Bureau Waardenburg
Ecology & Landscape

FINAL ASSESSMENT

Assessment of updated final EIA for Ocean Cleanup System S002

Bureau Waardenburg

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Preface

The State of the Netherlands has a duty of care towards the marine environment, which stems from the United Nations Convention on the Law of the Sea (UNCLOS). In this context, the Dutch Ministry of Infrastructure and Water Management and their executive agency Rijkswaterstaat Water Transport and Environment have asked Bureau Waardenburg as an independent third party to help them assess the environmental impact assessment (EIA) and associated environmental monitoring plan (EMP) of Ocean Cleanup System (version S002) that has been developed and was tested by The Ocean Cleanup in the summer of 2021. The scope of this assignment is described in section 1.3. Based on the current assessment of the updated final EIA, the Dutch Ministry of Infrastructure and Water Management will draft a letter to the House of Representatives of The Netherlands determining whether the duty of care was met.

The Ocean Cleanup, a non-profit organization mainly funded by donations from private (99%) and public (<1%) sponsors, has the mission to remove plastic waste from the environment through innovative plastic collection technologies. As part of their ocean plastics mission, they have developed a system to (passively) collect ocean plastic from the upper layer of the Great Pacific Garbage Patch with the aim to preserve and positively impact the marine environment. In the absence of applicable regulations for ocean cleanup activities in an area beyond national jurisdiction (ABNJ), a Covenant was drawn up and signed between The Ocean Cleanup and the State of The Netherlands. In this Covenant, marine scientific research (MSR) principles as set out in part XIII of UNCLOS are applied by analogy. Resulting from this Covenant, and in line with international law, The Ocean Cleanup has to "*take the necessary precautionary measures that may reasonably be expected of it to prevent damage to the marine environment and harm to species present in the area. Furthermore, The Ocean Cleanup has agreed that it will implement a monitoring plan during the first year of the system's deployment on the high seas, which will include interaction between the system and species present in the area of deployment".* For this purpose, The Ocean Cleanup has asked CSA Ocean Sciences (USA) to prepare an Environmental Impact Assessments (EIA). The Ocean Cleanup is one of the very few parties to have carried out an EIA for new activities in areas beyond national jurisdiction.

This report is the result of a careful and critical review of the updated final EIA for the S002 (version from the 2nd of May 2022) (CSA 2022) and the scientific rebuttal of The Ocean Cleanup to the previous reviews of the draft initial EIA (CSA 2021a) and the draft EMP (CSA 2021b). As such, this report aims to provide the Dutch Ministry of Infrastructure and Water Management with sufficient information to assess whether The Ocean Cleanup is taking the necessary precautionary measures that can reasonably be expected to prevent damage to the marine environment and/or to species occurring in the area because of the deployment of the new Ocean Cleanup System. The scientific review and formulation of advice was conducted by persoonsgegevens (plankton, neuston and fish) and persoonsgegevens (marine mammals, birds).

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Abbreviations

ABNJ	Area Beyond National Jurisdiction
DGWB	Directorate-General for Water and Soil; part of the Dutch Ministry of Infrastructure and Water Management (in Dutch: *Directoraat-generaal Water en Bodem van het Ministerie van Infrastructuur en Waterstaat*)
EIA	Environmental Impact Assessment
EMP	Environmental monitoring plan
EwE	Ecopath with Ecosym
HBJZ	Main Directorate of Administrative and Legal Affairs; part of the Dutch Ministry of Infrastructure and Water Management (in Dutch: *Hoofdirectie Bestuurlijke en Juridische Zaken van het Ministerie van Infrastructuur en Waterstaat*)
MSR principles	Marine Scientific Research principles as formulation in part XII of UNCLOS
NEBA	Net Environmental Benefit Analysis
NPSG	North Pacific Subtropical Gyre, also known as Great Pacific Garbage Patch, or Eastern Pacific Garbage Patch (EPGP): a collection of marine debris in the North Pacific Ocean
OCS	Ocean Cleanup System
OSPAR	Oslo and Paris Conventions
PSO	Protected Species Observer
Rijkswaterstaat WVL	Directorate-General for Public Works and Water Management - Water, Traffic and Environment; part of the Dutch Ministry of Infrastructure and Water Management (in Dutch: *Rijkswaterstaat Water, Verkeer en Leefomgeving)*
UNCLOS	United Nations Convention on the Law of the Sea

1 Introduction

The State of the Netherlands has a duty of care towards the marine environment, which stems from the United Nations Convention on the Law of the Sea (UNCLOS). In this context, the Dutch Ministry of Infrastructure and Water Management and their executive agency Rijkswaterstaat Water Transport and Environment have asked Bureau Waardenburg as an independent third party to help them assess the development of the Environmental Impact Assessment (EIA) of a new Ocean Cleanup System (version S002) and the additional research proposed in the North Pacific Subtropical Gyre (NPSG, also known as the Great Pacific Garbage Patch) in the summer of 2021.

Within the assessment the following evaluations were foreseen:

1) An evaluation report of the draft initial EIA
2) An evaluation report of the draft EMP (Environmental monitoring plan)
3) A short evaluation report of the updated final EIA, to be developed after the inclusion of comments and additional research.

The current evaluation report assesses the improvements made to the updated final EIA (CSA 2022) compared to the draft initial EIA (CSA 2021a). Assisting this process, several online meetings were held between the Dutch Ministry of Infrastructure and Water Management, Rijkswaterstaat Water Transport and Environment and The Ocean Cleanup. In March 2022, an online meeting was held to provide a mission update on the preliminary results from the field campaigns with the S002. In reaction to the evaluation report of the draft initial EIA (Schutter and Bravo-Rebolledo 2021a) and the draft EMP (Schutter and Bravo-Rebolledo 2021b), a scientific rebuttal was drafted by The Ocean Cleanup, giving a reaction to the recommendations made in the evaluation reports. A second online meeting was held in May 2022, where The Ocean Cleanup shared their main rebuttal points to the evaluation reports and an overview of changes made to the updated final EIA.

1.1 The Ocean Cleanup

The Ocean Cleanup, a non-profit organization mainly funded by donations from private (99%) and public (<1%) sponsors, has the mission to remove plastic waste from the environment through innovative plastic collection technologies. As part of their ocean plastics mission, they have developed a system to (passively) collect ocean plastic from the upper layer of the Great Pacific Garbage Patch with the aim to preserve and positively impact the marine environment. The current system under review (S002) is the newest version of their solution that has been optimized based on lessons learnt from previous deployments with system S001 and S001/B. The design of the system is an iterative process.

