Mekong River Commission
For Sustainable Development

TECHNICAL GUIDELINES

ON THE IMPLEMENTATION OF THE

PROCEDURES

FOR WATER QUALITY

2021

Technical Guidelines on the Implementation of the Procedures for Water Quality

2021

CONTENTS

TABLES

FIGURES

Technical Guidelines on the Implementation of the Procedures for Water Quality

Pursuant to the Mekong River Commission (MRC) Council Resolution of 18 October 1999 on the Water Utilization Programme, the MRC Council approved the Procedures for Water Quality (PWQ) at its 17th Meeting on 26 January 2011. To facilitate the implementation of the PWQ, the MRC Joint Committee does hereby adopt the Technical Guidelines on the Implementation of the Procedures for Water Quality (TGWQ) as a complimentary and supplementary document to the PWQ. The purpose of these Technical Guidelines is to facilitate the implementation of the PWQ as well as to address issues or points of the PWQ requiring clarification or elaboration and they are to be applied in conjunction with PWQ.

The objective of the PWQ is *"to establish a cooperative framework for the maintenance of acceptable/good water quality to promote the sustainable development of the Mekong River Basin."*

This statement from the PWQ elaborates the commitment of the Member States under the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin in 1995 ("the 1995 Mekong Agreement") in the subject of water quality. It is supported by national water quality legislation of each of the Member States. The TGWQ describe *how something should be done or what sort of action should be taken*[1]. These Technical Guidelines are presented in three parts: Part A provides the essential guidelines for water quality management to ensure the achievement of the objective of the PWQ, Part B presents a management action plan to address potential water quality emergencies, and Part C suggests a process for review of the Technical Guidelines on Implementation of the Procedures for Water Quality.

1 Guidelines: Official recommendations indicating how something should be done or what sort of action should be taken in a particular circumstance.

PART A. WATER QUALITY MANAGEMENT

Chapter 1. Guidelines for the Protection of Human Health (HH)

1.1 Scope

The Guideline for Protection of Human Health (hereafter referred to as "HH") has as its' target to maintain the ambient water quality of the Mekong mainstream good/acceptable for domestic purposes and primary human contact.

The terms "domestic purposes" and "primary human contact" in the HH refer to the direct use of water that may affect human health, which includes:

- Water used by water treatment plants in e.g. municipal areas;
- Water used in the rural areas, with no or minimum treatment;
- Direct use of river water for bathing and personal hygiene, washing, swimming, fishing, sailing, and splashing during water festivals.

The main concern for water quality for domestic purposes and primary human contact is the protection of public health. However, the risk to human health not only originates from the direct use of the river water, but also from the use of other river derived resources for consumption, such as fish and other aquatic products, which provide additional vectors for human exposure to waterborne diseases.

The Member States shall make every effort to maintain good/acceptable water quality in the Mekong River tributaries and other trans-boundary tributaries for which the HH does not apply.

The HH cannot be applied to assess the quality of the Mekong River water used:

- Directly as drinking water,
- Cleaning or preparation of food;
- Beverage preparation,
- Swimming pool water.

Water released from any activity along the Mekong mainstream, and the tributaries, such as discharge and wastewater from human activities, industry, agriculture and domestic areas shall be controlled by relevant Member State regulations (e.g. national wastewater standards).

1.2 Purpose

The HH shall be used as a decision support tool for management by the Member States to maintain good/acceptable water quality of the Mekong mainstream. The users include decision makers, water quality managers and any other stakeholders with an interest in maintaining good/acceptable water quality to protect human health. Furthermore, the HH shall be made available to the general public of the Member States as a guidance document on water quality management, providing a valuable source of information on different aspects of water quality and water management.

The HH shall define the water quality criteria, specific target values and information on how to assess suitability of the quality of water for domestic purposes and primary human contact.

1.3 Approach used to select water quality criteria

The approach used to select the water quality criteria is primarily based on the water quality criteria selected by the Member States for their national water quality guidelines and water quality standards. In addition, regional and international guidelines, research and experience from Member States shall be taken into account in developing the set of guidelines and criteria that are appropriate for the Mekong River Basin. The selected criteria shall be based on a consensus of the Member States.

The objective of this approach is to ensure consistency and to avoid confusion that can arise when different criteria and guidelines are applied by different stakeholders in the Mekong River Basin.

The methodology used to develop the HH criteria to protect human health for the Mekong River shall include the referral and review of:

- Water quality guidelines and water quality standards of Member States for domestic use;
- Regional and international guidelines;
- Scientific research from the region and Member States which identifies water quality criteria in the Mekong River Basin that may affect human health;
- International scientific information such as Maximum Contamination Level Goal (MCLG).

1.4 Criteria and target values

The water quality parameters in the Tables 1.4.1 and 1.4.2 are selected from the parameters from the Member States' water quality standards for domestic use of water.

The target values are the highest acceptable values of the Member States' Water Quality Standards for domestic use, but are not to be higher than those of the MCLG.

Table 1.4.1. Criteria and Target Values for the Protection of Human Health (Direct Impact Parameters)

No	Parameters	Symbol	Unit	Value	Analytical method[1]
1	Total Arsenic	Total As	mg/l	0.01	3550-As/SM
2	Cadmium	Cd	mg/l	0.005[2]	3110-Cd/SM
3	Chromium Hexavalent	Cr	mg/l	0.05	3550-Cr/SM
4	Cyanide	CN	mg/l	0.01	4500-CN/SM
5	Lead	Pb	mg/l	0.05	3110-Pb/SM
6	Total Mercury	Total Hg	mg/l	0.002	3112-Hg/SM
7	Oil and Grease	***Should not occur in such a way that:*** ▪ It can be observed as an oil film, sheen or discoloration; ▪ One can smell its odour; or ▪ It can be seen as oily deposits on the river bank and/or at the river bottom.			Observation
8	Phenol	C_6H_5OH	mg/l	0.005	5530-Phenol/SM
9	Total Organochlorine Pesticide		mg/l	0.05	6630-organochlorinePesticides/ SM
10	Faecal Coliforms		MPN/100ml	1000[3]	9230-E.coli Group/SM

Note:

[1] If the laboratories rely on their own methods and/or non-standard methods, they have to comply with the requirements of method validation of ISO/IEC 17025-2005

[2] When the water hardness is less than 100 mg/l as $CaCO_3$

[3]An interim target value requiring further review by the Technical Body on Water Quality (TBWQ). The TBWQ with support from the Mekong River Commission Secretariat will continue to study this issue in order to reconsider the interim target value.

Table 1.4.2. Criteria and Target Value for Protection of Human Health (Indirect Impact Parameters or Environmental Stressor Parameters)

No	Parameters	Symbol	Unit	Value	Analytical Method[1]
1	Ammonia as N	NH_3 as N	mg/l	0.5[2]	4500-NH_3/SM
2	Biological Oxygen Demand	BOD_5	mg/l	4	5210-BOD_5/SM
3	Chemical Oxygen Demand	COD_{Mn}	mg/l	5	$KMnO_4$ method
4	Conductivity	EC	mS/m	70-150	2510-Ec/SM
5	Dissolved Oxygen	DO	mg/l	≥ 6[3]	4500-O/SM
6	Total Nitrite and Nitrate as N	(NO_2 + NO_3) as N	mg/l	5	4500-NO_3/SM
8	pH	pH		6-9	4500-H^+/SM
9	Temperature	T	°C	Natural	2550-Temp/SM
10	Total Coliform		MPN/100ml	5000	9221-Coliform group/SM

Note:

[1]If the laboratories use their in-house methods and/or non-standard methods, they have to comply with the requirements of method validation of ISO/IEC 17025-2005.

[2] and [3] An interim target value requiring further review by the TBWQ. The TBWQ with support from the Mekong River Commission Secretariat will continue to study this issue in order to reconsider the interim target value

1.5 Water quality monitoring

The water quality monitoring *programme* should be designed to ensure that the results can be used to:

- Monitor the suitability of the Mekong River water for the protection of human health;
- Monitor the long-term trends in water quality:
- Identify problems and pressures along the Mekong River.

To optimize the programme, the following actions should also be taken into consideration:

- Ensure that it aligns with the existing MRC Water Quality Monitoring Network.
- Ensure linkages with other related environmental monitoring programmes, including ecological health monitoring, water quality monitoring for the protection of aquatic life (Chapter 2.5), hydrology monitoring and sediment monitoring.

The water quality monitoring programme should define the following:

1.5.1 Location of sampling points

The locations of the sampling points are important and the selected sites should be:

- Representative areas along the Mekong River where people use, are exposed to, and in contact with water from the mainstream Mekong River, e.g. riparian settlements.
- Close to any possible sources of pollution effluent such as factories, mines and intense farming areas, and sewage outfalls;
- At sites where there is a hydraulic change due to a dam, or a confluence with tributaries or other rivers;
- At trans-boundary positions to check the quality of the water entering and leaving the country.

The selected points should be discussed and agreed among the Member States to finally notify the MRC Secretariat.

1.5.2 Sampling frequency

The sampling frequency is determined by a number of factors which include:

- Seasonal hydrological cycles;
- River flow and velocity regime;
- Location of the sampling point, e.g. a point susceptible to pollution;
- Parameters that are more variable than others and that will therefore need to be monitored at different frequencies;
- Logistical constraints such as the availability of sampling resources, appropriate vehicles etc.

Taking these factors into account, it has been proposed to sample at a minimum:

- Indirect Impact Parameters (Table 1.4.2) - at a regular bi-monthly frequency - 6 times per year starting from February. For a specific area or location in the Mekong River, the Member States may increase the sampling frequency, although not exceeding 12 times per year.
- Direct Impact Parameters (Table 1.4.1) - once every two years, though this frequency would increase if there was any indication of pollution, e.g. abnormal environmental SP results.

The total number of samples will depend on the number of sampling locations and sampling frequency. The total number of collected samples and their locations should be sufficient to determine the possible sources and impacts of water contamination to human health.

1.5.3 Monitoring and analytical methodology

The water sampling and analysis shall be performed in compliance with international standard methods or nationally accepted methods (Tables 1.4.1 and 1.4.2). The analytical results should be recorded to show full traceability and should therefore include the following information:

- Sampling details recorded in the chain of custody documentation, detailing date, time, name of sampler, sampling method used, etc.
- Analysis records showing the analytical result, date, location (e.g. on-site or at the laboratory),

analytical method, equipment, and analytical quality control results. If the laboratories use their in-house methods and/or non-standard methods, they must comply with the requirements of method validation of ISO/IEC 17025-2005.

1.5.4 Quality assurance and quality control (QA/QC)

To ensure that the results are credible and acceptable, the laboratories that participate in the monitoring programme shall establish, implement and maintain a QA/QC system for the scope of their sampling and analytical work. The laboratories shall apply appropriate standard methods and procedures for all activities, including sampling, preservation, transport, storage and analysis, and apply internal and external analytical quality controls to ensure compliance with the requirements of QA/QC systems at the international standard. Finally, the laboratories should ensure that all their relevant staff are fully trained, with their training recorded in the official training logs.

1.5.5 Responsible parties

To ensure that the monitoring programme runs efficiently, the responsible bodies and their roles should be defined as follows:

- Each Member State is responsible for monitoring water quality. They can assign line agencies to undertake the key monitoring tasks, including the implementation of the MRC monitoring programmes.
- The MRC Secretariat is responsible for the coordination and technical support to establish and maintain the monitoring programmes.
- The MRC Secretariat is responsible for periodically reporting the results of monitoring activities to the Joint Committee.

1.6 Assessment

The PWQ requires that the water quality of the Mekong River mainstream is regularly reported to the MRC Joint Committee. It is also essential to disseminate the results to the stakeholders in an easy understandable format.

1.6.1 Annual Regional Water Quality Assessment Report

The objective of the *Annual Regional Water Quality Assessment Report* is to report whether the water quality monitoring programme indicates that the protection of human health has been achieved. The results shall therefore be interpreted in the context of the assessment's objective. The report shall evaluate the reliability and quality of the data, on which the assessment is based, and the mathematical/statistical methods that have been used to analyze the data. The assessment report shall also provide recommendations for management actions, if improvements are required.

Management actions shall respond to the outcomes and recommendations of the assessment report. They may include remedial actions and/or the review of monitoring activities, among others. The assessment report needs to be clear, concise, unambiguous and timely in order to facilitate effective management action to respond to the assessment results.

1.6.2 The Mekong River report card on water quality

The *Mekong River Report Card on Water Quality* will be produced by applying a water quality index and a water quality classification system, which will be developed and proposed by the MRC Secretariat. This will also be based on the selected water quality criteria and target values.

The proposed methods for water quality assessment and classification will be further discussed and periodically reviewed among the Member States in order to determine systems that are acceptable to all parties. These agreed systems shall then be incorporated into the *Mekong River Report Card on Water Quality*.

1.6.3 Reporting responsibilities

In order to produce the two above reports, each Member State shall be responsible for producing an *Annual National Water Quality Report* each year and in a timely manner. The MRC Secretariat is responsible for streamlining and coordinating this reported data and information to produce the *Mekong River Report Card on Water Quality.*

CHAPTER 2. GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (AL)

2.1 Scope

The Guidelines for Protection of Aquatic Life (hereafter referred to as "AL") has as its target to maintain the ambient water quality of the Mekong Mainstream good/acceptable for protection of the Mekong's freshwater aquatic life.

All components of the aquatic life, flora and fauna in the Mekong River are considered by the AL.

The Member States shall make every effort to maintain good/acceptable water quality in the Mekong River tributaries and other trans-boundary tributaries for which the AL does not apply.

The main concern for the Mekong River water quality is the protection of the health and integrity of aquatic life. However, the threats to freshwater aquatic life are not only from the Mekong River water quality, but also from the other natural vectors such as human activities, alien species, over-fishing, and changes in hydraulic flow, etc., which may not only affect a healthy ecology, but also spread aquatic diseases.

