in consecutive summers, and with further global warming, mass bleaching of corals will soon occur every summer. The severity of coral bleaching and mortality depends on the intensity of marine heatwaves (positive sea temperature anomalies relative to the long-term average) and their duration (usually measured in weeks), which are combined in the 'Degree Heating Week' (DHW) thermal exposure metric[45]. During the 2016 mass bleaching event on the GBR an accumulated heat exposure of 5 °C-weeks–6 °C-weeks resulted in an average loss of 60% of corals, and 8 °C-weeks–10 °C-weeks increased the average loss to 90% of corals[43]. Each increase in heat exposure of 1 °C-weeks resulted in the death of 2–5% more corals[43]. The 0.00039 °C (0.00024 °C–0.00055 °C likely range) of additional global warming caused by CO_2 emissions from the Scarborough project would increase accumulated thermal exposure on the GBR by 0.0017 °C-weeks (0.00060 °C–0.0037 °C-weeks likely range; Methods; Supplementary Fig. 3). Over the entire GBR, this would result in the death of an additional 16 million coral colonies (4.7 to 37 million likely range) during every future mass bleaching event (Fig. 2c, Methods).

The additional global warming attributable to a single fossil fuel project has quantifiable consequences for people and the environment (Fig. 2), and these can be robustly evaluated in a risk assessment framework. Risk assessments typically use the likelihood of an outcome, and the consequence of that outcome, to determine whether the risk of an activity is acceptable (Supplementary Fig. 4). The "*negligible (level F) for all receptors*" impact level of greenhouse gas emissions that was reached in the proponent's risk assessment of the Scarborough project (Supplementary Table 1)[27] is assigned where consequences are expected to be localised and have no lasting effect (Supplementary Fig. 4). The quantified, evidence-based approach that we demonstrate here does not support this assessment of a negligible impact. We quantify additional warming, and examples of its consequences, with an uncertainty range that encompasses a likelihood of 66% or higher. In the Scarborough risk assessment framework these constitute a "likely" (51 to 80% chance) to "highly likely" (>80% chance) outcome (Supplementary Fig. 4a). The additional warming caused by CO_2 emissions from the Scarborough project will persist for multiple decades to centuries and cause long-term impacts across a range of environmental and social receptors, as illustrated by the examples developed above (Fig. 2a–c). In the Scarborough risk assessment framework these long-term impacts to communities and highly valued ecosystems equate to the highest levels (levels A and B) of consequence (Supplementary Fig. 4b). When these quantified assessments of likelihood and consequence are combined, the result is a risk rating of "severe" (Supplementary Fig. 4c). In an approval process, a severe risk rating should necessitate actions to reduce residual risk to an acceptable level.

Climate change mitigation context

In addition to assessing the acceptability of the consequences of CO_2 emissions from new fossil fuel projects, another important policy consideration is how these proposed emissions relate to national emission reduction commitments. Fossil fuel projects span multiple decades, meaning that approval of new or newly extended fossil fuel projects today typically commit additional CO_2 emissions through to and beyond 2050 (Supplementary Table 1). Frequently, the context of annual emissions of these individual fossil fuel projects is quantified to be only a small percentage of today's CO_2 emissions relative to state, national or global emissions levels (Supplementary Table 1). For example, the anticipated annual domestic emissions of the Scarborough project of 6.2 Mt CO_2 per year (based on scope 1 emissions and 15% of production that is reserved for domestic consumption; Methods) are equivalent to 1.6% of Australia's fossil CO_2 emissions in 2024. However, the rapidly depleting remaining carbon budgets available to limit global warming to well-below 2 °C[11,13] necessitate deep and rapid CO_2 emission reductions this decade, and achieving net-zero emissions by around mid-century[46]. This means that an appropriate emissions context of new fossil fuel projects should encompass a rapidly decarbonising world.