1.2 Covenant and EIA procedure

The Ocean Cleanup has to investigate the possible impacts of their new Ocean Cleanup System on marine life. This has been recorded in a Covenant between The State of the Netherlands and The Ocean Cleanup. In this Covenant, marine scientific research (MSR) principles are applied analogous to those set out in part XIII of UNCLOS, although the activities of The Ocean Cleanup are not classified as marine scientific research. As a result, The Ocean Cleanup has to take the necessary precautionary measures that can reasonably be expected to prevent damage to the marine environment and/or to species occurring in the area because of the deployment of the new Ocean Cleanup System. In light of international law and in order to further comply with the Covenant signed with the State of the Netherlands, The Ocean Cleanup has chosen to voluntarily conduct an environmental impact assessment (EIA) to properly assess potential impacts and describe relevant mitigation measures for implementation to reduce or eliminate such impacts. For this purpose, The Ocean Cleanup has asked CSA Ocean Sciences (USA) to prepare an Environmental Impact Assessments (EIA). In the absence of specific regulatory requirements, their EIA was created to meet the 1999 International Association for Impact Assessment Principles of Environmental Impact Assessment Best Practices (IAIA, 1999) and has taken the draft text of the upcoming Biodiversity Beyond National Jurisdiction Treaty into account.

1.3 Scope of the assignment

The assignment to Bureau Waardenburg was to provide an in-depth scientific review of the EIA and EMP for The Ocean Cleanup activities with the new Ocean Cleanup System S002. Also, Bureau Waardenburg was asked to place The Ocean Cleanup activities in the NPSG in the context of international law and therefore beyond the legal framework of the covenant. At last Bureau Waardenburg was asked to provide an analysis of scientific opinions, which was mainly delineated to critical articles in The Correspondent related to the previous Ocean Cleanup System S001. The relationship between the documents elaborated for this assignment is laid out in Appendix I.

The results of the assignment serve to advise the Ministry. It is the task of the Ministry to assess whether The Ocean Cleanup complies with the Covenant. Not all recommendations made in the evaluation reports should be implied as requirements for The Ocean Cleanup at this stage. Some recommendations are *within the scope* of The Ocean Cleanup's mission and the legal framework of the Covenant ("expected"), while other recommendations are *within a broader context* such as international law, the opinionated society and climate change ("nice to have"). The last category of recommendations ("*within a broader context*") currently go beyond the scope of The Ocean Cleanup's mission and beyond what can be reasonably expected from The Ocean Cleanup based on the Covenant or international law in general. It is advised to consider these recommendations in the (near) future (e.g., when expanding or enlarging the Ocean Cleanup activities). The scope of the assignment to Bureau Waardenburg was not shared with The Ocean Cleanup.

1.4 Reading this report

In Chapter 2, the material and methods are described for the analyses in this review report. In Chapter 3, the results of the final assessment are described: section 3.1 provides an evaluation of the final EIA and 3.2 evaluates the incorporation of general recommendations. Finally, in Chapter 4, the final advice to the Ministry is stated. And at last, in Chapter 5, a closing remark is given.

2 Materials and methods

2.1 Evaluation of updated final EIA

Improvements to EIA

Improvements made to the EIA are evaluated following the main chapters addressed in the EIA document. This was done while taking into account the analyses presented in the previous review reports and the scientific rebuttal to the review reports.

Addressing formulated knowledge gaps

The intention was expressed in the conclusion of the draft initial EIA that the following aspects would be incorporated in the final EIA:

- Assessment of impact on biodiversity:
- Assessment of impacts at the ecosystem level
- Assessment of net environmental benefit of plastic removal
- Assessment of impact from the removal of neuston and ichthyoplankton:
- Environmental management plan (EMP)

Incorporation of general recommendations

The incorporation of general recommendations that were made in the reviews of the draft initial EIA and draft EMP was briefly analyzed. Recommendations were either made *within the scope* of The Ocean Cleanup's mission and the framework of the Covenant ("expected"), while other recommendations were made *within a broader context* such as international law, the opinionated society and climate change ("nice to have"). When deemed necessary, it is explicitly stated whether a recommendation should be seen as an obligation or not.

2.2 Final advice

In the final advice, an answer to the general questions posed in the assignment was formulated. The question being:

"*Is The Ocean Cleanup taking the necessary precautionary measures that can reasonably be expected to prevent damage to the marine environment and/or to species occurring in the area because of the deployment of the new Ocean Cleanup Systems?*"

3 Results of the assessment

The evaluation of the final EIA is based on two aspects: improvement made to the final EIA (section 3.1) and incorporation of general recommendations (section 3.2).

3.1 Improvements made to the EIA

Improvements made to the EIA are evaluated following the main chapters addressed in the EIA document:

- Project description (3.1.1)
- Legislative and regulatory environment (3.1.2)
- Description of existing environment (3.1.3
- Potential Environmental impacts and mitigation measure (3.1.4)
- Conclusions of updated final EIA (3.1.5)

3.1.1 Project description

Development of system design – The development of system design and the choices made during this process are more clearly described. The new Ocean Cleanup System S002 and the proposed plastic collection and plastic extraction operations are explained in sufficient detail. System 001 and 001/B were passive drifting systems with supporting vessels, whereas the S002 is being actively towed by two vessels, the Maersk Tender and Maersk Trader.

Adaptive management – A separate section is included about adaptive management, which was previously only included in the EMP. Some examples:

- A predictive model is used to determine the system deployment location, based on the expected area of highest plastic density.
- Implementation of active monitoring and using the data collected to modify the project methodologies and improve future designs of plastics collection systems. The design of the next Ocean Cleanup System S03 will -among other things – reflect the observations from the S002 to further reduce potential impacts to marine animals.

Mitigation measures – A new section is included describing all mitigation measures considered for implementation. This included the motivation for their use and the reference to relevant literature. The selection of mitigation measures is based on pre-assessment of their effectiveness. Also, the rationale for not moving forward is given when a mitigation measure considered for implementation has not been selected.

Bycatch research – The bycatch research is more clearly explained. After freeing living organisms from the extracted plastic, dead animals are separated from the plastic and sorted by category (e.g., fish, barnacles, crabs). Bycatch is classified as primary or secondary bycatch based on if it can be determined if the animal was dead prior to being

captured in the S002 (e.g., condition) and if the animal was associated with the plastic (e.g., barnacles attached to plastic, crabs associated with floating plastic). Each group of primary and secondary bycatch is then further separated by species, if possible, photographed, weighed, and frozen for further laboratory analysis, including stomach content analysis. The collected data are being extrapolated to assess the **ecological significance and impact of the bycatch** for mission continuation and the scale-up scenario. Bycatch composition is reported in the relevant section of Chapter 5 "Potential Environmental Impacts".

