



**Conference of the Parties to the
Minamata Convention on Mercury
Fifth meeting**

Geneva, 30 October–3 November 2023
Item 4 (k) of the provisional agenda*

**Matters for consideration or action by the
Conference of the Parties: effectiveness evaluation**

**The first effectiveness evaluation of the Minamata Convention
on Mercury (article 22)**

**Draft plans developed by the Open-ended Scientific Group to
support the first effectiveness evaluation of the Minamata
Convention**

Note by the secretariat

1. At its fourth meeting, in decision MC-4/11, the Conference of the Parties to the Minamata Convention on Mercury agreed to begin the first effectiveness evaluation of the Convention and adopted a framework, as set out in annex I to the decision. In the same decision, the Conference of the Parties established the Open-ended Scientific Group to develop a scientific report and draw conclusions thereon for the consideration of the Effectiveness Evaluation Group.
2. As is provided for in the adopted framework for the first effectiveness evaluation and in its adopted terms of reference,¹ the Open-ended Scientific Group will deliver its expected outputs in two stages, with stage 1 foreseen for completion by the fifth meeting of the Conference of the Parties and stage 2 foreseen for completion in time for submission of the outputs to the Effectiveness Evaluation Group, taking into account the overall timeline for the first effectiveness evaluation, which the Conference of the Parties has agreed to consider at its fifth meeting.
3. The expected outputs of the Open-ended Scientific Group for each stage are:
 - (a) Stage 1:
 - (i) Plan for the compilation and summary of monitoring data;
 - (ii) Plan for the summary of available data on emissions and releases;
 - (iii) Plan for data analysis;
 - (b) Stage 2:
 - (i) Compilation and summary of monitoring data;
 - (ii) Summary of available data on emissions and releases;

* UNEP/MC/COP.5/1.

¹ Annex II to decision MC-4/11.

(iii) Data analysis addressing the guiding questions outlined in the monitoring guidance.

4. A detailed description of the work of the Open-ended Scientific Group is presented in its progress report to the fifth meeting of the Conference of the Parties, as contained in document UNEP/MC/COP.5/16/Add.2.

5. The present note contains drafts of the plan for the compilation and summary of monitoring data (annex I), the plan for the summary of available data on emissions and releases (annex II) and the plan for data analysis (annex III). The annexes are presented without formal editing.

6. Additional information on the work of the Open-ended Scientific Group during the intersessional period will be available in document UNEP/MC/COP.5/INF/37.

Annex I***“Plan for Monitoring Data Compilation and Summary”
to inform the Effectiveness Evaluation of the Minamata Convention***Draft (14 August 2023)***Table of Contents**

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* The annex has not been formally edited.

1 Executive summary

2 The purpose of the “plan for monitoring data compilation and summary” (hereafter “monitoring data plan”) is to
3 structure and guide the process for the submission, collection, quality control check, management, and accessibility of
4 existing data on mercury levels in humans and the environment to inform the first effectiveness evaluation of the
5 Minamata Convention.¹ In accordance with decision MC-4/11 of the Conference of the Parties to the Minamata
6 Convention, the monitoring data that is compiled through the process set out in this plan will subsequently be
7 compared and analysed, as per a separate “data analysis plan”, for consideration of the Effectiveness Evaluation
8 Group.

9 The work of the OESG to inform the first effectiveness evaluation will focus on existing sources of monitoring data
10 while an analysis of gaps related to monitoring data, including potential scientific actions to address the identified
11 gaps, will be included in the scientific report of the OESG. Mercury observations in the different matrices, ancillary
12 observations and metadata will be collected from a broad range of sources and the quality of the collected data will be
13 assessed (more details below). Main available sources of mercury monitoring data for air, biota, humans, and “other
14 matrices” (soil, water, and sediment) have been identified and include monitoring programs, both ongoing and
15 completed, as well as independent studies.

16 An overview of the characteristics and type of information contained in each identified set of data were compiled in
17 spreadsheets² that also include, in addition to providing a snapshot of the type of mercury measurements in each
18 dataset, examples of metadata available, such as the type of data collected, geographic coverage, monitoring period,
19 relevant publications, etc. In addition, summaries of the available sources of data for each matrix are presented as
20 addenda to this document.

21 The identified sources of monitoring data will serve as a starting point for the collection of data through an invitation
22 to parties and other data providers to submit their datasets containing observational mercury data and metadata. The
23 identified data gaps will be summarised in the OESG final report to inform future effectiveness evaluation cycles.

24 A data dictionary was developed, as contained in Annex 2, to facilitate the work of the OESG in collecting,
25 comparing and analysing mercury levels in air, humans, biota, and other matrices. The data dictionary lists possible
26 descriptors that can be used to describe each dataset, and identifies the minimum required data elements.

27 The objective of the data dictionary is to help those who wish to contribute to the first effectiveness evaluation of the
28 Minamata Convention in identifying and structuring the necessary mercury observations, ancillary observations, and
29 descriptive elements, or metadata. To support the OESG’s analysis of comparable mercury monitoring data, a shared
30 data dictionary will be necessary to facilitate standardization by documenting common data structures and providing
31 the precise definitions, agreed nomenclature, units of measurement, time scales and formats, as well as further
32 information and external references that are needed to compare and analyse mercury measurements.

33 Several types of data elements are included in the data dictionary: the mercury observations, ancillary observations of
34 other relevant contaminants or environmental parameters, and descriptive data elements (or metadata) that are
35 necessary for interpretation of the observations. The data elements contained in the data dictionary are grouped into
36 nine sections, from A to I. Sections A-C, H and I contain categories of data elements that are common to all
37 monitoring matrices, whereas sections D through G contain data elements that are specific for each matrix. The data
38 elements are further grouped by categories and, where relevant, sub-categories.

39 The data dictionary will be used to develop matrix-specific standardized formats to facilitate the submission and
40 compilation of data in a harmonized manner. The standardized formats will identify the minimally essential data
41 elements to be submitted. It is recognized that many of the existing monitoring datasets do not necessarily include all
42 the elements identified in the data dictionary and that, particularly during the first effectiveness evaluation cycle, data
43 providers will not be able to provide all the data elements in the proposed data dictionary. Nevertheless, the data
44 dictionary may be useful to guide the generation of data in the future with the aim of having data that is more
45 comparable and detailed for future effectiveness evaluation cycles.

46 Once the data dictionary has been finalized, standardised data formats for data collection will be developed for each
47 matrix to facilitate data submissions and subsequent comparison and analyses. The standardized formats will be
48 aligned, to the extent possible, with existing formats in use by established monitoring programmes to minimize the

¹ In the context of this document, “monitoring data” includes: (a) mercury observations which have associated parameters including units, time, location, etc.; (b) ancillary observations, which are observations of environmental parameters other than mercury that are needed to interpret the mercury observations, and (c) metadata, which includes information that describes the observational datasets, include such things as the data provider, data formats, number of sites, frequency of observations, time period covered, operating procedures and quality assurance methods employed, etc.

² Available online through the [OESG document review folder](#) as separate supplemental materials in their original format.

49 workload and to facilitate the use of existing data. A long-term vision of this plan is to cooperate with established
50 monitoring programmes for the generation of data in formats that can best respond to the OESG needs. Matrix-
51 specific standard formats will ensure that datasets, including those from different sources, will share a consistent
52 structure, i.e., they will share the same sequence of data fields. It will also be possible to harmonize the units of
53 measurement, time, and location to enable the comparison of multiple sets of data.

54 Parties and other data holders will be invited to submit monitoring data by using the standardised formats. Datasets
55 submitted in their native nomenclature and formats will also be accepted and will be included in the compilation
56 following a reorganization of the data in accordance with the standardized formats. Datasets from all sources will be
57 welcome during the data collection phase but, during the analysis phase, prioritization and/or weighting of data to
58 support the effectiveness evaluation will be necessary. In addition, active searching for relevant and publicly available
59 data may also be carried out, where necessary, in an attempt to improve the data quality and coverage, both temporal
60 and spatial.

61 Data providers or copyright holders will retain the ownership and rights over their data, including mercury and
62 ancillary observations and metadata. For datasets that are not publicly available or that have use restrictions, the
63 Secretariat will establish data use agreements with the individual data providers, as appropriate, and guidance will be
64 provided to the OESG members and the experts in the roster to ensure that the data is used only for the purpose of
65 supporting the effectiveness evaluation. The original sources of all data used by the OESG will be duly acknowledged
66 in the OESG outputs. Lessons learned from data ownership and data use licensing will be summarised in the OESG
67 final report to inform future effectiveness evaluation cycles.

68 As part of the quality check, the collected data will first be evaluated for completeness, followed by a quality control
69 process that will include an assessment of the reliability and relevance of the data. A set of data quality flagging
70 criteria will be developed by the OESG once a preliminary analysis of the collected metadata has been performed.
71 This will be done, for example, on the basis of the validation of sampling and analytical methods, the quality
72 assurance and quality control (QA/QC) measures that were applied, the generalizability or representativeness of the
73 data (e.g., whether samples were randomly selected or there is some bias; considerations of the sample size, etc), as
74 well as taking into account the type of monitoring programme (e.g., long term or isolated study). Data quality flags
75 will be added to help the OESG, during the analysis phase, to assign different weights to the different datasets
76 depending on the purpose of the analysis or questions being addressed.

77 The OESG will prioritize the use of data that have been subjected to QA/QC protocols. Only in the absence of such
78 data (e.g., for specific areas where no other data is available), data without proper QA/QC, and flagged as such, may
79 be included on a case-by-case basis in a preliminary analysis of mercury levels and in the identification of gaps.

80 To enable analyses of the data, the OESG members and experts in the roster will be able to access the compiled
81 datasets remotely. A range of possible options for data storage were considered during the development of the present
82 plan. For the first effectiveness evaluation, a simple data management system will be implemented (e.g., with manual
83 input of data and without machine-to-machine data transfer protocols between repositories). With an eye to improving
84 the data management infrastructure for future effectiveness evaluations, the OESG will continue to explore best
85 practices for data providers to make their data accessible electronically for analysis, to facilitate submission of data to
86 regional or global repositories that can make the data available electronically, and to facilitate the implementation of
87 common machine-to-machine data transfer protocols between existing national, regional, or global data repositories.
88 Lessons learned from these efforts will be included in the final OESG report.

89 Considerations on the contributions of Indigenous Peoples to global efforts to monitor mercury are contained in annex
90 3, including examples of best practices and identified Knowledge and capacity gaps.

91 **Acknowledgements**

92 This document would not have been possible without the commitment and contribution of the OESG members and the
93 experts in the roster, particularly the Leads and participants of the “small groups” on air, biota, humans and other
94 matrices, who have volunteered much of their time to drafting and reviewing this plan. The lists of OESG members
95 and roster of experts who are supporting the OESG are available through the Convention’s [website](#).

96 The OESG co-Chairs shared a vision and provided guidance on how to translate decision MC-4/11 and the OESG
97 terms of reference into action. Support to the OESG and its co-Chairs was provided by Secretariat.

98 Parties and organizations who have nominated and allowed experts to participate in this process have also played an
99 important supportive role by enabling their nominees to dedicate time to tasks that often go beyond their duty of
100 service. Parties are also acknowledged for having allocated sufficient funds to enable the OESG to meet face-to-face
101 during the intersessional period with participation of OESG members from all regions.

102 List of Abbreviations

103	COP	Conference of the Parties
104	CSV	Comma-separated values
105	DOI	Digital Object Identifier
106	EEG	Effectiveness Evaluation Group
107	FAIR	Findable, accessible, interoperable, reusable
108	OESG	Open-Ended Scientific Group
109	QA	Quality assurance
110	QC	Quality control

1. Objective

The purpose of the “plan for monitoring data compilation and summary” (hereafter “monitoring data plan”) is to structure and guide the process for the submission, collection, quality control check, management, and accessibility of existing data on mercury levels in humans and the environment to inform the first effectiveness evaluation of the Minamata Convention.³

The monitoring data plan includes considerations on:

- (a) How existing mercury and ancillary observations and associated metadata will be sought and collected from Parties and other relevant stakeholders
- (b) How data will be submitted, flagged, stored, and made available to the Open-Ended Scientific Group (OESG) for further analysis
- (c) Roles and responsibilities of different players to execute specific tasks
- (d) Schedule for the identified tasks

The monitoring data that is compiled through the process set out in this plan will subsequently be compared and analysed by the OESG for consideration of the Effectiveness Evaluation Group (EEG). The “Plan for Monitoring Data Compilation and Summary” will not elaborate on how the monitoring data will be analyzed because, as per [decision MC-4/11](#), this will be addressed in a separate plan (“Plan for Data Analysis”) to be drafted by the OESG. Please refer to the paragraph 4 of the OESG terms of reference.

The monitoring data plan may need to be reviewed and adapted as progress is made and experience is gained through the collection of monitoring data and planning for data analysis, as well as to account for feedback provided by the EEG.

2. Background

2.1 Framework for the first effectiveness evaluation of the Minamata Convention

Article 22 of the Minamata Convention states that the Conference of the Parties (COP) will evaluate the effectiveness of the Convention, beginning no later than six years after the Convention’s entry into force and periodically thereafter at intervals to be decided by the COP.⁴ The effectiveness evaluation is to be conducted on the basis of, among other things, available information on the presence and movement of mercury and mercury compounds in the environment, as well as trends in levels of mercury and mercury compounds observed in biotic media and vulnerable populations.

The need for an effectiveness evaluation framework that included a strategic, cost-effective approach to provide appropriate and sufficient data was recognized by the COP at its first meeting and further discussed at its second meeting. At its third meeting, the COP considered the report of the ad hoc technical expert group for effectiveness evaluation, which included a description of a proposed effectiveness evaluation framework, as well as the following policy questions aimed at supporting an assessment of whether the control measures, as implemented, would lead to the achievement of the Convention’s objective:

- (a) Have the Parties taken actions to implement the Minamata Convention?
- (b) Have the actions taken resulted in changes in mercury supply, use, emissions and releases into the environment?
- (c) Have those changes resulted in changes in levels of mercury in the environment, biotic media and vulnerable populations that can be attributed to the Minamata Convention?
- (d) To what extent are existing measures under the Minamata Convention meeting the objective of protecting human health and the environment from mercury?

³ In the context of this document, “monitoring data” includes: (a) mercury observations which have associated parameters including units, time, location, etc.; (b) ancillary observations, which are observations of environmental parameters other than mercury that are needed to interpret the mercury observations, and (c) metadata, which includes information that describes the observational datasets, include such things as the data provider, data formats, number of sites, frequency of observations, time period covered, operating procedures and quality assurance methods employed, etc.

⁴ The Minamata Convention entered into force on 16 August 2017.

(e) The report of the ad hoc technical expert group also contained technical information on monitoring and a proposal on monitoring arrangements pursuant to article 22; proposed reports to be used to formulate findings/recommendations for the consideration of the COP; and a set of indicators developed based on an article-by-article review for assessing progress and impact of the measures. In decision MC-3/10, the COP continued the preparation for the first effectiveness evaluation by requesting the drafting of guidance on monitoring and a report on trade, supply and demand of mercury and mercury compounds and by inviting further discussion of effectiveness indicators.

At its fourth meeting, in decision MC-4/11, the COP agreed to begin the first effectiveness evaluation of the Convention. In the same decision, the COP adopted a framework for the first effectiveness evaluation, as reproduced in Figure 1, and established the OESG. In accordance with its terms of reference outlined in annex II to the decision, the OESG shall work in two stages to develop a scientific report for consideration by the EEG. The OESG report shall be composed of the following elements:

Stage 1:

- (i) Plan for the Monitoring Data Compilation and Summary (*this document*)
- (ii) Plan for the summary of available emissions and releases data
- (iii) Plan for Data Analysis consistent with the Monitoring Guidance⁵

Stage 2:

- (i) Monitoring Data Compilation and Summary
- (ii) Emissions and Releases Data Summary
- (iii) Data Analysis addressing the guiding questions outlined in the Monitoring Guidance

Furthermore, the OESG shall provide an analysis of data gaps, including the identification of existing gaps as well as potential scientific actions to address identified gaps in information and knowledge related to monitoring, and lessons learned to be submitted to the Effectiveness Evaluation Group.

The process laid out in the OESG terms of reference also foresees support by the Secretariat, contribution of a roster of scientific and technical experts, input from different stakeholder groups, various rounds of review by Parties, and face-to-face meetings of the OESG, including one meeting during the current intersessional period.

To achieve its expected outputs, the OESG will assess the data and coordinate the analysis to be included in the scientific report, taking into consideration the monitoring guidance and its guiding questions,⁶ as well as differences in scientific capacities, national circumstances, environmental conditions and demographic characteristics across parties and regions. The expected outputs of the OESG and the framework for the first effectiveness evaluation of the Convention, as adopted in decision MC-4/11, are shown in Figure 1 below. The first effectiveness evaluation will also be informed by other sources of information, including a set of indicators, a synthesis of national reports submitted under article 21, and a report on trade, supply and demand of mercury and mercury compounds.

Based on the framework for the effectiveness evaluation that was adopted in decision MC-4/11 (Figure 1), the OESG has been working under the assumption that the first effectiveness evaluation would be completed by the sixth meeting of the COP, which is expected in 2025.⁷

In accordance with the adopted framework, the OESG's scientific report must be completed in time for consideration by the EEG, whose terms of reference are expected to be agreed upon at COP-5 in 2023. Thus, the majority of the OESG's work (including data collection, analysis, report writing, as well as the associated opportunities for review by Parties) must be completed in 2023 and 2024. A draft schedule for the process is shown in Figure 2. It must be emphasized that in order to achieve its expected outcomes under the assumption that the first effectiveness evaluation will end at COP-6, the draft schedule as shown below is very ambitious, particularly because a significant amount of time will be needed for collecting existing monitoring data from multiple data providers, which will require

⁵ The "Monitoring Guidance" referenced in decision MC-4/11 is the "Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention" available as document [UNEP/MC/COP.4/18/Add.2](#).

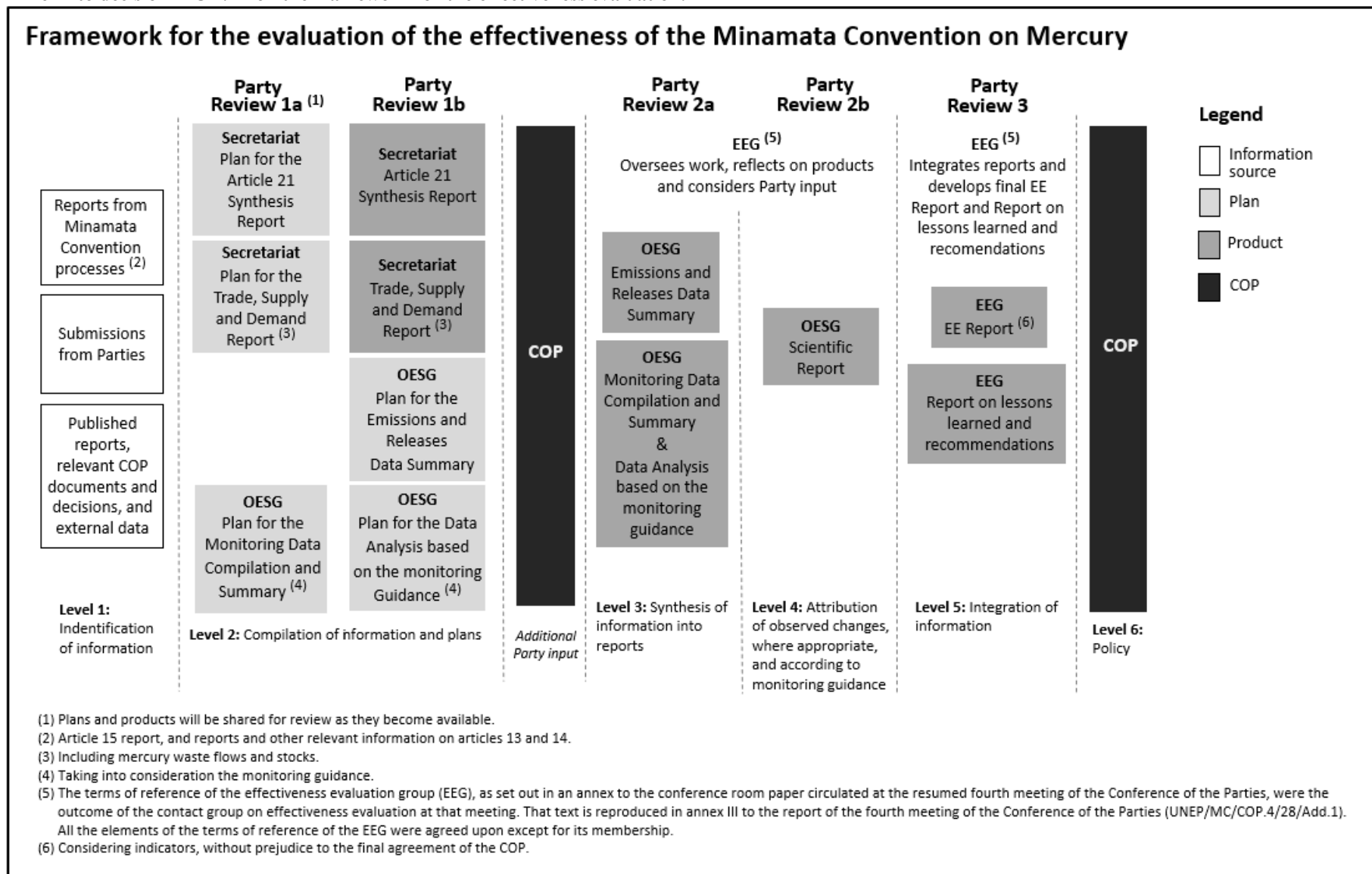
⁶ As set out in documents [UNEP/MC/COP.4/18/Add.2](#) and [UNEP/MC/COP.4/INF/12](#).