National Determined Contributions (NDCs) provide an unambiguous, policy-aligned target for assessing the emissions context of proposed fossil fuel projects. Remaining carbon budgets for limiting global warming are determined at the global level[11,13], but emission reduction commitments and actions are implemented at national and sub-national levels. Principles of fairness that encompass capability, equality and responsibility have been discussed for guiding national allocations of the remaining global carbon budget[2,47]. The Australian Government has previously determined that a national allocation of 0.97% might be considered as Australia's fair share of the remaining global carbon budget to guide national emission reduction targets[48]. Australia's 2022 NDC[49] is a legislated commitment to reduce national greenhouse gas emissions by 43% below 2005 levels by 2030, and to achieve net-zero emissions by 2050. This is broadly equivalent to Australia doing its fair share to limit global warming to 1.7 °C with around a 50–67% likelihood of success (Fig. 3a; Supplementary Fig. 5; Supplementary Fig. 6).

Scarborough project emissions can be anticipated to constitute a rapidly increasing fraction of the national CO_2 emissions budget under Australia's committed climate change mitigation pathway (Fig. 3b). The expected annual CO_2 emissions from production, processing and domestic consumption of Scarborough gas (i.e., emissions covered under Australia's national greenhouse gas inventory; Methods) will be around 1.9% of the national annual CO_2 budget at the commencement of production in 2026. This proportion rises to 2.5% by 2030 and 4.9% by 2040. By 2049, the anticipated Australian emissions from the Scarborough project alone will comprise half (49%) of Australia's entire annual CO_2 emissions budget. Beyond 2050, all CO_2 emissions from the Scarborough project would require durable CO_2 removal from the atmosphere of an equivalent quantity to be consistent with Australia's NDC.

CO_2 removal is necessary in net-zero pathways to compensate for hard-to-abate emissions, but should not be employed to avoid the rapid, near-term emission reductions required to achieve Paris Agreement goals[50,51]. In 2023, human activities to move CO_2 from the atmosphere into durable geological storage (i.e., effectively reversing the carbon flux caused by fossil fuel combustion) amounted to only 0.04 Mt CO_2 globally[52], which is equivalent to only 0.6% of the planned annual Australian emissions from the Scarborough project. The context illustrated here for Scarborough emissions represents a single project. However, the reality is that many approved and proposed fossil fuel projects, both in Australia (Supplementary Table 1) and globally[3], now have life spans that extend through the time when nations have committed to substantially reducing emissions and achieving net zero. The context of project-level and aggregated fossil fuel emissions commitments relative to climate change mitigation commitments, as well as the significant financial burdens, technological limitations and environmental risks of durable CO_2 removal at scale[50,51,53], will become increasingly pressing factors as the remaining carbon budgets for limiting global warming continue to decline.

Discussion

Our analysis demonstrates how tangible and quantified examples of socio-economic and environmental consequences, across regional to global scales,

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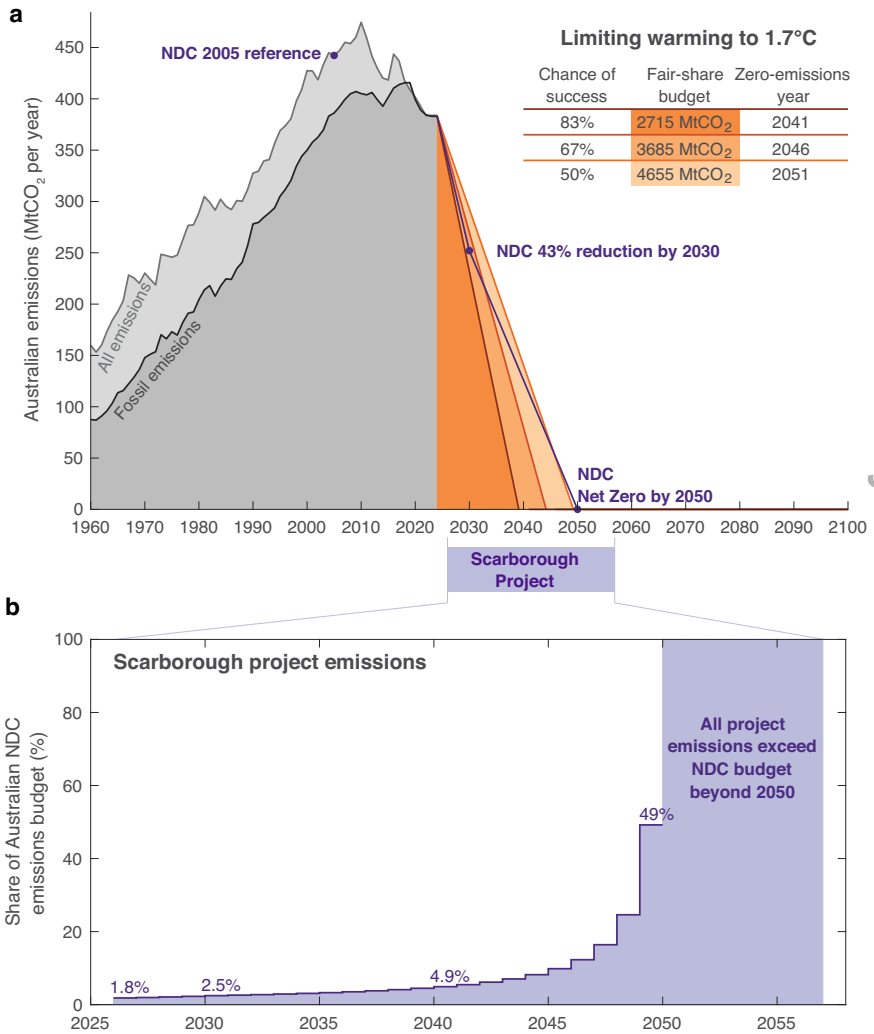