The AL is not applicable for aquaculture farming areas and estuarine and marine ecosystems

2.2 Purpose

The AL shall be used as a decision support tool for management by the Member States to maintain good/acceptable water quality of the Mekong mainstream. The users include decision makers, water quality managers and any other stakeholders who have an interest to maintain good/acceptable water quality to protect aquatic life. Furthermore, the AL shall be used by the general public of the Member States as a guidance document on water quality management, providing a valuable source of information on different aspects of water quality and water management.

The AL shall define the water quality criteria, specific target value and information on how to assess whether the quality of water is suitable for Mekong's freshwater aquatic life.

2.3 Approach used to select criteria

The approach used to select the water quality criteria is primarily based on the water quality criteria selected by the Member States for their national water quality guidelines and water quality standards. In addition, regional and international guidelines, research and experience from Member States shall be taken into account in developing the set of guidelines and criteria that are appropriate for the Mekong River Basin. The selected criteria shall be based on a consensus of the Member States.

The objective of this approach is to ensure consistency and to avoid confusion that can arise when different criteria and guidelines are applied by different stakeholders in the Mekong River Basin.

The methodology used to develop the AL criteria to protect aquatic life of the Mekong River shall include the referral and review of:

- Member States' water quality guidelines and water quality standards for aquatic life;
- Regional and international guidelines;
- Scientific research from the region and Member States to determine the water quality pollutants and their concentrations in the Mekong River that may affect the health of freshwater aquatic life;
- International scientific information such as the Criterion Continuous Concentration (CCC).

2.4 Criteria and target value

The water quality parameters in the Table 2.4.1 are selected from the Member States' Water Quality Standards for the protection of aquatic life.

The target values are the acceptable values in the Water Quality Standards for the protection of aquatic life of the Member States and values from freshwater guidelines of countries with similar natural conditions to the Mekong River countries. The selection of values should furthermore be guided by the CCC.

Table 2.4.1. Criteria and Target Values for the Protection of Aquatic life (Direct Impact Parameters)

No	Parameters	Symbol	Unit	Value	Analytical method[1]
	Name				
1	Arsenic	Total As	mg/l	0.01	3550-As/SM
2	Cadmium	Cd	mg/l	0.005[2]	3110-Cd/SM
3	Chromium Hexavalent	Cr (VI)	mg/l	0.05[3]	3550-Cr/SM
4	Copper	Cu	Mg/l	0.1	
5	Cyanide	CN	mg/l	0.005	4500-CN/SM
6	Lead	Pb	mg/l	0.05[4]	3110-Pb/SM
7	Total Mercury	Total Hg	mg/l	0.001[5]	3112-Hg/SM
8	Oil and Grease[6]	***Should not occur in such a way that:*** • It can be observed as an oil film, sheen or discoloration. • One can smell its odour, or • It can be seen as oily deposits on the river bank and/or at the river bottom.			Observation
9	Phenol	C_6H_5OH	mg/l	0.005	5530-Phenol/SM
10	Total Organochlorine Pesticide		mg/l	0.05	6630-organochlorinePesticides/ SM
11	Ammonia	NH_3 as N	mg/l	0.2[8]	4500-NH_3/SM
12	Biological Oxygen Demand	BOD_5	mg/l	3[7]	5210-BOD_5/SM
13	Dissolved Oxygen	DO	mg/l	> 5	4500-O/SM
14	pH	pH		6-9	4500-H^+/SM

15	Temperature		°C	Natural	2550-Temp/SM
16	Nitrite[9]	NO_2 as N			
17	Nitrate	$NO_{3\ as}$ N	mg/l	5	4500-NO_2-C/SM
18	Phosphate[9]	PO_4 as P			

Note:

(1) If the laboratories use their in-house methods and/or non-standard methods, they have to comply with the requirements of method validation of ISO/IEC 17025-2005.

(2) When the water hardness is less than 100 mg/l as $CaCO_3$

(3), (4),(5),(6) and (7)An interim target value requiring further review by the TBWQ. The TBWQ with support from the MRC Secretariat will continue to study this issue in order to reconsider the interim target value.

(8) An interim target value requiring further review by the TBWQ. The TBWQ with support from the MRC Secretariat will continue to study this issue in order to reconsider the interim target value. Thailand proposes 0.5 mg/l; Vietnam proposes 0.1 mg/l.

(9) Target values will be proposed in the future when the national standard target values for Lao PDR and Thailand are available.

2.5 Water quality monitoring

The water quality monitoring *programme* should be designed to ensure that the results can be used to:

- Monitor the suitability of the Mekong River water quality for the protection of aquatic life;
- Monitor the long-term trends in water quality;
- Identify problems and pressures along the Mekong River.

To optimize the programme, the following actions should be taken:

i. Ensure that it aligns with the existing MRC Water Quality Monitoring Network.

ii. *Ensure linkages with other related environmental monitoring* programmes, including ecological health monitoring, water quality monitoring for the protection of human health (Chapter 1.5), hydrology monitoring and sediment monitoring.

The water quality monitoring programme should define the following:

2.5.1 Location of sampling points

The locations of the sampling points are *important* and the selected sites should:

- Cover a broad geographical range- representative of a wide range of freshwater riverine ecosystems;
- Be representative areas of different types of anthropogenic activities, e.g. settlements and fish hatcheries;
- Be close to any possible sources of pollution such as effluent from factories, mines, and intense farming areas, and sewage outfalls;
- Be at sites where there is a hydraulic change due to a dam, or a confluence with tributaries or rivers;

- Be at trans-boundary positions to check the quality of the water entering and leaving the country.

The selected points should be discussed and agreed among the Member States to finally notify the MRC Secretariat.

2.5.2 Sampling frequency

The sampling frequency is determined by a number of factors, which include:

- Seasonal hydrological cycles;
- River flow and velocity regime;
- Location of the sampling point e.g. is it a point susceptible to pollution;
- Parameters that are more variable than others and that therefore will require different sampling frequencies;
- Logistical constraints such as the availability of sampling resources, such as an appropriate vehicle.

Taking these factors into account, it has been proposed to sample at a minimum:

- Environmental Stressor Parameters (SP) (Parameters 11-18 in Table 2.4.1) - at a regular bi-monthly frequency - 6 times per year starting from February. For a specific area or location in the Mekong River, the Member States may increase the sampling frequency, although not exceeding 12 times per year.
- Direct Impact Parameters (Parameters 1-10 in Table 2.4.1) - once every two years, although this frequency would increase if there was any indication of pollution, e.g. abnormal environmental monitoring results and emergency pollution incidents.

The total number of samples will depend on an identification of the number of sampling locations and sampling frequency. The total number of collected samples and their locations should be sufficient to determine the possible sources of water contamination and its impacts on aquatic life.

2.5.3 Monitoring and analytical methodology

The water sampling and analysis should be performed in compliance with international standard methods or nationally accepted methods (Table 2.4.1). The analytical results should be recorded to show full traceability, and would therefore include the following information:

- Sampling details recorded in the chain of custody documentation detailing date, time, name of sampler, sampling method used, etc.
- Analysis records showing the analytical result, date, location (on-site or at the laboratory), analytical method, equipment and analytical quality control results. If the laboratories use their in-house methods and/or non-standard methods, they must comply with the requirements of method validation of ISO/IEC 17025-2005.

2.5.4 Quality assurance and quality control (QA/QC)

To ensure that the results are credible and acceptable, the laboratories that participate in the monitoring programme shall establish, implement and maintain a QA/QC system for the

scope of their sampling and analytical work. The laboratories shall apply appropriate standard methods and procedures for all activities, including sampling, preservation, transport, storage and analysis, and apply internal and external analytical quality controls to ensure compliance with the requirements of QA/QC systems at international standards. Finally, the laboratories should ensure that their relevant staff are fully trained and their training recorded in the official training logs.

2.5.5 Responsible parties

To ensure that monitoring programme runs efficiently, the responsible bodies and their roles should be defined as follows:

- Each Member State is responsible for monitoring water quality. They can assign line agencies to undertake the key monitoring tasks, including the implementation of the MRC monitoring programmes;
- The MRC Secretariat is responsible for the coordination and technical support to establish and maintain the monitoring programs;
- The MRC Secretariat is responsible for periodically reporting the results of monitoring activities to the Joint Committee.

2.6 Assessment

The PWQ requires that the water quality of the Mekong River mainstream be regularly reported to the MRC Joint Committee. It is also essential to disseminate the results to the stakeholders in an easily understandable format.

2.6.1 Annual regional water quality assessment report

The objective of the *Annual Regional Water Quality Assessment Report* is to report whether the water quality monitoring programme indicates that the protection of aquatic life has been achieved. The results shall therefore be interpreted in the context of the assessment's objective. The report shall evaluate the reliability and quality of the data on which the assessment is based, and the mathematical/statistical methods that have been used to analyze them. The assessment report shall also provide recommendations for management actions, if improvements are required.

Management actions shall respond to the outcomes and recommendations of the assessment report. They may include remedial actions and/or the review of monitoring activities, etc. The assessment report needs to be clear, concise, unambiguous and timely in order to facilitate effective management action to respond to the assessment results.

2.6.2 The Mekong River Report card on water quality

The *Mekong River Report Card on Water Quality* will be produced by applying a water quality index and a water quality classification system, which will be developed and proposed by the MRC Secretariat. This will also be based on the selected water quality criteria and target values.

The proposed methods for water quality assessment and classification will be further discussed and periodically reviewed among the Member States in order to determine systems that are acceptable to all parties. These agreed systems shall then be incorporated into the *Mekong River Report Card on Water Quality*.

2.6.3 Reporting responsibilities

In order to produce the two above reports, each Member State is responsible for producing an *Annual National Water Quality Data Assessment Report* each year and in a timely manner. The MRC Secretariat is responsible for streamlining and coordinating this reported data and information to produce the *Mekong River Report Card on Water Quality.*

Chapter 3. Cooperative Framework on the Implementation of the Procedures for Water Quality with regard to HH and AL

3.1 Purposes

This Chapter defines the framework for the implementation of the PWQ with regard to HH and AL. It facilitates the implementation of HH and AL, and is therefore aimed at elaborating on how Member States and the MRC would cooperate on, administer and apply HH and AL. This cooperative framework addresses:

- Support mechanisms for cooperation;
- Collaborative processes including specific provisions for handling non-conformity with HH and AL;
- Sustainability of the application of the HH and AL including capacity building.

3.2 Support mechanisms for cooperation

To support Member States implementing HH and AL, the necessary support mechanisms for cooperation shall be established. The support mechanisms comprise both national and regional institutions, including the MRC Joint Committee, the TBWQ, the National Mekong Committee Secretariats, and the MRCS Secretariat. Their roles and responsibilities are as follows:

i. The Joint Committee's roles and responsibilities include:

    - Providing guidance to the TBWQ regarding the implementation of its mandates;
    - Approving the HH and AL when revised or amended by the TBWQ;
    - Establishing any regional working groups as needed to support the revision and implementation of HH and AL.

ii. The TBWQ's roles and responsibilities include:

    - Assisting in strengthening and maintaining the Water Quality Monitoring Network (WQMN) as well as, if necessary, prepare information for establishing new water quality monitoring stations and any relevant set-up, in accordance with the objective and principles of the PWQ;
    - With the assistance of the MRC Secretariat, reviewing and preparing an annual capacity building plan to strengthen the implementation of HH and AL;
    - Assisting in establishing a framework for Integrated Water Quality Management (IWQM) within the water quality objectives;
    - Preparing the HH and AL for the Joint Committee's approval and propose revisions or amendments on the HH and AL, to the Joint Committee as appropriate.
    - Reviewing the MRC annual report and other related reports on the water quality of the Mekong River mainstream.

iii. The NMCS's roles and responsibilities include:

- Informing, engaging and assisting relevant line agencies on the PWQ with regard to HH and AL, to ensure their effective implementation;
- Assisting relevant line agencies to ensure that data and information collected as part of the implementation of HH and AL are shared with other Member States;
- Cooperating with the MRC Secretariat on the establishment, operation and maintenance of the water quality monitoring stations;
- Facilitating the MRC Secretariat's work in preparing an annual progress report on the implementation of the PWQ with regard to HH and AL.

iv. The MRC Secretariat's main roles and responsibilities include:

- Providing support to NMCSs and relevant line agencies in the implementation of the PWQ with regard to HH and AL;
- Providing technical support to NMCSs and relevant line agencies for the resolution of non-conformities;
- Providing support to the TBWQ in the revision of HH and AL;
- Assisting Member States in data and information exchange pertaining to HH and AL;
- Assisting the TBWQ in preparing an annual progress report on the implementation of the PWQ, with regard to HH and AL for the Joint Committee consideration;
- Preparing the MRC annual water quality monitoring report and other related reports on the water quality of the Mekong River mainstream;
- Providing support to the TBWQ in assessing capacity needs and strengthening the capacity of the Member States to implement the PWQ, with regard to HH and AL.

In addition, key support mechanisms will include continuous capacity building for the full implementation of the PWQ with regard to HH and AL. Improved capacity of the Member States will be a key milestone and an indicator of an effective Cooperative Framework.

3.3 Regional cooperation for water quality monitoring

The WQMN is an integral part of the regional cooperation for the implementation of HH and AL. In addition to the WQMN, Member States are committed to cooperatively strengthen the capacity to implement HH and AL at the national level through exchange visits and on-the-job capacity building.

The Member States have agreed to assign their designated WQMN laboratories and relevant institutions to support the implementation of PWQ with regard to HH and AL. The designated laboratories of the WQMN will have the following responsibilities:

- Monitoring the suitability of Mekong River water for the protection of human health and aquatic life;
- Monitoring the long-term trends in water quality;
- Reporting water quality status and trend within their national boundaries in the Annual National Water Quality Data Assessment Report.

The water quality data and annual water quality data assessment report, compiled by the designated WQMN laboratories of each Member State, shall be forwarded to the MRC Secretariat for sharing.