⁷ Pending further consideration by the COP, at its fifth meeting, of the timeline for the first effectiveness evaluation.

202 entering data use agreements with each data provider, before data analysis can begin. With the current
203 draft schedule, it is possible that only part of the available monitoring data will have been collected
204 and harmonized in time to be analysed by the OESG.

205
206

Figure 1
Annex I to decision MC-4/11 on the framework for the effectiveness evaluation.



207

255 processes that link sources to environmental concentrations and exposures (see monitoring objective
256 6). Tier 3 focuses on processes; thus, the results would likely yield insights that are broadly applicable
257 and strengthen the weight of scientific evidence used to support the other monitoring objectives. Tier 3
258 information should therefore be taken into consideration in the effectiveness evaluation where
259 available.

260 The Monitoring Guidance notes that, to the extent possible and in accordance with requirements of
261 individual data providers, data used in the effectiveness evaluation should follow the FAIR principles
262 (findable, accessible, interoperable and reusable) for data management and stewardship.¹² Elements of
263 the FAIR principles that are applicable to the effectiveness evaluation are shown below (box 1). The
264 Monitoring Guidance also discusses ethical considerations for the use of data, including the need to
265 follow guidance provided by Indigenous Peoples with regards to self-determination of research,
266 research ethics, data considerations, utilization of Indigenous Knowledge, and communication of
267 results as guided by principles such as the “CARE Principles for Indigenous Data Governance”.¹

Box 1. Elements of the FAIR principles for data management and stewardship in the context of the effectiveness evaluation

Findable:

- A searchable and interoperable database acting as a repository of available data;
- Unique identification systems (e.g., “Digital Object Identifiers” or “DOIs”) and controlled vocabulary to facilitate searching and retrieval of information;
- Detailed metadata associated with each data record to facilitate the submission, searching, location and retrieval of information;

Accessible:

- Free and open access to the data to Governments, Indigenous Peoples, and relevant stakeholders, taking into account the relevant ethical considerations;

Interoperable:

- An interoperability mechanism to facilitate the exchange of information across different programmes and databases;

Reusable:

- Data usage license/agreement identifying the terms and conditions for further use of the data;
- Metadata including enough information describing how the data were collected/produced to enable an assessment of the quality and comparability of the data, reproducibility and further analyses.

268 The Monitoring Guidance also notes that different types of observations and sources of data may be
269 most appropriate for addressing different questions during the effectiveness evaluation. National and
270 multi-country monitoring programmes, including, but not limited to, those identified in the
271 Supplementary Material, as well as programmes and projects overseen by international organizations,
272 may be prioritized as the preferred sources of monitoring data. In the absence of those, additional
273 sources of data may also provide valuable information to the effectiveness evaluation. Below, Chapter
274 3 of the current document extends the list of potential sources of data for each of the key media.

275 To help structure the process to compile and analyse mercury monitoring data, the Monitoring
276 Guidance lists mercury and ancillary observations for air, biota and humans across the three tiers (see
277 page 94 of the Monitoring Guidance). It also proposes a preliminary format for the submission of
278 monitoring data based on the minimum mercury and ancillary observations and metadata that would
279 need to accompany each dataset that is submitted to support the work of the OESG (see annex 2 of the
280 Supplementary Material). Moreover, lists of data quality control measures that will help to assess the
281 usefulness and validity of different monitoring data sets and maximize scientific weight of evidence to
282 support the effectiveness evaluation are also included in the Monitoring Guidance and its
283 Supplementary Material. Chapter 4 of the current document builds upon this information to provide a
284 data dictionary for the mercury and ancillary observations and metadata. Chapter 5 explains how data
285 will be collected, checked for quality and stored.

286 **3. Planning for the compilation of monitoring data**

287 **3.1 Sources of data**

288 The work of the OESG to inform the first effectiveness evaluation will focus on existing sources of
289 monitoring data. An analysis of gaps related to monitoring data, including potential scientific actions

¹ CARE Principles for Indigenous Data Governance: <https://www.gida-global.org/care>.

290 to address the identified gaps, will be included in the scientific report of the OESG and will not be part
291 of the present plan for monitoring data.

292 Mercury observations in the different matrices, ancillary observations and metadata will be collected
293 from a broad range of sources and the quality of the collected data will be assessed (more details
294 below). Working in small groups focused on air, biota, humans, and “other matrices” (soil, water and
295 sediment), the OESG and experts in the roster, have identified the main available sources of
296 monitoring data for each matrix. The sources include monitoring programs, both ongoing and
297 completed, as well as independent studies.

298 Spreadsheets were developed for the different matrices to provide an overview of the characteristics
299 and type of information contained in each set of data. In addition to providing a snapshot of the type of
300 mercury measurements in each dataset, the spreadsheets also include examples of metadata available,
301 such as the type of data collected, geographic coverage, monitoring period, relevant publications, etc.
302 Some of the categories of metadata included in the spreadsheets are common to all matrices while
303 others are matrix specific.

304 Summaries of the available sources of data for each matrix are presented as addenda to this document,
305 as follows: addendum 1 (air), 2 (biota), 3 (human biomonitoring) and 4 (soil, water and sediment).²
306 Due to the size of the resulting spreadsheets for sources of mercury data in biota, human
307 biomonitoring and other matrices, they are being made available online through the [OESG document
308 folder](#) as separate supplemental materials in their original format.

309 The identified sources of monitoring data will serve as a starting point for the collection of data
310 through an invitation to parties and other data providers to submit their datasets containing
311 observational mercury data and metadata (see Chapter 5).

312 **3.2 Data elements to be collected: the data dictionary**

313 A data dictionary was developed to facilitate the work of the OESG in collecting, comparing and
314 analysing mercury levels in air, humans, biota, and other matrices (soil, water and sediment).

315 Data dictionaries are used to catalogue and communicate the structure and content of data and provide
316 descriptions for individual data elements. Shared dictionaries help to ensure that the meaning,
317 relevance, and quality of data elements are the same for all users. Data dictionaries also provide
318 information needed downstream to build systems and applications to support the comparison and
319 analysis of monitoring data.³

320 The objective of the data dictionary, as contained in Annex 2 below, is to identify and structure the
321 necessary mercury observations, ancillary observations, and descriptive elements, or metadata, to be
322 submitted by those who wish to contribute to the first effectiveness evaluation of the Minamata
323 Convention on Mercury. To support the OESG’s analysis of comparable mercury monitoring data, a
324 shared data dictionary will be necessary to facilitate standardization by documenting common data
325 structures and providing the precise definitions, agreed nomenclature, units of measurement, time
326 scales and formats, as well as further information and external references that are needed to compare
327 and analyse mercury measurements.

328 Several types of data elements are included in the data dictionary: the mercury observations, ancillary
329 observations of other relevant contaminants or environmental parameters, and descriptive data
330 elements (or metadata) that are necessary for interpretation of the observations. The data elements
331 contained in the data dictionary are grouped into nine sections, from A to I. Sections A-C, H and I
332 contain categories of data elements that are common to all monitoring matrices, whereas sections D
333 through G contain data elements that are specific for each matrix. The data elements are further
334 grouped by categories and, where relevant, sub-categories.

335 The data dictionary provides a detailed overview of possible elements that may be useful in the
336 analysis of data. It is recognized that many of the existing monitoring datasets do not necessarily
337 include all the elements identified in the data dictionary and that, particularly during the first
338 effectiveness evaluation cycle, data providers will not be able to provide all the data elements in the
339 proposed data dictionary. Nevertheless, the data dictionary may be useful to guide the generation of

² For existing sources of mercury monitoring data in air, please refer to pages 4-12 of the Supplementary Material, contained in document [UNEP/MC/COP.4/INF/25](#), which are being reproduced as addendum 1 to this document.

³ From the US Geological Survey (USGS) website. For more background information on data dictionaries, see <https://www.usgs.gov/data-management/data-dictionaries>.

340 data in the future with the aim of having data that is more comparable and detailed for future
341 effectiveness evaluation cycles.

342 The data dictionary will be used to develop matrix-specific standardized formats to facilitate the
343 submission and compilation of data in a harmonized manner. The standardized formats will identify
344 the minimally essential data elements to be submitted.

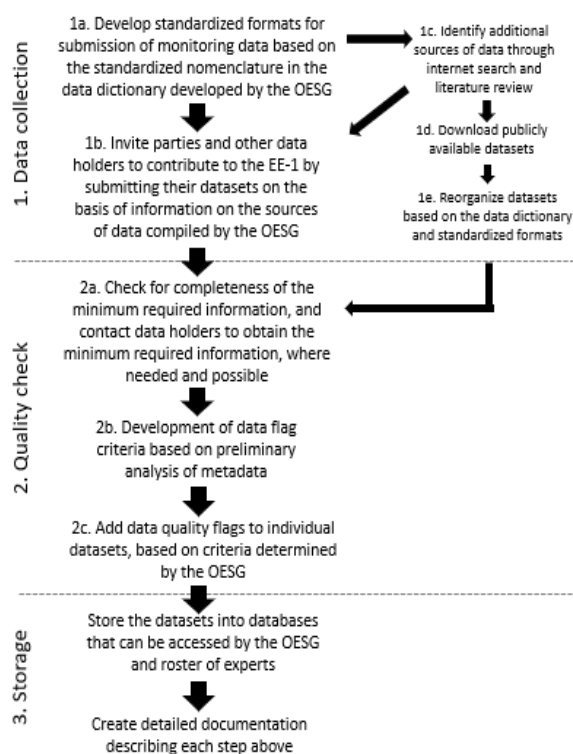
345 To maximize the comparability of data while providing the flexibility during the submission of
346 information, the use of controlled vocabulary (a standardized, pre-defined set of terms to describe the
347 mercury and ancillary observations and metadata) will be favoured in the formats for data submission
348 but free text fields will also be offered to describe data elements where the use of a controlled
349 vocabulary is not possible or desirable.

350 3.3 Data collection, quality check and storage

351 Putting the monitoring data plan into practice will require action for data collection, quality control
352 and storage as detailed below and shown in Figure 3. The aim here is to present the mercury
353 monitoring data in as concise and clear way as possible to enable users to understand and interpret the
354 data. Provision of concise relevant background information and explanations of submitted data helps
355 to ensure that the mercury monitoring data is transparent.

356 Figure 3

357 Implementation of the monitoring data plan: overview of the steps for data collection, quality 358 check and storage



359 (a) Data collection

360 Once the data dictionary has been finalized, standardised data formats for data collection will be
361 developed for each matrix to facilitate data submissions and subsequent comparison and analyses. The
362 standardized formats will be aligned, to the extent possible, with existing formats in use by established
363 monitoring programmes to minimize the workload and to facilitate the use of existing data. A long-
364 term vision of this plan is to cooperate with established monitoring programmes for the generation of
365 data in formats that respond to the OESG needs. Matrix-specific standard formats will ensure that
366 datasets, including those from different sources, will share a consistent structure, i.e., they will share
367 the same sequence of data fields. It will also be possible to harmonize the units of measurement, time,
368 and location to enable the comparison of multiple sets of data.

369 Parties and other data holders will be invited to submit monitoring data as “CSV” files using the
370 standardised formats.⁴ Datasets submitted in their native nomenclature and formats will also be
371 accepted and will be included in the compilation following a reorganization of the data in accordance
372 with the standardized formats. Submissions of monitoring datasets from all sources will be welcome
373 during the data collection phase but, during the analysis phase, prioritization and/or weighting of data
374 to support the effectiveness evaluation will likely be necessary (see further detail below).

375 In addition to inviting parties and other data holders to submit monitoring data, an active mining for
376 relevant and publicly available data will also be necessary. This will be achieved through internet
377 searches and literature review. The extent to which this approach will contribute to the overall data
378 collection efforts will likely vary from matrix to matrix, and it will depend on the quality and
379 coverage, both temporal and spatial, of data submitted upon invitation.

380 Both aggregated and raw data will be obtained from a variety of sources, including from data
381 providers as well as from scientific publications. Where appropriate and available, aggregated data and
382 published reviews that pass quality checks will be used to ensure effectiveness and reduce the
383 workload of the OESG and to avoid duplicative work.

384 Data providers or copyright holders will retain the ownership and rights over their data, including
385 mercury and ancillary observations and metadata. For datasets that are not publicly available or that
386 have use restrictions, the Secretariat will establish data use agreements with the individual data
387 providers, as appropriate, and guidance will be provided to the OESG members and the roster of
388 experts to ensure that the data is used only for the purpose of supporting the effectiveness evaluation
389 and that it is not shared outside the OESG members and experts in the roster. The original sources of
390 all data used by the OESG will be duly acknowledged in the OESG outputs. Lessons learned from data
391 ownership and data use licensing will be summarised in the OESG final report to inform future
392 effectiveness evaluation cycles.

393 (b) Quality check

394 As part of the quality check, the collected data will first be evaluated for completeness, followed by a
395 quality control process that will include an assessment of the reliability and relevance of the data.

396 The first task to check the quality of the data is to ensure that each dataset contains the minimally
397 required data elements in accordance with the data dictionary. If any data elements are missing, the
398 data providers will be contacted and invited to supply the missing information. As noted above,
399 minimally essential data elements will be indicated in the data formats but flexibility will be applied
400 when the submitted datasets do not meet the minimally required data elements, especially for areas
401 where mercury observations and metadata are scarce.

402 A set of data quality flagging criteria will be developed by the OESG once a preliminary analysis of
403 the collected metadata has been performed. This will be done, for example, on the basis of the
404 validation of sampling and analytical methods; the quality assurance and quality control (QA/QC)
405 measures that were applied; and the generalizability or representativeness of the data (e.g., whether
406 samples were randomly selected or there is some bias; considerations of the sample size, etc). Data
407 quality flags will be added to help the OESG, during the analysis phase, to assign different weights to
408 the different datasets depending on the purpose of the analysis or questions being addressed.

409 The OESG will prioritize the use of data that have been subjected to QA/QC protocols. Only in the
410 absence of such data (e.g., for specific areas where no other data is available), data without proper
411 QA/QC, and flagged as such, may be included on a case-by-case in a preliminary analysis of mercury
412 levels⁵ and in the identification of gaps. How data will be prioritized or weighted in specific analyses
413 as a result of the data quality flags will be discussed during the analysis phase and included in the
414 “plan for data analysis” and are not the focus of the present document.

⁴ “Comma-separated values” or “CSV” is a common data exchange format that is widely supported by databases and spreadsheets. As such, CSV files can also be used to transfer data across different data management platforms.

⁵ One member of the roster of experts supporting the OESG suggested to utilize monitoring data with insufficient QA/QC only for the purpose of identifying gaps rather than including such data sets in the actual analysis to support the OESG.

415 **(c) Data storage**

416 The compiled datasets will be stored in a manner that will support access to the data by the OESG and
417 experts in the roster via the internet so that it can be analysed. A range of possible options for data
418 storage were considered during the development of the present plan.

419 At the conclusion of the tasks covered by this plan, the compiled data for each matrix, along with the
420 original submissions from data providers, will be stored in databases (for example, MySQL) that will
421 be accessible to the OESG and experts in the roster.

422 For the first effectiveness evaluation, a simple data management system will be implemented (e.g.,
423 with manual input of data and without machine-to-machine data transfer protocols between
424 repositories). Based on the experience gained in the first effectiveness evaluation, a more elaborated
425 data management infrastructure may be considered for future effectiveness evaluation cycles at a
426 frequency to be decided by the Conference of the Parties.

427 How the compiled databases will be used to address specific questions to inform the effectiveness
428 evaluation, including considerations for the development of tools that will enable the newly compiled
429 data to be searched, analysed, modelled and visualised will be included in the forthcoming plan for
430 data analysis and is not the focus of the present document.

431 With an eye to improving the data management infrastructure for future effectiveness evaluations, the
432 OESG will continue to explore best practices for data providers to make their data accessible
433 electronically for analysis, to facilitate submission of data to regional or global repositories that can
434 make the data available electronically, and to facilitate the implementation of common machine-to-
435 machine data transfer protocols between existing national, regional, or global data repositories.
436 Lessons learned from these efforts will be included in the final OESG report.

437 **(d) Roles and responsibilities**

438 The OESG, with input from the roster of experts, will provide overall guidance and have oversight of
439 all steps involved in the different phases – data collection, quality check and storage – which are
440 needed to implement the monitoring data plan. In addition, the OESG will be directly responsible for
441 developing criteria for data quality flagging (step 2b).

442 To help the implementation of this plan, the Secretariat will engage and supervise one or more data
443 management consultants. The data management consultant(s) will be responsible for the day-to-day
444 tasks to collect, organize and store data in accordance with the guidance provided by the OESG. The
445 specific tasks of the data management consultants will include: assisting the OESG in developing
446 standardized formats for data collection (step 1a); assisting the Secretariat in inviting Parties and data
447 holders to submit data (step 1b); searching for additional sources of data; downloading publicly
448 available datasets and reorganising them as per the standardized formats (steps 1c-e); ensuring that
449 each dataset contains the minimum required data elements (step 2a); summarizing collected metadata
450 to inform the development of data quality flags (step 2b); adding data quality flags based on criteria
451 developed by the OESG (step 2c); storing the datasets so that they are accessible to the OESG (step
452 3a); and documenting all steps to enable traceability during further data handling and analysis (step
453 3b). The cost of consultancy services will be borne by the Convention's budget.

454 Furthermore, to maximize the current and future efforts to compile and analyse monitoring data,
455 considerations on the contributions of Indigenous Peoples to global efforts to monitor mercury are
456 contained in annex 3, including examples of best practices and identified Knowledge and capacity
457 gaps.

458 **4. Implementation of the Plan for Monitoring Data Compilation and**
 459 **Summary**

460 The main milestones for the implementation of the plan monitoring data compilation and summary are
 461 summarized below with associated tentative timelines.

