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June 23, 2023

Mr. William K. Paape
Associate Administrator for Ports & Waterways
U.S. Maritime Administration
1200 New Jersey Avenue SE, W21-310 (MAR-530)
Washington, DC 20590

Via E-mail to William.Paape@dot.gov

Subject: Delfin LNG Deepwater Port Project, Docket No. USCG2015-0472
Submission of Supplemental Greenhouse Gas Emissions Analysis

Dear Mr. Paape:

Delfin LNG LLC ("Delfin") continues to advance its Deepwater Port Project ("Project") and looks forward to the issuance by the U.S. Maritime Administration ("MARAD") of its final license pursuant to the Deepwater Port Act of 1974, as amended, and the Record of Decision issued in this proceeding on March 13, 2017 (the "ROD").[1] In response to your letter of March 30, 2023, Delfin submitted to MARAD and the U.S. Coast Guard ("USCG") on April 7, 2023 an Environmental Impact Assessment prepared by SWCA Environmental Consultants ("2023 SWCA EA"), which provided descriptions and analyses of environmental and operational information that has changed since the Final Environmental Impact Statement ("FEIS") for the Project was completed. The requested 2023 SWCA EA demonstrated that due to reduced impacts associated with Project engineering refinements there are no substantial changes or significant new circumstances or information relevant to environmental concerns that require supplemental National Environmental Policy Act ("NEPA") review prior to licensing.

Delfin continues to await confirmation from MARAD and USCG that no further NEPA analysis is required for license issuance. To address proactively any environmental issues that the agencies may be considering, Delfin submits the attached report *Monetization of Greenhouse Gas Emissions: Port Delfin LNG Project* ("SWCA GHG Analysis") prepared by SWCA Environmental Consultants (Attachment 1).

[1] MARAD, U.S. Dep't of Transp., The Secretary's Decision on the Deepwater Port License Application of Delfin LNG, LLC (Mar. 13, 2017).

As explained below, issues related to greenhouse gas ("GHG") emissions were fully addressed in the ROD, as well as by the Department of Energy in authorizing natural gas exports by Delfin. The 2023 SWCA EA (at pages 9-10) explained that Project refinements result in overall net air emissions decreases, including a reduction of approximately 160,000 tons per year ("tpy") of CO_2e, which is a decrease of 15% from the preliminary project design, with emissions of NOX would be decreased by 11% and emissions of CO would be reduced by 37% compared to the preliminary design considered in the ROD. The SWCA GHG Analysis provides more detailed, updated calculations of the Project's estimated direct GHG emissions during construction and operations, analysis of projected net GHG emissions, and monetization of the emissions using Social Cost of GHG ("SC-GHG") estimates. While this monetized SC-GHG estimate is not required to be considered under NEPA, Delfin submits this analysis for MARAD's and USCG's information in case the agencies consider it relevant, particularly in light of the January 2023 interim guidance from the White House Council on Environmental Quality ("CEQ") regarding how federal agencies should analyze the effects of GHG emissions and climate change in environmental reviews under NEPA ("2023 CEQ Guidance").2

As discussed further below, the attached SWCA GHG Analysis further confirms that no supplemental NEPA analysis is required for the Project. In addition, this letter explains why developments in the NEPA case law and guidance since the Project's FEIS was issued support MARAD's and USCG's approach to GHG emissions analysis, and do not warrant changes in the approach to analyzing these issues.

Quantifying the Project's GHG Emissions Under NEPA

The FEIS provided estimates of the Project's GHG emissions related to construction, operation and decommissioning activities, which are the subject of MARAD's action.3 Based on the FEIS, MARAD ultimately concluded in the Record of Decision "that construction and operation of the Delfin LNG deepwater port will be in the national interest and consistent with national security and other national policy goals and objectives, including energy sufficiency and environmental quality."4

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2 CEQ, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, 88 Fed. Reg. 1,196 (Jan. 9, 2023).

3 *See, e.g.*, Final Environmental Impact Statement for the Port Delfin LNG Project Deepwater Port Application, Nov. 2016 ("FEIS") at 4-154 (Table 4.9-1), 4-168–4-170 (& Table 4.9-15), 4-219. The ROD at 24-25 confirmed the appropriateness of the scope of the EIS analysis of GHGs.

4 ROD at 68.

The SWCA GHG Analysis provides updated estimates quantifying Project GHG emissions based on refinements in the Project design, as explained in the 2023 SWCA EA. These updated estimates demonstrate a reduction in GHG emissions as compared to the FEIS.

The 2023 CEQ Guidance, by its own terms, does ***not*** apply to the Project because the Project's NEPA process already concluded with a FEIS that need not be reopened.[5] CEQ's NEPA implementing regulations provide that supplemental NEPA analysis is only necessary when the agency is presented with "substantial changes to the proposed action" or "significant new circumstances or information" relevant to environment concerns after the EIS is prepared.[6] Neither is present here, as detailed in the 2023 SWCA EA. Delfin's reduction in GHG emissions as part of its Project design refinements reinforces the conclusion that no supplemental EIS is required for the Project.

The 2023 CEQ Guidance states that "agencies should quantify the reasonably foreseeable gross GHG emissions increases and gross GHG emission reductions for the proposed action, no action alternative, and any reasonable alternatives over their projected lifetime, using reasonably available information and data."[7] This Guidance also recommends that agencies "provide additional context for GHG emissions, including through use of the social cost of GHG (SC-GHG)".[8] Even though the 2023 CEQ Guidance does not apply to this Project, as discussed above, Delfin provides the attached SWCA GHG Analysis, which among other things includes a SC-GHG estimate for the Project, in case the agencies find this information to be relevant.

However, quantifying the Project's social cost of GHG emissions is not necessary or useful in its NEPA analysis. The Federal Energy Regulatory Commission ("FERC") has consistently held in the closely analogous context of onshore LNG export facility approvals that, while SC-GHG figures may be disclosed "for information purposes", "the social cost of GHGs tool was not developed for project level review and . . . does not enable the Commission to credibly determine whether the GHG emissions are significant," and "there are no criteria to identify what

5 *See id*. at 1,212 ("CEQ does not expect agencies to apply this guidance to concluded NEPA reviews and actions for which a final EIS or EA has been issued."). At this late stage in the licensing process, after issuance of the FEIS and ROD, applying the 2023 CEQ Guidance would not "inform the consideration of alternatives or help address comments raised through the public comment process" and thus it would be appropriate for MARAD and USCG to exercise their judgment to find this Guidance inapplicable. *See id*. In any event, the SWCA GHG Analysis quantifies the Project's GHG emissions consistent with this 2023 CEQ Guidance.

6 *See* 40 C.F.R. § 1502.9(c)(1).

7 2023 CEQ Guidance, 88 Fed. Reg. at 1,201 (footnotes omitted).

8 *Id*. at 1,198. *See also id*. at 1,202 ("In most circumstances, once agencies have quantified GHG emissions, they should apply the best available estimates of the SC-GHG [61] to the incremental metric tons of each individual type of GHG emissions [62] expected from a proposed action and its alternatives.").

monetized values are significant for NEPA purposes”.9 The U.S. Court of Appeals for the D.C. Circuit has repeatedly upheld the FERC’s decisions not to use the social cost of GHGs in its NEPA reviews, including in the context of approvals for LNG export facilities.10 Most recently, in *Center for Biological Diversity v. FERC*, the D.C. Circuit found FERC acted reasonably when the agency declined to apply the social cost of carbon for three reasons: the lack of consensus about how to apply the social cost of carbon on a long time horizon; the social cost of carbon places a dollar value on carbon emissions but does not measure environmental impacts; and FERC has no established criteria for translating these dollar values into an assessment of environmental impacts.11

These same reasons apply to this Project, and demonstrate that MARAD and USCG have no obligation to consider the SC-GHG.12 Furthermore, the 2023 CEQ Guidance “does not establish any particular quantity of GHG emissions as ‘significantly’ affecting the quality of the human environment.”13 Nevertheless, the SWCA GHG Analysis provides the Project’s SC-GHG estimates for information purposes for the agencies’ consideration.

