Criteria for Evaluating Oil Spill Planning and Response Operations

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A Report to IUCN, The World Conservation Union

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Contents

List of Tables

LIST OF ABBREVIATIONS, SYMBOLS, AND ACRONYMS

ADIOS	Automated Data Inquiry for Oil Spills
ERA	Ecological Risk Assessment
GIS	Geographic Information System
GPS	Global Positioning System
IMO	International Maritime Organization
IPIECA	International Petroleum Industry Environmental Conservation Association
ITOPF	International Tanker Owners Pollution Fund
MOU	Memoranda of Understanding
NEBA	Net Environmental Benefit Analysis
PDA	Personal Digital Assistant
SCAT	Shoreline Clean-up Assessment Techniques
SOPs	Standard Operating Procedures

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EXECUTIVE SUMMARY

This report seeks to provide the non-professional reader with a basis for helping determine what constitutes a "good" oil spill response plan and/or a good oil spill response effort for marine and coastal operations.

It provides an overview of the broad concepts important for understanding oil spill response planning and implementation (avoiding technical detail wherever possible), discusses the development of reasonable expectations regarding oil spill response efforts, and identifies the key factors which might be critical to determining if a response system is adequate and appropriate for the risks it seeks to address.

The main body of the report outlines the key aspects to cover and the types of questions to address at different stages of planning and response (including examples based on international literature and best practice) to meet the overall goal of minimising oil spill impacts. The body of each section has additional detail on the main goals, the options which may be available (along with a brief explanation and rationale), the preferred outcome, and the key advantages and disadvantages for the options under consideration. Guidance is also provided on what level of effort is considered appropriate for each element.

The report does not provide specific thresholds that must be met, but instead emphasises the types of outcomes that should result from an effective plan in the context of a decision having already being made to allow oil development, and seeks to provide "stakeholders" or interested parties with a set of questions which should be addressed when evaluating the adequacy of an oil spill response plan, keeping in mind that not all aspects necessarily need to be fulfilled within a plan.

References to supporting information and further reading are included at the end of the report, along with a checklist based on the material in the body of the report, to assist in the evaluation of specific plans or spill response exercises.

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1. INTRODUCTION

1.1 PURPOSE OF THE REPORT

> ***There is no formal framework designed to function as a checklist against which results from a readiness assessment can be compared.***
>
> *Taylor et al., 2008*

Twenty years ago oil spill response planning was in its infancy. Over time, as governments, industry and concerned citizens have become more aware of the risks, national and international regulations have been developed to improve spill prevention and provide structure to oil spill response. While the number and sophistication of planning guidance documents is extensive and is continuing to grow, there is little information on how to decide if a particular plan is appropriate. Taylor et al. 2008

This report seeks to provide the non-professional reader with a basis for helping determine what constitutes a "good" oil spill response plan and/or a good oil spill response effort for marine and coastal operations. That is, how do you, as an interested party, determine if the plan's developers have done an adequate job, or that information included in the Contingency Plan was used successfully during a response?

A simple, but not particularly satisfying answer (especially for individuals outside of the oil industry) is that a "good" plan (or response) will conform to industry "best practices." Unfortunately these are not easily defined, and it is very difficult to evaluate a plan in terms of how well "best practices" are addressed.

So while this report has drawn from a number of industry and governmental guidebooks and standards, our aim has been to provide the reader with an overview of the broad concepts important for understanding oil spill response planning and implementation (avoiding technical detail wherever possible). We have then sought to identify the key factors which might be critical to determining if a response system is adequate and appropriate for the risks it seeks to address, and to provide a set of questions which "stakeholders" or interested parties should address when evaluating the adequacy of an oil spill response plan. While the report identifies a relatively exhaustive list of requirements for inclusion, a realistic approach needs to be taken. Not all plans will require all aspects to be addressed.

In doing so, we also recognise recent complimentary efforts by Taylor et al. (2008) and IMO/IPIECA (2007) which have very similar objectives (the development of evaluation criteria), but a more technical emphasis to this report.

1.2 HOW TO USE THIS REPORT

For any review of a response plan, not all elements will be equally important in all circumstances and the site-specific nature of the risks, the location, and the environmental conditions will all guide where the emphasis should lie. As we begin, we would therefore like to stress three themes to which we will return throughout the report.

First, decisions have to be made, in both the planning phase and the response phase, which will change the relative risk to various resources. This includes "trade-offs" between economic as well as ecological resources, which may be in conflict. Agreeing in advance as to how such trade-offs will be analysed and addressed is a key element for a successful response. We have emphasised ecological resources in this report because they are most commonly the source of conflict in terms of evaluating success, but social and economic effects of oil spills must also be considered.

1. INTRODUCTION (CONTINUED)

1.2 HOW TO USE THIS REPORT (CONTINUED)

Second, more is not necessarily better. Adding additional resources or obtaining additional information can be valuable, up to a point, but it may not be justified if it will not substantively change the response plan or an operational decision. This is especially true when the associated costs are high or where spill response efforts may be driven by factors which cannot be overcome by simply increasing resources.

Finally, even an excellent oil spill response plan coupled with a subsequent excellent response cannot guarantee that there will be no impacts to the environment (either social, economic or natural). Oil spills are emergency events, and they often occur under unfavourable conditions, so guarantees of results are not possible.

Therefore, this report attempts to outline the key aspects to cover and the types of questions to address at different stages of planning and response (including examples based on international literature and best practice) to meet the overall goal of minimising oil spill impacts. We have not provided a list of specific thresholds that must be met, but have instead emphasised the types of outcomes that should result from an effective plan in the context of a decision having already being made to allow oil development.

1.3 REPORT STRUCTURE

The report is structured into the following sections:

- **Section 1.** Introduction,
- **Section 2.** Understanding key concepts - a brief introduction to the key concepts that underpin oil spill planning, and background for understanding the general philosophy and methodology used in oil spill response,
- **Section 3.** The effects of physical conditions on oil and spill response options,
- **Section 4.** Preparing before a spill - the cornerstone of an effective response,
- **Section 5.** Responding to a spill,
- **Section 6.** Termination of clean up effort,
- **Section 7.** References,
- **Section 8.** Additional sources of information.

Summary tables are presented at the beginning of Sections 3 through 6. These tables highlight the key questions that should be answered, along with potential sources of information, and a short discussion of how to evaluate when the questions have been adequately addressed. The body of each section has additional detail on the main goals, the options which may be available (along with a brief explanation and rationale), the preferred outcome, and the key advantages and disadvantages for the options under consideration. Guidance is also provided on what level of effort is considered appropriate for each element.

At the end of the report, Appendix 1 contains an "Oil Spill Planning Evaluation Checklist." This checklist, which is based on the material in the body of the report, is intended to assist in the evaluation of specific plans. It is divided into two parts. Part 1 deals with evaluating the planning process, while Part 2 deals with evaluating a spill response exercise.

2. UNDERSTANDING KEY CONCEPTS

2.1 BASIC CONCEPTS OF RESPONSE PLANNING AND READINESS

Four Basic Principles of Preparedness

Prevent

Prepare

Respond

Recover

There are four basic principles which apply to being prepared for any type of emergency; prevent, prepare, respond and recover. The latter three constitute the three phases of response (United States Department of Homeland Security (DHS), 2008). This report does not address prevention in detail, but clearly the most effective oil spill response is to never have a spill in the first place. Since there are no guarantees, a good risk management programme will address all four elements.

Because it is impossible to define an actual emergency event in advance, a good response framework will be scalable (capable of dealing with incidents of varying magnitude), flexible (able to respond to changing conditions), and adaptable (able to be modified as needed). In addition, the response capability implemented will be based on a realistic assessment of the potential risks (Section 2.2), usually based on a series of scenarios which define the range of potential responses. This is often an early area of contention when stakeholders become involved.

Key Principles of Response Planning

Engaged partnership

Tiered response

Scalable, flexible and adaptable operational capabilities

Unity of effort through a unified command

Readiness to act

DHS, 2008

Once risks have been defined, processes can be put in place for the remaining three principles of emergency preparedness, as discussed in detail in Sections 3 through 6. While every situation is unique and each country will have its own regulatory structure, all phases of a good response system should be based on five key principles:

- All levels of government, industry, and other stakeholders should be in communication and be active participants in planning for or responding to an event (*Engaged partnership*).
- Incidents should be handled at the lowest level, but additional resources should be available when needed (*Tiered response*).
- Provision must be made for the response system to respond to changes in circumstances during an incident – one size does not fit all (*Scaleable, flexible and adaptable operational capabilities*)
- Organisational structures must be in place to allow all of the participating organisations to work together effectively while meeting their individual obligations during a response (*Unity of effort through a unified command*).
- Incidents develop quickly and decisive action based on effective planning and communication is often critical to limiting adverse outcomes (*Readiness to act*).

Emergency managers are responsible for both planning and executing an emergency response. In order to execute a response effectively, they must prepare effectively. The best way to envision this is as a continuous cycle of planning, organising, training, exercising, and then evaluating and improving the plan, before beginning the cycle again (DHS, 2008). This 'Preparedness Cycle' allows the emergency manager to prepare for the entire course of a potential incident, evaluate capabilities, and allows stakeholders to practice their responsibilities. The entire cycle is defined by the quality of the exercise programme – the more rigorous and real the exercise, the better prepared the organisations involved become.

Exercises provide opportunities to test plans and improve proficiency in a risk-free environment. Using exercises to continuously evaluate and improve process is the key to being well prepared.

2. UNDERSTANDING KEY CONCEPTS (CONTINUED)

2.2 THE IMPORTANCE OF RISK ASSESSMENT, RISK MANAGEMENT, AND RESPONSE ANALYSIS

Risk assessment is used to establish the probability of a spill occurring, and indicate areas where the consequences of a spill may be high.

The application of risk assessment principles to marine oil spill events is the first stage in developing a risk management strategy to:

1. Reduce the likelihood of oil spills occurring, and to
2. Put in place adequate preparedness measures to mitigate their effects should a spill occur.

One of the primary objectives of a risk assessment is to evaluate whether the potential impact of an oil related activity (e.g. exploratory drilling) is considered acceptable, or whether the activity poses such a high risk that it should be avoided entirely, (acknowledging that who sets the criteria for something being acceptable is often contentious). It is usually undertaken prior to an activity commencing, and often prior to even knowing whether oil will be found. It therefore usually includes evaluation of a range of different spill scenarios based around three dimensional (3-D) modelling of potential oil fate, and assesses the environmental sensitivity of potentially affected areas. It generally does not consider how different response actions may alter the impact of a spill if it were to occur.

Risk management addresses how spill risks can be minimised, and how different response options may influence the outcomes of any spill.

Risk management generally follows this initial phase and includes a more specific analysis of the oil spill risk, including how spill risks can be minimised, and how different response options may influence the outcomes of any spill. It is often based around the same scenarios used in the risk assessment.

The general principles of both oil spill risk assessment and risk management are addressed in depth in a recent IMO/IPIECA publication ("Manual on Oil Spill Risk Evaluation and Assessment of Response Preparedness") and are summarised below. In terms of oil spill preparedness and planning, risk assessment and risk management are used in two main ways, to:

1. Establish the probability of a spill occurring and the nature of the spill, and
2. Establish the basis for assessing the adequacy of existing preparedness and response capabilities.

Establishing spill probability, at a broad level, is relatively straightforward to analyse where the potential sources of spills can be defined (e.g. pipelines, platforms, vessels), and where the operating risks are well understood. Operating risks are often based around industry best practice which is, in turn, based on a long history of practical experience. Where appropriate information is available, quantitative evaluation is often undertaken to estimate the likelihood of a spill occurring, and the potential size of any spill. Any additional uncertainty associated with extreme conditions, such as a limited ability to respond, must be taken into account.

Response analysis is the process of evaluating what response options are available, the conditions they can be used under, and their likely effectiveness.

Response Analysis is the process of evaluating what response options are available, the conditions they can be used under, and their likely effectiveness. Once this is done it is necessary to assess the adequacy of the preparedness and response capabilities. This is less straightforward. Although common methodologies are used, each oil spill planning situation requires a unique level of detail, resources, and commitment. The assessment of adequacy is also dependent on who defines what thresholds are acceptable and what the priorities should be for protecting different resources, particularly if choices have to be made about what to protect after a spill.

2. UNDERSTANDING KEY CONCEPTS (CONTINUED)

This is obviously an area where different stakeholders tend to hold quite different perspectives, which will strongly influence how adequate they perceive a plan to be.

There are a wide number of different approaches used within the general risk assessment framework, different ones appropriate under different circumstances. However, in essence, risk approaches provide a formal method to reduce the likelihood or reduce the impact of an event by:

- Identifying areas where intervention to reduce the likelihood or consequences of a particular event will be most effective.
- Identifying areas susceptible to spills or which have high environmental and economic value and vulnerability, allowing a focus on prevention and response measures.
- Selecting the most effective and lowest risk operations, maintenance and repair programmes.
- Developing site-specific spill response strategies.
- Designing operations to reduce environmental and economic oil spill risk.

In recognition of different stakeholder perspectives, any good oil spill risk assessment (and subsequent response plan) should include input from stakeholders. The goal is to, insofar as possible, integrate the views of all stakeholders into a contingency plan which provides reasonable protection for all of the resources of concern and allows planning and decision-making to be understood and, ideally, agreed in principle before a spill occurs.