Fig. 3 | Australia's emission reduction pathway commitment and the changing context of Scarborough project emissions. a Australia's historical CO_2 emissions from 1960 to 2024 are shown for fossil (black line) and total (grey line) emissions, along with Australia's 2022 Nationally Determined Contribution (NDC; purple line) for emission reductions of 43% by 2030 (relative to 2005 levels) and net-zero emissions by 2050. Orange shading and table details show linear emission reduction pathways from the start of 2025 that are consistent with Australia's fair share of the remaining global carbon budget for limiting warming to 1.7 °C (Methods; See Supplementary Figs. 5 and 6 for the equivalent analyses for remaining carbon budget pathways to limiting warming to 1.5 °C and 2.0 °C, respectively). **b** Demonstration of the rising contribution of Scarborough project CO_2 emissions that fall under Australian carbon reporting (production, processing and domestic consumption) relative to Australia's NDC emissions reduction pathway.

can be brought into science-informed decision-making in ways that recognise that every fraction of a degree of additional warming matters. The most pressing concerns of decision-makers related to future CO_2 emissions may vary depending on the climate change vulnerabilities and values of the jurisdiction where new fossil fuel projects are being approved, or of the groups and nations where future emissions will have particularly dangerous and costly consequences. These factors may determine decisions on which consequences to prioritise when quantifying the impact of future CO_2 emissions[54]. For example, in Australia a range of nationally significant animals, plants, habitats, water resources or places, including the GBR Marine Park (Fig. 2c), are protected by national legislation through the Environmental Protection and Biodiversity Conservation Act[40]. Significant impacts on these Matters of National Environmental Significance[40] can be addressed in environmental approvals for proposed fossil fuel projects under Australia's jurisdiction. In other jurisdictions, human rights laws may provide instruments for climate change litigation, such as recent high-profile examples in Europe[54]. In these settings the quantification of consequences for people (Fig. 2a), including excess mortality (Fig. 2b), may have the greatest relevance for decision-making. The International Court of Justice (ICJ) recently concluded in a unanimous Advisory Opinion that States have binding legal obligations under international law to prevent significant harm to the climate system and to reduce emissions to levels capable of achieving the 1.5 °C Paris Agreement goal (para. 457 of ref. 55). States must apply best available science to all their climate-related decision-making (paras. 278, 284, 298, and 347 of ref. 55). The ICJ Advisory Opinion is highly relevant for national decision-making on the compatibility of proposed fossil fuel projects with achieving a State's climate change mitigation commitments for rapid decarbonisation over the coming decades (Fig. 3), including the ICJ conclusion that Developed States may be committing internationally wrongful acts by granting new fossil fuel project licences (para. 427 of ref. 55).