Scope of the FEIS’s GHG Emissions Analysis

The scope of the GHG emissions analysis in the Project’s FEIS focused “on the direct and indirect impacts of the proposed LNG facility that is subject to MARAD’s Federal action, the licensing of the construction and operation of the LNG facility, and the Federal actions of cooperating agencies, including but not limited to the FERC (certificating onshore components of the LNG facility) and USEPA (permitting under [Clean Water Act] and [Clean Air Act]).”14 The FEIS included estimations of GHG emissions related to construction, operation and decommissioning activities, but did not include an analysis of upstream effects from potential induced production or downstream effects from the export of natural gas. The ROD and FEIS explains the reasons supporting this approach. With respect to potential upstream effects, because the Project proposes to receive natural gas through its interconnection with other existing natural gas pipelines, the factors for “a meaningful analysis—including when, where,

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9 *E.g., Rio Grande LNG, LLC*, 183 FERC ¶ 61,046 at P 92-93 (Apr. 21, 2023); *Texas LNG Brownsville LLC*, 183 FERC ¶ 61,407 at P 20 (Apr. 21, 2023); Commonwealth LNG, LLC, 183 FERC ¶ 61,173 at P 40 (June 9, 2023). The Project’s FEIS was not required to include the SC-GHG for the same reasons as FERC has articulated in these cases.

10 *See, e.g.*, *Ctr. for Biological Diversity v. FERC*, 67 F.4th 1176, 1184 (D.C. Cir. 2023) (upholding as reasonable FERC’s decision not to use the social cost of carbon in its EIS for an LNG facility); *EarthReports, Inc. v. FERC*, 828 F.3d 949, 956 (D.C. Cir. 2016) (same).

11 *Ctr. for Biological Diversity*, 67 F.4th at 1184.

12 *See id*. (holding “FERC had no obligation in this case to consider the social cost of carbon”).

13 2023 CEQ Guidance, 88 Fed. Reg. at 1,200.

14 ROD at 24-25; FEIS at 4-169; *see also* FEIS at ES-14, 1-10; ROD at 24, 60. The FEIS also accounted for these GHG emissions in the cumulative impacts analysis. *See* FEIS at 6-2.

and how natural gas development would occur as related to the proposed project—are unknown."[15] And "the actual scope and extent of potential GHG emissions from upstream natural gas production is not reasonably foreseeable."[16] With respect to downstream GHG emissions from overseas transport, regasification and combustion of exported LNG, the "necessary factors for a meaningful analysis, including the demand for LNG exported from this Project, the destination(s) of the exports, the transport routes, and the ultimate end uses of the LNG, are unknown and, as such, the GHG emissions from same are not reasonably foreseeable."[17] Those same reasons continue to make the indirect effects related to these potential upstream and downstream impacts not "reasonably foreseeable" for this Project and thus not required to be analyzed pursuant to NEPA.

With respect to downstream emissions, the ROD also recognized that the U.S. Department of Energy ("DOE") had authorized Delfin to export natural gas to Free Trade Agreement ("FTA") countries and took note of DOE's 2014 "life cycle" analysis of GHG emissions associated with LNG exports.[18] Following the ROD, DOE also authorized Delfin to export LNG to non-FTA countries and, when doing so, considered downstream GHG emissions and this life-cycle emissions analysis at length.[19] DOE held that "The conclusions of [its 2014 life cycle emissions analysis], combined with the observation that many LNG-importing nations rely heavily on fossil fuels for electric generation, suggests that exports of U.S. LNG may decrease global GHG emissions, although there is substantial uncertainty on this point as indicated above. In any event, the record does not support the conclusion that U.S. LNG exports will increase global GHG emissions in a material or predictable way. Therefore, while we share the commenters' strong concern about GHG emissions as a general matter, based on the current record evidence, we do not see a reason to conclude that U.S. LNG exports will significantly exacerbate global GHG emissions."[20]

DOE updated its 2014 GHG study in 2019 to provide additional information to the public and to inform DOE's LNG export decisions with information about the life cycle GHG emissions of U.S. LNG exports.[21] In its response to comments on that updated study, DOE/FE concluded that "natural gas is one part of an environmentally preferable global energy portfolio" and

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15 ROD at 25; FEIS at 4-169.

16 *Id.*

17 *Id.*

18 ROD at 25 and n. 54.

19 DOE/FE Order No. 4028, issued in FE Docket No. 13-147-LNG (June 1, 2017) at 100-125 and 152-159.

20 *Id.* at 159.

21 DOE, DOE/NETL-2019/2041, Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States: 2019 Update (Sept. 12, 2019), available at: https://fossil.energy.gov/app/docketindex/docket/index/21.

reiterated that the 2019 GHG Study, just like the 2014 study, "supports the proposition that exports of LNG from the lower-48 states will not be inconsistent with the public interest."22

Even if the 2023 CEQ Guidance did apply to this Project (which it does not, as described above), the Guidance does not require NEPA analysis to include effects the agencies have determined are not "reasonably foreseeable."23 Under CEQ regulations, "indirect effects" are defined as effects "which are caused by the action and are later in time or farther removed in distance, but are *still reasonably foreseeable*."24 In the LNG approval context, courts have consistently held that agencies need not consider upstream or downstream impacts that are not reasonably foreseeable.25 The D.C. Circuit recently once again held that FERC's lack of jurisdiction over LNG export approvals—over which the U.S. Department of Energy has exclusive jurisdiction—"means it has 'no NEPA obligation stemming from th[e] effects' of export-bound gas."26 The same is true of MARAD and USCG: just as with land-based LNG export projects, MARAD's action does not authorize natural gas exports, which depend upon DOE authorization. As a result, MARAD and USCG need not consider potential upstream or downstream GHG emissions or make any determination on the potential net effects on GHG emissions, as described in the SWCA GHG Analysis, Section 3.

In addition to the direct emissions that are properly the focus for MARAD and the USCG, the SWCA GHG Analysis addresses total "net emissions" from the Project, taking into consideration downstream emissions and fuel switching overseas. This analysis extends beyond the scope of

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22 DOE, Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas From the United States: 2019 Update—Responses to Comments, 85 Fed. Reg. 72, 86 (Jan. 2, 2020).

23 *See* 2023 CEQ Guidance, 88 Fed. Reg. at 1,204 ("NEPA requires agencies to consider the *reasonably foreseeable* direct and indirect effects of their proposed actions and reasonable alternatives (as well as the no-action alternative)." (emphasis added)); *id*. ("Indirect effects generally include *reasonably foreseeable* emissions related to a proposed action that are upstream or downstream of the activity resulting from the proposed action." (emphasis added)); *id*. ("agencies generally should quantify all *reasonably foreseeable* emissions associated with a proposed action and reasonable alternatives (as well as the no-action alternative)." (emphasis added)).

24 40 C.F.R. § 1508.1(g)(2) (emphasis added) (cited by 2023 CEQ Guidance, 88 Fed. Reg. at 1,204).

25 *See, e.g.*, *EarthReports, Inc. v. FERC*, 828 F.3d 949, 955-56 (D.C. Cir. 2016) (holding that FERC was not required to consider in the NEPA analysis for a proposed LNG facility the potential indirect effects of increased exports on upstream natural gas production or the downstream emissions arising from the transport and consumption of exported natural gas); *Sierra Club v. FERC (Freeport)*, 827 F.3d 36, 47 (D.C. Cir. 2016) (holding FERC was not required to consider the potential increase in domestic natural gas production that the proposed LNG facility may induce because FERC reasonably explained that the asserted linkage was too attenuated); *Sierra Club v. FERC (Sabine Pass)*, 827 F.3d 59, 68 (D.C. Cir. 2016) (similar); *Ctr. for Biological Diversity*, 67 F.4th at 1185 ("indirect emissions are not reasonably foreseeable if the Commission cannot identify the end users of the gas").