In reality, the type and degree of stakeholder involvement often varies greatly, and while it can work well under the right circumstances, it can also result in very different views on the approaches used and end points sought. Consensus on the best approach to take is uncommon, often because stakeholders are seeking the best protection for their particular element, while the contingency plan is trying to find a balance among different stakeholder views as well as operational considerations. However, stakeholder engagement does provide one way for participants to exchange views and to try and resolve issues prior to a spill. Even where consensus cannot be reached, the process generally provides more benefit than not.

2.3 THE PRINCIPLE OF 'NET ENVIRONMENTAL BENEFIT ANALYSIS' (NEBA)

The advantages and disadvantages of different responses need to be weighed up and compared both with each other and with the advantages and disadvantages of natural clean-up, a process commonly known as Net Environmental Benefit Analysis (NEBA).

IPIECA, 2000b

Net Environmental Benefit Analysis (NEBA) is an approach used to compare how different ecological, social, economic, and aesthetic aspects are affected by different oil spill prevention, planning and response actions. While it is not universally embraced, it has such a central role in oil spill planning and decision-making that it is important to understand how and why it is used. NEBA compares the impact of different scenarios on the resources and values that could be affected if a spill occurred. NEBA is also used to identify where more information is needed to determine what impacts may occur, and to identify potential conflicts that may arise in the protection of different resources. In the United States, Ecological Risk Assessment (ERA) is essentially NEBA that focuses solely on ecological aspects (Aurand, 1995).

NEBA (and ERA) are most effective at the planning phase when there is strong stakeholder involvement and where potential conflicts between environmental, social, economic or aesthetic concerns are identified and resolved as part of the planning process, and not during a spill (e.g. Baker 1995). Ideally, this will provide clear direction about how to manage tradeoffs between different resources, although it is fair to say that complete stakeholder consensus over what actions are most appropriate is rare.

At a spill response level, NEBA uses natural recovery (where no spill response is undertaken) as a reference point to determine which response actions may improve or impair natural recovery. This generally focuses on potential conflicts between and within resources, e.g.:

- Does the socioeconomic benefit of having a clean beach outweigh direct ecological impacts (e.g. shellfish impacts during cleaning)?
- Does the benefit to shoreline organisms or seabirds from using oil dispersants at sea outweigh the potential impact to fishery resources from dispersed oil?
- Does a clean-up method benefit one species but impact another?
- Do different clean-up methods achieve the same outcome, but at different levels of impact or over different timeframes?

NEBA is a holistic approach that considers all the potentially impacted resources, looks at how well they can be protected with the available response techniques under the conditions prevailing at the time of a spill, and seeks to implement the response that provides the best overall outcome to a spill. A common criticism of this approach is that it often results in tradeoffs where a reduced level of protection may be given to individual species because wider benefits are perceived to accrue from targeting response efforts elsewhere.

2.4 THE AIM OF A CONTINGENCY PLAN

The aims of oil spill response are to minimise damage to environmental and socioeconomic resources, and to reduce the time for recovery of affected resources by achieving an acceptable standard of cleanliness.

IPIECA, 2000a

The aim of a contingency plan is to provide spill responders with the information needed to prevent or minimise the overall impacts of an oil spill. It should identify the procedures and resources necessary to implement the plan, specify priorities for protection and clean-up, and contain all the relevant information needed to respond to a spill in a clear, concise and easy to use format. It should enable an integrated, flexible and effective response effort, ideally based on thresholds endorsed by stakeholders, and with realistic assessments of the expected effectiveness of the proposed response options.

Individual stakeholders will often initially disagree over the priorities to be established because protection of one resource (be it economic, social, or ecological) may place another at risk (see Section 2.3). These issues should ideally be resolved during the planning process, with participants recognising the viewpoints of other stakeholders.

The real value of contingency planning comes from raising and answering key questions about response issues.

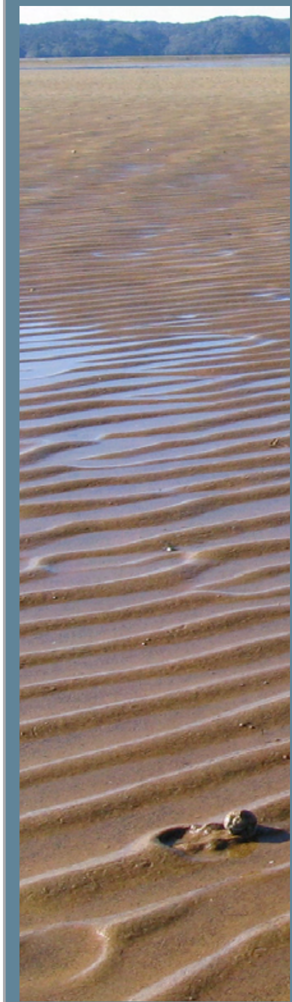
Most contingency plans seek to address all credible spill possibilities and response options. While this comprehensive type of approach provides assurance for both industry and regulatory agencies that all the bases have been covered, it can result in formulaic contingency plans in which the significance of key response options for particular sites may not stand out from the background detail. It is therefore important that those response options most likely to be used are clearly identified and given a level of focus commensurate with their likely use. For locations with the potential for a large release of oil, a good response plan incorporates the concept of tiered response, so that local resources can be supplemented as necessary in a timely manner.

As a contingency plan reflects the operating philosophy and commitment of those involved, it is also more than just a written document. In most cases, the real value of a contingency plan comes from raising and answering key questions about response issues. As such, it is not an endpoint in its own right, but should be a living document that is reviewed and updated as new information becomes available, as operations change, and following feedback and learning gained from spill exercises, incidents, and research and development.

Implementing the ‘readiness cycle’ concept, based on a rigorous training, exercise, and evaluation schedule is the key to continued improvement.

To that end, it is not possible to evaluate the effectiveness of a contingency plan by looking simply at what it contains. The willingness and ability of staff to implement the plan, the commitment put into training and exercising, staff familiarity with the plan, and the layout and readiness of equipment are all examples of aspects that need to be assessed directly on site, and by meeting with those responsible for implementing the plan. A plan is only as good as its implementation.

It is important to emphasise that in many cases the final Contingency Plan represents a “response plan” - a short action-orientated document with a clear structure containing only the information needed to initiate and undertake a rapid response to a spill with detailed supporting information commonly contained in separate reports.



The following list indicates the common issues most contingency plans address; presented in the general chronological order they are likely to be encountered in a spill; and indicates where separate supporting documents are often used:

- Notification
- Spill evaluation procedures (incorporating outcomes from risk and consequence analyses, including pre-spill NEBA - in a separate report)
- Oil characteristics and fate, including scenario based oil weathering predictions and response recommendations (in a separate report)
- Environmental and wildlife assessment (in a separate report)
- Mobilisation of responders
- Setting of response objectives
- Operational planning procedures
- Standard operating procedures (SOPs) for field operations e.g. At Sea Recovery, Dispersants, Containment and Recovery, Shoreline Cleanup, Alternative technologies (e.g. In Situ Burning, Bioremediation) (in a separate report/s)
- Wildlife response
- Health and safety
- Logistics and supply
- Documentation (of decisions, actions, costs) (documentation in a separate report, but action plans should be a part of the Contingency Plan)
- Communication
- Media
- Waste disposal
- Termination
- Aftermath assessments

Contingency plans may also contain strategies for activities such as search and rescue, salvage, lightering (offloading cargo), or marine firefighting, as well as aspects such as equipment maintenance, sampling and monitoring, training and exercising, and plan review and amendment.

2.5 KEY QUESTIONS TO ASK ABOUT A CONTINGENCY PLAN

In reviewing the adequacy of a contingency plan, there are several pertinent questions that should be asked and evaluated against the thresholds and efficiencies agreed to by stakeholders and the risk assessment outcomes. For example, within the contingency plan:

- Has there been a realistic assessment of the probable type and size of spill that could occur and the resources that could be impacted? Has it considered the likely movement and fate of spilled oil?
- Have priorities for protection been identified and agreed, keeping in mind that different mitigation options may change what resources are affected?
- Have protection and cleanup strategies been agreed on or discounted? Have the reasons been clearly explained and documented?
- Have the responsibilities of all those likely to be involved been clearly specified, and are those likely to be involved aware of and available to do what is expected?

- Is there sufficient equipment, materials, and labour to deal with the anticipated spill, and are backup resources identified and available if needed?
- Is the response equipment appropriately located and maintained, and are responders trained and available to use it?
- Have options for the safe temporary storage and final disposal of waste been identified?
- Are initial notification and evaluation procedures clearly stated, robust, and tested?
- Are arrangements in place for continual review of cleanup progress and effectiveness?
- Are there effective arrangements for communication between land, sea, and air?
- Have all aspects of the contingency plan been tested and deficiencies rectified?
- Is the plan compatible with plans for adjacent areas and activities?

This list is not intended to be exhaustive (additional questions are presented in Sections 3-6), but highlights the types of questions that need to be asked of a contingency plan. Most debate is commonly focused on the thresholds used in answering them, as this is where different stakeholders often hold different views on what constitutes a reasonable or appropriate level of effort.

2.6 HOW MUCH INFORMATION IS ENOUGH?

A "rule of thumb" is that information should continue to be refined for as long as the refinement contributes to a change in the planning or response strategy.

In general terms, a contingency plan should contain sufficient information to make informed and defensible (transparent and justifiable) decisions on the key issues of how to identify and minimise risks, how to mobilise an effective spill response, and when to end a cleanup. The goal is to continue planning or response operations for as long as they measurably contribute to achieving the goals identified in the risk assessment (e.g. reducing the impact of a spill). In this context, a rule of thumb for "how much information is enough?" is that information should continue to be refined for as long as the refinement could contribute to a change in the planning or response strategy being used. Beyond this point, further refinement is difficult to justify in terms of response planning alone. A common argument for collecting more information is that it is not possible to decide if the planning or response strategy would change without it. However, in most circumstances, it is possible to identify a point where the risks and possible outcomes are sufficiently well understood that decisions can be made about whether to undertake an activity, and if so, how to best protect against adverse impacts.

An ideal outcome would be for planning and response thresholds to be based on quantitative risk estimates of the effects of oil and response activities on ecological resources. While not barriers to undertaking this type of assessment, quantitative risk estimates are often very difficult, if not impossible, to achieve due to:

- Limitations in the available scientific information, as well as
- Variability in conditions which may occur at the time of the spill.

Notwithstanding, there is a point at which a decision (often subjective and contested by stakeholders) will still need to be made regarding how much scientific information is enough, and how much variability can and should be accounted for in the planning process.

2. UNDERSTANDING KEY CONCEPTS (CONTINUED)

Understanding what can be achieved is a necessary part of determining an appropriate level of effort.

Setting thresholds for "how much information is enough?" also needs to recognise that the level of detail required for good oil spill planning and response decisions is often relatively coarse, reflecting the limited number of rather "blunt" response tools available. Understanding what can be achieved through current best practice in terms of risk reduction, risk management and spill response is therefore a necessary part in evaluating what an appropriate level of effort is, and what outcomes may result.

It is also important to appreciate that the spill planning approach seeks to allocate resources to those activities that provide the best overall strategy for avoiding, remedying and mitigating oil activities. As a consequence, individual stakeholders may feel aspects they consider to be of very high importance do not get the attention they deserve, while planners may consider it a disproportionate allocation of effort to focus on elements where a significantly reduced risk or improved response is unlikely to result. Resolving such differences in viewpoints, and even planning philosophies, is often not possible.

3. THE EFFECTS OF PHYSICAL CONDITIONS ON OIL AND SPILL RESPONSE OPTIONS

3.1 THE CASE FOR REALISTIC EXPECTATIONS

Information Source(s)	Key Questions
• Climate and weather data • Hydrographic modelling	Are any adverse environmental conditions that are likely to occur, including timing, duration and frequency, clearly defined?
	Are limitations for the available response options realistically defined and understood by all stakeholders?

HOW MUCH IS ENOUGH? A contingency plan needs to define response options suitable for the range of environmental conditions likely to be encountered, and needs to define the environmental limits of proposed response options. Alternative options to extend or modify the response when adverse conditions occur should also be described. The plan should account for the fact that sometimes no response other than monitoring and surveillance will be possible. As the prevalence of adverse conditions increase, the need for prevention and flexibility in the response also increases.

For moderate to large-sized spills in open water, even under "ideal" conditions, recovery rates are relatively low (often less than 20% of the oil released).

For oil spills there are times when environmental conditions will prevent an effective response, and times when any sort of response other than monitoring and surveillance may be impossible. A Contingency Plan needs to reflect how often such conditions are likely to occur, how long they could exist for, and what the ultimate fate and consequence of the oil is likely to be along a continuum of environmental conditions – from favourable through to the worst case. It needs to set clear expectations about what can be achieved under the range of conditions likely to be present.

Winter arctic conditions generally represent the most consistently adverse response situation, providing exceedingly difficult and often dangerous conditions to work in, as well as a host of unique difficulties in recovering oil from ice. Even in temperate and tropical regions, weather conditions are often severe enough to limit operations. For small spills, when conditions are favourable and the response is rapid, it may be possible to recover or treat a significant percentage of a spill. However, as the size of the spill increases and/or environmental conditions deteriorate, it is often impossible to significantly influence the fate of the oil (IPIECA, 2000a).