<i>Milestones</i>	<i>Tentative timeline</i>
Review by Parties of the draft plan for monitoring data compilation and summary	3 February – 1 March 2023
Revision of the monitoring data plan, including the data dictionary, following the face-to-face meeting of the OESG, 27-31 March 2023	April 2023
Development/Selection of matrix-specific common formats for the submission and compilation of monitoring data	May-October 2023
Invitation to Parties and other data providers to express their intent to submit data to support the first effectiveness evaluation	September 2023
Invitation to Parties and other data providers to submit data to support the first effectiveness evaluation	October 2023
Deadline for submission by Parties and other data providers to submit data to support the first effectiveness evaluation	January 2024
Progress report on the status the data submitted to support the first effectiveness evaluation	March 2024
Party review of draft report on compilation of monitoring data and summary	April 2024
Submission of the report on monitoring data compilation and summary to the Effectiveness Evaluation Group (EEG)	TBD (pending decision at COP-5)

462 **Annex 1**463 **Monitoring objectives and associated guiding questions¹****Monitoring objectives and associated guiding questions**

1. *Estimation of mercury concentrations for areas without (i.e., background sites) or with (i.e., affected sites) local anthropogenic sources*
 - 1.1 What are the levels and form of mercury found in sites that are considered to be remote from anthropogenic sources?
 - 1.2 What are the levels and form of mercury found in sites that are expected to be affected by local anthropogenic point sources?
2. *Identification of temporal trends*
 - 2.1. Do the levels and form of mercury in the observed matrix (air, biota, human) at a given location change over time – for example, in the short term (< 5 years), medium term (5 to 20 years) and long term (> 20 years)? Is there a long-term trend or trajectory (a signal) that can be separated from the temporal variability (noise)?
 - 2.2. How do observed temporal variations and trends differ spatially, and how do they differ among matrices?
 - 2.3. How do observed temporal variations and trends in mercury compare to, or co-vary with, variations and trends of mercury in different forms (chemical species) or within other matrices?
 - 2.4. How do observed temporal variations and trends in mercury compare to, or co-vary with, variations and trends of mercury emissions and releases?
 - 2.5. How do observed temporal variations and trends in mercury compare to, or co-vary with, variations and trends of related pollutants/emissions or environmental variables?
3. *Characterization of spatial patterns*
 - 3.1. What are the levels and form of mercury in the observed matrix (air, biota, human) at a given location and time?
 - 3.2. Taken together, what does the available data suggest about spatial variability in environmental mercury concentrations?
 - 3.3. Taken together, what does the available data suggest about Variability in mercury concentrations within and among human populations, wildlife populations and their habitats, and ecosystems?
 - 3.4. Do the observed spatial variations and patterns differ among forms (chemical species) of mercury?
 - 3.5. Do the observed spatial variations and patterns differ among air, biota and human matrices?
 - 3.6. How do the observed spatial variations and patterns or gradients compare to those of mercury emissions and releases?
 - 3.7. How do the observed spatial variations and patterns or gradients compare to those of related pollutants/emissions or environmental variables?

¹ As per table 2.1 of the Monitoring Guidance (document [UNEP/MC/COP.4/18/Add.2](#)).

4. *Estimation of source attribution of anthropogenic mercury*
 - 4.1. Using models and statistical analyses consistent with observational data, how can the observed levels, spatial patterns, temporal trends and adverse impacts on species, ecosystem services, biodiversity and human populations be attributed to changes in anthropogenic, natural and legacy mercury?
 - 4.2. Using models and statistical analyses consistent with observational data, how can the observed levels, spatial patterns, temporal trends and adverse impacts on species, ecosystem services, biodiversity and human populations be attributed to changes in anthropogenic sources (local, regional, global) of mercury?
 - 4.3. Using models and statistical analyses consistent with observational data, how can the observed levels, spatial patterns, temporal trends and adverse impacts on species, ecosystem services, biodiversity and human populations be attributed to changes influenced by the Convention?
 - 4.4. Using models and statistical analyses consistent with observational data, how can the observed levels, spatial patterns, temporal trends and adverse impacts on species, ecosystem services, biodiversity and human populations be attributed to changes not influenced by the Convention?
5. *Estimation of exposure and adverse impacts*
 - 5.1. How do the observed levels of mercury in air, biota and humans compare to established national and international benchmark levels associated with adverse effects on human health, wildlife and environmental sustainability?
 - 5.2. How significant are the observed changes in exposures for different types of impacts on humans and wildlife in regions that are remote from sources, as well as those that are locally impacted by anthropogenic sources?
 - 5.3. Are observed changes in exposure attributable to mitigation measures or changes influenced by the Convention?
6. *Quantification of key environmental processes to improve understanding of cause-effect relationships*
 - 6.1. How ancillary measurements contribute to establishing the level, spatial pattern or temporal trends of mercury and improve understanding about the relative importance of environmental processes and parameters driving transport and fate?
 - 6.2. How consistent are the observed levels, temporal trends and spatial patterns with the modelled estimates and what lessons can be learned from them to improve the existing models?

464 **Annex 2**465 **Data dictionary to facilitate the submission and analysis of mercury**
466 **monitoring observations and metadata¹**

467 This document presents a data dictionary that defines common data structures and provides the precise
468 vocabulary needed to facilitate the work of the Open-Ended Scientific Group in collecting, comparing
469 and analysing mercury levels in air, humans, biota, and other matrices (soil, water and sediment).

470 As shown below, the data dictionary contains information that will be applicable for the collection of
471 datasets containing individual observations as well as aggregated data. For example, for many of the
472 information categories, allowing the selection of multiple options for descriptive terms will be
473 necessary for describing aggregated data but will not be applicable for an individual observation. The
474 standardized formats, which will be developed for each matrix on the basis of formats already in use
475 by established monitoring programs and nomenclature shown in the data dictionary, will be adjusted to
476 accommodate both sets of individual observations as well as aggregated datasets.

477 Three types of data elements are defined: mercury observations, ancillary observations that are
478 necessary to interpret the mercury observations, and descriptive data elements (or metadata) that are
479 useful for evaluating and managing the data. The data elements contained in this document are
480 grouped into seven sections, from A to G. Sections A, B, G and H contain categories of data elements
481 that are common to all monitoring matrices, whereas sections C through F contain data elements that
482 are specific for each matrix. The data elements are further grouped by categories and, where relevant,
483 sub-categories. For each data element a set of possible options, using controlled vocabulary, or free
484 text entries are offered. For each data element, one or multiple options may be relevant.

485 Different types of metadata may be relevant, including quantitative information that may be provided
486 using the “number fields” or qualitative and semi-quantitative information that may be added in the
487 “text fields”. Quantitative fields, where a value is indicated, will be accompanied by a field where the
488 unit is indicated.

489 While the data dictionary lists many descriptors that could be used to describe the datasets, these are
490 all possible selections which may or may not apply to specific datasets. The minimum required data
491 elements are identified by an asterisk (*).

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
A. SUBMISSION OR ACCESS DETAILS (<i>ALL MATRICES</i>)		
A.1. Date of submission or access:*		<Text entry>
A.2. Contact details of the person submitting or accessing the data :*	Name:*	<Text entry>
	Affiliation:*	<Text entry>
	Address:*	<Text entry>
	Email:*	<email field>
	Country:*	<list of countries>
A.3. Contact details of the data owner or originator :*	Name:	<Text entry>
	Affiliation:	<Text entry>
	Address:	<Text entry>
	Email:	<email field>
	Country:	<list of countries>
A.4. Data use restrictions:	Data is publicly available:	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, please indicate where: <Text entry>
	Data subject to a specific use license:	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, please explain conditions for allowable use: <Text entry>

¹ An earlier version of this form was published as annex 2 to document [UNEP/MC/COP.4/INF/25](#). The current draft builds on the original form and incorporates input from the OESG and experts in the roster.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
B. AIM AND SCOPE OF THE STUDY (ALL MATRICES)		
B.1. Aim of the study:*		<input type="checkbox"/> Identification of temporal trends <input type="checkbox"/> Characterization of spatial patterns <input type="checkbox"/> Estimation of source attribution <input type="checkbox"/> Exposure assessment <input type="checkbox"/> Impact / Health assessment <input type="checkbox"/> Quantification of particular environmental processes <input type="checkbox"/> Other, please specify: <Text entry>
B.2. Brief description of the study:*		<Text entry – max. 150 words >
B.3. Geographic scope:		<input type="checkbox"/> Sub-national <input type="checkbox"/> National <input type="checkbox"/> Multi-Country Details on the geographic scope: <Text entry>
B.4. Type of organization carrying out the study:		<input type="checkbox"/> Government agencies <input type="checkbox"/> Universities or research institutions <input type="checkbox"/> Non-governmental organizations <input type="checkbox"/> Other, please specify: <Text entry>
C. SITE CHARACTERISTICS (ALL MATRICES)		
C.1. Characteristics of the monitoring site(s):	Human settlements:	<input type="checkbox"/> Remote or unpopulated areas <input type="checkbox"/> Low population density areas (<500 persons per square Km) <input type="checkbox"/> Medium population density areas (500-1000 persons per square Km) <input type="checkbox"/> High population density areas (>1,000 persons per square Km)
	Geographic coordinates: * ²	Latitude: <Number entry> Longitude: <Number entry> Unit: <input type="checkbox"/> decimal degrees <i>OR</i> <input type="checkbox"/> degrees / minutes / seconds
	Elevation of site:	<Number entry> Unit: <input type="checkbox"/> Metres <i>OR</i> <input type="checkbox"/> Feet
	Proximity to point sources:	Distance: <Number entry> Unit: <input type="checkbox"/> Metres <i>OR</i> <input type="checkbox"/> Kilometres <input type="checkbox"/> ASGM site <input type="checkbox"/> Large-scale gold mining site <input type="checkbox"/> Mercury mine <input type="checkbox"/> Chlor-alkali plant <input type="checkbox"/> Coal-fired power plant <input type="checkbox"/> Hydroelectric power plant <input type="checkbox"/> Non-ferrous metal processing/smelting facilities <input type="checkbox"/> Oil and natural gas processing facilities <input type="checkbox"/> Cement clinker production facilities <input type="checkbox"/> Vinyl chloride monomer (VCM) production <input type="checkbox"/> Acetaldehyde production <input type="checkbox"/> Manufacturing of mercury containing products/devices <input type="checkbox"/> Waste disposal, recycling or incineration facilities <input type="checkbox"/> Forestry site

² It may be necessary to reduce the accuracy of geographic coordinates to protect privacy (e.g., when the samples were collected in private properties) while still allowing the data to carry spatial information that is relevant for the work of the OESG.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		<input type="checkbox"/> No local sources identified (i.e., long-range mercury transport) <input type="checkbox"/> Other, please specify: <Text entry>
	Type of ecosystem(s):	Terrestrial ecosystems: <ul style="list-style-type: none"> <input type="checkbox"/> Agricultural area <input type="checkbox"/> Forest <input type="checkbox"/> Inland wetland <input type="checkbox"/> Savanna <input type="checkbox"/> Steppe <input type="checkbox"/> Desert Freshwater ecosystems: <ul style="list-style-type: none"> <input type="checkbox"/> River <input type="checkbox"/> Lake Marine and coastal ecosystems: <ul style="list-style-type: none"> <input type="checkbox"/> Estuary <input type="checkbox"/> Coastal area <input type="checkbox"/> Open ocean <input type="checkbox"/> Other, please specify: <Text entry>
	Details on the monitoring site(s): <Text entry>	
C.2. Co-location of other monitoring activities:		<input type="checkbox"/> Co-located with other Hg monitoring networks or other relevant measurement activities (e.g., monitoring in other matrices) – please explain: <Text entry> <input type="checkbox"/> Not applicable
C.3. Monitoring frequency:		<input type="checkbox"/> Single time point <input type="checkbox"/> Continuous <input type="checkbox"/> Daily <input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Yearly <input type="checkbox"/> Seasonal, please specify: <Text entry> <input type="checkbox"/> Other, please specify: <Text entry>
C.4. Monitoring period:*		From: <Date> To: <Date>
C.5. Ongoing monitoring:		<input type="checkbox"/> Yes <input type="checkbox"/> No
C.6. Monitoring matrix:*		<input type="checkbox"/> Air » Section D <input type="checkbox"/> Biota (animals and plants) » Section E <input type="checkbox"/> Human biomonitoring » Section F <input type="checkbox"/> Other matrices » Section G
D. AIR		
D.1. Sampling method:*		<input type="checkbox"/> Continuous analysers <input type="checkbox"/> Manual trap methods <input type="checkbox"/> Passive samplers <input type="checkbox"/> Wet deposition samplers <input type="checkbox"/> Dry deposition samplers <input type="checkbox"/> Bulk deposition samplers <input type="checkbox"/> Litterfall <input type="checkbox"/> Other, please specify: <Text entry>
D.2. Height of sample collection from ground:		<Number entry> Unit: <input type="checkbox"/> Metres <i>OR</i> <input type="checkbox"/> Feet
D.3. Sample collection date:*		<input type="checkbox"/> Single date: <YYYY-MM-DD> <i>OR</i> <input type="checkbox"/> Period: From <YYYY-MM-DD> To <YYYY-MM-DD>
		Frequency: <input type="checkbox"/> Automated measurements (in minutes): <Number entry>

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		<input type="checkbox"/> Manual measurements (in hours): <Number entry>
D.4. Mercury observations:*	Mercury species:*	<input type="checkbox"/> Gaseous Elemental Mercury (Hg ⁰ , GEM) <input type="checkbox"/> Gaseous Oxidized Mercury (Hg ^{II} , GOM) <input type="checkbox"/> Total Gaseous Mercury (TGM = GEM + GOM) <input type="checkbox"/> PM10 <input type="checkbox"/> PM2.5 <input type="checkbox"/> Total mercury in precipitation <input type="checkbox"/> Methyl mercury in precipitation <input type="checkbox"/> Total mercury in litterfall <input type="checkbox"/> Methyl mercury in litterfall <input type="checkbox"/> Mercury isotopes <input type="checkbox"/> Other, please specify: <Text entry>
	Unit of concentration measurement:*	<input type="checkbox"/> ng/m3 <input type="checkbox"/> pg/m3 <input type="checkbox"/> Other, please specify: <Text entry>
	Unit of deposition measurement:	<input type="checkbox"/> ng/m2*week <input type="checkbox"/> µg/m2*week <input type="checkbox"/> ng/m2*year <input type="checkbox"/> µg/m2*year <input type="checkbox"/> ng/ha*year <input type="checkbox"/> µg/ha*year <input type="checkbox"/> Other, please specify: <Text entry>
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> OR <input type="checkbox"/> Provide URL: <Text entry>
	Have the observations been aggregated?*	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, please explain the data aggregation process: <Text entry>
D.5. Ancillary observations:	Precipitation & meteorological data (value and unit):	<input type="checkbox"/> Air Temperature <input type="checkbox"/> % relative humidity <input type="checkbox"/> Wind speed <input type="checkbox"/> Wind direction <input type="checkbox"/> Pressure <input type="checkbox"/> Other, please specify: <Text entry>
	Emission inventories:	<Text entry>
	Air quality tracers (value and unit):	<input type="checkbox"/> SO ₂ <input type="checkbox"/> CO ₂ <input type="checkbox"/> CO <input type="checkbox"/> O ₃ <input type="checkbox"/> PM10 <input type="checkbox"/> PM2.5 <input type="checkbox"/> Sea salt sulphate (SSF) <input type="checkbox"/> Non-sea salt sulphate (NSSF) <input type="checkbox"/> Radon <input type="checkbox"/> Other, please specify: <Text entry>
	Land cover:	<Text entry>
	Land use:	<Text entry>
	Leaf area index:	<Text entry>
	Other:	Please specify: <Text entry>
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> OR Provide URL: <Text entry>

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
D.6.	Additional information regarding sampling, mercury measurement or ancillary information:	<Text entry>
E.	BIOTA	
E.1.	Type:*	Aquatic: <ul style="list-style-type: none"> <input type="checkbox"/> Invertebrates <input type="checkbox"/> Fish <input type="checkbox"/> Reptiles <input type="checkbox"/> Birds <input type="checkbox"/> Mammals (marine) <input type="checkbox"/> Mammals (fresh water) <input type="checkbox"/> Plants Terrestrial: <ul style="list-style-type: none"> <input type="checkbox"/> Invertebrates <input type="checkbox"/> Amphibian <input type="checkbox"/> Reptiles <input type="checkbox"/> Birds <input type="checkbox"/> Mammals <input type="checkbox"/> Plants <input type="checkbox"/> Other, please specify: <Text entry>
E.2.	Species name(s):	<Text entry>
E.3.	Brief description of the study population in terms of mercury exposure:	<Text entry – max. 150 words >
E.4.	Number of individuals sampled:	<Number entry> Further detail on sample size: <Text entry>
E.5.	Sampling strategy:	<input type="checkbox"/> Random <input type="checkbox"/> Not random, please describe the level of representativeness: <Text entry> <input type="checkbox"/> Other, please specify: <Text entry>
E.6.	Characteristics of the samples:	Sample collection date: <ul style="list-style-type: none"> <input type="checkbox"/> Single date: <YYYY-MM-DD> OR <input type="checkbox"/> Period: From <YYYY-MM-DD> To<YYYY-MM-DD> <hr/> Type of sample: <ul style="list-style-type: none"> <input type="checkbox"/> Whole specimen <input type="checkbox"/> Whole organ(s) <input type="checkbox"/> Specific tissue(s), please specify: <Text entry> <hr/> Sampled tissue(s): <ul style="list-style-type: none"> <input type="checkbox"/> Blood <input type="checkbox"/> Kidney <input type="checkbox"/> Liver <input type="checkbox"/> Muscle <input type="checkbox"/> Blubber <input type="checkbox"/> Fur / Hair <input type="checkbox"/> Feathers <input type="checkbox"/> Eggs <input type="checkbox"/> Brain <input type="checkbox"/> Nails and others keratinoid tissues <input type="checkbox"/> Leaves <input type="checkbox"/> Shoots <input type="checkbox"/> Roots <input type="checkbox"/> Other, please specify: <Text entry> <hr/> Sample digestion / extraction: <ul style="list-style-type: none"> <input type="checkbox"/> Direct analysis (no digestion) <input type="checkbox"/> Aqua regia <input type="checkbox"/> Nitric acid <input type="checkbox"/> Hydrochloric acid <input type="checkbox"/> Other, please specify: <Text entry>

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
E.7. Mercury observations:*	Mercury species:*	<input type="checkbox"/> Total mercury <input type="checkbox"/> Inorganic mercury <input type="checkbox"/> Methyl mercury <input type="checkbox"/> Other, please specify: <Text entry>
	Unit of measurement:*	<input type="checkbox"/> µg/g (or mg/kg) <input type="checkbox"/> ng/g <input type="checkbox"/> µg/L <input type="checkbox"/> Other, please specify: <Text entry>
	Data reporting:*	<input type="checkbox"/> Dry weight <input type="checkbox"/> Wet weight
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> OR Provide URL: <Text entry>
	Have the observations been aggregated?*	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, please explain the data aggregation process: <Text entry>
E.8. Ancillary observations:	Biota:	<input type="checkbox"/> Species name(s) <input type="checkbox"/> Weight <input type="checkbox"/> Length <input type="checkbox"/> Age <input type="checkbox"/> Sex <input type="checkbox"/> Maturity stage (e.g. juvenile, adult) <input type="checkbox"/> Fatty acids <input type="checkbox"/> Protein <input type="checkbox"/> Selenium <input type="checkbox"/> Other, please specify: <Text entry>
	Trophic level:	<input type="checkbox"/> Primary Producers <input type="checkbox"/> Primary consumers <input type="checkbox"/> Primary carnivores <input type="checkbox"/> Secondary carnivores <input type="checkbox"/> Tertiary carnivores <input type="checkbox"/> Other, please specify: <Text entry>
	Surrounding seawater, freshwater, soil and sediment:	<input type="checkbox"/> Temperature (value/unit) <input type="checkbox"/> Depth (value/unit) <input type="checkbox"/> pH (value) <input type="checkbox"/> Salinity (value/unit) <input type="checkbox"/> Conductivity (value/unit) <input type="checkbox"/> Dissolved oxygen (value/unit) <input type="checkbox"/> Total organic carbon (value/unit) <input type="checkbox"/> Dissolved organic carbon (value/unit) <input type="checkbox"/> Particle size distribution (sand, clay, etc) <input type="checkbox"/> Total oxidized nitrogen (value/unit) <input type="checkbox"/> Sulfur (species/value/unit) <input type="checkbox"/> Trace elements (species/value/unit) <input type="checkbox"/> Organic pollutants (species/value/unit) <input type="checkbox"/> Other, please specify: <Text entry>
	Inland areas:	<input type="checkbox"/> Landscape/watershed characteristics (e.g., lake and catchment morphology) <input type="checkbox"/> Local data on mercury deposition <input type="checkbox"/> Local pollution history <input type="checkbox"/> Other, please specify: <Text entry>
	Stable isotopes (value and unit):	<input type="checkbox"/> Carbon ($\delta^{13}\text{C}$) <input type="checkbox"/> Nitrogen ($\delta^{15}\text{N}$) <input type="checkbox"/> Mercury ($\delta^{202}\text{Hg}$) <input type="checkbox"/> Mercury ($\delta^{199}\text{Hg}$)