The approaches demonstrated here provide a science-based foundation that can be employed by companies, governments, decision-makers, governance boards, climate consultants and legal practitioners in quantifying the consequences of continued fossil fuel production and use, and in assessing whether these projects fall within acceptable levels of environmental and societal risk. In particular, we argue that companies proposing new or extended fossil fuel projects must better account for the impacts of their projected emissions. It is no longer defensible to simply state that their consequences will be negligible (Supplementary Table 1) when scientific evidence allows significant impacts to be anticipated and quantified (Fig. 2; Supplementary Fig. 4). A science-based approach also allows for a more explicit assessment of the financial burdens that result when new fossil fuel projects are approved, including through implicit assumptions and dubious feasibility[50,53] of rapidly increasing large-scale CO_2 removal as continued fossil fuel production and use coincide with national decarbonisation commitments (Fig. 3). This work has developed the quantification process for a small number of example consequences, but many other consequences of additional warming can also be anticipated. Future work will broaden the quantified consequences so that the best-available scientific evidence is able to more readily be incorporated into climate-relevant decision-making globally. The future-focused framework developed here reinforces that

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every tonne of CO_2 emissions adds to global warming, and that every fraction of a degree of additional warming matters[1].

Methods

All datasets and documents used for the analyses in this paper are derived from publicly available sources. These data sources are specified in the Methods text below, and in the analysis source code (https://doi.org/10.5281/zenodo.16516964).

Transient climate response to CO_2 emissions (TCRE)

The TCRE relationship used in this study is derived from the IPCC 6th Assessment Report of Working Group 1. The IPCC assessed that the *best estimate* is that 0.45 °C of global warming results from every 1000 Gt CO_2 emissions, with a *likely range* of global warming between 0.27 °C and 0.63 °C for every 1000 Gt CO_2 emissions[1].

Following established protocols for IPCC calibrated language[28], the *best estimate* represents the most likely value of the TCRE, and the *likely range* quantifies the possible range of TCRE values around the best estimate that are assessed to have a 66–100% likelihood (i.e., greater than 66% likelihood). IPCC assessments of likelihood involve statistical approaches to quantify uncertainty used alongside expert judgement. In the case of the TCRE, the *likely range* was derived from the statistical 90–100% likelihood of the TCRE (i.e., the 5th to 95th percentiles that statistically define a *very likely range* around the *best estimate*) in combination with expert judgement to account for incomplete coverage of all Earth system components in the approaches that were used to statistically define the TCRE. This consolidated assessment thus conservatively uses the statistical 5th–95th percentile range to describe a *likely range* (66–100% likelihood) of the TCRE[11].

It is well established that CO_2 is a well-mixed and long-lived gas in the atmosphere. This means that human-caused CO_2 emissions from fossil fuel combustion influence global climate in the same way, regardless of where these emissions are made. It also means that the climate warming impact of CO_2 emissions is sustained over timescales of multiple centuries to millennia. Short-lived greenhouse gases, notably methane (CH_4), cause warming that is sustained only over decadal timescales and for which an analogous TCRE relationship is not expected[11]. For this reason, this study only quantifies the additional warming and consequences of project-level CO_2 emissions. For fossil fuel projects, CO_2 emissions are the dominant greenhouse gas that is produced (typically >99%; see example for Scarborough emissions below).

Scarborough emissions

Greenhouse gas emission data is derived from the Scarborough Offshore Project Proposal[27]. Anticipated routine greenhouse gas emissions from the project are summarised in units of CO_2-equivalent. To facilitate application of the TCRE to determine the additional global warming caused by the Scarborough project, the CO_2-equivalent emission estimates are converted to CO_2 emissions using available information as follows:

Offshore production: Emissions (scope 1) from offshore production are derived from Table 7–14 and Table 7–15 of ref. 27. These are used to determine that fuel gas emissions of 9.88 Mt CO_2-equivalent are comprised of 99.7% CO_2, and flaring emissions of 1.38 Mt CO_2-equivalent are comprised of 95.4% CO_2. Scarborough gas has a CO_2 composition of 0.1 mol% (page 378 of ref. 27), and so offshore fugitive emissions of 0.26 Mt CO_2-equivalent (primarily CH_4) are omitted from the CO_2 emission estimates. Emissions from installation, construction and decommissioning of the offshore production infrastructure are estimated at 1 Mt CO_2-equivalent (page 378 of ref. 27), and are converted to CO_2 using 99.3% CO_2 composition derived from Australian Government national greenhouse gas accounting guidelines for heavy duty diesel fuel used for transport[4].