Environmental research – A separate section is included that explains the environmental research that was conducted during S002 deployment. The aim of the environmental research is described as to monitor the environmental impacts of the operations and increase baseline knowledge of the NPSG ecology, while allowing for comparison with marine life around the S002 in relation to bycatch assessment. The research consisted of bongo, manta, and plankton net (single ring) sampling focused on the plankton and neuston component at the surface (top 3 m) of the water column within the NPSG. The results are presented in the relevant sections of chapter 4 "Description of existing environment" and chapter 5 "Potential environmental impacts". The results will be used as input for an Ecopath with Ecosym (EwE) model that is being developed to assess the potential effects of removing a portion of the neuston on ecosystem dynamics (Appendix C). Data is also being collected for future system testing and design to determine a potential scale-up scenario and to minimize environmental impacts.

Project alternatives – The Ocean Cleanup added a new analysis of Net Environmental Benefit to the EIA. This is a thorough analysis for which data limitations are acknowledged. A comparison is made between the "Intervention" alternative (i.e., ocean cleanup activities) with the "No Intervention" alternative (i.e., leaving ocean plastics in place). The potential impacts of intervention/no intervention are identified as: fish aggregation, changes in buoyancy of macroplastic because of biofouling, potential plastic removal impacts to neuston, short- and long-term fate of ocean plastic, plastic toxicity, macroplastic degradation to microplastic or smaller sizes, life cycle analysis for ocean plastic. In Appendix B, a topical literature review of these potential impacts is elaborated, which forms the basis for a Net Environmental Benefit Analysis (NEBA). NEBA is a methodology for identifying and comparing net environmental benefits of alternative management options, usually applied to oil spills or contaminated sites being considered for remediation. Due to a lack of information about the potential plastic removal impacts to neuston and life cycle analysis of ocean plastics, a "Medium" impact was assigned until more information becomes available. For each scenario (intervention/no intervention) and potential impact factor (sub-criterium), three key metrics are evaluated: the impact consequence (Low, Medium, High), recovery capacity (-5 to 5) and relative weight (-5 to 5) are estimated. The impact scores for some sub-criteria offers the highest degree of environment benefit for the "No Intervention" alterative, while other were favorable for the "Intervention" alternative. Nevertheless, the overall impact score offered the highest degree of environment benefit to the Intervention alternative: removal of ocean plastics by the S002.

3.1.2 Legislative and regulatory environment

Dutch jurisdiction **–** The State of the Netherlands has a certain duty of care for the activities of The Ocean Cleanup as it is a Dutch foundation. To ensure the safety of the system at sea and maritime traffic, the Covenant between The Ocean Cleanup and the State of the Netherlands was drafted. The Ocean Cleanup and State of the Netherlands decided jointly to base this agreement on the provisions of Part XIII of UNCLOS. Based on the Covenant, Aim was to conclude a number of arrangements regarding matters such as the safety of shipping, the marine environment, and other uses of the high seas. By applying the UNCLOS provisions on marine scientific research by analogy, the Netherlands can sufficiently fulfil its duty of care and provide for a recognizable context in the international arena. In an earlier stage of this reviewing process, it was unclear whether Danish laws would also apply, as the MAERKS vessels are flying the Danish flag. This is not of any influence on the arrangements laid down in the Covenant signed between the State of the Netherlands and The Ocean Cleanup.

Voluntary elaboration of EIA **–** The Ocean Cleanup has chosen to conduct an environmental impact assessment (EIA) to properly assess potential impacts and ensure mitigation measures could be implemented to reduce or eliminate any substantial impacts. While the United Nations Convention on the Law of the Sea (UNCLOS), amongst others, provides an international legal regime that governs those portions of the ocean lying outside of any States' jurisdiction (high seas), it is up to the State Party to implement those general provisions of UNCLOS, more in particular part XII.

Voluntary report of any incident with projected species **-**The Ocean Cleanup reports any incidental harassment (if any) of a protected species to the Dutch ministry once per quarter.

Incorporation of recommendations from Espoo convention **-** Although not formally required, as the NPSG is an area beyond national jurisdiction, The Ocean Cleanup did incorporate some of the recommendations formulated by Espoo convention for the elaboration of an EIA. In the absence of specific regulatory requirements, The Ocean Cleanup applied the 1999 International Association for Impact Assessment Principles of Environmental Impact Assessment Best Practices (IAIA, 1999) for the elaboration of the EIA. In addition, they have taken the draft text of the upcoming Biodiversity Beyond National Jurisdiction Treaty into account.

3.1.3 Description of existing environment

Ecological processes – One of the recommendations made in the evaluation of the draft EIA is the acknowledgement and/or description of important ecological processes in the NPSG. Although the rebuttal document states that this recommendation is considered out of scope, the final version of the EIA does acknowledge that "The eastern region of the NPSG is a well-known open ocean ecosystem that contributes significantly to global primary production and export production" and "studies have shown that deep carbon sequestration occurs in the eastern NPSG".

The adoption of an ecosystem approach in Environmental Impact Assessments is becoming more and more important. For example, internationally in the OSPAR agreement and Convention of Biological Diversity (CBD). This principle is also applied in the *European Marine Strategy Framework Directive (MSFD)* ("Kader Richtlijn Marien", or KRM in Dutch). The *MSFD* incorporates 11 descriptors to describe good environmental status. These descriptors include the functioning of food webs (descriptor no. 4), maintenance of biodiversity (descriptor no. 1) and non-indigenous species not altering ecosystems (descriptor no. 4).

Limited data – As recommended in the review of the draft EIA, it is acknowledged in the final EIA when limited information on certain species groups (e.g., plankton) is available. In such cases, assessment of potential impacts is not possible and precautionary principles should be applied. The Ocean Cleanup has gathered more data on these species groups during their ocean cleanup activities with the S002, including their distribution, abundance and the effectiveness of mitigation measures.

Plankton - Results from the environmental sampling of plankton are added to the final EIA, providing additional baseline characterization data for the plankton and neuston communities within the NPSG. Based on observations made during the current campaigns, there has been overtopping of the S002 wings by waves and water, which was not completely expected. This overtopping may have contributed to these and other plankton species being able to escape the S002 prior to being captured in the retention zone (RZ) for macroplastic.

Neuston – Results from the environmental sampling of neuston are added to the final EIA. Neuston were predominantly captured in the manta net sampling as those samples were only performed at the surface (as opposed to bongo net plankton net). During Campaigns 1 through 3 for the S002, there were no observations of large aggregations or accumulations of pelagic or neuston species within the areas transited. Also bycatch data were incorporated: many barnacles were observed in the bycatch from Campaigns 1 through 4 and were considered secondary bycatch because they were associated with the plastics collected.