The sharing of routine water quality monitoring data and the annual national water quality monitoring report will follow the provisions of the MRC Procedures for Data and Information Exchange and Sharing (PDIES) and its Technical Guidelines.

3.4. Resolution of non-conformity with the water quality objectives

With the PWQ, the Member States have agreed to comply with the water quality objectives set out in HH and AL. The results of the water quality monitoring will be assessed against the water quality objectives and reported to the Joint Committee, through the TBWQ and the MRC Secretariat, on a regular basis as described in HH and AL. The reports will highlight any results that do not comply with the water quality objectives set out in HH and AL. In case of non-conformity, the following supplementary actions shall be taken by the Member States through the designated WQMN laboratories:

i. Repeat sampling and analysis of the samples.

ii. Investigate why these non-conformities have occurred and include the reasons in the Annual National Water Quality Data Assessment Report.

iii. Any non-conformities assessed as constituting a water quality emergency will, without delay upon detection, be referred to the WQERM.

3.5 Monitoring, evaluation and reporting on the implementation of the procedures for water quality with regard to HH and AL

An annual progress report for the MRC Joint Committee, on the implementation of the PWQ with regard to HH and AL will be produced by the MRC Secretariat. This report will document collaborative efforts made by the Member States to maintain good/acceptable water quality of the Mekong River mainstream. The Member States shall make the following collaborative efforts to ensure timely monitoring, evaluation and reporting on the implementation of the PWQ:

- Ensure timely submission of the routine water quality data and the National Annual Water Quality Data Assessment Report, in accordance with provisions outlined in HH and AL.
- Report on any lesson learned from the implementation of the PWQ, including any identified actions that would improve cooperation among the Member States.

3.6 Sustainable institutional arrangements

It has been recognized that capacity building is needed to ensure the implementation of the HH and AL in all Member States. In the longer term, this must be supplemented with funding arrangements, making the Member States fully responsible for the funding of the implementation of the PWQ, which is part of the core functions of MRC.

3.6.1 Capacity building for sustainable implementation

Capacity needs assessment and a capacity building plan for the PWQ with regard to HH and AL will be designed for implementation based on the MRC Strategic Plan and collaboration with relevant MRC Secretariat's Divisions and Member States.

Capacity needs assessments will be regularly reviewed by the TBWQ with support from the MRC Secretariat. An annual capacity building plan for the implementation of the PWQ will be prepared by the TBWQ with the support of the MRC Secretariat.

To address the concerns of the Member States regarding their capacity to apply HH and AL, the following actions shall be taken by the TBWQ with support from the MRC Secretariat:

- Together with the Member States, review capacity including laboratory equipment and capacity building needs of the designated national laboratories.
- In collaboration with the Member States, using the results of the capacity needs assessment, design and implement a programme of work to strengthen the implementation of HH and AL.

3.6.2 Financial sustainability

The implementation of the PWQ is a core function of the MRC which is under the decentralization process. Partial funding for the implementation of the PWQ from the MRC will be provided until full financial autonomy[2] is reached by Member States.

2 Member Countries are fully responsible for financing the implementation of the PWQ.

PART B. WATER QUALITY EMERGENCY RESPONSE AND MANAGEMENT

Chapter 4. Guidelines for Water Quality Emergency Response and Management

These Guidelines for Water Quality Emergency Response and Management (hereafter referred to as "WQERM") shall be used as a decision support tool for the Member States in response to, and for the management of trans-boundary water quality emergencies. The users include the main stakeholders e.g. decision makers, water quality emergency operators and managers responsible for water quality emergency response and management.

The WQERM provides a template for trans-boundary water quality emergency response and management, including:

- The definition of the steps, processes and content of the trans-boundary water quality emergency response and management;
- The identification of the National Focal Point in the Member States responsible for water quality emergency response and management;
- The definition of the pathways for communication, including official information and consultation on water quality emergency;
- The definition of the trans-boundary implementation arrangements targeted at combating water pollution, and mitigating environmental degradation caused by any water quality emergency;
- The identification of the necessary processes for mutual assistance in case of any water quality emergency; and
- The identification of important corroborating information and studies for trans-boundary water quality emergency response and management.

The WQERM will be applied to any water quality emergencies that occur in:

- The Mekong mainstream;
- The trans-boundary tributaries [3].

The WQERM will apply to water quality emergencies including those caused by floods and other natural and human-induced hazards.

4.2 Definition of terms

For the purpose of the WQERM, the following terms shall, unless otherwise stated, mean:

1. **Water quality emergency**: An accidental situation or occurrence involving the release or spill of substance(s), potentially degrading the water quality of the Mekong mainstream and trans-boundary tributaries. A water quality emergency may be the result of human activities or natural occurrences.

3 The geographical scope shall be revisited following lessons learned from implementation.

2. **Substance(s)**: Material(s) with a specific chemical and/or biological composition. It can exist as solid, liquid or gases, and can be converted to another chemical substance due to changes in the surrounding environment (changes in temperature, pressure, pH, etc.)

3. **Water pollution**: The direct or indirect introduction (as a consequence of human or natural activity) of substances or heat into the water that may be harmful to human health or the quality of aquatic ecosystems, or to terrestrial ecosystems directly depending on aquatic ecosystems, or which result in damage to material property or impair or interfere with amenities and other legitimate uses of the environment.

4. **Water quality emergency response:** A detailed programme of action to control and/or minimize the effects of a water quality emergency requiring prompt corrective measures, beyond normal procedures, to protect human life, minimize injury, optimize loss control, and reduce the impacts of the incident to physical assets and the environment or to protect aquatic life.

5. **Water quality emergency management:** A programme that embraces all administrative and operational activities that are designed to reduce the risk of water quality emergencies. These programmes include but are not limited to: design safety of new and existing equipment; standard operating procedures; preventive maintenance; operator training; accident investigation procedures; risk assessment for unit operations; emergency planning; and internal and external procedures to ensure that these programmes are being executed as planned.

6. **Incident:** A set of circumstances that are a consequence of human activities or a natural phenomenon from which there is, or is likely to be a leak, spill, escape, or deposit of (a) substance(s).

7. **Main stakeholders**: Representatives from government and non-government organizations of the Member States who are involved in the implementation of the WQERM.

8. **Country of Origin**: The Member State in which the water quality emergency incident causing trans-boundary pollution originally occurs.

9. **Potentially Affected Countries:** A Member State or Member States which may be exposed to a risk of pollution from a trans-boundary water quality emergency.

10. **Trans-boundary water quality emergency**: For the purposes of the present Procedures, trans-boundary water quality emergency refers to any water quality emergency incident occurs within the defined geographical scope and originates in one Member State with a potential to reach another Member State, potentially causing harm to human health and aquatic life.

11. **Trans-boundary tributaries:** For the purposes of the present Procedures, trans-boundary tributary [4] refers to any Mekong tributary, as decided by the Joint Committee, which crosses national boundaries of the Lower Mekong States.

4.3 Purposes

The objective of the WQERM is to set out the processes required to implement section 5.2 of the Procedures for Water Quality – Emergency Water Quality Situations. The WQERM aims to provide guidance to the Member States and MRCS to allow them to prepare, implement and

4 Under the MRC Procedures for Notification, Prior Consultation and Agreement (PNPCA), Mekong Tributary is defined as "a natural stream of the Mekong River System. For the purposes of the PNPCA, a tributary as decided by the joint Committee is a natural stream of the Mekong River System whose flows have a significant impact on the mainstream. This definition is subject to be reviewed and agreed upon after some time of implementation if any concern is raised."

cooperate on trans-boundary water quality emergency response and management.

The WQERM has been developed to ensure timely and effective cooperation among Member States in response to trans-boundary water quality emergencies. It aims to minimize the extent of trans-boundary water quality emergencies and mitigate their negative effects on the water quality.

The WQERM defines the roles and responsibilities of the main stakeholders who are involved in the implementation of the trans-boundary water quality emergency response and management.

The WQERM can, where appropriate, help, support and strengthen the relevant national emergency response and management mechanisms of the Member States.

4.4 Approach

The Member States shall respond to water quality emergencies in alignment with their relevant existing national emergency response and management mechanisms.

The WQERM describes how to cooperate and integrate concerted actions of the Member States on preparation, operation and post-incident evaluation of the water quality emergency response and management. Roles and responsibilities of national and trans-boundary emergency response organizations and agencies involved in the water quality emergency response and/or support functions, are clearly defined and will function under the overall umbrella of the ASEAN Agreement on Disaster Management and Emergency Response (2005); the Mekong Agreement (1995) and the MRC Procedures for Water Quality (2011) while also taking into account the Sendai

Framework for Disaster Risk Reduction 2015-2030[5]. Relevant MRC guidelines should be taken into account in implementing the WQERM, including the guidelines for Carriage, Handling and Storage of Dangerous Goods along the Mekong River and the Dangerous Goods Management Manual.

In a disaster situation where the emergency is beyond the response capacity of an individual Member State, the ASEAN Standard Procedure for Regional Standby Agreements and Coordination of Joint Disaster relief and Emergency Response Operations (SASOP) will be applied to request for assistance.

4.5 Process

The WQERM comprises three phases (preparedness, operation and post-incident evaluation) and nine technical and administrative tasks that will be further described below, as shown in the diagram below (Figure 4.5.1).

5 A short description of the AADMER, SASOP and Sendai framework is provided in Appendix 4.3

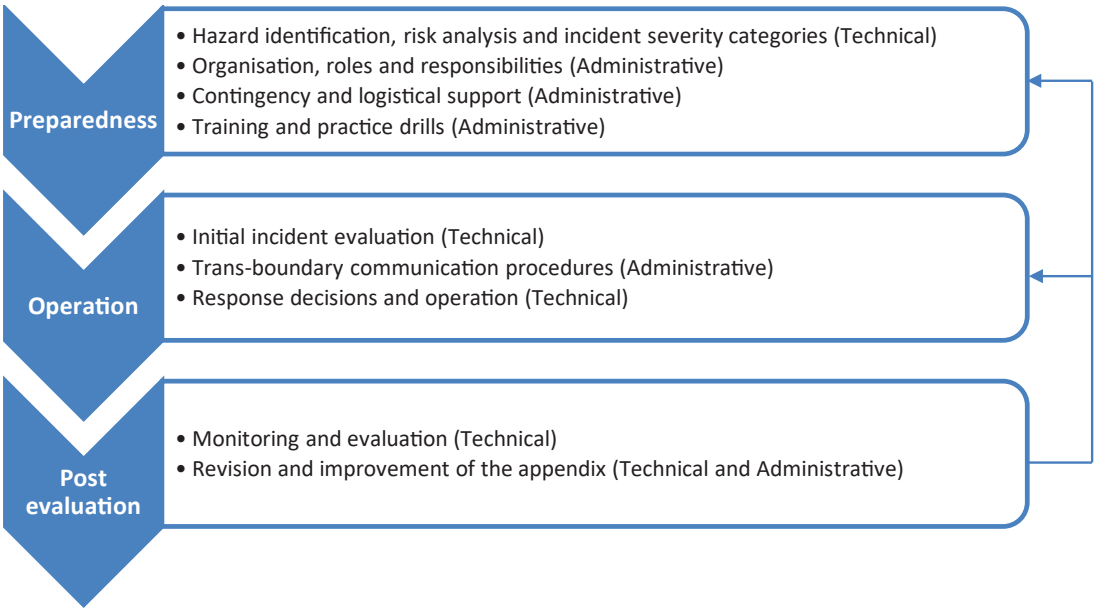


Figure 4.5.1. Phases and Tasks of the Mekong Water Quality Emergency Response and Management Process

The different Member States have diverse capacities and regulations. Several of the tasks as well as the roles and responsibilities may already be arranged and assigned within a Member State.

If this is the case, then there is no need for the Member State to take additional action regarding those aspects that are settled.

4.5.1 Preparedness

The Preparedness phase provides approaches and solutions to be prepared for a water quality emergency. It deals with developing a classification of the type and extent of a potential water quality emergency (hazard/risk/severity); establishing the necessary preparedness (organization, equipment, personnel); outlining the various types of support available and suggesting training including practice drills.

4.5.1.1 Hazard, sisk and severity

The first task is to develop a system to categorize the severity level of any water quality emergency. Two main criteria are taken into account when defining the incident severity category:

- The potential consequences of the pollution incident, i.e. the amount of spill, toxicity of the pollutant, the sensitivity of the potentially affected environment, the likelihood of occurrence and the capacity to respond effectively (severity criteria).
- The potential extent of the pollution, i.e. how far will a significant amount of the pollutant travel, i.e. will it reach the Potentially Affected Countries? (trans-boundary criteria).

The details of the score evaluation system and incident severity categories are explained in Appendix 4.4.

A map identifying environmental and safety hazards and determining the magnitude of risks (i.e. identification of sensitive sites) will support the preparation and operation of the water quality emergency response and management systems.

The severity of any water quality emergency is defined based on the scoring and ranking system:

1. Minor serious situation: water quality emergency unlikely to lead to a trans-boundary water quality emergency situation.
2. Moderately serious situation: water quality emergency with a moderate probability of reaching any other country causing environmental degradation and affecting human health and aquatic life.
3. Very serious situation: water quality emergency with a high probability of reaching another country and potentially causing harm to human health and aquatic life.

The severity categories are used to determine the response level. The water quality emergency response level depends on the incident severity category as shown in Table 4.5.1.

Table 4.5.1. Definition of response levels

Incident severity category	**Emergency response level**
Category 1: Minor serious situation	National water quality emergency response and management
Category 2: Moderately serious situation	National water quality emergency response and management – notification to the potentially affected country(ies)
Category 3: Very serious situation	Trans-boundary water quality emergency response and management

4.5.1.2 Organization, roles and responsibilities

This task aims at assigning the organizations involved in water quality emergency response and management, at both trans-boundary and national levels as well as their roles and responsibilities. The objective of this task is to facilitate trans-boundary cooperation and pooling of resources for implementing Mekong water quality emergency response and management.