Onshore processing: Emissions (scope 1) from onshore processing of Scarborough gas are derived from Tables 7–17 of ref. 27. Reservoir CO_2 emissions of 0.55 Mt CO_2-equivalent are assumed to be 100% CO_2. Processing emissions of 87.42 Mt CO_2-equivalent use the fuel gas emissions composition of 99.7% CO_2.

Consumption: End use emissions (scope 3) for Scarborough gas are derived from Table 7-19 of ref. 27. Under the domestic gas reservation policy of Western Australia, 15% of Scarborough gas production is required to be marketed in Western Australia (p. 387 of ref. 27). This amounts to 92.69 Mt CO_2-equivalent emissions from domestic consumption. International use amounts to 685.84 Mt CO_2-equivalent. The CO_2 composition of these emissions is estimated at 99.7%, based on Australian government greenhouse gas reporting for gas distributed by pipeline[4].

Scarborough project emissions are provided[27] as fixed estimates without uncertainty values. As such, any uncertainty associated with emissions from the project are not incorporated in error calculations in this study.

Anticipated CO_2 emissions from Scarborough gas total 876 Mt CO_2 over the life of the project. Total CO_2 emissions are used in this study to quantify the additional warming and consequences of the Scarborough project. Of the total emissions, 192 Mt CO_2 fall under Australian jurisdiction for carbon accounting purposes (i.e., the emissions from production, processing and domestic consumption). The component of Australian emissions is used to demonstrate the time-evolving context of the Scarborough project relative to Australia's Nationally Determined Contribution to emission reductions.

The following text describes the methods used to quantify consequences and context of emissions from the Scarborough project, however, these are applicable in the same way to any project-level fossil fuel emissions. As such, in the following text we refer simply to the Project, rather than continuing to specify the Scarborough project.

Quantifying additional warming

The additional global warming that will be caused by CO_2 emissions from the Project is quantified using the TCRE through Eq. 1:

$$Additional\ warming(^{\circ}C) = Emissions(Mt\ CO2) \times \frac{0.45\,(^{\circ}C)}{1,000,000\,(Mt\ CO2)}$$

This results in a *best estimate* of 0.00039 °C of additional global warming that will be generated by the 876 Mt CO_2 emissions from the Project. To calculate the *likely range* of additional global warming, the best estimate constant of 0.45 °C is substituted with 0.27 °C and 0.63 °C in the equation above, generating the *likely range* of 0.00024 °C–0.00055 °C of additional global warming.

Quantifying consequences

For each of the quantified consequences demonstrated here, we use a Monte Carlo approach to fully propagate uncertainty. Errors are propagated using 100,000 realisations that randomly sample the uncertainty distributions of each variable used in quantifying consequences. Following the same approach used by the IPCC in determining the TCRE (see TCRE methods text above), we quantify a conservative *likely range* of consequences by calculating the 5th and 95th percentiles across the 100,000 realisations that sample the uncertainty distributions.

To propagate uncertainty in additional warming, we randomly sample a normal distribution[11] around the mean TCRE (mean = 0.45 °C, σ = 0.11 °C) and use this to calculate 100,000 realisations of the additional warming that can be anticipated for CO_2 emissions from the Project. The 5th and 95th percentiles of this distribution correspond to additional warming of 0.00024 °C and 0.00055 °C, consistent with the IPCC-defined *likely range* of the TCRE.

Human climate niche: Quantification of the impacts of additional global warming caused by the Project are derived from the relationships developed in ref. 32, and the associated code archive[56]. We quantify impacts based on a world with 9.5 billion people, which represents a middle-of-the-road shared socioeconomic pathway (SSP2) by the middle of the 21st century.

Two aspects of how global warming will affect people in relation to the human climate niche are quantified[32] (Supplementary Fig. 1a).

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Unprecedented heat exposure quantifies the proportion of the global population whose local climate shifts to be beyond the upper limit of the human climate niche (i.e., above a mean annual temperature of 29 °C). In a world with 9.5 billion people this increases linearly by 13.8 ± 1.6% (mean and 95% confidence interval) per °C of global warming. The number of people left outside of the human climate niche takes into account the full temperature distribution of the human climate niche, with the proportion of the global population left outside the human climate niche increasing linearly by 9.5 ± 1.0% per °C of global warming in a world with 9.5 billion people. The uncertainty in these relationships is randomly sampled 100,000 times assuming a normal distribution around the mean.