Fish and fisheries resources – Observations and results from the S002 deployment are added to this section. Regarding the evaluation of **mitigation measures**, many fish species are seen exiting the system via the fyke openings, and smaller fish swim freely through the S002's larger netting. Regarding the **bycatch research**, fish taxa collected as primary

bycatch included representatives of groups known to associate with flotsam or drifting algae, either as juveniles or during their entire lives.
Interestingly, two fish species were found that are less well known as flotsam associates but have been reported to associate with drifting sargassum or flotsam off Japan (blackbanded blenny *Petroscirtes breviceps* and the knifejaw *Oplegnathus* sp.). The presence of these two species, common around the Japanese archipelago and western Pacific, suggests a western origin for the recovered flotsam. As such, the flotsam-associated species community could point to the origin of flotsam. Also, it would be helpful to report these species to relevant parties, as they may be added to an (inter)national list of potential invasive non-indigenous ("horizon scan").

Marine mammals - Observations and results from the S002 campaign are added to this section. A list of common behaviors of marine mammals (as suggested in the evaluation report) could have explained the attraction of the common bottlenose dolphins and humpback whales to the S002 during the field campaigns.

Sea turtles - Observations and results from the S002 deployment are added to this section. Also, the migration routes for the different sea turtle species are added. Knowing the migration of sea turtles gives an idea of the chance of an encounter between the Ocean Cleanup System and a sea turtle.

Coastal and oceanic birds - Coastal birds are not documented during campaigns 1 through 5, as bird monitoring was not a priority during transit to the NPSG. The focus was on (oceanic) bird interactions with the S002 during operation. Observations from the S002 campaign are added for oceanic birds. Also, activity (flying vs. resting on deck, on the system or on water) was recorded for the different birds, showing the interaction of birds with the system and the vessels. Only one bird was observed resting on the system.

Biodiversity – The Ocean Cleanup expects no significant impacts at the level of biodiversity, although the deployment of the S002 may have impacts on individuals of a variety of species. The main concern raised by members of public is for the neuston component of biodiversity. In order to better be able to characterize such effects, The Ocean Cleanup is exploring the modeling method Ecopath with Ecosim (EwE) as a tool to better characterize the function of neuston in this open ocean ecosystem and, in doing so, address the potential for the S002 to impact the open ocean neuston community and overall ecosystem dynamics. These efforts are presented in Appendix D of the updated final EIA.

3.1.4 Potential Environmental impacts

Long-term impacts of project activities (i.e., plastic removal) –

Net environmental benefit analysis - Mostly processes that would contribute to a positive impact of ocean plastic removal are discussed. A reference is given to appendix B of the final update EIA which provides a discussion of potential impacts of ocean plastic and a net environmental benefit analysis comparing intervention/no intervention scenarios (see section 3.1.1 about project alternatives). It is expected that the long-term positive impacts resulting from the removal of large amounts of floating plastic from the NPSG will provide a beneficial impact to all biological resources in the region.

Plankton and neuston – Due to limited available data on neuston dynamics in the NPSG, the potential impacts of **plastic pollution and plastic** cleanup activities on the plankton and neuston community remain uncertain. The development of an Ecopath model specific to the NPSG is mentioned as a potentially viable means of assessing the potential effects of removing a portion of the neuston on ecosystem dynamics.

Spread of invasive species – The contribution of the presence of floating plastic debris to the spread of invasive species from coastal environments to open ocean and across waterbodies is acknowledged. The potential impact of ocean cleanup activities on this spread is not discussed. Although impact could be minimal or even positive, it is helpful to make this explicit in the EIA. In the scientific rebuttal, The Ocean Cleanup described that they foresee a positive effect: “The plastic itself has already provided the potential for the spread of invasive species and the removal of the plastic would assist to reduce this spread.”

Potential habitat removal – Attention is given to the possible benefits of oceans plastic as new surfaces for colonization by organisms and use as a nursery habitat. The potential impact of removing habitat for rafting neustonic species or structure for egg deposition is not explicitly mentioned. The Ocean Cleanup thinks it is important to recognize that plastics are an artificial habitat that should not be present and is being utilized often by non-native species in the area.

Short-term impacts of project activities (i.e., plastic removal) -

Impacts on plankton and neuston – The Ocean Cleanup has added information about neuston distribution, abundance and bycatch rates from their research and monitoring activities during the 2021 summer campaign. Prior to deployment of the S002, a conservative estimate of neuston potentially captured by the system was calculated using a basic area-swept model. The quantity of neuston, particularly *V. velella*, that were anticipated to be captured by the S002 have not been observed in the environmental samples in high numbers nor captured in the S002 in the bycatch or clogging the mesh. Neuston appear to escape the system or are displaced in the water column due to the “wake” created by the S002. In addition, the lower than anticipated catch rates could be due, in part, to the patchy nature of plankton and neuston distribution within the NPSG. Nevertheless, additional data is needed to understand why plankton and neuston have not been observed as a significant bycatch in the Retention Zone of the S002.

Results are presented of the **effect of the S002 on neuston densities**. Neuston samples were collected in front of the S002 and behind the S002 during the second campaign in 2021. As explained in the Project Description, due to practical limitations, different netting

types (manta and half-submerged plankton net) were used for this study. It would be helpful to discuss the implications of this for the results. Especially since the manta net deployed in front of the S002 (before ocean cleanup) caught significantly higher densities of neuston than the half-submerged plankton net deployed behind the S002 (after ocean cleanup). If the manta net consequently has a higher neuston catching efficiently compared to the plankton net, the wrong conclusion might be drawn. As pointed out in the EIA, additional data is needed to determine the significance of this finding.

Impacts on fish and fisheries **resources –** Results from the bycatch analysis and evaluation of relevant mitigation measures are presented in this section. Although fish were caught by the system as primary bycatch, observations made from the underwater cameras and system inspections showed many fish could readily swim into and out of the S002, including the RZ using the fyke openings, by swimming under the wings, or by swimming through the mesh holes. This indicates that effective mitigation measures have been taken to reduce the fish primary bycatch.

Impacts on marine mammals **–** Results from the observations from the Protected Species Observers (PSOs) on board of the vessels are presented in this section, 18 marine mammals were observed during the campaigns 1 through 5, in the NPSG, from the vessels. Most marine mammals were seen 500 to 2,000 m from the vessels or the S002. Only a group of three common bottlenose dolphins approached one of the vessels and a group of three humpback whales approached the S002. One humpback whale was observed within the S002 wings but swam out and away unharmed. When animals approach the S002, the vessels were slowed to minimum speed. PSOs monitor the animals continuously. When a group was observed in the direct path of the vessels, they were switched to full stop.