The key principles, elements and entities of a national water quality emergency response organization are outlined in the Appendix 4.5 to facilitate the mutual understanding of organizational aspects of water quality emergency pollution response and management.

The National Focal Point for each Member State will be assigned. Further water quality emergency response entities from each Member State will be described and regularly updated in Appendix 4.1 to ensure the smooth operation of the WQERM.

The national focal point

A National Focal Point will be assigned by each Member State. The NFP function should be assigned to an institution as it must be available full-time (24 hours, 7 days a week) to ensure timely communication and action. The NFP is responsible for:

- Communicating any water quality emergency to their counterparts (NFPs) in the Potentially Affected Countries. The official information procedure is described in detail in section *4.5.2.2 Trans-boundary Communication Procedures*;
- Assisting and facilitating trans-boundary water quality emergency response, especially concerning any aspects of communication between the Country of Origin and the Potentially Affected Countries, supported by the NMCSs and MRCS;
- Compiling and regularly updating the list of national entities involved in the trans-boundary water quality emergency response and management, to be included as described in Appendix 4.1; and
- Compiling, reviewing, checking and regularly updating of the national contingency list and details of logistical support providers available for water quality emergency response, and for assembling and transmitting the information in a timely manner through the NMCS and MRC Secretariat for sharing with other Member States.

National response organization for water quality emergency

The National Response Organization for Water Quality Emergency is responsible for facilitating national mobilization of resources such as personnel, equipment and materials in the event of a water quality emergency and support the operation on any other matters related to national coordination. The Organization consists of:

- National Body/Committee that is responsible for supervising, monitoring and evaluating the water quality emergency pollution incident response;
- Coordinating Centre that is responsible for coordination and reporting on the emergency pollution incident;
- Command Centre responsible for development of action plans and supervision of the response operations;
- Operation unit responsible for conducting the water quality emergency response operation; and
- Support unit responsible for providing various technical, legal, administrative and field support.

The roles and responsibilities of the National Response Organization for Water Quality Emergency are described in more detail in Appendix 4.5.

National Mekong Committee Secretariats

NMCSs are responsible for:

1. Ensuring that a National Focal Point is appointed for the implementation of WQERM;
2. Working with relevant national organizations to ensure that national communication and information pathways are timely delivered and updated; and
3. During the operation, providing administrative assistance to the NFP regarding the communication, information and consultation processes.

The expert group on environmental management

Technical Guidelines for the Implementation of the PWQ (TGWQ) has been developed through the Technical Body for Water Quality (TBWQ), now the MRC Expert Group on Environmental Management (EGEM). The EGEM is responsible for supporting the implementation of the WQERM with the assistance from the MRCS as follows:

1. Reviewing and preparing annual capacity building plan to strengthen the implementation of WQERM;
2. In cooperation with the MRC Joint Platform and other relevant MRC bodies proposing revisions or amendments on the WQERM to the Joint Committee as appropriate.

Mekong River Commission Secretariat

The role of the MRC Secretariat is to support the Member States in the implementation of the WQERM as follows:

1. Providing technical assistance to the Member States on risk analysis and developing the system for severity categorization; providing response methods including containment and remediation; and providing access to key water quality and other water-related experts within the MRC Secretariat and beyond in the Lower Mekong Basin;
2. Providing administrative assistance to the Member States in order to ensure that the official information procedure is maintained and functioning;
3. Facilitating the problem solving and consensus building process required to enable the response operations to cooperate closely, rapidly, efficiently and consistently; and
4. Assisting in the capacity building and training, including practice drills for the Member States' organizations and personnel involved in the implementation of the WQERM.

4.5.1.3 Contingency and logistical support

Contingency and logistical support, one of the administrative tasks as defined in the WQERM, includes available human resources, expertise and necessary equipment to support the response decision and implementation as well as manufacturers and suppliers of water pollution containment and remediation equipment and materials. Member States are requested to prepare and share their list of available national contingency and logistical support, in accordance with the PDIES.

The Member States shall compile, review, check and regularly update the national contingency list and logistical support available for water quality emergency response, as well as disseminate the information in a timely manner through the MRC Secretariat for sharing with other Member States. Regional contingency lists and logistical support shall be made available for sharing with other Member States as well as with the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) at a moment's notice. In addition to the MRC Water Quality Monitoring Network of national designated labs, three key types of resources are identified:

- Universities and institutions specializing in the analysis of water quality parameters relevant to emergency response;
- Manufacturers and suppliers of water pollution containment and remediation equipment; and
- Water pollution containment and remediation experts together with their associated expertise.

An extensive overview of techniques for pollution containment and remediation is provided in Appendix 4.6.

4.5.1.4 Training and practice drills

Training and practicing drills are an integral part of a comprehensive water quality emergency response and management system. Initial training must be followed by periodic updates to maintain familiarity with all aspects of emergency response and management. The training programme shall be provided to all personnel involved in preparing and operating water quality emergency response and management activities.

Training should be provided annually and in the following situations:

- For new employees during their orientation period;
- For current employees when there is a change in their duties;
- When new equipment or materials are introduced;
- When emergency procedures are revised; and
- When a practice drill indicates need for improvement.

Practice drills are important to develop employee skills and evaluate the adequacy of the WQERM, through the use of mock exercises or drills. The objectives of a mock drill include evaluation of the following:

- Practicality of the water quality emergency response and management (structure and organization);
- Adequacy of communications and interactions among parties;
- Emergency equipment effectiveness;
- Adequacy of first aid and rescue procedures;
- Adequacy of emergency personnel response and training;
- Public relations skills; and
- Evacuation and personnel count procedures.

Drills may be conducted in various forms such as desktop, on-site or computer synthesized. The complexity of the drills may be increased as the response team gains proficiency. Drills must be frequent enough to ensure that the response team maintains proficiency in all aspects of WQERM, preferably on an annual basis.

The MRC Secretariat shall survey the training needs and prepare an annual training and practice drill plan. Also, the MRC Secretariat will facilitate joint training and practice drills, as requested by the Member States, and conduct mutual visits for assessment of water quality emergency response preparedness among the Member States.

4.5.2 Operation

Upon identification of a water quality emergency incident with potential trans-boundary implications, the following operational tasks should be undertaken:

1. Initial Incident Evaluation
2. Trans-boundary Communication Procedure
3. Trans-boundary Response Decisions and Operations

These tasks are further described below. All of these tasks may occur over a short or protracted time period depending on the circumstances and magnitude of the water quality emergency

incident. Figure 4.5.2 gives an overview of the order of the tasks involved.

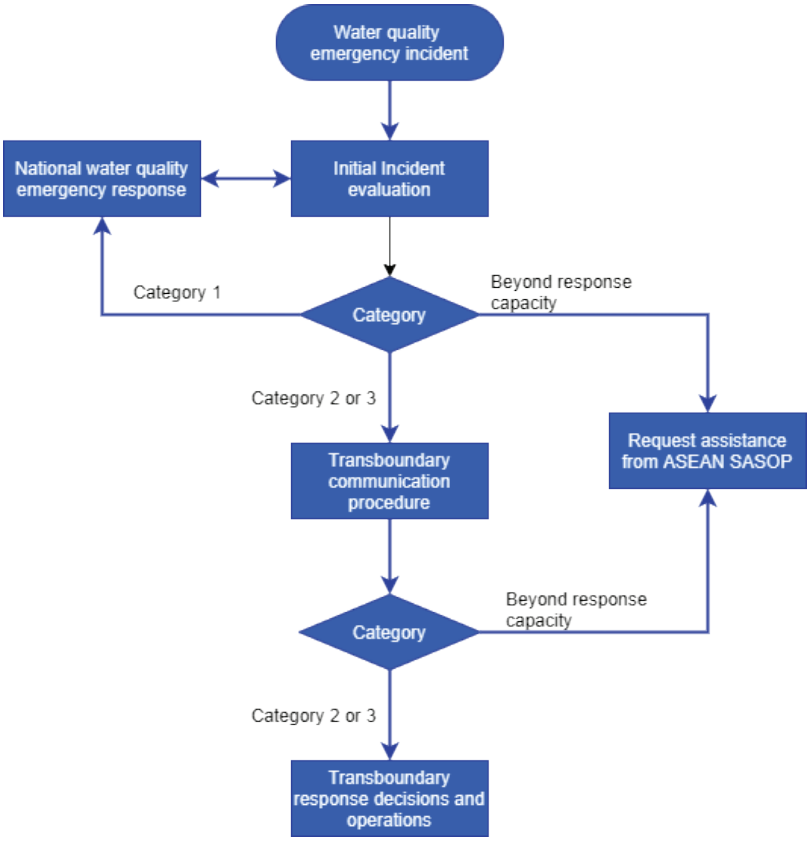


Figure 4.5.2. Main steps in the Operations phase in case of a water quality emergency incident

4.5.2.1 Initial incident evaluation

An initial incident evaluation is undertaken in the Country of Origin when an incident occurs. A risk analysis is performed to determine the incident severity category, following the principles outlined in section 4.5.1.1 and the detailed information described in the Appendix 4.2. The National Response Organization for Water Quality Emergency evaluates and categorizes the incident, as described in Appendix 4.5 in close communication with the WQERM NFP.

In any water quality emergency incident, the Member States shall operate their own national water quality emergency response mechanisms in accordance with national regulations and guidelines. It is recommended to apply the precautionary principle to allow the Potentially Affected Countries to prepare and initiate their national water quality emergency response system even though the severity category does not denote a very serious situation. Therefore, if the water quality emergency incident is categorized as a moderately serious situation (Severity Category 2) or very serious situation (Severity Category 3), the Country of Origin shall, without delay and by the most expeditious means available, notify the Potentially Affected Countries, indicating the Severity Category, to allow them to prepare. This is the start of the Trans-boundary Communication Procedure.

If the water quality emergency situation is discovered by one Member State but probably caused by another Member State, the trans-boundary communication procedure in the WQERM shall be used, and the MRC Secretariat will facilitate identification of the water quality emergency sources in collaboration with the Member States concerned.

If elements of a water quality emergency incident are beyond the response capacity of the Country of Origin for containment, remediation and monitoring, presumably outside the water quality domain, the WQERM NFP of the Country of Origin shall, if they are separate entities, without delay and by the most expeditious means available, notify the NFP of the ASEAN Agreement on Disaster Management and Emergency Response within the country, that will start the procedure of request for assistance as described in the ASEAN Standard Procedure for Regional Standby Agreements and Coordination of Joint Disaster relief and Emergency Response Operations (SASOP).

4.5.2.2 Trans-boundary communication procedure

Once the emergency is categorized, information regarding the emergency must be communicated promptly and accurately throughout the following relevant organizations. Figure 4.5.3 gives an overview of the main communication lines.

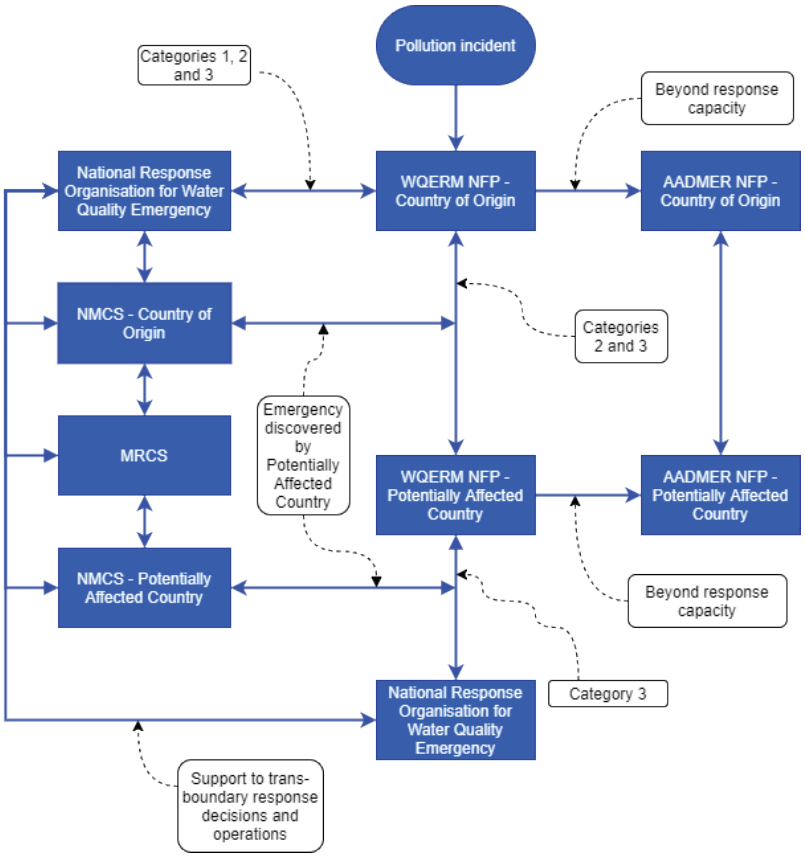


Figure 4.5.3. Main communication lines after a water quality emergency incident

In case of a water quality emergency incident, the NFP of the Country of Origin is immediately notified. The NFP instantaneously communicates with the National Response Organisation for Water Quality Emergency to categorize the incident. In the case of an incident with Severity Category 2 or 3, the NFP of the Country of Origin, without delay and by the most expeditious

means available, notifies the NFPs of the Potentially Affected Countries and, in parallel, the NMCS and the MRC Secretariat. In the case of an incident with Severity Category 3, the NFPs of the Potentially Affected Countries immediately notify their respective National Response Organisations and NMCS.

The NFP of the Country of Origin conveys details about the water quality emergency as accurately as possible through the Trans-boundary Official Information Template, with the following information:

- Date and time that the water quality emergency incident occurred or was observed;
- The location of the water quality emergency incident, and the extent;
- Description, characteristics and movement of pollutants associated with the water quality emergency incident, including volumes where this can be estimated;
- Estimated time until the pollutant reaches the national boundaries of the Potentially Affected Countries; and
- Information on the response operation and action taken to mitigate or contain the pollutants.