Because the effectiveness of mechanical oil recovery techniques such as booms and oil skimmers is dependant on many different factors, it is impossible to provide a percentage of likely oil recovery rates. However, previous spill responses to moderate to large sized spills in open water, even under "ideal" conditions, have tended to have relatively low recovery rates (e.g. commonly less than 20% of the oil initially released to the environment is recovered).

Further, even a benign condition like darkness can severely limit the ability to respond, while small changes in sea state, tides, wind or currents can cause booming and skimming operations to rapidly lose effectiveness or become unsafe. Seager et al. (2007) used oil spills as a case study in reviewing the difficulties in developing measurable performance standards for management of environmental crises. They concluded that determining a baseline to measure effectiveness against is extremely difficult, since conditions for marine oil spills are so variable. In addition, they noted that stakeholders often have widely divergent perceptions of the success (or lack thereof) of a response, often because there is no common definition of success in the first place.

As some level of environmental protection is almost always part of how success is defined, the difficulty in defining success is a significant issue for stakeholders since no oil spill response plan can offer an assurance of preventing all environmental impacts even in generally favourable conditions. It is therefore important for all stakeholders to understand the limits placed on the response by the local environment and to acknowledge how those constraints will affect any definition of success. Those considerations fall into two primary groupings, the effects adverse conditions may have on the oil itself, and the effects the adverse conditions will have on the response tools.

3.2 EFFECTS ON OIL PROPERTIES

Information Source(s)	Key Questions
• Climate and weather data • Hydrographic modelling	Have the impacts of adverse conditions (especially temperature, the presence of ice and sea state conditions) on oil properties been considered?
	How do expected changes in oil properties over time influence the response options available?

HOW MUCH IS ENOUGH? How oil behaves depends on how the properties of the oil react to the environmental conditions prevailing at the time of a spill. This should be known for the range of conditions which can be expected to occur, and should be incorporated into predictive models of oil weathering and transport.

Oil behaves differently depending on how the oil properties react to the environmental conditions prevailing at the time of a spill. This process, generally referred to as oil "weathering" is a key element in oil spill response planning (see Daling et al. 1997, 1999 for further information). The key weathering parameters (based primarily on Scholz et al., 1999; DeCola et al., 2006; Fingas, 2001 and NRC, 1985) are described on the following page:

KEY OIL WEATHERING PARAMETERS

- **Spreading and Advection** (the movement of oil horizontally on the surface of water is due primarily to oil properties such as viscosity and surface tension, or movement due to wind or currents).

  Slick movement and coherence is affected primarily by sea state, currents and wind; Viscosity is affected by temperature which in turn affects spreading; Physical barriers are also important e.g. oil can be sequestered in, on or under ice.

- **Evaporation** (the loss of oil from a liquid phase to vapour released to the atmosphere).

  This is the primary natural weathering process removing oil from the water surface. Mostly dependent upon oil type, slick thickness and wind speed; it proceeds rapidly in warm conditions, but can essentially cease at cold temperatures or when ice prevents a slick from spreading, or through coverage by snow or ice. Evaporation physically and chemically changes the composition of remaining oil (e.g. increases viscosity, reduces toxicity).

- **Dissolution** (the transfer of oil components (mostly from dispersed oil droplets) into solution in the water column).

  Generally a minor component, as the most water soluble components are also the most volatile and tend to evaporate early in a spill. It is temperature dependent and influenced by sea state.

- **Dispersion** (the suspension of small oil droplets in the water column).

  Dispersion is highly influenced by sea state (wave action is a key process in dispersing oil), as well as the oils chemical properties, (e.g. high viscosity oils and emulsions disperse less readily).

- **Emulsification** (incorporation of seawater into oil to form a (usually) stable product. Can increase the amount to be handled by an oil spill cleanup operation as much as 3-4 times).

  Most common with viscous oils (including crude oils that have undergone weathering where the viscosity increases) with a large wax or asphaltene content. Influenced by sea state providing mixing energy to promote the process, and temperature, which influences both viscosity and evaporative losses.

- **Photo-oxidation** (chemical transformation of oil into new compounds through exposure to sunlight).

  A relatively minor process in the removal of oil from the sea surface, but important where oil components oxidise to resins and eventually asphaltenes. This contributes to the stability of water in oil emulsions and therefore has a large influence on the oils persistence on the sea surface. Photo-oxidation is inhibited in higher latitudes in winter, and in rough sea states.

- **Sedimentation and shoreline stranding** (incorporation of oil with suspended or shoreline/seabed sediment).

  Influenced by high turbulence that increases mixing with sediments. Ice can prevent movement of oil on or off shorelines, and can dampen sea state.

- **Biodegradation** (the natural consumption of oil by bacteria and fungi).

  A significant but slow process. Cold (and very hot) temperatures slow the process which (mostly) requires oxygenated (aerobic) conditions.

3. THE EFFECT OF PHYSICAL CONDITIONS ON OIL AND SPILL RESPONSE OPTIONS (CONTINUED)

3.3 EFFECTS ON RESPONSE OPTIONS

Information Source(s)	Key Questions
• Climate and weather data • Hydrographic modelling • Oil spill response plan • Equipment performance data	Has there been a realistic assessment of likely outcomes for a range of oil spill scenarios under the most favourable conditions likely to occur?
	Has there been a detailed and realistic assessment of the impact that adverse conditions will have on the proposed response options – both on water and on shore?
	Does the Contingency Plan deal with the consequences of adverse conditions?

HOW MUCH IS ENOUGH? Because environmental conditions vary greatly (often over short periods of time) and influence response options in different ways, a Contingency Plan needs to support flexible decision-making and response options. As the prevalence and/or severity of adverse conditions and spill consequences increases, there should be increased emphasis on prevention and readiness. The planning process must address not being able to respond because of adverse conditions, and the consequences of this. Realistic performance standards should be described (along with limitations to achieving them), and stakeholders should be able to understand what different types of responses may be able to achieve under different conditions.

Adverse environmental conditions can limit or prevent response operations both on-water and on-shore, although the limitations to on-water operations are generally more extensive. Many of the parameters of concern are interrelated and synergistic, so that it is often difficult to separate their effects. The following factors (listed alphabetically) are the key environmental parameters to consider in an evaluation of adverse conditions and their effect on potential response options:

- **Currents/tides** – on-water mechanical containment and recovery operations are generally ineffective due to boom leakage where "relative" currents (the shear current between the boom and surrounding water) exceeds 1m/s (~2 knots). Tides can limit shoreline operations in the intertidal zone and can compromise shoreline protection strategies.
- **Day/night cycle** – oil spill response, both on-water and on-land, remains essentially a daytime operation although improvements in remote sensing and night vision technologies allow some assessment of oil at night. Small recovery operations in sheltered areas may also be possible where floodlighting is possible.
- **Ice** – the formation or presence of sea ice can severely limit or prevent on-water mechanical containment or recovery operations, as well as dispersant application and monitoring. The degree of impact depends upon the condition and extent of the ice. Oil may be completely inaccessible, or equipment may fail because it cannot separate oil from ice. With increasing ice coverage, oil recovery can be more challenging depending on the prevailing ice conditions. Despite its generally adverse effects, the presence of ice may sometimes offer opportunities. It may form barriers to oil movement, leading to its concentration (such as in ice leads), allowing either recovery or in-situ burning. Snow and ice also interfere with

on-shore response options, but somewhat less severely. The degree of impact depends on a variety of factors, but especially on whether the oil is on or under the ice. Ice may form a natural protective barrier along shorelines and if strong enough may permit recovery equipment to be positioned on the ice.

- **Sea state** – on-water mechanical containment and/or recovery operations can be rendered ineffective or prevented if the sea state exceeds the limitations of the equipment. There is considerable debate as to just what those limits might be, and it is specific to both the type of equipment used, and the way it is deployed. In general, coastal and harbour equipment tends to lose effectiveness when waves exceed 5 feet (1.5m) in height, while larger offshore systems may remain effective with waves double this height. However, it is emphasised that these heights are not operational limits, but indications of when effectiveness may begin to be limited. Wave period is also important. Increased sea state will aid both natural and chemically-enhanced dispersion, but can also enhance emulsion formation. Increased sea state will make land operations near the water more difficult, but may enhance natural removal. Shoreline protection operations are ineffective if waves are too severe.
- **Temperature** – mechanical equipment can be affected by temperature, but the greater concern is the consequences for individuals involved in the response. Both extreme heat and cold limit the length of time individuals can be actively working, as well as their efficiency. Mechanical equipment in contact with water spray may freeze up when used at low temperature, even if ice is not otherwise present.
- **Visibility/precipitation** – all on-water and on-shore response activities require reasonable visibility and can be restricted or prevented if fog, rain, or snow occurs. The restrictions are more severe on operations at sea. Monitoring and mapping operations using aircraft can be severely restricted as conditions deteriorate.
- **Wind** – winds above approximately 20 knots severely limit use of on-water mechanical containment and recovery equipment as well as effective dispersant application (especially from aircraft). Again, this figure is not a limit, as increasing wind will generally see a steady decrease in effectiveness and actual effectiveness will depend on a range of factors. Operations on land are less affected, but as wind speed increases operations become more hazardous, especially in the intertidal zone.

A reasonable response plan will examine the limitations likely to be caused by each of these factors (including the expected frequency and duration) for each of the response options available. Based on this review, the plan will determine a realistic "window of opportunity" for an effective response. For those periods when an effective response is unlikely, there needs to be contingency plans for:

1. Monitoring the situation,
2. Tracking potential environmental effects, and
3. Being ready to respond with either recovery or restoration activities when conditions improve.

4. PREPARING BEFORE A SPILL

4.1 WHO NEEDS TO PARTICIPATE AND WHY?

As discussed in Section 2.1, all levels of government, industry, and other stakeholders should be in communication and be active participants in planning for or responding to an event (Engaged partnership). Each situation will be unique and influenced by national laws and social values, but if a group either will be affected by a spill, or will participate in a response operation, then they need to be involved in the pre-spill preparation. Without full participation the plan will lack validity and credibility, and the response will suffer because of a lack of awareness on the part of participants. IPIECA (2000a) identified the following generic list of parties that should be involved in developing contingency plans; national government agencies, local government agencies, port authorities, coastal authorities, emergency services, other oil companies in the area, contractors, environmental organisations, and local communities.

4.2 INFORMATION TO ASSESS THE RISK FROM SPILLED OIL

4.2.1 WHAT AREAS ARE OF CONCERN?

This initial stage of planning aims to gather the general information needed to understand how oil could be spilt, how it will behave if spilt, where it may go, and what it might affect, including social and economic resources as well as ecological resources. While sections are presented sequentially, in reality much of the planning is undertaken concurrently and in an iterative manner, allowing approaches to be modified as knowledge increases. Planning is also generally hierarchical in nature, starting at broad level and increasing in detail as the focus is refined.

Information Source(s)	Key Questions
• Risk and Resource Identification and Assessment	Have high risk activities been identified (potential spill sources) and assessed?
	Have high sensitivity areas been identified (potentially impacted areas)?
	Have the potential consequences to high sensitivity areas from high risk activities been assessed (how might spills affect resources)?
	Have risk and consequence estimates been incorporated into the oil spill planning process?
	Have broad response strategies been identified based on NEBA e.g. is dispersant use preferred over at sea recovery or shoreline clean-up?

HOW MUCH IS ENOUGH? Areas of concern should be defined in a transparent and defensible manner with information sufficient to prioritise planning effort within those areas likely to be affected. This should be directly linked to potential spill activities to ensure that planning, avoidance and mitigation measures are implemented appropriately and in a coordinated manner.

Several standard protocols for mapping shoreline resources, based on their sensitivity to oil (sensitivity mapping), already exist, and these should be used as much as possible to encourage compatibility.

In the early stages of planning, the risk posed by different activities and the potential consequences of spills must be defined in a semi-quantitative and consistent manner to optimise both operational and environmental aspects of oil development. Risk assessment techniques are commonly used to define the expected frequency, type, location, and volume of releases from different activities, and the extent that the risk can be controlled. Planning generally incorporates modelling of oil fate to identify which areas may be affected to enable possible consequences to be assessed.

Assessing oil spill consequences is usually an iterative process and often starts in the first instance with intertidal shoreline type, as a coarse measure of both oil sensitivity and persistence, to identify low risk areas where operations may be best suited, areas where sensitivity may be high but operational risk can be managed, and areas where a spillage of oil is unacceptable. The identification and assessment of the vulnerability and sensitivity of different habitats to oil spills is commonly referred to as 'sensitivity mapping'. This usually refers to shoreline habitats, although near shore resources such as coral reefs, seagrass beds or areas of value to marine mammals, birds or fish may be included.

From this point, additional detail is generally necessary to validate assumptions and identify where further effort is required to define resources and resource sensitivity more accurately. Assessment should address environmental consequences to the water surface (particularly to birds), the water column, benthic habitats, and shoreline types (ranging from sheltered wetlands to high energy exposed coastlines), the plants and animals present, and existing protection status, as well as the human consequences of a spill including economic, social, cultural, recreational, and political components.

NOTE: Subtidal effects of oil spills are generally considered to be less of a threat than that posed by oil on the shoreline or on the water surface, so initial planning usually concentrates on preventing or treating shoreline impacts and recovering floating oil. If dispersants are a part of the response plan, then water column and subtidal effects become critical, as is the case for secondary transport of oil due to erosion or sedimentation.