26 *Ctr. for Biological Diversity*, 67 F.4th at 1185 (citations omitted); *see also Dep't of Transp. v. Pub. Citizen*, 541 U.S. 752, 770 (2004) ("[W]here an agency has no ability to prevent a certain effect due to its limited statutory authority over the relevant actions, the agency cannot be considered a legally relevant 'cause' of the effect. Hence, under NEPA and the implementing CEQ regulations, the agency need not consider these effects…"); *Sierra Club v. FERC (Freeport)*, 827 F.3d at 47-49; *Sierra Club v. FERC (Sabine Pass)*, 827 F.3d 59, 68 (D.C. Cir. 2016).

appropriate NEPA analysis needed for license issuance and extends to issues within DOE jurisdiction. Nevertheless, the broader analysis is included in the event that the agencies are interested in considering the potential full GHG impact of the Delfin Project. As detailed in the SWCA GHG Analysis, SWCA estimates that the Project will result in a ***net decrease*** of 200 million metric tons of carbon dioxide equivalents being emitted over the life of the Project. Were the SC-GHG estimates utilized to value this net reduction in emissions, SWCA estimates the benefit would have a value of $2.6 to $10.4 billion, expressed in 2023 dollars and discounted to the year 2023.

* * *

We believe the attached SWCA GHG Analysis, which reflects the reductions in projected GHG emissions due to Project design refinements, further confirms that no supplemental NEPA analysis is required. Please feel free to contact the undersigned or our counsel if you have any questions about the attached analysis or the 2023 SWCA EA that Delfin submitted to you on April 7.

Respectfully submitted,

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Monetization of Greenhouse Gas Emissions: Port Delfin LNG Project

JUNE 23, 2023

PREPARED FOR

Delfin LNG LLC

PREPARED BY

SWCA Environmental Consultants

MONETIZATION OF GREENHOUSE GAS EMISSIONS: PORT DELFIN LNG PROJECT

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June 23, 2023

EXECUTIVE SUMMARY

On April 7, 2023, Delfin LNG LLC submitted to the U.S. Maritime Administration (MARAD) and U.S. Coast Guard (USCG) an Environmental Assessment for the Port Delfin LNG Project that was prepared by SWCA Environmental Consultants, which provided updated environmental analysis relating to engineering refinements that have occurred in the Project design process.

This document has been prepared on behalf of Delfin LNG LLC to provide additional analysis of greenhouse gas emissions in connection with the proposed Port Delfin LNG Project. Both direct and net greenhouse gas emissions have been estimated over the life of the proposed Delfin LNG project. These estimates reflect the Project as described in the Final Environmental Impact Statement for the Port Delfin LNG Project Deepwater Port Application (USCG and MARAD 2016) as updated in the 2023 Environmental Assessment for the Port Delfin LNG Project (SWCA 2023).

This document uses methodologies consistent with the Council on Environmental Quality's 2023 interim guidance on consideration of greenhouse gas emissions and climate change in the context of the National Environmental Policy Act (CEQ 2023). Interim estimates of the social cost of carbon, methane, and nitrous oxide, as reported by the Interagency Working Group on Social Cost of Greenhouse Gases (IWG 2021), have been used to place the potential project-related change in GHG emissions in context.

It is estimated that the Project will result in a net decrease of 200,000,000 metric tons of carbon dioxide equivalents being emitted into the Earth's atmosphere. The monetized social benefit of this net reduction is estimated to be between $2.6 billion (assuming a 5% annual discount rate) and $15.9 billion (assuming a 2.5% annual discount rate) with an estimate of $10.4 billion associated with a 3% annual discount rate.

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Tables

1 INTRODUCTION

On April 7, 2023, Delfin LNG LLC submitted to MARAD and USCG an Environmental Assessment for the Port Delfin LNG Project (SWCA 2023), which provided updated environmental analyses relating to engineering refinements that have occurred in the Project design process since the agencies issued the Final Environmental Impact Statement for the Port Delfin LNG Project Deepwater Port Application (USCG and MARAD 2016). The Environmental Assessment (SWCA 2023) explained that there would be a net decrease of operating air emissions of around 160,000 U.S. tons per year (tpy) of carbon dioxide equivalent (CO2e) for the Project, which represents an overall reduction of approximately 15 percent as compared to the 2016 Final Environmental Impact Statement. This document has been prepared on behalf of Delfin LNG LLC to provide additional analysis of greenhouse gas emissions in connection with the proposed Port Delfin LNG Project.

In January of 2023, the Council on Environmental Quality (CEQ) issued interim guidance regarding the treatment of greenhouse gas (GHG) emissions and climate change under the National Environmental Policy Act (NEPA) (CEQ 2023). The guidance reports that the Intergovernmental Panel on Climate Change (IPCC), the United Nations body for assessing the science related to climate change, has determined that rising atmospheric concentrations of greenhouse gases are causing corresponding increases in average global temperatures and in the frequency and severity of natural disasters (IPCC 2022). As such, CEQ's 2023 interim guidance recommends that NEPA documents evaluate a proposed action's effects on GHG emissions over its expected lifetime and that those effects be put in context using the social cost of GHG emissions to express the monetary cost or benefit of the proposed action-related change in GHG emissions.

This document uses methodologies consistent with CEQ's 2023 interim guidance on consideration of GHG emissions and climate change in the NEPA context.

- Both direct and net GHG emissions have been estimated over the life of the proposed Delfin LNG project. These estimates reflect the Project as described in the Final Environmental Impact Statement for the Port Delfin LNG Project Deepwater Port Application (USCG and MARAD 2016) as updated in the 2023 Environmental Assessment for the Port Delfin LNG Project (SWCA 2023).

- Interim estimates of the social cost of carbon, methane, and nitrous oxide, as reported by the Interagency Working Group on Social Cost of Greenhouse Gases (IWG 2021), have been used to place the potential project-related change in GHG emissions in context.

It is estimated that the Project will result in a net decrease of 200,000,000 metric tons of carbon dioxide equivalents being emitted into the earth's atmosphere over the life of the Project. The monetized social benefit of this net reduction is estimated to be between $2.6 billion (assuming a 5% annual discount rate) and $15.9 billion (assuming a 2.5% annual discount rate) with an estimate of $10.4 billion associated with a 3% annual discount rate.

2 DIRECT GREENHOUSE GAS EMISSIONS

Direct greenhouse gas emissions are defined to include GHG emissions that would be directly caused by the Project from sources that are owned or controlled by, in this case, Delfin LNG LLC. The primary GHGs of concern are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (NO_2). Construction-related emissions occur when barges, tugs and other marine vessels combust fossil fuels while supporting Project construction. Operational emissions are associated with stationary emission sources on the deepwater port, as well as LNG trading carriers, tugs, other vessels, and helicopters that support routine operations.

Emissions have been separated into two time periods: direct emissions associated with Project construction would occur from 2024 through 2027; direct emissions associated with Project operation would occur from 2028 through 2052. Operations includes 2028 emissions related to start-up and commissioning.

As illustrated in Table 2-1, direct GHG emissions over the life of the Project are estimated to be 89.7 million metric tons of CO_2e. Emissions are denominated in metric tons and reported as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (NO_2). The CO_2e column represents total emission of all GHGs expressed as an equivalent amount of CO_2 after adjusting for the differential global warming potential of each GHG. The methods, models and assumptions underlying Table 2-1 are reported in Appendix A.