The Trans-boundary Official Information Template is provided in Appendix 4.2.

The communication between the National Response Organization of the Country of Origin and the counterparts of the Potentially Affected Countries shall be made by all communication means e.g. telephone, fax, SMS and email. The telephone and fax numbers and email addresses of the concerned agencies shall be listed, updated and available for all personnel as referred in Appendix 4.1.

In order to respond in a timely manner to a water quality emergency, a 24-hour communication structure shall be set up within the Member States.

In the event that people in the incident area are likely to be affected by the water quality emergency incident, relevant information shall be disseminated to the public by the respective Country, where appropriate, as soon as possible.

In all organisational set-up, care should be taken that timely communication is of the utmost importance and has to be guaranteed at all times.

4.5.2.3 Trans-boundary response decisions and operations

The Trans-boundary Response Decisions and Operations procedure is started in the case of an incident with Severity Category 3. The response decision and operations task requires the NFP for the Country of Origin to work with the counterpart NFPs in the Potentially Affected Countries and, via NMCS, the MRCS to establish a trans-boundary response team, in accordance with Article 10 of the 1995 Mekong Agreement [6].

The composition of the trans-boundary response team is depending on the type of water quality emergency incidence and the expertise needed, but the team should at least contain representatives of the National Response Organisations of the Country of Origin and the Potentially Affected Countries. The trans-boundary response team shall coordinate and

6 "Whenever a Party becomes aware of any special water quantity or quality problems constituting an emergency that requires an immediate response, it shall notify and consult directly with the party (ies) concerned and the Joint Committee without delay in order to take appropriate remedial action."

communicate detailed response actions for water quality emergency response operations. The trans-boundary response team can develop and undertake specific actions when relevant, in close communication with the NFPs and NMCSs.

Information will be exchanged regarding:

- Mobilized resources including staff and equipment for containment, and remediation/clean-up of the water quality emergency incident area and the potentially affected area;
- The progress and status of the operation for containment and remediation/clean-up at national and trans-boundary levels; and
- Evaluating the situation and level of clean-up achieved.

During the operation, the NMCSs shall provide administrative assistance to the NFPs with regard to communication, information and consultation processes; facilitate national mobilization of resources such as personnel, equipment and materials, and support the operation on any other matters related to national coordination.

During the operation, the MRC Secretariat, upon the request of the Member States, shall provide technical and administrative assistance to the NFPs with regard to trans-boundary communication, information and consultation processes.

A description of examples of operational response methods for containment and remediation/ clean-up are provided in the Appendix 4.6.

If the water quality emergency incident or elements thereof are beyond the response capacity of one of the countries, the WQERM NFP of that country without delay and by the most expeditious means available notifies the AADMER NFP requesting for assistance. This is done through the procedures as described in the SASOP. In the case that the NFP for WQERM and AADMER are the same institution, the NFP can start the SASOP procedure next to the already active WQERM procedure.

4.5.3 Post-incident evaluation

The purpose of the post-incident evaluation is to account for the actions taken, provide material for any legal action, for public relations and for identifying weaknesses or strengths in the WQERM and to improve it.

The results of the post-incident evaluation can be used to identify the party responsible for damages caused by water quality emergency. Follow-up collaborative actions among parties related to the incident must be in line with Article 8 “State Responsibility for Damages” of the 1995 Mekong Agreement.

Also, the results of the post-incident evaluation will be used as feedback and lessons learned to improve the implementation of the Preparedness and Operation Steps of the WQERM (see Figure 4.5.4).

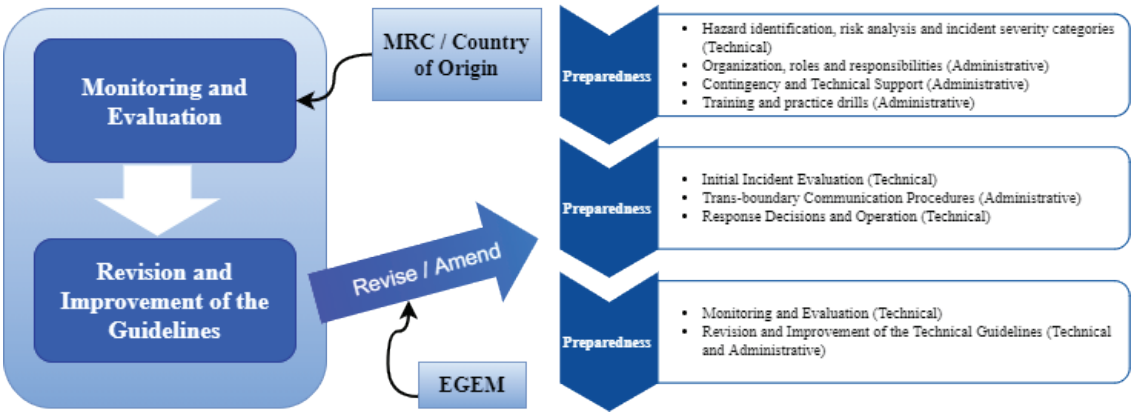


Figure 4.5.4. The evaluation process

The post-incident evaluation includes the following tasks:

4.5.3.1 Monitoring and evaluation

The purpose of the monitoring and evaluation task is to identify:

- Impacts on the quality of the river environment during and after the water quality emergency and associated impacts on the socio-economic and environmental situation in the affected area; and
- Weaknesses or strengths in the Preparedness and Operation Steps of the WQERM.

The monitoring and evaluation task should provide a written report on each water quality emergency operation. The report provides at least the following information:

- A general description of the water quality emergency incident;
- Sources and causes of the water quality emergency incident;
- Scope of influence, affected population, and exploitation and use of water resources;
- A description of the response efforts and operation actions and associated costs;
- Quantity of the spill and percent recovered;
- Water quality of the river during and after the incident;
- Damage costs of impacts to the environment, society and economy;
- Itemized clean-up costs;
- Recommendations for prevention and mitigation measures; and
- Recommendations for improvement of water quality emergency response and management;

The monitoring and evaluation shall be carried out by a third party that should be a state or private institutional organization such as a research institute or consultant company. The Country of Origin is responsible for this assignment. The monitoring and evaluation report will be submitted to the EGEM for consideration of revision and improvement of the Guidelines.

The monitoring and evaluation shall be undertaken for every “very serious situation” of water quality emergency (Severity Category 3) and in the case that a moderately serious situation (Severity Category 2) has turned into a Severity Category 3 situation. Monitoring and evaluation of other water quality emergencies is at the discretion of the Country of Origin. The MRC

Secretariat shall provide the available technical and administrative support for any monitoring and evaluation as requested by the Member States.

4.5.3.2 Revision and improvement of appendix 4

The information as requested in the formats of Appendix 4.1 and Appendix 4.2 should be in place and updated periodically so that its call-out numbers and procedures are current. The revision and improvement of Appendix 4 requires both administrative and technical inputs. Therefore, when an amendment is made, the amendment date should be noted on the version tracking page of Appendix 4. The NFP ensures that all Member States are notified of changes as soon as possible. Member States should be requested to verify that they have received the changes. They should be notified immediately of any key changes regardless of review period. The most common amendments include telephone listings, response personnel, equipment, chemicals handled, emergency services available and resource lists.

4.6 Data and information sharing

The NFP will share the list of national entities (also see Appendix 4.1), the national contingency list and logistical support information following the provisions of the MRC PDIES and its Technical Guidelines. When relevant, the NFP may share the information with the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre).

For any event of a water quality emergency, sharing of data and information regarding the water quality emergency shall follow the provisions outlined in Section 4.5.2.2.

4.7 Sustainable institutional arrangements

It has been recognized that capacity building is needed to ensure the implementation of PWQ with regard to WQERM in all the Member States. In the longer term, this has to be supplemented with funding arrangements that would make the Member States fully responsible for the funding of the implementation of the PWQ which is a core function of MRC.

4.7.1 Capacity building for sustainable implementation

Capacity needs assessments will be regularly reviewed by the EGEM with support from the MRC Secretariat. An annual capacity building plan for implementation of the PWQ with regard to WQERM will be prepared by the EGEM with the support of the MRC Secretariat and will be reported to the MRC Joint Committee.

To address the concerns of the Member States regarding their capacity to apply the WQERM, the following actions shall be taken by the EGEM with support from the MRC Secretariat:

- Together with the Member States, review capacity of emergency response and management and the capacity building needs of the designated agencies;
- In collaboration with the Member States, by using the capacity needs assessment results, design and implement a programme of work to strengthen the capacity for implementation of the WQERM including the design of the long-term overall training plan; and
- Collaborate with external partners, including the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre), to jointly implement capacity building activities.

PART C. REVIEW OF THE TECHNICAL GUIDELINES ON THE IMPLEMENTATION OF THE PROCEDURES FOR WATER QUALITY

The TGWQ shall be periodically reviewed upon request of any of the Member States. They shall be reviewed by the EGEM, supported by scientific and technical experts as required. Final approval of the TGWQ shall be made by the MRC Joint Committee.

The reviewing mechanisms are as follows:

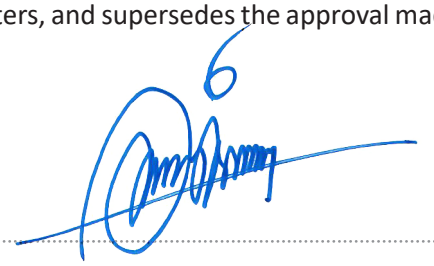
- The users of the TGWQ or EGEM members should request to revise the TGWQ through National Mekong Committee Secretariat.
- National Mekong Committee Secretariat should send an official request to the MRC Secretariat to initiate the revision process.
- The MRC Secretariat shall inform other National Mekong Committee Secretariats regarding the request and ask all NMCSs to consider a revision drafted by the MRC Secretariat.
- If this proposed draft revision cannot be approved, the MRC Secretariat should prepare and convene an EGEM meeting on the specific request.
- The EGEM meeting agenda would consider the specific request and related sections of the TGWQ. If the revision is agreed by the EGEM, the MRC Secretariat shall submit the revised version of the TGWQ for approval to the MRC Joint Committee.

The MRC Joint Committee, at its Preparatory Meeting of the 23rd MRC Council Meeting held on 22 November 2016 in Pakse, Lao People's Democratic Republic, approved Part A[7], which includes Chapters 1, 2 and 3 of the Technical Guidelines on the Implementation of the Procedures for Water Quality.

7 Part A of the Technical Guidelines was jointly developed and finalized by the Technical Body on Water Quality (TBWQ), a regional technical working group tasked with the implementation of the Procedures for Water Quality (PWQ). Following the restructure of the MRC Secretariat in 2016, the TBWQ was replaced by the MRC Expert Group on Environmental Management (EGEM), who developed and finalized Part B of the Technical Guidelines. As such, in the context of the approved Technical Guidelines on the Implementation of the Procedures for Water Quality, any references made to the TBWQ are replaceable with the EGEM.

Adoption of the Technical Guidelines

The MRC Joint Committee, which convened its 51st Meeting on 16 June 2021 in Vientiane, Lao People's Democratic Republic, via videoconferencing, approved Part B: Chapter 4 of the Technical Guidelines on the Implementation of the Procedures for Water Quality. This approval marks the full approval of the Technical Guidelines on the Implementation of the Procedures for Water Quality, which includes four Chapters, and supersedes the approval made on 22 November 2016.

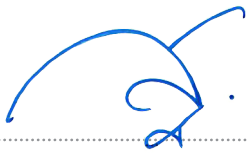


H.E. Mr So Sophort

Secretary General
Cambodia National Mekong Committee
Member of the MRC Joint Committee for Cambodia

Mr Phonepaseuth Phouliphanh

Acting Chairperson of the MRC Joint Committee for 2021
Acting Secretary-General
Lao National Mekong Committee Secretariat



Dr Surasri Kidtimonton

Secretary General of the Office of the National Water Resources
Member of the MRC Joint Committee for Thailand

Mrs Nguyen Thi Thu Linh

Acting Secretary-General
Viet Nam National Mekong Committee
Member of the MRC Joint Committee for Viet Nam

Appendices of Chapter 4. Guidelines for Water Quality Emergency Response and Management

Appendix 4.1: Internal and external contact detail

The Member States are responsible for filling out the table below with the most updated and concise information

1) **National Focal Point**

Name	Organization/Position	Phone number			E-mail	Fax (Office)
		Mobile	Office	Home		

2) **Operation Unit**

Name	Organization/Position	Phone number			E-mail	Fax (Office)
		Mobile	Office	Home		

3) **Support Unit**

Name	Organization/Position	Phone number			E-mail	Fax (Office)
		Mobile	Office	Home		

4) **Private contractor and Consultants**

Name	Organization/Position	Phone number			E-mail	Fax (Office)
		Mobile	Office	Home		

Appendix 4.2: Trans-boundary Information Template

4.2.1 Initial information

Where there is an actual or probable water quality emergency water quality emergency incident in the Mekong River Basin it is the responsibility of the Country of Origin to inform the National Focal Points on Water Quality Emergency and the MRCS by the quickest means possible.

The National Focal Point on Water Quality Emergency will provide 24-hour contact telephone numbers for water quality emergency response. Informing about a water quality emergency incident in no way implies an admission of guilt, but failure to report an incident of Severity Category 2 or 3 within 48 hours is clearly an offence.

4.2.2 Official information

The National Focal Point of the Country of Origin shall notify the counterpart National Focal Point of the Potentially Affected Countries and the MRC Secretariat, even if there is uncertainty as to whether the water quality emergency incident might cause a trans-boundary water quality emergency. For this initial information purpose, the initial information template is used (section 4.4.3).

The National Focal Point on Water Quality Emergency is responsible for officially informing the Potentially Affected Countries and the MRC Secretariat when the water quality emergency is initially evaluated and assessed as a moderately or very serious situation (Severity Category 2 or 3). This official information will use the Official Information template form below (section 4.4.4).