Supplementary Fig. 1a shows the data used to calculate the number of people moved outside of the human climate niche through additional global warming for the middle-of-the-road (SSP2 in 2070) scenario of a world with 9.5 billion people. Supplementary Fig. 1b, c, further demonstrate the consequences for scenarios with lower (6.9 billion) and higher (11.1 billion) global population scenarios, as quantified in ref. 32.

Excess mortality in Europe: Quantification of excess deaths in Europe due to the additional warming caused by the Project is based on relationships determined across 854 European cities and quantified for various future climate scenarios[39,57]. We note that this example is used due to the availability of data from Europe to be able to quantify the excess deaths associated with additional warming. Some other parts of the world will be more severely impacted than Europe by excess deaths as a result of additional global warming, but data availability currently precludes quantification of these consequences.

Consistent with our approach for the human climate niche, we quantify excess climate change-related deaths in Europe using a middle-of-the-road (SSP2-4.5) future climate scenario. We extract data for cumulative excess deaths using a climate-change only option that has removed the effects of changing demographics under a no climate change scenario. Cumulative deaths are based on all age groups and a 0% adaptation scenario. The dataset quantifies cumulative deaths between 2015–2099, and so may slightly overestimate deaths caused by the Project where CO_2 emissions will occur over the 2026–2057 period. However, this should be countered by our approach of calculating additional deaths above 1.5 °C of global warming, which is near to today's climate warming level and so discounts any intensification of the impact of emissions on European deaths as global warming worsens over the lifetime of the Project.

Using the parameters described above, we extract Europe-wide information for cold-related deaths, heat-related deaths and total deaths at 1.5 °C, 2.0 °C, and 3.0 °C global warming levels (Supplementary Fig. 2a). Information for cumulative deaths at 4.0 °C is omitted as this level of global warming is poorly constrained in the SSP2-4.5 scenario of future climate simulations. Cumulative deaths data is provided as a best estimate, as well as lower and upper bounds that represent a 95% confidence interval. To estimate the additional deaths in Europe caused by the Project, we fit polynomials to the best estimate and 95% confidence interval data across the 1.5 °C to 3.0 °C global warming levels. We then use these polynomial functions to calculate the consequences of additional warming caused by the Project above 1.5 °C (e.g., the additional deaths at 1.50039 °C global warming level for the best estimate of additional warming, compared to deaths at 1.5 °C). The 95% confidence interval is not symmetrically distributed around the best estimate of cumulative deaths, and varies based on the level of additional warming. To account for this, the uncertainty distribution is randomly sampled 100,000 times based on a normal distribution that is defined by the 95% confidence interval at the level of additional warming above 1.5 °C caused by the Project, and the midpoint of this confidence interval.

The quantification of additional deaths in Europe is also repeated using the same methods, but for the impact of global warming levels defined in a high emissions (SSP3-7.0) scenario (Supplementary Fig. 2b).

Coral loss on the GBR: The consequences of additional warming caused by the Project for coral loss on the GBR requires first determining how global warming relates to thermal stress in the Great Barrier Reef Marine Park (GBRMP). Thermal exposure is measured using the Degree Heating Weeks (DHW) parameter that is indicative of conditions that lead to coral bleaching and mortality[41,58]. We examine the relationship between DHW and global warming using global mean surface temperature anomalies from the Berkeley Earth global temperature record (monthly resolution)[59] and the 5km-resolved DHW dataset from the NOAA Coral Reef Watch product (daily resolution)[45,58]. These datasets illustrate that the annual, summer-centred maximum of accumulated DHW averaged over the GBRMP has been increasing at 4.4-times (± 1.0 standard error; °C-weeks per °C) the rate of annual (July–June) global mean surface temperature (Supplementary Fig. 3a, b). This relationship is based on fitting a linear model, which is expected to be an appropriate estimate for the small magnitudes of additional warming being examined in this study. However, over larger magnitudes of additional global warming it is expected that the increase in DHW will be non-linear, as demonstrated by the lognormal distribution of the spatial relationship between the 5 km grid level (12222 individual grid cells) annual maximum of accumulated DHW over the GBRMP with annual (July–June) global mean surface temperature (Supplementary Fig. 3c, d). The linear model (Supplementary Fig. 3b) estimates that 0.00039 °C of additional global warming will result in a best estimate of additional thermal exposure in the GBRMP of 0.0017 °C-weeks, and 100,000 random samples of a lognormal distribution of uncertainty on this relationship based on the spatial relationship across the GBRMP (Supplementary Fig. 3d) results in a 5–95% range of 0.00060 °C-weeks to 0.0037 °C-weeks.