Table 2-1. Direct GHG emissions by year

Year	Metric Tons of Emissions[a]			
	Carbon Dioxide	**Methane**	**Nitrous Oxide**	**Carbon Dioxide Equivalents**
2024	48,957.69	0.34	1.45	49,398.04
2025	13,507.82	0.09	0.40	13,629.55
2026	13,507.82	0.09	0.40	13,629.55
2027	13,507.82	0.09	0.40	13,629.55
2028	3,637,153.56	1,140.14	6.19	3,736,487.35
2029	3,484,996.86	955.07	5.86	3,579,606.69
2030	3,484,996.86	955.07	5.86	3,579,606.69
2031	3,484,996.86	955.07	5.86	3,579,606.69
2032	3,484,996.86	955.07	5.86	3,579,606.69
2033	3,484,996.86	955.07	5.86	3,579,606.69
2034	3,484,996.86	955.07	5.86	3,579,606.69
2035	3,484,996.86	955.07	5.86	3,579,606.69
2036	3,484,996.86	955.07	5.86	3,579,606.69
2037	3,484,996.86	955.07	5.86	3,579,606.69
2038	3,484,996.86	955.07	5.86	3,579,606.69
2039	3,484,996.86	955.07	5.86	3,579,606.69
2040	3,484,996.86	955.07	5.86	3,579,606.69
2041	3,484,996.86	955.07	5.86	3,579,606.69
2042	3,484,996.86	955.07	5.86	3,579,606.69
2043	3,484,996.86	955.07	5.86	3,579,606.69
2044	3,484,996.86	955.07	5.86	3,579,606.69
2045	3,484,996.86	955.07	5.86	3,579,606.69
2046	3,484,996.86	955.07	5.86	3,579,606.69
2047	3,484,996.86	955.07	5.86	3,579,606.69
2048	3,484,996.86	955.07	5.86	3,579,606.69
2049	3,484,996.86	955.07	5.86	3,579,606.69
2050	3,484,996.86	955.07	5.86	3,579,606.69
2051	3,484,996.86	955.07	5.86	3,579,606.69
2052	3,484,996.86	955.07	5.86	3,579,606.69
Total	***87,366,559.35***	***24,062.53***	***149.54***	***89,737,334.49***

a Values include two decimal places to facilitate the readers ability to track and validate calculations. The use of two decimal places is not indicative of the associated level of precision.

3 NET GHG EMISSIONS

In addition to direct GHG emissions, the CEQ's 2023 interim guidance states that agencies should quantify a proposed action's net GHG emissions relative to baseline. That is, agencies should consider whether the implementation of an action is likely to result in a net increase or a decrease in global GHG emissions by considering reasonably foreseeable direct emissions, indirect emissions, and any gross emissions reductions brought about by the proposed action. This calculation is explicitly intended to include the potential displacement of, in this case, energy produced at a higher GHG emission intensity.[1]

This question of the net effect of LNG export on global GHG emissions has been studied by DOE and academics using both attributional[2] and consequential[3] lifecycle analysis. There is a general consensus across these studies that LNG exports from the U.S. Gulf region are likely to bring about a net decrease in global GHG emissions (DOE 2014, Abrahams 2015, DOE 2019, Smillie et al. 2022). The most recent estimate, Smillie et al. (2022) considered natural-gas-related GHG emissions for a 2.1 billion cubic feet per day (Bcfd) LNG export project that occur during extraction, liquification, transport, regassification, and combustion; these researchers found that increasing U.S. LNG export capacity will decrease global GHG emissions; the median estimated change is an 8 billion kg annual CO2e reduction; this is equivalent to an annual reduction of 8,000,000 metric tons during each year of project operation.

While Smillie et al. predict among the smaller net reductions in the literature, their annual estimate is conservatively incorporated into this analysis. As illustrated in Table 3-1, the net change in GHG emissions over the Project's expected lifespan is estimated to be -200,000,000 metric tons CO_2e.

[1] GHG emission intensity refers to the amount of CO_2e emitted to the atmosphere per unit of product produced. In this case, GHG emission intensity can be thought of CO_2e per kilowatt hour of electricity produced via combustion of either natural gas or coal.

[2] In an attributional life cycle analysis, the goal is to assess the environmental impacts of a product/service. Market forces related to supply, demand, and substitution are not considered (Finnveden et al., 2009).

[3] Prox and Curran (2017) note that, in Consequential Life Cycle Assessment (CLCA), the system boundaries are defined to include the activities that change as a consequence of a small change in the demand for the studied products. To understand the potential consequences of a decision that involves the substitution of one product with another, the differences between the alternative product systems are modeled.

Table 3-1. Net Change in GHG Emissions Brought About by the Project

Year	Change in GHG Emissions (Metric Tons of CO_2e)
2024	49,398.04
2025	13,629.55
2026	13,629.55
2027	13,629.55
2028[a]	-7,843,119.35
2029	-8,000,000
2030	-8,000,000
2031	-8,000,000
2032	-8,000,000
2033	-8,000,000
2034	-8,000,000
2035	-8,000,000
2036	-8,000,000
2037	-8,000,000
2038	-8,000,000
2039	-8,000,000
2040	-8,000,000
2041	-8,000,000
2042	-8,000,000
2043	-8,000,000
2044	-8,000,000
2045	-8,000,000
2046	-8,000,000
2047	-8,000,000
2048	-8,000,000
2049	-8,000,000
2050	-8,000,000
2051	-8,000,000
2052	-8,000,000
Total	***-199,752,832.66***

a The net GHG reduction in the first year of operation is reduced relative to subsequent years to reflect extra GHG emissions associated with Project commissioning.

b Values reflect the social cost of a metric ton of CO2e emitted in the specified year expressed in 2023 dollars and discounted to the year 2023 using a 3% annual discount rate.

4 MONETIZATION

CEQ (2023) recommends reporting societies' estimated willingness-to-pay to avoid greenhouse gas emissions as a way of contextualizing proposed action-related changes in greenhouse gas emissions.

This process of estimating societies' willingness-to-pay is commonly called "monetization" and it relies extensively on a concept called the social cost of GHG emissions where the social cost of GHG emissions is intended to indicate the economic losses that result from emitting one extra ton of GHGs into the atmosphere at a specific point in time.

- When a proposed action is expected to increase global greenhouse gas emissions, multiplying the expected increase by the social cost of GHG emissions is a measure of the cost imposed on society by proposed action-related GHG emissions.

- When a proposed action is expected to reduce GHG emissions, multiplying the expected reduction by the social cost of GHG emissions is a measure of the benefit society receives because of the proposed action-related GHG emissions reduction.

The Interagency Working Group on Social Cost of Greenhouse Gases (IWG 2021) reports interim estimates of the social cost of carbon, methane, and nitrous oxide. IWG estimates are used in this assessment with the following provisions.

1. IWG expresses the social cost of carbon in 2020 dollars and discounts losses that occur after GHGs are emitted to the year of emissions. This report updates the costs to 2023 dollars to account for inflation[4] and discounts all future costs to a base year of 2023.

2. IWG reports a unique social cost for GHGs released in any year from 2020 through 2050; these values increase as time passes. Some changes to greenhouse gas emissions associated with proposed action would occur after the year 2050. In this assessment, emissions occurring after 2050 are assigned the social cost of carbon that IWG estimated for greenhouse gasses emitted in 2050.

IWG (2021) addresses differences in the timing of when GHG will be emitted through discounting[5]. To address uncertainty related to the appropriate rate of discount, IWG (2021) evaluates social costs under the assumption of 2.5%, 3%, and 5% annual discount rates. Table 4-1 illustrates net benefit calculations assuming a 3% annual discount rate. Appendix B provides additional calculation detail, reports the results associated with 2.5% and 5% annual discount rates, and monetizes the project's direct greenhouse gas emissions in isolation.