4.2.2 WHERE WILL THE OIL GO?

Information Source(s)	Key Questions
• Trajectory and fate models	Have trajectory and fate estimates been based on a 3-D hydrodynamic model?
	Do trajectory and fate estimates take oil weathering into account?
	Have trajectory and fate estimates used representative (ideally actual) weather data?
	Do trajectory and fate estimates match local observations?
	Have multiple-iteration stochastic modelling approaches been used to assess risk?
	Have trajectory and fate estimates been incorporated into the oil spill planning process?

HOW MUCH IS ENOUGH? Models are approximations of the real world and there is almost no limit to the amount of refinement that can be undertaken. While models need to be reliably predictive, they are not expected to be 100% accurate. Models should highlight the primary areas of concern, be used to help select appropriate prevention options, and guide spill response actions. They should be able to predict general oil movement, concentrations, and weathering, with model outputs consistent with real world observations. They should be regarded as a tool to support practical planning and decision-making, and not an end point in their own right.

Understanding where oil is likely to go enables high risk areas to be identified, and indicates what resources may be impacted by oil under different physical conditions (e.g. weather, season), spill scenarios (e.g. bunker spill, vessel grounding, well blowout), and different response options (e.g. natural recovery, shoreline cleaning, chemical dispersants).

The most basic predictive tools are two dimensional (2-D) vector calculations of surface movement based on wind and currents. Calculations are made either manually, or using simple computer models, supported by field observations. While surface movement provides a vital piece of information for mobilising an effective response, it doesn't enable estimates to be made of likely oil concentrations and exposure periods to resources, nor predictions of the likelihood of spills to move in specified directions as part of a risk assessment.

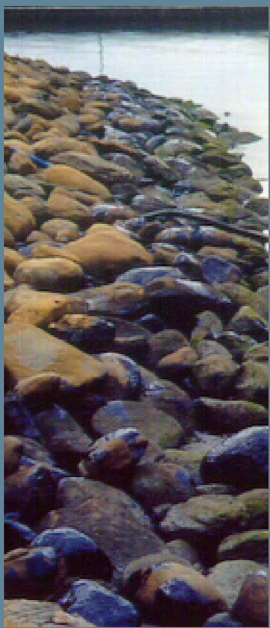
Since 3-D models tend to be more expensive than 2-D models, and stochastic modeling is more expensive than scenario modeling, the benefits from any improved modeling effort must always justify the cost.

While the use of surface trajectory (2-D) models is still prevalent, the oil industry is beginning to use 3-D hydrodynamic computer models to predict likely oil movement and concentrations from real data. The models are generally run using actual weather data (wind strength and direction), commonly combined with chart bathymetry and tidal streams to compute waves and currents. Data from current meter and wave buoy deployments may also be available. The models provide a picture of surface movement as well as subsurface dilution and dispersion. Key outputs are predictions of oil concentrations that can be used to assess the likely ecological response of leaving a spill to recover naturally, or following the use of different response options, particularly dispersant use. Models ideally incorporate oil weathering to predict aspects such as the rate and extent of evaporative losses, viscosity changes, and the potential for emulsion formation. At a planning level, two basic modelling approaches are used:

- **Scenario modelling:** Spill modelling using specified release data and actual weather. This is usually done to identify the probable extent and concentration of oil resulting from a specified spill from a high risk area like a well head or bunker point.
- **Stochastic modelling:** Modelling multiple iterations of stochastic releases under prevailing weather (long-term actual data). This is used to build a risk profile of where oil is most likely to go most of the time.

The information from both these approaches is subsequently used to modify planning and operational aspects, as well as refining response strategies and allocating resources. However, since 3-D models tend to be more expensive than 2-D models, and stochastic modelling is more expensive than scenario modelling, the benefits from an improved modelling effort must always justify the cost.

4.2.3 HOW WILL THE OIL BEHAVE?



Information Source(s)	Key Questions
• Laboratory analyses • Existing data sources • Spill observations	Are the oil properties known and specified (e.g. pour point, viscosity, specific gravity, surface tension, flash point, solubility)?
	Have characteristics been determined for weathered oil, including emulsification properties?
	Do weathering predictions reflect likely spill conditions (including sea ice)?
	Are specific oil properties affecting response options specified (e.g. wax or asphaltene content)?
	Has information on oil characteristics been incorporated into the oil spill planning process?

HOW MUCH IS ENOUGH? There is almost no excuse for not having direct information on oil properties and weathering. Exceptions may occur in the development or exploration phases of drilling where oil samples have not been collected, in which case data on similar oils from nearby wells etc. may be appropriate to use in the interim. Testing on the specific oil should be undertaken as soon as practicable.

Oil behaviour is determined by its physical properties (e.g. oil viscosity, specific gravity, density, pour point, flash point). Knowing these properties enables estimates to be made of the oil's form (solid, liquid, gas), its likely fate (e.g. evaporation, dispersion, dissolution, spreading rates), changes that may result as it undergoes weathering (e.g. loss of volatiles leading to a change in viscosity, emulsion formation), and general indications about persistence, toxicity and volatility of the oil. This information is used to select suitable response options (and therefore equipment and staffing needs), as well as predicting how oil is likely to behave following a spill, and how the oil may change at different times of the year, particularly under different seasonal conditions.

Information on oil properties can be obtained from existing datasets, laboratory analyses, as well as from past spill experience. Laboratory analyses of oil specific to a location will provide the most reliable information on physical characteristics under defined conditions. Details on the testing conditions, particularly temperature, should be specified with any results. In addition, information on group properties of oils (e.g. aromatics, asphaltenes, benzene, napthenes, paraffins, polars, resins, saturates, sulphur and wax), and heavy metal content, is also highly desirable.

A single source of up to date information should be available for both fresh and weathered oil, with oil weathering studies reflecting the conditions likely to be encountered, particularly the influence of sea ice and wind and wave conditions (see Section 3).

4.2.4 WHAT RESOURCES MIGHT BE AFFECTED?

Exposure + sensitivity = impact.

Information Source(s)	Key Questions
• Field based data acquisition • Resource mapping • Stakeholders	Have information needs for identifying potentially affected resources been specified?
	Has relevant information been collected or obtained from existing sources?
	Have any data acquisition or usage issues been resolved?
	Have resources been mapped appropriately and incorporated into the oil spill planning process?
	Is there a strategy to keep information updated?

HOW MUCH IS ENOUGH? Resource mapping should identify the resources present and likely to be affected by spilled oil at a level that defensible response decisions can be made. The broad sensitivity of most marine organisms to oil can be estimated from existing scientific knowledge or past spill experience, although priority species or unique oils may have a case for specific study. However, there is seldom a requirement for comprehensive scientific studies for the majority of resources most commonly present. Information collection should target the collection of data which is most likely to affect response decisions.

Once potentially impacted locations are identified, information is needed on the resources present that could be exposed to oil or impacts from an oil spill response. This is the very heart of a contingency plan as it provides the building blocks essential for almost all of the decisions relating to environmental protection, as well as for determining the relative importance of social, cultural and economic aspects.

"ecological impacts are both longer lasting, and once they have occurred, harder to repair than most other kinds of impacts (e.g. aesthetic, economic)"

Lindstedt-Siva, 1991

There is a sound basis for using ecological criteria to define environmental sensitivity on the grounds that "ecological impacts are both longer lasting, and once they have occurred, harder to repair than most other kinds of impacts (e.g. aesthetic, economic)" (Lindstedt-Siva 1991). The resources present should be clearly described in the contingency plan (or in a supporting report referenced to the plan), along with their likely sensitivity and exposure to oil (exposure + sensitivity = impact). Once resources are identified, assessment should be made of the potential magnitude and duration of any exposure, noting that estimates of exposure are often harder to develop than information on sensitivity, and must be realistic in terms of concentration and duration. Sensitivity must also consider variations due to life history stages.

Assessment should incorporate modelling results of both oil movement, and likely concentrations under a range of scenarios. For ecological resources, information is needed on species richness, diversity and abundance, although the availability of accurate, pre-spill data is highly variable. Information from the scientific literature on reproduction and recruitment strategies, feeding preferences, and foraging ranges on a seasonal basis is very valuable. Detail on local / regional / national / international conservation status should be included. In all cases, the natural variability of all of the populations in space and time, while very difficult to quantify, needs to be considered. Sensitivity assessment should also include both direct impacts (e.g. smothering, toxicity) and indirect impacts (e.g. habitat loss, feeding or breeding disruptions, loss of food sources etc.), as well as likely recovery rates, likely effectiveness of response options, and should be done on a seasonal basis where appropriate.

Interpretation of the sensitivity information is often made difficult because a lot of the available information focuses on individual organisms, rather than populations or, even more importantly, communities. This is important as decisions about which spill response option to use, or which resources to protect, are often made by considering community or population benefits, reflecting the limited ability to protect individual organisms with available oil spill response techniques.

Summary information should be mapped and available both as hard copy maps and electronically (e.g. as GIS layers), and provision made for updating information.

4.2.5 WHAT PHYSICAL FEATURES ARE PRESENT?

Information Source(s)	Key Questions
• Pre-spill segmentation studies • Field based data acquisition • GIS-data • Existing knowledge • Maps and charts	Is a framework available for segmenting and classifying shorelines and subtidal features?
	Has it been populated and verified?
	Is it integrated with existing GIS datasets and knowledge?
	Are responders familiar with it and trained in its use?
	Have existing sources of knowledge been incorporated?

HOW MUCH IS ENOUGH? Baseline data should be available for all high priority sites describing the physical environment and any response preferences or limitations. A framework should be available to add data for other sites as needed.

The physical environment is a significant determinant of both oil exposure and persistence, therefore gathering information on the dominant physical shoreline and subtidal features (e.g. substrate type, exposure, water depth, tidal range, ice cover etc.) provides a good guide to the most likely ecological or socio-economic impacts, and may also help define social or economic resources in the area. For example, potential amenity beaches, marine mammal haul-outs, bird rookeries, or shellfish beds all have different physical features. This information can also be used to guide the selection of different clean-up options, the resources required to protect different areas, and physical limitations in applying different techniques, e.g. site access, currents, wave exposure.

As physical features generally don't change significantly over short to medium time frames, information should ideally be gathered in advance to compile a database able to be presented visually using spatial mapping techniques which can be integrated directly with other planning and response data (there are various different sorts of proprietary software available e.g. ARCMAP, ShoreSeg, ideally suited to this). The information should be used strategically (to highlight which parts of the environment may be most adversely impacted by a spill), tactically (to define the individual resources in impacted areas), and operationally (to determine what the best sort of response may be).

If a spill occurs, responders should be able to go to shorelines with detail about what physical conditions they will encounter, so they can quickly and efficiently record the location and extent of oiling, and from this, set specific spill response priorities.

4.3 SETTING RESPONSE PRIORITIES

The information described in the previous section on risk assessment enables the identification of priority sites for protection and, following this, the options most appropriate to reduce impacts and clean up spills. For anything other than very small spills, there will be a need to decide where to allocate response effort. This is because of combined constraints on the availability of equipment, personnel, and prevailing conditions. Defining which areas are priority sites before a spill greatly facilitates decisions about where effort should be allocated during a spill.

4.3.1 DEFINING PRIORITY SITES FOR PROTECTION

Information Source(s)	Key Questions
• Contingency Plan development	Are priority sites defined, defensible and locally / regionally / nationally consistent?
	Do site priorities reflect seasonal variation, particularly in relation to resource presence or weather conditions?

HOW MUCH IS ENOUGH? All stakeholders should agree on high priority sites based on the risk assessment process and the fate modelling results. A framework should be available to periodically review the site rankings.

Fate and trajectory modelling provides a guide to where oil may go. Resource mapping identifies what is present that may be affected, and shoreline mapping indicates the physical character of intertidal areas, how oil may behave, and what physical limitations exist to responding.

Combining this information in a consistent way is necessary to identify the areas most in need of protection, as well as those more resilient and suited to natural recovery. In reality, the highest priority sites are usually where sensitive resources combine with significant exposure periods and long rates of natural recovery (in the absence of intervention). The priority of resources and sites themselves will often change under different spill or weather scenarios, the seasonal presence of key species, or the life stage of organisms present (e.g. breeding or juvenile), etc.

Priority site selection should involve relevant stakeholders and make use of realistic spill scenarios to assess the likely consequences to the resources present. A judgment can then be made about the relative value of different sites and resources, and the priorities for protection.

4.3.2 DEFINING PREFERRED PROTECTION AND CLEAN-UP OPTIONS

Information Source(s)	Key Questions
• Awareness of knowledge and techniques • Risk/benefit analysis of all available techniques • Assessments of effectiveness	Do priority sites have preferred response strategies based on NEBA identified?
	Have response limitations been identified?
	Have alternative strategies been identified?
	Is there consensus on the strategies and priorities identified?

HOW MUCH IS ENOUGH? Ideally, an oil spill response plan will emphasise flexibility and utilisation of all appropriate response options. This should include a realistic assessment of the likely effectiveness of each technology, as well as its ecological risks and benefits. There should be a mechanism in place to periodically review the potential value of new techniques.

