**UNITED STATES OF AMERICA**
**BEFORE THE**
**DEPARTMENT OF COMMERCE**

**Broadwater Energy LLC and Broadwater Pipeline LLC,**

**Appellants,**

**vs.**

**New York Secretary of State Lorraine Cortés-Vázquez,**

**Respondent.**

# MOTION TO SUPPLEMENT THE DECISION RECORD

1. On June 6, 2008, Broadwater Energy LLC and Broadwater Pipeline LLC (collectively, "Broadwater") filed a Notice of Appeal with the Secretary of Commerce pursuant to Section 307(c)(3)(A) of the federal Coastal Zone Management Act ("CZMA") and the applicable regulations at 15 C.F.R. Part 930, Subpart H. On July 7, 2008, Broadwater filed its Initial Brief on Appeal with the Secretary.

2. Broadwater is appealing an April 10, 2008 objection ("Objection") by the New York State Department of State ("NYSDOS") to Broadwater's coastal zone consistency certification ("CZCC") for its construction and operation of a liquefied natural gas import terminal (the "Project") in Long Island Sound, New York. As part of its Objection, NYSDOS purported to propose two alternatives ("Alternative 1" and "Alternative 2," or, collectively, the "Alternatives") to the Project. NYSDOS's proposed Alternatives involve the construction and operation of a floating storage and regasification unit ("FSRU") in the Atlantic Ocean south of Long Island, as opposed to the Long Island Sound location of the Broadwater Project.

3. By this motion, Broadwater seeks to supplement the decision record in this matter by including four additional documents: (1) a June 2008 Port & Terminal Logistics Review – Broadwater, Long Island Sound versus Atlantic Alternatives, Witness Modeling (attached hereto as <u>Supplemental</u>

Document I); (2) a June 2008 Alternative Site Operability Study prepared by Moffatt & Nichol (attached hereto as Supplemental Document II); (3) Broadwater Energy Alternate Pipeline Cost Estimate - June 2008 (attached hereto as Supplemental Document III); and (4) a Coastal Fish & Wildlife Habitat Rating Form for Great South Bay – West, prepared by NYSDOS on March 15, 1987 (attached hereto as Supplemental Document IV). Collectively, these documents are referred to as the "Supplemental Materials."

4. Under the applicable CZMA regulations, because the Broadwater Project is an "energy project," the consolidated record prepared by the Federal Energy Regulatory Commission ("FERC") (as the lead federal agency) is the "initial record" used by the Secretary for this consistency appeal. 15 C.F.R. § 930.127(i)(1). The Secretary may accept supplemental information into the decision record that clarifies information contained in the consolidated record. 15 C.F.R. § 930.130(a)(2)(ii)(B). The Secretary enjoys wide latitude and "broad authority" in determining the content of the decision record so as "to ensure efficiency and fairness to all parties." 15 C.F.R. § 930.127(e)(1); see also April 22, 2008 letter from Jane C. Luxton, General Counsel of National Oceanic and Atmospheric Administration, in regard to the Consolidated Consistency Appeal of Weaver's Cover Energy, LLC and Mill River Pipeline, LLC (attached hereto as Exhibit A).

5. Respectfully, the Supplemental Materials that Broadwater seeks to include in the decision record should be accepted by the Secretary because they clarify information relevant to alternatives analysis, which analysis is already contained in the consolidated record. 15 C.F.R. § 930.130(a)(2)(ii)(B).

6. To assist the Secretary in a full and accurate examination of the availability of NYSDOS's proposed Atlantic Ocean Alternatives, Broadwater commissioned the simulation, operability studies and cost estimate that it now moves to include in the decision record. These documents (and NYSDOS's Coastal Fish & Wildlife Habitat Rating Form for Great South Bay – West) address the specific alternative FSRU locations that were identified in the Objection for the first time. To the best of Broadwater's knowledge, although NYSDOS was a cooperating agency under the National Environmental Policy Act in the creation of FERC's Final Environmental Impact Statement ("FEIS") for the Broadwater Project, NYSDOS did not submit FSRU

alternatives to FERC during that process at the specific locations of Alternative 1 or Alternative 2. Nor did NYSDOS ever submit Alternative 1 and Alternative 2 to Broadwater prior to including them in the Objection (and even then, with a lack of specificity). While the general concept of an FSRU in the Atlantic Ocean was mentioned in a 2007 metocean analysis commissioned by NYSDOS, the specific locations of Alternatives 1 or 2 were not provided to Broadwater. Inclusion of the Supplemental Materials in the record will help to ensure "fairness to all parties" by allowing Broadwater substantive input on the merits of NYSDOS's specific Alternatives. Thus, the material in the consolidated record analyzing alternatives to the Project (such as Chapter 4 of FERC's FEIS, entitled "Alternatives" [BW29174-29230]) will be significantly clarified by consideration of the Supplemental Materials.

7. Accordingly, Broadwater respectfully requests that the Secretary accept the attached Supplemental Materials into the decision record in this matter.