Determining how increasing thermal stress relates to anticipated coral loss on the GBR uses information on the observed relationship between heat exposure and coral cover losses, alongside estimates of the area of coral reef habitats within the GBRMP and the density of coral colonies within these habitats.

The empirical relationship between heat exposure and observed losses of corals on the GBR during the 2016 mass bleaching event estimates that each increase in heat exposure of 1 °C-weeks resulted in the death of 2–5% more corals (Fig. 2c)[43]. This defines a best estimate of 3.5% coral cover loss per °C-weeks, and an uncertainty around this central estimate that has a normal distribution with $\sigma = 0.91$.

The GBRMP includes an estimated 1.06 million hectares of coral habitat (hard substrate) at depths of 0–20 m[60]. This is used as a conservative fixed estimate in our calculations and may underestimate total reef area. For example, another study that also measured deeper reefs estimated reef area to be more than 3-times larger (3.47 million hectares)[61].

The number of corals per hectare is highly variable and poorly documented because coral abundance is typically measured as percent cover. Approximately 270,000 colonies larger than 9 cm^2 in size were counted per hectare on a Pacific reef[62]. Counts like this are highly sensitive to cutoffs in the minimum size of individuals recorded (e.g., the smallest size visible underwater to the naked eye, or in photographs or videos), and it is not feasible to count the youngest corals at the scale of hectares because newly recruited corals are microscopic. Their densities can exceed thousands per square metre[63] and far outnumber older and larger corals[64]. Consequently, we conservatively assume that, on average, 250,000 individual coral colonies larger than 1 cm in diameter currently occur per hectare on each of the 1.06 million hectares of coral habitat on the GBR (i.e., an average density of 25 corals per m^2 of reef habitat). This average fixed estimate of density discounts many billions of juvenile corals that are smaller than 1 cm.

Based on the relationship between DHW and coral cover, each increase in heat exposure of 1 °C-weeks results in a loss of 2–5% of corals, which represents an average decline per hectare of 5000 to 25,000 individual coral colonies (from an original average of 250,000). Consequently, across all 1.06 million hectares of shallow coral habitat on the GBR, a further increase in accumulated thermal exposure of 0.0017 °C-weeks (*likely range* of 0.00060 °C to 0.0037 °C-weeks) would result in the loss of 16 million corals (*likely range* of 4.7–37 million corals) during every future mass bleaching event. Within a decade or two, mass bleaching on the GBR, and elsewhere, is likely to occur every summer[41,42].

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This quantification of consequences of Project emissions focuses only on losses of corals due to additional warming worsening the intensity of marine heatwave events. It discounts the compounding impacts of diminishing return-times between mass coral bleaching events, and of concurrent ocean acidification and intensified flooding that also degrade reef ecosystems[65]. The calculation of coral loss assumes that the relationship between DHW and coral losses on the GBR remains constant in the future. However, it is plausible that mortality rates in response to DHW could increase if the proportion of weedy, heat-susceptible corals increases over coming decades. Weedy corals are the first to rebound after bleaching events, despite their susceptibility to heat stress, and their prevalence may rise in response to repeated mass bleaching events[44]. Our quantification focuses only on losses of corals, without quantifying the impacts of worsening heat stress on other climate-sensitive species in the GBRMP such as mangroves, sea grasses, turtles, dugongs and sea birds. The loss of millions of corals will also reduce the population sizes of many species that depend on corals and the habitat they provide, including juveniles and adults of many fish species[66]. Many critical ecological processes, including calcification, reef growth, predation, and symbiosis will be further diminished throughout the GBR.