[4] The U.S. Bureau of Labor Statistics CPI Calculator (https://www.bls.gov/data/inflation_calculator.htm), reports that the consumer price index increased by 18% between June 2020 and April 2023.

[5] Resources for the Future (2022) describes discounting as a way to address the difference between the value of some good, service, or payment if it is received today and the value of that same good, service, or payment if it is received in the future. Discounting has the effect of reducing the value of goods/services/money received in the future relative to the value that would be generated if it were received today. Economists cite several reasons for this reduction in value. First, people tend to display impatient behavior, preferring their immediate well-being to future well-being. This means that people often value benefits received sooner more than they value the same benefits received later. Second, people may reasonably expect to be wealthier in the future. If individuals expect to have access to more wealth in the future, then having extra goods/services/money today (when they are relatively less available) is more valuable than having them in the future (when they are relatively more available). Finally, it is reasonable to expect that money invested today will earn a positive rate of return over the long run. Therefore, the value of a dollar received today is greater than the value of a dollar received in the future because it can be invested and earn a return in the interim.

The net reduction in GHG emissions associated with Project construction and operation is approximately 200,000,000 metric tons of CO2e. The monetized social benefit of this net reduction is estimated to be between $2.6 billion (assuming a 5% annual discount rate) and $15.9 billion (assuming a 2.5% annual discount rate) with an estimate of $10.4 billion associated with a 3% annual discount rate.

Note that direct GHG emissions are monetized in Appendix B as doing so appears to be a component of the calculations described in the CEQ (2023) guidance. However, this monetization is not meaningful without consideration of the potential net effects, as described in Section 3 above.

Table 4-1. Social Benefit of Project-Related Change in GHG Emissions: 3% Discount Rate

Year	Change in GHG Emissions (Metric Tons of CO_2e)	Present Value Social Cost per Metric Ton[a]	Present Value Cost of Change in GHG Emissions
2024	49,398.04	$63.01	$3,112,571
2025	13,629.55	$62.29	$848,985
2026	13,629.55	$61.55	$838,899
2027	13,629.55	$61.86	$843,124
2028	-7,843,119.35	$61.07	-$478,979,299
2029	-8,000,000	$60.28	-$482,240,000
2030	-8,000,000	$59.49	-$475,920,000
2031	-8,000,000	$58.68	-$469,440,000
2032	-8,000,000	$57.88	-$463,040,000
2033	-8,000,000	$57.07	-$456,560,000
2034	-8,000,000	$56.26	-$450,080,000
2035	-8,000,000	$55.45	-$443,600,000
2036	-8,000,000	$55.44	-$443,520,000
2037	-8,000,000	$54.61	-$436,880,000
2038	-8,000,000	$53.78	-$430,240,000
2039	-8,000,000	$52.94	-$423,520,000
2040	-8,000,000	$52.12	-$416,960,000
2041	-8,000,000	$51.29	-$410,320,000
2042	-8,000,000	$50.47	-$403,760,000
2043	-8,000,000	$50.31	-$402,480,000
2044	-8,000,000	$49.48	-$395,840,000
2045	-8,000,000	$48.65	-$389,200,000
2046	-8,000,000	$47.83	-$382,640,000
2047	-8,000,000	$47.02	-$376,160,000
2048	-8,000,000	$46.21	-$369,680,000
2049	-8,000,000	$45.96	-$367,680,000
2050	-8,000,000	$45.15	-$361,200,000
2051	-8,000,000	$43.84	-$350,720,000
2052	-8,000,000	$42.56	-$340,480,000
Total	***-199,752,832.66***		***-$10,415,495,721***

a Values reflect the social cost of a metric ton of CO2e emitted in the specified year expressed in 2023 dollars and discounted to the year 2023 using a 3% annual discount rate

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APPENDIX A

Derivation of Direct Emission Estimates

Construction emissions are based on construction phasing, with a known roster of barges, tugs and other marine vessels. Engine rating, hours of use per day, and number of days each vessel would operate are used to calculate a total cumulative hours of use for each vessel type for each construction phase. Emission factors obtained from the Gulfwide Emission Inventory Study (BOEM 2014-666) are used to calculate CO_2, CH_4, and N_2O emission rates on an annual basis. CO_2e emission rates are calculated using the global warming potentials of 25 for CH_4, and 298 for N_2O from 40 CFR 98.

Operational emissions are calculated for all stationary sources associated with the operation of the deepwater port and from LNG trading carriers, tugboat operations, supply vessels, helicopters and heavy weather port operations. Stationary sources are based on a known roster of equipment required to support the deepwater port's operation. These include gas turbines, power generation engines, thermal oxidizers, flares, and emergency generators. CO_2, CH_4, and N_2O emissions resulting from combustion relied on Project-specific design requirements and emission factors based on 40 CFR 98 Tables C-1 and C-2 to Subpart C. Marine vessels and helicopter emission factors for CO_2, CH_4, and N_2O are from the Gulfwide Emission Inventory Study (BOEM 2014-666). CO_2e emission rates are calculated using the global warming potentials of 25 for CH_4, and 298 for N_2O from 40 CFR 98.

Though construction and operation of the deepwater port have the potential to overlap (i.e. some LNG export could begin prior to the completion of all construction) this analysis assumes they will not. This approach tends to increase net GHG emissions relative to a scenario where overlap occurs. Tables A-1 through A-8 summarize and describe direct GHG emission calculations.

Table A-1. Construction Emissions

Construction Phase	CO_2	CH_4	N_2O	CO2e	Year
Pipeline Installation	8,889.89	0.06	0.26	8,970	2024
Flooding and Testing	1,232.62	0.01	0.04	1,244	2024
Trenching	7,620.49	0.06	0.23	7,689	2024
Diving	17,161.84	0.11	0.51	17,316	2024
Precommissioning	4,171.94	0.03	0.12	4,209	2024
TYMS for FLNGV #1	14,889.82	0.1	0.44	15,024	2024
TYMS for FLNGV #2	14,889.82	0.1	0.44	15,024	2025
TYMS for FLNGV #3	14,889.82	0.1	0.44	15,024	2026
TYMS for FLNGV #4	14,889.82	0.1	0.44	15,024	2027

Table A-2. Startup and Commissioning Emissions for FLNGV

FLNGV Number	CO_2	CH_4	N_2O	CO2e	Year
FLNGV #1	41,931	51	0.09	43,232.82	2028
FLNGV #2	41,931	51	0.09	43,232.82	2028
FLNGV #3	41,931	51	0.09	43,232.82	2028
FLNGV #4	41,931	51	0.09	43,232.82	2028

Table A-3. Operational Emission Rates 2028

Pollutant Type	Year 1 Operation Annual Emissions (ton CO2e/yr)																								Year
	Pollutant	Turbine A	Turbine B	Turbine C	Turbine D	Generator A	Generator B	Acid Gas Vent with Thermal Oxidizer	Warm Gas Flare	Cold Gas Flare	Emergency Generator A	Emergency Fire Water Pump A	Emergency Fire Water Pump B	Emergency Fire Water Pump C	Emergency Fire Water Pump D	Aux Boiler	Fugitive	LNG Trading Carrier	Tug Ops	Supply Vessel	Helicopter	Liq Train Restart Flaring	Heavy Weather Port Ops	TOTAL	
Greenhouse Gas	CO2	754,087.04	754,087.04	754,087.04	754,087.04	230,088.68	1,313.29	391,406.63	27,849.00	122,768.00	766.42	244.10	244.10	244.10	244.10	24,648.48	18.28	10,214.00	14,821.00	321.00	11.00	0.00	0.00	**3,841,550.36**	2028
	N2O	1.42	1.42	1.42	1.42	0.43	0.00	N/A	0.05	0.23	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.46**	2028
	CH4	14.21	14.21	14.21	14.21	4.34	0.02	N/A	0.52	2.24	0.03	0.01	0.01	0.01	0.01	0.46	988.28	0.00	0.00	0.00	0.00	0.00	0.00	**1,052.79**	2028
	CO2e	754,865.86	754,865.86	754,865.86	754,865.86	230,326.31	1,314.65	391,406.63	27,877.76	122,892.00	769.05	244.94	244.94	244.94	244.94	24,673.93	24,725.28	10,233.00	14,954.00	321.00	11.00	70,000.00	5,892.00	**3,945,839.81**	2028