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		<input type="checkbox"/> Sulfur ($\delta^{34}\text{S}$) <input type="checkbox"/> Compound specific stable isotopes <input type="checkbox"/> Other, please specify: <Text entry>
	Other:	<input type="checkbox"/> Please specify: <Text entry>
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> OR Provide URL: <Text entry>
E.9. Additional information regarding sampling, mercury measurement or ancillary information:		<Text entry>
F. HUMAN BIOMONITORING		
F.1. Ethics certificate:		Institutional Review Board (IRB): <Text entry> Date issued: <YYYY-MM-DD> Please attach copy of ethics certificate.
F.2. Study population exposure/vulnerability:*	Demographics:	<input type="checkbox"/> General population <input type="checkbox"/> Early life (fetus, newborn, children: 0-11 years old) <input type="checkbox"/> Adolescents (12-17 years old) <input type="checkbox"/> Adult men (18+ years old) <input type="checkbox"/> Pregnant women <input type="checkbox"/> Women in child-bearing age (<50 years old) <input type="checkbox"/> Women past child-bearing age (>50 years old) <input type="checkbox"/> Workers <input type="checkbox"/> Subsistence fishers/hunters <input type="checkbox"/> Recreational fishers/hunters <input type="checkbox"/> Other, please specify: <Text entry>
	Environmental or dietary exposure:	<input type="checkbox"/> Indigenous Peoples <input type="checkbox"/> Local communities <input type="checkbox"/> People living in islands or coastal areas <input type="checkbox"/> People living alongside freshwater ecosystems (e.g., rivers, lakes) <input type="checkbox"/> People living near ASGM sites <input type="checkbox"/> People living near mercury sources other than ASGM sites, please specify: <Text entry> <input type="checkbox"/> People living in the arctic and subarctic <input type="checkbox"/> Other, please specify: <Text entry>
	Occupational exposure:	<input type="checkbox"/> Primary mercury mining <input type="checkbox"/> Artisanal and small-scale gold mining (ASGM) <input type="checkbox"/> Non-ferrous ore mining (e.g., zinc, lead, copper) <input type="checkbox"/> Chlor-alkali production <input type="checkbox"/> Vinyl chloride monomer (VCM) production <input type="checkbox"/> Acetaldehyde production <input type="checkbox"/> Coal-fired power plants <input type="checkbox"/> Oil and natural gas processing <input type="checkbox"/> Healthcare (using mercury-containing measuring and control devices) <input type="checkbox"/> Dentistry <input type="checkbox"/> E-waste recyclers <input type="checkbox"/> Healthcare waste processors <input type="checkbox"/> Manufacture of mercury containing devices (e.g., mirrors, paint, fluorescent lights, batteries, barometers) <input type="checkbox"/> Agriculture (using certain pesticides) <input type="checkbox"/> Other, please specify: <Text entry>

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
F.3. Study population sample size:		<Number entry> Details regarding the sample size: <Text entry>
F.4. Study population sampling strategy:		<input type="checkbox"/> Random <input type="checkbox"/> Not random, please describe the level of representativeness: <Text entry> <input type="checkbox"/> Other, please specify: <Text entry>
F.5. Study population sex:		% male: <Number entry> % female: <Number entry>
F.6. Study population age:	Interval:	Min.: <Number entry> Max.: <Number entry>
	Percentage:	% 0 – 5 years of age: <0-100> % 6 – 11 years of age: <0-100> % 12 – 17 years of age: <0-100> % 18 – 49 years of age: <0-100> % 50 years of age and older: <0-100>
F.7. Characteristics of the samples:*	Sample collection date:	<input type="checkbox"/> Single date: <YYYY-MM-DD> <i>OR</i> <input type="checkbox"/> Period: From <YYYY-MM-DD> To <YYYY-MM-DD>
	Sampled tissue(s):*	<input type="checkbox"/> Whole blood <input type="checkbox"/> Cord blood <input type="checkbox"/> Urine <input type="checkbox"/> Specific Gravity Correction <input type="checkbox"/> Osmolality Correction <input type="checkbox"/> Creatine Correction <input type="checkbox"/> Hair <input type="checkbox"/> Other, please specify: <Text entry>
	Sample digestion / extraction:	<input type="checkbox"/> Direct analysis (no digestion) <input type="checkbox"/> Aqua regia <input type="checkbox"/> Nitric acid <input type="checkbox"/> Hydrochloric acid <input type="checkbox"/> Other, please specify: <Text entry>
F.8. Mercury observations:*	Mercury species:*	<input type="checkbox"/> Total mercury <input type="checkbox"/> Methyl mercury <input type="checkbox"/> Inorganic mercury <input type="checkbox"/> Other, please specify: <Text entry>
	Unit of measurement:*	<input type="checkbox"/> µg/g <input type="checkbox"/> ng/g <input type="checkbox"/> µg/L <input type="checkbox"/> Other, please specify: <Text entry>
	Data reporting:*	<input type="checkbox"/> Dry weight <input type="checkbox"/> Wet weight
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> <i>OR</i> Provide URL: <File name>
	Have the observations been aggregated?*	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, please explain the data aggregation process: <Text entry>
F.9. Ancillary observations:	Mercury isotopes:	<input type="checkbox"/> δ ²⁰² Hg <input type="checkbox"/> δ ¹⁹⁹ Hg <input type="checkbox"/> Other, please specify: <Text entry>
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> <i>OR</i> Provide URL: <File name>

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
F.10.	Additional information: General:	<input type="checkbox"/> Occupational exposure <input type="checkbox"/> Dental amalgam status <input type="checkbox"/> Use of skin-lightening creams <input type="checkbox"/> Use of traditional medicine / homeopathy <input type="checkbox"/> Education <input type="checkbox"/> Socio-economic status <input type="checkbox"/> Indigenous knowledge or local knowledge ³ Please provide details: <Text entry> and/or attach file: <Text entry>
	Dietary habits:	<input type="checkbox"/> Freshwater fish <input type="checkbox"/> Marine fish <input type="checkbox"/> Marine mammal <input type="checkbox"/> Subsistence or recreational fishing <input type="checkbox"/> Commercial purchase <input type="checkbox"/> Rice <input type="checkbox"/> Other, please specify: <Text entry> Please provide details: <Text entry> and/or attach file: <Text entry>
	Dietary survey:	<input type="checkbox"/> Available (please attach) <input type="checkbox"/> Not available
F.11.	Additional information regarding sampling, mercury measurement or ancillary information:	<Text entry>
G. OTHER MATRICES		
G.1. Matrix:*		<input type="checkbox"/> Soil <input type="checkbox"/> Sediment <input type="checkbox"/> Freshwater <input type="checkbox"/> Estuary/brackish water <input type="checkbox"/> Seawater <input type="checkbox"/> Snow <input type="checkbox"/> Geologic <input type="checkbox"/> "Natural archives" ⁴ <input type="checkbox"/> Other, please specify: <Text entry>
G.2. Brief description of the matrix:*		<Text entry – max. 150 words >
G.3. Characteristics of the samples:*	Sample collection date:	<input type="checkbox"/> Single date: <YYYY-MM-DD> <i>OR</i> <input type="checkbox"/> Period: From <YYYY-MM-DD> To <YYYY-MM-DD>
	Sample filtration	<input type="checkbox"/> Yes, please explain: <Text entry> <input type="checkbox"/> No
	Sample digestion / extraction:	<input type="checkbox"/> Direct analysis (no digestion) <input type="checkbox"/> Aqua regia <input type="checkbox"/> Nitric acid <input type="checkbox"/> Hydrochloric acid <input type="checkbox"/> Other, please specify: <Text entry>
G.4. Mercury observations:*	Mercury species:*	<input type="checkbox"/> Total mercury <input type="checkbox"/> Inorganic mercury <input type="checkbox"/> Methyl mercury <input type="checkbox"/> Dimethyl mercury <input type="checkbox"/> Dissolved Gaseous Mercury (DGM) <input type="checkbox"/> Other, please specify: <Text entry>

³ Further information on indigenous knowledge and local knowledge, including similarities and differences, may be found at [Houde et al. \(2022\)](#).

⁴ Measurements from "natural archives", such as peat bogs and tree rings, may be used as a tool to aid the characterization of sites with no background information.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
	Fractions:	<input type="checkbox"/> Reactive Mercury (R-Hg) <input type="checkbox"/> Dissolved <input type="checkbox"/> Suspended <input type="checkbox"/> Extractable <input type="checkbox"/> Recoverable <input type="checkbox"/> Filtered <input type="checkbox"/> Non-filtered <input type="checkbox"/> Integrated
	Unit of measurement:*	<input type="checkbox"/> µg/g (or mg/kg) <input type="checkbox"/> ng/g <input type="checkbox"/> µg/L <input type="checkbox"/> Other, please specify: <Text entry>
	Data reporting:*	<input type="checkbox"/> Dry weight <input type="checkbox"/> Wet weight
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> OR Provide URL: <File name>
	Have the observations been aggregated?*	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, please explain the data aggregation process: <Text entry>
G.5. Ancillary observations:	General information:	<input type="checkbox"/> Landscape/watershed characteristics (e.g., lake and catchment morphology) <input type="checkbox"/> Local data on mercury deposition <input type="checkbox"/> Local pollution history <input type="checkbox"/> Other, please specify: <Text entry>
	Sampling methodology and characteristics of the sampled area:	Please describe: <Text entry>
	Measured parameters:	<input type="checkbox"/> Temperature (value/unit) <input type="checkbox"/> Depth (value/unit) <input type="checkbox"/> pH (value) <input type="checkbox"/> Salinity (value/unit) <input type="checkbox"/> Conductivity (value/unit) <input type="checkbox"/> Dissolved oxygen (value/unit) <input type="checkbox"/> Total organic carbon (value/unit) <input type="checkbox"/> Dissolved organic carbon (value/unit) <input type="checkbox"/> Particle size distribution (sand, clay, etc) <input type="checkbox"/> Total oxidized nitrogen (value/unit) <input type="checkbox"/> Sulfur (species/value/unit) <input type="checkbox"/> Trace elements (species/value/unit) <input type="checkbox"/> Organic pollutants (species/value/unit) <input type="checkbox"/> Other, please specify: <Text entry>
	Measurement values:*	<input type="checkbox"/> Attach file in CSV format: <File name> OR Provide URL: <File name>
G.6. Additional information regarding sampling, mercury measurement or ancillary information:		<Text entry>
H. DETECTION AND QUALITY CONTROL (ALL MATRICES)		
H.1. Detection method:*		<input type="checkbox"/> Cold-vapor atomic fluorescence spectroscopy (CVAFS) <input type="checkbox"/> Cold-vapour atomic absorption spectroscopy (CVAAS) <input type="checkbox"/> Inductively coupled plasma mass spectrometry (ICP-MS) <input type="checkbox"/> Multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS)

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		<input type="checkbox"/> Combustion and CVAAS <input type="checkbox"/> Direct mercury analyser <input type="checkbox"/> Other, please specify: <Text entry>
H.2. Equipment used (e.g., producer and model):		<input type="checkbox"/> Please specify: <Text entry>
H.3. Performance parameters for analytical method validation: ⁵	Sensitivity:*	<input type="checkbox"/> Limit of detection (LOD): <Number entry> <input type="checkbox"/> Limit of Quantification (LOQ): <Number entry> <input type="checkbox"/> Not available
	Analytical or linear range:*	<Text entry> <input type="checkbox"/> Not available
	Trueness / systematic error:*	<Text entry> <input type="checkbox"/> Not available
	Precision / random error:*	<Text entry> <input type="checkbox"/> Not available
	Robustness:*	<Text entry> <input type="checkbox"/> Not available
	Accuracy / measurement uncertainty:*	<input type="checkbox"/> Quantitative estimation of uncertainty (in %): <Number entry> <input type="checkbox"/> Description of accuracy or measurement of uncertainty: <Text entry> <input type="checkbox"/> Not available
	Other:	<Text entry>
	H.4. QA/QC measures:	Quality scheme in place in the laboratory:*
Use of traceable calibration reference standards:*		<input type="checkbox"/> Yes, please explain: <Text entry> <input type="checkbox"/> Not available
Use of matrix-matched (certified) reference material(s):*		<input type="checkbox"/> Yes, please explain: <Text entry> <input type="checkbox"/> Not available
Inter-laboratory comparisons:*		<input type="checkbox"/> Yes, please explain: <Text entry> <input type="checkbox"/> Not available
Duplicate analysis:*		<input type="checkbox"/> Yes, please explain: <Text entry> <input type="checkbox"/> Not available
Matrix spike:*		<input type="checkbox"/> Yes, please explain: <Text entry> <input type="checkbox"/> Not available
Proficiency testing:*		<input type="checkbox"/> Yes, please explain: <Text entry> <input type="checkbox"/> Not available
Other:		<Text entry>
H.5. Methods, manuals or standard operating procedures which were applied:	Sample collection and handling:	<input type="checkbox"/> Please attach method, manual or SOP or indicate publicly available source <Web address> <input type="checkbox"/> Not available
	Sample digestion / extraction:	<input type="checkbox"/> Please attach method, manual or SOP or indicate publicly available source <Web address> <input type="checkbox"/> Not available
	Analytical measurement:	<input type="checkbox"/> Please attach method, manual or SOP or indicate publicly available source <Web address>

⁵ See <https://link.springer.com/article/10.1007/s00769-014-1093-0#ref-CR11> for an explanation on how the terms are being used.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		<input type="checkbox"/> Not available
	Data validation and QA/QC:	<input type="checkbox"/> Please attach method, manual or SOP or indicate publicly available source <Web address> <input type="checkbox"/> Not available
	Data analysis and reporting:	<input type="checkbox"/> Please attach method, manual or SOP or indicate publicly available source <Web address> <input type="checkbox"/> Not available
H.6. Additional information regarding detection methods, validation, QA/QC and standard procedures:		<Text entry>
I. ADDITIONAL INFORMATION (ALL MATRICES)		
I.1. Relevant publications:		Please attach document and/or provide URL or DOI: <Text entry>
I.2. Relevant analytical methods and/or SOPs		Please attach document and/or provide URL or DOI: <Text entry>
I.3. Additional information:		Please attach document and/or provide URL: <Text entry>

492 **Annex 3**493 **Indigenous contributions to global efforts to monitor mercury**494 **Background**

495 1. Indigenous Peoples have the highest mercury levels globally and have been noted by the
 496 Minamata Convention on Mercury as particularly vulnerable (Basu et al. 2022). Therefore,
 497 information about mercury levels in Indigenous Peoples and the ecosystems they depend upon needs
 498 to be highlighted in the monitoring reports. Indigenous Peoples need to be taken into account
 499 separately from national populations since they are often a small part of the population but greatly
 500 exceed national average mercury levels. Therefore, data disaggregation is key in order to make
 501 Indigenous Peoples visible in statistics. Furthermore, Indigenous Peoples have a lot of knowledge
 502 about their ecosystems that needs to be utilized for a holistic understanding of mercury movement in
 503 the environment and processes affecting mercury levels in various media (Houde et al 2022). This
 504 knowledge should be appropriately included and recognized in OESG monitoring reports.

505 **Examples of best practices**

506 2. Examples of equitable partnership approaches between Indigenous Peoples and scientists are
 507 available that produce mercury data and where Indigenous Knowledge is appropriately utilized. This
 508 includes monitoring programs such as the Northern Contaminants Program (NCP) in Canada, such as
 509 the beluga monitoring in the Inuvialuit Settlement Region (ISR), and many others (Houde et al. 2022).
 510 Several additional examples for the Arctic are provided in Chapter 9 of the Mercury Assessment of the
 511 Arctic Monitoring and Assessment Programme (AMAP, available at www.amap.no). There are also
 512 some peer reviewed publications on mercury concentrations available that can be used for OESG
 513 reports, and on how Indigenous Peoples should be engaged (preliminary list added below). These
 514 publications should be taken in consideration to well-inform the first round of the effectiveness
 515 evaluation. In several cases these are non-government publications. Gaps that are identified need to be
 516 outlined in the first round and addressed in the following rounds.

517 **Knowledge and capacity gaps**

518 3. Many countries in the southern hemisphere are currently lacking satisfactory mercury
 519 monitoring activities, particularly those that work with Indigenous Peoples on a partnership approach.
 520 Such an approach would be of particular importance in countries/regions with ASGM activities, with
 521 emphasis on the Amazon. While observing particularities within each region, it is recommended to use
 522 existing examples such as the NCP in Canada to help build capacity in other regions in order to
 523 support mercury monitoring which is carried out with Indigenous Peoples, in an equitable and ethical
 524 way.

525 4. In many cases scientists may not be aware of proper procedures on how to work with
 526 Indigenous Peoples. Therefore, the following points need to be taken into account with regards to
 527 ethical and equitable engagement of Indigenous Peoples in monitoring efforts:

528 (a) Free, prior and informed consent, a basic human right, is needed. Indigenous Peoples
 529 need to be aware of and support the project.

530 (b) Scientists need to educate themselves about realities of Indigenous Peoples and their
 531 territories in the region they want to work in, apply for any authorization or licences that are needed to
 532 be obtained for research, follow research guidance/protocols that the particular region/community may
 533 have in place, build contacts and trust. The right contacts need to be established to ensure that proper
 534 representation of Indigenous Peoples is included in any decision making. The legal status and
 535 legitimate Indigenous representation and its forms of self-government has to be acknowledged and
 536 followed.

537 (c) Research needs to be of value for the Indigenous Peoples who are part of the research.

538 (d) Time is needed to build trust before the project is started. It is important to respect
 539 Indigenous Peoples' own time in decision-making, in the whole process.

540 (e) The project needs to be developed with the effective participation of Indigenous
 541 Peoples from the very beginning (pre-proposal stage) and throughout all stages of the project.
 542 Communication needs to be continuous throughout the project. Indigenous Peoples need to be part of
 543 decision making on all levels: where, what, and when to sample (and what happens to leftovers from

544 sampling matrices), results analysis, determining what kind of communication products are created,
545 when and how communication is done. Any publications are to be discussed with the involved
546 Indigenous Peoples first.

547 (f) Capacity sharing is crucial. Indigenous Peoples need to be recognized for the
548 knowledge they hold and contribute. They need to be appropriately compensated for their
549 participation, and at the same level that scientists are compensated for their work.

550 **Literature**

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Annex II***“Plan for the summary of available emissions and releases data”
to inform the Effectiveness Evaluation of the Minamata Convention***Draft (14 August 2023)***Table of Contents**

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* This present annex has not been formally edited.

1 **Executive summary**

2 The purpose of the “Plan for the summary of available emissions and releases data” (hereafter “emissions and releases
3 data plan”) is to structure and guide the process for the collection, management and compilation of data on the
4 emissions and releases of mercury and mercury compounds to the environment, in support of the first effectiveness
5 evaluation of the Minamata Convention.

6 The work of the Open-Ended Scientific Group (OESG) to inform the first effectiveness evaluation will focus on
7 existing sources of emissions and releases data while an analysis of gaps related to those data, including potential
8 scientific actions to address the identified gaps, will be included in the scientific report of the OESG.

9 Available emissions and releases data will support the effectiveness evaluation in multiple ways through two sets of
10 tasks that will proceed mostly in parallel. One set of tasks will look into whether and to what extent the actions taken
11 to implement the Minamata Convention resulted in changes in mercury emissions and releases. This plan is intended
12 primarily to provide a structure and a process on which to build a summary of available emissions and releases data
13 over the period beginning prior to the Convention (circa 2010) and extending to as close as possible to the present to
14 support this first set of tasks.

15 A second set of tasks involves the use of emissions and releases data to examine whether and to what extent the
16 changes in emissions and releases resulted in changes in levels of mercury in the environment, biotic media and
17 vulnerable populations. How emissions and releases data will be used in such analyses will be addressed in the
18 separate forthcoming “data analysis plan”.

19 The compilation and comparison of available data for emissions and releases from anthropogenic sources is the main
20 focus of this plan. For purposes of the effectiveness evaluation, sources that are specifically addressed by articles of
21 the Convention (including Articles 4, 5, 7, 8 and 9) are to be distinguished from the sources that are not addressed by
22 the Convention. The OESG will also consider the influence of natural and legacy emissions and releases based on
23 available information in the forthcoming analysis plan.

24 Sources of available emissions and releases data include:

- 25 • National reports under Article 21 of the Convention
- 26 • National action plans for artisanal and small-scale gold mining
- 27 • Minamata Initial Assessment (MIA) reports
- 28 • Pollutant Release and Transfer Registries (PRTR)
- 29 • Emissions database under the Convention on Long-Range Transboundary Air Pollution
- 30 • National emissions and releases inventories
- 31 • Scientific assessments and research literature

32 Based on an initial review of these data sources, a draft format to facilitate the data comparison will be developed.
33 This data format and an initial list of available datasets collected will be circulated to Parties and other data providers
34 along with an invitation to submit additional datasets for consideration by the OESG. The emissions and releases data
35 including the available data from the initial list of sources and the submission by parties and other data providers will
36 be stored in open-source databases on a data server that will be accessible to the OESG and experts in the roster. The
37 original sources of all data used by the OESG will be duly acknowledged in the OESG outputs. Data providers or
38 copyright holders will retain the ownership and rights over their data.