Dated: July 7, 2008

Respectfully submitted,

______________________________

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# Exhibit A

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE GENERAL COUNSEL

APR 22 2008

**VIA FAX [(202) 639-7890 AND (617) 727-9665] AND U.S. MAIL**

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RE: Consolidated Consistency Appeal of Weaver's Cove Energy, LLC and Mill River Pipeline, LLC

Dear Mr. Kiely and Ms. Iancu:

This letter concerns the parties' March 14, 2008 motions to supplement the record, two documents forwarded to this office on April 11, 2008 by counsel for Massachusetts, and additional comments recently solicited from the U.S. Coast Guard (USCG), Department of the Interior (DOI), the Federal Energy Regulatory Commission (FERC), the Environmental Protection Agency (EPA), and the Northeast Field Office of the National Marine Fisheries Service's (NMFS) Habitat Conservation Division.

## I. Motions to Supplement

Massachusetts requests that the Secretary accept and include in the decision record two Massachusetts Department of Environmental Protection (MassDEP) documents dated March 10, 2008.

Appellants, for their part, move to supplement the record with the following documents:

(1) Letters from the New England Regional Council of Carpenters Local 1305, Local 51 Plumbers and Pipefitters, Construction and General Laborers Local 610, and Massachusetts Chemistry & Technology Alliance to FERC;
(2) U.S. Department of Energy, Energy Information Administration (EIA), Supplemental Tables to the Annual Energy Outlook 2007, Energy Consumption in New England by Sector and Source – Table 1 (Feb. 2007);
(3) Weaver's Cove's Response to the U.S. Fish and Wildlife Service (FWS) Comments on Dredging Proposals and Modeling (June 8, 2006);

(4) E-mail from M. Thabault, Assistant Northeast Regional Director, FWS, to M. Bartlett, New England Field Office Supervisor, FWS (Nov. 6, 2006);
(5) Weaver's Cove Responses to MassDEP's Inquiry Regarding Water Quality Issues (Apr. 17, 2007) and SSFATE Modeling (July 2, 2006);
(6) Appeal of Weaver's Cove under 33 C.F.R. § 127.015(b) of the Letter of Recommendation and Response to Request for Reconsideration (Jan. 11, 2008).

Under the Natural Gas Act and the Coastal Zone Management Act, as amended by the Energy Policy Act of 2005, the consolidated record prepared by the lead Federal permitting agency is the initial record used by the Secretary for consistency appeals. 15 U.S.C. § 717n; 16 U.S.C. § 1466. The Secretary may accept supplemental information into the decision record that clarifies information contained in the consolidated record. 15 C.F.R. § 930.130(a)(2)(ii)(B). The Secretary enjoys wide latitude in determining the content of the appeal decision record. 15 C.F.R. § 930.127(e)(1).

In this instance, inclusion of the above documents is appropriate because they clarify information already contained in the consolidated record of this appeal. The two MassDEP documents clarify and update information contained in the consolidated record and in Massachusetts' briefs regarding the views of MassDEP on several state authorizations related to the Project and Massachusetts' consistency objections. The remaining documents clarify and update information contained in the consolidated record and in Appellants' briefs regarding the Secretary's analysis under Ground I.

Accordingly, the parties' March 14, 2008 motions to supplement the decision record are ***granted***. The documents discussed above shall be considered part of the decision record for this consistency appeal.

## II. Appellants' Further Change of Information and Berthing Proposals

I next address two letters authored by Weaver's Cove, which Massachusetts provided to this office on April 11, 2008.

- The first is a letter to the USCG dated March 21, 2008, entitled "Further Change of Information in the Letter of Intent" (Further Change of Information Proposal). This letter contains additional information on Weaver's Cove's proposal for transporting liquefied natural gas (LNG) on the Taunton River, using an alternate tanker size. It clarifies Weaver's Cove's views on the USCG's previously-issued Letter of Recommendation, and was previously discussed in Appellants' Joint Supplemental Reply Brief. Accordingly, the letter is hereby incorporated into the decision record. Appellants are requested to provide any additional materials sent to the USCG along with the Further Change of Information Proposal, to the extent such documents are not currently in the decision record.

- The second is a letter from Weaver's Cove to FERC dated March 28, 2008, concerning a new proposal for transferring LNG from tankers to the terminal (Berthing Proposal). The Berthing Proposal, sent to FERC, involves "the construction of an offshore berth and LNG pipeline to transfer the LNG to the terminal site previously approved by FERC." In the Berthing Proposal, Weaver's Cove observes that "[i]n the near future, Weaver's Cove will initiate FERC review of this alternative berthing and unloading option by requesting to participate in FERC's pre-filing review process." On April 21, 2008, Appellants filed objections to including this document. However, because this letter clarifies the information contained within the consolidated record, it is hereby incorporated into the decision record.

The Further Change of Information and Berthing Proposals raise potentially significant issues related to the sufficiency of the information before the Secretary as to the coastal effects associated with the Project. These documents arguably inject uncertainty as to, *inter alia*, (a) the size of LNG tankers and frequency of tanker trips Weaver's Cove will employ to transport LNG; (b) whether Weaver's Cove will abandon its plan to transport LNG to the terminal by vessel; (c) the nature and extent of dredging within the Taunton River (based upon whether dredging is undertaken to accommodate tanker traffic or install a four-mile LNG pipeline); and (d) whether any additional coastal effects not currently discussed in the record could result under these proposals.

I have asked FERC to provide its views, if any, on the significance of the Berthing Proposal. Any views FERC offers will likely be included in the record. A copy of this letter is attached and any response from FERC shall be provided to the parties.