Climate mitigation context

Australia's 2022 Nationally Determined Contribution[49] is for a 43% reduction in greenhouse gas emissions by 2030 (relative to 2005 emissions), and net-zero emission by 2050. The emissions reduction pathway of Australia's NDC from actual emission levels at the start of 2025 is calculated using a linear reduction rate (Fig. 3a).

To give context to these emission reduction commitments we demonstrate them relative to historical emissions data from the Global Carbon Budget 2024[52] (data accessed: https://globalcarbonbudget.org/gcb-2024/). The Global Carbon Budget 2024 provides annual CO_2 emissions datasets at global and national scales to the end of 2023, along with published estimates for global emission in 2024[52]. Australia's emissions for 2024 are assumed to be equivalent to 2023 emissions, which is a valid approximation based on Australian Government reporting[67].

The historical emissions data for Australia are based on annual fossil CO_2 emissions, as well as land-use change (LUC) emissions, which we take as the average of two accounting methods (OSCAR and HN23 datasets; the BLUE and LUCE datasets were excluded as they are highly variable at national scales, making them inconsistent with national emissions reporting). We note that the emission reduction and negative emission trends (i.e., reforestation) in Australian LUC emissions from the Global Carbon Budget are not as strong as for Australian Government emissions reporting[67], due to government-reported inventories also including the natural land sink in managed forests[52].

To demonstrate how Australia's NDC relates to the remaining carbon budget for limiting warming to policy-relevant thresholds (Fig. 3a; Supplementary Figs. 5 and 6), we use the remaining global carbon budgets from the start of 2024[13] adjusted for estimated 2024 emissions[52] to reflect the remaining carbon budget from the start of 2025. In 2013, the Australian Government determined that Australia's "fair share" of the remaining global carbon budget should be 0.97%[48]. From 2013–2024 (inclusive) Australia's total CO_2 emissions were 1.03% of global CO_2 emissions, based on global and national inventories of the Global Carbon Budget[52]. We adjust for Australia's proportion of actual global emissions between 2013 and 2024 in determining Australia's fair share of the remaining carbon budget from the start of 2025. This approach sets Australia's fair-share budget relative to 2013 (i.e., when the fair-share was established by the Australian Government) and adjusts for both changes in scientific evidence for the remaining global carbon budget[13] and for Australia's actual emission rate since the fair-share was established. Linear emission reduction pathways[49] are used to show the pathways that would be consistent with Australia achieving its fair share to limit warming to 1.5 °C (Supplementary Fig. 5), 1.7 °C (Figs. 3a) and 2.0 °C (Supplementary Fig. 6) with a 50, 67, and 83% chance of success. Australia's 2022 NDC is broadly consistent with a fair-share emission reduction pathway to limit global warming to 1.7 °C with between a 50% and 67% chance of success.

For each year of the Project, we calculate the proportion of Project emissions (using only CO_2 emissions that fall under Australia's jurisdiction for carbon reporting) relative to anticipated annual total Australian emissions based on a linear reduction of emissions from the start of 2025 that achieves Australia's NDC (Fig. 3b).

Software

All analysis and figure panels were generated with MATLAB 2024b software. This included using the M_Map mapping package[68].

Data availability

All datasets and documents used for the analyses in this paper are derived from publicly available sources. These data sources are specified in the Methods text, and in the analysis source code.

Code availability

MATLAB code for the analyses performed in this study is available at Zenodo: https://doi.org/10.5281/zenodo.16516965. Future work will be linked to this Zenodo archive, including development of a Python version of the code, and an interactive app that can be utilised for proposed project-level fossil fuel emissions that are made anywhere in the world. Future work will also extend the quantified consequences across a greater range of examples to aid translation of the methods demonstrated here into applications across various sectors and locations.

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Author contributions

N.J.A. conceived the study. N.J.A. and T.P.H. developed the analysis, with contributions from N.M., G.M.F., and S.P.K. N.J.A. wrote the analysis code and prepared the figures. N.J.A. led the writing, and all authors contributed to discussions and editing of the manuscript.

Competing interests

This manuscript builds upon consultancy work previously undertaken by N.J.A. and T.P.H. as independent experts for the Australian Conservation Foundation engaged through the Environmental Defenders Office.

Additional information

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