4.2.3 Initial information template form

General information:

- Date and time of official information
- Informing officer:
  - Name:
  - Organization
  - Position
  - Contact detail:
  - Phone number: (Office, home, and mobile)
- Receiving officer
  - Name:
  - Organization
  - Position
  - Contact detail:
  - Phone number: (Office, home, and mobile)

1) Source: *(if so, give the name of incident maker)*

2) Date and Time of Incident:

3) Location of Incident *(Latitude-Longitude, or nearest landmark, name of commune, village, district, province etc.)*

4) Cause:

5) Estimate of quantity and characteristic of pollutants:

4.2.4 Official Information Template Form

Water Quality Emergency Incident – Information Form

General information:

- Date and time of official information
- Informing officer:
  - Name:
  - Organization
  - Position
  - Contact detail:
  - Phone number: (Office, home, and mobile)
- Receiving officer
  - Name:
  - Organization
  - Position
  - Contact detail:
  - Phone number: (Office, home, and mobile)

A. Detail of Water Quality Emergency Water quality emergency Incident

1) Source: *(if so, give the name of incident maker)*

2) Date and Time of Incident:

3) Location of Incident *(Latitude-Longitude, or nearest landmark, name of commune, village, district, province etc.)*

4) Cause:

5) Estimate of quantity and characteristic of pollutants:

6) Probability of affecting neighboring countries:

7) Severity category:

B. Weather and River flow condition

8) Weather:

9) River flow rate:

C. Response actions

10) Current action being taken to limit the effects of the water quality emergency incident

Appendix 4.3. Summary of AADMER, SASOP and Sendai framework

ASEAN Agreement on disaster management and emergency response (AADMER)

The ASEAN Agreement on Disaster Management and Emergency Response (AADMER), which came into force in December 2009, sets the foundation for regional cooperation, coordination, technical assistance, and resource mobilisation in all aspects of disaster management and emergency response.

The objective of the Agreement is to provide effective mechanisms to achieve substantial reduction of disaster losses in lives and in the social, *economic* and environmental assets of the Parties, and to jointly respond to disaster emergencies through concerted national efforts and intensified regional and international co-operation. To this end, the AADMER contains provisions for Parties to request and provide assistance in emergency situations. Next to that, Parties shall develop and maintain measures to identify disaster risks and to mitigate and prevent disaster risks.

Standard Operating Procedure for Regional Standby Arrangements and Coordination of Joint Disaster Relief and Emergency Response Operations (SASOP)

The Standard Operating Procedure for Regional Standby Arrangements and Coordination of Joint Disaster Relief and Emergency Response Operations (SASOP) is developed under the AADMER to guide the actions of Parties. The SASOP provides

i. the guides and templates to initiate the establishment of the ASEAN Standby Arrangements for Disaster Relief and Emergency Response;

iii. the procedures for joint disaster relief and emergency response operations;

iv. the procedures for the facilitation and utilisation of military and civilian assets and capacities; and

v. the methodology for the periodic conduct of the ASEAN Regional Disaster Emergency Response Simulation Exercises (ARDEX) which shall test the effectiveness of the SASOP.

Sendai Framework for Disaster Risk Reduction 2015-2030

Working hand in hand with the 2030 Agenda, the Sendai Framework for Disaster Risk Reduction 2015-2030, that was adopted at the Third UN World Conference on Disaster Risk Reduction in Sendai, Japan, on March 18, 2015, is the roadmap to make communities safer and more resilient to disasters. It aims to achieve the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries until 2030. The Sendai Framework outlines four priorities for action to prevent new and reduce existing disaster risks:

i. Understanding disaster risk;

ii. Strengthening disaster risk governance to manage disaster risk;

iii. Investing in disaster reduction for resilience; and

iv. Enhancing disaster preparedness for effective response, and to “Build Back Better” in recovery, rehabilitation and reconstruction.

Appendix 4.4. Score Evaluation System for Incident Severity Categories

4.4.1 Criteria for defining the seriousness of the water quality emergency incident

To determine the actions, required reporting levels, and to optimize the trans-boundary communications between Member States, it is important to define the agreed response level for these actions. Each water quality emergency incident should be assessed individually taking into account important criteria. The Coordinating Centre of the Water Quality Emergency Response and Management system in the Country of Origin is responsible for this initial assessment of the **Seriousness of the Water Quality Emergency Incident,** which will determine the response level.

Two main criteria need to be taken into account to define this viz.:

1. Severity of the water quality emergency incident.
2. Possible extent of the water quality emergency, i.e., how far will significant amounts of the pollutant travel and potentially reach other countries. (trans-boundary criteria)
3. The approach to relate these two criteria is to construct a Risk Analysis Matrix as described in Table 1.

Table 1. River Water Quality Emergency Criteria Matrix

EXTENT		SEVERITY				
		Insignificant	Minor	Moderate	Major	Catastrophic
		No Impact (1)	Potentially affect aesthetic quality (2)	Potentially harmful to ecosystem (3)	Potentially harmful to aquatic life (4)	Potential harmful to human health (5)
Probability of affecting other countries	Unlikely (1)	1	2	3	4	5
	Moderately/likely probable (2)	2	4	6	8	10
	Highly probable (3)	3	6	9	12	15

Severity scores

These have been scored from "No Impact" at a score of 1 to "Catastrophic" score 5. This assessment will depend mainly on the toxicity of pollutant, the dilution by the river and the sensitivity of the potentially affected river stretches. The sensitivity can be related to e.g. vulnerable ecosystems, wetlands or biodiversity and/or high population densities (cities).

The extent of travel scores

The extent of travel score ranges from the "Unlikely" score of 1 to "Extremely Probable" score of 3. This will depend mainly on the amount of water quality emergency and velocity and flow of the river, but it also depends on the capacity of the Country of Origin to contain the water quality emergency and thereby decrease the travel distance of the pollutant. Assessment of extent of travel will be greatly assisted by using computerised predictive models.

4.4.2 Incident severity categories

Seriousness of the water quality emergency Incident

The product of these scores is defined in the matrix table 2 to give a measure of the seriousness of the water quality emergency incident. This table can assist the Member States to determine a semi-quantitative scoring of an incident and to manage each type of incident accordingly. Three categories of seriousness are proposed below of which the category 3 calls for trans-boundary cooperation.

Category 1: Score 1 to 5 – Minor Situation, The incident shall cause

- **Potential consequences**
  - No impact on river environment.
  - o Potentially affecting to aesthetic quality
  - o Potentially harmful to ecosystem

- **Potential extent**
  - Low probability for the pollutant to travel to the Potentially Affected Countries
  - Moderate probability for the pollutant to travel to the Potentially Affected Countries
  - High probability for the pollutant to travel to the Potentially Affected Countries

Category 2: Score 6 to 10 – Moderately Serious Situation. The incident shall cause

- **Potential consequences**
  - Potentially harmful to ecosystem
  - Potentially harmful to aquatic life
  - Potentially harmful to human health

- **Potential extent**
  - Low probability for the pollutant to travel to the Potentially Affected Countries
  - Moderate probability for the pollutant to travel to the Potentially Affected Countries

Category 3: Score 11 to 15 – Very Serious Situation . The incident shall cause

- **Potential consequences**
  - Potentially harmful to aquatic life
  - Potentially harmful to humans health

- **Potential extent**
  - High probability for the pollutant to travel to the Potentially Affected Countries

Appendix 4.5. National Response Organization for Water Quality Emergency

This section briefly describes the principles and possible organisation of national water quality emergency response management. The key principles, elements and entities of a national water quality emergency response organization are outlined to facilitate the mutual understanding of organisational aspects of water quality emergency water quality emergency response and management. Member States who have not yet established and endorsed a national response organization on prevention and combating of oil spill and other water quality emergency situations may wish to consult the below descriptions on the operation of emergency responses and the delegation of authority from operations personnel to emergency response personnel.

4.5.1 Organization chart

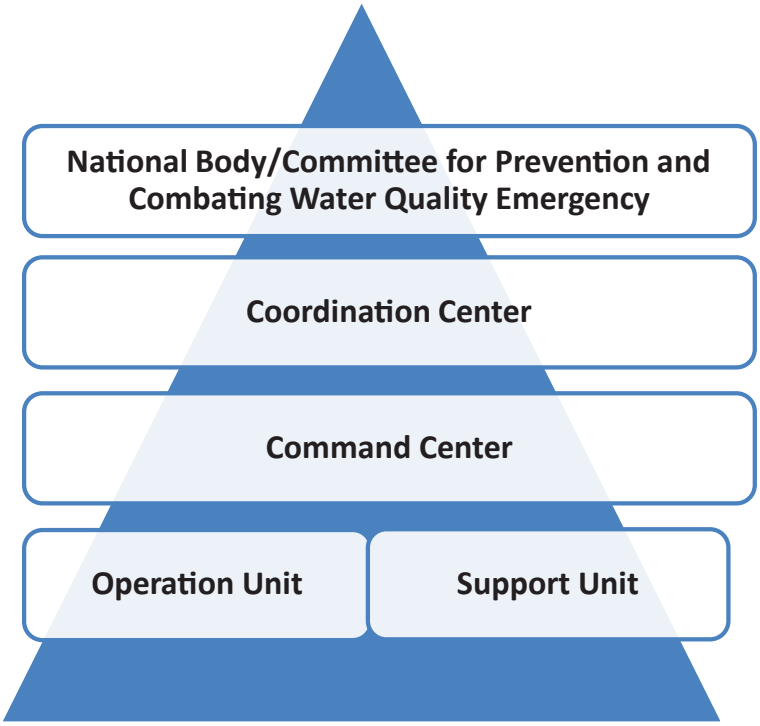


Figure 1. Principles of a possible national water quality emergency response organization

4.5.2 Duties and responsibilities

i. ***National Body/Committee on the Prevention and Combating of Water Quality Emergency***

The national body/committee on the prevention and combating of water quality emergency shall be responsible for supervising, monitoring and evaluating the water quality emergency water quality emergency incident response including disseminating information to the public and media, and submitting the report to the government, and coordination with other Member States with regards to trans-boundary water quality emergency response.

The national body/committee on the prevention and combating of water quality emergency would normally consist of the Water Quality Emergency Control Department, Department of Water Resources or similar according to the national organization of the Member States.

ii. Coordinating Centre

The Coordinating Centre shall have the following responsibilities:

- Report of the operation to the national body/committee on the prevention and combating of water quality emergency.
- Coordination of activities with concerned agencies.
- Gathering evidence for legal action against polluters for compensation claim of clean-up cost.
- Arrangement of a budget for training, practice drills, and response operation.

The Coordinating Centre role is normally performed by the Water Quality Emergency Control Department or similar agency according to the national organization of the Member States.

iii. Command Centre

The Command Centre has following responsibilities:

- Development of action plans and determination of response methods
- Direction, supervision and co-ordination of the response operations
- Reporting of response activities to the Coordinating Centre.

The Command Centre will be formed in the event of an incident and is the main body responsible for undertaking the Water Quality Emergency Response operations. Overall responsibility for the activities of the Command Centre and response to an incident lies normally either with the Water Quality Emergency Control Department or Department of Water Resource depending on the national organization of the Member States.

The Command Centre consists of representatives of the “Operational” and “Support” units. Representation of the various Operations and Support Units within the Command Centre is as deemed necessary by the Director of the Centre.

iv. Operation Unit

The operation unit shall conduct the water qualify emergency response operation as assigned by the Command Centre and shall continuously report the progress of the operation and difficulties encountered to the Command Centre.

The operation unit has the following responsibilities

- Incident surveillance and verification
- Water quality emergency incident clean-up
- Assistance to local communities - clean-up of the river
- Preventative measures for river impact
- Assistance in equipment support

The operation unit consists of representatives from the Water Quality Emergency Control Department, Water Resource Department, Irrigation Department, Fishery Department, Navigation Department, and Provincial Administration according to the needs of the actual response operation. The composition will be determined and decided by the Command Centre.

v. Support Unit

Support Units are responsible for providing various technical, legal, administrative and field support to the spill response effort as follows:

- Modelling of water quality emergency incident characteristics & movement
- Identification of sensitive sites
- Verification of water quality emergency incident reports
- Restoration of the environment
- Legal action against polluter
- Transport of equipment
- Manpower and general equipment (shoreline clean-up)
- Control of river traffic at water quality emergency incident
- Provision of information on weather conditions
- Support of river clean-up operation with provision of equipment and vehicles for transport of personnel
- Provision of information on spawning, cultivation and fishery grounds
- Facilitate disbursement of advance funds and central budget funds for water quality emergency response
- Provision of boats, equipment and transportation for clean-up

The Support unit consists of representatives from the Water Quality Emergency Control Department, Water Resource Department, Irrigation Department, Fishery Department, Navigation Department, Army, Police, Hydro-Meteorological Department, Provincial Administration and private sector concerned.

Appendix 4.6. Techniques for Pollution Containment and Remediation

A. Pollution Containment

4.6.1 Introduction

One of the first ways to limit the effects of a pollutant is to contain it and to prevent as much as possible the amount entering the river or water source. There are a number of ways to effect containment and these include the following:

4.6.2 Techniques for pollution containment

4.6.2.1 Barriers

The barriers are temporary erections to obstruct the flow of the pollutant or to localise it. The simplest barrier is the sealing and covering of drains and possible points where the pollutant can enter via storm drain into the river as shown below in figures 1 & 2.

Figure 1. Sealing a storm drain[8]

Figure 2. Erecting a barrier for drain[9]

4.6.2.2 Boom

One of the ways of localising the pollutant especially oil is to use booms. There are several types of booms: inflatable, permanent Bank seal booms and specially designed.

Inflatable Booms

Inflatable booms can be used for offshore and inshore use. They are typically emergency booms for rapid deployment. The booms incorporate a number of features, including either tension wires or a ballast chain and quick release couplings.