Table A-4. Operational Emission Rates 2029

Pollutant Type	Year 2 Operation Annual Emissions (ton CO2e/yr)																								Year
	Pollutant	Turbine A	Turbine B	Turbine C	Turbine D	Generator A	Generator B	Acid Gas Vent with Thermal Oxidizer	Warm Gas Flare	Cold Gas Flare	Emergency Generator A	Emergency Fire Water Pump A	Emergency Fire Water Pump B	Emergency Fire Water Pump C	Emergency Fire Water Pump D	Aux Boiler	Fugitive	LNG Trading Carrier	Tug Ops	Supply Vessel	Helicopter	Liq Train Restart Flaring	Heavy Weather Port Ops	TOTAL	
Greenhouse Gas	CO2	754,087.04	754,087.04	754,087.04	754,087.04	230,088.68	1,313.29	391,406.63	27,849.00	122,768.00	766.42	244.10	244.10	244.10	244.10	24,648.48	18.28	10,214.00	14,821.00	321.00	11.00	0.00	0.00	**3,841,550.36**	2029
	N2O	1.42	1.42	1.42	1.42	0.43	0.00	N/A	0.05	0.23	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.46**	2029
	CH4	14.21	14.21	14.21	14.21	4.34	0.02	N/A	0.52	2.24	0.03	0.01	0.01	0.01	0.01	0.46	988.28	0.00	0.00	0.00	0.00	0.00	0.00	**1,052.79**	2029
	CO2e	754,865.86	754,865.86	754,865.86	754,865.86	230,326.31	1,314.65	391,406.63	27,877.76	122,892.00	769.05	244.94	244.94	244.94	244.94	24,673.93	24,725.28	10,233.00	14,954.00	321.00	11.00	70,000.00	5,892.00	**3,945,839.81**	2029

Table A-5. Operational Emission Rates 2030

Pollutant Type	Year 3 Operation Annual Emissions (ton CO2e/yr)																								Year
	Pollutant	Turbine A	Turbine B	Turbine C	Turbine D	Generator A	Generator B	Acid Gas Vent with Thermal Oxidizer	Warm Gas Flare	Cold Gas Flare	Emergency Generator A	Emergency Fire Water Pump A	Emergency Fire Water Pump B	Emergency Fire Water Pump C	Emergency Fire Water Pump D	Aux Boiler	Fugitive	LNG Trading Carrier	Tug Ops	Supply Vessel	Helicopter	Liq Train Restart Flaring	Heavy Weather Port Ops	TOTAL	
Greenhouse Gas	CO2	754,087.04	754,087.04	754,087.04	754,087.04	230,088.68	1,313.29	391,406.63	27,849.00	122,768.00	766.42	244.10	244.10	244.10	244.10	24,648.48	18.28	10,214.00	14,821.00	321.00	11.00	0.00	0.00	**3,841,550.36**	2030
	N2O	1.42	1.42	1.42	1.42	0.43	0.00	N/A	0.05	0.23	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.46**	2030
	CH4	14.21	14.21	14.21	14.21	4.34	0.02	N/A	0.52	2.24	0.03	0.01	0.01	0.01	0.01	0.46	988.28	0.00	0.00	0.00	0.00	0.00	0.00	**1,052.79**	2030
	CO2e	754,865.86	754,865.86	754,865.86	754,865.86	230,326.31	1,314.65	391,406.63	27,877.76	122,892.00	769.05	244.94	244.94	244.94	244.94	24,673.93	24,725.28	10,233.00	14,954.00	321.00	11.00	70,000.00	5,892.00	**3,945,839.81**	2030

Table A-6. Operational Emission Rates 2031

Pollutant Type	Year 4 Operation Annual Emissions (ton CO2e/yr)																								Year
	Pollutant	Turbine A	Turbine B	Turbine C	Turbine D	Generator A	Generator B	Acid Gas Vent with Thermal Oxidizer	Warm Gas Flare	Cold Gas Flare	Emergency Generator A	Emergency Fire Water Pump A	Emergency Fire Water Pump B	Emergency Fire Water Pump C	Emergency Fire Water Pump D	Aux Boiler	Fugitive	LNG Trading Carrier	Tug Ops	Supply Vessel	Helicopter	Liq Train Restart Flaring	Heavy Weather Port Ops	TOTAL	
Greenhouse Gas	CO2	754,087.04	754,087.04	754,087.04	754,087.04	230,088.68	1,313.29	391,406.63	27,849.00	122,768.00	766.42	244.10	244.10	244.10	244.10	24,648.48	18.28	10,214.00	14,821.00	321.00	11.00	0.00	0.00	**3,841,550.36**	2031
	N2O	1.42	1.42	1.42	1.42	0.43	0.00	N/A	0.05	0.23	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.46**	2031
	CH4	14.21	14.21	14.21	14.21	4.34	0.02	N/A	0.52	2.24	0.03	0.01	0.01	0.01	0.01	0.46	988.28	0.00	0.00	0.00	0.00	0.00	0.00	**1,052.79**	2031
	CO2e	754,865.86	754,865.86	754,865.86	754,865.86	230,326.31	1,314.65	391,406.63	27,877.76	122,892.00	769.05	244.94	244.94	244.94	244.94	24,673.93	24,725.28	10,233.00	14,954.00	321.00	11.00	70,000.00	5,892.00	**3,945,839.81**	2031

Table A-7. Operational Emission Rates 2032

Pollutant Type	Year 5 Operation Annual Emissions (ton CO2e/yr)																								Year
	Pollutant	Turbine A	Turbine B	Turbine C	Turbine D	Generator A	Generator B	Acid Gas Vent with Thermal Oxidizer	Warm Gas Flare	Cold Gas Flare	Emergency Generator A	Emergency Fire Water Pump A	Emergency Fire Water Pump B	Emergency Fire Water Pump C	Emergency Fire Water Pump D	Aux Boiler	Fugitive	LNG Trading Carrier	Tug Ops	Supply Vessel	Helicopter	Liq Train Restart Flaring	Heavy Weather Port Ops	TOTAL	
Greenhouse Gas	CO2	754,087.04	754,087.04	754,087.04	754,087.04	230,088.68	1,313.29	391,406.63	27,849.00	122,768.00	766.42	244.10	244.10	244.10	244.10	24,648.48	18.28	10,214.00	14,821.00	321.00	11.00	0.00	0.00	**3,841,550.36**	2032
	N2O	1.42	1.42	1.42	1.42	0.43	0.00	N/A	0.05	0.23	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.46**	2032
	CH4	14.21	14.21	14.21	14.21	4.34	0.02	N/A	0.52	2.24	0.03	0.01	0.01	0.01	0.01	0.46	988.28	0.00	0.00	0.00	0.00	0.00	0.00	**1,052.79**	2032
	CO2e	754,865.86	754,865.86	754,865.86	754,865.86	230,326.31	1,314.65	391,406.63	27,877.76	122,892.00	769.05	244.94	244.94	244.94	244.94	24,673.93	24,725.28	10,233.00	14,954.00	321.00	11.00	70,000.00	5,892.00	**3,945,839.81**	2032