39 Based on this dataset, the OESG will develop an emissions and data summary that describes the following:

- 40 • Summary of available emissions and releases data for the period circa 2010 to present, with consideration of
41 their comparability
- 42 • Challenges in obtaining the data
- 43 • Perceived data gaps within and across data sets
- 44 • Potential for supplemental data to be added to the existing information, and
- 45 • Data inconsistencies and the work needed to resolve these for future effectiveness evaluation

46 **Acknowledgements**

47 This document would not have been possible without the commitment and contribution of the OESG members and the
48 experts in the roster, particularly the Leads and participants of the “small groups” on emissions and releases, who
49 have volunteered much of their time to drafting and reviewing this plan. The lists of OESG members and roster of
50 experts who are supporting the OESG are available through the Convention’s [website](#).

51 The OESG co-Chairs shared a vision and provided guidance on how to translate decision MC-4/11 and the OESG
52 terms of reference into action. Support to the OESG and its co-Chairs was provided by Secretariat.

53 Parties and organizations who have nominated and allowed experts to participate in this process have also played an
54 important supportive role by enabling their nominees to dedicate time to tasks that often go beyond their duty of
55 service. Parties are also acknowledged for having allocated sufficient funds to enable the OESG to meet face-to-face
56 during the intersessional period with participation of OESG members from all regions.

57 List of Abbreviations

58	AMAP	Arctic Monitoring and Assessment Programme
59	ASGM	Artisanal and Small-Scale Gold Mining
60	COP	Conference of Parties
61	DOI	Digital Object Identifier
62	EDGAR	Emissions Database for Global Atmospheric Research
63	EEG	Effectiveness Evaluation Group
64	GMA	Global Mercury Assessments
65	FAIR	Findable, accessible, interoperable, reusable
66	LRTAP	Long-Range Transboundary Air Pollution
67	MIA	Minamata Initial Assessment
68	OESG	Open-Ended Science Group
69	PRTR	Pollutant Release and Transfer Register
70	UNECE	UN Economic Commission for Europe
71	UNEP	United Nations Environment Programme

72 1. Introduction: Objective and scope

73 The purpose of the “Plan for Emissions and Releases Data Summary” (hereafter “emissions and
74 releases data plan”) is to structure and guide the process for the collection, management and
75 compilation of data on the emissions and releases of mercury and mercury compounds to the
76 environment, in support of the first effectiveness evaluation of the Minamata Convention. The
77 emissions and releases data plan includes considerations on:

- 78 (a) How available emissions and releases data will be sought and collected from Parties
79 and other relevant stakeholders
- 80 (b) How data will be submitted, managed, and made available to the Open-Ended Science
81 Group (OESG) for further analysis
- 82 (c) Roles and responsibilities of different players to execute specific tasks
- 83 (d) Schedule for the identified tasks

84 This plan is one of three plans that are being developed by the OESG to contribute to a scientific
85 report to inform the first effectiveness evaluation of the Minamata Convention per decision MC-4/11.
86 The other two plans will address (1) the collection, management, and compilation of available data on
87 observed levels of mercury in air, biota, humans and other matrices, and (2) the analysis of the trends
88 and patterns in the emissions, releases, and observation data, based on the guiding questions laid out in
89 the monitoring guidance (UNEP/MC/COP.4/INF/12). The emissions and releases data plan may need
90 to be revisited and adapted as progress is made and experience is gained through the collection of
91 emissions and releases data and planning for data analysis, as well as to account for feedback provided
92 by the EEG.

93 2. Background

94 2.1 Framework for the first effectiveness evaluation of the Minamata Convention

95 Article 22 of the Minamata Convention states that the Conference of the Parties (COP) will evaluate
96 the effectiveness of the Convention, beginning no later than six years after the Convention’s entry into
97 force and periodically thereafter at intervals to be decided by the COP.¹ The effectiveness evaluation
98 is to be conducted on the basis of, among other things, available information on the presence and
99 movement of mercury and mercury compounds in the environment, as well as trends in levels of
100 mercury and mercury compounds observed in biotic media and vulnerable populations.

101 The need for an effectiveness evaluation framework that included a strategic, cost-effective approach
102 to provide appropriate and sufficient data was recognized by the COP at its first meeting and further
103 discussed at its second meeting. At its third meeting, the COP considered the report of the ad hoc
104 technical expert group for effectiveness evaluation, which included a description of a proposed
105 effectiveness evaluation framework, as well as the following policy questions aimed at supporting an
106 assessment of whether the control measures, as implemented, would lead to the achievement of the
107 Convention’s objective:

- 108 (a) Have the Parties taken actions to implement the Minamata Convention?
- 109 (b) Have the actions taken resulted in changes in mercury supply, use, emissions and
110 releases into the environment?
- 111 (c) Have those changes resulted in changes in levels of mercury in the environment, biotic
112 media and vulnerable populations that can be attributed to the Minamata Convention?
- 113 (d) To what extent are existing measures under the Minamata Convention meeting the
114 objective of protecting human health and the environment from mercury?

115 The report of the ad hoc technical expert group also contained technical information on monitoring
116 and a proposal on monitoring arrangements pursuant to article 22; proposed reports to be used to
117 formulate findings/recommendations for the consideration of the COP; and a set of indicators
118 developed based on an article-by-article review for assessing progress and impact of the measures. In
119 decision MC-3/10, the COP continued the preparation for the first effectiveness evaluation by
120 requesting the drafting of guidance on monitoring and a report on trade, supply and demand of
121 mercury and mercury compounds and by inviting further discussion of effectiveness indicators.

¹ The Minamata Convention entered into force on 16 August 2017.

122 At its fourth meeting, in decision MC-4/11, the COP agreed to begin the first effectiveness evaluation
123 of the Convention. In the same decision, the COP adopted a framework for the first effectiveness
124 evaluation as reproduced in Figure 1 and established the OESG. In accordance with its terms of
125 reference outlined in annex II to the decision, the OESG shall work in two stages to develop a
126 scientific report for consideration by the EEG. The OESG report shall be composed of the following
127 elements:

128 *Stage 1:*

- 129 (i) Plan for the Monitoring Data Compilation and Summary
130 (ii) Plan for the summary of available emissions and releases data (*this document*)
131 (iii) Plan for Data Analysis consistent with the Monitoring Guidance²

132 *Stage 2:*

- 133 (i) Monitoring Data Compilation and Summary
134 (ii) Emissions and Releases Data Summary
135 (iii) Data Analysis addressing the guiding questions outlined in the Monitoring Guidance

136 Furthermore, the OESG shall provide an analysis of data gaps, including the identification of existing
137 gaps as well as potential scientific actions to address identified gaps in information and knowledge
138 related to monitoring, and lessons learned to be submitted to the Effectiveness Evaluation Group.

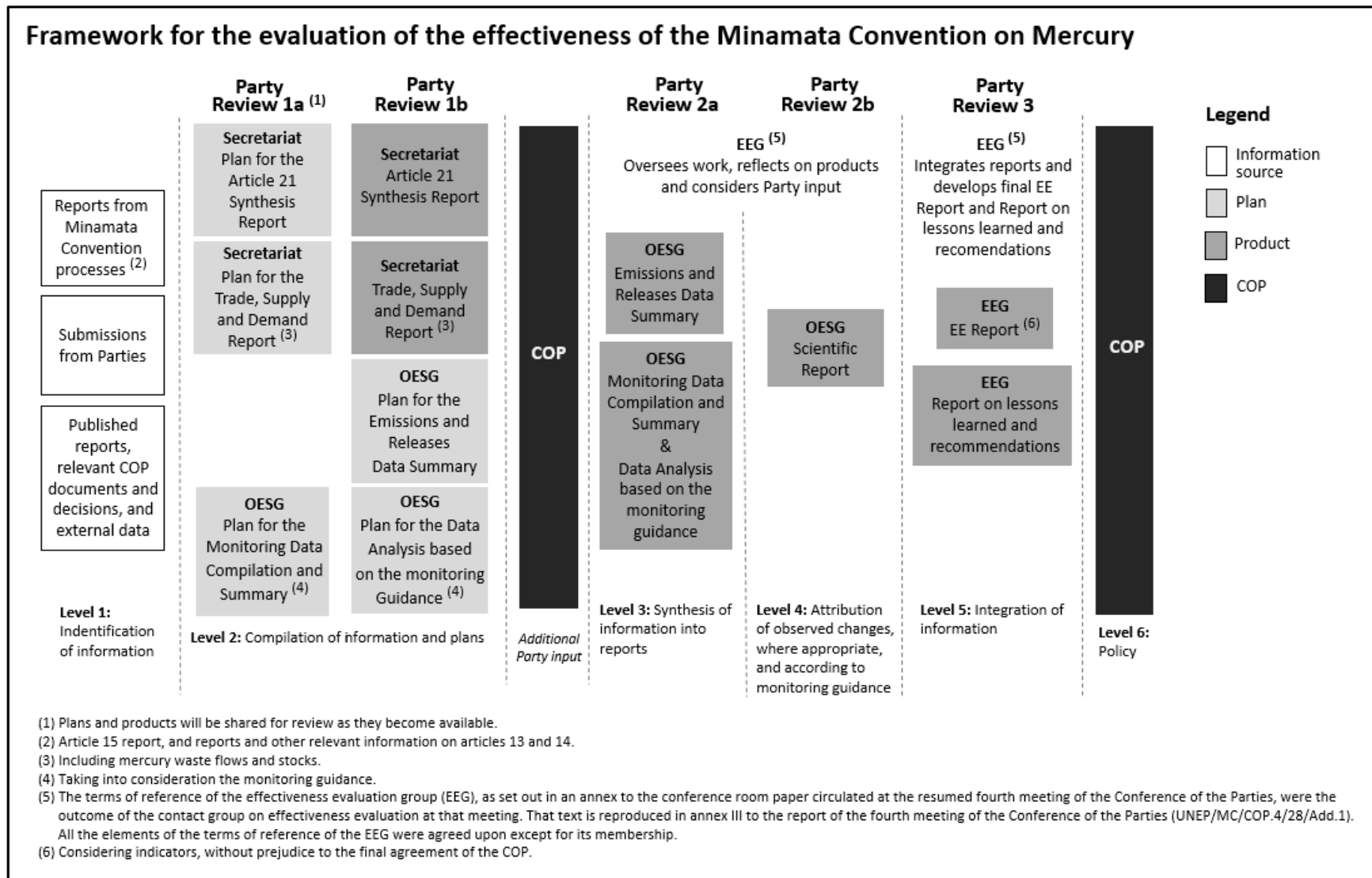
139 The process laid out in the OESG terms of reference also foresees support by the secretariat,
140 contribution of a roster of scientific and technical experts, input from different stakeholder groups,
141 various rounds of review by Parties, and face-to-face meetings of the OESG, including one meeting
142 during the current intersessional period.

143 To achieve its expected outputs, the OESG will assess the data and coordinate the analysis to be
144 included in the scientific report, taking into consideration the monitoring guidance and its guiding
145 questions,³ as well as differences in scientific capacities, national circumstances, environmental
146 conditions and demographic characteristics across parties and regions. The expected outputs of the
147 OESG and the framework for the first effectiveness evaluation of the Convention, as adopted in
148 decision MC-4/11, are shown in Figure 1 below. The first effectiveness evaluation will also be
149 informed by other sources of information, including a set of indicators, a synthesis of national reports
150 submitted under article 21, and a report on trade, supply and demand of mercury and mercury
151 compounds.

² The “Monitoring Guidance” referenced in decision MC-4/11 is the “Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention” available as document [UNEP/MC/COP.4/18/Add.2](#).

³ As set out in documents [UNEP/MC/COP.4/18/Add.2](#) and [UNEP/MC/COP.4/INF/12](#).

Figure 1. Annex I to decision MC-4/11 on the framework for the effectiveness evaluation.

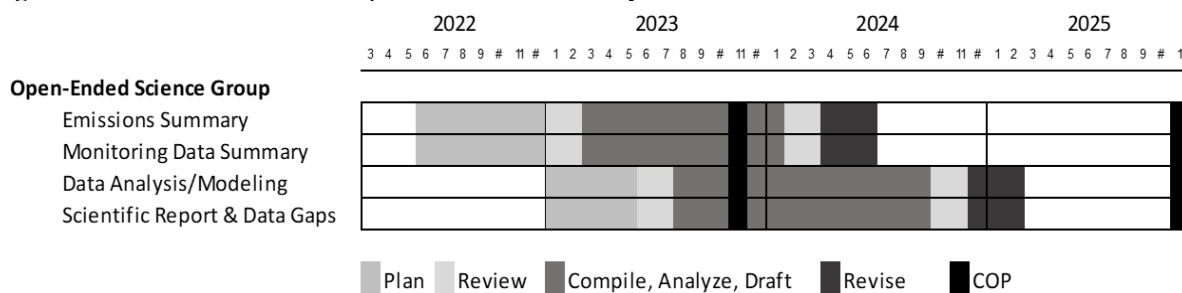


153 Based on the framework for the effectiveness evaluation that was adopted in decision MC-4/11
 154 (Figure 1), the OESG has been working under the assumption that the first effectiveness evaluation
 155 would be completed by the sixth meeting of the COP, which is expected in 2025.¹

156 In accordance with the adopted framework, the OESG's scientific report must be completed in time
 157 for consideration by the EEG, whose terms of reference are expected to be agreed upon at COP-5 in
 158 2023. Thus, the majority of the OESG's work (including data collection, analysis, report writing, as
 159 well as the associated opportunities for review by Parties) must be completed in 2023 and 2024. A
 160 draft schedule for the process is shown in Figure 2. It must be emphasized that in order to achieve its
 161 expected outcomes under the assumption that the first effectiveness evaluation will end at COP-6, the
 162 draft schedule as shown below is very ambitious, particularly because a significant amount of time
 163 will be needed for collecting existing monitoring data from multiple data providers, which will require
 164 entering data use agreements with each data provider, before data analysis can begin. With the current
 165 draft schedule, it is possible that only part of the available emissions and releases data will have been
 166 collected and harmonized in time to be analysed by the OESG.

167 Moreover, the time available to gather and analyse the available scientific information is very limited,
 168 especially given that: this is the first effectiveness evaluation for the Convention; the necessary data
 169 management infrastructure does not yet exist; there are limited financial resources available from the
 170 Convention to fund the work; and multiple opportunities for review by Parties have been built into the
 171 process to improve transparency, credibility and ownership. Therefore, the approach proposed by the
 172 OESG is to provide the EEG, and subsequently the COP, the best information possible within the
 173 limited time and resources available and to outline how the scientific basis of effectiveness evaluation
 174 could be improved in future evaluation cycles.

175 **Figure 1:** A draft schedule for completion of OESG tasks by COP-6.



176 2.2. The Roles of Emissions and Releases Data in the Effectiveness Evaluation

177 Available emissions and releases data will support the effectiveness evaluation in multiple ways
 178 through two sets of tasks that will proceed mostly in parallel. One set of tasks will focus on addressing
 179 question (ii) of the four policy questions identified for the effectiveness evaluation: *"Have the actions*
 180 *taken [to implement the Minamata Convention] resulted in changes in mercury supply, use, emissions*
 181 *and releases to the environment?"* To address this policy question, the OESG intends to compile and
 182 compare available emissions and releases data for the period beginning prior to the Convention (circa
 183 2010) and extending to as close as possible to the present. The OESG will also compile and compare
 184 available projections of future emissions. The compiled data will be used to address a number of
 185 analysis questions, which may include:

- 186 • How have mercury emissions and releases addressed by the Convention changed over time?
 187 How are they expected to change in the future? How do the measures taken to implement the
 188 Minamata Convention affect the emissions and releases?
- 189 • How have mercury emissions and releases from human activities that are not addressed by
 190 the Convention changed over time? How are they expected to change in the future?
- 191 • How have emissions and releases from natural sources changed?
- 192 • How do uncertainties, spatial patterns, and temporal trends compare across source categories?
- 193 • What improvements in emissions and releases data are most needed to better understand the
 194 impact of the Convention?

¹ Pending further consideration by the COP, at its fifth meeting, of the timeline for the first effectiveness evaluation.

195 This plan is intended primarily to provide a structure and a process on which to build a summary of
196 available emissions and releases data, as well as their drivers, to address these types of questions.

197 A second set of tasks involves the use of emissions and releases data to help address question (iii) of
198 the four policy questions for the effectiveness evaluation: *“Have the changes in emissions and*
199 *releases resulted in changes in levels of mercury in the environment, biotic media and vulnerable*
200 *populations and can these changes be attributed to the Minamata Convention?”* This question can
201 only be answered by using both emissions and releases data and observational data in quantitative
202 models that account for the various physical, chemical, and biological processes involved in the fate,
203 transport, and cycling of mercury in the environment. How emissions and releases data will be used in
204 such analyses will be addressed in the separate forthcoming analysis plan and not in this document.
205 However, the current plan includes the collection and compilation of relevant parameters that are
206 needed to use emissions and releases information in such analyses, including source location
207 information (geo-referencing), chemical speciation, emission or release characteristics (e.g., stack
208 heights), where this information is available.

209 3. Overview of Sources of Emissions and Releases

210 The Convention addresses emissions of mercury and its compounds to the atmosphere and their
211 releases to land and water. Emissions and releases from relevant point sources are addressed in
212 Articles 8 and 9, respectively, and other articles, such as Articles 4 (mercury-added products), 5
213 (manufacturing processes) and 7 (artisanal and small-scale gold mining) also mention the control of
214 emissions and releases. Throughout this plan, the terms “emission” and “release” are used accordingly.
215 The first Global Mercury Assessment (UNEP 2002) grouped mercury emissions and releases into
216 several main categories:

- 217 • Natural sources associated with the mobilization of naturally occurring mercury from the Earth's
218 crust through natural processes, such as volcanic and geothermal activity and physical and
219 chemical weathering of rocks;
- 220 • Current anthropogenic sources due to either
 - 221 ○ the mobilization of mercury impurities in raw materials, such as fossil fuels and other
222 extracted, treated and recycled minerals, or
 - 223 ○ the intentional use of mercury in products and processes, and emitted or released
224 during manufacturing, use (including breakage), and disposal or incineration of spent
225 products;
- 226 • Re-mobilization of historic anthropogenic mercury emissions and releases deposited in previous
227 years in soils, sediments, water bodies (including oceans), landfills, waste/tailings piles, and
228 vegetation. These are referred to here as legacy emissions or releases.

229 Current anthropogenic sources may be divided into more specific sector and process categories, as
230 shown in Table 1. For purposes of the Convention’s effectiveness evaluation, these specific sector and
231 process categories can be re-grouped into (a) sources that are specifically addressed by articles of the
232 Convention and (b) sources that are not. Table 1 compares sector and process specific categories used
233 in several available guidance documents and published data sets. Methodologies used to estimate
234 emissions and releases from these anthropogenic source categories, as well as primary data sources,
235 are described further in Annex 2.

236 Note that anthropogenic releases to land and water include discharge over soil or to a waterbody
237 (including through sewage system), infiltration to underground water and spreading or depositing onto
238 land, and that they are to be distinguished from the disposal of waste in engineered landfill sites.
239 Releases can occur at any stage of the lifecycle of mercury and its compounds, including during
240 supply, trade, application for extraction of metals, storage, or management of landfills and
241 contaminated sites.

242 The compilation and comparison of available data for emissions and releases from anthropogenic
243 sources is the main focus of this emissions and releases data plan.

244 Natural emissions and releases from volcanoes and geothermal fields and from the chemical and
245 physical weathering of geological deposits have been estimated in the scientific literature. Legacy
246 emissions and releases of mercury originally mobilized by anthropogenic sources and deposited in
247 previous years may be re-emitted from the ocean, soils, and vegetation, through a variety of processes,
248 including by wildfires. These legacy emissions depend on current conditions as well as the history of
249 deposition and accumulation. They are best estimated through modelling of these physical processes,

250 informed by observations. It will be necessary to consider trends in natural and legacy emissions and
 251 releases to understand trends and spatial patterns in environmental observations and separate the
 252 influence of the Convention from the influence of other drivers of environmental change. The OESG
 253 will consider the influence of natural and legacy emissions and releases based on available information
 254 in the forthcoming analysis plan.

255 **Table 1: Anthropogenic Sources of Mercury Emissions and Releases²**

Source and Process Categories		Convention provisions³
Extraction and use of fuels/energy sources		
	Coal combustion in power plants	Article 8, Annex D
	Coal combustion in coal fired industrial boilers	Article 8, Annex D
	Other coal use	
	Coal mining	
	Mineral oils - extraction, refining and use	
	Natural gas - extraction, refining and use	
	Other fossil fuels - extraction and use	
	Biomass fired power and heat production	
	Geothermal power production	
Primary (virgin) metal production		
	Mercury (primary) extraction and initial processing	
	Gold (and silver) extraction with mercury amalgamation processes	Article 7, Annex C
	Zinc extraction and initial processing	Article 8, Annex D
	Copper extraction and initial processing	Article 8, Annex D
	Lead extraction and initial processing	Article 8, Annex D
	Gold extraction and initial processing by methods other than mercury amalgamation	Article 8, Annex D
	Aluminium extraction and initial processing	
	Other non-ferrous metals - extraction and processing	
	Primary ferrous metal production	
Production of other minerals and materials with mercury impurities		
	Cement clinker production	Article 8, Annex D
	Pulp and paper production	
	Production of lime and light weight aggregates	
Intentional use of mercury in industrial processes		
	Chlor-alkali production with mercury-technology	Article 5, Annex B 5
	Vinyl chloride monomer production with mercury catalyst	Article 5, Annex B
	Acetaldehyde production with mercury catalyst	Article 5, Annex B
	Other production of chemicals and polymers with mercury	Article 5, Annex B
Consumer products with intentional use of mercury		
	Thermometers with mercury	
	Electrical switches and relays with mercury	
	Light sources with mercury	
	Batteries with mercury	
	Polyurethane with mercury catalysts	
	Biocides and pesticides with mercury	
	Paints with mercury	

² The description of the source categories is based on the UNEP Toolkit for Identification and quantification of Mercury Releases. A more detailed table including the comparison of source categories is included in Annex 1.

³ This column refers to the articles that specifically mention the emissions and releases from specific sources. Article 9 does not specify release source categories and therefore is not included in the column. Measures taken under other articles may also address emissions and releases from specific sources.

Source and Process Categories		Convention provisions ³
	Pharmaceuticals for human and veterinary uses	
	Cosmetics and related products with mercury	
Other intentional product/process use		
	Dental mercury-amalgam fillings	
	Manometers and gauges with mercury	
	Laboratory chemicals and equipment with mercury	
	Mercury metal use in religious rituals and folklore medicine	
	Miscellaneous product uses, mercury metal uses, and other sources	
Production of recycled metals ("secondary" metal production)		
	Production of recycled mercury ("secondary production")	
	Production of recycled ferrous metals (iron and steel)	
	Production of other recycled metals	
Waste incineration		
	Incineration of municipal/general waste	Article 8, Annex D
	Incineration of hazardous waste	Article 8, Annex D
	Incineration of medical waste	Article 8, Annex D
	Sewage sludge incineration	Article 8, Annex D
	Informal waste burning	
Waste deposition/landfilling and waste water treatment		
	Controlled landfills/deposits	
	Diffuse disposal under some control	
	Informal local disposal of industrial production waste	
	Informal dumping of general waste	
	Waste water system/treatment	
Crematoria and cemeteries		
	Crematoria/cremation	
	Cemeteries	
Others		

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4. Overview of Data Available for Effectiveness Evaluation

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While a number of recommended guidelines exist, the Convention does not yet have an agreed set of guidelines for uniform emissions and releases estimation and reporting covering all the major sources. Therefore, the data to inform the effectiveness evaluation will have to be drawn from a diverse set of data sources. This section will provide an overarching description of the data sources and methodologies that will be used to gather information and compile estimates of emissions and releases.

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4.1. Article 21 National Reports

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Under the Minamata Convention, Parties have an obligation to develop emissions and releases inventories for sources specifically addressed in Articles 8 and 9 of the Convention and to provide information about the availability of these inventories in their national reports under Article 21. Article 8 addresses mercury emissions to air from five categories of point sources listed in Annex D of the Convention: coal-fired power plants, coal-fired industrial boilers, non-ferrous metals production, cement production, and waste incineration. Article 9 requires Parties to identify significant anthropogenic point sources of release to land and water that are not addressed in other provisions of the Convention. Parties are asked to identify relevant point sources no later than three years after the entry into force of the Convention and to continue to update their point source database on regular basis. Only some Parties have identified relevant point sources under Article 9.

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Parties are obligated to establish inventories under Articles 8 and 9 no later than five years after entry into force of the Convention. However, the first full reporting period under Article 21 is for information up to 31 December 2020, before the Convention has been in force for five years. Thus, the

276 emissions and releases information was provided by a limited number of Parties in the first full
277 reporting cycle, which includes data from:

- 278 • Pollutant Release and Transfer Registries (PRTR)
- 279 • The UNECE Air Convention emissions database
- 280 • Minamata Initial Assessment (MIA) reports
- 281 • National Inventories developed for reporting to the Minamata Convention or other national
282 purposes

283 These different data sources are discussed further in separate sub-sections below.

284 Article 21 national reports are also expected to contain information that can contribute to the
285 estimation of emissions and releases, including information about

- 286 • the supply of mercury (Article 3), including the amount of primary mining and identified
287 stocks;
- 288 • mercury-added products (Article 4), including the impact of measures to phase out the
289 manufacture, import, or export of such products;
- 290 • manufacturing processes using mercury (Article 5), including the amount of mercury used
291 and abatement measures implemented for production of acetaldehyde, chlor-alkali, vinyl
292 chloride monomer, sodium or potassium methylate or ethylate, and polyurethane production;
- 293 • waste management (Article 11), including the mass of waste consisting of mercury or
294 mercury compounds that has been subject to final disposal; and
- 295 • contaminated sites (Article 12), including the development of strategies for identifying,
296 assessing, managing, and remediating contaminated sites.

297 **4.2. ASGM National Action Plans**

298 Article 7 addresses artisanal and small-scale gold mining (ASGM), considered to be the largest source
299 of mercury emissions and releases. Parties with more than insignificant ASGM activity are obligated
300 to develop and implement National Action Plans to reduce and where feasible eliminate, the use,
301 emissions, and releases of mercury in ASGM. These National Action Plans are to be updated every
302 three years and contain estimates of the use, emissions, and releases of mercury and the location of
303 ASGM activities.

304 **4.3. Minamata Initial Assessments**

305 As of January 2023, 69 countries have developed and submitted Minamata Initial Assessments (MIAs)
306 to support the ratification and implementation of the Convention. Most MIAs used the “UNEP Toolkit
307 for Identification and quantification of Mercury Releases,” which provides guidance on developing
308 quantitative estimates of emissions and releases from all the sectors addressed by the Convention as
309 well as other sectors. The toolkit is based on a mass-flow principle: mercury contained in fuel and
310 material inputs to a process should equal the mercury that is output from the process as a product or as
311 an emission or release to the environment. The toolkit contains recommended factors for initial (level
312 1) estimates of mercury emissions and releases based on the amount of raw materials and fuels
313 consumed or products produced (activity data), mitigation technologies employed, or more detailed
314 estimates (level 2) incorporating additional information and enabling the use of local estimation
315 factors about the fuel content of mercury or specific process and mitigation technologies employed.
316 MIAs that have been developed provide annual estimates for different years ranging from 2016 to
317 2021. The activity data underlying these estimates is from the most recent data available for each
318 Party, which may be from years before 2016. UNEP and the Biodiversity Research Institute have
319 conducted an analysis of available MIA inventories.⁴

320 **4.4. Pollutant Release and Transfer Registers**

321 Pollutant Release and Transfer Registers (PRTRs) are databases of emissions, releases, and transfers
322 of pollutants or wastes from large point sources, some of which also cover diffuse sources. Such
323 databases have been created at the national or regional (e.g., European) scale. The databases cover

⁴ [https://public.tableau.com/app/profile/mark.burton.bri/viz/MIAMercuryInventoryDashboard/
Main_Dashboard?publish=yes](https://public.tableau.com/app/profile/mark.burton.bri/viz/MIAMercuryInventoryDashboard/Main_Dashboard?publish=yes).

324 many pollutants, including mercury, and many types of industrial facilities, typically including those
 325 identified in Article 8 and Annex D of the Convention. Annual data is typically reported by facilities
 326 on an annual or multi-year cycle (e.g., every 3 years). The source categories reported do not
 327 necessarily correspond to those used by the Convention or other inventory developers. The size of
 328 facilities covered varies by national or regional program. Locations may be reported for the facility
 329 itself, or may be reported for a corporate office, depending on the program requirements. Reported
 330 data may be estimated under optimal conditions and may underestimate the actual emissions or
 331 releases.

332 **4.5. UNECE Air Convention Emissions Reporting**

333 The 1979 Convention on Long-Range Transboundary Air Pollution (LRTAP), also known as the
 334 UNECE Air Convention, includes obligations related to mercury air emissions under its 1998 Protocol
 335 on Heavy Metals. The Convention is organized under the UN Economic Commission for Europe and
 336 involves 51 Parties from Europe, North America, and Central Asia. The Convention requires annual
 337 emissions reporting for a variety of pollutants including mercury. Reports are compiled in a database
 338 maintained by the Center for Emissions Inventories and Projections hosted by UBA Austria.⁵
 339 Emissions are estimated based on tiered guidance in the EMEP-EEA air pollutant emissions inventory
 340 guidebook and emission factor database.⁶ Estimates are reported in accordance with “Guidelines for
 341 reporting emissions and projections data under the Convention.” Recent data use the 2014 version of
 342 the reporting guidelines, which were recently updated for application starting in 2024.⁷

343 **4.6. National Emissions (and Releases) Inventories**

344 In addition to national PRTRs mentioned earlier, a number of Parties maintain comprehensive national
 345 inventories of air emissions that address sources of mercury. Parties may also maintain inventories of
 346 mercury releases to land and water, or develop detailed national mass-flow analysis that quantitatively
 347 assesses the mercury flow through society and environmental media. These inventories are typically
 348 annual estimates that are developed on an annual or multi-year cycle (e.g., every 3-5 years).

349 **4.7. Scientific Assessments and Research Literature**

350 In addition to emissions and releases estimates produced by Parties, there are estimates of mercury
 351 emissions and releases in the published scientific literature, including in the periodic Global Mercury
 352 Assessments (GMA) produced from 2002-2018 (UNEP 2002, 2008, 2013, 2018).

353 At the global scale, there are four groups of mercury emissions inventories:

- 354 (a) Arctic Monitoring and Assessment Programme/UNEP Global Mercury Assessment
 355 (AMAP/GMA) (Pacyna and Pacyna 2002; Pacyna et al. 2006; AMAP/UNEP 2008, 2013, 2019;
 356 Steenhuisen and Wilson, 2015, 2019)
- 357 (b) Emissions Database for Global Atmospheric Research (EDGAR) (Muntean et al. 2014,
 358 2018)
- 359 (c) Streets et al. (2011, 2019a, 2019a, 2019b, 2019c)
- 360 (d) WHET (Zhang et al 2016), which evolved from Streets et al. incorporating additional
 361 data developed at the national and regional level, particularly for China

362 In general, the AMAP/GMA inventories were produced to provide the best estimate of annual
 363 emissions in a given year. Group (a) includes estimates for annual emissions in five-year increments
 364 from 1990 to 2015. However, the estimation methodologies applied to each annual period evolved
 365 through different assessment cycles with increasing levels of detail incorporated into more recent
 366 inventories. Thus, the estimates from before 2010 are not directly comparable to the estimates after
 367 2010. In contrast, each version of the EDGAR emissions (group (b)) is intended to be a consistent time
 368 series going back to 1970. Each new version updates the whole time series. The Streets et al.
 369 inventories (group (c)) include estimates for the period 2000-2015, that have been estimated in a
 370 manner consistent with estimates at ten-year intervals going back to 1510. However, the estimates are
 371 based on activity data and technology assumptions at the regional level, not the country level. The

⁵ <https://www.ceip.at>.

⁶ <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019>.

⁷ <https://www.ceip.at/reporting-instructions>.

372 WHET inventory (group (d)) includes annual emissions for 1990, 2000, and 2010, driven by a mix of
373 regional and country level data.

374 Global totals and maps of emissions can be compared across these groups. However, comparing the
375 estimates for individual countries (or regions) by source category is challenging, as the source
376 categories included and their definitions vary between the different families. Within a particular source
377 category, differences in the activity levels, the distribution of different technologies and fuel types
378 within a sector, and the effect of different process and control technologies on mercury emissions
379 assumed in the inventories all can contribute to significant differences in the estimated emissions for
380 particular source category in a single country over a single year.

381 In addition to these global inventories, there are numerous articles in the literature estimating mercury
382 emissions for a single country or region or for a specific source category.

383 **5. Considerations for Comparing and Compiling Available** 384 **Emissions and Releases Estimates**

385 The Effectiveness Evaluation of the Convention will require emissions and releases data that is
386 comparable and credible. The following describes some considerations for comparing emissions and
387 release data.

388 **5.1. Data elements**

389 The elements of emissions and releases data to be collected include the following. It should be noted
390 that these elements may not be available for all the data sets. A format for collecting these data in a
391 comparable manner will be developed.

- 392 • Quantity of emissions and releases (with units)
- 393 • Source Categories
- 394 • Methodology
- 395 • Activity data
- 396 • Emission/release/distribution factors or parameters related to those factors
- 397 • Location/Spatial Information
- 398 • Temporal Information
- 399 • Chemical Speciation of Emitted or Released Mercury

400 **5.2. Transparency**

401 Full transparency regarding the methods, data and assumptions used in generating any given emissions
402 and release estimate is key to ensuring that the estimate can be used in an appropriate way. Therefore,
403 compilations and comparisons should strive to make available as much information as possible about
404 the underlying sources of data, assumptions, and methods applied in the original estimates and in the
405 process of comparison.

406 **5.3. Uncertainties**

407 Ideally, all estimates would be accompanied by an associated measure of their uncertainty. For an
408 individual estimate, this may involve a calculation recognizing, e.g., the range of mercury content in a
409 fuel or raw material, the accuracy of measurements, or assumptions regarding the removal efficiency
410 of applied emission mitigation technologies or representativeness of measurements. For estimates that
411 combine other estimates this may involve statistical methods to address propagation of errors,
412 recognizing that some values will be over-estimated and others under-estimated. Realistically, many of
413 the data that will be made available to the OESG in this process will not include associated
414 quantification of uncertainties. Thus, it will be incumbent upon the OESG to do its best to characterize
415 the scale of uncertainties in the available data and communicate the limitations of the data in
416 addressing the effectiveness evaluation questions.

417 **5.4. Defining the temporal dimension of estimates**

418 Emissions and releases estimates are associated with a given time period, typically a year, for which
 419 activity data or observations have been collected. For the purposes of establishing a comprehensive
 420 inventory or estimate for a particular year, it is sometimes not possible to gather all of the necessary
 421 information for the specific time period. A pragmatic approach is often taken to refer to a nominal
 422 target year but use information from a range of years around the target (e.g., plus/minus one year) that
 423 is judged to be reasonably representative of the target year (considering the interannual variability of
 424 the relevant processes). However, in the process to implement the Convention, a large number of
 425 control measures will be taken over a short period, which will lead to rapid changes of parameter
 426 values used to estimate the emissions and releases. Therefore, for Convention-related sources,
 427 information is recommended to be collected as annual estimates (along with, if relevant, information
 428 on underlying parameters) instead of using multi-year average data. For other sources, when such data
 429 are used to establish a trend and to ascribe that trend to drivers such as the implementation of the
 430 Convention, it is important to document the underlying time period(s) associated with each estimate in
 431 the time series and to consider the implications for apparent trends.

432 **5.5. Geospatial distribution and speciation**

433 Most of the data available to quantify emissions and releases pertain to a given facility or a given
 434 sector at the national or sometimes sub-national level, in a given year or period. To compare trends in
 435 emissions and releases data to trends in observations, it is necessary to account for the intervening
 436 environmental processes that might affect the source-receptor relationships, such as through the use
 437 of models that represent the environmental fate and transport of the emissions and releases. Most such
 438 models require emissions and releases information to be geo-spatially distributed, typically at a spatial
 439 resolution of some 10's of km, ideally with a seasonal or better temporal resolution (currently most
 440 available data are annual), and 'speciated' to represent the chemical form of the mercury emitted. The
 441 methods applied to geo-spatially distribute emissions and releases data are complex, benefit
 442 considerably if information can be delivered at the facility level (in particular for large point sources),
 443 and otherwise rely on 'proxies' for distributing emissions and releases where point sources cannot be
 444 defined, which is the case for many of the sources associated with waste. The information required to
 445 geospatially distribute emissions and releases is also time dependent – facilities open, close, change
 446 their processes or fuels and apply new mitigation technologies over time. Similarly, proxies used to
 447 distribute emissions and releases without defined point sources (e.g., population distribution) change
 448 over time. No mechanism currently exists for reporting, compiling, or ensuring consistent application
 449 of information used in defining geospatial distributions, or updating it at appropriate temporal scales.
 450 The OESG will endeavour to compile and compare the geospatial data used in available inventories
 451 and consider how needed geospatial data may be compiled or managed in the future.

452 **5.6. FAIR principles for data management and stewardship**

453 The monitoring guidance (UNEP/MC/COP.4/INF/12) notes that, to the extent possible and in
 454 accordance with requirements of individual data providers, data used in the effectiveness evaluation
 455 should follow the FAIR principles (findable, accessible, interoperable and reusable) for data
 456 management and stewardship. This will apply not only to monitoring data but also to emissions and
 457 releases data. The Monitoring Guidance also discusses ethical considerations for the use of data,
 458 including the need to follow guidance provided by Indigenous Peoples with regards to self-
 459 determination of research, research ethics, data considerations, utilization of Indigenous Knowledge,
 460 and communication of results as guided by principles such as the "CARE Principles for Indigenous
 461 Data Governance".⁸ Elements of the FAIR principles that are applicable to the effectiveness evaluation
 462 are shown below (Box 1).

Box 1. *Elements of the FAIR principles for data management and stewardship in the context of the effectiveness evaluation*

Findable:

- A searchable and interoperable database acting as a repository of available data;
- Unique identification systems (e.g., "Digital Object Identifiers" or "DOIs") and controlled vocabulary to facilitate searching and retrieval of information;
- Detailed metadata associated with each data record to facilitate the submission, searching, location and retrieval of information;

⁸ CARE Principles for Indigenous Data Governance: <https://www.gida-global.org/care>.

Accessible:

- Free and open access to the data to Governments, Indigenous Peoples, and relevant stakeholders, taking into account the relevant ethical considerations;

Interoperable:

- An interoperability mechanism to facilitate the exchange of information across different programmes and databases;

Reusable:

- Data usage license/agreement identifying the terms and conditions for further use of the data;
- Metadata including enough information describing how the data were collected/produced to enable an assessment of the quality and comparability of the data, reproducibility and further analyses.

6. Data Collection, Management, and Summary

The following describes proposed tasks to develop the emissions and releases data summary.

Task 1 - Identify the available data sources through national reporting, MIA inventory reports and other existing databases, and compare the data elements, source categories and estimation methodologies. This may include sources not initially identified in developing inventories. The information on estimation methodologies will include procedures for collecting activity data and developing emissions/releases factors.

Task 2 - Create a draft format to facilitate the comparison of the data elements identified in section 5.1 from available data sources. This format should be able to a) incorporate currently available information, and b) provide a framework to incorporate new and more detailed information for estimating emissions and releases. This data format and a list of available datasets collected by OESG in Task 1 will be circulated to Parties and other data providers along with an invitation to submit additional datasets for consideration by the OESG.

Task 3 – Compile the information collected in Task 1 and submitted as a result of the invitation in Task 2 into a dataset using the format developed under Task 2. The original sources of all data used by the OESG will be duly acknowledged in the OESG outputs. The dataset will be stored in open-source databases (for example, MySQL) on a data server that will be accessible to the OESG and experts in the roster.

Task 4 – Based on the dataset developed under Task 3, develop an emissions and data summary that describes the following:

- (a) Summary of available emissions and releases data for the period circa 2010 to present, with consideration on their comparability
- (b) Challenges in obtaining the data
- (c) Perceived data gaps within and across data sets
- (d) Potential for supplemental data to be added to the existing information, and
- (e) Data inconsistencies and the work needed to resolve these for future effectiveness evaluation.

How the compiled dataset will be used to address specific questions to inform the effectiveness evaluation, including considerations for the development of tools that will enable the newly compiled data to be searched, analysed, modelled and visualised, will be included in the forthcoming plan for data analysis and is not the focus of the present document.

The OESG, with input from the roster of experts, will provide overall guidance on the tasks described above.

To help the implementation of this plan, the Secretariat will engage and supervise one or more data management consultants. The data management consultant(s) will be responsible for the day-to-day tasks to collect, organize and store data in accordance with the guidance provided by the OESG.

The cost of consultancy services will be borne by the Convention's budget, as approved by COP in decision MC-4/13 on the programme of work and budget for 2023.

501 **7. Schedule for the implementation of the Plan for Emissions and**
 502 **Releases Data Summary**

503 The main milestones for the implementation of the plan for emissions and releases data summary is
 504 summarized below with associated tentative timelines.

<i>Milestones</i>	<i>Tentative timeline</i>
Review by parties of the draft plan, including an invitation to identify relevant available datasets	3 February – 1 March 2023
Revision of the emissions and releases data plan, including a list of initially available data sets, following the face-to-face meeting of the OESG, 27-31 March 2023	April 2023
Development of initial formats for data submission and comparison of data elements from different sources	May-October 2023
Invitation to Parties and other data providers to submit additional relevant data on emissions and releases to support the first effectiveness evaluation	September 2023
Deadline for submission by Parties and other data providers to submit data to support the first effectiveness evaluation	Mid-January 2024
Progress report on the data submitted to support the first effectiveness evaluation	March 2023
Party review of draft report on compilation and summary of available emissions and releases data	April 2024
Submission of the report on available emissions and releases data summary to the Effectiveness Evaluation Group (EEG)	TBD (pending decision at COP-5)

505 **Annex 1**

506 **Anthropogenic sources of mercury emissions and releases¹**

Source and Process Categories	UNEP Toolkit Section	GMA 2018 Sector Codes	EDGARv4.tox (IPCC) Sector Codes and Names		Streets et al. Sector Categories	GAINS sector codes
Extraction and use of fuels/energy sources	5.1		1.A	Combustion activities		
Coal combustion in power plants	5.1.1	SC-PP-coal	1.A.1.a (coal combustion)	1.A.1.a:Main Activity Electricity and Heat Production	Coal combustion	Subsectors of PP_ In combination with 5 coal types (HC1, HC2, HC3, BC1, BC2)
Coal combustion in coal fired industrial boilers	5.1.2.1	SC-IND-coal	1.A.2 (coal combustion)	1.A.2: Manufacturing Industries and Construction		Subsectors of IN_BO_ IN_OC_ In combination with 5 coal types (HC1, HC2, HC3, BC1, BC2)
Other coal use	5.1.2.2	SC-DR-coal	1.A.4, 1.A.1.bc (coal combustion)	1.A.4: Other sectors including residential 1.A.1.bc: Petroleum Refining Manufacture of Solid Fuels and Other Energy Industries		CON_COMB DOM
Coal mining			1.A.2.i (coal combustion)	Mining		MINE_HC MINE_BC (no associated Hg emissions)
Mineral oils - extraction, refining and use	5.1.3	SC-DR-oil, SC-IND-oil, SC-PP-oil, CO-OR	1.A.1.a , 1.A.2, 1.A.4, 1.A.1.bc (oil combustion)	1.A.1.a:Main Activity Electricity and Heat Production 1.A.2: Manufacturing Industries and Construction 1.A.4: Other sectors including residential	Oil combustion	Extraction, refining: PR_REF Use: Sectors associated with the fuels HF, LPG, MD, GSL (PP, IN, DOM)

¹ This annex is a work in progress. The current table does not imply that the sources listed in the same row are already comparable, or that the blank cells are missing from the inventory. The intention is to further work on dividing the left columns into smaller categories to compare which inventory covers which sources under which categories.

Source and Process Categories	UNEP Toolkit Section	GMA 2018 Sector Codes	EDGARv4.tox (IPCC) Sector Codes and Names		Streets et al. Sector Categories	GAINS sector codes
				1.A.1.bc: Petroleum Refining Manufacture of Solid Fuels and Other Energy Industries		
Natural gas - extraction, refining and use	5.1.4	SC-DR-gas, SC-IND-gas, SC-PP-gas	1.A.1.a , 1.A.2, 1.A.4, 1.A.1.bc (gas combustion)	1.A.1.a: Main Activity Electricity and Heat Production 1.A.2: Manufacturing Industries and Construction 1.A.4: Other sectors including residential 1.A.1.bc: Petroleum Refining Manufacture of Solid Fuels and Other Energy Industries		Sectors associated with the fuel GAS (PP, IN, DOM)
Other fossil fuels - extraction and use	5.1.5		1.A.5	Non-Specified		
Biomass fired power and heat production	5.1.6	BIO	1.A.1.a (biomass combustion)	1.A.1.a: Main Activity Electricity and Heat Production		Sectors associated with the fuel OS1
Geothermal power production	5.1.7					Sectors associated with activity GTH (no Hg emissions associated)
Primary (virgin) metal production	5.2		2.C	Metal Industry		
Mercury (primary) extraction and initial processing	5.2.1	NFMP-HG	2.C.7	Mercury extraction	Mercury production	OTHER_HG
Gold (and silver) extraction with mercury amalgamation processes	5.2.2	ASGM	2.C.7	Other (ASGM)	Gold artisanal production, Silver production	AU_SGP
Zinc extraction and initial processing	5.2.3	NFMP-ZN-P, NFMP-ZN-T	2.C.6	Zinc production	Zinc smelting	PR_OT_NFME
Copper extraction and initial processing	5.2.4	NFMP-CU-P, NFMP-CU-T	2.C.7	Other (Copper production)	Copper smelting	PR_OT_NFME
Lead extraction and initial processing	5.2.5	NFMP-PB-P, NFMP-PB-T	2.C.5	Lead production	Lead smelting	PR_OT_NFME
Gold extraction and initial processing by methods other than mercury amalgamation	5.2.6	NFMP-AU	2.C.7	Other (Gold large scale production)	Gold large scale production	AU_LGP
Aluminium extraction and initial processing	5.2.7	NFMP-AL-P				PR_ALPRIM

Source and Process Categories	UNEP Toolkit Section	GMA 2018 Sector Codes	EDGARv4.tox (IPCC) Sector Codes and Names		Streets et al. Sector Categories	GAINS sector codes
Other non-ferrous metals - extraction and processing	5.2.8		2.C.7	Other		PR_OT_NFME PR_ALSEC
Primary ferrous metal production	5.2.9	PISP	2.C.1	Iron and Steel production	Ironmaking, Steelmaking	PR_BAOX PR_PIGI PR_EARC
Production of other minerals and materials with mercury impurities	5.3					
Cement clinker production	5.3.1	CEM	2.A.1	Cement production	Cement production	PR_CEM
Glass production			2.A.3	Glass production		PR_GLASS
Pulp and paper production	5.3.2					PR_PULP
Production of lime and light weight aggregates	5.3.3				Caustic soda production	PR_LIME
Intentional use of mercury in industrial processes	5.4					
Chlor-alkali production with mercury-technology	5.4.1	CSP	2.B.8	Chemical Industry		PR_CSP
VCM production with mercury catalyst	5.4.2	VCM				OTHER_HG
Acetaldehyde production with mercury catalyst	5.4.3					
Other production of chemicals and polymers with mercury	5.4.4					
Consumer products with intentional use of mercury	5.5					
Thermometers with mercury	5.5.1					
Electrical switches and relays with mercury	5.5.2				Electrical and measuring equipment	
Light sources with mercury	5.5.3					
Batteries with mercury	5.5.4					
Polyurethane with mercury catalysts	5.5.5				Chemicals' manufacturing	
Biocides and pesticides with mercury	5.5.6					
Paints with mercury	5.5.7					

Source and Process Categories	UNEP Toolkit Section	GMA 2018 Sector Codes	EDGARv4.tox (IPCC) Sector Codes and Names		Streets et al. Sector Categories	GAINS sector codes
Pharmaceuticals for human and veterinary uses	5.5.6					
Cosmetics and related products with mercury	5.5.9					
Other intentional product/process use	5.6					
Dental mercury-amalgam fillings	5.6.1				Dental	
Manometers and gauges with mercury	5.6.2					
Laboratory chemicals and equipment with mercury	5.6.3					
Mercury metal use in religious rituals and folklore medicine	5.6.4					
Miscellaneous product uses, mercury metal uses, and other sources	5.6.5					
Production of recycled metals ("secondary" metal production)	5.7					
Production of recycled mercury ("secondary production")	5.7.1					
Production of recycled ferrous metals (iron and steel)	5.7.2	SSC				
Production of other recycled metals	5.7.3					
Waste incineration	5.8		4.C	Incineration and Open Burning of Waste		Waste incineration with energy recovery: PP_EX_OTH, Fuel = OS2; Waste sectors: MSW_RUR_OTH, MSW_URB_OTH INW_OTH Waste treatment options are treated as pollution reduction technologies.
Incineration of municipal/general waste	5.8.1	WI	4.C.1	Waste incineration	Municipal waste incineration	Waste sectors associated with combustion: Technology = TREAT_INC_ENE,

Source and Process Categories	UNEP Toolkit Section	GMA 2018 Sector Codes	EDGARv4.tox (IPCC) Sector Codes and Names		Streets et al. Sector Categories	GAINS sector codes
						TREAT_INC, TREAT_BURN, SWD_FLA
Incineration of hazardous waste	5.8.2	WASOTH	4.C.1	Waste incineration	Other waste burning	
Incineration of medical waste	5.8.3		4.C.1	Waste incineration		
Sewage sludge incineration	5.8.4		4.C.1	Waste incineration		
Informal waste burning	5.8.5					Technology: UNC_BURN SWD_FLARE
Waste deposition/landfilling and waste water treatment	5.9					Waste sectors: MSW_RUR_OTH, MSW_URB_OTH INW_OTH; these sectors are combined with different control technologies (see sub-sectors)
Controlled landfills/deposits	5.9.1					Technology: SWD_COMP SWD_COVER
Diffuse disposal under some control	5.9.2					Technology: SWD_COVER SWD_UNM_HIGH, SWD_UNM_LOW,
Informal local disposal of industrial production waste	5.9.3					Technology: NOC, UNC_BURN
Informal dumping of general waste	5.9.4					Technology: NOC, UNC_BURN
Waste water system/treatment	5.9.5					WW_sectors IND_sectors DOM_CC sectors (currently no Hg associated)
Crematoria and cemeteries	5.10					
Crematoria/cremation	5.10.1	CREM				RES_CREM
Cemeteries	5.10.2					
Others			1.A.3.b	Road Transportation no resuspension		TRA_RD

Source and Process Categories	UNEP Toolkit Section	GMA 2018 Sector Codes	EDGARv4.tox (IPCC) Sector Codes and Names		Streets et al. Sector Categories	GAINS sector codes
			1.A.3.d	Water-borne Navigation		TRA_INW, TRA_OTS (inland and coastal navigation)
			3.C.1	Emissions from biomass burning (Agricultural waste burning)		

507 **Annex 2**508 **Emission estimation methodologies and primary data sources¹**509 **1. Introduction**

510 This annex provides an overview of methodologies employed in existing emission and release
 511 inventories at the global, regional or national levels, together with primary sources of data used for the
 512 estimation of emissions and releases.

513 Section 2 describes estimation methodologies for point sources, including the sources covered by
 514 Articles 8 and 9 of the Convention, as well as manufacturing processes using mercury and
 515 manufacturing of mercury-added products. Section 3 addresses artisanal and small-scale gold-mining
 516 (ASGM), which is known to be the largest source of anthropogenic mercury emissions and releases.
 517 Section 4 covers mercury emissions and releases from waste management, including those associated
 518 with the end-of-life mercury-added products. Section 5 discusses methodologies for other sources.

519 **2. Point sources**520 **2.1. General context**

521 Different definitions of ‘point sources’ exist. Article 8 of the Minamata Convention controls emissions
 522 from coal-fired power plants, coal-fired industrial boilers, non-ferrous metals smelting and roasting,
 523 waste incineration and cement-clinker production. Article 9 addresses point sources of mercury
 524 releases to land and water not addressed in other provisions of the Convention, but the Convention
 525 does not define “point sources”. This section covers emissions and releases from stationary locations
 526 or fixed facilities, including point sources addressed in Articles 8 and 9 and also facilities
 527 manufacturing mercury-added products and using mercury in industrial processes. Some jurisdictions
 528 may regard artisanal and small-scale mining and waste landfills as point source, but there are
 529 discussed in other sections.

530 **2.2. Approaches for estimating point source emissions and releases**

531 *Mass-balance / material-flow approaches:*

- 532 • Use information on the amount of fuels and raw materials utilised in a given activity and/or
 533 amounts of energy produced or product of the activity (**‘activity data’**), together with information
 534 on mercury content of fuels, raw materials or products (**“input factors”**), as well as information
 535 on emission control measures in place (to establish **“output distribution factors”, ODF’s**), to
 536 estimate mercury inputs and emissions/releases to relevant media at different points in the
 537 process.
- 538 • Information on mercury content of fuel and raw materials and consideration of the processes
 539 involved is used to define **emission factors (EFs)** that quantify the amount of mercury emitted per
 540 unit of activity. Emission factors can be **‘unabated’**, i.e., reflecting emissions in the absence of
 541 control measures, or **‘abated’**, reflecting emissions following application of abatement measures
 542 such as air pollution control (APC) technologies. Approaches employing activity data and EFs to
 543 calculate emissions are widely used in all inventory methods described below.
- 544 • Releases to water are estimated using similar approaches for emissions to air as described above.
 545 For some sources, it is assumed that major releases originate from the wet gas cleaning
 546 technologies used, and therefore estimated in conjunction with the emissions. For other sources,
 547 releases are estimated using the estimated flow rate of wastewater and the estimated mercury
 548 concentration in wastewater.
- 549 • Accuracy of emission estimates is dependent on the availability and accuracy of both activity data
 550 and EFs or output distribution factors employed, and all related assumptions. Important in this
 551 regard is whether the factors defined for a specific type of fuel or ore, industrial process, or
 552 location/region can be applied in other circumstances (e.g., other ore belts, countries or regions).
 553 Similarly, whether assumptions regarding effectiveness of abatement technologies can be

¹ This annex is still a work in progress.

- 554 extrapolated beyond the situations where they were originally estimated adds uncertainty to
555 estimates. Some methods recommend using site-specific factors, when available.
- 556 • The factors used in estimating mercury emissions are a key part of documentation that is made
557 available to individuals responsible for preparing national inventories or facility reporting to
558 PRTRs. This documentation exists in national guidance documents (e.g., specifying requirements
559 for national PRTR reporting), international guidance documents (e.g., EMEP/EEA air pollutant
560 emission inventory guidebook used in connection with CLRTAP reporting) and in documentation
561 compiled in connection with national or global inventory activities (e.g., UNEP Toolkit,
562 AMAP/GMA, BAT/BEP guidance documents, UNEP Process Optimization Guidance).
 - 563 • Transparent and adequate information on the activity data, estimation factors and any related
564 assumptions applied in estimating emissions is essential for the validity of the estimate to be
565 evaluated, as well as determining associated uncertainties and *post hoc* adjustments that may be
566 required in connection with establishing time trends in emissions or ensuring comparability
567 between estimates.
 - 568 • The mass-flow approach can be applied at all scales from individual facility to national or global
569 inventory estimates. They are the basis of work employing the UNEP-Toolkit (including most
570 MIAs), global inventories (e.g., GMA, EDGAR), national emissions inventories (NEIs, CLRTAP
571 reporting) and many facility estimates reported in PRTRs.
 - 572 • In global inventory work, in particular, the approach relies on availability of activity data for all
573 sectors and countries included; and in this respect data compiled (annually) by IEA (on amounts
574 of different fuels used in energy and industry) or e.g., UNEP, USGS or industry bodies (e.g., on
575 production of cement, ferrous and non-ferrous metals) are extremely useful if not essential. It is
576 reasonable to assume that more appropriate (specific) information on activity levels, amounts and
577 characteristics of fuels and raw materials used, and details of abatement technology applied would
578 be available to inventories developed at the national or facility level; however, this is not always
579 the case.
 - 580 • One advantage of estimating emissions based on a general mass-flow approach is that
581 quantification of amounts the difference between the amounts of mercury entering the flow, and
582 the emissions to air, provides (quantitative) insight into amounts of mercury that may be released
583 to land or water or accumulated in waste; this is reflected by ‘output distribution factors’ defined
584 in the UNEP Toolkit methodology. The fate of mercury not emitted to air can be highly variable
585 (by country, facility, etc.), leading to large real variability and associated uncertainties in the
586 distribution to other environmental compartments. This is attempted reflected in the UNEP
587 Toolkit methodology, with decreasing uncertainty when ensuring use of locally relevant output
588 distribution factors.
 - 589 • The chemical speciation of mercury emissions to air, whether assumed or measured, has large
590 impacts on the extent to which emissions will be deposited locally versus transported in the
591 atmosphere, with implications for linking emission changes to changes in environmental media as
592 will be required in effectiveness evaluation. Inventories differ as to whether they report speciated
593 emissions (in contrast to total mercury emissions only) and, if so, whether they report the
594 speciation assumptions used and the source of those assumptions. As for estimation factors and
595 abatement, the speciation is among the aspects that influence on whether measurements and
596 assumptions can be widely extrapolated, and transparent reporting of speciation assumptions is
597 therefore valuable. The inadequacy of the currently applied speciation schemes was one of the
598 major needs for improvement noted during the GMA work. Considerable new relevant
599 information has become available for specific types of sources in a few countries; however, this
600 information may not be widely applicable at the global scale, and building out the data base on
601 speciation is therefore a priority.
- 602 *Measurement-based approaches.*
- 603 • Most on-site emissions measurement are carried out at larger facilities with high emissions, often
604 to ensure compliance with limit values; however, measurements are also conducted for research
605 purposes including, e.g., evaluating the effectiveness of installed air pollution control devices
606 (APCDs) or technologies, developing EFs and other estimation factors, or validating estimates
607 based on indirect methods.
 - 608 • Mercury concentrations are typically measured at the point of emission (e.g., combustion exhaust
609 stacks), or in outlets from industrial units where mercury processes are concentrated (e.g., chlor-
610 alkali plants). Concentration measurements alone do not quantify emissions; they need to be

- 611 combined with further measurements or estimates of the exhaust flow rate, or assumptions
 612 regarding the latter. It should be noted that emission estimates based on measurement also have
 613 associated uncertainty. Therefore, information on the amount of mercury in ‘inputs’ relevant for a
 614 given plant or sector may provide a useful means of validating measurement-based estimates.
 615 Indeed, such ‘triangulation’ should be applied wherever possible to any emission estimate to
 616 narrow down the associated uncertainty
- 617 • Reliability of measured emissions depends on a number of factors, particularly whether the
 618 measurements are made under representative conditions. This includes the frequency and duration
 619 of the measurements and whether measurements are made under all relevant operating conditions
 620 (in consideration of all pollution control systems) and cycles (many plants vary their fuels, sources
 621 of raw materials, operating parameters, etc.). Measurements made only under optimal (low
 622 emission) situations will underestimate plant emissions, and vice versa.
 - 623 • Measurements can produce valuable information on emitted species that are important for
 624 characterizing emissions for purposes of determining air transport and fate, etc. However,
 625 accurately quantifying reactive forms of mercury remains difficult, with some common techniques
 626 having limited sensitivity to certain forms of reactive mercury. These measurements are valuable
 627 but should be treated with caution.
 - 628 • Measurement data (and associated details of emission calculations) may be commercially
 629 sensitive, considered proprietary in nature and therefore unavailable for independent evaluation
 630 unless commissioned by public authorities or published in the scientific literature.
 - 631 • *Further information is needed for measurement of mercury in wastewater being conducted.*

632 2.3. Available activity resources for estimating/documenting point source 633 emissions

634 In the absence of national statistics on activity levels, resources (preferably compiled on the basis of
 635 globally consistent, documented and transparent methods) can be used to fill gaps; these include:

636 Worldwide data compilations

- 637 • International Energy Agency (IEA) (<https://www.iea.org/data-and-statistics/data-sets>)
- 638 • USGS ([https://www.usgs.gov/centers/national-minerals-information-center/minerals-yearbook-](https://www.usgs.gov/centers/national-minerals-information-center/minerals-yearbook-metals-and-minerals)
 639 [metals-and-minerals](https://www.usgs.gov/centers/national-minerals-information-center/minerals-yearbook-metals-and-minerals))
- 640 • UN Comtrade (<https://comtrade.un.org/data/>)
- 641 • The UNEP Toolkit Reference Report’s data base ([https://www.unep.org/explore-topics/chemicals-](https://www.unep.org/explore-topics/chemicals-waste/what-we-do/mercury/mercury-inventory-toolkit)
 642 [waste/what-we-do/mercury/mercury-inventory-toolkit](https://www.unep.org/explore-topics/chemicals-waste/what-we-do/mercury/mercury-inventory-toolkit), Section 5; compilation of available
 643 relevant technology data and examples of mercury input and output data)
- 644 • *other?*

645 Sector focused data compilation

- 646 • OSPAR
 - 647 ○ Chlor-alkali (in cooperation with Eurochlor) ([https://www.ospar.org/work-](https://www.ospar.org/work-areas/hasec/hazardous-substances/discharges-emissions-and-losses)
 648 [areas/hasec/hazardous-substances/discharges-emissions-and-losses](https://www.ospar.org/work-areas/hasec/hazardous-substances/discharges-emissions-and-losses))
- 649 • UNEP mercury partnership reports:
 - 650 ○ Chlor-alkali (in cooperations with World Chlorine Council)
 - 651 ○ Oil and gas
 - 652 ○ NFM smelting and mining
- 653 • World Resource Institute - Global Power Plant Database
 654 (<https://datasets.wri.org/dataset/globalpowerplantdatabase>)([https://resourcewatch.org/data/explore/](https://resourcewatch.org/data/explore/Powerwatch)
 655 [Powerwatch](https://resourcewatch.org/data/explore/Powerwatch))
- 656 • Wikipedia – power plants in ...
- 657 • Harvard/MIT - World Electric Power Plants Database, March 2017
 658 (<https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/OKEZ8A>)
- 659 • *other?*

660 Industry compiled data

- 661 • World Steel Association (e.g., <https://worldsteel.org/steel-topics/statistics/steel-data-viewer/>)
- 662 • World Chlorine Council
- 663 • CEMNET (<https://www.cemnet.com/global-cement-report/>)
- 664 • IPIECA
- 665 • *other?*

666 3. Artisanal and small-scale gold mining

667 Mercury emissions to air, and releases to water and land from ASGM are estimated to be over 2000
 668 tonnes each year (UNEP Global Mercury Assessment 2018). It is the sector demanding the largest
 669 quantity of mercury, with virtually all of the mercury used released to the environment. The sector
 670 produces about 12 to 15% of the world's gold. An estimated 10 to 15 million miners, including 4 to 5
 671 million women and children, are involved in the sector.