Impacts on sea turtles **-** In this section The Ocean Cleanup added the results of the sea turtles that were found in the S002. During campaign 1 through 6 15 sea turtles encountered the S002. Twelve of the encounters were between 3 December 2021 and 4 April 2022. Necropsies were performed on four dead loggerhead sea turtles captured in the RZ. Four entangled sea turtles were released unharmed after implementing mitigation measures, while one perished. Necropsy results of the dead sea turtle indicated it was extremely ill and therefor likely unable to escape the S002.

Impacts on coastal and oceanic **birds –** In this section The Ocean Cleanup added the results of the birds that were found near the S002 or one of the vessels. Numerous birds were observed resting on the vessels during campaign 1 through 5. None of the birds were observed within or captured by the S002. Only three birds interacted with the system; one observed sitting on a S002 buoy and two approached the S002. Fatal vessel strike bird injuries occurred 24 times during campaign 1 through 5. In addition, 17 stunned Leach's Storm-petrels were found on deck. 16 were safely released while one succumbed to its injuries.

Results of impact assessment - The impact assessment is updated with data collected during S002 deployment. The significance of potential impacts of the proposed activities are all estimated be Negligible or Low. In the draft initial EIA, the residual impact rating on plankton and neuston (i.e., after mitigation measures) was estimated to be Medium due the potential entrapment of plankton and neuston. In the final Updated EIA this residual impact has been updated to Negligible to Low, as observations during S002 deployment were more optimistic than previously expected. Due to the patchy distribution of neuston in the

NPSG (as observed and acknowledged in the EIA), it is however possible that higher abundances of neuston are encountered during next trips. The Ocean Cleanup is confident that mitigation measures will still reduce impact to Low in this situation.

3.1.5 Conclusions of updated final EIA

The conclusion of the draft initial EIA listed some limitations of the draft EIA and the promise to support the updated Final EIA (i.e., “description of the existing environment” and “potential environmental impacts”) with additional data to be collected during this summer’s deployment activities of 2021. The following is an analysis of the limitations that were acknowledged in conjunction with recommendation made:

Development Ecopath with Ecosim model – Potential Ecopath models were reviewed for the evaluation any biodiversity impacts from The Ocean Cleanup activities (Appendix D of updated final EIA). It was determined that the potential for developing an Ecopath with Ecosim (EwE) model specific to the NPSG appears viable to assess the potential effects of removing a portion of the neuston on ecosystem dynamics. The data from the S002 campaigns will be used in an EwE model to better evaluate biodiversity and will be included in the EIA for the scaled-up version of The Ocean Cleanup system.

Assessment of impacts at the ecosystem level – The Ocean Cleanup commented in the rebuttal that impact analysis was performed on a resource-by-resource basis and could not fully consider impacts at the ecosystem level. As such, the current analysis does not fully address potential impacts on the trophic cascade and food web and community structures. The development of an Ecopath model (appendix D of updated final EIA) will be an instrumental in evaluating impact at an ecosystem level.

Assessment of impact from the removal of neuston and ichthyoplankton – Progress towards assessment of this species group is made by gathering ecological data and developing an Ecopath model using these data. See evaluation in section 3.1.4.

Assessment of impact on biodiversity – The potential impact on the neuston component of biodiversity is the major concern. Progress towards assessment of this species group is made by gathering ecological data and developing an Ecopath model using these data. See evaluation in section **3.1.3 and 3.1.4.** This model, together with relevant data collected in the NPSG, is expected to support the evaluation of impacts on biodiversity in future EIAs.

Environmental monitoring plan (EMP): A draft EMP was developed to identify and describe mitigation measures that will be employed to reduce or eliminate the potential environmental impacts identified in the draft EIA. In the updated final EIA, the section from the EMP that are relevant to (the readability of) the EIA were incorporated.

Addressing knowledge gaps – Progress is made toward addressing knowledge gaps, as demonstrated in this section.

3.2 Incorporation of general recommendations

Scientific rigor– A transparent research and monitoring plan is needed to be able to assess the scientific rigor of the research efforts made during S002 deployment. Such plan was not present in the draft initial EIA, nor in the draft EMP. In the absence of a research and monitoring plan, it was difficult to assess beforehand to what extent the research goal of complementing and enhancing the draft EIA would be reached.

Research and monitoring plan – The Ocean Cleanup is currently working towards a document on their current research scope and their overall research plan, which will be part of the Environmental Monitoring Plan. This document was not yet available during the evaluation period for the current assignment. Their efforts show that they are taking the recommendations made in the evaluation reports seriously and are using them for their benefit to improve the formulation of research questions and the collection of appropriate (scientific) data to answer them. Reviewing this document should be on the list for the next round of evaluations.

Data interpretation - The updated final EIA does not always give an interpretation of the presented data: e.g., which mitigation measures were effective, which mode of operation had the low bycatch rates (day/night, speed), etc. The Ocean Cleanup has been pointed to this fact and will include this aspect into future EIAs. In some cases, the data were still incomplete (and therefore not ready for interpretation), as not all S002 ocean cleanup campaigns had been analyzed yet.

Cost-benefit analysis – It was recommended to include an (environmental) cost-benefit analysis in the EIA to assess the net environment benefit of the S002 ocean cleanup activities. Although The Ocean Cleanup stated in the rebuttal that a cost-benefit analysis is not a requirement of an EIA, they did address long-term cost-benefit of ocean cleanup activities, by elaborating a net environmental benefit analysis (NEBA) (see also section 3.1.1 about project alternatives). NEBA is a method for identifying and comparing net environmental benefits of alternative management options. Based on the NEBA approach, it was concluded that removal of ocean plastics by the S002 provides a greater environmental benefit for all marine resources impacted, including marine mammals, sea turtles, fish/sharks and fishery resources, juvenile and pre-juvenile fishes, seabirds, and neuston, compared to leaving the plastics in the ocean. The complete impact analysis using the NEBA approach is provided in Appendix B of the updated final EIA.
The NEBA approach is a qualitive assessment of long-term effects. The Ocean Cleanup is still processing and analyzing the data from all ocean cleanup campaigns with the S002. The actual (short-term) environmental impact of the S002 (bycatch vs. plastic removal) is not yet available for all campaigns. Nevertheless, the data from the first four S002 ocean cleanup campaigns suggest lower than expected (short-term) environmental impact.

Readability of document – The readability of the document has been improved by incorporating relevant sections from the draft EMP into the updated final EIA, which makes the EIA as a standalone document more complete. Nevertheless, being a bulky document by nature, the readability could be further improved with concluding sections stating an interpretation of what the information means for the projects.