8 MBZ Industrial Inc., 2021. 2130 Ultra-Drain Seal Drain Cover. www.thorspillproducts.com.
9 Green State Services, 2021. Ultra-Spill Berm – Spill Containment Berm. www.greenstateservices.com

The smaller booms can be supplied in packs complete with carrying case and a foot operated inflation pump. The larger booms can be contained on a reel for storage, deployment, and boom retrieval. For the larger booms a petrol-powered air pump/blower is required

Figures 3 and 4. Erecting Inflatable Booms[10]

These booms usually come in standard lengths e.g. 5 m with end connectors such as Velcro using self-tensioning ties to create a complete seal. The buoyancy chamber is folded and welded but with open ends into which are inserted inflatable air bags made from robust heavy duty synthetic material with air valves which can be connected to foot pumps. These air bags can be removed for repair in the event of puncture using conventional repair kits and if badly torn can be completely replaced.

Permanent Booms

Permanent booms usually apply solid buoyancy technology and can be used for a multitude of uses. Using PVC or polyethylene filled floats they are manufactured as a continuous flat strip about 4 cm in thickness and varying heights and lengths. Foam blocks rather than an air chamber provide the buoyancy; thus, they are less prone to deflation and vandalism than air inflated booms. In the longitudinal direction the fabric is welded vertically, to form individual pockets into which is inserted synthetic foam blocks for buoyancy. Mild steel ballast is fitted at the manufacturing stage in individually sealed pockets in the lower part of the boom

Solid buoyancy booms can be an incorporate as part of a contingency plan fixed close to the outlet of drains alongside ponds and lagoons in general industry for the prevention of oil/ chemical spills to our inland waterways or coastal regions.

This range of booms can be also used as a debris screen on rivers, canals, or reservoirs in conjunction with the 'trash trap'. These booms greatly assist in the prevention of costly maintenance and additional pollution problems associated with floating debris.

10 Ly, Kongmeng. 2015. The Joint MRC-Thailand's Marine Department Oil Spill Training. Bangkok. Thailand

Figure 5. Permanent Boom protecting the Water Treatment works intake[11]

Bank Seal Boom

Bank seal booms are booms that can be deployed over water and land without losing a seal, which would inherently allow contaminants to escape. Maintenance of the boom is minimal, but should the fabric become torn this can easily be repaired using a boom repair kit. This boom is ideal where the pollution source is from an overturned tanker, which has spilled its load close to the bank, and so the source is a non point source.

Figure 6. Bank Seal Boom[12]

Specially Designed Booms

Certain situations require a special type of boom that is designed to cope with the various local conditions.

11 Ly, Kongmeng. 2015. The Joint MRC-Thailand's Marine Department Oil Spill Training. Bangkok. Thailand
12 Marine Department. 2015. Oil spill training. Bangkok. Thailand

These situations include, but are not limited to:

- The type of material the boom is in contact with;
- Efficiency of seal required;
- Local weather conditions;
- Speed of deployment required;
- Period of use;
- Geographical location.

This type of boom would not normally be suitable in an emergency, owing to the time required for construction. However, it could be constructed in an area which is prone to pollution incidents, therefore be part of the pollution protection strategy.

Rising-Sinking Boom

The rising- sinking boom is an example of a customised boom which was developed initially as a preventative barrier in loading areas within docks for tankers to offload and load their shipments.

The boom rests in position on the riverbed, held together in one piece by the use of universal end connectors and pilings fixed to the riverbed. When a ship arrives at the berth-loading bay, the boom is activated by a remote switch. Air is then allowed to fill the hollow chambers of the boom so that it rises to the sea surface. The shape is maintained by the pilings and pre-positioned anchors on the river or lake bed.

The advantages of this type of boom over conventional booms can be summarized as follows:

- No specialist manpower required for boom deployment.
- Rapidly activated - boom can effective within minutes.
- Manpower efficient - a maximum of 2 people required for deployment.
- Easily deactivated - no delay to shipping movement when boom no longer required.
- Renewable skirt gives the boom a long working life.

This could be useful, with not only shipping areas, but also where there are particularly sensitive areas such as water treatment intakes or where there are areas very prone to pollution incidents, such as close to a dangerous road junction or near shared effluent pipes.

Oil & Chemical Adsorbent Booms

Absorbent Booms use specialised material to temporarily contain small spills during a clean-up operation. They can be used for drain protection, inland waterways, settlement ponds, and shoreline areas. They are normally used for small pollution spills – 3 metres can absorb 70 litres of oil or floating chemicals.

Figure 7. Absorbent Boom[13]

The Absorbent Boom can be a 'fibre filled woven fabric that has been 'stitched closed'. This means that the fibre filling adsorbs the oil or hydrocarbon chemicals while allowing the water to pass through, effectively acting as a filter and does not allow the oil or chemical to pass outside the boomed area.

The fibre filling is a special polypropylene crimped fibre opened and blown into the fabric. The fibre is treated to make it water repellent and the material is already naturally oleophillic, i.e. has an affinity for hydrocarbons.

The fabric cover is produced from polypropylene fabric, which is woven with sufficient picks to allow total enclosure of the fibre whilst allowing ingress of oil.

Each section of the booms has rope support and Velcro to create strength as well as a seal.

The rope support is stitched into a special sleevage in the outer fabric of the cover and provides the strength to allow multiple booms to be joined together. Each length of rope is spliced at each end, with one ring and one clip to allow quick, safe connection. The rope and overall length including the ring and clip is slightly shorter than the overall length of the boom to allow an overlap of an adjoining boom.

The Velcro is stitched into the outer cover at each end of the boom to form a seal at each end to reduce the possibility of leakage of oil from each section.

Temporary Bunds or Berms

Often the pollution can emanate from a leaking storage tank. When this is the case, temporary bunds or berms can be used to contain the leakage in the same way that a permanent bund operates as shown in figures 9 & 10 below.

13 Empteezy Ltd., nd. Oil selective absorbent booms. www.empteezy.co.uk

Figure 8. Temporary Bund[14]

Figure 9. Berm[15]

4.6.3 Pollution removal

After containment of the pollutant it is will be necessary to remove it. This can be accommodated by pumping this into a transport tanker, but if this is not possible then flexible tanks can be applied to store the pollutant ready for disposal or recycling later.

Self-Erecting Tanks

The simplest tank is the self-erecting tank, which has a buoyancy chamber at the top of the tank so it automatically rises to contain the liquid whilst it is being filled.

Its properties include:

- Land-based pollution recovery storage.
- Shoreline and inland spills.
- Used in many cases in preference to open-topped containers.
- *Capacity* standard range from 5-20 tonnes.

However, as it is not covered so it should not be used for flammable chemicals

14 Trade Enviro., 2021. Temporary bunding – spill response. www.tradeenviro.com.au
15 Global Spill & Safety. 2021. Collapsible bund. www.globalspill.com.au

Figure 10. Self-Erecting Tank[16]

Pillow Tanks

Pillow tanks are typically used the collection of recovered oil for land-based pollution recovery storage. The capacity standard ranges 5-20 tones and is normally used for:

- Shoreline and inland spills.
- Used in many cases in preference to open-topped containers.

Figure 11. Examples of Pillow Tanks[17]

Towed Flexible Storage Tanks (TFST)

The TFST is a temporary storage facility that can be towed alongside a vessel in water

This tank is available in various sizes (5 to 100 tonnes capacities) and consist of a long cylindrical bag with a tapered nose constructed from nylon fabric coated each side with polyurethane.

The T.F.S.T floats at the surface when loaded with a cargo, having density less than that of the surrounding water and, because of built-in buoyancy, it also floats when empty and therefore may be easily towed or moored if required in the unloaded condition.

Filling is by means of flexible hoses attached to the upper surface of the T.F.S.T in such a position that it may be easily reached when the T.F.S.T is lying alongside the towing vessel. There is a screw-down vent valve to bleed off any air that may become trapped in the container during the pumping operation.

16 Bartlett Pty Ltd. 2019. Flexitanks. www.bartlett.net.au
17 Versatech Products Inc. 2011. Bladder / pillow tanks. www.versatech.com

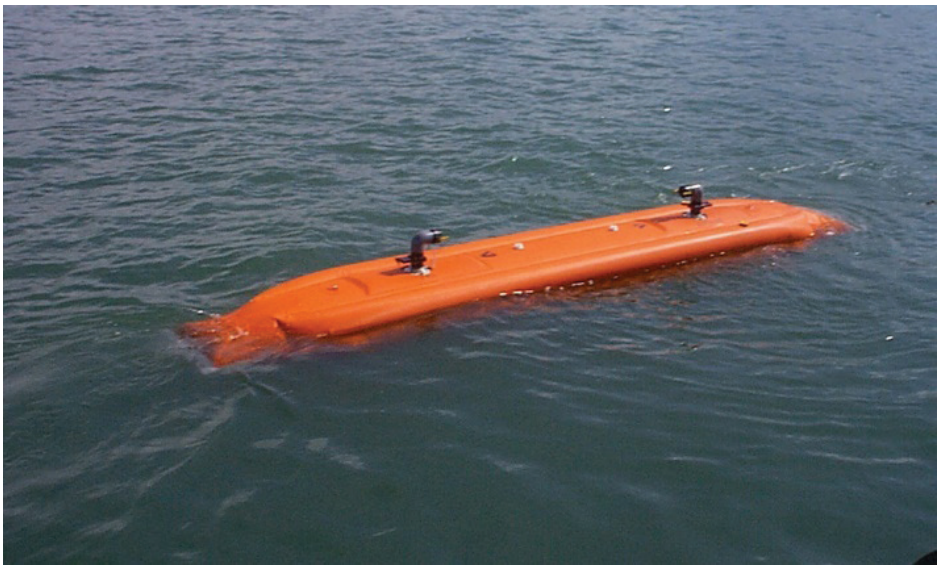


Figure 12. Towed Flexible Storage Tanks (TFST)[18]

B. Pollution Remediation

4.6.4 Introduction

Once the pollutant has entered the water course one needs to consider how to remove or deactivate the pollutant. There are many options that can be considered depending on the incident.

4.6.5 Pollution absorbents

One means of treating a spillage is by the application of sorbent materials to absorb the chemical. These include synthetic and natural materials such as: polypropylene, polyethylene, peat fibre, wool, clay and activated carbon. These can be in the form of rolls, booms, fibres, or granules. Figure 1 shows the comparison of the absorption capacities for some types of absorbents for different types of chemicals. However when selecting the absorbent one has also to take into account:

- Availability & costs;
- Location and type of pollutant;
- Whether the absorbent can be regenerated after use.

18 Vikoma International Ltd. nd. Flexible floating storage tank. www.vikoma.com

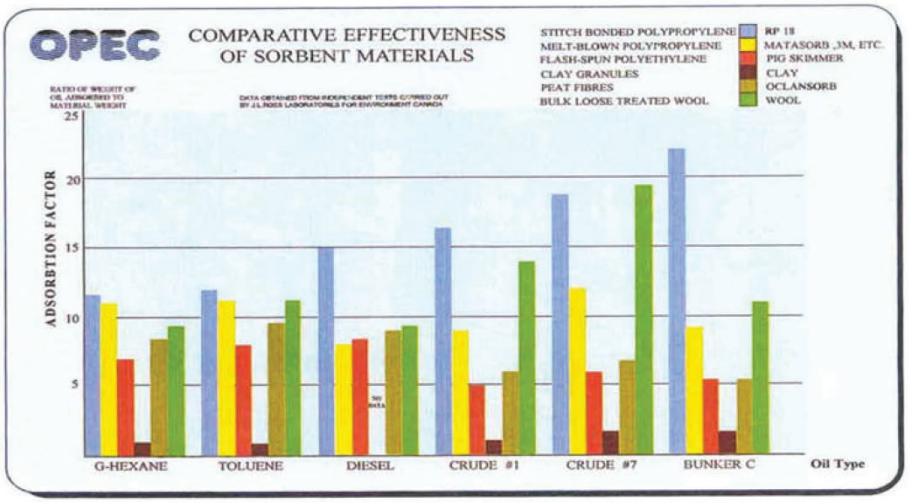


Figure 1. Comparison of the Absorption Capacities

Sometimes these adsorbent fabrics can be used as filters too. The fabric is useful where the water flows are high, and the concentration of oil/hydrocarbon is low e.g., firewater. If the fabric is used as a full flow filter, care must be taken in the design of unit to ensure that flow does not exceed the loading capacity of the fabric and the captured oil migrates through the filter element.

A large area with very low flow is ideal and the thickness of the element will determine the time between renewals. Because the fabric is white, the captured oil causes a brown stain as it percolates through the fabric, it is therefore easy to see when the element is fully saturated with oil requires replacement. Figure 2 shows an example of this being applied to an outfall to a river this reduced the concentration of oil from 50ppm to 10ppm.

Figure 2. Application of the absorbent as a hydrocarbon filter[19]

19 Oil Spills. nd. Chemical methods: Sorbents. Oil Spills - A Brief Overview (weebly.com)

4.6.6 Water treatment

Sometimes it is possible to set up temporary treatment works and an example of this is the Temporary Oil/Water Separator Tank. Some separators are readily assembled but delays can be incurred transporting such large units. However, there are also collapsible ones which can be easily assembled on site, which are preferable in an emergency situation.

The collapsible separator consists of polyurethane sides and baffles supported by an easily assembled frame. It consists of three chambers – the first provides a stilling area and primary oil removal, the second incorporates coalescing media to aid oil/water separation and the third chamber holds oil absorbent materials prior to clean water discharge. (Figure 3)

Figure 3. Collapsible oil/water emergency oil spill containment and separation[20]

4.6.7 Skimmers

When the pollutant has discharged into the river one has to consider ways of controlling it, limiting its effects and if possible, removing it from the river. One way of effecting this is by the application of Skimmers.