## III. Additional Federal Agency Solicitation Responses

The parties in their March 14 and 21, 2008, supplemental briefs and Fall River in its *amicus* brief raise a number of issues necessitating further consultation with potentially-interested federal agencies. For this reason, on April 9 and 14, 2008, letters were sent to the USCG, DOI, EPA, and the Northeast Field Office of NMFS' Habitat Conservation Division. Copies of these letters are attached. Responses were requested on or before April 25, 2008.

On April 17, 2008, the Northeast Field Office of NMFS' Habitat Conservation Division provided comments, a copy of which is enclosed. It will also be posted on the website for this appeal. As these comments clarify and update information contained in the consolidated record, they are hereby included in the decision record for this appeal.

Any responses received in the future will be forwarded to the parties upon receipt and will likely be included in the record.

## IV. Supplemental Briefing Schedule

In light of the forgoing, the parties are invited to comment on the response of the Northeast Field Office of NMFS' Habitat Conservation Division, any responses received in the future from the USCG, DOI, EPA, or FERC, as well as all other documents included in the decision record by this letter. The parties are also invited to comment on the Further Change of Information and Berthing Proposals, in particular addressing the impact, if any, they have on: (a) FERC's July 15, 2005 "Order Granting Authority under Section 3 of the Natural Gas Act and Issuing Certificate"; (b) FERC's prior findings concerning the Project, including its May 2005 Environmental Impact Statement; and (c) the Secretary's analysis in this appeal as required under 15 C.F.R. § 930.121(b).

These additional briefs should be submitted on or before **May 5, 2008.** Should your staff have questions concerning this letter, please contact Mr. Grosko at (301) 713-7384 or by e-mail at brett.grosko@noaa.gov.

Sincerely,

Jane C. Luxton

Jane C. Luxton
General Counsel

Enclosures (6)

# Supplemental Document I

# BROADWATER LNG PROJECT OFFSHORE NEW YORK HARBOR

# ALTERNATIVE SITE OPERABILITY STUDY

Prepared for:

## SHELL TRADING (US) COMPANY

| Rev No | A | B | C | 0 | – |
|---|---|---|---|---|---|
| Issue Purpose | Study Basis | Progress Report | For Client Comments | Final | |
| Date | 05/07/2008 | 06/06/2008 | 06/30/2008 | 07/02/2008 | |
| By | RTH | OM | RTH/OM/ IM | RTH/OM/ IM | |
| Checked | GMP | RTH | RTH | RTH | |
| Approved | MW | MW | MW | MW | |
| | | | | | |

Prepared by:

MOFFATT & NICHOL

# SHELL TRADING (US) COMPANY

# BROADWATER LNG PROJECT
# OFFSHORE NEW YORK HARBOR

# ALTERNATIVE SITE OPERABILITY STUDY

MOFFATT & NICHOL

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## 1.0 EXECUTIVE SUMMARY

This report documents the results of the operability study for the Broadwater FSRU (Floating Storage & Regasification Unit) LNG Project for two alternative sites in the Atlantic Ocean, offshore New York Harbor entrance area.

The objective of this study is to provide estimated marine operability for the two alternative sites in order to assess their impacts on the availability of the FSRU relative to the original proposed site within the Long Island Sound (LIS). M&N had performed a marine operability study in 2005 for the Broadwater FSRU at the original LIS site.

The study basis for this investigation is the same as the earlier 2005 study except for the change in Metocean data at the alternate locations and the Client's request to add two sensitivity cases for the operating wave limits of 2.5m and 3.0m to the original 2.0m wave limit studied earlier.

Operating Metocean data for the two alternative sites was collected by M&N from four available public sources (three USACE WIS stations and one NDBC buoy). Alternative Site-1 is located near the middle of two WIS stations (WIS-A123 and WIS-A124). The hindcast wave data at WIS-A124 was used for Alternative Site-1 in this study since it was used by Battelle in the New York Department of State's document. The wave heights at WIS-A124 are higher than those at WIS-A123 for no apparent explanations since WIS-A123 is located further offshore. NDBC Buoy 44025 was used for Alternative Site-2 since it is closer to Site-2 than WIS-A119 and is expected to replicate the sea conditions at Alternative Site 2. The wave heights for the two alternative sites are higher than that at the original proposed LIS site since these two sites are located in the open Atlantic Ocean. Buoy 44025 has the highest wave heights due to it is located further offshore than Site-1.

M&N performed a preliminary operability assessment of the two alternative sites using the same simplified approach as that used in the New York Department of State's document (prepared by Battelle). This approach utilizes only the significant wave height statistics and the berthing/departure operating wave limits (2m and 3m) to assess the FSRU operability without accounting for the effects of duration and persistence of the wave heights. This simplified approach only provides a rough estimate of the overall FSRU operability.

For Site-1, based on WIS-A124 wave data and 2.0m operating wave limit, the preliminary FSRU unavailability estimates indicate that the highest monthly unavailability will be 17.5% or 5.4 days in March and the estimated annual downtime will be 9.3% or 33.9 days.

For Site-2, based on NDBC buoy 44025 and 2.0m operating wave limit, the preliminary FSRU unavailability estimates indicate that the highest monthly unavailability will be 24.7% or 7.6 days in January and the annual downtime will be 14.0% or 51.1 days. Site-2 has higher downtime due to higher waves because it is located further offshore.