The options for dealing with spilt oil are relatively limited, and are often constrained by physical conditions, prevailing weather, and safety considerations. The options selected must also consider the resources they are trying to protect and balance this against impacts of the response itself, and the effectiveness of different clean-up options. Response options are well described in the literature, the key attributes being:

- **Natural recovery** – allowing natural processes (physical and biological) to break down the oil. This requires an understanding of spill consequences, and a decision that a response is either not required or not possible. Monitoring of natural recovery is necessary to assess whether a response may be required.
- **Chemical dispersants** – enhancing natural dispersion of oil into the underlying water. This requires consensus on the extent of water column impacts based on predicted exposure profiles, dispersant effectiveness knowledge (based on the oil spilt), and, at a minimum, visual monitoring of chemically dispersed oil supported, where possible, by real-time fluorometric monitoring.
- **Contain and recover oil on-water** – techniques to confine and collect oil (e.g. booms and skimmers). Requires a defensible decision-making framework to select areas (when near shore) where oil may be collected and contained for recovery effectively under prevailing conditions.
- **Shoreline clean-up** – allowing oil to strand before removing (many possible manual and mechanical techniques). This requires an evaluation of the impact of equipment and clean-up teams on wildlife and habitat, compared to the impact of oil spill on the same sites.
- **Other response options** – e.g. In-situ burning (controlled ignition of spilled oil on water or shorelines or in ice); bioremediation (facilitation of microbial breakdown of oil, often through the addition of nutrients). Secondary response options are often cited in plans, and are generally suitable under limited circumstances.

Interventions must be evaluated in terms of both feasibility and effectiveness and, in all circumstances, the options selected should achieve a net environmental benefit for the spill. Ideally, available and preferred response options should be identified, with stakeholder input, prior to a spill occurring.

4.3.3 HOW COULD DIFFERENT RESPONSE OPTIONS AFFECT RESOURCES?

Information Source(s)	Key Questions
• Ecological Risk Assessment	Is the planning process based on sound Ecological Risk Assessment (ERA) principles?
	Have the impacts of different response options on sensitive resources been assessed?
	Has there been relevant scientific input to the ERA process?
	Have relevant stakeholders been engaged in the ERA process?
	Do decision-makers understand how the ERA process underpins the response process?

HOW MUCH IS ENOUGH? Combined knowledge of the resources present and response options available should be used to identify the preferred response for each resource, as well as the impacts that each form of response can have. The ERA framework should ensure relevant information has been used to reach response decisions, address conflicts over the protection of different resources, and to engage and inform stakeholders.

NEBA and ERA (see Section 2.3) provide a framework for evaluating what is likely to happen if the environment is left to recover naturally following a spill, and for comparing how this post-spill "baseline" state will change for different response options. It is often useful to look first at the ecological tradeoffs (ERA) and then integrate the results into a broader NEBA analysis. It takes information on what resources are present and the areas where they are found, assesses the different ways they may be exposed to oil, and the consequences of any exposure. This is then used to determine the circumstances under which different clean-up options may be appropriate considering the tradeoffs that may occur between different resources, and the specific impacts that clean-up options themselves may have.

A common example of ERA use is in deciding whether the benefit of using chemical dispersants to remove oil from the sea surface (to reduce seabird or shoreline oiling) is greater than the potential impact to subsurface resources from dispersing surface oil into underlying seawater. At a planning stage ERA enables information gaps to be defined, potential conflicts between the protection of different resources to be identified, and scientific and stakeholder engagement in conflict resolution over different protection or clean-up strategies. It is also a valuable training tool for responders and stakeholders as it highlights how different response options will change impacts to different resources, and enables preferred protection strategies and priorities to be defined for specific resources (covered in the following section).

4.4 DEVELOPING AN APPROPRIATE RESPONSE CAPACITY

This section addresses the aspects required to deliver a specific response to a spill. It covers the equipment and staff needs, as well as training and exercising. It is interrelated to a large extent with the information developed in Sections 4.2 and 4.3, and should reflect the priorities already developed. This is largely a numbers exercise based on the risk assessment which defined the type of response options and the resources needed to implement them. If there is the potential for a significant release of oil, use of a tiered response to supplement local resources when needed, is important. There is significant industry experience with this aspect of oil spill response.

4.4.1 DEFINING EQUIPMENT NEEDS

Information Source(s)	Key Questions
• Equipment annex of the Contingency Plan • Product technical data • Tier 1, 2, and 3 response organisations	Did risk assessments use realistic scenarios to define oil volumes and release locations?
	Have preferred response options been defined?
	Are appropriate resources allocated to implement the preferred response options?
	Is sufficient equipment available?
	Is equipment appropriate for the oil and conditions likely to be encountered?
	Is it deployed in suitable locations, well maintained and available for use?
	Does the equipment adequately protect against adverse impacts?
	Is spill response support available from other organisations and are appropriate documents such as memoranda of understanding (MOU) in place?

HOW MUCH IS ENOUGH? Risk assessments will identify possible spill volumes, and the equipment available for different techniques should reflect this risk. Often, the ability to source equipment from external sources limits what needs to be located on-site.

The equipment available should reflect the potential risk and size of spill, taking into account prevailing weather, and following identification of the best response options available. Mobilisation times, suitability of equipment, and staging locations are key factors to define. The ability to access equipment from off-site, and the time frame for doing so, is an important consideration in how much equipment is needed on-site. As there is considerable cost associated with equipment stockpiles, requirements need to be carefully documented, and reflect a realistic evaluation of the conditions likely to be encountered and the resultant effectiveness of the equipment.

4.4.2 DEFINING STAFF NEEDS

Information Source(s)	Key Questions
• Contingency Plan • Equipment Operating Manuals • Tier 1, 2, and 3 response organisations	Have staff with appropriate skill and knowledge undertaken pre-spill planning?
	Are specific roles clearly identified and are staff available to undertake them?
	Are staff appropriately trained for the roles they are allocated?
	Is spill response support available from other organisations and are appropriate documents such as memoranda of understanding in place?

HOW MUCH IS ENOUGH? Staffing requirements should be based on both mobilised and non-mobilised conditions, and provide for the orderly transition from one to the other. There should be sufficient staffing available to allow for extended operations, based on the contingency plan.

Staff (or contractors) developing a contingency plan need to understand the potential for spills to occur, the possible impacts, the oil spill response requirements, and the methods available for combining this information into a coherent plan. Once a plan is completed, sufficient full-time staff need to be available to manage the spill response structure when not mobilised, and to update planning documents, monitor equipment and conduct oversight activities. When an event occurs, there must be a plan which provides for an organised and timely activation of both staff and resources that reflect the likely needs of a response.

4.4.3 ENSURING EQUIPMENT AND STAFF AVAILABILITY

Information Source(s)	Key Questions
• Contingency Plan • Corporate records	Are local resources trained and available?
	Does the Plan include provision for a tiered response, based on clear criteria?
	Is spill response support available from other organisations and are appropriate documents such as memoranda of understanding in place?
	Is there a mobilisation plan that is up to date?
	Is the plan realistically exercised?
	Is there a process for tracking staff and equipment readiness, and is it updated regularly?

HOW MUCH IS ENOUGH? Records of staff assignments, training and availability and equipment maintenance and readiness state need to be maintained and regularly updated. Availability needs to be demonstrated periodically through mobilisation exercises.

The effectiveness of any spill response is determined early on by the organisation's ability to appropriately mobilise to deal with the situation. This process should be described in detail in the Contingency Plan, which should ensure that:

- An appropriate command and control structure has been planned for and can be developed.
- The number of trained personnel is appropriate for anticipated response activities.
- The location of trained personnel has been considered in the Contingency Plan.
- There are contingencies in place to utilise untrained but available personnel if necessary.
- A human resource plan in place.
- Responders are competent and training is up to date.
- Medical profiles are available and up to date for responders.
- A health and safety plan is in place.
- There are contingencies to mobilise outside resources, such as Tier 2 or Tier 3 organisations, if necessary.

As with much of the plan development, the effectiveness of this aspect will reflect more than simply what is on paper. Not all up-to-date responders are equal, and their commitment to developing spill response skills, exercising them, and being ready to respond is best assessed directly.

4.4.4 MANAGEMENT AND COMMUNICATION

Information Source(s)	Key Questions
• Contingency Plan • Staff development plan	Is there a clear and well-communicated management structure?
	Is the internal flow of information defined?
	Are there processes in place for external communication?

HOW MUCH IS ENOUGH? The oil spill response Incident Command structure must be predefined and flexible enough to deal with both large and small spills. There must be processes and equipment available to ensure that both internal and external communication is timely.

There are four fundamental elements that contribute to effective management of an oil spill. They are:

1. A formal response organisation (often based on an Incident Command structure),
2. Clear roles and responsibilities,
3. Effective communications, and
4. Suitable resources.

It is important that the management structure be able to function effectively for a variety of spill sizes, and that a transition process is in place as an incident escalates in size or complexity. Effective internal communication is vital to ensure the incident control team receives incoming information, and outgoing information reaches the intended recipients, in a timely and accurate manner. Communication with field teams, particularly in remote response areas, often requires special consideration and should address how to deal with situations where public networks may not exist, or could fail through overloading or, where during a spill, temporary networks may need to be established such as radio repeaters etc.

4.4.5 TRAINING

Information Source(s)	Key Questions
• Contingency Plan • Staff development plan	Is training available locally or do staff participate in courses offered by outside sources?
	Are individuals fully qualified to conduct their jobs in the event of a spill?

HOW MUCH IS ENOUGH? There are a wide variety of sources available for certified training. Internationally, the International Maritime Organization (IMO) has produced model training courses for Senior Managers, Supervisors, and Operators. National training standards may also apply. All individuals should have documented training commensurate with their responsibilities, and they should participate in periodic recertification training.

Organisations need to make a conscious commitment to training. This should include training for operators of specific equipment, as well as appropriate training for spill managers and supervisors. Periodic "refresher" training is important, and cross-training should be encouraged. It is important to note that being trained is not the same as being committed to training and the effectiveness of any training will depend on the attitude of both the company and individuals concerned. This aspect should not be evaluated solely by what is included in a Contingency Plan, but should also involve direct on site evaluation.

4.4.6 EXERCISING

Information Source(s)	Key Questions
• Risk assessment • Contingency Plan	Are exercises based on realistic, risk-based scenarios?
	Do exercises incorporate environmental aspects in decision-making?
	Is feedback from the exercises included in plan revisions?
	Is exercise frequency appropriate to the level of risk?

HOW MUCH IS ENOUGH? Exercising should ensure an actual response can be undertaken effectively and efficiently with key staff familiar with their roles and responsibilities. Differing frequencies are appropriate for different aspects, e.g. several desktop exercises for every field deployment.

Contingency planning should include exercises based on realistic, risk-based scenarios to test and evaluate its efficacy, and make changes where needed. Exercises should address all aspects of the plan including notification, mobilisation, assessment, decision-making, equipment deployment, monitoring and termination. These can be exercised individually and collectively – preferably as a combination of both desktop and practical exercises.

It is ideal for criteria to be established for evaluating performance e.g. mobilisation within X minutes, establishment of a control centre within X hours, deployment of equipment within X hours. Contingency Plan components that should be tested include:

- Discharge containment
- Notification
- Staff Mobilisation
- Operations in the response management system
- Assessment
- Containment
- Recovery
- Protection
- Transportation
- Equipment Maintenance
- Personnel Support
- Disposal
- Communications
- Procurement
- Documentation

There should be a clear process where the lessons learned from exercising are evaluated and fed back into the plan as needed.

5. RESPONDING TO A SPILL

This section reviews key questions which relate to events that would occur in the event of an actual spill. In this section it may appear that there is a lot to develop during a spill. However, in practice much of the response should draw directly from the planning structure and system already in place. As such, the plan should show how it integrates the underlying preparedness information, and how it will be used and added to during a spill response. That is, the Contingency Plan should address how the key questions identified for each activity will be addressed or resolved, and should demonstrate that the requirements have been carefully thought through and have a clear way of being undertaken.

5.1 MOBILISING A RESPONSE

Information Source(s)	Key Questions
• Contingency Plan	Are clear procedures in place to notify, assess and initiate a response?
	Can spills be reported rapidly and reliable to the appropriate staff to take action?
	Have reporting procedures been tested?
	Are communications and backup systems available and reliable?

HOW MUCH IS ENOUGH? A tested and effective reporting framework identifying key roles and responsibilities. Ideally, target response times should be specified.

Spill reports need to capture sufficient information to allow the report to be verified and acted on appropriately and in a timely manner. Procedures should be clearly specified as to how reports will be dealt with, what information is required to be provided by those reporting spills, and who is responsible for the reporting.

5.2 ASSESSING WHAT'S BEEN SPILT AND WHERE IT'S GOING

Information Source(s)	Key Questions
• Spill report • Oil characteristics • Direct observations • Oil spill modelling	Are procedures specified and trained observers available to confirm, characterise and quantify spilled oil?
	Are procedures in place to provide information on the size, type, location, and movement of oil to identify whether sensitive areas may be impacted?
	Can the information be used to guide planning and mobilisation of response?
	Is there a reliable model to provide timely prediction of oil spread, fate and likely zones of impact?
	Does the assessment indicate the time available and physical constraints to mounting a response (e.g. prevailing weather, site access, habitat type, etc.)

HOW MUCH IS ENOUGH? Timely and reliable methods for predicting and tracking oil movement following a spill. Ideally based on real time aerial observation and recording using GPS data capture tools, supported by GIS based hydrodynamic oil spill models using real-time met-ocean data and oil characteristics. NOTE: modelling is not a substitute for real observations and is simply a supplementary assessment technique.