Skimmers are devices that used are for the application of the absorbents to be suspended into the polluted water to absorb the pollutant. There are two main types of skimmers viz.:

Passive Skimmers

Passive skimmers do not use any external forces or mechanisms to present the sorbent. The polluted water can be passed through the contained absorbent similar to a filter as shown in figure 4 or these can be pillows of the sorbent, such as activated carbon, with buoyancy aids, which are floated on top of the water surface to absorb the supernatant pollutant.

20 Westech Equipment. 2021. Containment Solution. https://westechequipment.com

Figure 4. Passive Skimmer

Active Skimmers

Active skimmers use a continuous belt of material, synthetic or otherwise, which can remove oil from the surface of water, by means of adsorption or absorption. This utilizes a polypropylene material to form a continuous loop of material, which floats on the surface of water, at the interface of the oil and water. This adsorbs the oil and then the material loop continues on to mechanical wringers and washers to desorbs the oil into storage containers.

These types of skimmer system are continually being developed so that there are a number of different designs such as the mop, disc, drum, brush, belt, and tube or weir skimmers.

Mop Skimmers

The yarn used to produce the mop material in Mop Skimmers has a very large surface area, due to the network structure of the special polypropylene base yarn. It can be used in heavy oil (viscous) or in light oils such as gas oil, diesel, Jet fuel, spindle oil, light to medium lube oil, etc. The construction of the mop incorporates a centre tape within the structure (not on the outside) which gives an efficiency and strength support.

Mop skimmers can be deployed vertically or horizontally using floating pulleys. The mop can be set out with different flow patterns on the oil/water surface to create surface oil movement. (Figure 5)

Figure 5. Mop Skimmers[21]

21 Cleanupoil.com. 2021. Rope mop oil skimmer. www.cleanupoil.com

Belt Skimmers

Belt Skimmers are only available as vertical deployment systems. This seriously limits the effectiveness of the skimmer, since it is located down through the oil layer at one very localized location, which can be useful for boreholes, but not lakes lagoons or rivers where oil may be spread over a wide area.

The belt skimmers are prone to limitations in performance due to the presence of debris. This blocks up the feed of the oil into the V shaped hopper feed when the oil is scraped off the belt. This causes any oil removed from the belt to spill over and fall back into the area from which it has been picked up. The belt also has a very small surface area compared to a mop and there is a very poor retention of oil because of the relatively smooth surface which allows recovered oil to run off - especially the lighter oil range.

As the belt has to be kept straight, there has to be a bottom roller attached to the bottom of the belt. This then means that the belt passes through the oil on the surface and due to the movement of the belt, will carry some of the surface oil down with it, and displace it into the water phase. (Figure 6)

Figure 6. Small Belt Skimmer[22]

Drum Skimmers

Drum Skimmers are basically the same as the Belt Skimmers. The surface area is small, oil is forced below the surface by drum rotation. This skimmer also can suffer from problems with handling debris at the scrape off point.

22 Abanaki Corporation. 2021. Belt Skimmer. www.abanaki.com

Tube Skimmers

Tube Skimmers have small surface areas, and also can suffer from problems with handling debris at the scrape off point.

Disc Skimmers

Disc Skimmers have relatively small surface areas and localized oil contact and pick similar to the Belt Skimmers. Due to the centrifugal force created by the rotation of the discs, oil will be ejected from the discs (even "T" discs), so putting the oil back into the water phase. Again, this is prone to debris problems, especially being caught up between the discs, so distorting them and causing mechanical damage. In addition, this causes a blockage of the recovered oil to the oil collection in the centre of the disc skimmer, which can even cause the skimmer to sink.

Weir Skimmers

Due to the inherent design of auto adjusting, weir skimmers will pick up a lot of free water. In addition, very prone to debris blocking the flow of oil to the weir - depending upon the location of the support floats. This is particularly apparent when "sticky" - viscous oil is present, - such as Bunker "C" fuel oil.

Brush skimmers

Brush Skimmers are better than most of the units described above, but again prone to problems with debris being caught up in the bristles. This works well for very viscous oil, but with light oil it is not so efficient, because the oil readily runs off the filaments. The Brush Skimmer is not constructed like the mop, with a fibrous structure.

Most Skimmers require an oil transfer pump however, in most cases the mop skimmer systems do not need transfer pumps to be fitted.

4.6.8 Operational examples of remediation

Removing Surface Pollution from Streams

Streams are usually small in width and relatively easy manage. By treating the stream's surface but allowing the continuation of water flow at the base, one can treat surface pollution, particularly oil. A length of PVC tubing or pipe is laid on the bottom of the stream with a small section of containment boom and adsorbent boom above at the surface to capture floating contamination such as oil.

If there are large amounts of pollution are involved a series of these installations may be required.

The set-up is as illustrated below in figure 7.

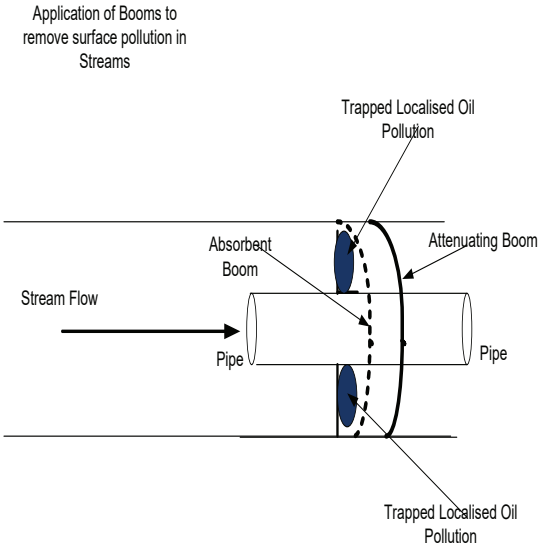


Figure 7. System for Removing Surface Pollution from Streams

Hydraulic Methods

Hydraulic Techniques can be used to manage the flow of the water by using dams to either attenuate the flow to localise the pollution plume for treatment, or by accelerating the flow so that the pollutant is diluted and/or flushes the pollutant rapidly past sensitive sites such as drinking water treatment works.

If the pollutant is in a small stream, then temporary dams can be used to localise the pollution plume for disposal as shown in Figure 8.

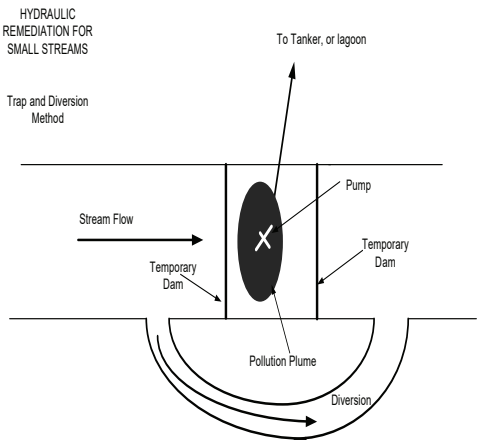


Figure 8. Hydraulic remediation for small streams

Removing Surface Pollution from Rivers

It is important to restrict the flow of oil as quickly as possible. Owing to the high flow rates normally encountered in rivers, it is not possible to deal with the problem of oil pollution as with streams. A boom deployed at right angles to a body of water flowing at a rate in excess of 1 knot is virtually useless.

To boom a river effectively, angles must be used as much as possible to allow deflection of the floating oil to a convenient point at the riverbank suitable for vehicle access.

In these circumstances it is important to remove the collected pollutant with the skimmer as quickly as possible, otherwise the pollutant will be sucked under the boom.

In choosing a suitable position for collection, it is advisable to pick a spot near, or on the inside bend of the river where the flow is considerably slower than the water flowing on the outside of the bend. An illustration of a suitable deployment of booms and skimmers is shown in Figure 9.

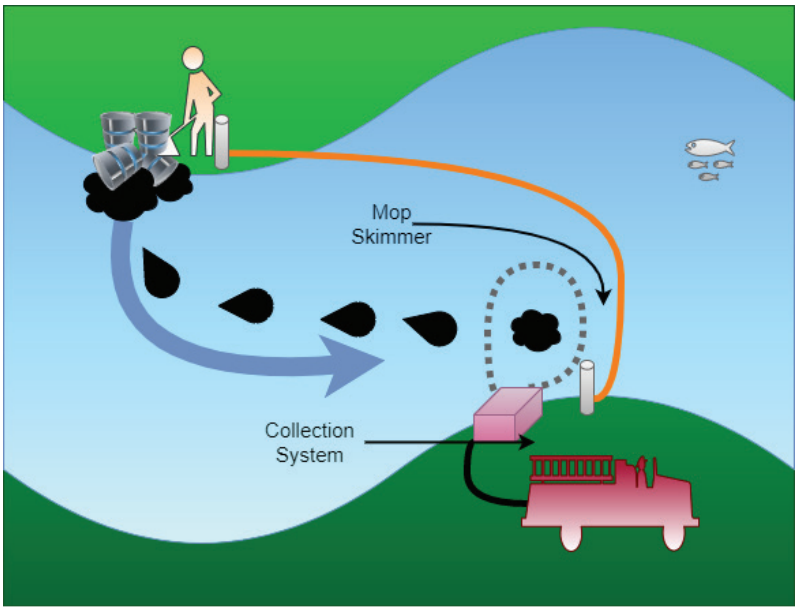


Figure 9. Removal of surface Pollution from a River

Removal of Surface Pollution from Inland Lagoons, Reservoirs, or Lakes

It is usually not too difficult to reduce the risk of oil pollution escaping from a land locked lagoon or lake, but it is important to remove the oil. The best location to set up an oil spill clean-up unit is at a point on the opposite side from the direction in which the prevailing wind blows. This reduces the need for containment booms. As the oil film thickness reduces, so the body of floating oil will move towards the point of removal by the application of an extensive skimmer system as shown in Figure 10.

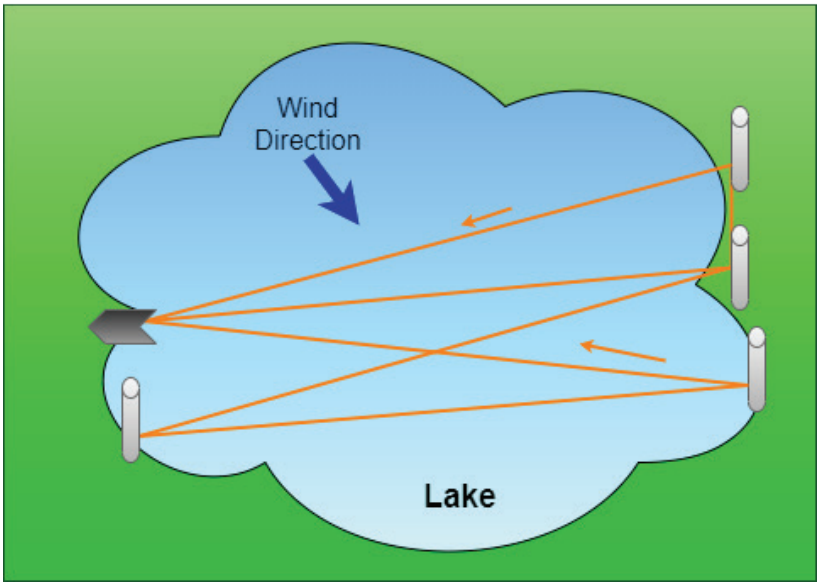


Figure 10. Skimmer setup for Lakes

Removing Suspended or Dissolved Pollution

When the pollutant is dissolved or mixed with the water the above techniques cannot be applied. Other techniques must be applied such as: chemical techniques using air or hydrogen peroxide to oxidise the pollutant to either change it chemically, or to also change it physically to an insoluble form, such that this settles on the river bed so that it can be removed at a later stage.

It is possible to inject chemicals into the water to neutralise the effect of the pollutant. In the UK two purpose-built vessels have been built and each can inject up to 30 tonnes of oxygen per day directly into the River Thames. These are used during periods when the dissolved oxygen is low, following a pollution incident, or after a storm has stirred up the riverbed. Similarly, there are two locations along the River Thames where hydrogen peroxide is injected for the same purpose. These techniques can normally be used where there is a constant regular problem, rather than an accidental emergency pollution and these facilities are already in place.

Figure 11. The "Thames Vitality"- Oxygenating Ship

Advanced Combination Techniques

The application of suspend static skimmers or absorbent filter can be used in combination with connected anchored boats. These filters are suspended between the boats. However, this technique is best applied to slow flowing narrow rivers or canals, which is shown in Figure 12.

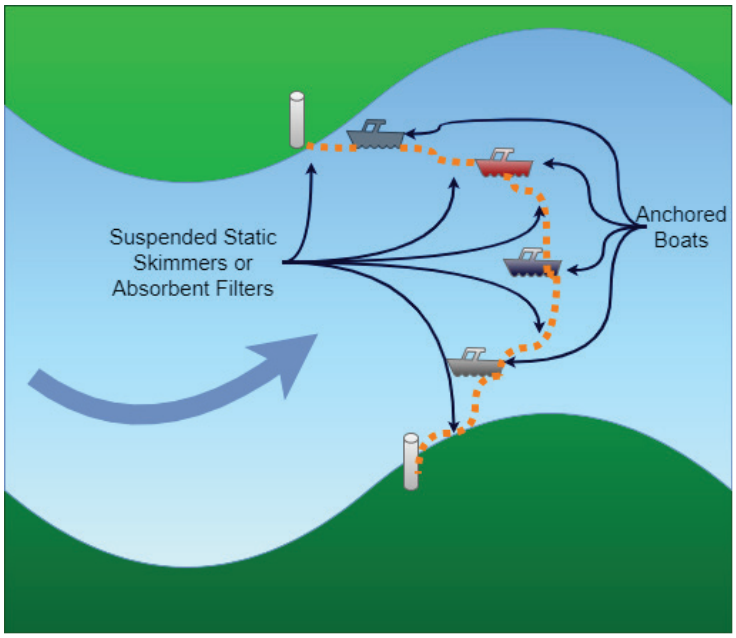


Figure 12. Remediation of slow flowing rivers or canals

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