A set of operational simulation analyses for the FSRU system was performed to investigate the effects of duration and persistence of wave heights on the operability at the two proposed alternative sites. This task uses the same simulation model developed in 2005. The simulations included detailed modeling of the LNG Carrier's operations at the FSRU and the weather conditions that may result in operational downtime. A database of environmental conditions (10-year time series of environmental data) was used that included on an hourly basis; daylight hours, local wind speed, and sea state (Hs, Tp, and direction).

The simulation analyses provided the following estimated FSRU availability in term of percent of LNG vessels experiencing no waiting at all:

| | Operating Wave Limit | LIS | Site-1 | Site-2 |
|---|---|---|---|---|
| **Base Case** | 2.0m | 99.1% | 91.5% | 85.3% |
| **Sensitivity Case 1** | 2.5m | --- | 96.9% | 91.6% |
| **Sensitivity Case 2** | 3.0m | --- | 98.7% | 95.8% |

The base-case results with 2.0m operating wave limit indicate that, at the original LIS site, there will be 99.1% of LNG vessels which will experience no waiting at all. At Site-1, there will be 91.5% of LNG vessels experiencing no waiting at all. At Site-2, there will be 85.3% of LNG vessels experiencing no waiting at all.

With the operating wave limit increasing from 2.0m to 2.5m or 3.0m, the percent of LNG vessels experiencing no waiting at all will also increase. Overall, the results for Site-2 show the lowest percent of LNG vessels experiencing no waiting at all since it is located further offshore and the wave heights are the highest of all three sites.

## 2.0 INTRODUCTION

Shell Trading (US) Company (hereinafter "Client") requested Moffatt & Nichol (hereinafter "M&N") to provide an operability study for the Broadwater FSRU LNG Project for two alternative sites in the Atlantic Ocean, offshore New York Harbor entrance area.

The Department of State for the State of New York has proposed two alternative locations for the Broadwater FSRU, namely:

Site-1: 40º 23' 0"N & 73º 37' 0"W in about 80 feet of water; located 13 miles offshore south of Long Beach, NY, west of Cholera Bank

Site-2: 40º 20' 0"N & 73º 10' 5"W in about 130 feet of water; located in the Atlantic Ocean, 22 miles south of Fire Island Inlet.

Figure 2-1 provides the location map for the two proposed alternative sites.

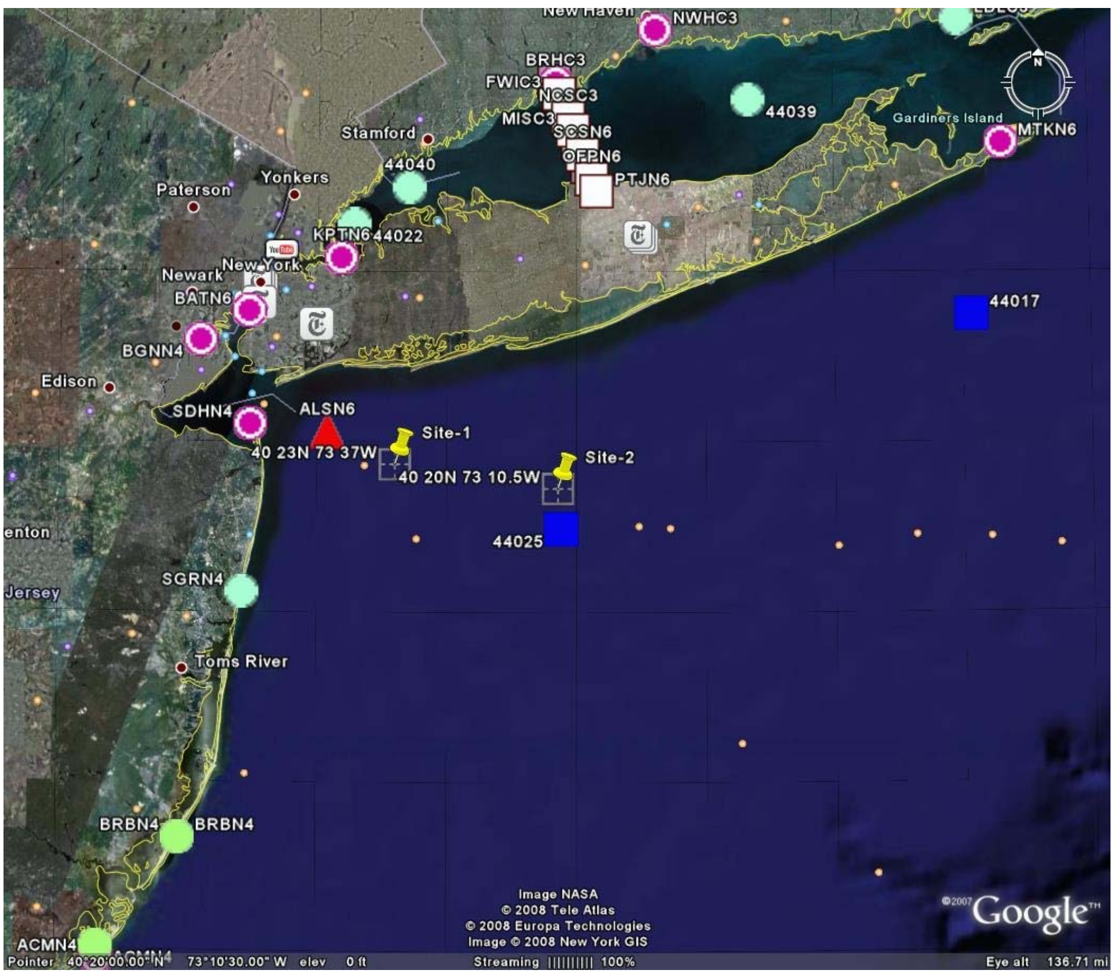



**Figure 2-1: Locations of Proposed Offshore Alternative Sites**

## 2.1 Study Objective

The objective of this study is to provide an estimated marine operability for the two alternative sites in order to assess their impacts on the availability of the FSRU and compare the results to the original Long Island Sound site.

M&N had performed an earlier marine operability study in 2005 for the Broadwater FSRU for the proposed site within the Long Island Sound. In order to meet the project time constraints for this study, M&N based the new study on the mathematical models developed from the earlier study.

Figure 2-2 provides an aerial view of the Broadwater FSRU with a LNG Carrier moored alongside.


**Figure 2-2: Broadwater FSRU Aerial View**

## 2.2 Scope of Work

The scope of work for this study is divided into the following tasks:

- Task 1: Establish Study Basis
- Task 2: Obtain Operating Metocean Criteria
- Task 3: Perform Preliminary Operability Assessment
- Task 4: Perform Operational Downtime Simulation
- Task 5: Final Report and Meetings

## 3.0 TASK 1: ESTABLISH STUDY BASIS

The objective of this task is to establish the study basis to be used for the study. The study basis includes the following major items:

- FSRU data – same as the earlier study with 350,000 $m^3$ LNG storage capacity
- FSRU's turret mooring system details – similar to the earlier study except the necessary adjustments due to the change of the site location (water depth difference)
- LNG Carrier data – same as the earlier study (250,000 $m^3$ capacity)
- LNG Carrier/FSRU side-by-side mooring layout – same as the earlier study
- Tug type and size – same as the earlier study
- Tug characteristics and efficiency – same as the earlier study
- Marine operations scenario (steps and durations) – same as the earlier study except that the pilot boarding station will be assumed to be located 3 nm away from the FSRU
- LNG Carrier/FSRU operational environmental limits – same as the earlier study except that the operational wave limits for berthing and departure operations will vary (2.0m, 2.5m and 3.0m)

### 3.1 FSRU Data

**Table 3-1: FSRU Characteristics**

| Study Basis Data | Value |
|---|---|
| LNG Storage Capacity | 350,000 $m^3$ |
| Displacement | 250,000 tonnes |
| LOA | 363.3 m |
| LBP | 348.3 m |
| Beam | 58.0 m |
| Depth | 29.0 m |
| Loaded Draft | 13.0 m |
| Operating Draft | 12.5 m |
| Ballast Draft | 11.5 m |
| Center of Gravity Forward of Station 0 (LCG, Laden) | Approx. 4m aft of midships |
| Center of Gravity Above Keel (KG=VCG) | 16.0 m |

| Study Basis Data | Value |
|---|---|
| Transverse Metacentric Height (GMt) | Follow from the FSRU model |
| Transverse Radius of Gyration in Air (Kxx) | 20.3 m |
| Longitudinal Radius of Gyration in Air (Kyy=Kzz) | 110.4 m |
| Yaw Radius of Gyration in Air (Kzz) | 110.4 m |
| Frontal (Transverse) Wind Area at 12.5 m Draft | Estimated from FSRU Drawing |
| Side (Longitudinal) Wind Area at 12.5 m Draft | Estimated from FSRU Drawing |
| Thruster location & capacity | From FSRU Drawing |
| General arrangement drawing | A drawing provided by Shell |

Note: The FSRU will maintain at a constant operating draft of 12.5m.

## 3.2 FSRU's Turret Mooring Details

**Table 3-2: FSRU's Turret Mooring System Details**

| Study Basis Data | Value |
|---|---|
| Turret type | Wishbone soft yoke SPM |
| Location of Point of Rotation at FSRU's Bow | Scaled from FSRU Drawing |
| Location of Point of Rotation at the Fixed Tower | Scaled from FSRU Drawing |
| Location of Point of Rotation at Yoke Intermediate Connection | Scaled from FSRU Drawing |
| Restoring Force Characteristics (Load-Excursion Curves) | Provided by Shell (see Figure 3-1) |

The FSRU will be moored by a tower wishbone system (soft yoke mooring) to allow 360-degree weathervane capability. The design of the soft yoke mooring system is the scope of another contractor. The soft yoke mooring system is modeled as mechanical links connected to the FSRU to account for the proper relative motions between the FSRU and the soft yoke mooring system. The dynamic effects of the soft yoke system will not be accounted for.

The load-excursion curves for the soft yoke system are provided in the following figure. The curve for the loaded draft of 11.8m is used.

