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OGC IOGP/IPIECA Recommended Practice for a Common Operating Picture for Oil Spill Response

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Work Package 5: Common Operating Picture

Recommended practice for Common Operating Picture architecture for oil spill response

FINAL REPORT

Produced in collaboration with:

On behalf of the Oil Spill Response Joint Industry Project

The global oil and gas industry association for environmental and social issues

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Abstract

Responding to an oil spill requires access to and understanding of many types of information. Effective, coordinated operations for the response are based on a shared, common picture of the situation. Interoperability provides shared situational awareness of the crisis and the response activities. What is needed is a common picture of reality for different organizations that have different views of the spill so that they all can deal with it collectively.

Recent oil spills have provided lessons learned and recommendations on forming a Common Operating Picture for oil spill response. Through a joint project, industry is responding to the call, moving from recommendations to reusable best practices supported by open standards that can be deployed quickly in any region of the globe.

This architecture report is part of The International Association of Oil & Gas Producers and IPIECA Oil Spill Response - Joint Industry Project (IOGP–IPIECA OSR-JIP) to produce a recommended practice for GIS/mapping in support of oil spill response and for the use of GIS technology and geospatial information in forming a “Common Operating Picture” to support management of the response.

Interoperability seems to be at first a technical topic, but in fact, it is about organization. Interoperability seems to be about the integration of information. What it’s really about is the coordination of organizational behavior. The Oil Spill Response Common Operating Picture (OSR COP) project seeks to facilitate the coordination of organizational response to any oil spill in the future.

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Introduction

Scope of this report

This report provides an architecture for creating a Common Operating Picture (COP) for use during a response to an oil spill. This report provides recommended practice for the implementation of an effective COP and the requisite data management by the response community.

The report was prepared as part of a project to assess the current state of standards and implementations that could support recommendations regarding a COP for use during an oil spill response (OSR). It has been compiled after a Request for Information (RFI) process based on an initial document developed by the organizations mentioned in Section 1.3, followed by two industry workshops (in Houston and in London) where oil & gas companies, vendors and suppliers, academia, and regulators participated and provided valuable contributions, which were taken into account when developing this version 1 of the Recommended Practice.

Future versions of this Recommended Practice are expected after further work is done at an industry level to develop common data models/schema and standards, to support a more effective implementation of a COP.

Oil Spill Response Joint Industry Project

The April 2010 Gulf of Mexico (Macondo/Deepwater Horizon) oil spill incident, and the Montara incident in Australia which preceded it, have had far-reaching consequences in prompting the re-examination by industry not only of operational aspects of offshore operations, but also of an operator’s ability to respond in the event of an oil spill incident or well blowout (Figure 1).

In response to the foregoing, the International Association of Oil and Gas Producers (IOGP) formed the Global Industry Response Group (GIRG), tasked with identifying learning opportunities both on causation and in respect of the response to the incident. Nineteen recommendations were identified and these are being addressed via a three-year Oil Spill Response - Joint Industry Project (OSR-JIP) funded by oil industry members[1].

[1] Oil Spill Response – Joint Industry Project main website. See: http://oilspillresponseproject.org/

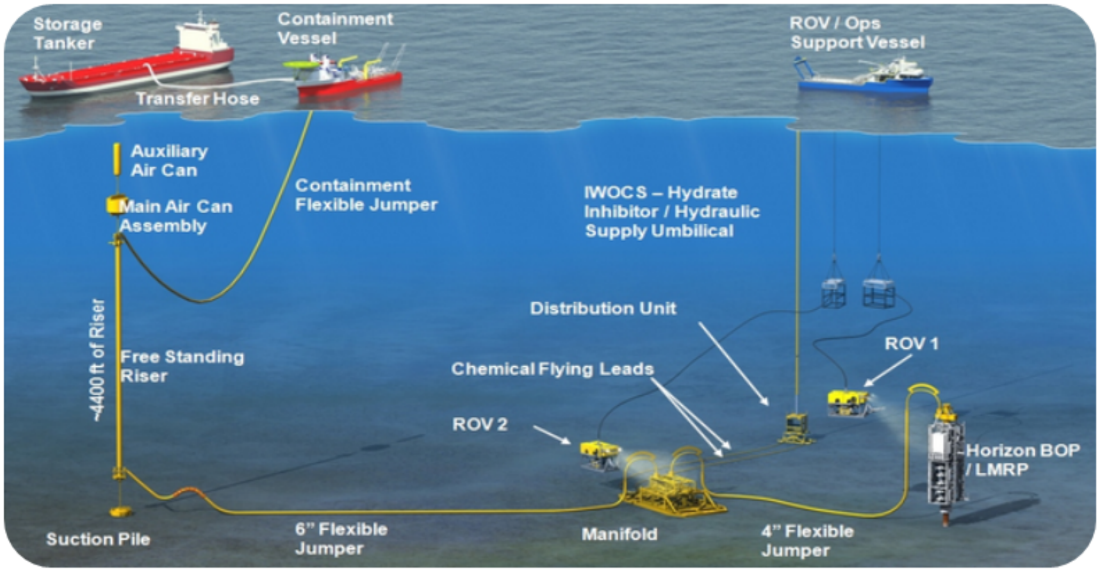

Figure 1 Typical subsea well intervention project

Source: Oceaneering, 2014

The OSR-JIP has initiated discreet projects or provided support to projects initiated by other trade associations in the nineteen subject areas resulting from the IOGP GIRG recommendations. The OSR-JIP is managed by IPIECA on behalf of IOGP in recognition of its long-standing experience with oil spill response matters.

The OSR-JIP is composed of several work streams. This project forms part of *JIP 8, 10, 11, & 16: Surveillance, Modelling & Visualization* and is entitled Work Package 5 (WP5) - GIS/Mapping and Common Operating Picture.

The aim for WP5 was to produce a recommended practice for the use of GIS and mapping in support of oil spill response and for the use of GIS technology and geo-information in forming a "Common Operating Picture" for management of the response.

WP5 should identify:

- What data needs to be available?
- Where does it come from?
- What format should it be in, and to what spatial accuracy?
- How should it be delivered, and to whom?
- How should it be archived and preserved.

In addition, the outputs of WP5 are to align with the Incident Command System (ICS) model.

WP5 is being conducted in close coordination with a number of other WPs that are part of *JIP 8, 10, 11, & 16: Surveillance, Modelling & Visualization:*

- WP1 - In-Water Surveillance
- WP2 - Surface Surveillance
- WP3 - Modelling & Prediction
- WP4 - Metocean Databases
- WP6 - Regulatory Issues
- WP7 - Report Deliverable

Organizations preparing this report

The International Association of Oil & Gas Producers (IOGP)[2] is a unique global forum in which members identify and share best practices to achieve improvements in every aspect of health, safety, the environment, security, social responsibility, engineering and operations. IOGP encompasses most of the world's leading publicly traded, private and state-owned oil & gas companies, industry associations and major upstream service companies. IOGP members produce more than half the world's oil and about one third of its gas.

IPIECA[3] is the global oil and gas industry association for environmental and social issues. IPIECA was formed in 1974 following the launch of the United Nations Environment Programme (UNEP). IPIECA is the only global association involving both the upstream and downstream oil and gas industry on environmental and social issues. IPIECA's membership covers over half of the world's oil production. IPIECA is the industry's principal channel of communication with the United Nations. When IPIECA was set up in 1974 the acronym stood for the International Petroleum Industry Environmental Conservation Association. In 2009, recognizing that this no longer accurately reflected the breadth and scope of the association's work, IPIECA stopped using the full title. The association is now known as IPIECA, the global oil and gas industry association for environmental and social issues.

Resource Data, Inc.[4] (RDI) has been supporting the oil & gas industry with information technology for spill response since 1989. RDI brings unparalleled experience to oil spill response, leading the geographic information system (GIS) and database teams for the Exxon-Valdez spill and more recently the GIS response team in the Macondo/Deepwater Horizon spill. RDI has developed numerous spill response data systems, participated in multiple drills, and developed risk analysis systems for major pipeline networks. Our depth and breadth of expertise in spill preparedness and response uniquely positions RDI to assist in the development of a COP for the oil & gas industry.

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[2] International Association of Oil and Gas Producers website. See: http://www.iogp.org/
[3] IPIECA website. See: http://www.ipieca.org/
[4] Resource Data, Inc website See: http://www.resdat.com/

The Open Geospatial Consortium (OGC)[5] is an international consortium of more than 480 companies, government agencies, research organizations, and universities participating in a consensus process to develop publicly available geospatial standards. OGC standards support interoperable solutions that "geo-enable" the web, wireless and location-based services, and mainstream IT. OGC standards empower technology developers to make geospatial information and services accessible and useful with any application that needs to be geospatially enabled.

Architecture viewpoints used in this document

This report provides a technical description of a COP for oil spill response using an architecture perspective. The organization of this technical description is based on ISO/IEC 10746, Information Technology — Open Distributed Processing — Reference Model. RM-ODP defines viewpoints that separate the various concerns when developing an information system architecture.

- Section 2 of the report provides an Enterprise Viewpoint, including a definition of a COP, the target audience (Users) and stakeholders, and example Use Case scenarios.
- Section 3 provides an Information Viewpoint, outlining the specific information and data that is delivered through the COP, and the basic governing principles.
- Section 4 outlines the computational Services Viewpoint, including interfaces and workflows pertinent to a COP using a service oriented architecture.
- Section 5 provides a Deployment Viewpoint, identifying the key types of components required to support the deployment, management and integration of the services and data.

[5] Open Geospatial Consortium website. See: http://www.opengeospatial.org/

COP Enterprise Viewpoint

Observations about Deepwater Horizon

Accurate, timely, and geo-referenced information is vital to operational and strategic decision-making. The Deepwater Horizon incident created an unprecedented need for information on a real-time basis. Barriers to synchronized and total domain awareness during the Deepwater Horizon incident included:

- Lack of agreement on what data needed to be tracked and transmitted;
- Vast geography of the response area of operations;
- Lack of availability of appropriate interoperable communications technology;
- Limited ability to push real-time data, both vertically and laterally, throughout the response organization;
- Different computing standards.

The incompatibility of proprietary databases and software used by the private sector appeared to be a hindrance to developing a universal COP for the response organization. Integrating data from multiple restricted sources slowed the development of a complete and an accurate COP.

The demand for information within Deepwater Horizon however drove an evolution of knowledge management and the response eventually established a strong COP, which provided for more effective communication throughout the response organization. An efficient information flow that met the needs of both the response organization and senior officials was also established, however there remained significant scope for improvement.

Many of those interviewed specifically stated that the National Incident Management System/Incident Command System (ICS) worked as intended. Because NIMS/ICS is scalable, adaptive, and dynamic, responders were able to tailor the response organization according to need. The 'Deepwater Horizon Incident Specific Preparedness Review' (ISPR[6]) provides recommendations that serve to further enhance NIMS/ICS use in future spills.

Based on lessons learned from the Deepwater Horizon oil spill response, a Notice To Lessees (NTL) was issued by the US Bureau of Safety and Environmental Enforcement (BSEE) providing 'Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast Line Concerning Regional Oil Spill Response Plans'[7]. The NTL provides clarification, guidance, and information concerning the preparation and submittal of a regional Oil Spill Response Plan (OSRP) for Oil and Gas Operators in the Gulf of Mexico.

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[6] 'Final Action Memorandum - Incident Specific Preparedness Review (ISPR) Deepwater Horizon Oil Spill', US Coast Guard, March 18, 2011. See: https://www.uscg.mil/foia/docs/DWH/BPDWH.pdf

[7] BSEE Notice to Lessees Number 2012-N06, 10 August 2012. See: http://www.bsee.gov/uploadedFiles/BSEE/Regulations_and_Guidance/Notices_to_Lessees/2012/NTL2012-N06.pdf

The NTL encouraged lessees to specify primary and alternate communications technology and software for use when coordinating and directing oil spill response operations and/or providing a Common Operating Picture to all oil spill management and response personnel, including the Federal On-Scene Coordinator and participating federal and state government officials.

Establishing an oil spill response COP

Definition of a COP

After consideration of several definitions provided by various parties, the following is considered to provide a concise definition of a Common Operating Picture:

A Common Operating Picture (COP) is a computing platform based on Geographical Information System (GIS) technology that provides a single source of data and information for situational awareness, coordination, communication and data archival to support emergency management and response personnel and other stakeholders involved in or affected by an incident.

Figure 2 provides a summary graphical perspective of a COP for responding to an oil spill.

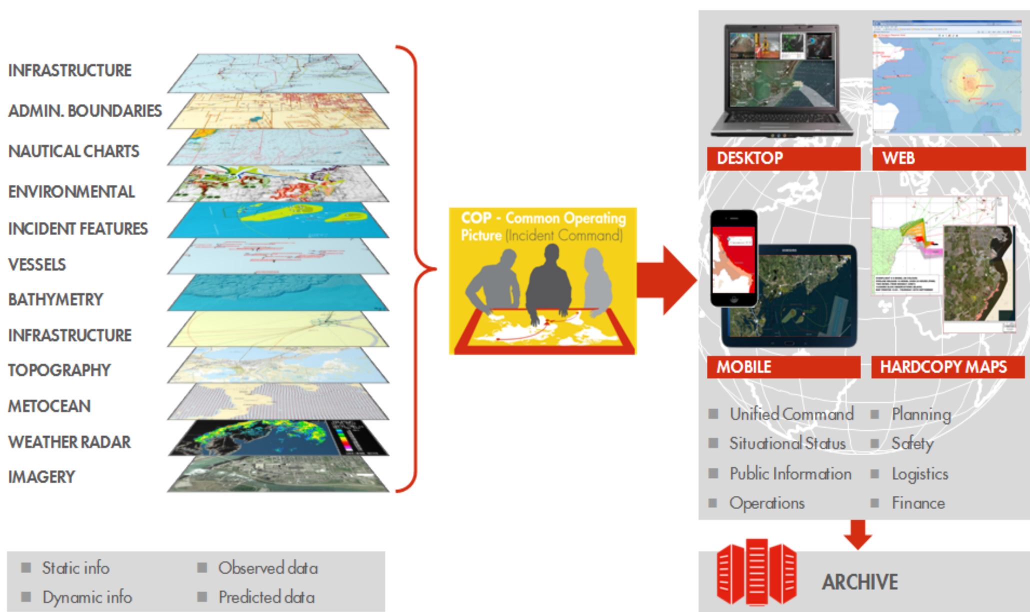

Figure 2 Common Operating Picture - highlighting geospatial information

Source: Shell, 2014

In addition to the COP, an incident command will use other information technology (IT) tools and systems to support processes such as equipment and services procurement, internal and external communications, asset management, invoice/payments, claims and recovery, reporting, and so forth. Such systems are commercially available and are evolving in capability to include basic COP functionality.

Integration of the COP with such systems is encouraged to facilitate information flow and simplify information management processes. However, the need to access high quality, reliable geospatial data from a variety of sources - including data that is proprietary to the oil company or its service providers - may necessitate that the COP is delivered and operated externally to these systems/tools. The interoperability standards that will form part of this guideline are designed to ensure that geospatial data can be integrated whilst applying appropriate levels of data security.

Geographic setting and source of spill

To understand how a COP can be used in a response it is important to understand the types of oil spill events targeted in this recommended practice. Figure 3 shows a set of scenarios in which a COP would be critical for effective Emergency Response.

Figure 3 Geographic setting and source of spills

Source: IPIECA, 2014

Incident lifecycle

Lifecycle overview

The needs and focus of data-related activities change through the phases of a spill. For the purpose of information management only, we have defined the life cycle of a spill as shown in Figure 4.

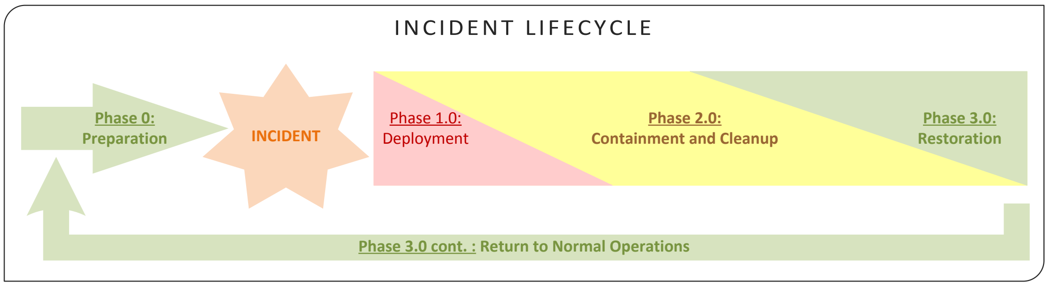

Figure 4 Incident lifecycle

Source: IPIECA–IOGP, 2015

Phase 0 – Preparation

This phase is characterized by planning, data identification and acquisition, and drills.

Table 1 Incident lifecycle phase 0 – Preparation

Activities	Completion Criteria
• Operations in new geographic areas. • Changes in organizational technology and technology strategy. • Changes to data sources. • New tools becoming available. • COP Information Management Plan template prepared.	• Response plan is complete (including data archiving). • All required datasets should be identified. • Base data should be acquired . • All tools should be on hand. • Staff should be assigned and trained in their specific ICS roles.

Phase 1 – Mobilization

Initial response activities are the primary focus of this phase, and minimizing the time of response is the key theme. The focus of this phase is damage limitation, resource acquisition, and building and implementing teams.

Table 2 Incident lifecycle phase 1 – Mobilization

Activities	Completion Criteria
• Incident command center initiated. • Resources identified and initially gathered. • Communications lines established. • Data access and sharing at various levels of technology (web services, hardcopy forms, response repository). • Information Management Plan implemented here.	• Initial Geomatics Unit is in place. • Roles and accountabilities are assigned. • Infrastructure is in place and operational. • Software tools are installed and available to users. • Data structures are implemented and populated (base data) or available for population (incident data). • Communications to all stakeholders is established. • Archiving strategy is implemented and data is being backed up and archived.

Phase 2 – Containment and cleanup

Containment and cleanup is entered into as soon after an incident as possible. Typically, it will begin concurrently to Mobilization but will continue after mobilization is complete.

Table 3 Incident lifecycle phase 2 – Containment and Cleanup

Activities	Completion Criteria
• Data loading. • Production of outputs based on templates. • Data backups. • Periodic snapshots taken. • Ad-hoc data requests fulfilled by on-site staff.	• Containment and cleanup activities are shut down.

Phase 3 – Restoration and return to normal operation

The final stages of a response are restoration and then returning to normal operations.

Table 4 Incident lifecycle phase 3 - Restoration and Return to Normal Operations

Activities	Completion Criteria
• Restoration and on-line access of archived datasets. • Litigation support. • Ad-hoc data requests fulfilled.	• Litigation and restoration activities are complete.

COP Information Management Plan

An Information Management Plan (IMP) should be developed at the beginning of any oil spill response using a standardized template prepared before the incident. This document would lay the groundwork for information management and data sharing across the response. It would include agreed upon data standards, field reporting requirements, media formats, as well as data archiving.

In order for a COP to function effectively, it must provide operational information in near real-time. This requires not only system continuity but also structure in the response organization to facilitate communication among the appropriate responders. Formalized ICS positions for information management are needed. In particular experts for geospatial information and remote sensing are needed either in the response or on call.

Information available during the incident response needs to be retained for activities after the incident. Activities include maintaining accurate and comprehensive incident files, including a complete record of the major steps taken to resolve the incident as well as storing incident files for legal, analytical, and historical purposes. Snapshots of the COP and the Response Center database need to be made on a periodic basis and transferred to a location remote from the Response Center.

Information release process

Different users of the COP may have access to differing information based on access control. Access is provided to the data through role-based security established prior to the event. Access control is the selective restriction of access to resources. An access control policy is established as part of the COP information release process. The policy is then implemented as part of the deployment of the COP. Access control can involve authorization of access based on authentication of the user using a credentials system.

User Identity and Management Services as deployed, for example in a web services environment for the COP, is discussed further below in this report.

Users and developers of the COP

Categories of users

A COP is established and maintained by gathering, collating, synthesizing, and disseminating incident information for all appropriate parties. A COP potentially allows on-scene and off-scene personnel to have the same information about the incident including the availability and location of resources and the status of assistance requests.

Figure 5 is a list of potential types of users of a COP. While the intention is to provide the same basic information for all users, some specific types of information may be available to a limited set of users managed through the assignment of access privileges, as further explained in Section 3.1.3.

COP users are categorized as:

1) Public (including media and academia)
2) Responders (including the Response Center)
3) Responsible Party

Public	Responders	Responsible Party
• Affected public • NGOs • Interested parties	• Incident Command • Response Teams • Government • Vendors, service providers • Volunteers	• Oil companies • Industry associations

Figure 5 Potential COP users

ICS organization roles

Experience has demonstrated the value of integrating incident response functions and resources into a single operational organization, managed and supported by one command structure and supporting processes. The IPIECA–IOGP 'Incident Management System for the Oil and Gas Industry' Good Practice Guide (IMS-GPG, IPIECA–IOGP, 2014)[8] provides experienced-based good practice guidelines for incident management and emergency response personnel. IMS-GPG is based on the Incident Command System (ICS), a version of IMS that is widely used by industry, response contractors and professional emergency services organizations. An IMS includes a set of proven organizational and management principles including common organizational elements (e.g. sections, branches, divisions, etc.), management structure, terminology and operating procedures.

The IPIECA–IOGP good practice guidelines define an organizational structure for an IMS to include four major sections under the Command function: Operations, Planning, Logistics and Finance/Administration (Figure 6).

[8] 'Incident Management System for the Oil and Gas Industry: Good practice guidelines for incident management and emergency response personnel', IPIECA–IOGP, IOGP Report Number 517, August 2014.