Determining the extent, movement and fate of oil following a spill is necessary to guide response planning and to determine the risk to surface, shoreline and subtidal resources. It is an integral part of the initial operational response, and is usually required on an ongoing basis throughout the spill.

Many options exist for directly collecting information on surface oil including: aerial overflights, video/photographic records, remote sensing (e.g infra-red imagery), GPS tracking and/or GIS based mapping, manual or computer predictions of oil movement, response plans and resource databases, local knowledge, and shoreline assessments. Methods should be specified for calculating spill volumes based on either release data or direct observation of areas affected by oil. It is accepted that initial estimates are unlikely to be very accurate.

Estimates of oil fate provide guidance on the nature and type of exposures expected for different resources. Oil databases, (e.g. ADIOS and SINTEF's Oil Weathering Model), ideally populated with detail on the specific oils being assessed, can be used to estimate weathering under different conditions, although site specific hydrodynamic models incorporating detail on oil properties are ideal.

An initial coarse assessment is needed to assess the likely fate of oil with regard to what remains on the sea surface, and what enters the water column, impacts shorelines, or is lost through weathering processes such as evaporation. Basic objectives are:

- Evaluate the extent and character of a spill.
- Track spill movement consistently and accurately.
- Identify areas and resources potentially affected.
- Establish protection priorities.
- Provide information to plan response actions, and monitoring/assessment studies.
- Document justification for response actions.
- Collect baseline data for effects of clean-up actions.
- Collect baseline data on oil fate and effects.

5.3 ASSESSING THE EXPOSURE OF VULNERABLE SITES AND RESOURCES TO OIL

Information Source(s)	Key Questions
• Contingency Plan • ERA • Local knowledge • Field observation	Are priority sites and resources of concern defined in the plan?
	Does the plan enable the rapid identification of priority sites and resources in a consistent and defensible manner?
	Can local knowledge be easily captured and incorporated into the planning framework and used in decision-making in a timely manner?
	Can further information be accessed quickly if needed?
	Do responders understand the risk and consequence of different response options and can they defensibly make tradeoff decisions that are understood (if not always agreed with) by stakeholders.

HOW MUCH IS ENOUGH? Actions which are taken during a spill should be consistent with the priorities for protection developed through the risk assessment process.

This is a key part of the response – identifying the specific sites and resources of concern following a spill so that the response can target the highest priority areas. The Contingency Plan should guide decision-making by taking into account priorities for protection, and any limitations with available response options. The Plan should allow decision makers to consider the impact of different response options on specific resources and to choose response options that best minimise the threat to most vulnerable resources. It should provide a flexible structure that allows the rapid integration of local knowledge and stakeholder input to guide response actions.

5.4 SELECTING CLEAN-UP OPTIONS

Information Source(s)	Key Questions
• Contingency Plan • ERA	Are all potential response options defined and evaluated in the plan?
	Does the plan provide for the integration of all appropriate response options?
	Are criteria presented in the plan for choosing between response options in different circumstances and obtaining approval from the command authority in a timely fashion?

HOW MUCH IS ENOUGH? Actions which are taken during a spill should be consistent with the priorities for protection and response selection developed through the risk assessment process.

The primary focus of an ERA (Section 2.2) is to evaluate the feasibility and effectiveness of all potential response options (see Section 4.3.2). The Contingency Plan should, in broad measure, describe the response options available and under what circumstances, and in what locations, they would be most appropriate. When a spill occurs, it is then necessary to develop detailed operational plans for implementing them that reflect the specific circumstances of the spill. This needs to be done quickly, so standard protocols to present information to the command authority for approval need to be in place. These protocols must consider the probable effectiveness in the actual conditions, as well as the risks and benefits. Ideally, as much of the approval process as possible should be completed during the planning stage (i.e. preauthorisation or expedited approval zones) so the final decision is simplified as much as possible. This is particularly important for response options such as dispersants or in-situ burning which are generally most effective on freshly spilt oil, and for which consensus may be difficult.

It is also necessary to incorporate direct measures of the actual or potential impact of the oil itself to assist in the final selection of response options. To this end, monitoring the impact of a spill is commonly needed and is discussed below.

5.5 MONITORING OIL AND RESPONSE IMPACTS

In general, there is a lot of debate about what oil spill monitoring is required and how it should be undertaken. For spill response purposes, it is vital for monitoring programmes to provide timely, reliable, accurate and interpretable information. How this is achieved, and indeed, whether it is possible, will depend largely on the reason the monitoring is being undertaken. AMSA (2003) have prepared a Spill Monitoring Handbook that describes in detail the issues and requirements of spill monitoring.

5. Responding to a Spill (continued)

Monitoring is commonly split into two types:

- **Type I monitoring** which provides information of direct relevance to spill response operations i.e. information needed to plan or execute response or clean-up strategies, and
- **Type II monitoring** which relates to non-response objectives and includes short-term environmental damage assessments, longer term damage assessments (including recovery), purely scientific studies, and all post spill monitoring activities.

The most common form of Type I monitoring is usually surveillance by boat or aircraft to confirm the presence of a spill, monitor its movement, collect samples of the spilt oil, and to guide response operations. The monitoring commonly undertaken at different stages of a spill is summarised in Table 1.

Table 1. Description of monitoring according to the stage of a spill.

Stage	Response	Description of Monitoring
1	Pre Spill	This includes true baseline monitoring and may be long term and large scale. "Control" sites can be well established. Study design can be modified and refined over time. Generally, such monitoring is undertaken in areas of high risk or on resources that are sensitive to spills or are otherwise of interest.
2	Post Spill – Pre Impact	Monitoring done at this stage is reactive and must often be designed and implemented at short notice to collect a "snapshot" of pre-impact conditions. Establishment of reliable "control" sites is difficult.
3	Post Impact – Pre Cleanup	Monitoring of oil-impacted shorelines, waters or resources. Examples include monitoring of oil behaviour and persistence in un-cleaned shorelines or monitoring of immediate damage due to oil (not cleanup).
4	Cleanup	Monitoring that occurs through a cleanup activity. For example, monitoring the success or the effect of cleanup on shorelines, water quality or biological resources.
5	Post Cleanup - Pre Response Termination	Monitoring of resources, water or shorelines after cleanup activities have ceased but before the response has been terminated. These are usually short-term programmes. This would include final assessments of cleaned shorelines, perhaps as a precondition to terminating a response.
6	Post Response	This includes all monitoring that occurs after the formal end of a response. Such studies may be short- , medium- or long-term.

Stage	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Spill	Pre spill	Post Spill				
Response		Response				Post Response
Impact	Pre Impact		Post Impact			
Cleanup	Pre Spill	Pre Cleanup		Cleanup	Post Cleanup	

Spill ↑ Impact ↑ Start of Cleanup ↑ End of Cleanup ↑ End of Response ↑

(based on AMSA 2003)

Obviously, depending on the stage of a spill, different monitoring approaches are appropriate, and need to be carefully evaluated to ensure they are relevant and will produce meaningful results. Before a spill, where high risk activities and resources combine, monitoring to define pre-spill baseline conditions may be appropriate if an accurate assessment of impacts following a spill is considered important. Following a spill, it may be appropriate to collect pre-impact information to define pre-spill conditions. Response options should also be monitored to show whether or not the response option is reducing the impact of the spill (achieving a net environmental benefit), and to therefore guide decision-making regarding whether to keep doing it. Note, this is not the same as monitoring the impact of the spill.

The Contingency Plan should outline the methods that can be used, although decisions on what monitoring should be undertaken should consider the concerns associated with a specific spill, and the resulting benefit that monitoring may provide. Type I response monitoring information in particular should be robust, provide rapid feedback, and be limited to those parts of a response that provide a reliable measure of both effectiveness and impacts. When the monitoring programme is more focused on defining impacts (Type II) it should incorporate appropriate control or reference (non-oiled) sites, and allow for adequate replication of both oiled and non-oiled sites so that conclusions will be statistically valid.

Information Source(s)	Key Questions
• Contingency Plan • ERA	Does the plan provide for the monitoring of impacts caused by oil and response measures, especially oil dispersants?
	Does the plan provide standardised survey protocols?
	Are there criteria for how the information is to be used?
	Are personnel appropriately trained and equipment and supplies readily available?

HOW MUCH IS ENOUGH? A decision to use any response option will require monitoring to verify that unexpected adverse impacts did not occur. Such monitoring plans should be in place as part of the planning process. Monitoring should continue until the risk of adverse effects has passed.

The following sections overview the key questions for monitoring in different habitats. They are not listed in order of priority and in all cases the monitoring should reflect where oil impacts occur following a spill, the sensitivity of the areas and resources affected. Most importantly, the purpose of the monitoring must be clearly defined.

5.5.1 AT-SEA SURVEYS

Information Source(s)	Key Questions
• Contingency Plan • Standard handbooks on at-sea survey methods	Are provisions made for standardised at-sea surveys?
	Are these surveys consistent with international best practice?
	Are there provisions for incorporating the results of the surveys into operational plans in a timely manner?

HOW MUCH IS ENOUGH? The goal is to provide information on the size, type, location and movement of oil to identify whether sensitive resources may be affected, and to guide mobilisation and clean-up activities.

A primary need following a spill report at sea is to locate and confirm a reported slick. Then, if confirmed, to monitor its movement to determine what resources may be affected and require protection or clean-up, and to guide response and recovery operations.

The Contingency Plan should include methods for the rapid collection of data to establish the size and movement of the spill. Photographic/video surveillance should be collected, while remote sensing techniques (e.g. infra-red imagery) can identify the thickest parts of the slick to guide dispersant applications or recovery operations. It is common for oil samples to be collected and assessed to guide subsequent response decisions, particularly where dispersant use is likely to be considered. A systematic assessment should:

- Evaluate the extent and character of a spill.
- Track movement in a consistent and accurate manner.
- Identify areas and resources potentially affected.
- Establish protection priorities.
- Provide information to scope and plan response actions including other monitoring studies.
- Collect baseline data on the fate and effects of the oil.

5.5.2 SHORELINE SURVEYS

Information Source(s)	Key Questions
• Contingency Plan • Standard handbooks on shoreline survey methods	Are provisions made for standardised shoreline surveys?
	Are these surveys consistent with international best practice?
	Are there provisions for incorporating the results of the surveys into operational plans in a timely manner?

HOW MUCH IS ENOUGH? The goal is to complete initial shoreline surveys prior to oil reaching the shore, and then periodically for as long as necessary to define the distribution and accumulation of oil.

Shorelines are where most oil ultimately accumulates and most impacts occur, and where there is a high expectation of clean-up. Furthermore, shore types greatly influence likely oil persistence, and environmental fate. Shoreline assessment allows the monitoring of the effectiveness and impact of response activities. It also supports decision-making for protection or restoration actions, and documents post-spill recovery.

The Contingency Plan should include methods for the rapid collection of data to establish the pre-spill environmental conditions existing for comparison against conditions following the impact of oil. Photographic/video surveillance provides the ability to rapidly assess shoreline status to determine if pre-cleaning is required. Subsequent surveys form the basis for shoreline activities and should continue until clean up is suspended. During a major oil spill, shoreline oiling must first be assessed before selection of treatment methods. A systematic assessment should consider:

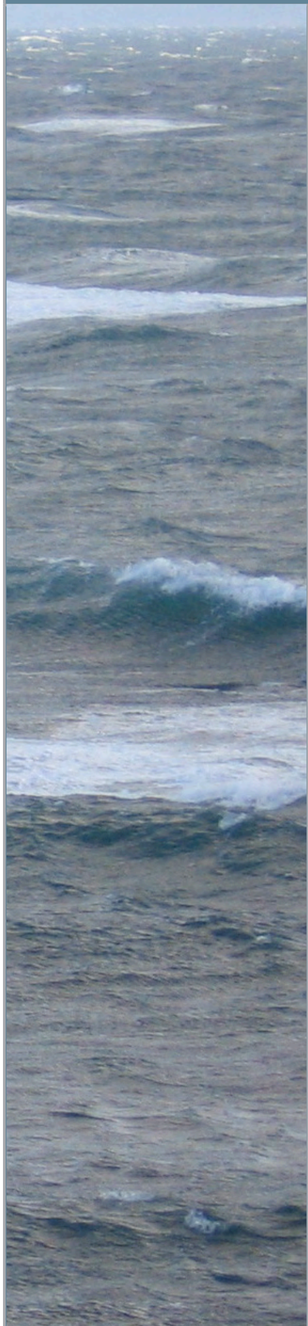
- The amount and properties of oil that has reached the shore.
- Possible interactions with the environment.
- The geological character and ecological conditions of affected shorelines.

It is important that staff have the ability to survey shorelines and to accurately and consistently record shoreline oiling characteristics. Aerial observation and recording is particularly valuable. Commercial and custom-developed software packages, such as ShoreAssess and PDA data capture tools, are available to assist in this process, and well established methods such as SCAT (Shoreline Clean-up Assessment Techniques) are also available (e.g. Owens and Sergy 2000).

5.5.3 WATER COLUMN ANALYSIS

Information Source(s)	Key Questions
• Contingency Plan • ERA	Have the circumstances which justify water column surveys been clearly defined?
	Is there a generalised sampling plan and objectives?
	Are the analytes to be determined and the analytical methods to be used defined?
	Are there criteria for how the information is to be used?
	Are personnel appropriately trained and equipment and supplies readily available?
	Are protocols in place for chain of custody, analytical methodologies and data compilation and analysis?