672 The Global Mercury Assessment 2018 estimated the emissions and releases of mercury based on the
 673 estimates of the amount of mercury used in ASGM and gold production methods, assuming
 674 distribution factors for different gold production methods. Such information was collected from
 675 literature and field evidence including projects to develop national action plans (NAPs), addressing the
 676 following key questions.

- 677 1. What are the practices in use? (whole ore amalgamation; concentrate amalgamation; Hg
 678 recycling - retorts)
- 679 1. How much Hg is used per unit gold produced? (the Hg:Au ratio; grams of Hg lost per gram of
 680 gold produced); Do miners discard used Hg or recycle Hg?
- 681 2. How much gold do miners produce per year? It is important to evaluate the value of the gold
 682 and consider whether that value makes sense.
- 683 3. What is the total number of miners involved in this production?

684 NAPs are an important data source for the relevant countries. There is also potential of incorporating a
 685 temporal dimension, when countries submit a review of their NAP (as requested by Art 7 , paragraph 3
 686 (c)) – if the same methodologies are used to obtain mercury use estimates as in the original NAP.

687 Regarding data uncertainties, it should be made clear that due to various challenges surrounding
 688 ASGM sector, the uncertainties might be relatively high. It should be noted that e.g. in NAPs
 689 quantitative uncertainties are not always reported – they might be expressed in narrative/qualitative
 690 manner. Further consideration is needed on how to deal with this kind of challenges while
 691 collecting/analyzing/comparing ASGM data on emissions and release.

692 4. Waste management

693 Mercury is emitted and released to the environment at various stages of the waste stream. Emissions
 694 from the controlled incineration of waste is covered in Article 8 of the Convention and included in the
 695 estimated emission from point sources. Existing inventories estimate emissions and releases including
 696 other stages, such as re-emission from landfill sites. Open burning of waste is also important since it is
 697 widely practiced in developing countries.

698 The Global Mercury Assessment 2018 estimates emissions from wastes associated with mercury-
 699 added products. Mercury consumed in mercury-added products is distributed on different pathways
 700 using distribution factors with emission factors applied to estimate emissions.

701 GMA estimates for mercury emission from the waste sector do not currently include emissions due to
 702 incineration of industrial waste and sewage sludge, or (in most cases) hazardous waste. This is because
 703 it is not currently possible to obtain reliable information on the amounts of such wastes incinerated,
 704 and more importantly the Hg content of such wastes, which can be highly variable.²

705 The UNEP Mercury Toolkit used in MIA inventories includes emissions from all common waste
 706 handling methodologies. Again, however, these estimates are based on calculation factors that can

² An OESG member submitted a paper on methodologies to estimate emissions from open burning of domestic waste and reemission from landfill.

707 locally vary significantly, and in many cases national inventory developers have not had such local
 708 data available and have instead used default input factors - Hg concentrations in waste - not specific to
 709 local conditions. In the newest Inventory Level 3, available only from 2023, the emissions and releases
 710 estimates are fully mass-flow linked to inputs with products and materials, meaning that local Hg
 711 concentrations in waste are not needed. However, this method is dependent on a thorough inventory
 712 being made for mercury-added products and materials.

713 **5. Mercury-added products except for emissions and releases** 714 **associated with their manufacturing and waste management**

715 While most emissions and releases from mercury-added products are associated with their waste
 716 management and their manufacture, emissions and releases may occur from the use phase for some
 717 products. Most such releases and emissions however relate to breakage (for example thermometers
 718 and lamps) or diffuse littering, and these can be defined as being accounted for as (incomplete) waste
 719 management. There is little focus on emissions and releases in methodologies and data that does not in
 720 some way related to waste management or the lack thereof.

721 Releases and emissions from diffuse littering of waste are accounted under open waste dumping or
 722 open waste burning, as the national case may be, in the UNEP Mercury Inventory Toolkit.

723 Most emissions and releases from the use of dental amalgam are associated with

- 724 • Placing amalgam filling in the dental clinics (mostly from new waste amalgam, drilling particles
 725 from older filings and extracted teeth);
- 726 • Lost teeth with amalgam fillings to diffuse waste littering or to collected municipal waste; and
- 727 • Cremation (air emissions and filter waste) and burial (direct releases to land).

728 Releases to water (or land) are documented to occur while the amalgam fillings are in the mouth, but
 729 in the lifecycle of dental amalgam, these are usually relatively minor fractions (see the UNEP Mercury
 730 Inventory Toolkit Reference Report for details).

731 Emissions and releases from all these lifecycle phases are covered in the Toolkit, and therefore in the
 732 MIAs, but with varying associated uncertainty, as explained below.

733 The Toolkit (in levels 2 and 3) allows and recommends the use of national data on number (and
 734 weight) of fillings made. As such detailed data are lacking in many developing countries, default
 735 estimation of mercury inputs to the dental amalgam lifecycle based on national population combined
 736 with WHO data on dental personnel in the country are however used in many MIA inventories. From
 737 review of MIA inventories, a few examples have been seen where countries used both the default
 738 methodology and had access to data on number of amalgam fillings made nationally. These have
 739 indicated that the default methodology results in reasonable estimates, but they are associated with
 740 quite some uncertainty. As regards distribution of outputs, similarly, Toolkit default output distribution
 741 factors were used in most countries. The Toolkit default factors are based on available data as
 742 reviewed in the Toolkit Reference Report.

743 The outputs from dental clinics are highly associated with the mercury control equipment and
 744 procedures used at the clinics. Chair strainers only retain larger amalgam particles from drilling, while
 745 dedicated amalgam separators can retain up to about 95% of the mercury drilled out. Amalgam
 746 separators are in turn very dependent on correct mounting and maintenance to have high retention
 747 rates. The use of amalgam separators is only gradually increasing, and so far mostly in developed
 748 countries. Another important factor influencing the emissions and releases is the clinic's handling of
 749 waste with dental amalgam, including extracted teeth with amalgam fillings. If this waste is
 750 incinerated or burned in the open, it will contribute to mercury emissions. Dental amalgam (large
 751 chunks) may still in some countries be recycled for recovery of the silver (and mercury) and in cases
 752 where such operations are not managed carefully to retain mercury, it may lead to emissions during the
 753 recovery operations. Treating waste with dental amalgam as hazardous waste that is disposed of
 754 environmentally soundly will result in the lowest emissions and releases.

755 Mercury in amalgam fillings present in deceased persons cremated are considered primarily emitted to
 756 air, unless crematoria are equipped with air pollution controls (filters) that can retain most (~95%) of
 757 the mercury. Crematoria equipped with relevant filters are most prevalent in developed countries, and
 758 also there, filter use is only gradually increasing. Most MIA inventories are developed for developing
 759 countries where filters on crematoria are rare or absent. For most such countries, outside major cities,
 760 burial is more common than cremation. The general distribution between cremation and burial in a
 761 country is primarily dependent on the religions and traditions prevailing in the countries.

762 **6. Other sources**

763 Further work is needed on sources not covered in the sections above, including the following:

- 764 • Coal mining
- 765 • Mercury production
- 766 • Mobile sources

Annex III***Plan for data analysis consistent with the Monitoring Guidance¹***(draft of 20 September 2023)***Executive summary***[to be added]***Acknowledgements***[to be added]***1. Introduction**

As per its terms of reference adopted in [decision MC-4/11](#), the Open-ended Scientific Group (OESG) shall perform a data analysis addressing the guiding questions outlined in the “Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention”.²

An overview of the adopted framework for the first effectiveness evaluation of the Minamata Convention, as contained in annex I to decision MC-4/11, and key points from the Monitoring Guidance, including its six monitoring objectives and associated guiding questions are available in the “Plan for Monitoring Data Compilation and Summary” and “Plan for the summary of available emissions and releases data”.³

2. Objective

The objective of the present “Plan for data analysis consistent with the Monitoring Guidance” (hereafter “Plan for data analysis”) is to structure and guide the OESG’s analysis of available information on mercury emissions and releases and monitoring data on mercury levels in humans and the environment.

In the context of this document, “monitoring data” includes: (a) mercury observations which have associated parameters including units, time, location, etc.; (b) ancillary observations, which are observations of environmental parameters other than mercury that are needed to interpret the mercury observations, and (c) metadata, which includes information that describes the observational datasets, including the data provider, data formats, number of sites, frequency of observations, time period covered, operating procedures and quality assurance methods employed, etc.

The output of the data analysis will be a data analysis report addressing the guiding questions outlined in the Monitoring Guidance to inform the first effectiveness evaluation of the Minamata Convention. The data analysis report will be submitted to the Effectiveness Evaluation Group (EEG).

3. Planning for the analysis of data**(a) Mapping questions from monitoring to data analysis**

The first step in the development of the data analysis plan was to break down the monitoring objectives and associated guiding questions of the Monitoring Guidance into themes to support the data analysis. For each data analysis theme, the OESG co-Chairs and small groups developed operational questions for each of the monitoring matrices and for emissions and releases.

* This present annex has not been formally edited.

¹ This draft plan has yet to be reviewed by Parties.

² Available as document [UNEP/MC/COP.4/INF/12](#).

³ Presented as annex 1 and 2 to the present document, respectively.

A detailed matrix of operational questions was organized according to the type of data by having one spreadsheet for each monitoring matrix, one spreadsheet for emissions and releases data and an additional spreadsheet for integrated analysis across emissions, releases and monitoring data. By alternating work under the small groups with discussions among the entire group, the OESG populated and cross-referenced the operational questions in an iterative manner.

The resulting matrix of operational questions is available as a spreadsheet the [OESG document folder](#). It is expected that the matrix of operational questions may need to be reviewed and adapted as progress is made and experience is gained through the data analysis, as well as to account for feedback provided by the EEG.

Because the matrix of operational questions for the data analysis does not lend itself easily for presentation as a single document, Table 1 presents summary-level operational questions which capture the scope of the individual questions under each theme.

Table 1

Mapping of the data analysis themes and summary-level operational questions to guide the analysis of data by the OESG in relation to the monitoring objectives in the Monitoring Guidance.

Monitoring objectives (from the Monitoring Guidance)	Data analysis themes	Summary-level operational questions
1. Estimation of mercury concentrations for areas without (i.e., background sites) or with (i.e., affected sites) local anthropogenic sources	A. Current Levels	A.1. What are current levels of Hg emissions and releases and current levels of Hg observed in air, biota, humans, and other media?
2. Identification of temporal trends	B. Temporal Trends	B.1. How have levels of Hg emissions and releases and Hg observed in air, biota, humans, and other media changed over the available record? B.2. How do those changes compare to the timeline of the Minamata Convention? B.3. What specific mitigation measures have contributed to changes in emissions and releases? B.4. How are levels of Hg emissions and releases and Hg observed in air, biota, humans and other media expected to change in the future?
3. Characterization of spatial patterns	C. Spatial Patterns	C.1. How do current levels and temporal trends vary geographically at the global scale?
4. Estimation of source attribution of anthropogenic mercury	D. Source or Process Attribution	D.1. What is the fractional contribution of contemporary anthropogenic emissions and releases to current Hg levels observed in air, biota, humans, and other media? D.2. How have these contribution levels changed over the timeline of the Minamata Convention? D.3. How do the contribution levels and their trends vary geographically at the global scale? D.4. How have drivers other than changes in emissions and releases contributed to the trend in observed Hg levels?
5. Estimation of exposure and adverse impacts	E. Health and Ecosystem Impacts	E.1. How do current levels of Hg observed in air, biota, humans, and other media compare to levels in established guidelines, as well as to observed and projected thresholds for effects to humans, other living organisms and biodiversity based on recent research and knowledge? E.2. How do changes in Hg levels over the timeline of the Minamata Convention compare to those guideline levels and effect thresholds?
6. Quantification of key environmental processes to improve understanding of cause-effect relationships	F. Process Understanding	F.1. How consistent are current levels, temporal trends, and spatial patterns of Hg emissions and releases and Hg levels in air, biota, humans, and other media with estimates from current mechanistic models?

(b) Associated information to the operational questions

To further support the data analysis and help assess the extent to which the operational questions can be answered, a set of ten categories of information was added for each question in the matrix. The information categories are:

- (a) *Relevant versus available data* – to determine the type of “relevant and applicable” data that might be used to answer the operational questions, whether the data is accessible in a usable form, and the sources and formats of data readily accessible to the Open-ended Scientific Group;
- (b) *Methodological approach* – to identify an appropriate methodological approach for answering the operational question, taking into account the relevant data that are readily accessible to the Open-ended Scientific Group and whether the approach involves statistical modelling or mechanistic modelling;
- (c) *Form of the answer/output* – to identify how the answer to the operational question might be expressed (for example, as a map, a time series, a figure, a table of quantitative metrics or a narrative);
- (d) *Anticipated result* – to describe, based on published literature, what the answers to the operational questions might look like;
- (e) *Confidence* – to assess, based on the identified methodological approach, the level of confidence in the answer (qualitative or quantitative) to the operational question; to identify quality assurance measures applicable to the data and the analysis method; and to identify the most important sources of uncertainty and potential sources of bias;
- (f) *Lead responsibility* – to identify who, within the Open-ended Scientific Group or roster of experts, could take primary responsibility for performing the analysis to arrive at an answer to the operational question;
- (g) *Contributors* – to identify who, within the Open-ended Scientific Group or roster of experts, could contribute to performing the analysis to arrive at an answer to the operational question;
- (h) *Identified gaps* – to identify gaps in the existing data, knowledge and tools that might prevent analysis of the operational question;
- (i) *Capacity needs* – to determine the capacity needs to fill the identified gaps;
- (j) *Indigenous knowledge or traditional knowledge* – to identify Indigenous knowledge and traditional knowledge that might be used in the analysis.

4. Preliminary indicators related to the work of the OESG

Document UNEP/MC/COP.5/16/Add.1 lists a set of proposed indicators for consideration by the COP at its fifth meeting. Among the proposed indicators, two indicators are related to the work of the OESG. These are indicators 1 “*Levels and trends of mercury and mercury compounds in the environment and in humans due to anthropogenic emissions and releases*” and indicator 29 “*Mercury levels in vulnerable human populations*”. The document notes that as the analysis of monitoring data progresses, the Open-ended Scientific Group may further elaborate on those indicators, for example, by proposing sub-indicators.

Based on the summary level questions above, the OESG organized its tentative information outputs under each analysis theme. As the OESG progresses in the analysis of data, the tentative information outputs may be used to derive a set of draft sub-indicators to support the EEG. However, owing to gaps in information and limited resources, it is important to note that not all tentative information outputs are likely to be achievable during the first effectiveness evaluation.

Table 2

Tentative information outputs from the data analysis in relation to the analysis themes.

<i>Analysis themes</i>	<i>Information outputs</i>
A. Current levels	Current levels of mercury emissions and releases and current levels of mercury observed in air, biota, humans and other media
B. Temporal trends	Changes over the timeline of the Minamata Convention in the levels of mercury emissions and releases and mercury observed in air, biota, humans and other media Specific mitigation measures that have contributed to changes in emissions and releases

<i>Analysis themes</i>	<i>Information outputs</i>
	Expected changes in the levels of mercury emissions and releases and mercury observed in air, biota, humans and other media
C. Spatial patterns	Geographic variation at the global scale of current mercury levels and temporal trends
D. Source or process attribution	Changes over the timeline of the Minamata Convention in the fractional contribution of contemporary anthropogenic emissions and releases to current mercury levels observed in air, biota, humans and other media Geographic variation at the global scale of contribution levels and their trends Contribution of drivers other than changes in emissions and releases to the trend in observed mercury levels
E. Health and environmental impacts	Changes over the timeline of the Minamata Convention between current observed levels of mercury in air, biota, humans and other media in relation to (i) the levels established in health guidelines and (ii) observed and expected impacts on humans, other living organisms and biodiversity based on recent research and knowledge
F. Process understanding	Consistency in the observed levels, temporal trends and spatial patterns of mercury emissions and releases and mercury levels in air, biota, humans and other media in relation to estimates from current mechanistic models

5. Implementation of the Plan for Data Analysis consistent with the Monitoring Guidance

The main milestones for the implementation of the plan data analysis are summarized below with associated tentative timelines. For several milestones, the tentative deliverable timelines depend upon further consideration by the COP, at its fifth meeting, of the overall timeline for the first effectiveness evaluation.

It is noted that the OESG has a very ambitious timeline for its deliverables, particularly because a significant amount of time will be needed to collect existing data from multiple data providers, through a process which may require the secretariat to establish data use agreements with various data providers before data analysis can begin. Furthermore, the time available to harmonize and analyse the available scientific information is very limited, especially given that this is the first effectiveness evaluation for the Convention; the necessary data management infrastructure does not yet exist; there are limited financial resources available from the Convention to fund the work, which is almost entirely reliant on in-kind contributions of the OESG and its rostered experts; and multiple opportunities for review by parties have been built into the process to improve transparency, credibility and ownership.

Table 3
Milestones and tentative timelines for the analysis of data by the OESG.

<i>Milestones</i>	<i>Tentative timeline</i>
Party review of draft plan for data analysis (this document)	November 2023
Hiring of consultancy services to assist the OESG in the data collection and analysis	November 2023
Invitation to Parties and other data providers to submit data to support the first effectiveness evaluation	October – November 2023
Deadline for submission by Parties and other data providers to submit data to support the first effectiveness evaluation	January 2024
Preliminary analysis of the data submitted to support the first effectiveness evaluation	TBD (pending decision at COP-5)
Completion of the analysis of the data submitted to support the first effectiveness evaluation	TBD (pending decision at COP-5)
Party review of report on the analysis of data	TBD (pending decision at COP-5)
Submission of the report on the analysis of data to address the guiding questions in the Monitoring Guidance to the Effectiveness Evaluation Group (EEG)	TBD (pending decision at COP-5)