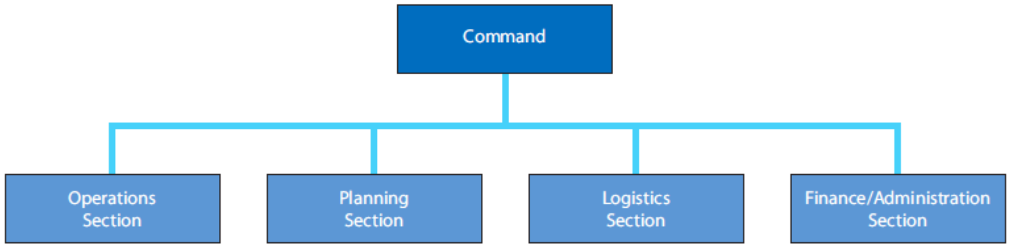

Figure 6 Organizational structure of an IMS

Source: IMS-GPG, IPIECA–IOGP, 2014

Geomatics Unit of ICS Planning Section

Given the pervasive and critical role of geospatial information to the COP for the response, it is recommended that a Geomatics Unit be defined within the Planning Section of the ICS structure.

The Geomatics Unit oversees the management and collection of spatial data; provides mapping, spatial analysis and meeting support for the response. The unit also develops, manages, and updates the Common Operation Picture.

Roles within the Geomatics Unit include:

- Geomatics Liaison – this role serves as a single POC within the command post that accepts and officially documents requests on an ICS-form, and then delegates out the work to geo-information analysts. The person sitting in this role must be fluent in geo-information to weed out inappropriate requests and understand basic deliverable timelines for geo-information products. This role serves as the data manager for geo-information. They also could serve as the role of oversight for any response GIS database and/or “working” data repository. They would work with the incident documentation unit to make sure that the correct information is collected and that the responders have access to it.
- Common Operating Picture Lead – this role publishes and updates the Common Operating Picture as the incident unfolds and attends official meetings to ‘drive’ the COP to support the talking points of the meeting. This role will also support briefings to executive leadership, the media, and local, state, federal authorities.
- Geo-information Analyst – this role performs mapping and analysis on request from the liaison. The role may also take direct assignment or embed with other sections such as Operations or Logistics. Cartography expertise may be included in this role.
- Geomatics Operations Specialist – arranges, specifies and coordinates survey operational activities required in support of the incident, including mobilizing survey equipment, vessels and resources, and overseeing safe operations. Geodesy and hydrography expertise may also be included in this role.
- Remote Sensing Specialist – this role provides specialist technical expertise in the acquisition and interpretation of remote sensing data in support of oil spill detection and mapping, as well as the use of remote sensing techniques for environmental mapping and assessment.

- Metocean Specialist – this role provides specialist technical expertise in the acquisition and interpretation of meteorological and oceanographic data and models in support of oil spill prediction and forecasting, in–situ measurements, and operational and logistic planning.

Scenarios for use of a COP

The following section outlines various scenarios for use of the COP within IMS.

Command Section use

The COP is the primary tool used for conducting daily command briefings during a response. A properly designed and implemented COP will visually show real-time or near real-time information within the area of responsibility (AOR). This will allow command staff to make decisions based upon actual and up-to-date information from the various sections of the response. The COP can be adapted and updated to meet the particular needs of a response, which often change due to the physical and political environment. Information present should include any datasets the command wants to see, report on, and discuss.

This may include:

- Satellite and aerial information
- Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV) data and video feeds
- Real-time vessel locations from Automatic Identification System (AIS) feeds
- Oil plume versus oil trajectory
- Digital geo-tagged photographs of cleanup operations
- Shoreline Cleanup and Assessment Technique (SCAT) data
- Dispersant use data
- Boom locations (planned and actual)
- Skimming data
- In-situ burn information
- Wildlife sightings (dead and alive)
- Anything else Command is interested in seeing

Command should use the COP for reporting and analyzing the data. Examples include:

- Percentage of shoreline oiled in a geographic area, sorted by oiling density
- Percentage of shoreline cleaned in a geographic area
- Number of individuals working in a geographic area
- Total footage of boom deployed in an area
- Results of a sampling program
- Barrels of oil and oiled material collected in a specific geographic area

Use Case: The Public Information Officer (Command Staff)	**Actors:** PIO, local media resources

<table>
<tr><th colspan="2">Summary</th></tr>
<tr><td colspan="2">Computer modeling supported by the morning over-flight reveals that the oil spill will soon impact the shoreline.

The Public Information Officer (PIO) is preparing to brief local media resources on the new situation and turn of events.</td></tr>
<tr><th colspan="2">Preconditions</th></tr>
<tr><td colspan="2">Maps are used to support talking points during the local media briefing.</td></tr>
<tr><th>Description (‘Sunny Day scenario’)</th><th>Exceptions (‘Rainy Day scenario’)</th></tr>
<tr><td>• The PIO uses the digital COP to support the talking points while briefing local media resources.
• The ability to pan, zoom, and query results in the map makes the information easily readable to all the audience.
• During the Q&A session the PIO uses the digital COP to support their answers; can pan, zoom, and query and focus on the current topic of discussion.
• A better operations picture is conveyed to the audience.</td><td>• The PIO uses wall-mounted large-format paper maps to support talking points.
• Map scale versus the area of coverage results in audience have difficulty seeing map information.
• Paper maps leave the local media resources with an incomplete operations picture of the response, risking incorrect or incomplete information delivery to the public.</td></tr>
<tr><th colspan="2">Post conditions</th></tr>
<tr><td colspan="2">• Use of the digital COP results in the appearance of a better-informed response organization.
• A digital COP conveys a rich operational picture to the local media or the local media is left to inferring facts because of the inherent limitations of paper maps.</td></tr>
</table>

Planning Section use

The Planning Section of a response will use the COP to communicate planned activities out to other teams on the response. This may include in-situ burns, boom deployments, skimming operations and beach cleaning methods, as well as notifying responders of response areas on environmental hold or fishing closures. The Planning Section also uses the COP to report on activities such as SCAT surveys, oil plume trajectory, results of an over flight survey, areas on environmental hold, wildlife hazing activities, wildlife deaths, and sampling activities. The COP provides an enhanced situational status map; information can be gathered and disseminated in real or near real time, ready to be used by the Planning Section.

Use Case: Situation Unit Lead (Planning Section)	**Actors:** Situation Unit Lead, UC

Summary	
Computer modeling supported by the morning over-flight reveals that the oil spill will soon impact the shoreline. The Situation Unit Lead is preparing to give a situational update to the Unified Command (UC) during the Command and general staff meeting.	
Preconditions	
Maps are used to support talking points during the briefing.	
Description ('Sunny Day scenario')	**Exceptions ('Rainy Day scenario')**
• The Situation Unit Lead uses the digital COP to support his talking points to the UC. • In response to questions from the UC, the Situation Unit Lead can pan, query, and zoom to various response areas in the COP to support the answers.	• The Situation Unit Lead uses large-format paper maps hung on the wall to support his talking points to the UC. • Ideal map scale versus area of coverage *always* results in information being left off the map. • Multiple maps are needed. • Use of paper maps require time for preparation and printing. • Necessitates the use of paper resources.
Post conditions	
• Use of a digital COP results in a better-informed UC. • The sharing of information is efficient and is supported by reliable, up-to-date spatial information or use of paper maps may result in the UC having an incomplete operational picture.	

Operations Section use

Operations will use the COP to communicate planned activities to the field crews completing the tasks. The benefit of the COP is that it provides real-time access and location information on assets such as task forces, major vessels, and current and predicted weather information. Operations will also use the COP to communicate completed activities such as actual deployed boom, completed in-situ burn operations, and skimming locations and results. Typically operations are fully photographed and the resulting images are then immediately available for others in the response.

Use Case: Operations Section	**Actors:** Operations Section Chief, Branch Director for Shoreline Protection

Summary	
Computer modeling supported by the morning over-flight reveals that the oil spill will soon impact the shoreline. The Operation Section Chief is racing against time to have cleanup crews deployed before spill reaches the shoreline.	
Preconditions	
Maps are used to support decision-making.	
Description ('Sunny Day scenario')	**Exceptions ('Rainy Day scenario')**
• A COP is available throughout the Incident Command Post. • A newly acquired remotely sensed image, included in the COP, is used for identifying best access points to the shoreline and possible staging areas by the Operations Section Chief and the Branch Director for Shoreline Protection.	• A digital COP is not available • Paper maps are used to identify access points and staging areas. A crew chief out in the field later reports that a new housing development impedes the designated staging areas and access points. Must now find other suitable locations resulting in the loss of valuable response time.
Post conditions	
• Decision making is efficient and is supported by reliable, up-to-date, *shared* spatial information or decision making is based on various sources of spatial information—some conflicting, some incomplete —which contributes to a slower, more inefficient response	

Legal Team use

The COP may be used in long-term litigation support. The COP must provide all historical response data to fill this requirement. It must be designed to comply with legal hold orders, which means all data must be entered with date and time information. As this information is edited and deleted the underlying databases store all transaction information with each feature. This allows the legal team to virtually go back in time and see what operations and plans were in place on a particular day. Digital geo-tagged photographs are often in high demand by legal teams. A typical request is "show me all of the digital photographs on a certain date in a particular geographic area."

Public use

Public use of the COP is on a consumption basis. The public is viewed as anyone that is not directly involved in the response. This includes but is not limited to the general public, NGOs, news agencies, and academics. The COP provides the public with information regarding current situational status of an incident. The type of information from the COP that is shared with the public is for the purpose of awareness as opposed to the decision-making information provided to Command and other response sections.

Use Case: General Public	**Actors:** General Public

Summary
Computer modeling supported by the morning over-flight reveals that the oil spill will soon impact the shoreline. The Responsible Party and the Regulatory Party have approved on a public facing web application showing applicable response data. The general public also uses the COP data to better understand beaches and fisheries closed due to the incident. They can also leverage the COP in order to locate claims centers and incident volunteer centers. By having access to the most recent data and an interactive interface, the public can utilize the data as they wish, helping to alleviate apprehensions about the response status and concerns around information sharing.
Preconditions
Press releases and generalized graphics are used to convey spatial information on the current situation. The general public would have to go to a variety of different sites (State, City, Federal) to find out information about beach closures, closed fishing areas, claim centers, etc. A potential risk for the general that not all the information on these sites would be synchronized or up-to-date, therefor giving the public conflicting information.

Description ('Sunny Day scenario')	Exceptions ('Rainy Day scenario')
• Public facing web applications informs the general public which beaches maybe impacted and/or closed in their area. • The general public is able to identify the nearest claims centers available to them. • The interactive experience gives the user access to the most up-to-date data with regards to fishing closures. This also helps advice the public as to which areas to avoid from a safety perspective. • Getting information into the public eye quickly and accurately helps thwart accusations of hiding data and helps promote good public relations.	• The general public is only able to read/watch status updates from news outlets. • The user has to go several websites to find the information they need. • Lack of information presented and available to the public could result in accusations of hiding data.
Post conditions	
• Use of a digital COP (public version) will result in a more informed public. This will give the public the most up-to-date spatial information (as approved by command and legal) all the while allowing them to interpret the data as they wish. • With all the data in one location, the public can be assured that the information is recent and pertinent to the current situation. This will provide transparency, which will help with public relations, especially in areas affected by the response.	

Enterprise components for COP

A framework for deploying the COP as a set of enterprise components using a web services-based architecture is shown in Figure 7. Enterprise components for the COP provide an overview of the technical elements used to meet the objectives defined in the earlier sections of this enterprise viewpoint. Details for implementing and deploying these components are provided in the Services Viewpoint (section 4) and the Deployment Viewpoint (section 5).

The Response Center is the focus of the enterprise components – including the geospatial servers that will host the data needed for the users. Data coming from incident responders and additional data sources are ingested into the Response Center servers and quality checked before use in the COP. The COP is provided to connected users and supporting COPs using web services. Web services hosted at the Response Center is routine for medium and large size spills. As technology has progressed, e.g. with cloud hosting, web services have become easier and suitable to implement for all size spills. The Response Center also provides geospatial products for disconnected users. On a periodic basis the Response Center data is archived at a remote location.

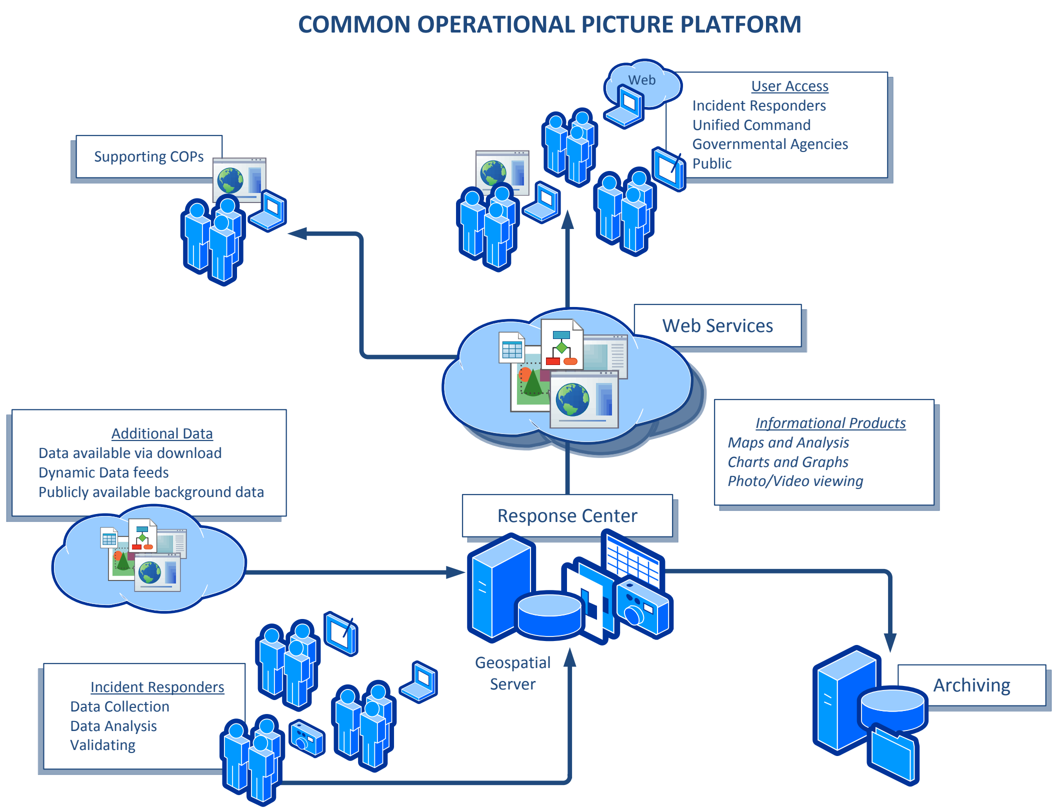

Figure 7 Enterprise components of COP platform

COP Information Viewpoint

The COP information landscape

Basic principals

An effective COP is grounded in the following basic principles:

1. The responsible party will manage all data and provide data to government agencies having oversight of response actions as appropriate.
2. All data will be archived and preserved as part of the critical records associated with the incident.
3. Access to incident data will be required for a considerable period of time after the closure of the incident.
4. A central repository of incident data will be created and maintained with the most current information available at any given time.
5. "Snapshots" of incident data are required and will be saved on a weekly basis; they will be available for limited access during the incident and will be preserved afterward.
6. Provenance of **all** data is to be captured at the time of data entry.
7. COP recommendations are "technology neutral"; users may utilize whatever technology and applications are appropriate.
8. The response effort is organized based on ICS structure and the roles.

Information architecture

The information architecture is predicated on the need for information to be processed, reviewed, and approved prior to being added to the official data store (labeled "Reporting" in the diagram). This process is important because it:

- Allows information release timing to be managed.
- Ensures data quality.
- Allows management to be informed before general release of information.
- Prevents contention between the technical GIS team and end users for system resources.
- Allows data to be processed prior to display thus facilitating integration between datasets.

A typical scenario would have a vendor collecting data associated with an event. At a prearranged interval the vendor would upload their data to the working data store. When data uploading is complete, manual or automated processing is conducted to check data accuracy, replace any obsolete data, and assign any key information to facilitate its integration with other datasets. If required, management can then review the data to ensure its readiness for publication. After all checks are complete the data is published to the "Reporting" data store and is made available to stakeholders according to their access privileges. Access is provided to the data through role-based security established prior to the event (see Section Authentication and authorization services 0). The roles defined by the ICS represent the most complete and common set.

Data access model

Figure 8 shows the model for data insertion and retrieval from the data repository. Typically data flows into the data repository through the top of the pyramid and is accessed the same way. It is expected that each event, vendor, or responsible party will require flexibility in how information is presented or inserted based on their particular tools and processes.

The exception to this assumption is the provision of a set of templates defined for the COP.

See Section 3.5.1 for more information on templates.

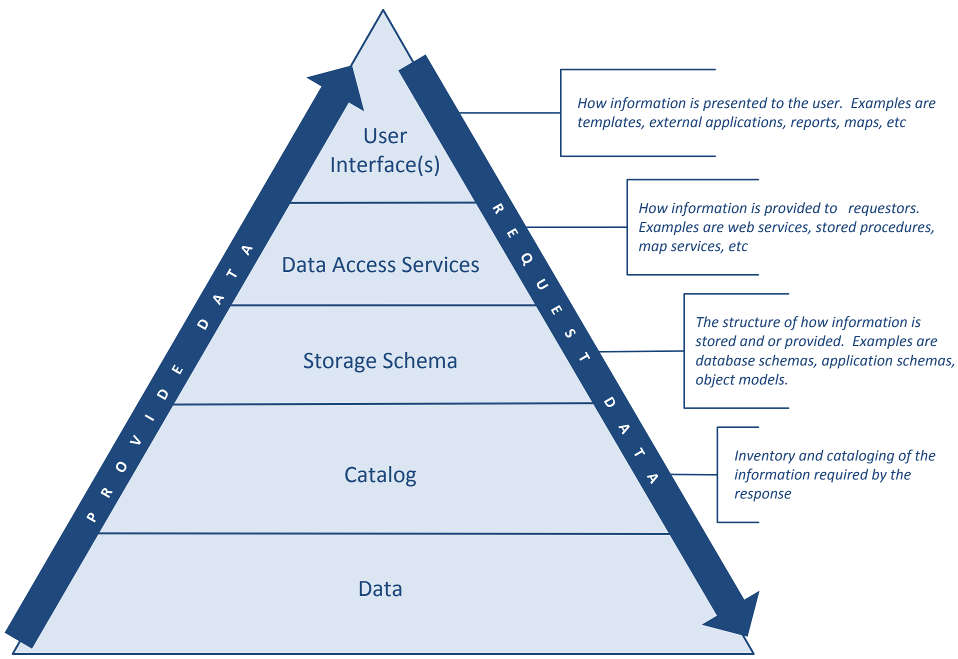

Figure 8 Data access model

User interface

Data is presented through a user interface associated with applications purchased or built by the parties associated with the event and/or custom queries or maps created by the teams working the event. Each party may use different applications, maps, or reports, as long as the information specified within the COP is provided. Use of open standards, as specified later in this report, ensures that information can be consumed by different parties and applications, and recognizes the inevitability that in major OSR events, there will almost certainly be more than one COP deployed (refer to Figure 7 – “Supporting COPs”). Data will be distributed using web services to network-connected users whilst other provisions can be made to deliver data to disconnected users.

Data access can be split into two components:

1) How a user physically connects to a data store. *This includes technologies such as Virtual Private Networks (VPN), remote logins, web services, and direct database connections.*
2) The objects built to select data from a data store and serve it to the requesting party in a presentation-neutral fashion.

Component 1 is discussed later in this document (section 4) while Component 2 is included in this section.

Each data service should provide a logically complete set of information for the subject of interest. For example, if a data service is created to provide information about employees, the entire employee record should be provided.

By following these rules, referential integrity can be enforced and data validity ensured. A standard set of data services is defined in Annex A but each application or company will no doubt want to enhance this set.

Storage schemas

It is critical that data is stored in the correct storage structure. This is accomplished by the creation of a standard storage schema(s) (also referred to as a data models). Storage schemas are typically documented through an entity-relationship diagram.

Communication, integration and precision are the three key benefits that make a data model important to applications that use and exchange data. A data model is the medium through which project team members from different backgrounds and with different levels of experience can communicate with one another. Precision means that the terms and rules on a data model can be interpreted only one way and are not ambiguous. Integration allows us to view different data together and know that it is logically related or refers to the same common subject.

A data model can be sometimes referred to as a data structure, especially in the context of programming languages. Data models are often complemented by function models, such as in the context of enterprise models.

For the purposes of the COP, the storage schema is best separated into two distinct areas:

1) Geospatial information. See section 3.2 for types of geospatial information. Typically this takes the form of feature classes, shapefiles, coverages, raster files, maps, or other proprietary data storage formats. These are the typical building blocks within a GIS. It is convenient that a GIS simplifies the creation and management of these data objects.

2) Tabular information. Tabular data would typically be data associated with spill activities such as tracking resources, managing inventory, and textual information about the spill. This information is usually associated with a specific location but is more descriptive in nature.

This is an area where careful data analysis and modeling can make or break a system. Unless data is stored in structures that are defined correctly based on the relationships between the data elements and the data type of the elements, storing, retrieving, and linking to data will always be difficult.

Data inventory

The data needed to support an incident response is the key element in a COP. A complete list of data elements is provided in Annex A.

Geospatial information

Geographic or geospatial information is information concerning phenomena implicitly or explicitly associated with a location relative to the Earth (see ISO 19101-1[9]). Geospatial information is often used as the basis to integrate assessments, situation reports, and incident notification into a COP and as a data fusion and analysis tool to synthesize many kinds and sources of data and imagery[10].

Everything about the COP—including the standards used to develop and maintain the system and data, the data that will be gathered and displayed, and how the system will integrate with other systems—depends on first understanding the underlying system. Section 3.3 outlines considerations that should be taken into account when planning and operating an OSR COP.

The information that will be displayed in the COP will come from a variety of sources in a variety of formats. In order to effectively maintain, display, and allow users to interact with the information, careful consideration of the standards that will be used within the COP and how the data will be organized should be a key component of the planning and ongoing maintenance processes. The next sections of this report discusses geospatial information standards and organization.

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[9] ISO/IS 19101-1:2014 Geographic information - Reference model - Part 1: Fundamentals. See: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=59164

[10] 'National Incident Management System', US Department of Homeland Security, December 2008, FEMA Publication P-501 (Catalog Number 08336-1). See: http://www.fema.gov/nims

Planning considerations

There are two broad categories of data to consider when determining the data that the system should display. The first is base map or reference data, which includes information about the area and environment that are not specific to the oil spill incident. The categories of reference data that are applicable to many COP implementations are outlined later in this report. The second category of data, also outlined later, is drill and incident specific information that includes information about the spill and the spill response.

The specific standards and data used to develop a COP will be driven by several considerations that include:

- Origin of spill
- Land-based vs. marine
- Arctic vs. temperate, desert or tropical
- Scope / tiered response
- Data access
- Availability of geographic information
- Static vs. real time information

Origin of spill

An oil spill may originate at the wellhead, but it could also originate from a pipeline, infrastructure (such as a refinery or terminal), rail car, or a vessel such as a tanker. Each origin type will require a different approach by the oil spill response team and different geospatial data. Examples include the possibility of a mobile source when a vessel-based spill is encountered.

Land-based vs. marine

COP information requirements must properly account for the unique characteristics of both marine and land-based spills. Simple examples include the need for land status information for terrestrial spills or the need for bathymetric data for marine spills.

Arctic vs. temperate, desert or tropical

Multiple unique challenges (and unique information requirements) are represented based upon the setting of a spill incident. For instance, consider a spill occurrence in the arctic climate. In this setting, information that would be unnecessary in an incident occurring in temperate areas could become critical. Specifically, additional information relating to the forming and movement of ice, operational safety considerations, and other elements would become both relevant and significant to the spill response effort in such a scenario. For a given location, seasonal differences must also be considered, e.g. in gathering geospatial information for the appropriate season.

Tiered Response

The established three-tiered structure allows those involved in contingency planning to describe how an effective response to any oil spill will be provided; from small operational spillages to a worst-case release at sea or on land. The structure provides a mechanism to identify how individual elements of capability will be cascaded. An organization's response capability and contingency plan should relate directly to the potential spill scenarios and cover each tier, as appropriate. It is important to note that the tiers are strictly for planning purposes and, in the event of a spill, whatever resources are necessary to adequately respond to the spill must be mobilized regardless of the tier. Planning according to the tiered approach ensures that an appropriate provision of resources is considered for a response of any magnitude as applies to an organization's risk. It enables responders with access to adequate resources to mobilize an effective and timely initial response using pre-planned strategies and Tier 1 capabilities and to cascade in additional resources as they adapt to any response as it unfolds. Further information can be found in the IPIECA–IOGP 'Tiered Preparedness and Response' Good Practice Guide[11].

Role based access to data

The organization and security applied to geospatial information within the COP should clearly delineate between information sets that are accessible to the operator and its direct constituents, as opposed to information that may be published for external (public) use.

Access to information is controlled by the role people fill in the response effort. For example, the Incident Commander can view different data than the public. Not only are their data access privileges different, the way they view the same data might be very different. The simplest example is summary views versus detailed views of the same data items.

Availability of geospatial information

The availability of geospatial information may be heavily dependent on the geographical location of an oil spill incident. For example, in North America, a wide array of government, commercial and environmental organizations may provide reference and/or operational information free of charge and without license restrictions. In other locations, it may not be possible to obtain the same wide array of information from such organizations and there will be greater reliance on third party vendor datasets, which will likely have restricted access due to the data licensing terms and conditions. In this case, the Responsible Party or government may need to negotiate alternative license terms with the data suppliers so that the data can be shared with the key users.

[11] 'Tiered Preparedness and Response: Good practice guidelines for using the tiered preparedness and response framework', IPIECA–IOGP, IOGP Report Number 526, February 2015.

Static vs. real-time information

Some of the information provided to the COP will be in real-time. The handling of this dynamic information impacts the design and the use of the COP. For example, should the COP display real-time depths or static depths as referred to on the chart datum on the one hand, and tidal information on the other hand, and both in separate layers? Also, this presents a challenge when archiving and storing data for future use and reference in time. Static information is relative easy to archive, however when consuming a service which shows real time information, such as weather information, there needs to be a method to capture it for future use.

Geospatial information standardization and organization

Need for geospatial information standards

Consistent standards are important for the use of geospatial information as it has the potential to be misinterpreted, transposed incorrectly, or otherwise misapplied, causing inconspicuous yet serious errors. Standards make it easier for disparate systems utilized during an incident to consume, analyze, display and interact with the information.

Such standards include:

- Coordinate reference system
- Metadata (e.g. ISO 19115)
- Cartographic symbolization
- Scale of use, and accuracy
- Data structure and format

Coordinate Reference System

Maintaining the ‘coordinate integrity’ of all geospatial data ingested, processed and displayed in the COP is vitally important to ensure that all data is displayed in its correct geographical location, both in an absolute and relative sense. For each dataset, it is important to know the Coordinate Reference System (CRS) relevant to the coordinates of the geographical features. For a dataset defined in geographical terms (latitude, longitude), the CRS defines the geodetic datum and reference ellipsoid or spheroid. For a projected (grid) dataset, the CRS will in addition define the map projection and its associated parameters, including units of measure. CRS information is therefore key metadata that needs to be associated with all datasets. Failure to correctly account for the CRS can lead to positioning errors of 100s of meters, or unusable data.

Knowledge of the positional accuracy of datasets is also important to ensure data is not used at map scales that are incompatible with their accuracy. Within a GIS system, the use of ‘scale management’ ensures that map features are only displayed or plotted at map scales they were intended for by setting upper and lower scale limits for each dataset. Beyond these limits, the data will not be displayed or mapped. The COP system administrators are responsible for assigning such parameters based on their knowledge of the accuracy of the data and its source.

The primary standards for Coordinate Reference Systems applicable to the Oil and Gas industry are those defined by the IOGP Geomatics committee in the EPSG database and associated online registry of global coordinate reference systems.[12]

IOGP Geomatics guidelines, such as 'Geodetic awareness guidance note (S&P 01)' (document ref 373-01), provide a useful reference for those unfamiliar with the topic, and the IOGP's Geospatial Integrity of Geoscience software (GIGS) guidelines provide methods for testing the integrity of software applications with respect to the correct handling of coordinate information[13].

Other useful reference information can be found in the ISO 19111:2007 'Geographic information -- Spatial referencing by coordinates'[14] and the Open Geospatial Consortium's 'Abstract Specification Topic 2 - Spatial referencing by coordinates'[15]. These OGC and ISO standards are identical and are aligned with IOGP/EPSG standards.

At a very early stage in an oil spill event, the appropriate CRS for the area shall be chosen and then used as the primary CRS within the GIS system. Any incoming data, which is based on a different CRS, will be transformed before integration into the COP. Accordingly, the availability of software to convert and transform data from different CRS is essential, as is having access to expert advice from a qualified geodesist. The choice of CRS will depend on the geographical extent of the incident, the regulatory environment, and common practice in the area. The EPSG registry[16] provides a useful reference of CRS applicable to specific geographies and countries.

Due to limitations in the technical capabilities of current web mapping technology, there may be constraints in the choice for a projected CRS for the COP map viewer (refer to section 4.2.3). Most current technologies adopt the Pseudo Mercator projection (EPSG Code 3857), which is based on the WGS84 datum (as used by Google Maps, Bing Maps etc.). Such a projection has severe limitations at high latitudes with significant distortion of distances and areas. The COP should warn users of such distortions. For incidents in the Polar Regions, appropriate polar map projections must be used.

Longer term, and when the technology allows, it is recommended to use a General Perspective projection (EPSG Code 9838), such as that used in products like Google Earth

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[12] IOGP Geomatics website. See: http://info.ogp.org.uk/geomatics/
[13] GIGS guidelines. See: http://publications.ogp.org.uk/?committeeid=476
[14] ISO catalogue. See: http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=41126&commid=54904
[15]OGC standards. See: http://portal.opengeospatial.org/files/?artifact_id=39049
[16] EPSG registry website. See: http://www.epsg-registry.org/

and ArcGIS Explorer. The General Perspective projection provides a point of perspective at an infinite (deep space) distance from the earth, providing an acceptable map projection at any location in the world.

For map printing purposes it is recommended to use the projected CRS chosen as applicable to the geographical area of the spill. With reference to section 4.6.2, recommended practice is to use a standard map template, which will clearly specify the chosen CRS (including the EPSG code).

The above implies that the map projection used for the COP map viewer may be different to that chosen for management of the geospatial data, for spatial analysis or processing, and for hardcopy map purposes. The COP support team must have the resources and expertise to handle the manipulation and quality assurance of the data to avoid any coordinate integrity errors occurring.

Consideration should also be given to the Vertical Datum for any data that refers to topographic heights or bathymetric (water) depths. In general it is recommended to use Mean Sea Level (MSL) (EPSG Code 5100) as the default vertical datum, however when working offshore with published nautical charts, it is likely that such charts will use a different Vertical Datum (usually known as 'Chart Datum'). This datum is often chosen to be equivalent to the Lowest Astronomical Tide, and, depending on the tidal regime in the area, could be offset significantly from the Mean Sea Level.

Metadata

Metadata should be captured and added to and maintained as datasets are created and populated. Information should not be considered complete unless it has metadata with it. Where possible, individuals generating the information should be the ones creating the metadata. The very minimum metadata to be captured is the provenance of the data, including:

- Source of the information
- Date of capture
- Contact
- Description of the information
- Any processing done to change the source information
- Any known limitations or issues with the information
- Geographic area of coverage
- Quality of data

Industry best practice for metadata is ISO 19115: Geographic Information – Metadata. It is recommended a profile of ISO 19115 is developed to define which metadata needs to be covered for the OSR COP.

Map symbolization

Map or cartographic symbolization should be standardized across the spectrum of the COP, including paper maps, web mapping, and mobile mapping. Any responder should be able to immediately use any and all of the different COP products without having to decipher the information. Where possible and appropriate, the COP should make use of community and international standards, some examples of which include:

- ICS map symbology as defined by the USCG[17] (Figure 9).
- Environmental Sensitivity Index mapping standards from IPIECA-477[18] (Figure 10 and Figure 11).
- The Shell Standard Legend (oil and gas cartographic symbols)[19].
- IOGP Seabed Survey Model Symbology standards, which in Version 2 will become closely aligned with the IHO standards[20] .
- UK Government- Civil Protection Common Map Symbology[21] .
- IHO standards for nautical and hydrographic charts[22]. *The IHO S-100 framework encompasses features such as tides, currents and other categories of nautical information.*

Figure 9 provides an example of symbols for use on maps and charts as developed in the ICS community [USCG]. This symbology has some limitations and will be considered for revision in the Data Modeling task of this Recommended Practice.

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[17] 'US Coast Guard Incident Management Handbook,' USCG Commandant Publication P3120.17B, May 2014. See: http://www.uscg.mil/hq/nsfweb/docs/FinalIMH18AUG2006.pdf
[18] 'Sensitivity Mapping for Oil Spill Response', July 2012, IOGP Report Number 477. See: http://www.ipieca.org/publication/sensitivity-mapping-oil-spill-response-0
[19] Release article. See: http://www.ogp.org.uk/news/2014/shell-releases-its-standard-legend-to-industry-and-academia/
[20] IOGP Geomatics website. See: http://info.ogp.org.uk/geomatics/
[21] Map symobology. See: https://www.gov.uk/government/publications/emergency-responder-interoperability-common-map-symbols
[22] IHO standards. See: http://iho.int/srv1/

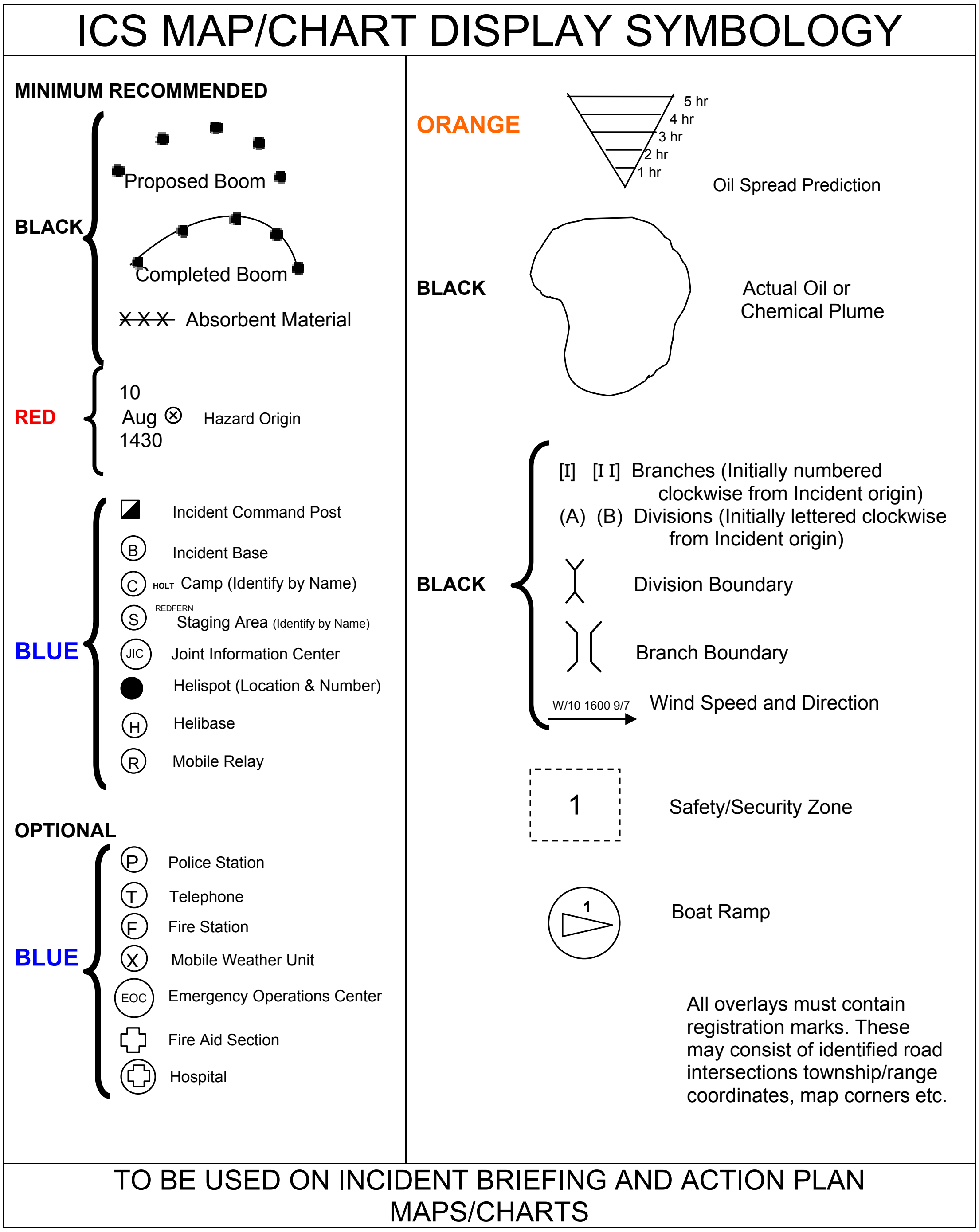

Figure 9 Map/chart symbology for incident response

Source: USCG, 2014

Environmental Sensitivity Index (ESI) maps should utilize the standard symbology defined by IPIECA, which is shown in Figure 10.

Figure 10 Symbols for the mapping of sensitive biological resources

Source: IPIECA–IOGP, 2012

A standardized color-coding methodology for shoreline classification should utilize the standard color-coding as defined by IPIECA and presented in Figure 11.

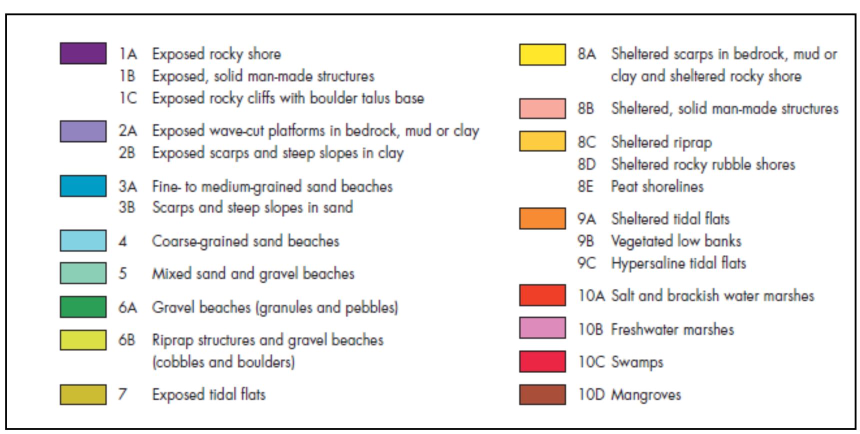

Figure 11 Color code of Environmentally Sensitive Index

Source: IPIECA–IOGP, 2012

Environmental Sensitivity Index (ESI) maps should utilize the standard symbology for relevant socioeconomic sites as defined by IPIECA. A symbol library for socio-economic sites of interest is presented in Figure 12.

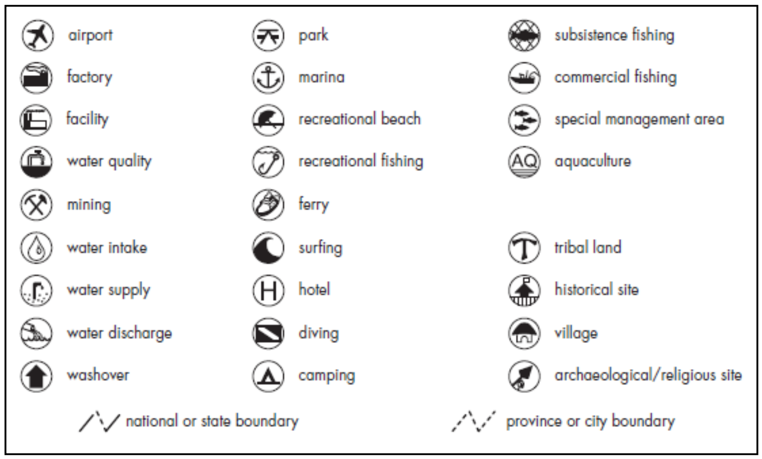

Figure 12 Symbols for the mapping of sensitive human use and activities

Source: IPIECA–IOGP, 2012

However the majority of the oil spill-specific standardization does not exist or what does exist was designed long ago and thus does not account for digital mapping systems. It is recommended that a standardized set of map symbolization should be created to support all of the oil spill-specific defined datasets. The symbology should be zoom scale dependent; at times, depending upon zoom scale, the symbology may need to change. For example a vessel task force may be represented as single point feature when zoomed out but when zoomed in it may show all the vessels that make up the task force. It is thus recommended that oil spill-specific symbology standardization is developed (it is currently planned to be accomplished in a future phase of this project as part of initiatives to create specific OSR data schemas and models). This approach has been successfully used by IOGP in the development specific GIS data models or schemas, an example being those developed for the Seabed Survey Data Model (see reference above).

Scale of use and accuracy

Scale is defined as the relationship between the distance on map and the distance in the real-world context. Scale of use and accuracy for response data being used in a COP application will vary based on the data layer type (point, line, polygon, and raster) and the maximum and minimum spatial extent. Whether the spill is large or small, all GIS data and raster layers should have scale information noted and should leverage reasonable scale dependencies when being displayed in an application. Setting a standard scale for data collection can be difficult and may only apply to spills in small geographic areas (harbors, small bays, etc.). Therefore, understanding and leveraging scale information will not only help with visual presentation and organization in an application, but it is important with ensuring accurate data analysis and even system preformation.

The resolution of the data is also a key factor. In an oil spill response environment there is little control over the resolution or scale from third party vendor data unless it has been prior established. It is therefore important information to note and record the scale and resolution of the data when acquiring its from external sources. Polygon layers and data covering wide spatial extents (e.g. oil plumes, oil trajectories, coverage areas) can vary greatly in detail. If the scale and resolution are big and broad, it can result in oversimplification and, if not layered correctly in an application, can hide other layers.

Conversely, the use of detailed data can result in data illegibility if used at higher scales. For example, line and point data that have been collected at fine scales can quickly clutter both map products and web applications. Within oil spill response, this may include features such as boom, dispersant lines, and even the land-water interface for shoreline. In addition, finer detail and a higher resolution can cause the data to render slower, prolonging processing time. To ensure data accuracy and speedy spatial analysis, it is recommended that scale and resolution is noted in the metadata. Data with low resolution overlaid or analyst against high resolution can leave a lot of room for error and/or approximation, running the risk of reducing the data integrity.

A recommended standard is to avoid changing scale by more than two and half times in either direction for data collection and display. However, response data varies in both feature type, size, scale, extent, and display priority. Logical scale dependencies need to be considered for optimal display and labeling when in use by a web application. Only a few key data layers should be displayed at all scales.

Map templates list

Map templates allow the COP to present geospatial information to the end users in a coherent fashion by providing selected sets of information for specific purposes. Mapping templates specific to OSR contain base map layers, incident specific information, commonly used page layouts, reports from the data, and standard symbology. Examples include the following:

Situation status maps

These are primary map templates used for command meetings and general briefings. Maps such as these have a very high priority and are critical to the IMS. Examples include:

Tactical situation map template	This is the single source of information, at-a-glance, for the drill/incident. It is intended for real-time vessels, weather, currents, extent of the incident, and current status of all operations.
Incident Action Plan (IAP) map template	Displays an overview of the current situation information, high level field assignments, execution zones, safety concerns, etc. To be used for briefings and general planning meetings. Included with the daily Incident Action Plan.
Briefing map template	A simplified high-level overview map of the situation and operation for easy reference.

Operational and tactical planning maps

These are examples of map templates used to help provide Planning and Operations with more detailed information about daily activities and to help assist in decisions for the next operational period. The information displayed helps identify risks and threats within the area of interest and what appropriate actions need to take place. Examples include:

Boom map template	A series of tactical maps developed to plan, approve, and manage boom deployment, monitoring, and retrieval.
Dispersants map template	A series of tactical maps developed to plan, approve, and manage use of dispersants on land, in water, or aerial.
Skimming map template	A series of tactical maps developed to plan, approve, and manage the skimming operations. Example of data present would be planned execution zones, vessel tracks, oil trajectory, summary information of daily activities, etc.
In-situ burning map template	A series of tactical maps developed to plan, approve and manage in-situ burning operations. Example of data present would be planned execution zones, burn locations, oil trajectory, summary information of daily activity, etc.
SCAT	A series of templates to support and manage SCAT operations including current oiling status, maximum oiling status, and shoreline cleanup status.
Operational shoreline/land cleanup	A series of templates to support and manage shoreline and on-land cleanup.

Environmental maps

Wildlife status map template	A series of map templates showing wildlife status and observations, for example, the locations of injured or dead wildlife.
Wildlife sensitive areas and hazing avoidance map template	A series of map templates used for identifying and minimizing impact and hazing in sensitive areas and critical habitat.
Closures map template	A series of maps displaying closed areas for commercial and recreational fishing and hunting.
Environmental quality maps and sampling	Examples include: water quality sampling (to support and report on water quality sampling), air quality sampling (to support and report on air quality sampling), and operational monitoring (to support environmental monitoring of operational activities).

Facility maps

Provides a recognized view of the operating facility/control center and surrounding area within the drill/incident. Examples include:

Safety	To communicate and report safety operations as well as crew housing location and evacuation routes.

Resource allocation maps

Used for identification of resources needed / available / at risk within an incident.

Public incident maps

A high-level view of the incident, intended for the general public or others who need a broad overview.

The details of the content, reports, and temporal information required by a specific template will be added into a future revision of this document.

Data modeling

It is the intention of WP5 to create an application and/or database schemas where necessary. This is the focus of the next phase of activity and will be added to future versions of this document, probably in phases, as it is completed. The following subject areas have been identified for analysis:

- SCAT
- Airborne observations
- Satellite interpretations
- Oil spill trajectories
- Boom
- Dispersant (aerial, surface and sub-surface.)
- In-situ burning
- Skimming
- Oil/gas infrastructure
- ICS Command Post, branches, decontamination, staging areas
- Geo-tagged photos and videos

To ensure that both computer systems and users will understand information, the structures used in access and exchange must be adequately specified. An application schema provides the formal description of the structure and content required by one or more applications. An application schema for geographic information contains the descriptions of both geographic features, as well as related information. The feature is a fundamental concept of geographic information.

The purpose of an application schema is twofold:

- To provide a computer-readable data description defining the structure, which makes it possible to apply automated mechanisms for data management.
- To achieve a common and correct understanding of the data by documenting the content of the particular application field, thereby making it possible to unambiguously retrieve information from the data

Feature modeling is specified in ISO 19109:2005 'Geographic information – Rules for application schema'[23]. Conceptual schemas define abstract feature types and provide the process for domain experts to develop application schemas that are used to encode content and describe feature instances. The developer of an application schema may use feature definitions from feature catalogues that already exist.

[23] ISO catalogue. See: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39891

Application schemas relevant to oil spill response and strongly recommended to be adopted include:

- IOGP Seabed Survey Data Model (SSDM)[24], which is a specification, used in the oil and gas exploration & production (E&P) industry in handling the delivery of various seabed survey datasets in GIS data format. It also includes SeabedML, a GML implementation that enables open data exchange of geographical features and is particularly useful for web-enabled platforms.
- OGC maintains an informal list of all known Geographic Markup Language (GML) Application Schemas[25]. These schemas are not necessarily approved or endorsed by the OGC.
- CleanSeaNet[26] has defined two types of information from satellite images that can be delivered as features in GML: oil spills and vessels[27].
- IHO S-100 provides the data framework for the development of the next generation of ENC products, as well as other related digital products required by the hydrographic, maritime and GIS communities.

Geospatial information datasets

Categories of geospatial information

For clarity, in the ongoing management and maintenance of geospatial-related information, the COP implementation distinguishes two distinct sets of information:

- **Base map or reference information:** this information typically exists in some form prior to the occurrence of a spill incident and should be gathered and updated routinely as newer information becomes available. Base map or reference information may not be pertinent to a specific incident.
- **Drill and incident specific information:** this includes all of the relevant information that is generated during and after a spill incident and pertains specifically to that incident.

Examples are listed in the following sections for each category of information.

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[24] IOGP Geomatics website. See: http://info.ogp.org.uk/geomatics
[25] OGC GML application schemas. See: http://www.ogcnetwork.net/node/210
[26] CleanSeaNet is a near real time European satellite based oil spill monitoring and vessel detection service, set up and operated by the EMSA. See: http://emsa.europa.eu/csn-menu/csn-how-it-works.html
http://emsa.europa.eu/csn-menu/csn-how-it-works.html
[27] Oil spill schema. See: http://www.emsa.europa.eu/schemas/csndc/Features/csndc_os.xsd
https://csndc.emsa.europa.eu/schemas/csndc/1_3_4/csndc_os.xsd.
Vessel detected schema. See: http://www.emsa.europa.eu/schemas/csndc/Features/csndc_ds.xsd

Base map or reference information

Base map or reference information includes information about the area and environment:

- Background data
- Administrative boundaries & references information
- Marine jurisdictions
- Bathymetry & hydrography
- Topography
- Imagery & remote sensing
- Natural resources, habitats, & managed areas
- Critical habitat and essential fish areas
- Environmentally Sensitive Index (ESI)
- Navigation & marine infrastructure
- Public safety & terrestrial infrastructure
- Oil & gas infrastructure
- Restoration data
- Weather, oceanography & natural hazards

The following sections provide more information about each type of information but the specific considerations surrounding an oil spill event will ultimately drive decisions about which type of base map and reference data are necessary and appropriate for the oil spill response teams.

Background data

Background data contains the information (datasets) utilized to present a base map. A base map is generally a non-editable dataset that provides background information pertinent to the geographic area of interest. It is typically designed to provide a visual reference for other information to help orient the user(s) of the map.

Base map background information may be provided by any of the following source datasets:

- Shoreline
- Streets
- Peripheral facilities, structures
- Aerial photography
- Satellite images

Administrative boundaries & references information

Administrative boundaries and references information provide contextual overlays to the base map background and include the following information sets:

- Geopolitical boundaries (states or provinces, counties or parishes, tribal lands, congressional or other governmental districts)
- Governmental agency regions & offices
- Place names & references (special geographic features, Geographic Names Information System (GNIS))

- Marine jurisdictions including:
    - Exclusive economic zones
    - Country or state/province waters
    - Unique marine protected areas
- The General Bathymetric Chart of the Oceans (GEBCO)

Geopolitical Boundaries

Any and all administrative entities representing country, state/province, county, and city (or similar geopolitical boundaries) within the region(s) of interest should be represented in this set of information. This information may be obtained from sources ranging from the United Nations Second Administrative Level Boundaries (SALB)[28] database, to city data contained in the Global Administrative Areas (GADM) information sets.

Government Agency Regions & Offices

Administrative boundaries for governmental agencies may also be included in reference information. Some possible examples of this information include the following:

- U.S. Coast Guard Areas of Responsibility (USCG AOR)
- USCG districts
- National Park Service (NPS) boundaries
- Aboriginal Land Governance
- Port jurisdiction zones
- Coastal wetlands
- Wildlife refuges or managed areas
- Environmental Protection Agency (EPA) regions
- Federal Emergency Management Agency (FEMA) regions
- U.S. Army Corps of Engineers (USACE) civil districts
- USACE regulatory districts
- U.S. Fish and Wildlife Service (USFWS) regions

Marine jurisdictions

Marine jurisdictions encompass the collection of marine boundaries and limits used to delineate the extent of a nation's sovereignty, exclusive rights, jurisdiction, and control over the maritime areas off its coast. Examples include the following:

- Marine jurisdictions
- Continental shelf boundary
- Federal / state boundaries
- Coast Guard boundaries
- Oil and gas leases / blocks
- Renewable energy leases

[28] Second Administrative Level Boundaries, United Nations Geographic Information Working Group (UNGIWG). See: http://www.unsalb.org

Bathymetry & hydrography

Key to any marine-based oil spill, bathymetry information provides reference material containing measurements of water depth (or depths of other major bodies of water) relative to a specific vertical datum. A wide range of bathymetry information is available from multiple sources and different formats, including national hydrographic services or resellers of digital chart data, port services, and other suppliers.

In addition, oil company operators will normally have detailed bathymetry measurements of their operating areas obtained from vessel-based geophysical and hydrographic surveys.

Bathymetry data may be delivered in different data structures such as raster images (scanned charts), as digital terrain models, or as data points (soundings) and vectors (contours or isobaths). The most accurate and reliable information shall be used from the best available source and suitable for the scale of use.

In addition, this section may include shoreline information sets representing the most recent available data to depict shoreline boundaries, including both seaside and inland (estuary) borders.

The range of information goes from "source data" to "derived products" such as paper nautical charts or Electronic Navigational Charts (ENC), noting that derived products are designed for specific purposes (i.e. safety of navigation) which are generally different from the purpose of the COP. Bathymetric surfaces (as defined in IHO Standard S-102) should always be preferred, when available, to charts. Nautical charts are generally available in raster format. Most nautical charts are now available as ENCs. Note that the GEBCO project, managed jointly by the IHO and the Intergovernmental Oceanographic Commission (IOC), seeks to provide the world's most authoritative public bathymetric dataset and make it available to all those that have a need to understand the depth and the shape of the world seas, oceans and coastal waters.[29]

Topography

Topographic information (e.g. elevation data) may also be required for coastal regions impacted by the spill and may be available from topographic maps, digital terrain models, aerial surveys, or site-specific oil company surveys.

In the U.S., seamless land-sea datasets have been developed in many coastal states to support coastal zone management and marine spatial planning. They should be used wherever available, preferably to separate topographic and bathymetric datasets that are often referred to with different vertical datums and not necessarily contiguous.

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[29] GEBCO project. See: http://www.gebco.net/

Imagery & remote sensing

Surveillance products are important geospatial information that will be used during an oil spill event, both to provide eye-in-the-sky overview imagery of impacted areas and to quantify spill areas. The data is collected as satellite imagery and airborne-based aerial photographs, as well as from in-water and surface-deployed sensors and platforms. Remote sensing imagery may also be obtained from sensors deployed on land, vessels or offshore structures, or from tethered balloons (aerostats). Surveillance using drones and UAVs is also now a viable option.

Accurate geo-referencing of such imagery to a common coordinate reference system is essential. In addition, satellite imagery and aerial photographs may need to be ortho-rectified (i.e. an ortho-rectification process adjusts images to correct for terrain displacement and camera tilt).

The OSR-JIP Work Program1 (In-Water Surveillance) provides a detailed overview of the types of in-water and surface-deployed platforms and sensors and the respective geospatial information available for use in detecting and monitoring of marine oil spills.

The OSR-JIP Work Program 2 (Surface Surveillance) provides a detailed overview of the types of remote sensing geospatial information available for use in detecting and monitoring of marine oil spills.

The COP will need to have the capability to handle and display any type of remote sensing imagery and be able to provide clear metadata to describe its source/origin, temporal characteristics, and so forth.

Natural resources, habitats, & managed areas

Natural resources, habitats and managed areas provide a wide range of information about habitat areas for wildlife in the area of interest, as well as areas defined as environmentally sensitive or protected.

In each subsection of this category, multiple subcategories may be required to organize the extensive array of wildlife and natural resource data.

Within each of the habitat areas, the subcategories for different species of wildlife and vegetation may be further detailed. Typically this information includes examples such as nesting, breeding and migration pattern data for the respective wildlife species, and coverage of submerged and shoreline vegetation.

A few specific examples of the information sets in this hierarchy are the following:

- Sediments
- Deep sea corals
- Benthic habitats
- Artificial reefs
- Cold-water coral habitats

Critical habitat and essential fish areas

Critical habitat information may be required in a geographic region containing threatened and endangered species as designated by the country or state/province laws. In addition, essential fish habitat information may be required, including aquatic habitats for managed species where fish may spawn, breed, feed, and grow into maturity.

Environmentally Sensitivity Index (ESI)

Environmental Sensitivity Index (ESI) maps provide summary information pertaining to coastal resources that are at risk in the event of an oil spill. At-risk resources may include biological resources (such as birds and shellfish beds), sensitive shorelines (such as marshes and tidal flats), and human-use resources (such as public beaches and parks).

The potential exists for such mapping to be available in all areas where oil and gas exploration and production takes place and for it to be maintained at a regular frequency (e.g. every five years). However, it is recognized that this would be a significant undertaking and would require a coordinated industry approach.

In response to an oil spill, ESI maps can help responders by reducing the environmental consequences of the spill and the cleanup efforts. Additionally, ESI maps can be used by planners to identify vulnerable locations, establish protection priorities, and define cleanup strategies.

Some examples of specific information gathered for ESI analysis include the following:

- Bird habitat
- Breakwaters
- ESI index
- Fish habitat
- Hydrological classification
- Invertebrate habitat
- Management areas
- Marine mammal habitat
- Access / vehicular access to shoreline
- Reptile habitat
- Socioeconomic (line)
- Socioeconomic (point)
- Shoreline classification (line)
- Shoreline classification (polygon)
- Terrestrial mammal habitat
- Vegetation
- Hazardous waste site
- Hoist
- Lock/dam
- Logging
- Marine sanctuary or wildlife refuge
- NOAA buoy data

ESI maps should utilize the standard symbology defined by IPIECA [IPIECA-477]. The symbol library for ESI maps is presented in Figure 10.

Shoreline Classification

Shoreline classification typically incorporates the use of the ESI, which can be adapted for each country. The ESI, ranging from 1 (low sensitivity) to 10 (very high sensitivity), considers the following attributes:

- Shoreline type (including grain size and slope) which evaluates the capacity of oil penetration, movement, and/or burial on the shore.
- Exposure to tidal energy (waves) which ascertains the natural persistence time of oil on the shoreline.
- General biological productivity and sensitivity.

A standardized color-coding methodology for shoreline classification should be implemented, based upon IOGP Report Number 477, ‘Sensitivity Mapping for Oil Spill Response’. This color-coding methodology is presented in Figure 11.

Socioeconomic data

This information includes human-use / resource data for airports, archaeological and historic sites, beaches, boat ramps, state borders, bridges, and marinas for a given region, such as a state. Location-specific type and source information are typically stored in relational data tables designed to be used in conjunction with this information.

In mapping socioeconomic information, the objective is not to identify all places of business and activity in a comprehensive fashion, but to locate the activities and the areas, which have the potential to suffer the greatest impact in the event of a spill incident.

ESI maps should utilize the standard symbology defined by IPIECA for relevant socioeconomic sites. The symbol library for socioeconomic sites of interest is presented in Figure 12.

Navigation & marine infrastructure

Navigation & marine infrastructure layers include information such as:

- Ports (including ferries, marinas, boat launch sites)
- Maritime Collision Regulation Lines
- Anchorage Areas
- Shipping Lanes
- Precautionary Areas for Navigation
- Dredge Disposal Areas
- Wrecks, Debris, and Archaeology Sites

Most of this information is available from nautical charts and other nautical publications, as well as in the format of Electronic Navigation Charts (ENCs). An ENC is an authoritative product with a mature definition and methodology for modeling the information (currently in IHO S-57 and in the future in IHO S-101).

Public safety & terrestrial infrastructure

Public safety & infrastructure information includes:

- Critical infrastructure
    - Hospitals
    - Police stations
    - Water intakes
    - Fire stations
    - Power generation facilities
    - Power lines and substations
- Transportation infrastructure
    - Roads
    - Bridges
    - Railways
    - Airports
    - Helipads

Oil and gas infrastructure

Oil and gas infrastructure includes, but is not limited to:

- Wells
- Pipelines
- Facilities and flowlines / umbilicals
- Platforms, TLPs, FPSOs and drilling rigs
- Onshore oil and gas transmission lines
- Onshore oil and gas processing facilities (refineries, tank farms etc.)
- Oil and gas reservoirs

Normally such information will be available from the oil and gas operator as its forms part of accurate as-built surveys often created during construction activities or as a result of routine maintenance operations.

Restoration data

This information represents spatial locations and other details related to coastal and marine habitat restoration projects and may contain species and habitat data relevant to spill exposure.

Weather, oceanography & natural hazards

This category covers a wide range of information including, but not limited to:

- Real-time data feeds and forecasts for weather, including atmospheric pressure
- Precipitation forecasts
- Natural hazards such as earthquakes, tsunamis, and hurricanes
- Buoys & gliders
- Radar
- Sea surface temperature and salinity
- Current and predicted wave heights
- Current and predicted wind velocities
- Tides
- Water levels
- High frequency (HF) radar
- Weather radar impact zones
- Weather radar stations (federal)
- Marine mammal observations
- In-water sampling
- Air quality measurements and predictions
- Visibility
- Tsunami hazard maps
- Subsurface geohazards
- Ice

Drill- and incident-specific information

Drill and incident specific information includes the following primary categories:

- Abstract, spill summary & reporting
- Damage assessment
- Oil spill response operations

For legal purposes, all information collected in the drill & incident specific hierarchy should be retained and archived, and changes to information in this hierarchy should be properly recorded (track changes), to allow post-incident review and timeline analysis.

Abstract, spill summary & reporting

The abstract, spill Summary & reporting section of the hierarchy contains the basic details of the incident or drill, including the following information:

- Incident abstract
- Spill origin details
- Wreckage details
- Summary reports and findings

Incident abstract

The incident abstract is a high-level summary of the incident, including basic attributes such as the operator, rig, well(s), or other source of the spill (e.g. ruptured pipeline), origin country/location, and an initial assessment of the scope based upon the IPIECA multi-tiered model [IPECA-V14].

Spill origin details

In a spill incident originating from a well, the specific details of the wellhead location are critical to both the damage assessment and the operational response activities that follow. If multiple wellheads exist, the location of adjacent wellheads should also be detailed, with information about the location, purpose, function, and current operating status of adjacent wellheads included. This section should accommodate details for other spill origins as noted above, such as pipelines, infrastructure, or vessels.

Such information will be provided by the operator.

Wreckage details

In a spill incident originating from a marine-based well in which rig wreckage occurs, the details of the wreckage must be captured to mitigate the risk of possible damage to marine-based operations in the vicinity of the wreckage, if such wreckage exists. As noted above, this section should accommodate details for other spill origins as well.

Summary reports & findings

Summary reports are used to release information updating the status of the spill incident.

Damage assessment

The damage assessment hierarchy contains all of the subcategories relating to assessments, evaluations and observations of the damage resulting from an oil spill, including:

- Imagery and remote sensing
- Damage assessment organization information
- Over-flight observations
- Trajectories and extents
- Wildlife observations

Imagery and remote sensing

This subcategory includes imagery and remote sensing of the actual spill incident, and impact area of the spill. The data comes from in-water and surface-deployed platforms and sensors as well as aerial and satellite platforms. IOGP JIP Work Package 1 on In-Water Surveillance provides guidelines for in-water and surface-deployed platforms and sensors and their use in detecting and monitoring of marine oil spills. IOGP JIP Work Package 2 on Surface Surveillance provides detailed guidelines about the use of remote sensing techniques, including aerial observations, for surface surveillance of oil spills.

Aerial observation is typically the primary element of effective response to marine oil spills. It is used to assess the location and extent of oil contamination, and to confirm predictions of the movement and outcome of marine oil spills. Aerial observation provides information that aids in: the planning of operations at sea; the timely protection of locations along the threatened shorelines; as well as the preparation of resources for the cleanup of affected coastline. Dedicated remote sensing aircraft frequently have built-in downward looking cameras to accurately geocode photographs of an impact area.

When an oil spill occurs, information collected from helicopter or plane flights over the spill area helps responders assess the extent of the spill. The location of the oil, along with detailed observations about its appearance, is recorded onto an over-flight map. Photos taken during the over-flight may subsequently be associated to the over-flight map based on geographical coordinates obtained at the time the photo is taken. Use of a latest generation GPS-enabled camera or smart phone, will ensure that the photograph metadata (EXIF) includes the GPS coordinates as well as photo orientation, inclination, date/time. However other key metadata will need to be added manually, such as operator or mission description, by using, for example, an EXIF metadata software application (freeware).

Over-flight paths, information and photos are another important resource for operations planning within an oil spill incident.

For ease of incorporating data interpreted from remotely sensed imagery into the COP and to avoid the need for manual digitizing or re-formatting the data, the use of industry standards for acquiring and encoding the data is recommended.

Damage assessment organization information

This portion of the hierarchy includes the workgroup analysis and study information typically included in the preliminary assessment and restoration planning for injured natural resources and lost use of public properties. Among the typical assessments included in these information sets are the following:

- Sample stations – identification of sampling locations, purpose of sampling, and attributes relating to the obtained sample materials.
- Cumulative oiling – measures of potential cumulative surface oil exposure in the vicinity of a spill.
- Sediment chemistry – location and chemical attribute analysis of sediments obtained from various sampling locations.
- Oil chemistry – location and chemical attribute analysis of spilled oil obtained from various sampling locations.
- Tissue chemistry – location and chemical attribute analysis of organic tissue obtained from various sampling locations.
- Water chemistry – location and chemical attribute analysis of water obtained from various sampling locations.
- General environmental quality – includes additional sampling and analysis information for specific conditions, such as establishing baseline conditions in water chemistry, bottom sediments, and aquatic invertebrates prior to landfall of the oil spill.

Over-flight observations

When an oil spill occurs, information collected from helicopter or plane flights over the spill area helps responders assess the extent of the spill. The location of the oil, along with detailed observations about its appearance, is recorded onto an over-flight map. Photos taken during the over-flight may subsequently be associated to the over-flight map based on coordinates obtained at the time the photo is taken. Over-flight paths, information, and photos are another important resource for operations planning in an oil spill incident.

Trajectories & extents

Trajectories & extents present snapshots of the directional flow/movement, concentration, and range of the spill, for the purpose of planning OSR efforts. Trajectories should provide information to perform the following post-spill analysis:

- Oiling analysis – evaluation of how a given location would be affected by the flow or the movement of spilled oil based on current trajectories.
- Response time analysis – evaluation of where and when response actions must be taken to mitigate the impact of possible oil arrival.
- Shoreline impact analysis – evaluation of which shoreline areas are likely to be affected based on the spill trajectory.

Oil spill trajectory information is normally obtained from specialized modeling software either operated by a regulatory body, the oil and gas operator, or by an independent specialist organization (Figure 13 provides an example of the ASA oil spill model, OILMAP).

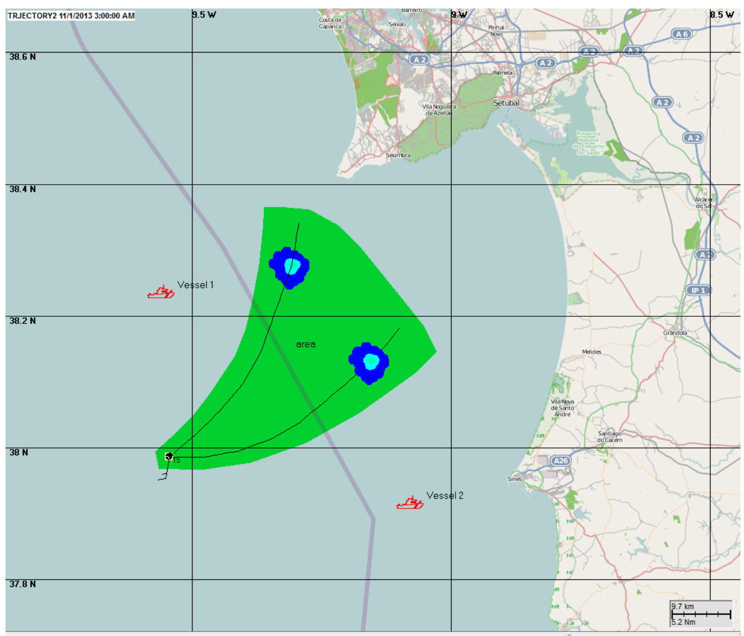

Figure 13 Oil spill trajectory model

Source: ASA, 2014

Wildlife observations

This portion of the Damage Assessment category allows for the tracking of specific wildlife groups that may be impacted by a spill incident. Several examples of wildlife observations include:

- **Bird observations** – includes information pertinent to the date and location of the observation, oiling characteristics, condition of the animal(s), count of animals observed at the location, and species and observation details.
- **Reptile observations** – examples include sea turtles and other amphibious reptiles.
- **Marine mammal observations** – includes reporting on both live and dead observations. Typically dead observations are reported as marine mammal stranding, where stranding is defined as a dead or debilitated animal that washes ashore or is found in the water.

OSR operations

OSR operations information includes:

- Areas of operation
- Operations implementation
- Response sampling & monitoring
- Closures
- Community support

Areas of operation

The area of operation is defined by the response organization. It should include (at a minimum) the following information sets:

- **Access points** – identification of physical shoreline locations providing access for various forms of operational response equipment and personnel.
- **Base locations** – identification of the Tier 1 (small bases typically used to store equipment such as boom and skimmers), Tier 2 (designed for larger equipment levels, and typically accommodating increased personnel), and Tier 3 (intended to deal with incidents where the equipment and supplies are managed by a group of commercial and/or governmental organizations).
- **Command locations** – identification of the locations designated by the response organization as primary, division, and branch operational sites.
- **Decontamination sites** – locations designated by the operations organization for decontamination of equipment and materials (such as retrieved boom) used in the spill response
- **Shoreline divisions** – designating areas of operation for Shoreline Cleanup and Assessment Technique (SCAT) surveys and related response activities.
- **Staging areas** – locations designated by the operations organization for staging of response equipment and personnel.

Operations implementation

Operations implementation covers all aspects of operations-related activities that are initiated to mitigate the impact of the oil spill, including:

- Boom deployment & retrieval
- Dispersant applications
- Hesco basket & sand bag deployment
- In-situ burning
- Operations equipment/resource tracking

- Operations cleanup (SCAT/STR)
- Personnel tracking
- Restricted areas
- Sorbent materials
- Skimming operations

Boom deployment & retrieval

Boom is a common type of oil spill response equipment normally used to protect shorelines or sensitive locations by acting as a barrier to spilled contaminants. Boom is also used to gather oil on the water to improve the recovery effectiveness of skimmers in containment and response, and burn efficacy in in-situ burning operations. Boom deployment information should include the type of boom deployed (solid boom, fire boom [used in conjunction with in-situ burning], sorbent boom and snare boom), boom configuration, and the location of the deployment. In some cases, such as the use of solid flotation curtain boom that is towed for the purpose of concentrating oil for skimmer recovery, the information requirements would include links to the vessel tracks for the towing vessels. As boom is sometimes recovered from a location and re-deployed, information relating to retrieval of the boom should also be gathered, if possible.

Dispersant applications

Dispersants accelerate the natural decomposition of oil, dispersing it from the surface of a body of water into the water column. Dispersants can quickly and effectively minimize the impact of oil on animals present at the surface, including birds and coastal plant life such as mangroves.

All dispersant applications must be closely tracked in a spill response due to the environmental considerations of, and the potential health impact on the personnel involved in, dispersant deployment. Additionally, the type of dispersant used in a spill response must be closely managed and monitored as dispersant products approved in one country or region may not be approved in another.

Additional information that is dependent on the application method may be required. Specifically, the application methods to be considered include:

- Aerial dispersant application
- Surface and sub-surface dispersant application
- Shoreline application

Hesco Basket & Sand Bag Deployment

Hesco baskets, named after the company that makes them, look like wire trashcans lined with fabric. The baskets can be quickly positioned and filled with sand to provide shoreline protection from oil spill residue.

Operational/response information in the COP portfolio should include tracking of Hesco basket installations (and re-installations if the baskets are later moved to a different location).

Sand bag deployments should also be tracked in similar fashion, to identify shoreline or other locations that have been protected from oiling by the installation of sand bags.

In-situ burning

In-situ burning, or ISB, is a procedure sometimes used as a remediation technique in an oil spill. In-situ burning involves the controlled burning of oil that has spilled, at the location of the spill. When conducted properly, in-situ burning significantly reduces the amount of oil on the water and minimizes the adverse effect of the oil on the environment. In addition, in-situ burning may avert or reduce the extent of shoreline impacts, including exposure of sensitive natural, recreational, and commercial resources.

Operational/response information in the COP system should include tracking of in-situ burning operations, capturing available in-situ burn monitoring information (such as video or photographic imagery of the burn), as well as sampling performed as a result of the in-situ burn activity.

Operations equipment / resource tracking (including AIS)

Operations equipment and resource tracking is another key requirement during the cleanup and remediation efforts in an oil spill response. This functionality should capture information about equipment and other assets used as well as the work performed by the respective equipment to provide current and historical resource tracking.

To improve the tracking of operational assets, it is strongly recommended that smart tags (such as RFID transmitters) and other supply chain and asset management technologies be implemented to facilitate identification and tracking of equipment and asset use.

The Automatic Identification System (AIS) (see section 4.5.8) is an automatic tracking system used on ships and by vessel traffic services (VTS) to identify and locate vessels by electronically exchanging information with other nearby ships, AIS base stations and satellites. IMO regulation "requires AIS to be fitted aboard all ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size"[30].

AIS transmitters allow the signal, which includes the ship's identity, type, position, course, speed, navigational status and other safety-related information, to be automatically transmitted to appropriately equipped shore stations, other ships and aircraft, or low orbit satellites.

Other vessels used in the OSR response may need to be fitted with dedicated, active point-point AIS transmitters. AIS information collection may therefore be utilized to provide current and historical tracking of vessels, such as skimmer boats and other vessels, used in oil spill response efforts.

[30] IMO AIS regulations. See: http://www.imo.org/OurWork/Safety/Navigation/Pages/AIS.aspx

Accordingly, a standard AIS protocol should be implemented among all vessels and vessel traffic services used in the oil spill response effort, which ensures that all vessels are tracked continuously with an update frequency of 5 minutes or less and provides information about the vessel location, speed, heading (or COG), and identification. As described above, a combination of AIS and equipment tracking may be required to ensure all vessels are tracked and are visible in the COP. Federation of AIS data feeds within the portal will ensure that data is presented in a single map layer to the users.

Operations cleanup (SCAT / STR)
Shoreline Cleanup and Assessment Technique (SCAT) is a well-defined and documented process used in performing surveys of an affected shoreline in an oil spill incident. SCAT uses standardized terminology to collect information on shoreline impact due to oiling and provides support for operations directors evaluating priorities for shoreline cleanup.

During the operational phase of an oil spill response the SCAT process will be used to review existing shoreline, define boundaries or segments of shoreline, and assign teams and conduct surveys of the shoreline sections. Reports from the SCAT process are used to develop cleanup plans and subsequently monitor the effectiveness of the cleanup process.

Collection and reporting of SCAT surveys is an essential part of the spill response process, and all planning, surveys, and reporting of the SCAT process should be managed within the COP system.

Personnel tracking
The safety of the general public and responders is assigned the highest priority during spill response operations. Within the COP, personnel tracking must be implemented to properly ascertain any potential health risks and exposures to responders in a spill incident. For example, detailed records should be maintained for all personnel involved in the delivery of dispersants or exposed to residue from in-situ burning activities. Increased information gathering and collection regarding personnel, the activities they perform, and any potential health-related exposures from their activities can significantly reduce the long-term risk and liability to responsible parties involved in a spill incident.

Restricted areas
To facilitate operations planning the COP should track areas designated as restricted, including flight restrictions over the operations area, as well as restrictions of marine vessels to operate in areas adjacent to the spill origin, commonly implemented for safety reasons.

Sorbent materials
Sorbent materials, including organics, inorganics, and synthetic materials such as polypropylene, may be used to recover oil in situations that are unsuitable for other recovery techniques. Operational/response information in the COP system should include tracking of sorbent materials used in the cleanup of a spill, as the sorbent materials present a waste disposal issue after use. Information relating to the type of sorbent used (bulk, enclosed, continuous, or loose) as well as the material (organic, inorganic, or synthetic) should be tracked, along with the location(s) and disposal methods utilized for the sorbent materials.

Skimming operations
The primary method utilized for recovery of oil in a marine-based spill is the use of skimming equipment. Typically recovery is accomplished using booms to collect oil, with the skimmer recovering and storing the oil for later processing or disposal. Within the COP, tracking of skimmer operations and their performance should receive high priority. In addition, the information collected should include the volume of oil recovered and details relating to the disposition of the recovered fluids. Ideally, in the tracking of vessels used for skimming operations, the prevailing conditions such as wind, currents, and sea levels should be monitored, as this information can be useful in evaluating the performance of skimming operations in varying conditions.

Response sampling & monitoring
Response sampling & monitoring information represents an array of information collected during the operations phase of an oil spill response. This information may include any or all of the following types of sampling information:

- Conductivity, temperature & depth information, collected by vessels during response activity
- Dissolved oxygen information
- Fluorometer information, which identifies the presence and amount of oil in water through light wavelength analysis
- Sediment sampling information (fingerprinting)
- Location information, indicating sampling zones and buffer areas (including wellhead buffer)
- Seafood sampling
- Snare sentinel monitoring & analysis
- Sorbent probe observations, in which probes are deployed from vessels and absorb subsurface oil if present
- VIPERS analysis information, which collects samples in trawl nets to determine if suspended or submerged oil exists
- Water quality sampling information

For further information, refer to OSR-JIP Work Package 1 reports.

Closures (fisheries, etc.)
Closures information represents areas designated as closed to commercial and/or recreational activities, and subsequent re-openings. Typically this information would include any of the following:

- Fishery closures and re-openings
- Shrimping, crabbing, shellfish closures and re-openings

Closure information may exist at varying governmental levels, including national and state/province level.

Community support
Community support includes the following:

- Administrative centers – operator offices in the surrounding area that may be used to provide administrative support for the spill response.
- Claims centers – locations of operator claims centers offering assistance to individuals and organizations affected by the oil spill.
- Community outreach centers – locations of operator centers designated to disseminate information and provide a meeting location for communities affected by the spill incident.

COP Services Viewpoint

Funneling information to the COP for users

A COP provides a variety of information to properly inform users about the status of a response. The COP information is managed by the Response Center and funnels potentially vast amounts of information into an intelligible and actionable view of the incident. The Response Center ingests multiple streams of information about the situation from a multitude of sources. Processing and decisions made in the Response Center create the dynamic view that is the COP. The COP is delivered by the Response Center to users on a variety of platforms: desktop, mobile, tablet, etc.

Key steps in the workflow for COP creation and release process (Figure 14) are addressed in the remainder of this viewpoint:

- Displaying the COP to users through a geospatial dashboard
- Data services for delivering the COP to users and supporting COPs
- Spatial analysis services
- Request, ingest and validate data sources into the Response Center
- Disconnected user operations (including maps and loading data on mobile devices)

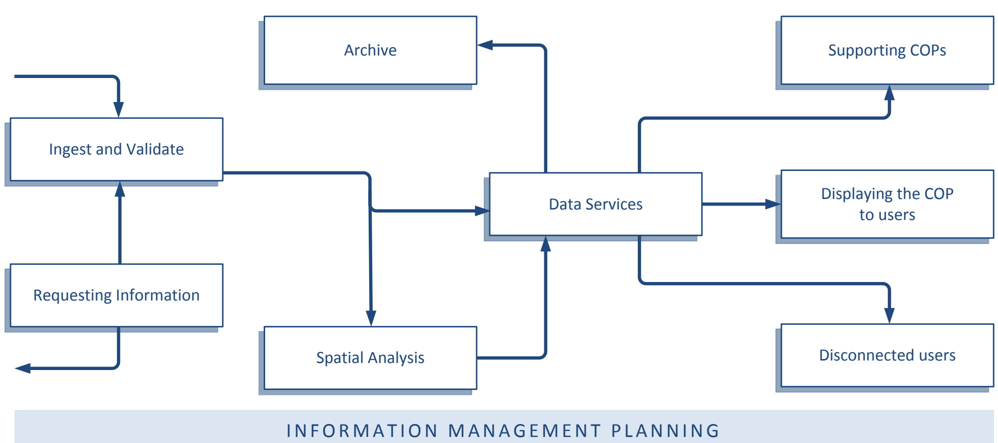

Figure 14 COP workflow process

Requirements for the Services Viewpoint

The architecture in this services section implements the following requirements:

- The architecture is defined using interoperable services, processes, and standards.
- The architecture provides access to authoritative information as listed in the Information Viewpoint and a hard copy is supplied to the data archive and documentation unit.
- The architecture provides a continuously updated overview of an incident, through:
    - Data collection and gathering of incident information.
    - Review and collating of incident information.
    - Analysis and synthesizing of incident information.
    - Publishing and disseminating a COP.

- The architecture integrates diverse information from multiple organizations based on location and other elements.
- The architecture provides standard views of the incident through display of multiple map layers.
- The architecture supports customization of map appearance as determined by the user, e.g. symbols, visible extents, layer addition, printing formats.
- The architecture can handle multiple coordinate reference systems of input data and for user display. *See section 'Handling CRS in the COP database'.*
- The architecture can ingest near real-time oil spill observations and trajectory predictions.
- The architecture can ingest near-real time position of assets, e.g. Automatic Identification System (AIS).
- The architecture can ingest live weather information and alerts from external sources.
- The architecture supports the creation and review of a historical record compiled over an incident's lifecycle.

Displaying the COP to users

Dashboard of multiple information displays

A dashboard provides an at-a-glance summary of the COP information. The dashboard is a composite of several displays of information. Each of these information displays are described in the following paragraphs:

- Information resources query and selection
- Map display including multiple layers and symbols
- Video display from remote cameras directly viewing some portion of the incident
- Graphical display (including histograms and other charts)

Variations on display of information will vary greatly, e.g. ranging from small format screens with a single display type to a wall of several screens with multiple, simultaneous displays.

The information in the displays of a dashboard may come from many different remote servers. 3D displays may also be provided to the user.

Figure 15 An example of an oil spill response COP geospatial dashboard

Source: Esri, 2014

Figure 15 shows an example of a dashboard for an oil spill response COP including:

- Top center – Map of the response site including:
    - Features of interest displayed using a chosen set of symbols.
    - Representation of real-time queried data, i.e. AIS feeds displayed as tracks.
    - All ships, within an area of interest (AOI), are being updated to the right of the map.
- Upper left – Layers in the map provided as a list.
- Middle left – Detail about a specific feature shown in the map.
- Middle right – Graphical display of real-time information.
    - The graphical half-moon display represents pressure readings from the capping stack.
- Bottom – Real-time video display of the spill location including location awareness.

Information resources query and selection

The user is provided with controls to choose which information is displayed and how e.g. symbol set. A set of map templates can be listed or individual datasets may be listed. A user interface to query a catalogue service of datasets and services may also be provided.

The user must be provided with a pre-established set of information as a COP. For example, the OGC Web Services Context Document can be used for a preconfigured set of map layers for a specific geographical area of interest.

Map viewer

A map viewer is a display of a projected, symbolized set of geographic information. Controls on a map display can include the selection of map layers, pan and zoom of the spatial area displayed, and the selection of different symbol sets in the maps. Information in a map layer may originate from cartographic maps, vector features, raster imagery, and model outputs, e.g. trajectories. Map information may come from local storage or from remote servers via web services. Symbols and styles for map display may come from a local storage or from remote symbol registry servers.

Minimum specifications for the map viewer content include:

- Map scale bar and inverse scale
- North arrow
- Coordinate reference system
- Cursor coordinate tracking
- Measurement of distance and areas
- Choice of map template
- Map layer manipulation/selection, adjust order of map layers, add new layers
- Bookmarks to navigate to previously defined locations (e.g. the incident or a port or cleanup area)
- Zoom in/out, pan and reset

Video display

Display of real-time and recorded video of key sites of the incident can be a key aspect of the COP, particularly with the Response Center and the planning team. The sites may include offshore platforms, drill ships, ROVs, docks, support vessels, and onshore field sites. Video streams can be provided from video servers. The video display may include options for pause, rewind, and fast-forward of the video. Video overlay shall include source, date/time and location.

Graphical display

Graphical displays can include time histories or other statistical displays of physical parameters relevant to the incident. Examples include graphical display of real-time information such as telemetry, pressure, or other sensor outputs.

Web services for delivering the COP

Service-oriented architecture

Figure 16 identifies the recommended COP services and interfaces based on best practices and open standards. The architecture in this section is based on operational and development systems that deliver a COP for OSR using open standards. Packaging the services into components is addressed in the Deployment Viewpoint section of this document.

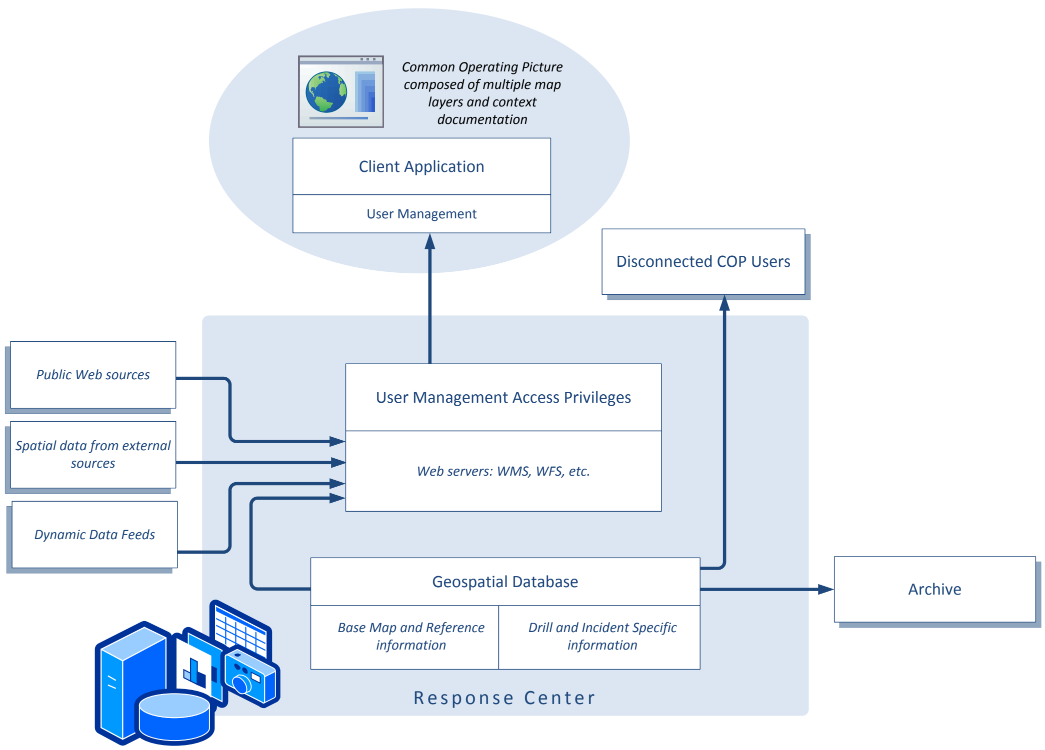

Figure 16 COP service-oriented architecture

Web mapping services

Web map services dynamically produce spatially referenced maps, portraying geographic features for retrieval by the user client dashboard. A map service provides operations to retrieve a description of the maps offered by a server, retrieve a map, and query a server about features displayed on a map.

The OGC Web Map Service (WMS)[31] standard, also published as ISO 19128, provides three operations (GetCapabilities, GetMap, and GetFeatureInfo) in support of the creation and display of registered and superimposed map-like views of information that come simultaneously from multiple remote and heterogeneous sources.

The OGC Web Map Tile Service (WMTS)[32] standard provides for serving spatially referenced tile images with predefined content, extent, and resolution. WMTS trades the flexibility of custom map rendering – as provided by WMS – for the scalability possible by serving a fixed set of tiles.

Typical open standard encoding formats for maps include: JPG, TIFF, PNG, etc.

The OGC Keyhole Markup Language (KML)[33] standard defines an XML grammar used to encode and transport representations of geographic data for display in an earth browser. KML encodes what to show in an earth browser and how to show it.

Servers for geographic features and coverages

The OGC Web Feature Service (WFS)[34] standard, also published as ISO 19142, allows a client to retrieve and update geospatial data encoded in Geography Markup Language (GML) and other encoding formats. WFS defines interfaces for data access and manipulation operations on geographic features. Via these interfaces, a user client can combine, use and manage geodata from different sources. Open standards for encoding feature data include GML, JSON, and KML.

The OGC Web Coverage Service (WCS)[35] standard supports electronic retrieval of geospatial data as "coverages" – that is, digital geospatial information representing space/time-varying phenomena. WCS provides access to coverage data in forms that are useful for client-side rendering, as input into scientific models, and for other clients. Open standards for encoding coverage data include NetCDF, HDF, GRIB, BUFR and GeoTIFF.

Map portrayal and symbols

While it is preferable that a single set of symbols are used for maps in an incident, this is not always possible depending on the organizations involved in the response. Maps in the COP may need to be portrayed in symbols chosen by the user. Examples of cartographic symbols standards are listed in the COP Information Viewpoint section.

The OGC Styled Layer Descriptor (SLD)[36] standard explains how WMS can be extended to allow user-defined symbolization of feature and coverage data. The standard defines how the Symbology Encoding (SE) standard can be used with WMS. SLD allows for user-defined

[31]OGC Web Map Service. See: http://www.opengeospatial.org/standards/wms
[32]OGC Web Map Tile Service. See: http://www.opengeospatial.org/standards/wmts
[33]OGC Keyhole Markup Language standard. See: http://www.opengeospatial.org/standards/kml
[34] OGC Web Feature Service. See: http://www.opengeospatial.org/standards/wfs
[35]OGC Web Coverage Service. See: http://www.opengeospatial.org/standards/wcs
[36] OGC Styled Layer Descriptor. See: http://www.opengeospatial.org/standards/sld

layers and named or user-defined styling in WMS. If a WMS is to symbolize features using a user-defined symbolization, the source of the feature data must be identified. WMS servers using feature data are also called Feature Portrayal Services (FPS), while those using coverage data are Coverage Portrayal Services (CPS).

The OGC Symbology Encoding (SE)[37] standard specifies the format of a map-styling language for producing geo-referenced maps with user-defined styling. SE is an XML language for styling information used to portray feature and coverage data. SE may be used together with SLD. As SE is a grammar for styling map data independent of any service interface specification, it can be used flexibly by a number of services that style geo-referenced information or store styling information that can be used by other services.

Video streaming and management

Video images can provide unique real-time and historical awareness of an incident. As part of the COP, video is delivered to the user using web services and encodings using open standards. Provisioning for the network and processing requirements must be accommodated; these are addressed in the Deployment Viewpoint section of this document.

The COP user interface and web services should provide the following functions:

- Viewing controls (play, pause, stop controls for video display)
- Query of video library (including search by keyword and tags)
- Selection of video streams for display

Media management by the Response Center includes:

- Media personnel assisting in cataloging and handling of video data
- Secure transfer of the hard drive media from offshore to onshore
- Professional editing and annotation of operations videos
- Archival of video feeds

The interface between the Response Center and the COP clients should be based on Motion Imagery Standards Board (MISB) standards. Multiple formats may need to be supported.

Context document for the COP

A COP contains a set of information collected for an incident. In order to manage and deliver the assembled set of information an OGC Web Services Context Document (OWS Context)[38] can be used. An OWS Context can be created by the Response Center for deploying the COP to users. The OWS Context contains a manifest of the COP contents.

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[37] OGC Symbology Encoding. See: http://www.opengeospatial.org/standards/symbol
[38] OGC Web Services Context Document. See: http://www.opengeospatial.org/standards/owc

The COP contents may be stored directly in the OWS Context file or the Context may contain references to remote resources. Multiple encoding formats for OWS Context have been developed (ATOM, JSON). User clients open the OWS Context, retrieve the information, e.g. map layers and display the COP in their dashboard displays.

Map templates can be encoded in OWS Context. Such OWS Context documents for map templates can be created in advance as templates. The templates are then completed during the time of the response using the specifics of the incident, e.g. spatial location.

Catalogue services

Catalogue services (also sometimes called registry services) provide interfaces to discover, browse, and query metadata about data, services, and other potential resources. The OGC Catalogue Service for the Web (CSW) is a binding defined in the OpenGIS Catalogue Services Implementation Standard (CAT)[39]. (An OGC OpenSearch Geo standard is nearing adoption as OGC standard and is applicable as well.)

ISO 19139 - an open standard for the encoding of geospatial metadata – is compatible with CSW.

Authentication and authorization services

Procedures and protocols must be established to ensure information security. Inadequate information security can result in the untimely, inappropriate, and piecemeal release of information, which increases the likelihood of misunderstanding and can compound already complicated public safety issues.

Individuals and organizations that have access to incident information and, in particular, contribute information to the system must be properly authenticated and certified. This requires services to ensure users can be properly authenticated and information flow can be properly authorized and protected.

User management services provide the authentication and authorization capabilities in a service oriented architecture. Authentication protocols and user management protocols for the purpose of user registration, user single sign-on (SSO), and user data access and use metrics are to be established.

OGC User Management for Earth Observation Services Best Practice[40] describes how user and identity management information may be included in the protocol specifications for OGC Services. The use cases addressed make reference to EO services, for example catalogue access, ordering and programming.

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[39] OpenGIS Catalogue Services Implementation Standard. See: http://www.opengeospatial.org/standards/cat
[40] OGC User Management for Earth Observation Services Best Practice. See: http://portal.opengeospatial.org/files/?artifact_id=40677

Spatial analysis services in the Response Center

In an incident response a good deal of on-the-fly analysis capability is required to deal with a very fluid changing situation. Although certain established products can and should be prepared as templates, there is also a need for interactive modeling and analysis skills within the team. The Response Center needs to be able to respond to unexpected analysis workflows in order for a COP to be successful.

Operators in the Response Center should be able to assess incoming data including images, together with supporting meteorological, oceanographic and ancillary information (e.g. AIS, vessel detection) where available, to identify the current and predicted situation. This analysis is provided to assist in planning the response.

Data analysis including image interpretation functions can and should be automated as much as possible to improve the efficiency, objectivity and speed of delivery of information to the COP. For example, oil spill extents can be detected and delineated automatically from satellite imagery. The Geomatics Unit should work with the data providers, e.g. image providers, to analyse the auto-interpreted results, not the imagery itself (except for verification purposes).

Inputs to the Response Center

Summary of inputs to the Response Center

The Response Center will receive data from a variety of sources. Each data feed has its own considerations for receiving, storing, and processing data before potential delivery to users. Subsequent sections address the ingestion of the data from the variety of sources into the Response Center:

- Base map and reference information sources
- Meteorological data sources
- Observations of the spill from surveillance systems
- Observations of the spill from field workers
- Modeling and prediction of the spill
- Tracking of Resources for Spill Response
- Social media monitoring about the spill

The sources of information coming into the Response Center are diverse. Planning in advance using an Information Management Plan approach is recommended. Advance planning must take into account the interoperability of the COP with diverse systems from multiple sectors: government, commercial, etc.

Basemap and reference information sources

Base maps and reference layers may come from many sources: government data, commercial map providers, or from responsible party.

Government data is readily available from spatial data infrastructures (SDI). While each country implements their SDI in differing ways, the Global Spatial Data Infrastructure "Cookbook"[41] provides recommendations that have been implemented widely.

Specific examples of SDIs include:

- In the United States: Geospatial Data.gov [42] and the Geospatial Platform[43]
- In Europe: INSPIRE Portal for access to national datasets[44]
- The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) has been established to promote common principles, policies, methods, mechanisms and standards for the interoperability and inter-changeability of geospatial data and services[45]

Commercial maps from public sources may be relevant to a response. Considerations for access to commercial map include:

- The maps may only be available using proprietary interfaces.
- Map projection may be limited to one projection which may not be suitable for use in the response.

Responsible parties may also have licensed data from geospatial information providers that is relevant to the response. Licensing issues will need to be considered when ingesting such data into the COP; for example some providers may prohibit the distribution of the proprietary data on public web services.

Meteorological data sources

Meteorological data may come from many sources: government data, commercial map providers, or from the responsible party. Radar on platforms in remote locations may be one potential source of meteorological data specific to the incident response.

[41] Global Spatial Data Infrastructure "Cookbook". See: http://www.gsdi.org/gsdicookbookindex
[42] Geospatial Data.gov. See: http://www.data.gov/geospatial
[43] Geospatial Platform. See: https://geoplatform.gov
[44] INSPIRE Portal. See: http://inspire-geoportal.ec.europa.eu/discovery/
[45] The United Nations Committee of Experts on Global Geospatial Information Management website. See: http://ggim.un.org/

Observations of the incident from surveillance systems

Surveillance of the spill may be conducted using a variety of sensor technologies located on a variety of platforms. An ocean spill, for example, will require both in-water surveillance and above-water surveillance inputs to the COP.

Real-time and near-real-time sensing of the spill incident provides situational awareness for the Response Center. Examples include video from ROVs and images from remote sensing instruments on airborne and space-borne platforms. To be useful the sensor data must typically be processed and interpreted by experts. The resulting derived products may then be made part of the COP. Suppliers of the information as well as the Response Center will process the sensor observations. The processing and workflow history, i.e. the provenance of the information, must be understood and retained.

An example scenario of a geographic imagery acquisition is provided in Figure 17 (from ISO 19101-2[46]). The Response Center requests geographic information derived from image acquisition. The request for geographic imagery information is assessed in the planning step. The desired information may be available from an archive or a model. Some additional processing may be needed on the archive or model outputs in order to meet the customer's request.

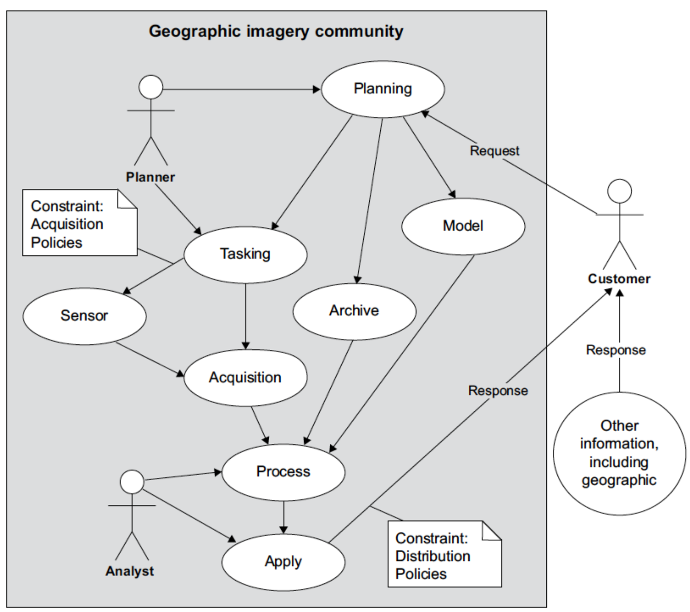

Figure 17 Surveillance observation request process Source: ISO 19101-2

[46] ISO/TS 19101-2:2008 Geographic information - Reference model - Part 2: Imagery. See: http://www.iso.org/iso/catalogue_detail.htm?csnumber=39983

The acquisition request for geographic imagery may require the collection of new imagery. Tasking determines the available sensors and platforms and develops an imagery acquisition request. The sensor is tasked to acquire the raw data and the acquisition is performed. Acquisition of the imagery data is done in accordance with the acquisition policies.

Whether the customer's request is to be satisfied from an archive holding, a model output, or a data acquisition, typically some type of additional processing is needed. This could range from changing the encoding format of the imagery to creating derived imagery or image knowledge products. The resulting imagery information may be applied with additional information to form a response that meets the customer's needs. Distribution of the imagery information response is done in accordance with the distribution policies.

It is important to understand that imagery acquisition takes time. Two durations are significant:

- Image lead-time – time from when the Response Center transmits an acquisition request until the time the sensor acquires the image. A significant portion of this lead-time is required for tasking (tasking is typically carried out at fixed times during the day and so will involve some lead time).
- Image latency – time from image acquisition by the sensor to delivery of the imagery-derived information to the Response Center. Image latency consists of: time to transmit the image from sensor platform to the processing center and the time for image processing and delivery.

It is recommend that the term "acquisition time" be avoided because this is ambiguous – it can mean the time taken for the sensor to acquire the data which is not synonymous for the time taken for the image to be recorded and then downlinked at the ground station.

The Response Center must manage the imagery acquisition for the incident including potential and planned acquisitions:

- Potential acquisitions –what is on standby (e.g. airborne platforms and sensors with appropriate permissions and accessibility) or feasible (satellite acquisitions that meet the imaging requirement) both with lead and latency times considerations in place. In effect a resource for tactical planning and avoiding delays - the resource has been provided in advance. Other platforms and sensors could be added to the resource during the event opportunistically.
- Planned acquisitions - what is scheduled to be available (which will change frequently). This might include planned flight paths, image coverages, etc. (routine as well as custom). This is a resource for planning of additional acquisitions - avoiding redundancy or coordinating multi-sensor observations. Also includes any "free" data that might be available routinely (e.g. Sentinel-1 SAR).

The Response Center may form a service level agreement with remote sensing suppliers to help manage image acquisitions.

Web services for the observation request process by the Response Center can be achieved using open standards:

- The OGC Ordering Services for Earth Observation Products[47] supports ordering of EO data products either from previously identified dataset collections via a typical catalogue interaction or from future acquisitions specified via a programming service. The service describes an interface that can be supported by many data providers (satellite operators, data distributors, etc.), most of whom have existing (and relatively complex) facilities for the management of these data.
- The OGC Sensor Observation Service (SOS)[48] implementation standard defines a web service interface for requesting, filtering, and retrieving observations and sensor system information. Observations may be from in-situ sensors (e.g. water monitoring devices) or dynamic sensors (e.g. imagery from Earth-observation satellites).
- The OGC Sensor Planning Service (SPS)[49] implementation Ssandard defines an interface to task sensors or models. Using SPS, sensors can be reprogrammed or calibrated, sensor missions can be started or changed, simulation models executed and controlled. The feasibility of a tasking request can be checked and alternatives may be provided. The OGC SPS Earth Observation Satellite Tasking Extension[50] supports the programming process of Earth Observation (EO) sensor systems used by many satellite data providers.

Two work packages of the Oil Spill Response Joint Industry Process (OSR-JIP) have developed recommendations regarding observations from surveillance systems. Reports from the WPs provide additional guidance on surveillance inputs to the Response Center:

- **WP1 - In-Water Surveillance:** Detection of hydrocarbons in the water column
- **WP2 - Surface Surveillance:** Satellite, aerial observation, in-situ sensors

OSR-JIP WP2 has published a report titled: 'An Assessment of Surface Surveillance Capabilities for Oil Spill Response using Airborne Remote Sensing', dated 21 May 2014. The key findings are as follows:

- The number of platform and sensor providers is very large, and the number identified through the report, particularly platform providers, is limited. A directory of this information would be very useful to the industry.
- Exercises would help considerably in supporting the development of effective airborne surveillance capabilities for oil spill response, for technology testing, migration to operational capabilities, training, integration with the COP, etc.
- Effective oil spill response based on opportunistic availability of platforms (with sensors) is not viable.

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[47] OGC Ordering Services for Earth Observation Products. See: http://www.opengeospatial.org/standards/oseo
[48] OGC Sensor Observation Service. See: http://www.opengeospatial.org/standards/sos
[49] OGC Sensor Planning Service. See: http://www.opengeospatial.org/standards/sps
[50] OGC SPS Earth Observation Satellite Tasking Extension. See: http://www.opengeospatial.org/standards/sps

- Given that oil spill surveillance using opportunistically available platforms and sensors is not viable, there is a need to build surveillance capabilities around local jurisdictions and physical environments for OSR.
- Unmanned Aerial Systems are clearly going to be important platforms for OSR in the future, with the market likely to expand rapidly in the next 5 years. The industry should ensure that it is ready to exploit this technology effectively, which requires keeping a close eye on developments over the next few years, both technical and regulatory.
- Standard sensor packages on standby for deployment are potentially very useful, but only if their deployment can be provided with necessary approvals in advance (for example, export and import-compliant, and approvals for sensor mounts).
- A technology road map would be useful to identify critical technologies that the industry needs for effective oil spill response. Important research topics include: spectroscopy; full polarization imaging radar; effective and practical deployment of, and fusion of information from, multiple sensors and real time, or near real time, data transmission.
- Training is a critical part of effective airborne surveillance for OSR, particularly as the complexity of sensors, and their greater use in combination (perhaps also with multiple platforms), becomes more frequent.
- Experience from Deepwater Horizon and elsewhere has demonstrated that processing of data can delay ingestion of the information into the COP. The drive to develop new sensors and data analysis techniques should not obscure the strong requirement to enable information to be available rapidly for responders.
- In order to achieve rapid processing and delivery times, on-platform processing of data should be considered to reduce data volumes for remote delivery from airborne platforms to decision-makers, and airborne platform external communications capabilities should be considered central to the effective use or remote sensing.
- It will be very important for airborne surveillance to be compatible with the COP in terms of products. There may be implications for products from some sensors in terms of metadata, time stamping, positioning accuracy, codes, symbology, units, naming, delivery mechanisms and formats.
- Remote sensing creates large datasets, which require proper management not only for OSR itself, but for post-event analysis.
- Synergies between airborne and satellite derived information have to be established and relevant case studies prepared.

Observations of the incident by response personnel

Data collected by response personnel deployed in the field must be ingested into the Response Center database. The methods for workers to send information to the Response Center will be highly varied, including applications on smartphones or similar handheld device, emails to the Response Center and notes on paper delivered to the Response Center.

Applications on mobile devices can utilize location information available in the device to record the location when an observation is made. Prior to deployment the mobile device can be configured with COP information, e.g. base maps and best current estimates of spill impact as in the field, it is likely that the observations will be made while disconnected, i.e. no cellular or other communications. Upon returning to a location with communications, an upload of the fieldwork observations (including location information) should then be uploaded to the Response Center. Upon ingestion at the Response Center, analysis of the field observations will be made for confirmation and inclusion in the COP updates.

The Disconnected Users section below provides recommendations for the support of disconnected response personnel operations, including provisioning of mobile units and printing maps from COP information.

Modeling and Prediction of the Spill

Modeling of an oil spill as part of the response can be split into two different types:

- Modeling of the trajectory of an oil spill / plume.
- Metocean modeling of wave currents and winds that supports plume modeling.

The Response Center may request oil spill drifting services (hindcast and forecast) from different oil spill models. The model can simulate the impact of an oil spill for a time period (for example 72 hours) according to the specifics of the oil spill and the oceans/weather conditions. Access to the models, e.g. using OGC Web Processing Services (WPS) or FTP, can return the outcomes of the modeling in two type of formats: CSNDC oil spill schema[51] or netCDF[52].

The integration of metocean data (currents, winds, ice cover, temperature, visibility, precipitation etc.) is a challenge as it is generated and held by a wide range of private companies and public agencies. The data is available in a wide variety of formats, primarily formats used by the Earth & Ocean Sciences community such as GRIB, NetCDF, HDF and a variety of ASCII and other non-standard conventions.

Some of the challenges in delivering metocean data include symbolization and the display of scalars (e.g. temperature) and vectors (e.g. current speed and direction). The use of WMO standards for representation of wind (barbs) and standard vector representations for currents is recommended.

Work Package 3 of the Oil Spill Response Joint Industry Process (OSR-JIP) has developed recommendations regarding modeling and prediction of the spill. The WP3 report, focused on Modelling & Prediction, provides additional guidance on surveillance inputs to the Response Center.

[51] CSNDC oil spill schema. See: https://csndc.emsa.europa.eu/schemas/csndc/1_3_4/csndc_os.xsd
[52] NetCDF standard. See: http://www.opengeospatial.org/standards/netcdf

Tracking of resources for oil spill response

Many resources are needed for oil spill response including personnel and equipment. Tracking the location and the status of these resources is vital to the planning, logistics and operations management of the response and thus is key information for the COP.

Tracking of people includes current and previous deployment locations, deployment tasks and any health and safety implications resulting from the deployment task (e.g. exposure to dispersants, or poor weather conditions). Several commercial software applications are specifically designed for the tracking of human resources. Outputs from these applications, including geospatial information, can be provided as inputs to the COP.

Tracking of assets and equipment, e.g. small boats and boom, includes their location and operational status. Tracking of assets and equipment can be automated using RFID or similar tagging along with associated information systems.

For ships, tracking can be performed using Automatic Identification System (as previously discussed). Web delivery of AIS to the Response Center can be an input to the COP. Historical tracks of AIS may be stored by the Response Center.

Social media monitoring about Spill

Social media is a recent phenomenon that can inform oil spill response, particularly if the spill is in an area close to people. Attention must be paid to monitoring, filtering and confirming social media reports as part of including them in the COP information.

Use of social media for response operations is a new capability and not yet well understood. Multiple research projects and studies are focused on the subject and, in particular, on the topic of “Volunteered Geographic Information” (VGI). An example is the research reported by the OGC Testbed-10 VGI Engineering Report[53]. The report describes an approach for integrating VGI into a spatial data infrastructure and reports on findings studying the advancements made in using VGI resources. It includes optimization ideas, service change recommendations, and lessons learned.

[53] OGC Testbed-10 VGI Engineering Report. See: https://portal.opengeospatial.org/files/?artifact_id=58925

Disconnected user operations

Mobile unit provision

COP users with mobile devices may be disconnected from communications for extended periods of time. Before deployment the mobile device is provisioned with COP information. During deployment the COP information is used in the operation; the applications used must be able to support queries on the COP while disconnected. Disconnected users may record updates to geographic features that can be later provided to the Response Center once reconnected. The Response Center will then need to consider whether to use these modifications to update the COP.

To equip a mobile device with a 'ready-to-use' COP before deployment, the previously mentioned OWS Context standard can be used to define views on the COP. To provide the underlying information for the COP while disconnected, the OGC GeoPackage[54] standard can be used to provision the mobile device with features, tiles and other geo-information. OWS Context and GeoPackage were designed specifically to provide situational awareness for disconnected users.