Table A-8. Operational Emission Rates 2033+

	Year 6+ Normal Operations After Full Buildout Annual Emissions (ton CO2e/yr)																								Year
	Pollutant	Turbine A	Turbine B	Turbine C	Turbine D	Generator A	Generator B	Acid Gas Vent with Thermal Oxidizer	Warm Gas Flare	Cold Gas Flare	Emergency Generator A	Emergency Fire Water Pump A	Emergency Fire Water Pump B	Emergency Fire Water Pump C	Emergency Fire Water Pump D	Aux Boiler	Fugitive	LNG Trading Carrier	Tug Ops	Supply Vessel	Helicopter	Liq Train Restart Flaring	Heavy Weather Port Ops	TOTAL	
Greenhouse Gas	CO2	754,087.04	754,087.04	754,087.04	754,087.04	230,088.68	1,313.29	391,406.63	27,849.00	122,768.00	766.42	244.10	244.10	244.10	244.10	24,648.48	18.28	10,214.00	14,821.00	321.00	11.00	0.00	0.00	**3,841,550.36**	2033+
	N2O	1.42	1.42	1.42	1.42	0.43	0.00	N/A	0.05	0.23	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.46**	2033+
	CH4	14.21	14.21	14.21	14.21	4.34	0.02	N/A	0.52	2.24	0.03	0.01	0.01	0.01	0.01	0.46	988.28	0.00	0.00	0.00	0.00	0.00	0.00	**1,052.79**	2033+
	CO2e	754,865.86	754,865.86	754,865.86	754,865.86	230,326.31	1,314.65	391,406.63	27,877.76	122,892.00	769.05	244.94	244.94	244.94	244.94	24,673.93	24,725.28	10,233.00	14,954.00	321.00	11.00	70,000.00	5,892.00	**3,945,839.81**	2033+

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APPENDIX B

Monetization Details

IWG (2021) presents interim estimates of the social cost of carbon dioxide, methane, and nitrous oxide developed under Executive Order 13990 and denominated in 2020 dollars. The estimates are intended to reflect the monetary value of the harm imposed on society when a U.S. ton of GHG is emitted to the atmosphere at a specific point in time.

Social cost estimates are specific to both the year in which a release occurs and the GHG being released. For any specified year/GHG combination, the IWG assigned social cost represents the present value of the costs imposed on society by the release and then discounted to the year of the release using either a 2.5%, 3%, or 5% annual discount rate.

For this assessment, all social costs were converted to 2023 dollars. This was done by multiplying the IWG (2021) social cost estimates by 1.18 which accounts for inflation between June 2020 and April 2023 as estimated using the consumer price index. In addition, all social costs were discounted to a base year of 2023 using either a 2.5%, 3%, or 5% annual discount rate as appropriate. The resulting present value social costs, denominated in 2023 dollars and discounted to the year 2023, are reported in Tables B-1, B-2, and B-3.

Monetizing Net GHG Emissions

The methods, data, assumptions and results of net GHG emission calculations are described in the main body of this report. The calculations generate an estimate of the change in CO_2e emissions[6] by year from 2024 (when Project construction is assumed to begin) through 2052 (when operation is assumed to end). These estimates, denominated in metric tons, are reported in Table 3-1.

To calculate the present value social cost associated with 1) a net change in emissions denominated as Co_2e, 2) released in a specific year, and 3) assuming either a 2.5%, 3% or 5% discount rate, it is necessary to identify the corresponding emission estimate in Table 3-1 and present value cost in Table B-1. For example, the present value social cost associated with the net change in GHG emissions in 2033 assuming a 2.5% discount rates is calculated as the product of a) the net change of -8,00,000 metric tons CO_2e in 2033 (from Table 3-1) and b) $86.65 per U.S. ton of carbon dioxide emitted (from Table B-1).

To calculate the total social cost of the net change in GHG emissions under a specific discount rate, the calculations described in the preceding paragraph are performed for all years and then summed.

Depending on the assumed discount rate, the monetized social benefit of this net reduction is estimated to be between $2.6 billion (assuming a 5% annual discount rate) and $15.9 billion (assuming a 2.5% annual discount rate), with an estimate of $10.4 billion associated with a 3% annual discount rate.

Monetizing Direct GHG Emissions

It is difficult to assign meaning to monetary values associated with the direct GHG emissions estimated to arise from the Project. Only the potential net effect of the Project on global GHG emissions may affect future GHG concentrations. Nonetheless, the remainder of this appendix illustrates calculations which associate a monetary value with the Project's estimated direct GHG emissions for informational purposes.

[6] CEQ (2023) recommends monetizing changes in GHG emissions by GHG (i.e., carbon dioxide, methane, nitrous oxide) rather than monetizing CO_2e because doing so may increase the accuracy of the resulting monetization. However, because net GHG estimates rely on a complex bio-economic model that is denominated in CO_2e, this net GHG assessment adopts the CO_2e metric. This approach is consistent with CEQ (2023) guidance which suggests that analysists "apply the rule of reason when determining the appropriate depth of analysis such that precision regarding emission reduction benefits does not come at the expense of efficient and accessible analysis."

To calculate the present value social cost associated with 1) the direct emission of a specific GHG, 2) released in a specific year, and 3) assuming either a 2.5%, 3% or 5% discount rate, it is necessary to identify the corresponding emission estimate in Table 2-1 and the appropriate present value cost in Table B-1, B-2, or B-3. For example, the present value social cost associated with the direct emission of carbon dioxide in 2033 assuming a 2.5% discount rates is calculated as the product of a) 3,484,996.86 metric tons of carbon dioxide emitted in 2033 (from Table 2-1) and b) $86.65 per U.S. ton of carbon dioxide emitted (from Table B-1).

To calculate the total social cost of direct GHG emissions under a specific discount rate, the calculations described in the preceding paragraph are performed for all GHGs and years and then summed.

Table B-4 illustrates the methods used to associate a $4.6 billion social cost with direct GHG emissions assuming a 3% annual discount rate. Assuming a 2.5% annual discount rate, the social cost would be $7.0 billion, whereas it would be $1.2 billion assuming a 5% annual discount rate.

Table B-1. Social Cost of CO_2 Denominated in 2023 dollars and Discounted to the Year 2023

	Social Cost of Emitting 1 Metric Ton of Carbon Dioxide in the Specified Year		
Year	**5% Annual Discount Rate**	**3% Annual Discount Rate**	**2.5% Annual Discount Rate**
2020	$19.12	$65.76	$96.58
2021	$19.51	$65.10	$96.70
2022	$18.59	$64.42	$95.55
2023	$18.88	$63.72	$94.40
2024	$17.98	$63.01	$94.40
2025	$18.20	$62.29	$93.22
2026	$17.33	$61.55	$92.04
2027	$17.47	$61.86	$91.94
2028	$16.64	$61.07	$90.74
2029	$16.73	$60.28	$89.54
2030	$15.93	$59.49	$88.35
2031	$15.97	$58.68	$88.13
2032	$15.97	$57.88	$86.93
2033	$15.21	$57.07	$86.65
2034	$15.18	$56.26	$85.44
2035	$14.46	$55.45	$84.23
2036	$14.39	$55.44	$83.89
2037	$13.71	$54.61	$82.68
2038	$13.62	$53.78	$81.47
2039	$13.51	$52.94	$81.08
2040	$12.87	$52.12	$79.88
2041	$12.75	$51.29	$78.68
2042	$12.14	$50.47	$78.24
2043	$12.01	$50.31	$77.05
2044	$11.86	$49.48	$75.88
2045	$11.29	$48.65	$75.40
2046	$11.14	$47.83	$74.23
2047	$10.98	$47.02	$73.07
2048	$10.45	$46.21	$72.56
2049	$10.29	$45.96	$71.41
2050	$10.11	$45.15	$70.27
2051	$9.63	$43.84	$68.56
2052	$9.17	$42.56	$66.89

Table B-2. Social Cost of CH_4 Denominated in 2023 dollars and Discounted to the Year 2023

	Social Cost of Emitting 1 Metric Ton of Methane in the Specified Year		
Year	**5% Annual Discount Rate**	**3% Annual Discount Rate**	**2.5% Annual Discount Rate**
2020	$915.22	$1,934.13	$2,578.84
2021	$897.66	$1,877.79	$2,503.72
2022	$892.08	$1,944.64	$2,552.34
2023	$885.00	$1,888.00	$2,478.00
2024	$865.33	$1,947.57	$2,520.39
2025	$856.24	$1,890.85	$2,446.98
2026	$846.04	$1,943.76	$2,483.69
2027	$834.88	$1,887.15	$2,411.35
2028	$813.61	$1,933.97	$2,442.91
2029	$801.29	$1,877.64	$2,470.58
2030	$788.29	$1,918.90	$2,398.62
2031	$774.71	$1,863.01	$2,421.91
2032	$760.64	$1,899.18	$2,351.37
2033	$724.42	$1,843.86	$2,370.68
2034	$758.91	$1,875.41	$2,386.88
2035	$722.77	$1,820.78	$2,317.36
2036	$688.36	$1,848.10	$2,330.22
2037	$715.18	$1,794.27	$2,340.36
2038	$681.12	$1,817.75	$2,272.19
2039	$648.69	$1,838.34	$2,279.54
2040	$669.28	$1,784.80	$2,213.15
2041	$637.41	$1,802.13	$2,218.00
2042	$653.75	$1,749.64	$2,220.69
2043	$622.62	$1,764.01	$2,156.01
2044	$592.97	$1,712.63	$2,156.65
2045	$605.07	$1,724.33	$2,155.42
2046	$576.26	$1,674.11	$2,092.64
2047	$548.82	$1,683.40	$2,089.73
2048	$557.53	$1,690.72	$2,085.23
2049	$530.98	$1,641.48	$2,024.49
2050	$537.30	$1,646.79	$2,018.65
2051	$511.72	$1,598.83	$1,959.85
2052	$487.35	$1,552.26	$1,902.77

Table B-3. Social Cost of N_2O Denominated in 2023 dollars and Discounted to the Year 2023

	Social Cost of Emitting 1 Metric Ton of Nitrous Oxide in the Specified Year		
Year	**5% Annual Discount Rate**	**3% Annual Discount Rate**	**2.5% Annual Discount Rate**
2020	$7,922.79	$23,209.52	$34,814.28
2021	$7,805.70	$23,785.38	$35,052.14
2022	$7,681.80	$23,092.60	$34,031.20
2023	$7,552.00	$23,600.00	$34,220.00
2024	$7,417.14	$22,912.62	$33,223.30
2025	$7,278.00	$23,357.53	$33,367.90
2026	$7,135.30	$22,677.21	$32,396.01
2027	$6,989.68	$22,016.71	$32,500.86
2028	$6,841.75	$22,393.32	$32,572.11
2029	$6,692.06	$21,741.09	$31,623.41
2030	$6,541.11	$22,067.30	$31,661.78
2031	$6,389.36	$21,424.57	$30,739.60
2032	$6,313.30	$21,704.92	$30,748.64
2033	$6,157.55	$21,072.74	$30,731.08
2034	$6,071.31	$21,311.43	$29,836.00
2035	$5,913.61	$20,690.71	$29,794.62
2036	$5,819.75	$20,891.59	$28,926.81
2037	$5,661.81	$20,283.09	$28,864.40
2038	$5,562.48	$20,449.72	$28,781.09
2039	$5,405.72	$19,854.10	$27,942.81
2040	$5,148.30	$19,989.74	$27,842.86
2041	$5,393.46	$19,407.52	$27,031.90
2042	$5,136.63	$19,515.19	$26,917.50
2043	$4,892.03	$18,946.78	$26,786.83
2044	$4,659.07	$19,029.24	$26,006.63
2045	$4,840.59	$18,474.99	$25,864.99
2046	$4,610.09	$18,534.78	$25,709.54
2047	$4,390.56	$17,994.94	$24,960.72
2048	$4,529.94	$18,034.39	$24,797.28
2049	$4,314.23	$17,509.11	$24,622.19
2050	$4,108.79	$17,530.36	$23,905.04
2051	$3,913.14	$17,019.77	$23,208.78
2052	$3,726.80	$16,524.05	$22,532.79

Table B-4. Monetization of Direct GHG Emissions: 3% Discount Rate

Year	Metric Tons of Emissions			Social Cost of GHG Emissions			Social Cost
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	
2024	48,957.69	0.34	1.45	$63.01	$1,947.57	$22,912.62	$3,118,710
2025	13,507.82	0.09	0.40	$62.29	$1,890.85	$23,357.53	$850,915
2026	13,507.82	0.09	0.40	$61.55	$1,943.76	$22,677.21	$840,652
2027	13,507.82	0.09	0.40	$61.86	$1,887.15	$22,016.71	$844,570
2028	3,637,153.56	1,140.14	6.19	$61.07	$1,933.97	$22,393.32	$224,464,579
2029	3,484,996.86	955.07	5.86	$60.28	$1,877.64	$21,741.09	$211,996,291
2030	3,484,996.86	955.07	5.86	$59.49	$1,918.90	$22,067.30	$209,284,461
2031	3,484,996.86	955.07	5.86	$58.68	$1,863.01	$21,424.57	$206,404,469
2032	3,484,996.86	955.07	5.86	$57.88	$1,899.18	$21,704.92	$203,652,659
2033	3,484,996.86	955.07	5.86	$57.07	$1,843.86	$21,072.74	$200,773,272
2034	3,484,996.86	955.07	5.86	$56.26	$1,875.41	$21,311.43	$197,981,956
2035	3,484,996.86	955.07	5.86	$55.45	$1,820.78	$20,690.71	$195,103,296
2036	3,484,996.86	955.07	5.86	$55.44	$1,848.10	$20,891.59	$195,095,716
2037	3,484,996.86	955.07	5.86	$54.61	$1,794.27	$20,283.09	$192,148,191
2038	3,484,996.86	955.07	5.86	$53.78	$1,817.75	$20,449.72	$189,279,045
2039	3,484,996.86	955.07	5.86	$52.94	$1,838.34	$19,854.10	$186,367,822
2040	3,484,996.86	955.07	5.86	$52.12	$1,784.80	$19,989.74	$183,459,785
2041	3,484,996.86	955.07	5.86	$51.29	$1,802.13	$19,407.52	$180,580,377
2042	3,484,996.86	955.07	5.86	$50.47	$1,749.64	$19,515.19	$177,673,179
2043	3,484,996.86	955.07	5.86	$50.31	$1,764.01	$18,946.78	$177,125,973
2044	3,484,996.86	955.07	5.86	$49.48	$1,712.63	$19,029.24	$174,184,838
2045	3,484,996.86	955.07	5.86	$48.65	$1,724.33	$18,474.99	$171,300,217
2046	3,484,996.86	955.07	5.86	$47.83	$1,674.11	$18,534.78	$168,394,906
2047	3,484,996.86	955.07	5.86	$47.02	$1,683.40	$17,994.94	$165,577,768
2048	3,484,996.86	955.07	5.86	$46.21	$1,690.72	$18,034.39	$162,762,142
2049	3,484,996.86	955.07	5.86	$45.96	$1,641.48	$17,509.11	$161,840,787
2050	3,484,996.86	955.07	5.86	$45.15	$1,646.79	$17,530.36	$159,023,136
2051	3,484,996.86	955.07	5.86	$43.84	$1,598.83	$17,019.77	$154,408,993
2052	3,484,996.86	955.07	5.86	$42.56	$1,552.26	$16,524.05	$149,900,814
Total	***87,366,559***	***24,063***	***150***				***$4,604,439,519***

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