HOW MUCH IS ENOUGH? Information on water column concentrations of hydrocarbons is useful to estimate the distribution of dissolved or dispersed oil and exposure for both benthic (subtidal) and pelagic (free swimming) organisms. Detailed analysis of individual compounds is rarely justified and most decisions need to be made quickly, therefore total hydrocarbon estimates (e.g. fluorometry), followed by subsequent analysis in a laboratory, is usually sufficient. Surveys of water column organisms are rarely productive.



Water column monitoring of hydrocarbons is expensive, difficult to implement, and may not contribute to response decisions in a timely fashion. Nevertheless, consideration must be given to such monitoring programmes if there are resources at risk where such information is important to defining the impacts of a spill. If such a programme is implemented, pre-planning is essential.

A water column monitoring programme seeks to evaluate the fate of spilled oil and to determine the risk to subtidal and water column resources. It can be useful in the estimation of the oil budget, and verification of oil spill trajectory and fate modelling, including subsurface oil movement and concentration. Because oil in the water column tends to show a great deal of variation both spatially and through time, this type of monitoring is very difficult and needs to be carefully justified. Potential benefits of an analytical water sampling programme include:

- Define pre-spill baseline water quality .
- Monitor response effectiveness, especially dispersant use and shoreline flushing.
- Monitor spill and response.
- Identify low-level oil contamination related to the spill.
- Assess safety of water usage (e.g. contact recreation, seafood gathering).
- Assess biological exposure/bioavailability of contaminants in edible resources.
- Monitor impact of oil and response activities.
- Document post-spill recovery.

For near-real-time monitoring of hydrocarbon concentrations, fluorometry is the most common technique used to assess subsurface oil concentrations, and is often used as an indicator of dispersant efficacy. Discrete water samples analysed for hydrocarbon concentrations can also be used to define actual concentrations and to calibrate fluorometry measures and computer models. Both are usually expensive and should be carefully considered for their value. Laboratory analysis of hydrocarbon components cannot provide information for real-time spill management, but can help define exposure.

Even though sensitive organisms in the water column may be exposed to elevated hydrocarbon concentrations, biological water column monitoring offers little in the way of real-time information, is very difficult and time consuming, and would require a high probability of severe impacts to be justified. In-situ biomarker monitoring technology is now available for use in assessing impact and recovery of aquaculture and fisheries resources. Sentinel organism monitoring (e.g. natural populations or caged deployment of bivalves like mussels) is often very valuable if there are specific concerns.

5.5.4 SEDIMENT COMPOSITION AND ANALYSIS

Information Source(s)	Key Questions
• Contingency Plan • ERA	Are priority sites of concern and the criteria justifying sediment sampling defined in the plan?
	Does the plan provide a sampling plan and protocol?
	Are trained staff and sampling equipment available for rapid deployment?
	Are protocols in place for chain of custody, analytical methodologies and data compilation and analysis?

HOW MUCH IS ENOUGH? Sediment sampling usually refers to intertidal sediment sampling, but if conditions warrant, or dispersants are used in shallow waters, subtidal samples should be collected. Sampling should be adequate to define the presence and distribution of hydrocarbons in the areas of priority concern.

Sediment sampling seeks to establish pre-spill sediment quality and monitor post-spill contamination and recovery. It is valuable in evaluating the fate and behaviour of spilled oil and in determining the risk to subtidal resources. Such data are also used in the estimation of the oil budget. It is also used to determine whether the oil is from the spill, or is from other sources e.g. previous spills or natural seeps.

5.5.5 WILDLIFE SURVEYS

Information Source(s)	Key Questions
• Contingency Plan • ERA	Are priority species and survey locations defined in the plan?
	Does the plan provide standardised survey protocols?
	Are there criteria for how the information is to be used?
	Are personnel appropriately trained and equipment and supplies readily available?

HOW MUCH IS ENOUGH? Wildlife surveys must supplement previously established distribution information. Protocols to conduct wide area surveys, as well as localised surveillance should be in place. The response team should be able to rapidly translate information into operational plans.

Wildlife in the context of oil spill response refers primarily to marine mammals and birds, and to a lesser extent terrestrial mammals which may utilise the shoreline. Surveys need to identify pre-spill wildlife status, based on accurate and authoritative data on wildlife resources around the coast collected from the literature as well as baseline surveys during response planning. This includes whether seasonal wildlife are present, numbers, breeding stages, etc. These must be supplemented by monitoring which commences as soon as possible when a response begins, to directly assess what is likely to be affected during a spill.

5.5.6 INTERTIDAL ORGANISMS

Information Source(s)	Key Questions
• Contingency Plan • ERA	Are priority species and survey locations defined in the plan?
	Does the plan provide standardised survey protocols?
	Are there criteria for how the information is to be used?
	Are personnel appropriately trained and equipment and supplies readily available?

HOW MUCH IS ENOUGH? Intertidal impacts are often physical and obvious, and can be quantified fairly easily by standard population survey methods. Intertidal organism surveys should focus on priority areas of concern in the path of the oil or, in the case of dispersed oil, the trajectory of the plume. Such surveys can be expensive and should be tightly focused.

Intertidal surveys are usually initiated at the outset of a spill incident where shorelines are expected to be impacted to determine species richness, abundance and ecosystem structure for subsequent, post-spill comparisons. If necessary, this can be combined with information on hydrocarbon distribution, and other biological information, including tissue sample collection for contaminant analysis, the use of sentinel organisms, or the use of semi-permeable membrane devices to determine seafood safety and presence of oil in the surrounding water.

5.5.7 SUBTIDAL ORGANISMS

Information Source(s)	Key Questions
Contingency Plan ERA	Are priority species and survey locations defined in the plan?
	Does the plan provide standardised survey protocols?
	Are there criteria for how the information is to be used?
	Are personnel appropriately trained and equipment and supplies readily available?

HOW MUCH IS ENOUGH? Subtidal impacts are generally not expected except near shore or possibly in the presence of dispersed oil. While impacts can be inferred from standard population survey methods, they must be combined with sediment data and knowledge of oil exposure in order to verify that any changes are due to hydrocarbons. Such surveys are expensive and should focus on priority areas of concern in the path of the oil or, in the case of dispersed oil, the trajectory of the plume. Pre and post-spill sampling is required.

Subtidal surveys at the outset of a spill are used to establish pre-spill biological conditions for comparison with post spill conditions, and commonly include assessment of species richness, abundance and ecosystem structure. As seabed impacts are generally uncommon in deep water (>10-20 m), sampling is generally designed to collect information confirming that any changes are due to hydrocarbon exposure. Because of natural variability, statistically valid comparisons require a rigorous and well designed sampling programme. This is difficult, if not impossible to implement in a timely fashion at an oil spill. The benefits of such an expensive effort must be clearly justified before it is implemented.

5.5.8 STATUS OF ECONOMIC RESOURCES

Information Source(s)	Key Questions
• Contingency Plan • ERA • Local knowledge	Are priority species and survey locations defined in the plan?
	Does the plan provide for the collection of appropriate biological and economic data?
	Does the plan provide for an economic damage claims structure to be implemented in the event of a spill?
	Are personnel appropriately trained and equipment and supplies readily available?

HOW MUCH IS ENOUGH? Information collected immediately prior to and during a spill must be adequate to determine the potential for exposure and economic loss.

The objective of collecting economic resource data is to identify the status and quality of resources for evaluation of monetary costs and possible claims for compensation following the spill. The goal is to have accurate data on resources of commercial or subsistence value present in the vicinity of a spill and to quantify the value of those resources. This effort may draw on biological and physical data from shoreline surveys, intertidal and subtidal organism monitoring, and fisheries tainting information, in addition to tissue sample collection from aquaculture facilities. This supplements purely economic information from commercial activities which are affected by the spill. In reality, economic impacts are often independent of biological impacts, being driven by management decisions or perceptions which limit economic activity.

5.6 WASTE MANAGEMENT

Information Source(s)	Key Questions
• Contingency Plan	Are protocols for waste management defined in the plan?
	Does the plan enable the rapid identification of priority sites and methods for waste disposal?
	Are personnel appropriately trained and equipment and supplies readily available?

HOW MUCH IS ENOUGH? Actions which are taken during a spill should be consistent with the protocols for waste disposal presented in the Contingency Plan.

Where response options include on-water collection or shoreline cleaning, significant quantities of waste may be generated e.g. recovered oil, oily debris, discarded oily equipment, used sorbents, disposable personnel protective gear, food and sanitary wastes, and oily wastewater. In a large spill this waste can become a major logistics issue. Storage, handling (initial collection, temporary storage, and final disposal) and waste minimisation all need to be addressed. The goal is for all waste to be collected and transported to storage sites in appropriately constructed containers with no discharges to surrounding land or water and no risk to response personnel. All wastewater from de-watered waste oil should be discharged either to trade waste or discharged to the marine environment with the minimum practicable residual oil remaining.

6. TERMINATION OF CLEANUP EFFORT

6.1 DEFINING WHEN TO STOP RESPONDING

Hydrocarbons (both biogenic and petrogenic) are ubiquitous, so clean cannot be defined as complete absence of petroleum hydrocarbons.

Baker, 1997

Information Source(s)	Key Questions
• Contingency Plan • Field observation	Does the Contingency Plan identify a methodology for terminating spill response operations?
	Are monitoring plans in place to collect the information necessary to terminate operations?

HOW MUCH IS ENOUGH? Actions which are taken during a spill should be consistent with the priorities for protection developed through the risk assessment process.

It is important for the Contingency Plan to establish criteria for ending a shoreline cleanup. Criteria may also be appropriate for subtidal areas in the case of sinking oils, or for under ice conditions. Cleanup endpoints should be linked to pre-spill conditions and defined prior to a response (if not specified in the Contingency Plan). Monitoring plans for various habitats should be used to confirm that endpoints have been achieved. It should be recognised that continuing clean-up activities in some habitats may be detrimental to recovery, as well as costly, and so endpoint criteria are very important. Examples of shoreline cleanup endpoints are shown in Table 2.

6.2 ENDING THE RESPONSE

Information Source(s)	Key Questions
• Contingency Plan	Are demobilisation procedures defined in the plan?
	Does the plan provide for after-action review and evaluation?
	Is there a mechanism in place to revise the plan and seek approval for changes from the stakeholders?
	Is there a mechanism in place to re-supply and re-equip response centres?

HOW MUCH IS ENOUGH? Actions which are taken during demobilisation should be consistent with the protocols in the Contingency Plan and should provide for re-establishment of pre-spill readiness conditions.

At the conclusion of the spill there must be a protocol for the treatment and clean up of response equipment. These protocols should ensure that equipment clean up has no adverse environmental impact and is appropriately monitored. All oiled equipment should be segregated into waste streams for disposal and clean up as appropriate. All clean up should be undertaken in an appropriate facility with trade waste disposal. All work should be subject to an environmental management plan and monitored for performance and compliance.

Table 2. Examples of clean up endpoint criteria for different shoreline types.

Shoreline Type	Cleanup Endpoint
Exposed rocky shores and wave cut platforms	Shoreline no longer generates sheens that affect sensitive wildlife. For seal haulouts: remove persistent oil until no longer sticky except where clean-up considered too disruptive to animals.
Solid man-made structures	Industrial areas: terminate when shoreline no longer generates liquid oil or heavy rainbow sheens. High use public areas: clean up until oil no longer rubs off on contact. Low use public areas: visible oil stains and patches of coat can remain.
Sand beaches	No visible oil on the surface. Remove tarballs or tar patties that could be remobilised by reasonable clean-up techniques until at normal background frequency. No layers of oil are found in trenches dug into the beach.
Mixed sand and gravel beaches	All liquid oil in the sediments has been removed. No more than a stain may remain on the gravel-sized sediments. No oil layers in pits dug. Buried tarballs at/or below background frequency. Subsurface oil removal should cease when clean-up results in excessive habitat disruption that will cause more harm than natural oil removal.
Riprap structures	Industrial areas: terminate when shoreline no longer generates liquid oil or heavy rainbow sheens. Visible oil stains and patches of coat can remain. Remove flushable oil in crevices and on the sides and bottom of riprap. High use public areas: clean up until oil no longer rubs off on contact.
Exposed and sheltered tidal flats	When the shoreline no longer releases sheens that will affect sensitive areas, wildlife, or human health. Gross oil removal should cease when clean-up results in excessive habitat disruption that will cause more harm than natural oil removal.
Marshes	When free-floating oil is removed and the shoreline no longer releases sheens that will affect sensitive areas, wildlife, or human health. Gross oil removal should cease when clean-up results in excessive habitat disruption that will cause more harm than natural oil removal.

(based on Michel and Benggio, 1999)

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8. ADDITIONAL SOURCES OF INFORMATION

There are an almost unlimited variety of information sources available on oil spills, the impacts of oil in the environment, and oil spill response planning. Since there are literally thousands of scientific and general literature articles associated with these topics, as well as innumerable industry, governmental, environmental and internet resources, no such list can be inclusive. Therefore, to provide a reasonable place gain access to the wider oil spill literature, we have provided a few information sources we have found useful. We have omitted commercial vendors as well as non-governmental organisations in order to avoid any impression of endorsement. Most of those sites can be reached via links at many of the sites listed below, or by a general search of the internet.