Printed map capability

The COP will likely need to produce large-format printed maps at regular intervals, and thus printing/plotting facilities will need to be available at the Response Center. Standard map templates ensure that the map meets minimum technical standards and provides clear and unambiguous cartographic symbols. In addition the maps should be saved as snapshots in a reproducible format, such as PDF, and archived as part of the record retention process.

In order to present the geospatial information to the end users in a coherent fashion, a series of map templates will be required. These should provide selected sets of information for specific purposes (as previously discussed in Map Templates). Such map templates should be available to be printed as large-format wall maps and for maps that can be taken on deployment operations by disconnected users.

The minimum map contents should include:

- Map frame with annotated grid and graticule
- Coordinate reference system
- North arrow
- Map scale and scale bar
- Legend describing all features in the map content
- Map title, security classification, author, date
- Unique map reference number and version
- Index map
- Intended map print size
- Date and time the map was created

[54] OGC GeoPackage. See: http://www.opengeospatial.org/standards/geopackage

COP Deployment Viewpoint

Preparing for deployment before the incident

The Deployment Viewpoint identifies the types of COP components needed to support the deployment and management of distributed interaction between the components. Components defined in the Deployment Viewpoint are implementations of the services, interfaces, and encoding identified in the Services Viewpoint. The COP components provide the persistent storage and management of the data identified in the Information Viewpoint.

Prior to the response, multiple organizations will implement various instances of the COP components. At the beginning of the response, a challenge for response team is to quickly assemble these components into an operational COP platform. This challenge is eased by the architecture defined in this section: a reusable interoperable architecture with standardized interfaces that will facilitate efficient data sharing during a response event.

The process to deploy a COP for a response should consider these elements:

- COP components should be "ready-to-go" and agreed in advance.
- Some components used in a response will be used in day-to-day operations.
- Data required for the response should be considered in advance.
- Drills and exercises should be used to test and train for the COP.
- The COP components must conform to open standards, common enterprise IT, and utilize web-computing frameworks.
- Some of the components should be developed as open-source to enable development options.

The component deployment architecture for a Tier 3 Response is shown in Figure 18. The individual component layers (client, Response Center, and sources) along with the intervening networks (client networks and source networks) are detailed in the following sections.

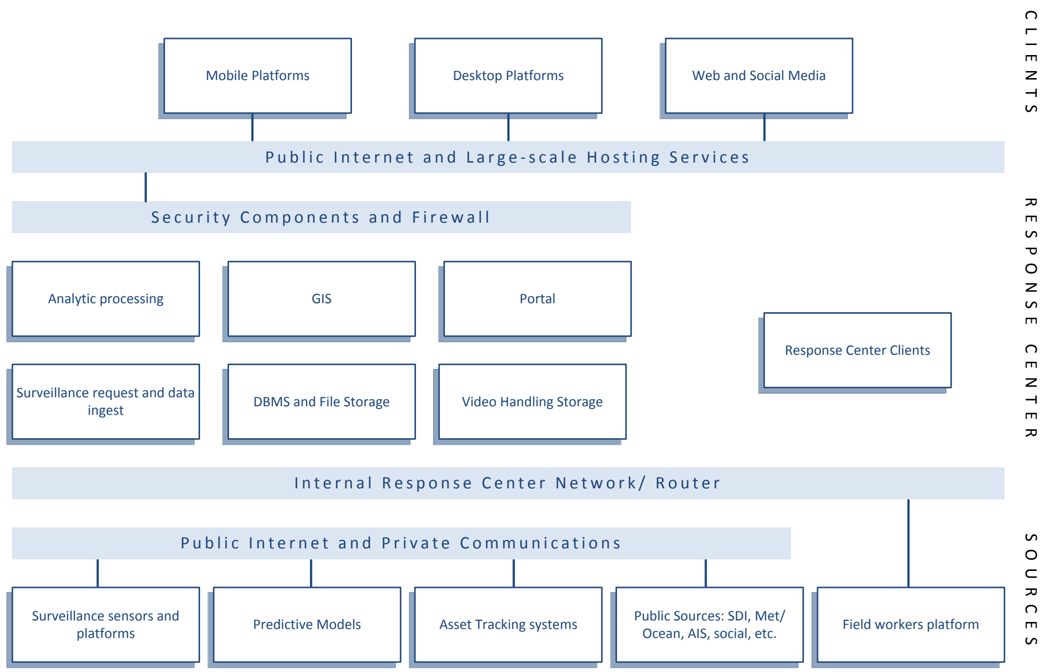

Figure 18 COP component deployment architecture

The Response Center will need some amount of computer system hardware to establish the deployment architecture. With the increasing availability, accessibility and afforability of remote resources, e.g. cloud computing, the Response Center may rely on the remote hosting and computation of certain functions, such as database management and file storage, if sufficient security measures can be put in place. The use of remote resources, and in particular cloud computing, has multiple benefits that should be taken into account when deploying for response. These include:

- Scalability (i.e. good for both big and small disasters)
- Data upload from various remote locations (i.e. no need to deliver data to the command center)
- Data processing power and speed (i.e. increase by a factor of 10 at least)
- Data storage (almost limitless storage capacity, pay as you go)

Clients

The public client layer will include a diversity of hardware platforms, e.g. mobile, desktop, and websites, that can be developed and launched on a multitude of operating systems (e.g. Android, iOS for mobile / tablet; Windows, Linux for tablet / computer) (see Figure 19).

Figure 19 Diversity of deployment platforms

Client networks (including security)

The Response Center must connect to networks to allow access by components in the public client layer.

A public internet connection with bandwidth to support public access to the public COP must be available.

Security at both network level (e.g. firewalls) and application (e.g. authentication and authorization services) must be implemented before the COP hosts any data.

Response Center components

The Response Center will contain the following components:

- Portal to provide dashboard access to users including maps, video, displays, etc.
- Portal provides access to continuously updated incident-specific information through:
    - Data collection and gathering of incident information
    - Review and collating of incident information
    - Analysis and synthesizing of incident information
    - Publishing and disseminating
- Geographic Information System (GIS)
- Surveillance planning and ingest
    - Including feasibility analysis for observations and receiving data from sensors without loss, e.g. streaming
- Analytic processing to support Response Center analysis
- Video handling and storage
    - Data recording and media management

    - Live streaming video to clients
    - DBMS and file storage
- Response Center clients

Any of the components listed above could be hosted on computers physically located at the Response Center or hosted at a remote location, e.g. via cloud hosting. If hosted remotely, secure networking with sufficient reliability and performance needs to be procured. Consideration for physical redundancy of the Response Center should also be considered.

Source networks

Source networks will need to include:

- Networks internal to the Response Center, e.g. Wi-Fi router.
- Dedicated communications to response assets, e.g. offshore network services. These may be wired or wireless communications.
- Public Internet may be used for the Source Networks.

The security considerations for the source networks must also be addressed.

Source layer components

Source layer components are generally at locations physically separate from the Response Center. These will include:

- Surveillance sensors and platforms.
- Predictive models hosted at remote compute facility.
- Asset tracking systems, e.g. RFID readers and communications.
- Public sources of information, including spatial data infrastructures, information from relevant governments, met/ocean information, AIS for vessel tracking, social networks, e.g. Twitter, and other sources.
- Field worker platforms for disconnected operations and field collection.

Annex A. Oil Spill Response COP datasets

The table shows the following for each dataset:

1. **Data group category** – Groups data layers together based on common pairings.
2. **Oil Spill Response COP dataset** – A general type of data that could be leveraged/ used in a COP.
3. **Oil Spill Response units** – Core units with in the IMS system and if the OSR dataset is relevant for their use.
4. **Category** – Indicates whether it is a base map dataset or incident related dataset (base, incident).
5. **Pre-populated prior to incident** – Data that can mostly be pre-populated and available prior to an incident.
6. **Generated, collected, or updated during incident** – This is indicates whether the data is created and populated as a result of the incident. In some cases, various pre-existing data can be updated with more recent information.
7. **Priority** – The relative priority of the dataset (high, medium, low).
8. **Land/water/both** – Whether the dataset is required for terrestrial incidents, marine incidents (specifically at water), or both (land, water, both).

Table 5 Oil spill response COP datasets

		Oil Spill Response Units									Usage Summary				
Data Group	**Oil Spill Response COP Datasets**	**Incident Command**	**Situation Status**	**Planning**	**Tactical Operations**	**Air Operations**	**Public Information**	**Safety**	**Logistics**	**Finance**	**Category (Base/ Incident)**	**Pre-Populated prior to Incident**	**Generated/ Collected/ Updated during incident**	**Priority (High/Medium/ Low)**	**Land/ Water/ Both**
BASE MAP DATA															
Base Map Background															
	Google or other general web maps	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Hybrid	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Streets	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Physical	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Satellite	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Esri	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Bing	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Open Street Maps	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Aerial Imagery	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Satellite Imagery	x	x	x	x	x	x	x	x	x	Base	x		H	Both
Administration Boundaries & Reference Information															
	Geopolitical (UN SALB/GADM)	x	x	x	x	x	x	x	x	x	Base	x		H	Both

		Oil Spill Response Units									Usage Summary				
Data Group	**Oil Spill Response COP Datasets**	**Incident Command**	**Situation Status**	**Planning**	**Tactical Operations**	**Air Operations**	**Public Information**	**Safety**	**Logistics**	**Finance**	**Category (Base/ Incident)**	**Pre-Populated prior to Incident**	**Generated/ Collected/ Updated during incident**	**Priority (High/Medium/ Low)**	**Land/ Water/ Both**
	Governmental Agency Boundaries (Example: BOEM, EPA, COTP, WMA, etc.)	x	x	x	x	x	x	x	x	x	Base	x		M	Both
	Area Place Names (Ex: GNIS)	x	x	x	x	x	x	x	x	x	Base	x		H	Both
	Marine Jurisdiction (Ex: EEZ, State Waters, NMS, Maritime Zones, Coast Guard, etc.)	x	x	x	x	x	x	x	x	x	Base	x		M	Water
	Lease blocks	x	x	x	x	x	x	x	x	x	Base	x		L	Both
Bathymetry and Hydrography															
	Scanned Charts	x	x	x	x		x	x			Base	x		M	Water
	DTM	x	x	x	x		x	x			Base	x		M	Water
	Sounding Points	x	x	x	x		x	x			Base	x		H	Water
	Contours (Water Depth)	x	x	x	x		x	x			Base	x		H	Water
	Hydrography (Ex: NHD data)	x	x	x	x		x	x			Base	x		H	Both
	Geological data	x	x	x	x		x	x			Base	x		M	Both
	Seabed Survey data	x	x	x	x		x	x			Base	x		M	Water
Topography															
	Scanned Topography Maps	x	x	x	x	x	x	x	x		Base	x		M	Both
	DTM	x	x	x	x			x	x		Base	x		M	Land

Data Group	Oil Spill Response COP Datasets	Oil Spill Response Units									Usage Summary				
		Incident Command	Situation Status	Planning	Tactical Operations	Air Operations	Public Information	Safety	Logistics	Finance	Category (Base/ Incident)	Pre-Populated prior to Incident	Generated/ Collected/ Updated during incident	Priority (High/Medium/ Low)	Land/ Water/ Both
	LiDAR	x	x	x	x						Base	x	x	M	Both
	Contours (Land Elevation)	x	x	x	x		x	x	x		Base	x		H	Land
Aerial Photography and Remotely Sensed Data															
	Geo-referenced Aerial Imagery	x	x	x	x		x				Base	x	x	H	Both
	In Water Surveillance (OSR JIP Work Program 1)	x	x	x	x						Base		x	H	Water
	Surface Surveillance (OSR JIP Work Program 2)	x	x	x	x						Base		x	H	Both
Natural Resources, Habitats, Cultural Resources, and Managed Areas															
	Critical Habitat and Endangered Species	x	x	x	x	x	x				Base	x		H	Both
	Fish Habitat	x	x	x	x	x	x				Base	x		M	Both
	Bird Habitat	x	x	x	x	x	x				Base	x		M	Both
	Reptile Habitat	x	x	x	x	x	x				Base	x		M	Both
	Marine/Terrestrial Mammal Habitat	x	x	x	x	x	x				Base	x		M	Both
	ESI Shoreline Classification	x	x	x	x			x			Base	x		H	Both
	Vegetation Classification	x	x	x	x						Base	x		M	Both
	Wrecks, Debris, Archaeology Sites	x	x	x	x			x			Base	x	x	H	Both
	Socio-Economic Data	x	x	x	x		x	x	x		Base	x	x	M	Both

Data Group	Oil Spill Response COP Datasets	Oil Spill Response Units									Usage Summary				
		Incident Command	Situation Status	Planning	Tactical Operations	Air Operations	Public Information	Safety	Logistics	Finance	Category (Base/ Incident)	Pre-Populated prior to Incident	Generated/ Collected/ Updated during incident	Priority (High/Medium/ Low)	Land/ Water/ Both
NAVIGATION AND MARINE INFRASTRUCTURE DATA															
Navigation Charts and Buoy Data															
	Electronic Navigation Charts (ENC)	x	x	x	x	x		x	x		Base	x		H	Water
	Raster Nautical Charts (RNC)	x	x	x	x	x	x	x	x		Base	x		H	Water
	Buoy location and data										Base	x		M	Water
Vessel Traffic, Shipping Lanes and Zones															
	AIS (Vessel Tracking Feeds)	x	x		x			x			Base	x	x	H	Water
	Maritime Collision Regulation Lines	x	x	x	x			x			Base	x		L	Water
	Anchorages	x	x	x	x			x			Base	x		M	Water
	Precautionary Areas	x	x	x	x			x			Base	x		M	Both
	Restricted Areas	x	x	x	x			x			Base	x		H	Both
	Dredge Disposal Areas	x	x	x	x			x	x		Base			M	Water
Marine Infrastructure															
	Ports	x	x	x	x		x	x	x		Base	x		H	Both
	Ferries	x	x	x	x		x	x	x		Base	x		H	Both
	Marinas	x	x	x	x		x	x	x		Base	x		H	Both

		Oil Spill Response Units									Usage Summary				
Data Group	**Oil Spill Response COP Datasets**	**Incident Command**	**Situation Status**	**Planning**	**Tactical Operations**	**Air Operations**	**Public Information**	**Safety**	**Logistics**	**Finance**	**Category (Base/ Incident)**	**Pre-Populated prior to Incident**	**Generated/ Collected/ Updated during incident**	**Priority (High/Medium/ Low)**	**Land/ Water/ Both**
	Boat Launches	x	x	x	x		x	x	x		Base	x		H	Both
	Locks, Dams, and Levees	x	x	x	x			x			Base	x		M	Both
	Navigable waterways	x	x	x	x			x			Base	x		H	Both
	Aids to Navigation	x	x	x	x		x	x	x		Base	x		H	Water
PUBLIC SAFETY & TERRESTRIAL INFRASTRUCTURE DATA															
Critical Infrastructure															
	Hospitals	x	x	x	x		x	x	x		Base	x		H	Land
	Police Stations	x	x	x	x		x	x			Base	x		H	Land
	Water Intakes	x	x	x	x		x	x			Base	x		H	Land
	Fire Stations	x	x	x	x		x	x			Base	x		H	Land
	Power Generation Facilities	x	x	x	x			x	x		Base	x		H	Both
	Power lines and infrastructure	x	x	x	x			x	x		Base	x		H	Both
Transportation Infrastructure															
	Roads	x	x	x	x		x	x	x	x	Base	x		H	Land
	Bridges	x	x	x	x		x	x	x	x	Base	x		H	Land
	Railways	x	x	x	x		x	x	x	x	Base	x		H	Land

Data Group	Oil Spill Response COP Datasets	Oil Spill Response Units									Usage Summary				
		Incident Command	Situation Status	Planning	Tactical Operations	Air Operations	Public Information	Safety	Logistics	Finance	Category (Base/ Incident)	Pre-Populated prior to Incident	Generated/ Collected/ Updated during incident	Priority (High/Medium/ Low)	Land/ Water/ Both
	Airports	x	x	x	x	x	x	x	x	x	Base	x		H	Land
	Heliport/Helipad	x	x	x	x	x	x	x	x	x	Base	x		H	Land
	Parking	x	x	x	x			x	x	x	Base	x		H	Land
Oil and Gas Infrastructure															
	Wells	x	x	x	x		x	x	x		Base	x		H	Both
	Platforms, FPSOs, Drilling Rigs	x	x	x	x	x	x	x	x		Base	x		H	Both
	Offshore Pipelines	x	x	x	x		x	x	x		Base	x		H	Water
	Subsea Facilities and Flow lines/Umbilical	x	x	x	x		x	x	x		Base	x		H	Water
	Onshore Transmission Lines	x	x	x	x		x	x	x		Base	x		H	Land
RESPONSE PLANNING AND INCIDENT SPECIFIC DATA															
Incident Information and Initial Planning															
	Initial Incident Briefing Information (ICS 201)	x	x	x	x	x	x	x	x		Incident		x	H	Both
	Wellhead Surface Location	x	x	x	x	x	x	x	x		Incident		x	H	Both
	All ICS Forms	x	x	x	x	x	x	x	x	x	Incident	x	x	H	
	Wreckage Details (Location)	x	x	x	x		x	x			Incident		x	H	
	Sensitive Sites	x	x	x	x		x	x	x		Base	x	x	H	Both

Data Group	Oil Spill Response COP Datasets	Oil Spill Response Units									Usage Summary				
		Incident Command	Situation Status	Planning	Tactical Operations	Air Operations	Public Information	Safety	Logistics	Finance	Category (Base/ Incident)	Pre-Populated prior to Incident	Generated/ Collected/ Updated during incident	Priority (High/Medium/ Low)	Land/ Water/ Both
	Pre-approved zones (Dispersants, Burning, etc.)										Base	x	x	H	Both
	Shoreline Response Strategies	x	x	x	x			x			Base	x	x	H	Land
Areas of Operations															
	Branch and Division Boundaries	x	x	x	x	x	x	x	x	x	Incident	x	x	H	Both
	Command Units (Branch, Division/Group, Task Force, Team)	x	x	x	x	x	x	x	x	x	Incident	x	x	H	Land
	Access Points	x	x	x	x			x	x		Incident		x	H	Land
	Base Locations	x	x	x	x	x	x	x	x	x	Incident	x	x	H	Land
	Staging Areas	x	x	x	x	x	x	x	x	x	Incident	x	x	H	Land
	Decontamination Sites	x	x	x	x		x	x	x		Base	x	x	H	Both
	Shoreline Divisions and SCAT segments for surveys	x	x	x	x	x	x	x	x		Incident	x	x	H	Land
Weather, Oceanography, and Natural Hazards															
	Real-time Data Feeds and Forecasts	x	x	x	x	x	x	x	x		Incident		x	H	Both
	Oceanographic Conditions	x	x	x	x	x		x	x		Incident		x	H	Water
	Buoys/Gliders	x	x	x	x			x			Incident		x	M	Water

Data Group	Oil Spill Response COP Datasets	Oil Spill Response Units									Usage Summary				
		Incident Command	**Situation Status**	**Planning**	**Tactical Operations**	**Air Operations**	**Public Information**	**Safety**	**Logistics**	**Finance**	**Category (Base/ Incident)**	**Pre-Populated prior to Incident**	**Generated/ Collected/ Updated during incident**	**Priority (High/Medium/ Low)**	**Land/ Water/ Both**
	Radar	x	x	x	x	x	x	x	x		Incident		x	M	Both
	Water Surface Temperatures	x	x	x	x	x	x	x			Incident		x	M	Water
	Current/Predicted Wave Heights	x	x	x	x	x	x	x			Incident		x	M	Water
	Current/Predicted Wind Velocities	x	x	x	x	x	x	x			Incident		x	M	Both
	Tides	x	x	x	x		x	x	x		Base		x	M	Water
	Water Levels	x	x	x	x		x	x	x		Incident		x	M	Water
	High Frequency (HF) Radar	x	x	x	x			x			Incident		x	M	Both
Natural Hazard Response Planning															
	Evacuation Routes	x	x	x	x		x	x	x		Base	x		H	Land
	Contra-Flow Routes	x	x	x	x		x	x	x		Base	x		H	Both
	Natural Hazards (Earthquakes, Tsunamis, Hurricanes Historical Information)	x	x	x	x	x	x	x	x	x	Base	x		L	Both
	Safe Haven Locations for Field Operations	x	x	x	x	x	x	x	x	x	Incident	x	x	H	Both
	Flood Control Maps	x	x	x	x		x	x	x		Base	x		H	Land
Tactical Operations															
	Boom Deployment and Retrieval	x	x	x	x	x	x	x	x		Incident		x	H	Both

Data Group	Oil Spill Response COP Datasets	Oil Spill Response Units									Usage Summary				
		Incident Command	Situation Status	Planning	Tactical Operations	Air Operations	Public Information	Safety	Logistics	Finance	Category (Base/ Incident)	Pre-Populated prior to Incident	Generated/ Collected/ Updated during incident	Priority (High/Medium/ Low)	Land/ Water/ Both
	Dispersant Applications (Aerial, Vessel, Vehicle, Sub-sea)	x	x	x	x	x	x	x	x		Incident		x	H	Both
	In-Situ Burning	x	x	x	x	x	x	x	x		Incident		x	H	Both
	Resource Tracking	x	x	x	x			x	x	x	Incident		x	H	Both
	Operations Cleanup (SCAT/STR)	x	x	x	x		x	x	x		Incident		x	H	Land
	Personnel Tracking	x	x	x	x			x	x	x	Incident		x	H	Both
	Waste Management		x	x	x			x	x	x	Incident		x	H	Land
	Execution Zones	x	x	x	x	x	x	x	x		Incident	x	x	H	Both
	Restricted Areas	x	x	x	x	x	x	x	x		Incident		x	H	Both
	Sorbent Materials	x	x	x	x			x	x		Incident		x	H	Both
	Skimming Operations	x	x	x	x	x	x	x	x		Incident		x	H	Water
	Fishery/ Hunting Closures	x	x	x	x		x	x	x		Incident		x	H	Both
	Beach Closures	x	x	x	x		x	x	x	x	Incident		x	H	Land
	Planned Operational Activities	x	x	x	x	x	x	x			Incident		x	H	Both
	Video Feeds	x	x	x	x		x	x	x	x	Incident		x	H	Both
	RSS Feeds	x	x	x	x		x	x	x		Incident		x	H	Both

		Oil Spill Response Units									Usage Summary				
Data Group	**Oil Spill Response COP Datasets**	**Incident Command**	**Situation Status**	**Planning**	**Tactical Operations**	**Air Operations**	**Public Information**	**Safety**	**Logistics**	**Finance**	**Category (Base/ Incident)**	**Pre-Populated prior to Incident**	**Generated/ Collected/ Updated during incident**	**Priority (High/Medium/ Low)**	**Land/ Water/ Both**
Over Flight Observations															
	Flight Path	x	x	x	x	x		x	x		Incident		x	H	Both
	Over Flight Photos	x	x	x	x	x	x	x			Incident		x	H	Both
Trajectories and Extents															
	Oiling Trajectory	x	x	x	x	x	x	x			Incident		x	H	Both
	Oiling Extent	x	x	x	x	x	x	x			Incident		x	H	Both
	Response Time Analysis	x	x	x	x	x	x	x			Incident		x	H	Both
	Shoreline Impact Analysis	x	x	x	x	x	x	x			Incident		x	H	Land
Wildlife Observations															
	Birds (Injured, Mortality, etc.)	x	x	x	x		x	x			Incident		x	H	Both
	Reptiles (Injured, Mortality, etc.)	x	x	x	x		x	x			Incident		x	H	Both
	Marine/Terrestrial Mammals (Injured, Mortality, etc.)	x	x	x	x	x	x	x			Incident		x	H	Both
	Nesting/ Breeding/ Spawning locations	x	x	x	x	x	x	x			Incident		x	H	Both
Damage Assessment Organization Information															
	Sample Stations	x	x	x	x			x	x		Incident		x	M	Both

Data Group	Oil Spill Response COP Datasets	Oil Spill Response Units									Usage Summary				
		Incident Command	Situation Status	Planning	Tactical Operations	Air Operations	Public Information	Safety	Logistics	Finance	Category (Base/ Incident)	Pre-Populated prior to Incident	Generated/ Collected/ Updated during incident	Priority (High/Medium/ Low)	Land/ Water/ Both
	Cumulative Oiling	x	x	x	x			x			Incident		x	H	Both
	Sediment Chemistry	x	x	x	x						Incident		x	M	Both
	Oil Chemistry	x	x	x	x						Incident		x	M	Both
	Tissue Chemistry	x	x	x	x						Incident		x	M	Both
	Water Chemistry	x	x	x	x						Incident		x	M	Water
	Seafood Sampling	x	x	x	x						Incident		x	M	Water
	General Environmental Quality (Baseline)	x	x	x	x						Incident	x	x	M	Both
	Best Management Practice Tracking										Incident		x	H	Both
Community Support															
	Administrative Centers	x	x	x	x		x	x	x	x	Incident	x	x	M	Land
	Claims Centers	x	x	x	x		x	x	x	x	Incident	x	x	M	Land
	Community Outreach Centers	x	x	x	x		x	x	x	x	Incident	x	x	M	Land
Restoration															
	Historical Restoration Projects (Coastal/Marine)	x	x	x	x		x			x	Base	x		L	Both
	Current Restoration Projects	x	x	x	x		x			x	Incident		x	M	Both

Annex B. Dataset Usage Summary

The dataset usage summary table shows the following for each dataset:

1. **Category** – Either base map or incident. Refers to when the data is generated.
2. **Dataset** – A general type of data e.g. streets, ESI, wildlife refuge.
3. **Dataset detailed** – Specific dataset names, often already existing somewhere, e.g. National Marine Fisheries Service regions.
4. **Category** – Whether it is basemap data or incident data - included twice to assist with sorting and categorization (B=basemap, I=incident).
5. **Priority** –The relative priority of the dataset (H=High, M=Medium, L=Low).
6. **Land/Sea/Both** –Whether the dataset is required for terrestrial incidents, marine incidents (specifically at sea), or both (L=land, S=sea, B=both).
7. **Lifecycle** – Lifecycle stage (P=plan, C=collect, U=use). These columns are used as follows:
    - **Plan** – Refers to the need to identify where the data is coming from. Ensure that a place has been created for it in a database, shapefile, etc., and a plan for collecting the data in a timely fashion exists.
    - **Collect** – Actually collect the data. For more volatile data, the collection effort is either more frequent or during the actual spill, as data collected during a drill will be stale by the time it is needed. If a column contains a “C,” a prior phase in the lifecycle should have a “P” (not always, but typically).
    - **Use** – The data is actually used during this phase.

Table 6 Dataset usage summary

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
Base Mapping			B	H						RFI
	Shoreline		B	H	B	C,U	U	U	U	RFI
	Streets		B	H	L	C,U	U	U	U	RFI
	Aerial photography		B	H	B	P,C,U	C,U	C,U,A	C,U,A	RFI
	Satellite images		B	H	B	P,C,U	C,U	C,U,A	C,U,A	RFI
	Peripheral facilities, structures, boundaries, etc.		B	M	B	C,U	U	U	U	MDA
	Admin Boundaries		B	M		C,U	U	U	U	RFI
	Geopolitical boundaries		B	H	B	C,U	U	U	U	RFI
	Gov't agency regions & offices		B	M	B	C,U	U	U	U	RFI
		Environmental Protection Agency Regions	B	M	B	C,U	U	U	U	ESRI
		Federal Emergency Management Agency Regions	B	M	B	C,U	U	U	U	ESRI
		National Park Service Regions	B	M	B	C,U	U	U	U	ESRI
		US Army Corps of Engineers Civil Districts	B	M	B	C,U	U	U	U	ESRI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		US Army Corps of Engineers Regulatory Districts	B	M	B	C,U	U	U	U	ESRI
		US Coast Guard Districts	B	M	S	C,U	U	U	U	ESRI
		US Fish and Wildlife Service Regions	B	M	B	C,U	U	U	U	ESRI
	Place names and references		B	H	B	C,U	U	U	U	RFI
	Marine jurisdictions		B	L	S	C,U	U	U	U	RFI
		12NM Territorial Sea	B	L	S	C,U	U	U	U	ESRI
		200NM EEZ and Maritime Boundaries	B	L	S	C,U	U	U	U	ESRI
		24NM Contiguous Zones	B	L	S	C,U	U	U	U	ESRI
		Active Oil and Gas Leases	B	L	B	C,U	U	U	U	ESRI
		Active Renewable Energy Leases	B	L	B	C,U	U	U	U	ESRI
		Atlantic Wildlife Survey Study Areas (2005-2012)	B	L	S	C,U	U	U	U	ESRI
		Atlantic Wildlife Survey Track lines (2005-2012)	B	L	S	C,U	U	U	U	ESRI
		BOEM Block Aliquots	B	L	S	C,U	U	U	U	ESRI
		BOEM Oil and Gas Planning Areas	B	L	S	C,U	U	U	U	ESRI
		BOEM Wind Planning Areas	B	L	S	C,U	U	U	U	ESRI
		COLREGS Demarcation Lines	B	L	S	C,U	U	U	U	ESRI
		Federal OCS	B	L	S	C,U	U	U	U	ESRI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Federal OCS Administrative Boundaries	B	L	S	C,U	U	U	U	ESRI
		Federal OCS Sand and Gravel Borrow Areas	B	L	B	C,U	U	U	U	ESRI
		Lease Blocks	B	L	B	C,U	U	U	U	ESRI
		Limit of OCSLA ‘8(g)’ zone	B	L		C,U	U	U	U	ESRI
		National Marine Fisheries Service Regions	B	L	S	C,U	U	U	U	ESRI
		OCS Oil and Gas Leasing Program 2012-2017	B	L	S	C,U	U	U	U	ESRI
		Outer Continental Shelf Lease Blocks	B	L	S	C,U	U	U	U	ESRI
		Outer Continental Shelf Protraction Diagrams	B	L	S	C,U	U	U	U	ESRI
		Unofficial OCS Boundaries	B	L	B	C,U	U	U	U	ESRI
		Unofficial State Lateral Boundaries	B	L	B	C,U	U	U	U	ESRI
	Bathymetry		B	H	S	C,U	U	U	U	RFI
	Hydrography		B	H	S	C,U	U	U	U	RFI
	Seabed Surveys		B	H	S	P	C,U	C,U	U	RFI
	Topography		B	H	L	C,U	U	U	U	RFI
	Imagery & Remote Sensing		B	H	B	P,C,U	C,U	C,U	C,U	RFI
	Natural Resources		B	H	B	C,U	U	U	U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
	Habitats		B	H	B	C,U	U	U	U	RFI
		Sediments	B	M	S	C,U	U	U	U	RFI
		Deep sea corals	B	M	S	C,U	U	U	U	RFI
		Benthic habitats	B	M	S	C,U	U	U	U	RFI
		Artificial reefs	B	M	S	C,U	U	U	U	RFI
		Cold-water coral habitats	B	M	S	C,U	U	U	U	RFI
	Managed Areas		B	M	B	C,U	U	U	U	RFI
	Critical Habitat		B	H	B	C,U	U	U	U	RFI
	Essential Fish Areas		B	H	B	C,U	U	U	U	RFI
	Environmental Sensitive Index (ESI)		B	H	B	P,C,U	C,U	C,U	U	RFI
		Bird habitat	B	M	B	C,U	U	U	U	RFI
		Breakwaters	B	M	B	C,U	U	U	U	RFI
		ESI Index	B	M	B	P	C,U	C,U	U	RFI
		Fish habitat	B	M	B	C,U	U	U	U	RFI
		Hydrological Classification	B	M	B	C,U	U	U	U	RFI
		Invertebrate Habitat	B	M	B	C,U	U	U	U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Management Areas	B	M	B	P,C,U	C,U	U	U	RFI
		Marine Mammal Habitat	B	M	B	C,U	U	U	U	RFI
		Reptile Habitat	B	M	B	C,U	U	U	U	RFI
		Socioeconomic	B	M	B	P,C,U	C,U	U	U	RFI
		Shoreline classification	B	H	B	P,C,U	C,U	U	U	RFI
		Terrestrial Mammal Habitat	B	M	B	C,U	U	U	U	RFI
		Vegetation	B	M	L	C,U	U	U	U	RFI
		Access - Vehicular access to the shoreline	B	H	B	P,C,U	C,U	U	U	ESRI
		Boat Ramp	B	M	B	C,U	U	U	U	ESRI
		Coast Guard	B	M		C,U	U	U	U	ESRI
		Critical Habitat	B	H	B	C,U	U	U	U	ESRI
		Equipment	B	H	B	C,U	U	U	U	ESRI
		ESI Socioeconomic	B	M	B	P,C,U	C,U	U	U	ESRI
		ESI/RSI Change	B	M	B	C,U	U	U	U	ESRI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Hazardous Waste Site	B	M	B	C,U	U	U	U	ESRI
		Hoist	B	H	B	C,U	U	U	U	ESRI
		Lock/Dam	B	M	B	C,U	U	U	U	ESRI
		Logging	B	M	B	C,U	U	U	U	ESRI
		Management Area - Managed areas (including nature conservancies)	B	M	B	C,U	U	U	U	ESRI
		Marine Sanctuary	B	M	B	C,U	U	U	U	ESRI
		National Park	B	M	B	C,U	U	U	U	ESRI
		NOAA Data Buoy	B	M	S	P,C,U	C,U	C,U	U	ESRI
		Wildlife Refuge	B	M	B	C,U	U	U	U	ESRI
		10E inundated low-lying tundra	B	M	B	C,U	U	U	U	ERM
	Navigation & Marine Infrastructure		B	H	B	C,U	U	U	U	RFI
		Ports	B	H	B	C,U	U	U	U	RFI
		Ferries	B	H	B	C,U	U	U	U	RFI
		Marinas	B	H	B	C,U	U	U	U	RFI
		Boat launches	B	H	B	C,U	U	U	U	RFI
		Aids to navigation	B	H	S	C,U	U	U	U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Maritime Collision Regulation Lines	B	L	S	C,U	U	U	U	RFI
		Anchorage Areas	B	M	S	C,U	U	U	U	RFI
		Shipping Lanes	B	M	S	C,U	U	U	U	RFI
		Precautionary Areas for Navigation	B	H	S	C,U	U	U	U	RFI
		Restricted Areas	B	M	B	C,U	U	U	U	RFI
		Dredge Disposal Areas	B	M	S	C,U	U	U	U	RFI
		Wrecks, debris and archaeology sites	B	H	S	P,C,U	C,U	C,U	U	RFI
		Historic and current vessel tracks	B	M	S	P,C,U	C,U	C,U	U	MDA
	Public Safety & Terrestrial Infrastructure		B	H	B	C,U	U	U	U	RFI
		Airports	B	H	L	C,U	U	U	U	ESRI
		First-aid	B	H	B	C,U	U	U	U	ESRI
		Helipad(s)	B	H	B	C,U	U	U	U	ESRI
		Parking	B	H	L	C,U	U	U	U	ESRI
		Water Stations	B	H	B	C,U	U	U	U	ESRI
	Critical infrastructure		B	H	B	C,U	U	U	U	RFI
		Hospitals	B	H	L	C,U	U	U	U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Police stations	B	H	L	C,U	U	U	U	RFI
		Water intakes	B	H	B	C,U	U	U	U	RFI
		Fire stations	B	H	L	C,U	U	U	U	RFI
	Power generation facilities		B	H	L	C,U	U	U	U	RFI
		Power lines and substations	B	H	L	C,U	U	U	U	RFI
	Transportation infrastructure		B	H	L	C,U	U	U	U	RFI
		Roads	B	H	L	C,U	U	U	U	RFI
		Bridges	B	H	L	C,U	U	U	U	RFI
		Railways	B	H	L	C,U	U	U	U	RFI
		Airports	B	H	L	C,U	U	U	U	RFI
	Oil and Gas Infrastructure		B	H	B	P,C,U	C,U	C,U	U	RFI
		Wells	B	H	B	P,C,U	C,U	C,U	U	RFI
		Pipelines	B	H	B	C,U	U	U	U	RFI
		Subsea facilities and flowlines/umbilicals	B	H	S	P,C,U	C,U	C,U	U	RFI
		Platforms, FPSO’s and drilling rigs	B	H	S	P,C,U	C,U	C,U	U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Onshore oil and Gas transmission lines	B	H	B	C,U	U	U	U	RFI
		Additional reservoirs in the area	B	H	B	C,U	U	U	U	MWCC
	Oil & Chemical Spills		B	M	B	P,C, U	C,U	C,U	U	RFI
		Sensitive sites	B	M	B	P,C, U	C,U	C,U	U	RFI
		Geographic response plans	B	M	B	P,C, U	C,U	U	U	RFI
		Shoreline response strategies	B	H	B	P,C, U	C,U	U	U	RFI
		Division and segments	B	H	B	P,C, U	C,U	U	U	RFI
	Restoration		B	L	B	P,C, U	C,U		U	RFI
	Weather, Oceanography & Natural Hazards		B	H	B	P,C, U	C,U		U	RFI
		Real-time data feeds and forecasts for weather	B	H	B	P,C, U	C,U		U	RFI
		Precipitation forecasts	B	H	B	P,C, U	C,U		U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Oceanographic conditions	B	H	S	P,C, U	C,U		U	RFI
		Natural hazards such as earthquakes, tsunamis, and hurricanes	B	H	B	P,C, U	C,U		U	RFI
		Buoys & Gliders	B	H	S	P,C, U	C,U		U	RFI
		Radar	B	H	B	P,C, U	C,U		U	RFI
		Sea surface temperature	B	H	S	P,C, U	C,U		U	RFI
		Current and predicted wave heights	B	H	S	P,C, U	C,U		U	RFI
		Current and predicted wind velocities	B	H	S	P,C, U	C,U		U	RFI
		Tides	B	H	B	P,C, U	C,U		U	RFI
		Water levels	B	H	B	P,C, U	C,U		U	RFI
		High frequency (HF) radar	B	H	B	P,C, U	C,U		U	RFI
		Weather Radar Impact Zones	B	H	B	P,C,	C,U		U	ESRI

Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	Lifecycle: 0 - Planning	Lifecycle: 1 - Deployment	Lifecycle: 2 - Containment	Lifecycle: 3 - Post Incident	Req. Source
						U				
		Weather Radar Stations (Federal)	B	H	L	P,C,U	C,U		U	ESRI
		In Water Sampling	B	M	S	P,C,U	C,U		U	ASA
		Air quality measurements and predictions	B	H	B	P,C,U	C,U		U	ASA
		Wind conditions	B	H	B	P,C,U	C,U		U	ASA
		Visibility	B	H	B	P,C,U	C,U		U	ASA
		Tsunami hazard maps	B	M	B	C,U	U	U	U	SINTEF
Drill & Incident Specific Information			I		B				U	RFI
	Abstract, Spill Summary & Reporting		I	H	B	P	C,U		U	RFI
		Incident Abstract	I	H	B	P	C,U		U	RFI
		Wellhead Surface Location (or alternate spill origin details)	I	H	B	P	C,U		U	RFI
		Wreckage Details	I	H	B	P	C,U		U	RFI
		Summary Reports & Findings	I	H	B	P	C,U		U	RFI
	Damage Assessment		I	H	B	p	C,U	C,U	U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Imagery and Remote Sensing	I	H	B	P	C,U		U	RFI
		Damage assessment organization data	I	H	B	P	C,U		U	RFI
		Over-flight Observations	I	H	B	P	C,U		U	RFI
		Trajectories & Extents	I	H	B	P	C,U		U	RFI
		Wildlife Observations	I	H	B	P	C,U		U	RFI
	Oil Spill Response Operations		I	H	B	P		C,U	U	RFI
		Areas of Operation	I	H	B	P	C,U		U	RFI
		Operations Implementation	I	H	B	P	C,U		U	RFI
	Boom Deployment & Retrieval		I	H	B	P	C,U	C,U	U	RFI
	Dispersant Applications		I	H	S	P	C,U	C,U	U	RFI
		Aerial Dispersant Applications	I	H	S	P	C,U		U	RFI
		Surface and Sub-surface Dispersant Applications	I	H	S	P	C,U		U	RFI
		Shoreline Applications	I	H	S	P	C,U		U	RFI
	Hesco Basket & Sand Bag Deployment		I	H	S	P	C,U		U	RFI
	In-Situ Burning		I	H	S	P	C,U		U	RFI
	Operations Equipment/Resource Tracking (including AIS)		I	H	B	P	C,U		U	RFI
	Operations Cleanup [SCAT/STR]		I	H	B	P	C,U		U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
	Personnel Tracking		I	H	B	P	C,U		U	RFI
	Restricted Areas		I	H	B	P	C,U		U	RFI
	Sorbent Materials		I	H	B	P	C,U		U	RFI
	Skimming Operations		I	H	S	P	C,U		U	RFI
	Oil Spill Extent		I	H	B	P	C,U		U	ESRI
	Oil Spill Trajectories		I	H	B	P	C,U		U	ESRI
	Over-flight pathways		I	H	B	P	C,U	C,U	U	ESRI
	Remote Operated Vehicle/Unmanned Aerial Vehicle		I	M	B	P	C,U	C,U	U	ESRI
	Strike Team/Task Force Assignments		I	H	B	P	C,U	C,U	U	ESRI
	Best Management Practices		I	H	B	P	C,U	C,U	U	ESRI
	Industrial Hygiene		I	M	B	P	C,U	C,U	U	ESRI
	SCAT Archeology		I	H	B	P	C,U		U	ESRI
	Response Sampling & Monitoring		I	M	B	P	C,U		U	RFI
		Conductivity, Temperature & Depth	I	M	S	P	C,U		U	RFI
		Dissolved Oxygen	I	M	S	P	C,U		U	RFI
		Fluorometer	I	M	S	P	C,U		U	RFI
		Sediment Sampling	I	M	B	P	C,U		U	RFI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Location information	I	M	B	P	C,U		U	RFI
		Seafood sampling	I	M	S	P	C,U		U	RFI
		Snare Sentinel monitoring & analysis	I	M	S	P	C,U		U	RFI
		Sorbent probe observations	I	M	S	P	C,U		U	RFI
		VIPERS analysis	I	M	S	P	C,U		U	RFI
		Water quality sampling	I	M	B	P	C,U		U	RFI
	Closures (Fisheries, etc.)		I	M	B	P	C,U		U	RFI
	Relief well information (status, plans)		I	H	B	P	C,U		U	MWCC
	Operator Services & Support		I	M	B	P	C,U		U	RFI
		Community Support	I	M	B	P	C,U		U	RFI
		Community Reports (Calls & Posts)	I	M	B		C,U		U	ESRI
	Model Outputs		I	H	B		C,U		U	
	Response Planning		B	M	B		C,U		U	ESRI
		Burn Exclusion Areas	B	M	S		C,U		U	ESRI
		Contractor/Vendor Locations (points)	B	M	B		C,U		U	ESRI
		Dangerous crossings (for capping stack move)	B	M			C,U		U	ESRI
		Dispersant Airports/Dispersant Pre-Approved Areas	B	H	S		C,U		U	ESRI

						Lifecycle				
Category	Dataset	Dataset Detailed	Category (Base/Incident)	Priority (H/M/L)	Land/Sea/Both	0 - Planning	1 - Deployment	2 - Containment	3 - Post Incident	Req. Source
		Preapproved Burn Areas	B	H	S		C,U		U	ESRI
		Resource Inventory	B	H	B		C,U		U	ESRI
		Tactical Contingency Plans / Shoreline Response Guides	B	H	B		C,U		U	ESRI
		Inventory of available satellite data	B	M	B		C,U		U	GeoCento
		Planned activities	B	H	B		C,U		U	MDA
	Severe Weather Response Plans		B	H	B		C,U		U	RFI
		Evacuation routes	B	H	B		C,U		U	RFI
		Contra-flow routes	B	H	B		C,U		U	RFI
		Flood control Maps	B	H	B		C,U		U	RFI
	Exclusion zones		B	M	B		C,U		U	RFI
	Beach closures		B	M	B		C,U		U	RFI