Major role in collecting scientific data – A role for The Ocean Cleanup to play a major role in collecting more scientific information about marine life in the NPSG was envisioned. The Ocean Cleanup states that is not the mission of The Ocean Cleanup to be a major player in collecting scientific data in the NPSG. The main mission of The Ocean Cleanup is to focus on ocean plastic cleanup activities, characterize the marine environment in the project area and the potential impacts to the environment from project operations.
Although not an obligation, as they are being active in the High Seas, they could play a major role in facilitating the collection of more scientific information on marine life in the NPSG and later on in the other gyres.

Discussion of project alternatives – It is customary to an EIA to include a discussion of (project) alternatives. The scenario of intervention vs. no intervention in the NPSG was elaborated in a NEBA (see section 3.1.1). As acknowledged in the scientific rebuttal, the discussion of alternatives does not include all potential alternatives to the problem. Each technology iteration by The Ocean Cleanup, as laid out in Project Description, has been a different alternative as well as a "No Intervention" alternative.

Application of good practice guideline for EIA practitioners - The guidelines mentioned in the review of the draft EIA were incorporated: The development of system design and the choices made during this process are more clearly described and the "do nothing" option (i.e., the possibility of not carrying out the proposed development at all) was assessed

Effectiveness of mitigation measures – The effectiveness of mitigation measures is mostly qualitatively described in the relevant sections of chapter 5 "Potential Environmental Impacts" in the updated final EIA. Upon request, The Ocean Cleanup can provide a list of mitigation measures that have proven to be effective and will be included in future ocean cleanup efforts.

Competing environmental interests – The Ocean Cleanup made clear that the apparently competing environmental interests of removing ocean plastic vs. preserving marine life (as perceived by some members of the public) are not competing from their point of view. It is not The Ocean Cleanup's end goal to collect plastic as such. Their goal is to remove plastic for the purpose of preserving/benefitting the marine environment.

Fuel consumption - The draft EMP described that the operation of the S002 will be evaluated regarding fuel consumption under different environmental and operating conditions, aiding further optimization and design choices in the future. The updated final EIA concluded that, based on the vessels used, actual fuel consumption and with a greater than expected number of campaigns, the fuel consumption of the S002 summer campaigns was less than anticipated. The average combined total of CO2 emissions per campaign was determined to be 2,473 mt. No comments are made regarding the factors that contributed to the less than expected fuel consumption, being either environmental or operational. Upon request, The Ocean Cleanup stated that fuel consumption was lower than anticipated, in part due to favorable weather conditions but also the use of biofuels, monitoring of fuel consumption and the use of Eco-Switch on the vessel Maersk Trader.

They will continue to improve fuel efficiency by improving the vessel routing and steering, in addition to monitoring the live fuel consumption of one of the vessels.

Mitigation measures - The Ocean Cleanup will continue to consider mitigation measures to reduce the emissions footprint. Fuel consumption is anticipated to further improve with subsequent campaigns as the vessel captains learn to tow and operate the system in an efficient manner. Additionally, The Ocean Cleanup has begun using biofuels to improve emissions.

Compensation measures - The Ocean Cleanup has compensated/offset all CO2 emissions produced by the vessels' operation during the first two campaigns in 2021, using golden standards via South Pole, and will compensate/offset all future campaign CO2 emissions.

4 Final advice

An answer is formulated to the following question stated by the Ministry:

"Is The Ocean Cleanup taking the necessary precautionary measures that can reasonably be expected to prevent damage to the marine environment and/or to species occurring in the area because of the deployment of the new Ocean Cleanup Systems?"

- *The Ocean Cleanup is taking the necessary precautionary measures to reduce their environmental impact –*
  Yes, The Ocean Cleanup is taking the necessary precautionary measures to reduce their environmental impact. The updated final EIA shows significant efforts and results towards characterizing and reducing the potential environmental impact. Mitigation measures were observed to be effective, and an adaptive management approach was adopted to feed the iterative learning process – not only after but also during ocean cleanup campaigns.
  Regarding potential environmental impacts, bycatch monitoring shows that the expected impact was lower than initially expected. No large accumulations of neustonic species were observed, as they seemed to pass through or above the system. In addition, the fuel consumption and emission footprint were lower than anticipated. Besides operational and technical advances, these results are in part due to favorable conditions (respectively, low to moderate neuston densities and favorable weather conditions). Therefore, monitoring to assess potential impacts remains essential. The Ocean Cleanup is committed to continue making improvements. A document is being elaborated on the current research scope and the overall research plan. This document will provide the research strategy for the next ocean cleanup campaign.

- *The Ocean Cleanup is furthering technical and environmental optimization of their missions in the future* **–**
  Yes, the Ocean Cleanup is furthering technical and environmental optimization of their missions in the future. Data is collected for several research activities to increase knowledge of marine environment and the interaction of the S002 with the marine environment. This data will feed the iterative learning process to improve Ocean Cleanup System operation and reduce environmental impact. The updated final EIA is still a growing document where new data gathered for the remaining (yet unanalyzed) S002 ocean cleanup campaigns will be added. Progress is made with filling in knowledge gaps (e.g., EwE model) and should be continued. Also in the EIA, attention should be given to the interpretation of analyzed data: what does it mean for the project and how can operations be optimized? In this way, the lessons learnt can continue to feed the learning process. The adaptive management strategies laid out by The Ocean Cleanup suggest a strong commitment to further technical and environmental optimization of their missions in the future. It is recommended to have the data analyses and lessons learnt from all S002 ocean cleanup campaigns (including the ones that were not yet analyzed for the updated final EIA) ready for the elaboration of the next EIA.

5 Closing remark

The Ocean Cleanup is in an advanced testing phase where apart from an iterative process to design the system, an iterative process is applied to incorporate knowledge on the ecosystem of the gyre and the potential impacts at hand. Quantification of impacts during the test phase will give insights in impacts for next phases.

We recommended in our previous review that **The Ocean Cleanup should not expand its activities as long as the net environmental benefit of their offshore cleanup activities has not been demonstrated**. The Ocean Cleanup states that the development of their Ocean Cleanup Systems is an iterative process, similarly, eventual expansion to multiple systems and multiple gyres is an iterative process as well. The Ocean Cleanup will prepare additional EIAs for Ocean Cleanup System 03 and for a scale-up scenario. In addition to the NEBA approach, which is holistic and qualitative, additional substantiation with quantitative own data (e.g., bycatch rates, CO2 emissions, plastic collection) that show how net environmental benefit is improved with each new "technological iteration" would be insightful.

We advise the Ministry to stay actively involved in this process and consult independent experts for evaluation of the plans in the context of ecological and juridical developments.

6 References

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Appendix I Relationship between documents

Relationship of review documents and their purpose.

- ***Review of draft initial EIA***
  The draft initial EIA assesses the impact of the offshore cleanup activities proposed during the summer of 2021. An assessment was made of the draft initial EIA, paying attention to scientific justification, logic of the conclusions and relevance of precautionary measures. In addition, a brief analysis of relevant scientific opinions (mostly critical articles by De Correspondent), a comparison with other ocean cleanup activities and an analysis of compliance with international conventions was elaborated. For summary see Appendix II.
  NOTE: *During the time frame of our assignment, only the draft initial EIA was available for review. The final initial EIA only became available when finalizing our review report for the Infrastructure and Water Management. For the record, The Ocean Cleanup supplemented and further improved the initial EIA up until the moment of publication on their website (July 2021) and before starting their cleanup activities.*

- ***Review of draft EMP***
  The draft EMP serves for the environmental management of the operations, i.e., providing direction to the field crew and management of the activities. An assessment was made of the draft EMP, paying attention to formulation of research questions, applied research methods, scientific justification, and logic of the conclusions. For summary see Appendix III.

- ***Review of updated final EIA***
  The update final EIA incorporated the recommendations made in the review of the draft initial EIA and the results of the first three S002 ocean cleanup campaigns.
  An assessment was made of the changes made compared to the information presented in the draft initial EIA and draft EMP. At last, a final advice is formulated to DGWB on whether The Ocean Cleanup complied with their duty of care.

	Action Bureau Waardenburg	**Documents supplied by TOC**	**Products Bureau Waardenburg**
Phase I (June-July 2021)	Review of draft initial EIA for the S002	draft initial EIA for the S002 (dd 24 May 2021)	Review of draft initial EIA for the S002 (dd 2 august 2021)
Phase II (July-August 2021)	Review of draft EMP for the S002	Draft EMP for the S002 (dd 23 July 2021)	Review of draft EMP for the S002 (dd 31 august 2021)
Phase III (May-June 2022)	Review of updated final EIA for the S002	Updated final EIA for the S002 (dd 2 May 2022) Rebuttal to review of draft initial EIA (dd 10 May 2022)	Final memo for updated final EIA for the S002 (dd 14 September 2022)

Appendix II Summary of review draft initial EIA

The State of the Netherlands has a duty of care towards the marine environment, which stems from the United Nations Convention on the Law of the Sea (UNCLOS). In this context, Bureau Waardenburg was asked as an independent third party to assess the draft EIA developed for the new ocean cleanup system (OCS) S002 of The Ocean Cleanup that will be deployed in the North Pacific Subtropical Gyre in the summer of 2021. The report consists of an evaluation of the draft EIA per chapter and topic, an analysis of relevant scientific concerns and compliance with international conventions.

Evaluation of the draft EIA

Project description – The project activities and design of OCS S002 are described in detail. It is recommended to give an overview of the design and operation choices (e.g. timing and location of activities) made and how these will benefit the plastic collection and protection of marine life.

Legislative and regulatory environment – a long list of relevant (international) regulations and legislations are described. As the head office of The Ocean Cleanup operates from the Netherlands and the vessels sail under Danish flags, it is recommend to add relevant Dutch and Danish legislation to the final EIA.

Description of existing environment – Based on a list of impact producing factors, the potentially impacted biological resources were described in more detail based on available data. It is recommended to add the risk of spreading or introducing invasive species to the list of impact producing factors. In addition, a description of important ecological processes to this section, such as primary production, nutrient cycling, and the importance of the area as CO_2 sink should be added. As there is little scientific information available on planktonic and neustonic marine life in the NPSG and their role food webs, The Ocean Cleanup could play a major role in collecting more scientific information on these groups and marine life in general. Sections will also benefit from adding information on ecology and behaviour of various species, e.g. fish, marine mammals, coastal and oceanic birds (e.g. attraction to the presence of vessels and other floating objects) and sea turtles (species-specific nesting and migratory season). The section about biodiversity should better describe the measures used to describe biodiversity and present these in the EIA.

Potential Environmental impacts – The impact analysis did not consider impacts at the ecosystem level, such as primary production, nutrient cycling, and CO_2 sink area. Also, the analysis could benefit from a cost-benefit analysis to determine the net environmental benefit of ocean cleanup activities in the NPSG. It is also customary to an EIA, to discuss the impact *of alternative scenarios (e.g.* no plastic cleanup, alternative plastic cleanup methods). The impact of several impact producing factors (except for the risk of spreading or introducing invasive species) was assessed for the existing biological environment. Recommendations are given for additional or improved mitigation measures.

Conclusions – The conclusion recognizes some of the limitions of the draft EIA and summarizes the topics that will be elaborated on in the final EIA, such as the assessment of impacts on biodiversity, ecosystem level, planktonic and neustonic communities and the addition of an environmental monitoring plan. Based on available date, it concluded that

the significance of potential impacts of the proposed activities will generally be **Negligible** or **Low**, except for the entrapment of plankton and neuston (**Medium** residual impact).

Analysis of relevant scientific opinions

Analysis of scientific opinions in literature and professional media – The main concern of the critics is that plastic pollution is a multi-faceted problem, with not just one solution. Many agree that the problem should be tackled at the source using both social (plastic reduction policies and consumer behavior change) and technological solution (waste management improvement). In the choice between technological ocean cleanup solutions several aspects should be weighted: importance of reducing plastic, cost-effectiveness of the technology and ecological side effects ("collateral damage") of the technology. It is important to realize that we are weighing two apparently competing environmental interests: removing plastic vs. preserving marine life. Nevertheless, there are also people who applaud The Ocean Cleanup for their "collateral benefit" of increasing awareness about plastic pollution and increased support for measures against the plastic industry

Comparison with other cleanups - The OCS mainly differs from other plastic cleanup initiatives in that its activities are either less targeted, have a larger carbon footprint or are further away from the source of pollution. The cleanup of floating Sargassum patches in the Caribbean uses a similar system, but as yet no environmental impact studies exist.

Compliance with international conventions

International treaties contain rights and obligations for States. As a consequence, this analysis intended as constructive advice for best practice by The Ocean Cleanup.

UNCLOS - As the offshore cleanup activities by The Ocean Cleanup are classified under "marine scientific research" with UNCLOS, this marine scientific research should remain a major goal of their campaigns. In addition, the Ocean Cleanup should stay informed about the developments on the conservation and sustainable use of biodiversity beyond national jurisdiction (BBNJ).

Convention of Biological Diversity (CBD) - According to the CBD, direct pressures on biodiversity should be identified and reduced. It is important to demonstrate the net environmental benefit of ocean cleanup activities using OCS S002 for biodiversity.

Espoo convention - The Espoo Convention concerns environmental impact assessment in a transboundary context, as such it does not apply to the ocean cleanup activities planned in the NPSG (an area beyond national jurisdiction, ABNJ). As changes in regulations with respect to activities planned in ABNJ are expected in the near future, this analysis is intended as advice and can help The Ocean Cleanup streamline their EIA with current and possible future regulations regarding EIAs. A selection of important topics: listing reasonable alternatives in addition to the no-action alternative and formulating a post-project analysis.

CITES convention – The aim of CITES is to ensure that the international trade in specimens of live or dead protected species does not threaten the survival of the species. As long as The Ocean Cleanup does not import (dead or alive) species into the EU or other countries, a CITES import permit, certification and/or notification would be not required.

Conclusions and recommendations

Drawing right conlusions regarding impact? - More information is needed to assess whether The Ocean Cleanup draw the right conclusions regarding their impact on the Marine Environment. This information will be presented in the final EIA in February 2022.

Taking correct precautions to prevent damage?- The information needed to asses whether The Ocean Cleanup is taking the correct precautions to prevent damage to the marine environment will be presented in the Environmental Monitoring Plan which will be reviewed this summer.

General recommendation - The Ocean Cleanup need to mitigate the general concerns that upscaling offshore cleanup systems to multiple fleets in multiple gyres could result in large ecosystem effects. Therefore, as part of their duty of care and to gain more scientific and public support, The Ocean Cleanup should not expand its activities as long as the net environmental benefit of their offshore cleanup activities has not been quantified. It is recommended to formulate clear and transparent goals for (the impact of) their ocean cleanup activities and promise to adjust, limit or stop its activities when net environmental benefit cannot reasonably be attained.

Note:
After the current document was reviewed by a legal advisor, comments were received on the phrasing of parts of the section “Compliance with international conventions” in the summary of the review of the draft initial EIA. The decision was made to leave the original text of the Summary unchanged and list the comments below:

Original text: “*As the offshore cleanup activities by The Ocean Cleanup are classified under “marine scientific research” with UNCLOS, this marine scientific research should remain a major goal of their campaigns*.”

Comment: When drawing up the Covenant, marine scientific research (MSR) principles were applied analogous to those set out in part XIII of UNCLOS, since the activities of The Ocean Cleanup are not classified as marine scientific research.

Appendix III Summary of review draft EMP

The State of the Netherlands has a duty of care towards the marine environment, which stems from the United Nations Convention on the Law of the Sea (UNCLOS). In this context, Bureau Waardenburg was asked as an independent third party to assess the draft EMP developed for the new ocean cleanup system (OCS) S002 of The Ocean Cleanup that will be deployed in the North Pacific Subtropical Gyre in the summer of 2021. The report consists of an evaluation of the final EMP (July 2021) per chapter and topic and a comparison of topics addressed in the EMP with the knowledge gaps identified in the draft EIA. Concluding, an assessment is made whether The Ocean cleanup is a) taking the necessary precautionary measures to reduce their environmental impact, b) collecting the appropriate (scientific) data that can help them assess their environmental impact, and c) collecting the appropriate (scientific) data aid in further technical and environmental optimization of their missions in the future.

Evaluation of EMP

The EMP describes the project and planned deployment of OCS S002 in the NPSG during the 2021 summer campaign. Besides describing the monitoring plan and procedures for the three primary activities (environmental research, bycatch research and environmental monitoring), the document also describes commitments and responsibility, mitigation measures, adaptive management and health, safety, and environmental policies.

The purpose of the EMP is described as supplementing the draft EIA by identifying mitigation measures and processes intended to minimize environmental risks for the OCS. The expected purpose of supplementing the draft EIA by addressing knowledge gaps identified therein using research and monitoring activities is missing. Also, in the remainder of the document, the research plan (methods and questions) for addressing knowledge gaps is not explicitly addressed, in addition to information not being well-structured and dispersed throughout sections and even documents.

Comparison with knowledge gaps

Knowledge gaps cited by CSA Ocean Sciences in the concluding section of the draft EIA were compared with the contents of the final EMP

Elaboration of an EMP - The EMP has been elaborated. Besides identifying and describing mitigation measures, the EMP also describes the intention to evaluate the efficacy of the new OCS S002 and mitigation measures. Unfortunately, the EMP is not well-structured with respect to the research questions to be answered and a clear research plan on how to answer them (e.g., which parameters to measure (and why), proposed data- analysis).

Assessment of impact on biodiversity - The EMP does not refer to this knowledge gap, nor explicitly states a research approach to gather data suitable for the description of biodiversity and the assessment of the impact of OCS S002 on it. The Ocean Cleanup should be more explicit on how it foresees to collect and analyze data for the purpose of describing biodiversity and assessing the potential impact of OCS S002 on it.

Assessment of impact on ecosystem level – The draft EIA described the intention to address potential impacts on the trophic cascade, food web and community structures and address the net environmental benefit of plastic removal from the environment. A research

plan for data collection and analysis to support this assessment is not (explicitly) described in the EMP. Possibly, The Ocean Cleanup sees the optimization of fuel consumption, bycatch and plastic collection as increasing net environmental benefit. If this is true, this should have been made explicit in the EMP.

Assessment of impact on neuston and ichthyoplankton - The assessment of neuston and ichthyoplankton is not clearly defined as a research goal in the EMP. Nevertheless, in appendix B of the EMP a plankton/zooplankton sampling method is described that will be executed before and after OCS002 passage. This sampling will increase baseline knowledge on the general presence of neuston. Unfortunately, the depth of the taxonomic analysis of these samples is not described (nor the use of an expert). This will determine the extent of the contribution to increasing baseline knowledge.

Concluding assessment

Precautionary measures – The EMP contains ample information about measures and procedures to prevent, reduce and mitigate potential environmental impacts. Again, the document could be more explicit on how the effectiveness of the formulated measures will be assessed. Iterative learning through their planned research activities could classify as indirect precautionary measure. Again, the document could be more explicit in describing how their research activities could improve OCS operation and reduce environmental impact.

Appropriate (scientific) data for environmental impact assessment – *T*he EMP is not very explicit about the specific data being collected. Therefore, it is not possible to assess whether the data collected during the 2021 summer campaign can help them assess their environmental impacts on e.g. biodiversity, ecosystem level, and neuston and ichthyoplankton.

Appropriate (scientific) data for technical and environmental optimization - The EMP describes that the operation of OCS S002 will be evaluated regarding the amount (and type) of bycatch and fuel consumption under different environmental and operating conditions. This will aid in further optimization and design choices in the future.