Internet Information Sources

- International Petroleum Industry Environmental Conservation Association (IPIECA), (http://www.ipieca.org)
- International Maritime Organization (IMO), (http://www.imo.org)
- International Tanker Owners Pollution Federation (ITOPF), (http://www.itopf.com)
- American Petroleum Institute (API), (http://www.api.org)
- Minerals Management Service, US Department of the Interior (MMS), (http://www.mms.gov)
- NOAA Office of Response and Restoration Division (NOAA ORR), (http://response.restoration.noaa.gov./)

General Publications

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Wells, P.G, J.N. Butler, J.S Hughes, editors. 1995. Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters. ASTM, Philadelphia.

Conference Proceedings

Arctic and Marine Oilspill Program (AMOP)

Contact: Environment Canada, Emergencies Science and Technology Division
Environmental Technology Centre
335 River Road, Ottawa, Ontario, K1A 0H3, Canada
Ph: (613) 998-6922

International Oil Spill Conference (IOSC)

- http://www.iosc.org/papers/search.asp
- http://apistandardsonline.api.org/servlet/ControllerServlet?Action=DisplayHomePage&SiteID=api&Locale=en_US&Env=BASE

APPENDIX 1.

OIL SPILL PLANNING EVALUATION CHECKLIST

PART 1 - EVALUATING THE PLANNING PROCESS						
PLAN EVALUATION QUESTIONS	OVERALL CONCLUSION					NOTES
	Fully Addressed	Key Elements Addressed	Most Elements Addressed	Key Elements Missing	Not Addressed	
WHAT AREAS ARE OF CONCERN?						
Have high risk activities been identified (potential spill sources) and assessed?						
Have high sensitivity areas been identified (potentially impacted areas)?						
Have the potential consequences to high sensitivity areas from high risk activities been assessed (how might spills affect resources)?						
Have risk and consequence estimates been incorporated into the oil spill planning process?						
Have broad response strategies been identified based on NEBA e.g. is dispersant use preferred over at sea recovery or shoreline clean up?						
WHERE WILL THE OIL GO?						
Have trajectory and fate estimates been based on a 3-D hydrodynamic model?						
Do trajectory and fate estimates take oil weathering into account?						
Have trajectory and fate estimates used representative (ideally actual) weather data?						
Do trajectory and fate estimates match local observations?						
Have multiple-iteration stochastic modelling approaches been used to assess risk?						
Have trajectory and fate estimates been incorporated into the oil spill planning process?						
HOW WILL THE OIL BEHAVE?						
Are the oil properties known and specified (e.g. pour point, viscosity, specific gravity, surface tension, flash point, solubility)?						
Have characteristics been determined for weathered oil, including emulsification properties?						
Do weathering predictions reflect likely spill conditions (including sea ice)?						
Are specific oil properties affecting response options specified (e.g. wax or asphaltene content)?						
Has information on oil characteristics been incorporated into the oil spill planning process?						
WHAT RESOURCES MIGHT BE AFFECTED?						
Have information needs for identifying potentially affected resources been specified?						
Has relevant information been collected or obtained from existing sources?						

PART 1 - EVALUATING THE PLANNING PROCESS

PLAN EVALUATION QUESTIONS	OVERALL CONCLUSION					NOTES
	Fully Addressed	Key Elements Addressed	Most Elements Addressed	Key Elements Missing	Not Addressed	
Have any data acquisition or usage issues been resolved?						
Have resources been mapped appropriately and incorporated into the oil spill planning process?						
Is there a strategy to keep information updated?						
WHAT PHYSICAL FEATURES ARE PRESENT?						
Is a framework available for segmenting and classifying shorelines and subtidal features?						
Has it been populated and verified?						
Is it integrated with existing GIS datasets and knowledge?						
Are responders familiar with it and trained in its use?						
Have existing sources of knowledge been incorporated?						
DEFINING PRIORITY SITES FOR PROTECTION						
Are priority sites defined, defensible and locally/regionally/nationally consistent?						
Do site priorities reflect seasonal variation, particularly in relation to resource presence or weather conditions?						
DEFINING PREFERRED PROTECTION AND CLEAN-UP OPTIONS						
Do priority sites have preferred response strategies based on NEBA identified?						
Have response limitations been identified?						
Have alternative strategies been identified?						
Is there consensus on the strategies and priorities identified?						
HOW COULD DIFFERENT RESPONSE OPTIONS AFFECT RESOURCES?						
Is the planning process based on sound Ecological Risk Assessment (ERA) principles?						
Have the impacts of different response options on sensitive resources been assessed?						
Has there been relevant scientific input to the ERA process?						
Have relevant stakeholders been engaged in the ERA process?						

PART 1 - EVALUATING THE PLANNING PROCESS						
	OVERALL CONCLUSION					
PLAN EVALUATION QUESTIONS	Fully Addressed	Key Elements Addressed	Most Elements Addressed	Key Elements Missing	Not Addressed	NOTES
DEFINING EQUIPMENT NEEDS						
Did risk assessments use realistic scenarios to define oil volumes and release locations?						
Have preferred response options been defined?						
Are appropriate resources allocated to implement the preferred response options?						
Is sufficient equipment available?						
Is equipment appropriate for the oil and conditions likely to be encountered?						
Is it deployed in suitable locations, well maintained and available for use?						
Does the equipment adequately protect against adverse impacts?						
Is spill response support available from other organisations and are appropriate documents, such as memoranda of understanding (MOU), in place?						
DEFINING STAFF NEEDS						
Have staff with appropriate skill and knowledge undertaken pre-spill planning?						
Are specific roles clearly identified and are staff available to undertake them?						
Are staff appropriately trained for the roles they are allocated?						
Is spill response support available from other organisations and are appropriate documents, such as MOU, in place?						
ENSURING EQUIPMENT AND STAFF AVAILABILITY						
Are local personnel resources trained and available?						
Does the Plan include provision for a tiered response, based on clear criteria?						
Is spill response support available from other organisations and are appropriate documents, such as MOU, in place?						
Is there an up to date mobilisation plan?						
Is the plan realistically exercised?						
Is there a process for tracking staff and equipment readiness, and is it updated regularly?						

PART 1 - EVALUATING THE PLANNING PROCESS						
PLAN EVALUATION QUESTIONS	OVERALL CONCLUSION					NOTES
	Fully Addressed	Key Elements Addressed	Most Elements Addressed	Key Elements Missing	Not Addressed	
MANAGEMENT AND COMMUNICATION						
Is there a clear and well-communicated management structure?						
Is the internal flow of information defined?						
Are there processes in place for external communication?						
TRAINING						
Is training available locally or do staff participate in courses offered by outside sources?						
Are individuals trained/qualified to fulfil their roles in the event of a spill?						
EXERCISING						
Are exercises based on realistic, risk-based scenarios?						
Do exercises incorporate environmental aspects in decision-making?						
Is feedback from the exercises included in plan revisions?						
Is exercise frequency appropriate to the level of risk?						
NOTES:						

PART 2 - EVALUATING A SPILL RESPONSE EXERCISE

EXERCISE EVALUATION QUESTIONS	OVERALL CONCLUSION					NOTES
	Appropriately Addressed	Addressed, Minor Problems	Addressed, Significant Problems	Relevant, But Not Accomplished	Not Relevant to this Exercise	
MOBILISING A RESPONSE						
Are clear procedures in place to notify, assess and initiate a response and were they followed?						
Was the incident reported rapidly and reliably to the appropriate staff to take action?						
Were reporting procedures adequately tested?						
Were communications and backup systems available and reliable?						
ASSESSING WHAT'S BEEN SPILT AND WHERE IT'S GOING						
Were trained observers available to confirm, characterise and quantify spilled oil using procedures clearly specified in the plan?						
Were procedures in place and used to provide information on the size, type, location, and movement of oil to identify if sensitive areas may be impacted?						
Was the information used to guide planning and mobilisation of response decisions?						
Was a reliable model used to provide timely prediction of oil spread, fate and likely zones of impact?						
Were participants able to identify the time available and physical constraints to mounting a response (e.g. prevailing weather, site access, habitat type, etc.)						
ASSESSING THE EXPOSURE OF VULNERABLE SITES AND RESOURCES TO OIL						
Was the information on priority sites and resources of concern defined in the plan used?						
Did the plan enable the rapid identification of priority sites and resources in a consistent and defensible manner?						
Was local (actual) knowledge captured and incorporated into the planning framework and used in decision-making in a timely manner?						
Was it possible to access additional information quickly as needed?						
Did responders understand the risks/benefits of different response options and were any trade-off decisions clearly documented and understandable to all?						
SELECTING CLEAN-UP OPTIONS						
Were all feasible response options defined and evaluated in the plan and reviewed by the participants?						
Did the plan provide information on how to integrate appropriate response options and was this information used?						
Were criteria in the plan for choosing between response options in different circumstances and were they used to obtain timely authorisation?						

PART 2 - EVALUATING A SPILL RESPONSE EXERCISE						
	OVERALL CONCLUSION					
EXERCISE EVALUATION QUESTIONS	Appropriately Addressed	Addressed, Minor Problems	Addressed, Significant Problems	Relevant, But Not Accomplished	Not Relevant to this Exercise	NOTES
MONITORING OIL SPILL RESPONSE IMPACTS						
Did the plan provide for the monitoring of impacts caused by oil and response measures (especially oil dispersants), and was it used?						
Were standardised survey protocols for monitoring presented in the plan and implemented where needed?						
Did the plan provide criteria for how monitoring information was to be used and was it followed?						
Did personnel demonstrate appropriate training and were equipment and supplies readily available?						
SHORELINE SURVEYS						
Were protocols and forms for standardised shoreline surveys provided in the plan and effectively used?						
Were the surveys conducted consistent with international best practice?						
Were participants able to incorporate the results of the surveys into operational plans in a timely manner by following the plan?						
WATER COLUMN CHEMISTRY ANALYSIS						
Were the circumstances which justify water column chemistry surveys clearly defined in the plan and were they followed?						
If water chemistry samples were collected, was there a generalised sampling plan and objectives available?						
Were the analytes to be determined and the analytical methods to be used defined in the plan and was it followed?						
Did the plan discuss how water chemistry results were to be used and was the plan followed?						
Did field and/or laboratory personnel demonstrate appropriate training and were equipment and supplies readily available?						
Were protocols for water chemistry sample chain of custody and data compilation and analysis as defined in the plan implemented?						
SEDIMENT CHEMICAL COMPOSITION ANALYSIS						
Were priority sites of concern and the criteria justifying sediment sampling defined in the plan and followed?						
Did participants follow a sampling plan and protocol that was specified in the plan?						
Were trained staff and sampling equipment available and were they deployed in a timely manner?						
Were protocols for sediment chemistry sample chain of custody and data compilation and analysis as defined in the plan implemented?						

PART 2 - EVALUATING A SPILL RESPONSE EXERCISE

EXERCISE EVALUATION QUESTIONS	OVERALL CONCLUSION					NOTES
	Appropriately Addressed	Addressed, Minor Problems	Addressed, Significant Problems	Relevant, But Not Accomplished	Not Relevant to this Exercise	
WILDLIFE SURVEYS						
Were priority species and survey locations defined in the plan and were the recommendations followed?						
Did participants implement standardised survey protocols as defined in the plan?						
Were there criteria for how information on wildlife is to be used presented in the plan and were they followed?						
Were trained staff and sampling equipment available and were they deployed in a timely manner?						
INTERTIDAL ORGANISM SURVEYS						
Were priority species and survey locations defined in the plan and were the recommendations followed?						
Did participants follow a sampling plan and protocol that was specified in the plan?						
Were there criteria for how information on intertidal organisms is to be used presented in the plan and were they followed?						
Were trained staff and sampling equipment available and were they deployed in a timely manner?						
SUBTIDAL ORGANISM SURVEYS						
Were priority species and survey locations defined in the plan and were the recommendations followed?						
Did participants follow a sampling plan and protocol that was specified in the plan?						
Were there criteria for how information on benthic organisms is to be used presented in the plan and were they followed?						
Were trained staff and sampling equipment available and were they deployed in a timely manner?						
ECONOMIC RESOURCES						
Were priority economic resources of concern defined in the plan and was this information used by the participants?						
Did the participants follow recommendations in the plan for the collection of appropriate biological and economic data?						
Did the plan provide for an economic damage claims structure to be implemented in the event of a spill and was it established?						
WASTE MANAGEMENT						
Did participants follow protocols for waste management defined in the plan?						
Did the plan enable the rapid identification of priority sites and methods for waste disposal?						

PART 2 - EVALUATING A SPILL RESPONSE EXERCISE

EXERCISE EVALUATION QUESTIONS	OVERALL CONCLUSION					NOTES
	Appropriately Addressed	Addressed, Minor Problems	Addressed, Significant Problems	Relevant, But Not Accomplished	Not Relevant to this Exercise	
ENDING A RESPONSE						
Did the plan identify a methodology for deciding when to terminate spill response operations?						
Did participants implement monitoring plans to collect the information necessary to terminate operations?						
Were demobilisation procedures defined in the plan followed?						
Did the plan provide for after-action review and evaluation and was this done?						
Was there a mechanism in place to evaluate the exercise, revise the plan and seek approval for changes from the stakeholders?						
Were response centers resupplied and reequipped according to an established plan?						

NOTES: