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DELTA STEWARDSHIP COUNCIL

SHORE-BASED BALLAST WATER TREATMENT IN CALIFORNIA

TASK 9: CURRENT BW DISCHARGE PRACTICES

PREPARED FOR

DELTA STEWARDSHIP COUNCIL
SACRAMENTO, CALIFORNIA

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Table of Contents

Revision History

Section	Rev	Description	Date	Approved
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References

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Executive Summary

The focus of this report, "Current Ballast Water Discharge Practices in California," considers the potential impact of shore-based ballast water management in California on vessels that have a need to discharge ballast water while underway.

Currently, all six vessel types considered in this study discharge ballast water while underway. Reasons for these discharges can be related to operational convenience, increased efficiency, vessel trim, stability, or hull stress management, or other safety purposes. However, based on the data analysis methods described in this report, the number of vessels conducting underway discharges in California appears to be few. In addition, though exact circumstances cannot be predicted, it appears that most or perhaps even all of these discharges are elective in nature, i.e. with prudent planning these vessels could either avoid discharging, discharge outside the 24-nautical-mile boundary of the US Contiguous Zone, or discharge in port.

This report proposes that underway discharges be planned in advance to the extent practicable, and, whenever they cannot be conducted outside the 24-nautical-mile boundary of the US Contiguous Zone, conducted in port at designated anchorages. This would effectively eliminate underway discharges in all but rare emergency situations.

It should be noted that planning and conducting ballasting operations at specified locations may result in unintended or undesirable outcomes. These outcomes may include vessels sailing in a less-than-optimal loading condition during transits from offshore waters to port (or vice versa), or vessel schedule delays associated with conducting ballasting operations in port that had previously been conducted while underway.

The system proposed herein will not prevent those few discharges that must be conducted immediately for the safety of the vessel and crew. In these instances, the capabilities of the vessels' onboard BWMS must be deemed sufficient. However, considering the apparent infrequency of underway discharges in California, and the ability to foresee and plan for the majority of these instances, the implementation of a shore-based ballast water management system utilizing treatment barges is well-suited to assist in minimizing or eliminating these discharges in California waters.

Introduction

This report is part of an overall coordinated study evaluating the feasibility of using shore-based mobile or permanent ballast water treatment facilities to meet California's Interim Ballast Water Discharge Performance Standards (CA Interim Standards). This report is presented to the Delta Stewardship Council to meet the objectives of Task 9 – Assessment of current practices related to ballast water discharges in California. Description of the overall study can be found in Appendix A, along with definitions for terms used in this study.

This report (Task 9) assesses current ballast water discharge practices from marine vessels in California, with focused discussion on vessels that need to discharge ballast while underway in California waters, rather than in port, and effective methods for minimizing or eliminating such discharges in state waters.

Current Underway Discharge Practices in California

Introduction

This report describes the current underway discharge practices of vessels calling ports in the State of California. Current practices are described using data obtained from the NBIC and information obtained during informal interviews with vessel owners and operators, vessel masters, local marine pilots, and vessel agents.

A vessel may discharge ballast water at any point during a voyage. When not conducted at berth, at anchor, or at a designated lightering area, a ballast water discharge may broadly be considered an "underway discharge." Primary reasons for discharging ballast water while underway include ballast water management (i.e. mid-ocean exchange), managing vessel stability and trim, and mitigating stresses imposed on the vessel's hull/structure. To meet the goal of preventing the introduction of aquatic invasive species and harmful pathogens into California waters, this Task Report investigates effective methods capable of minimizing or eliminating underway discharges. As implied by the 25 July 2012 US Supreme Court decision in *PMSA v. Goldstene*, individual states, California in particular, have the power to enact "conditions of entry" relative to shipping activities outside their territories, to the outer limit of the 24-nautical-mile US Contiguous Zone (Reference 10).

Although the NBIC data available for analysis does not specify whether a discharge was conducted while underway (or not), it does provide the reported location where a discharge occurred. For the purposes of this report, an underway discharge is defined as a ballast water discharge that occurs in any location within the US Contiguous Zone (24 nm offshore) other than at berth, at anchor, or in designated lightering areas in California waters. Ballast water discharges that occur outside of the US Contiguous Zone are not considered in this study.

Underway Discharges

Ballast water discharges are the elimination of water from ballast tanks, for purposes related to managing the draft, trim, and stability of a vessel, and to mitigate hull stresses imposed by its loading condition. Underway discharges can be classified as either "elective" or "non-elective."

A **non-elective** underway discharge can be described as one that must be conducted for the safe operation or navigation of the vessel, the timing of which the crew has limited ability to control (i.e. the discharge cannot practically be deferred or conducted in advance of an event or a specific portion of the voyage).

An **elective** underway discharge is one that is either:

A. Conducted for convenience (e.g. to reduce crew workload), to maintain or minimize impact to vessel schedule integrity, to minimize impact to marine terminal or shoreside facility operations, or to realize certain operating efficiencies;

B. Conducted to trim the vessel for routine cleaning, maintenance, or other operational purposes not critical for vessel safety;

C. Conducted for the safe operation or navigation of the vessel, but the crew has some discretion in the timing of the discharge (i.e. the discharge can be deferred or conducted in advance of an event or specific portion of the voyage without compromising vessel safety).

Elective and non-elective discharges are discussed in more detail in the following sections.

Elective Underway Discharges

For any portion of a voyage exposed to ocean swell and/or seas, vessels must be in an allowable seagoing loading condition (hereafter, sea condition), in accordance with parameters established by their vessel-specific trim and stability booklets and/or cargo loading manuals. These parameters include, but are not limited to:

- Minimum stability requirements.
- Minimum and maximum safe operating drafts.
- Maximum allowable longitudinal bending moment, torsion moment, and shearing forces.

For outbound vessels, an allowable sea condition is typically achieved dockside, through a combination of prudent cargo stowage planning and ballasting operations. On occasion, a vessel may depart her berth in an allowable but less-than-optimal loading condition, generally to maximize under-keel clearance (UKC) while in port, or to minimize time at berth. Once underway, ballasting operations may be conducted to:

- Minimize longitudinal bending forces and other stresses on the vessel's hull/structure.
- Optimize vessel draft and trim.
- Optimize or improve vessel motions.
- Optimize engine load or reduce fuel consumption (i.e. power management).
- Trim the vessel for operational purposes (e.g. cargo hold/tank cleaning).

These are considered elective discharges because it is feasible for them to be conducted dockside or at anchor prior to departure, or, alternatively, while underway, *after* the vessel has passed beyond the 24-nautical-mile boundary of the US Contiguous Zone.

Similarly, inbound vessels may electively discharge ballast while underway for the following purposes:

- To reduce draft and increase UKC for arrival/transiting in port.
- To trim the vessel for operational purposes.
- To reduce crew workload on arrival.
- To lighten the vessel in preparation for cargo operations and thereby reduce time at berth - either for schedule integrity, or to minimize impact to marine terminal or shoreside facility operations.

The latter is fairly common practice among tank vessels and dry bulk carriers arriving in an "in ballast" condition (no cargo aboard), or with a partial load. By discharging ballast in advance of arrival in port, the subject vessel can sometimes proceed directly to berth, and thereby avoid having to sit at anchor. In certain cases, generally for loading of grain or other dry-bulk cargoes, this is a matter of "cargo readiness," and is necessary to establish priority in terminal berthing queues; and, in virtually all cases, this practice ensures that cargo loading can begin immediately after the vessel is berthed, and proceed at the maximum rate achievable or allowable by the terminal. Figure 1 shows a dry bulk carrier discharging ballast while underway.

Figure 1 A dry bulk carrier discharging ballast while underway, in preparation for cargo operations (image from http://maritime-connector.com/)

For both inbound *and* outbound vessels, the ballasting operations described above are operational decisions for convenience and/or efficiency, and do not necessarily have to be conducted while the vessel is operating between 0 and 24 nautical miles offshore. These discharges can instead be conducted dockside, at anchor, or beyond the boundary of the US Contiguous Zone without compromising vessel safety.

Some underway discharges are necessary for the safe operation or navigation of the vessel, but, for the purposes of this study, are considered elective because the crew has some discretion as to when these ballasting operations are conducted. Examples include:

- Adjusting vessel trim to compensate for fuel consumption.
- Maintaining longitudinal bending and shear forces within allowable limits as fuel is consumed.
- Ballasting (proactively) for expected rough sea conditions:
    - To minimize stresses on the vessel's hull/structure for added margin of safety.
    - To prevent vessel motions that could put the safety of the vessel, crew, or cargoes at risk.
    - To prevent or minimize bow slamming and boarding seas.
    - To maintain propeller immersion.

Because fuel is consumed gradually over the course of an ocean voyage, ships' crews can easily anticipate the need to ballast or deballast to compensate for reduced fuel weight. Similarly, with access to today's sophisticated predictive models and active weather routing services, ships' crews can anticipate the timing and severity of foul weather events with considerable accuracy, generally days in advance. Therefore, it is reasonable to assume that ballasting for these purposes, when necessary, can also be conducted in advance, either in port or outside the US Contiguous Zone.

On rare occasions, vessels may find themselves in rapidly deteriorating metocean conditions that, depending on many variables, could require the immediate uptake or (less likely) discharge of ballast water to ensure the continued safety of the vessel, crew, or cargoes onboard. Such an event would constitute a non-elective "emergency discharge," discussed in more detail in the following section.

Non-elective Underway Discharges

Non-elective underway discharges are those that are essential for the continued safe operation or navigation of the vessel, the timing of which the crew has limited ability to control. For example, at some point during a voyage, a vessel may need to discharge ballast to reduce its draft so that it can safely transit over a shoal, navigate a shallow channel, or dock at a berth with a draft restriction. Deballasting for these purposes while offshore may not be feasible, given that ships are required to maintain a safe and stable condition for the environment they are in. Once the vessel passes into protected waters, where a "harbor condition" is generally allowable (i.e. an increase in permissible hull stresses), the vessel may eventually reach a point where it cannot continue without discharging due to insufficient UKC. This constitutes a non-elective discharge.

In California, such instances are limited almost exclusively to areas within protected bays and waterways (e.g. Humboldt Bay, San Francisco Bay, San Pedro Bay, San Diego Bay), as approaches from sea are maintained at controlling depths ranging from 36 to 83 feet, and impose few restrictions on vessel arrivals.

Another example of a non-elective underway discharge is when a vessel must *take on* ballast water to temporarily increase draft (thereby reducing air draft) for transiting beneath bridges, power lines, or other obstructions of relatively low clearance height. Once clear of the obstruction, the vessel, on occasion, must then discharge ballast to continue transiting with sufficient UKC. Such instances are rare and, in California, are also limited to areas within protected bays and waterways.

Other non-elective underway discharges are limited to emergency discharges. An emergency underway discharge is defined as one that must be initiated immediately to manage an imminent threat to the safety of the vessel and the lives onboard. Situations where emergency ballasting operations may be necessary while underway may include:

- Ballasting to cope with unanticipated severe weather events, in order to:
    - Minimize stresses on the vessel's hull/structure.
    - Improve vessel stability (e.g. increase or decrease metacentric height [GM_T]).
    - Reduce or improve vessel motions that put the safety of the vessel, crew, or cargoes at risk.
    - Minimize bow slamming and boarding seas.
    - Maintain propeller immersion.
    - Reduce the effects of set and drift by reducing freeboard and increasing draft (i.e. maintain steerage).
- To refloat a vessel in the event of a grounding.
- To correct a severe list incurred as a result of flooding or shifting of cargo while underway.

Such emergency discharges are extremely rare events and do not occur during normal vessel operations. Moreover, with the exception of deballasting to refloat a vessel after a grounding, the scenarios listed above would generally call for taking ballast onboard, rather than discharging.

Data Analysis

Underway discharges within the US Contiguous Zone were extracted from NBIC data for a five-year period from 2011-2015. This study defined an underway discharge event as one indicating a discharge amount >0 and a location recorded in the NBIC database as geographic coordinates (latitude and longitude), rather than the name of one of California's seaports or designated anchorage/lightering areas. It should be noted that, while the NBIC data includes all ballast water activity for vessels arriving at ports in California, it does not include ballast water activity for vessels departing California's ports for locations in other states or countries.

Figure 2 shows underway discharges reported by vessels arriving at ports in California during the period 2011-2015.

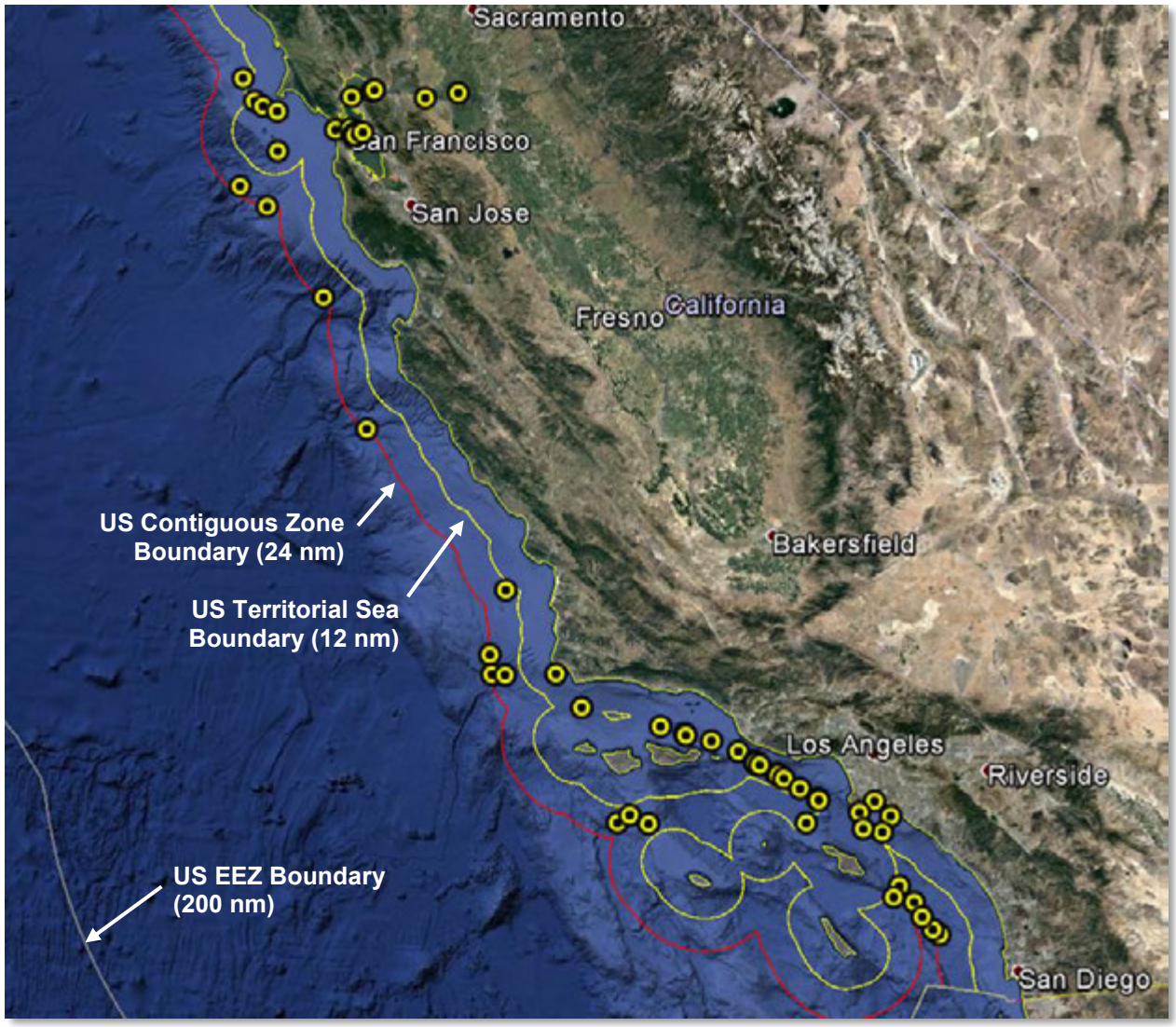

Figure 2 Underway discharges within US Contiguous Zone by vessels arriving at ports in California (NBIC, 2011-2015)

There are 53 individual underway ballast water discharge events attributable to 32 unique vessels shown in in Figure 2. The average discharge volume associated with these events is 700 MT. All 53 discharge events are less than 3,000 MT each. Discharge events and volumes per vessel type are indicated in Table 1.

Table 1 Underway discharges within US Contiguous Zone by vessel types arriving at ports in California (NBIC, 2011-2015)

Type	Count	Volume (MT)
Tanker	9	12531
Container	8	13490
Bulker	5	8670
Other	5	333
General Cargo	2	2288
Passenger	2	323
Combo	1	161

Some of the underway discharge events are multiple discharges by a single vessel on a single voyage. One such example is highlighted in in Figure 3, in the traffic separation scheme in Santa Barbara Channel. In this case, ballast water from different tanks is discharged as the vessel is steaming – each reported as a discrete discharge event.

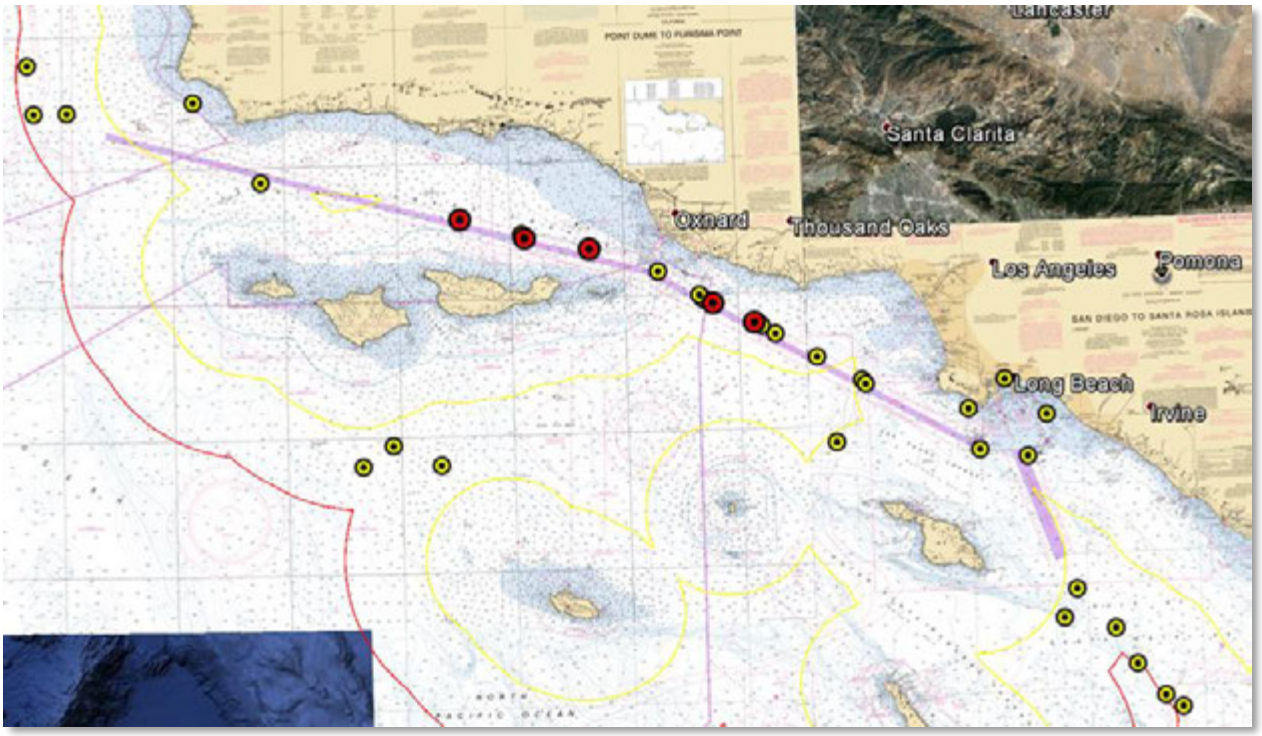

Figure 3 Underway discharges in the traffic separation scheme in Santa Barbara Channel (NBIC, 2011-2015), red dots denote discharges from the same vessel on the same voyage

There is no information in the NBIC database that clearly indicates whether an underway ballast water discharge is elective or non-elective. Therefore, for the purposes of this study, the following characterization of underway ballast water discharges is assumed:

- **Underway discharges that occur outside of California's protected bays and waterways, between 0 and 24 nautical miles offshore, are considered to be elective underway discharges**.

  Vessels operating in this area must be in an allowable seagoing condition in accordance with their ship-specific trim and stability booklet and/or loading manuals, or they risk

violation of port and/or flag-state rules as well as classification society and insurance company requirements. Therefore, it can be inferred that these vessels are in a safe operating condition.

Considering the time required to transit the short distance between 0 and 24 nautical miles offshore (~1.5-3.0 hours) any discharge of ballast for the continued safe operation or navigation of the vessel (e.g. to compensate for fuel consumption) can be carried out outside this area – either further offshore, or in port.

With the extremely rare exception of emergency deballasting, there is no practical explanation for non-elective underway discharges in this area.

- **Underway discharges that occur within California's protected bays and waterways are considered to be non-elective underway discharges**.

  Due to the limited information provided on NBIC reporting forms, it is not possible to determine from the data what percentage of underway discharges occurring within California's protected bays and waterways are truly non-elective. However, for purposes of conservatism, it is assumed that all are non-elective. Given the relative infrequency of these discharges, 17 (statewide) over a five-year period, even a significant margin of error in this assumption does not affect the study findings and recommendations relative to:

  - Methods for minimizing or eliminating such discharges into California waters.
  - Practical solutions to capture these discharges with barges, other marine vessels, or onboard mobile kits.
  - Operational considerations.

Underway Discharges within Zone Boundaries

Underway discharges that occurred within the zone boundaries defined in Reference 1 are shown in Figure 4 and Figure 5. Because the zone boundaries lie within California's protected bays and waterways, the discharges shown are assumed to be non-elective. Exceptions to this are the offshore satellite areas of Zone 5, namely Pacific Area Lightering (PAL). Though clearly located outside California's protected bays and waterways, PAL is a designated lightering area. Discharges reported within the boundaries of PAL showing geographic coordinates as the discharge location are believed to be the result of inconsistencies in reporting, rather than actual underway discharges, and are therefore not included in the statewide totals (Table 2).

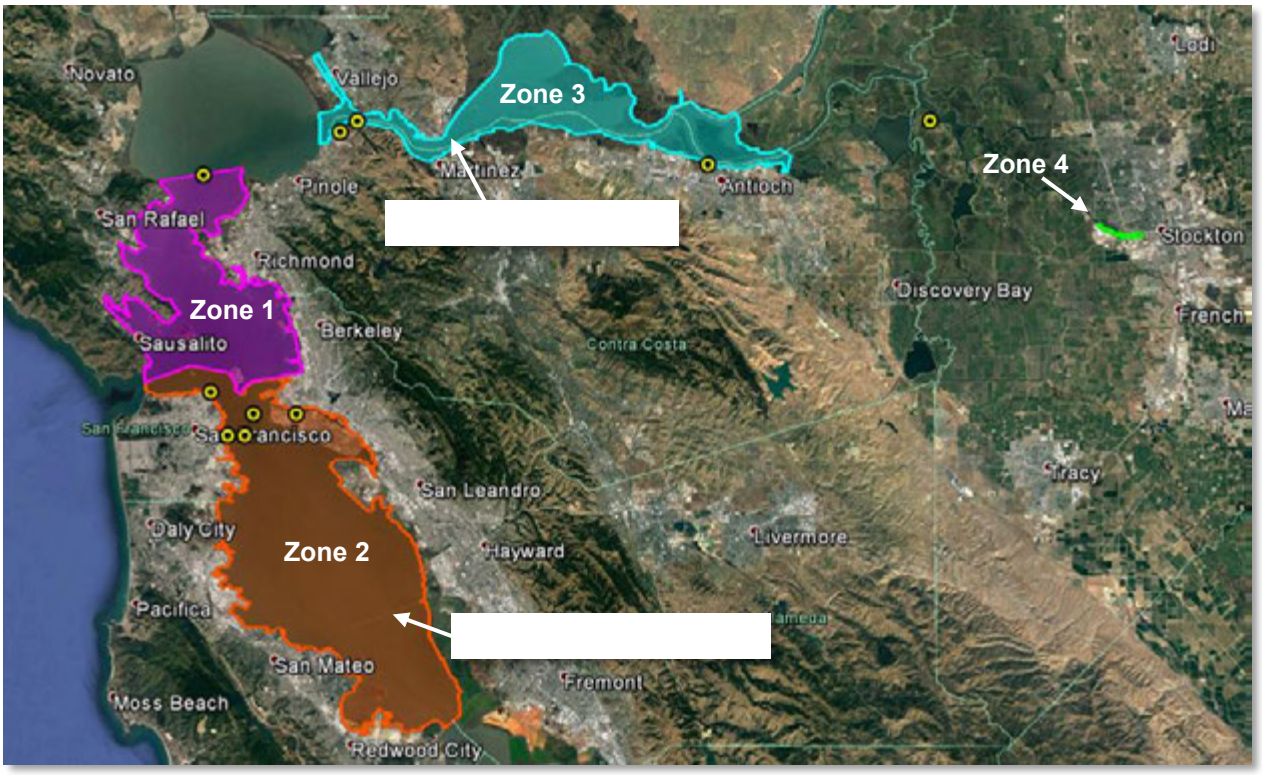

Figure 4 Underway discharges in Zones 1, 2, 3, and 4 (NBIC 2011-2015)

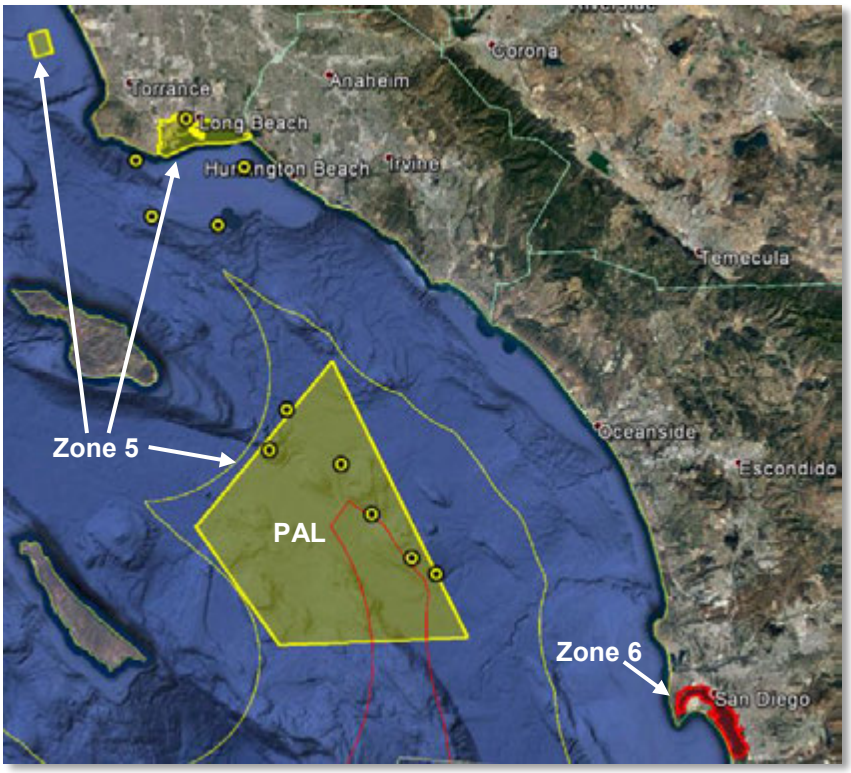

Figure 5 Underway discharges in Zones 5 and 6 (NBIC, 2011-2015)

Table 2 Number of non-elective underway discharges in California by Zone (2011-2015)

Zone Designation	Service Area	Non-elective Underway Discharges
Zone 1	San Francisco Bay (North Part) and Humboldt Bay	1
Zone 2	San Francisco Bay (South Part) and Monterey Bay	5
Zone 3	Carquinez Strait and Suisan Bay	4
Zone 4	Stockton	0
Zone 5	Los Angeles/Long Beach and Vicinity	1
Zone 6	San Diego	0
TOTAL		**11**

Anecdotal Information

The infrequent occurrence of underway discharges in the NBIC data is supported by accounts from vessel owners and operators, vessel agents, and marine pilots intimately familiar with vessel movements in California, specifically: Matson Navigation Company, Alaska Tanker Company, Transmarine Navigation Corporation, and San Francisco Bar Pilots. In informal surveys carried out by email and phone correspondence, these groups report that underway ballasting within California's protected bays and waterways is rare, but most often related to vessels *taking on* ballast to temporarily reduce freeboard or air draft (References 4, 5, 8). This is done to avoid interferences with shiploaders or other material handling systems while moored alongside marine terminals, or to allow passage under bridges with low clearance heights, generally either the San Mateo-Hayward Bridge or the Union Pacific Railroad (Benicia-Martinez) Bridge in the San Francisco Bay Area (see Figure 6). Reportedly, the latter (ballasting for clearance under bridges) is sometimes done only to avoid delays associated with waiting for the height of tide to reduce enough to allow safe passage. Once the vessel is clear of the bridge or other obstruction, the ballast water that was taken onboard is then sometimes discharged to achieve adequate UKC for the remainder of the voyage. Vessel agents and marine pilots questioned by the project team had no documentation or data on such instances, and could recall none more recent than 2012.

Figure 6 Tank vessel New Horizon passing under the Union Pacific Railroad (Benicia-Martinez) Bridge in Carquinez Strait (image from *www.liveleak.com/view?i=38f_1501058706*)

The subjects also relayed, from experience, that vessels discharging ballast after clearing the San Mateo and Benicia-Martinez bridges are most often bound for Redwood City, or up the Sacramento River (respectively) where controlling depths are reduced. Transits from Richmond/San Francisco to Redwood City require passage of San Bruno shoal/channel in the

southern part of San Francisco Bay, followed by the San Mateo-Hayward Bridge and Redwood Creek, which has a controlling depth of 28 feet at mean lower low water (MLLW). Transits from Richmond/San Francisco to Sacramento require passage of Pinole Shoal/Channel in San Pablo Bay, followed by the Benicia-Martinez Bridge, Suisan Bay, and the Sacramento River Deep Water Ship Channel, which has a controlling depth of 25 feet at MLLW. Figure 7 shows a vessel transiting the Sacramento River Deep Water Ship Channel in a light draft condition.

Figure 7 Vessel *Sanko Jupiter* transiting the Sacramento River Deep Water Ship Channel (image from *www.flickr.com/photos/scupper/sets/72157600263062196/*)

Methods of Minimizing/Eliminating Underway Discharges

Elective underway discharges, as previously discussed, are those that can be avoided, conducted in waters outside the 24-nautical-mile boundary of the US Contiguous Zone, or conducted in port (within California's protected bays in waterways), without increasing risks to vessel safety, human lives, or the environment. Non-elective discharges for navigational purposes – principally to reduce draft in advance of terminal arrival – can also take place in port without compromising safety.

Emergency deballasting is the only form of non-elective underway discharge that cannot necessarily be avoided, conducted outside the 24-nautical-mile boundary of the US Contiguous Zone, or deferred until arrival in port. The expected frequency of such events cannot be determined from the data available, but is estimated at <1 per year in waters between 0 and 24 nautical miles offshore. In such emergencies, the subject vessel would likely be unable to treat discharged ballast water to the CA Interim Standards, but, presumably, would be capable of treating to the IMO standard with its shipboard BWMS. In the face of an imminent threat to the safety of a vessel and the lives onboard, the risk to coastal ecosystems associated with this less-stringent standard of treatment may have to be accepted.

For both non-elective discharges related to normal vessel operations, and any elective discharges conducted in port, the practice of discharging ballast into coastal waters while a vessel is making way can be eliminated by conducting these operations at anchor within California's protected bays and/or waterways, where oceangoing vessels can be serviced by shore-based ballast water treatment barges (treatment barge), as described in Reference 1.

For non-elective discharges related to normal vessel operations, the data suggest that the expected frequency may be as low as two events per year statewide. For elective discharges, assuming 100% of vessels opt to discharge in port rather than in international waters beyond the 24-nautical-mile boundary of the US Contiguous Zone, the data suggest that the expected frequency may be as low as 11 per year statewide.

Potential impacts of these operations on vessel schedules, terminal/facility operations, and port congestion are discussed in the following section.

Deep Water Service Stations

This section serves to introduce the concept of a Deep Water Service Station (DWSS) as a means of minimizing or eliminating underway discharges in California waters.

A DWSS is essentially a designated anchorage area for the capture and treatment of ships' ballast water at anchor by way of treatment barge. For vessels needing to discharge ballast in port, but not at berth, DWSS would provide a safe deep-water location for this purpose, within the operating radius of local treatment barges. Instead of discharging while underway as they do now, vessels needing to discharge in port would go to anchor to deballast, either prior to transiting inland waterways, or on departure, before going to sea, as circumstances require.

Ballast water capture and treatment operations at a DWSS would be virtually equivalent to bunkering operations at anchor, as shown in Figure 8. Barges would be dispatched to vessels at pre-arranged times, and secured alongside in the same manner as for vessels at berth. The processes for connection, capture, and treatment of ballast would also be the same.

If implemented for each zone, DWSS would provide a suitable and practical means of eliminating current underway discharge practices in California, both for inbound and outbound vessels. The few vessels requiring this practice would experience schedule impacts, but the system would not cause disruptions to normal operations at marine terminals, or appreciably contribute to marine traffic in port or other port congestion issues.

Figure 8 Open-hatch gantry ship, *Star Florida* engaged in bunkering operations in Vancouver Harbor, British Columbia.

Implementation

In order to implement this system, one or more strategically located DWSS would need to be identified for each zone, as well as for all satellite areas. These could take the form of either a swing circle, as shown in Figure 9, or a large general anchorage area, as shown in Figure 10. No infrastructure would be required to establish DWSS.

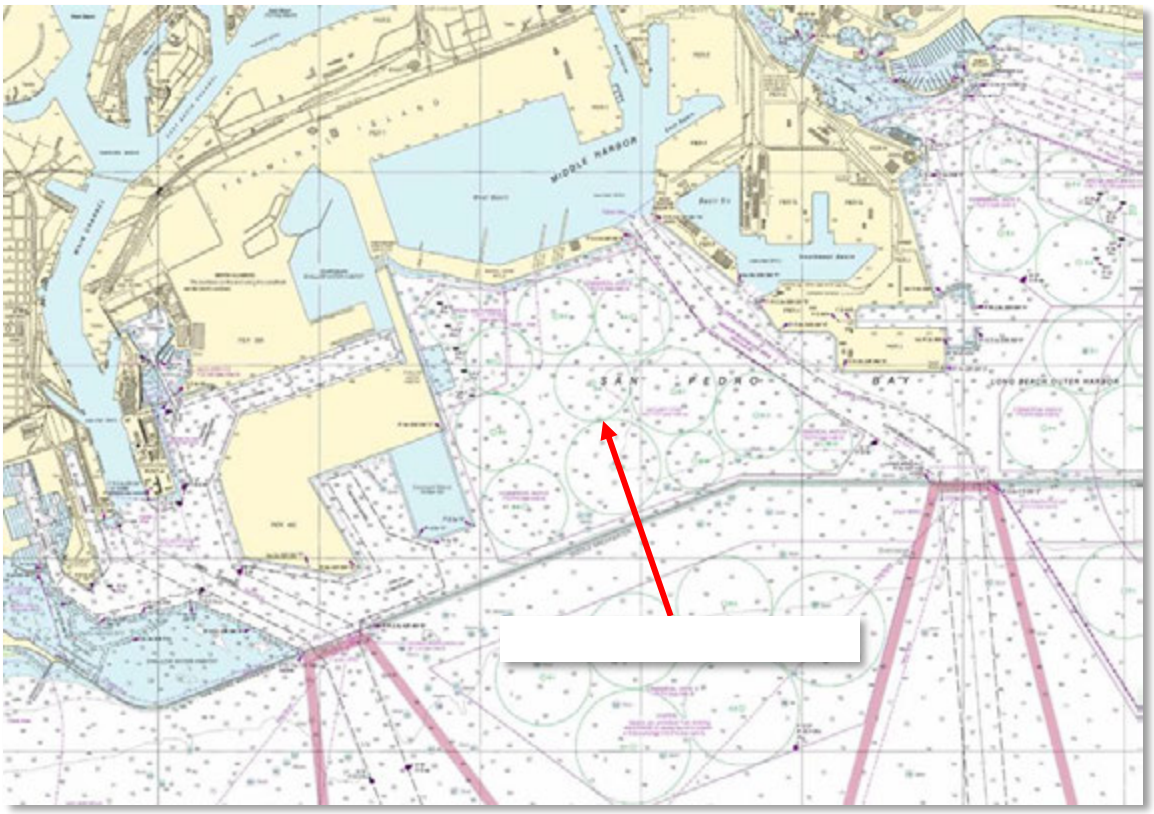

Figure 9 Capture from NOAA Nautical Chart No. 18749, "San Pedro Bay," showing Commercial Anchorages B through F

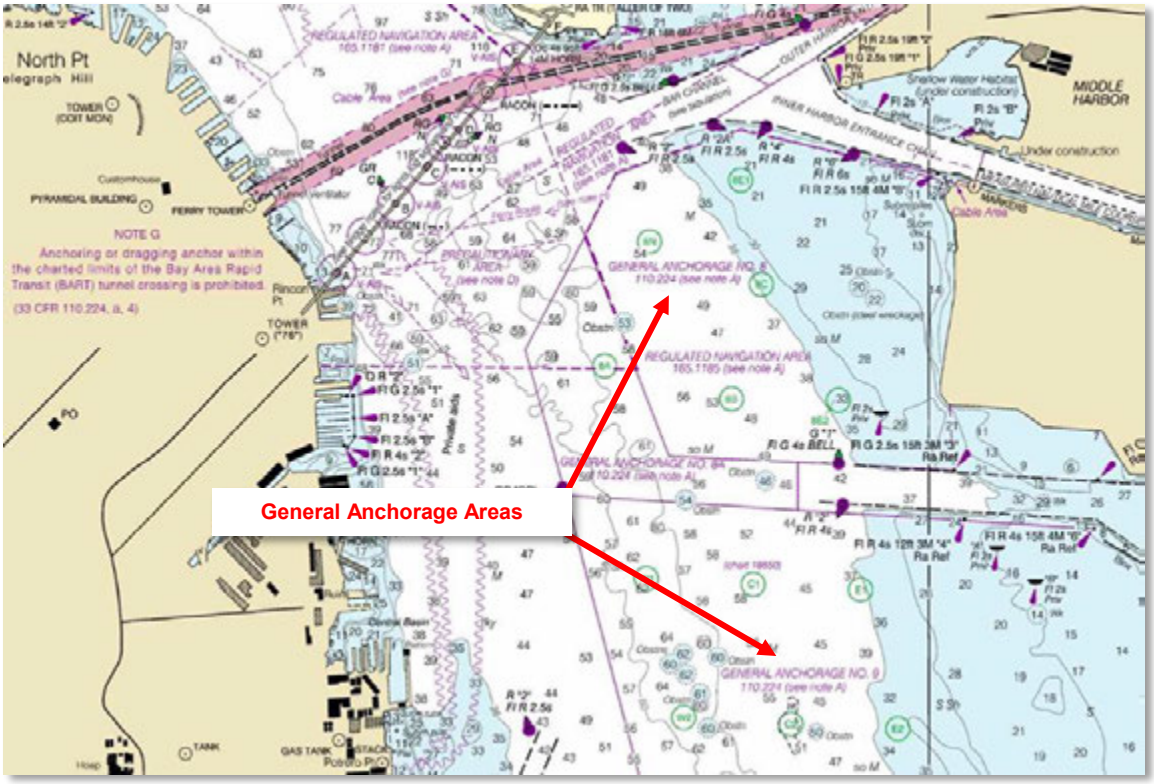

Figure 10 Capture from NOAA Nautical Chart No. 18649, "Entrance to San Francisco Bay," showing General Anchorage Areas No. 8 and 9

DWSS may be anchorages dedicated to ballast water capture and discharge operations exclusively, or multi-purpose commercial anchorages. The designation and location of DWSS would likely be led by local USCG Sectors (Captain of the Port Zones), with input from multiple federal and state agencies, as well as port authorities, pilotage associations, and vessel owners/operators.

For zones and/or satellite areas with significant physical constraints – potentially Zone 3 (Carquinez Strait and Suisan Bay), Zone 4 (Stockton), and Zone 5 satellite area, Port Hueneme – lay berths may need to be identified in place of DWSS.

For the reservation and use of a DWSS, vessels would make prior arrangements with the local port authority or marine exchange. Additionally, for international voyages, the vessel would be required to duly inform US Customs and Border Protection (CBP) of their intention to conduct ballast water capture and treatment operations either prior to entry, or after clearance. For inbound vessels, this request would most likely be made on CBP Form 3171 – "Application-Permit-Special-License-Unlading-Lading-Overtime Services" (see Appendix A). For outbound vessels, the request would be made on CBP Form 1300 – "Vessel Entrance or Clearance Statement" (see Appendix A). Once authorized, the vessel would contact the treatment barge operator to arrange treatment barge services upon arrival at the DWSS. All such arrangements would ordinarily be handled by the vessel agent, in communication with the Master or Chief Officer onboard the vessel, as well as port captains and vessel planners ashore.

Inbound Vessels

As discussed in previous sections, inbound vessels may need to discharge ballast once inside protected waters, before transiting inland bays or waterways, or prior to terminal arrival. In such cases, after making all necessary arrangements, an inbound vessel would pick up the marine pilot as it would normally, transit from the pilot station to the appropriate DWSS and set anchor(s). Once secure at anchor, the pilot would disembark by launch service. For international voyages, if the vessel is to spend less than 48 hours at anchor prior to entry, CBP would generally defer boarding the vessel for US immigration purposes (i.e. passport control) until it arrives at berth. In this case, the ship's crew would be free to coordinate with the treatment barge operator to bring the barge immediately alongside. After the barge is correctly spotted and secured, ballast water capture and treatment operations would proceed in analogous fashion to ship bunkering operations. Upon completion, the treatment barge would be disconnected and dismissed. A marine pilot would be dispatched, arrive to the vessel by launch service, and pilot the vessel from the DWSS to its next berth.

Outbound Vessels

As discussed in previous sections, outbound vessels may wish to depart from a berth or terminal in a sub-optimal loading condition and discharge ballast prior to calling another berth or transiting offshore. For international voyages, if the vessel is to spend less than 48 hours at anchor prior to departure for sea, CBP would generally clear the vessel while dockside, prior to shifting to the DWSS. After making all other necessary arrangements, the vessel would then depart its berth with a marine pilot onboard, transit the required distance to the appropriate DWSS, and set anchor(s). Once secure at anchor, the pilot would disembark by launch service and the ship's crew would coordinate with the treatment barge operator to bring the barge alongside. After the barge is correctly spotted and secured, ballast water capture and treatment operations would proceed in analogous fashion to ship bunkering operations. Upon completion, the treatment barge would be disconnected and dismissed. A marine pilot would be dispatched, arrive to the vessel by launch service, and pilot the vessel from the DWSS to the pilot station.

Operational Considerations

A mandatory no discharge rule (ballast water) in the offshore waters of California between 0 and 24 nautical miles, in combination with implementation of DWSS for each zone, as described above, would likely result in schedule impacts for a small percentage of calling vessels (mainly bulk carriers and tank vessels), but have little effect on port and marine terminal operations.

Vessel Schedule Impacts

For any inbound or outbound vessels unable to discharge ballast outside 24 nautical miles, the need to conduct ballast water capture and treatment operations at a DWSS (rather than discharging while underway) would likely introduce schedule delays. It is estimated that these delays could range from as few as 4 hours to 24 hours or more, depending on the volume of ballast water to be discharged and several other factors, including but not limited to:

- CBP authorization and potential entry/clearance processes at anchor.
- DWSS availability.
- Treatment barge availability.
- Marine pilot availability.
- Launch vessel availability.
- Metocean conditions.
- Marine traffic conditions.

That noted, it is expected that such delays would be limited almost exclusively to highly ballast-dependent vessels such as bulk carriers and tank vessels, which are often urged or incentivized to minimize "idle" time at berth (to minimize berth congestion or impacts to shoreside facility/refinery operations). However, based on estimates from the available NBIC data on underway discharges, there are about 11 elective and non-elective discharges per year on average (statewide), indicating that very few individual vessels would be affected. If it is assumed that 50% of these vessels can opt to discharge outside 24 nautical miles instead of in port, the number of affected vessels is reduced to less than 6 per year on average.

Impacts to Port and Marine Terminal Operations

Because the DWSS provide a means for vessels to conduct ballasting operations away from the berth, it is expected that a mandatory no discharge rule (ballast water) in the offshore waters of California, between 0 and 24 nautical miles, would have no significant impact on marine terminal operations, except perhaps to delay the arrival of a very small percentage of calling vessels under certain circumstances. Vessels would generally be able to arrive and depart in the same manner and similar frequency as they do currently.

Port operations would also be minimally affected, given how infrequently the DWSS would be utilized for ballast water capture and treatment operations. Anchorages within individual port districts might experience a slight increase in vessel activity over the course of a year (likely for some ports more than others); but, as the data suggest, these increases would be so small as to be scarcely noticeable. Therefore, a mandatory no discharge rule between 0 and 24 nautical miles would likely not:

- Have a noticeable effect on vessel traffic density in port.
- Limit the use of commercial anchorages by other vessels not engaged in ballast water capture and treatment operations.
- Noticeably affect the availability of tug, launch, or pilotage services for marine vessels.
- Influence the target number of marine pilots within a compulsory pilotage area.
- Generate a need for additional tug and/or launch vessels within port districts.

Appendix A Study Overview and Definitions

Study Overview

Marine vessels routinely uptake ambient sea or harbor water as ballast, transit to another port, and then discharge that ballast water. Unfortunately, the resulting ballast water discharges have been linked to the introduction of aquatic invasive species and harmful pathogens. In an effort to reduce or possibly eliminate further introductions, marine vessels are being required to manage ballast water discharges by a myriad of international, federal, and regional guidelines and rules. Vessels discharging in California will be required to meet an interim standard that is more stringent than international and US federal standards.

In response, there has been significant development work and commercial installations of ballast water management systems (BWMS) onboard marine vessels themselves. However, there is a lack of data to determine if shipboard BWMS are capable of meeting CA Interim Standards. Therefore, shore-based ballast water reception and treatment is under consideration as an approach to meet the CA Interim Standards.

This study evaluates the feasibility of shore-based ballast water reception and treatment in 13 separate tasks, beginning with a review of shore-based treatment research, followed by a series of detailed analyses, including: permitting and legal requirements, detailed cost estimates, timeline to implementation, and market implications.

Tasks Overview

Tasks 6 through 13 are submitted together to discuss the practical implementation of shore-based ballast water reception and treatment throughout California state waters, accomplished by a "network" of six (6) independently operating fleets of mobile treatment barges (see Table A-1).

During the course of this study, following completion of Tasks 2-5 and the comparative scale-up exercise described in Reference 2, this approach was deemed most technically, operationally, and financially feasible of the five approaches that were evaluated (i.e. new onsite treatment facility, new offsite treatment facility, existing wastewater treatment facility, shore-side mobile treatment, mobile marine vessel-based treatment).

Table A-1 Tasks 6 through 13

Task	Description
6	Assessment of construction related to outfalls for treated ballast water discharges, and provision for disposal of solids as needed.
7	Summarize pertinent permitting and legal requirements.
8	Comparative review of shipboard vs. barge-based ballast water management operations.
9	Assessment of current practices related to ballast water discharges in California.
10	Cost analysis.
11	Implementation timeline.
12	Market implications.
13	Other analysis and findings. Introduces the concept of a statewide network of mobile treatment barges for the provision of ballast water reception and treatment services across the state and forms the basis for assessments and analyses in Tasks 6-12.

Definitions

ABS	American Bureau of Shipping
ANSI	American National Standards Institute
ASTM	An international standards organization.
ATB	Articulated Tug Barge
AWL	Height Above Waterline
AWWA	American Water Works Association
Ballast Water	Water taken on by a ship to maintain stability in transit.
Ballast Water Exchange	The process of exchanging a vessel's coastal ballast water with mid-ocean water to reduce concentration of non-native species in accordance with regulatory guidelines.
Ballast Water Management	The entire process of treatment and handling of a ship's ballast water to meet regulatory requirements and prevent spread of non-native species.
BMPF	Ballast Manifold Presentation Flange
Booster Pump	Pump, typically centrifugal, that adds additional pumping force to a line that is already being pumped.
BWDS	Ballast Water Discharge Standards
BWE	Ballast Water Exchange
BWM	Ballast Water Management
BWMS	Ballast Water Management System
BWTP	Ballast Water Treatment Plant
BWTB, BWT Barge	Ballast Water Treatment Barge
BWTS	Ballast Water Treatment System
Capture	Capture is the method by which ballast water is transferred onto or off a marine vessel.
CD	Chart Datum
CFU	Colony Forming Units
CMSA	California Marine Sanitation Agency
DAF	Dissolved Air Floatation
DIN	Deutches Institut für Normung (German Institute for Standardization)
Discharge	Discharge of ballast water is the method by which post-treatment ballast water is disposed of in compliance with applicable standards and regulations.
DOC	Dissolved Organic Carbon
DWT	Deadweight Tonnage
EPA	Environmental Protection Agency (US, unless otherwise noted)
Filtrate	Water that has been separated from any particulate matter (used to clean ballast water treatment filters).

GA	General Arrangement
GM	Metacentric height (a measure of a ship's stability).
gpm	Gallons per minute. Any measurements quoted in gallons of ballast water per minute will also be shown in MT of ballast water per hour, or MT/h.
HDPE	High-density Polyethylene
IMO	International Maritime Organization
ISO	International Organization for Standardization
JIS	Japanese Industrial Standards (organization)
L	Liter
Lift Station	Means of receiving a liquid, typically from a drain or low-pressure piping, and 'lifting' it with pump(s) to a different location such as a remote tank.
Lightering	Cargo transfer between vessels, commonly practiced to reduce a vessel's draft before entering port.
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MARPOL	International Convention for the Prevention of Pollution from Ships
MF	Microfiltration
mg	Milligram
MG	Millions of gallons. Any measurements quoted in MG of ballast water will also be shown in MT of ballast water.
MGD	Millions of Gallons/Day
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MPA	Megapascal (unit of pressure)
MSL	Mean Sea Level
MT	Metric tons. One cubic meter of seawater is roughly equivalent to 1.025 MT, but this value varies depending on temperature and salinity of the water. In this report, conversions between volume and weight of seawater are merely approximate and assume 1 m3 of seawater has a mass of roughly 1 MT, for convenience.
Navy Mole	A man-made peninsula in the Port of Long Beach that flanks entrance to the middle and inner harbor
NBIC	National Ballast Information Clearinghouse
NOM	Natural Organic Matter
Non-native Species	Species that are not indigenous to a particular region. Non-native species can be introduced to marine ecosystems through a ship's ballast water. "Invasive" species are non-native species with the potential to cause harm to the environment or human health.
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit

NYSERDA	New York State Energy Research and Development Authority
O&M	Operations and Maintenance (cost)
OCIMF	Oil Companies International Marine Forum
POTW	Publicly Owned [Wastewater] Treatment Works
PSU	Practical salinity units.
Residuals	Particulate matter collected from cleaning ballast water treatment filters.
ROM	Rough Order of Magnitude (cost)
Ro-ro	Roll-on/roll-off (vessels designed to carry wheeled cargo such as car, trucks, trailers, and equipment)
RWCF	Regional Wastewater Control Facility (e.g. City of Stockton, CA)
Shipboard Ballast Water Treatment	Ballast water management approaches that do not require support from shore-based infrastructure and are conducted entirely by a vessel's crew.
Shore-Based Ballast Water Management	Ballast water management approaches that require support from shore-based infrastructure in order to meet ballast water management requirements. Such infrastructure may include: means of transferring ballast water to a land-based or another marine vessel facility for storage and/or processing, deployment of shore-based equipment and personnel for onboard treatment approaches, etc.
Slurry	Mixture of filtrate and filter residuals resulting from cleaning ballast water treatment filters.
Slurry Handling	Slurry handling includes activities related to the storage, treatment, and discharge of filtrate and residuals collected from cleaning ballast water treatment filters.
SOLAS	International Convention for Safety of Life at Sea
Storage	Storage of ballast water includes provision of space and containment for ballast water, either pre-or post-treatment.
STS	Ship-to-Ship. Transfer from one marine vessel to another.
TDS	Total Dissolved Solids
TEU	Twenty-foot Equivalent Unit
TOC	Total Organic Carbon
Transfer	Ballast water transfer considers the logistics and equipment required to capture the ballast water from the marine vessel and transport to a reception and treatment facility.
Transport	Transport is the method by which ballast water is moved post-capture from marine vessels to remote, non-mobile reception and treatment facilities – either land-based or otherwise.
Treatment	Treatment includes the various methods to process ballast water such that it is suitable for discharge in compliance with applicable standards and regulations.

Treatment Approach	A general method for implementing ballast water treatment. Treatment approaches may include mobile systems, land-based facilities, shipboard systems, etc.
Treatment Technology	Specific techniques for removal or inactivation of organisms in ballast water (e.g., UV disinfection, filtration, ozonation, etc.)
TRO	Total Residual Oxidant
TSS	Total Suspended Solids
UF	Ultrafiltration
UKC	Underkeel Clearance
UL	A global independent safety consulting and certification company (formerly Underwriters Laboratories).
USCG	United States Coast Guard
UV	Ultraviolet Light
UVT	UV Transmittance
VLCC	Very Large Crude Carrier
WWTF	Waste Water Treatment Facility
WWTP	Waste Water Treatment Plant