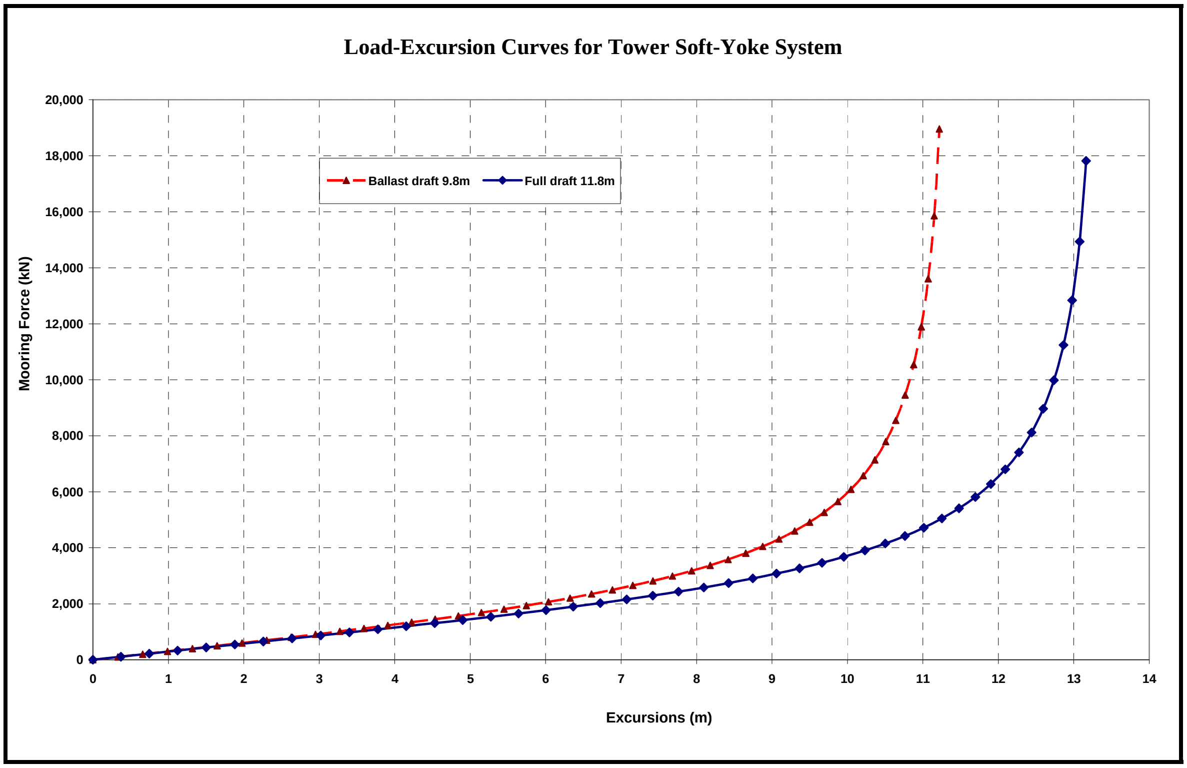



**Figure 3-1: Load Excursion Curves for FSRU's Tower Soft-Yoke System**

## 3.3 LNG CARRIER Data

**Table 3-3: LNG Carrier Characteristics (Q-Max Class)**

| Study Basis Data | Value |
|---|---|
| LNG Storage Capacity | 250,000 $m^3$ |
| Displacement | 177,000 tonnes |
| LOA | 345.0 m |
| LBP | 333.0 m |
| Beam | 55.0 m |
| Depth | 27.0 m |
| Loaded Draft | 12.4 m |
| Operating Draft | 12.0 m |
| Ballast Draft | 9.5 m |
| Center of Gravity Forward of Station 0 (LCG, Laden) | Approx. 4m aft of midships |
| Center of Gravity Above Keel (KG=VCG) | 16.0 m |
| Transverse Metacentric Height (GMt) | Follow from the FSRU model |
| Transverse Radius of Gyration in Air (Kxx) | 20.3 m |

| Study Basis Data | Value |
|---|---|
| Longitudinal Radius of Gyration in Air (Kyy=Kzz) | 110.4 m |
| Yaw Radius of Gyration in Air (Kzz) | 110.4 m |
| Frontal (Transverse) Wind Area at 12.5 m Draft | Estimated from FSRU Drawing |
| Side (Longitudinal) Wind Area at 12.5 m Draft | Estimated from FSRU Drawing |

### 3.4 LNG CARRIER/FSRU Mooring Layout

**Table 3-4: Mooring System Data for LNG Carrier and FSRU**

| Study Basis Data | Value |
|---|---|
| LNG Carrier number & size | One LNG Carrier – 250,000 $m^3$ |
| Total number of mooring lines | 20 |
| No. of mooring line type | One (Steelite) |
| Mooring line type | UHMWPE, Steelite, 12 Strand |
| Mooring load-elongation curve | See Marlow Rope catalog |
| Mooring line diameter | 48 mm |
| Mooring line minimum breaking strength | 1,442 kN |
| Mooring line allowable load | 793 kN |
| Mooring line tail type | Polyester |
| Polyester tail load-elongation curve | See Marlow Rope catalog |
| Polyester tail diameter | 80 mm |
| Polyester tail minimum breaking strength | 1,870 kN |
| Polyester tail allowable load | 1,029 kN |
| No. of fenders | 6 floating fenders |
| Fender type | Yokohama pneumatic fenders |
| Fender diameter / length | 4.5m x 9.0m |
| Fender energy absorption capacity | 3,550 kN-m |
| Fender rated reaction force | 4,531 kN |

## 3.5 Tug Type & Size

**Table 3-5: Tug Type and Size Data**

| Study Basis Data | Value |
|---|---|
| No. of tugs | 4 tugs |
| Bollard pull capacity | 60-tonne pull |
| Horsepower | 5,000 hp |
| LOA | 96.0 ft |
| Beam | 34.0 ft |
| Depth | 14.9 ft |
| Loaded Draft | 12.5 ft |

## 3.6 Tug Performance Characteristics & Efficiency

Tug performance curves in waves were provided by Client based on previous physical model test results.

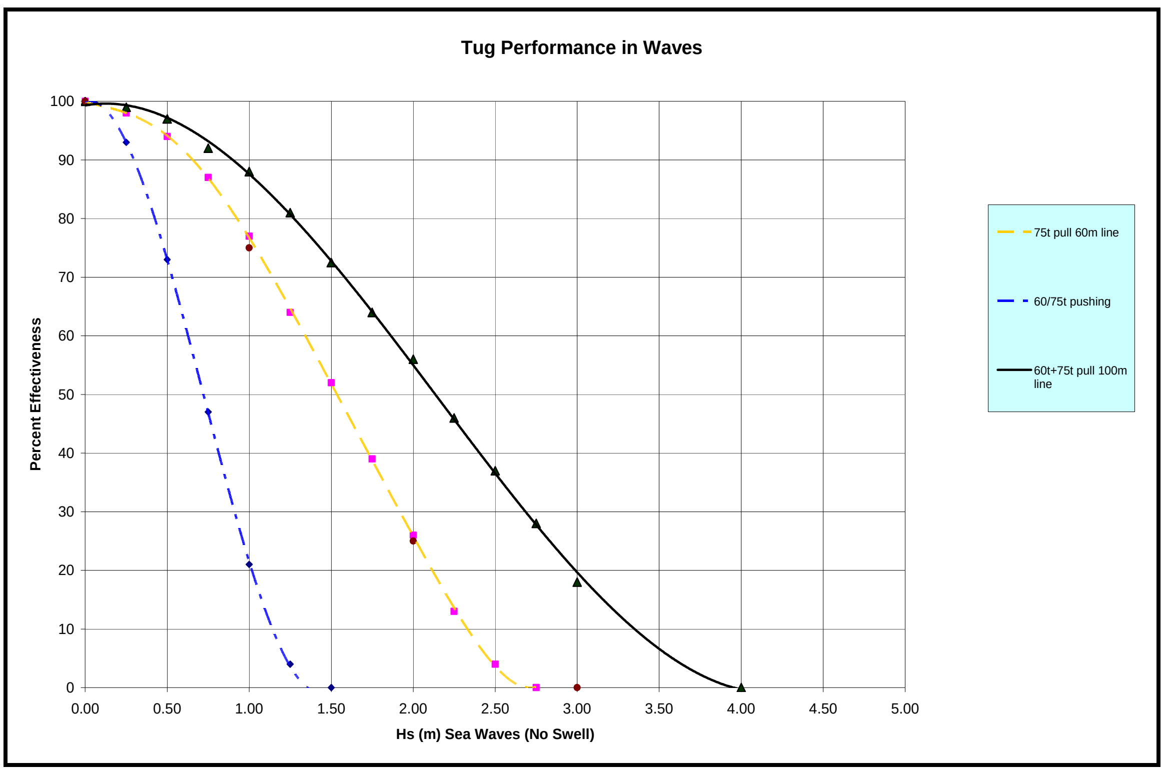



**Figure 3-2: Tug Performance Curves in Waves**

### 3.7 Marine Operations Scenario: Steps and Durations

**Table 3-6: Marine Operation Procedures and Durations**

| Marine Operations Scenario: Steps and Durations | | |
|---|---|---|
| **Activity** | **Duration** | **Comment** |
| Check weather limits (approach, berth, offload, unberth), proceed if OK for all operations | | |
| USCG Security Inspection before pilot boarding | | |
| Pilot boarding at Pilot Station | | Before Pilot Boarding. Broadwater confirms readiness to receive LNG Carrier |
| Pilot Station to FSRU. Approx 3.0nm | 0.5 hr | Compulsory Pilotage. 1-2 tug escort from the Pilot Station to the FSRU |
| | | Before final approach, FSRU PIC and LNG Carrier Master confirm safety |
| Final Approach to Berth. Tug Hook-Up | 1.5 hrs | 4 tugs made fast during final approach |
| Mooring | 1.5 hrs | |
| Complete Mooring | | Pilot remains on board. Tugs in close standby mode |
| Connect unloading arms, purge, safety checks, etc. | 2.0 hrs | Loading Master boards the LNG Carrier |
| Arm & ship cool down | 1.0 hrs | Weather limits to remain in berth in Table 3-7 |
| Cargo transfer | 20.0 hrs | Based on 250k LNG Carrier |
| Drain, purge, & disconnect | 1.5 hrs | |
| Preparations for departure | 1.5 hrs | Assumes stores taken at anchor |
| Unmooring | 0.5 hrs | Weather limits in Table 3-7 |
| Departure | 0.5 hrs | LNG Carrier clear of FSRU. Tugs dismissed |
| FSRU to Pilot Station | 0.5 hr | Pilot departs at Pilot Station |
| **Total** | **31.0 hrs** | |

The LNG Carrier approach and berthing strategy is based on the suitable weather window within the prescribed limiting weather conditions in which the LNG Carrier can safely approach, berth, mooring alongside, offload and unberth. If the forecasted weather conditions indicate that any of the environmental conditions are likely to exceed the prescribed limits, then the LNG Carrier will remain offshore near the pilot boarding station until the weather conditions improve.

Calculation of downtime will be performed by ‘fitting’ as many LNG Carrier offloading cycles as possible on the Metocean time trace. This means that no uncertainty in weather prediction is taken into account. Furthermore, in case the departure weather limit is more stringent than the remaining-moored weather limit, the LNG Carrier offloading cycle will be counted even if the departure limit is exceeded during the berthed period as long as it fits within the time frame of the being berthed period. Although in actual practice this decision is more complicated; the LNG Carrier will not berth if the Metocean conditions are predicted to go beyond the departure limits and if the departure limits are exceeded during the berthed condition (although not predicted) the LNG Carrier will remain moored until safe disconnection is possible.

### *3.7.1 Approach*

Pilotage is compulsory therefore all arriving LNG Carriers will utilize the services of a local pilot from approximately 3.0 nm out from the FSRU and proceed to the FSRU location under the pilot’s guidance using the normal shipping route for commercial through traffic. This trip will take approximately 0.5 hour to complete. Four tugs, each of 60 tonnes bollard pull (4,200 hp), will be in attendance and secured to the LNG Carrier as required to maneuver the LNG Carrier in the prevailing weather conditions.

Before commencing the final approach, both the FSRU Person In Charge (PIC) and the LNG Carrier master will confirm with the other party that all essential safety, maneuvering and operational equipment has been tested and is in working order. The final approach can then begin.

### *3.7.2 Berthing*

The LNG Carrier shall make the final approach to the FSRU with tug assistance on a course and speed commensurate with prevailing weather conditions. The intention of this maneuver will be to arrive at a position and stop at a short distance from, and parallel to the FSRU. The final part of the maneuver will involve the tugs pushing the LNG Carrier alongside the FSRU. Use of the FSRU’s thrusters may be required at this point to maintain a constant heading.

After the LNG Carrier has come to rest alongside the FSRU fenders, mooring lines will be passed from the LNG Carrier and secured to the quick release hooks on the FSRU. Final positioning of the LNG Carrier (manifold alignment) will be carried out using the mooring lines. Once in position, all mooring lines will be pre-tensioned to a similar load, after which the tugs will be released.

#### *3.7.3 Unberthing*

Unberthing of the LNG Carrier from the FSRU requires a similar degree of care and skill as berthing and the method employed to achieve this will be dependent on the weather conditions prevailing at the time.

Prior to commencing unberthing, tugs will be secured to the LNG Carrier at the forward and aft positions. Until all mooring lines have been released, the tugs will hold the LNG Carrier in position alongside the FSRU. Mooring lines will then be released in a controlled sequence and recovered onboard the LNG Carrier. When all mooring lines have been released and recovered, the tugs will commence pulling the LNG Carrier clear of the FSRU. When sufficiently clear of the FSRU, the LNG Carrier will steam clear of the FSRU.

#### *3.7.4 Tug Usage*

The methodology of how tugs are used for berthing/unberthing will depend on the Metocean conditions prevailing at the time. Under normal circumstances, the “push-pull” method will be employed, where tugs are secured alongside the hull of the LNG Carrier. When the sea state conditions are such that push mode cannot be carried out, tugs may have to revert to the traditional ‘long line’ tow. Both methods have their pros and cons, but the key difference will be in the berthing operation where the inability to push the LNG Carrier alongside the FSRU will require mooring lines to be passed to the FSRU in order to assist in pulling the LNG Carrier alongside the FSRU.

### 3.8 Operating Environmental Limits

In this study, the following operational environmental limits for the LNG Carrier/FSRU system are used for the operability assessment of each alternative site:

**Table 3-7: LNG Carrier/FSRU Operational Environmental Limits for Both Sites**

| Case No. | Berthing | Side-by-Side Mooring | Departure | Visibility | Daylight Restrictions |
|---|---|---|---|---|---|
| Base Case | Hs=2.0m<br>Vw=33 kt<br>Vc=0.9 kt | Hs=3.0m<br>Vw=39 kt<br>Vc=0.9 kt | Hs=2.0m<br>Vw=33 kt<br>Vc=0.9 kt | No Limit | No Limit |
| Sensitivity-1 | Hs=2.5m<br>Vw=33 kt<br>Vc=0.9 kt | Hs=3.5m<br>Vw=39 kt<br>Vc=0.9 kt | Hs=2.5m<br>Vw=33 kt<br>Vc=0.9 kt | No Limit | No Limit |

| Case No. | Berthing | Side-by-Side Mooring | Departure | Visibility | Daylight Restrictions |
|---|---|---|---|---|---|
| Sensitivity-2 | Hs=3.0m<br>Vw=33 kt<br>Vc=0.9 kt | Hs=4.0m<br>Vw=39 kt<br>Vc=0.9 kt | Hs=3.0m<br>Vw=33 kt<br>Vc=0.9 kt | No Limit | No Limit |

(1) Parameters must be less than or equal to the specified value
(2) Wave height limit for side-by-side is reduced by 0.5m for the cross-wind case, for all cases

The operating limits for the base case are the same as for the earlier study for the proposed site in the Long Island Sound.

Approach and departure operations: The operating wave limit of Hs=2.0m for berthing and departure operations were based on real-time simulation results for the Long Island Sound location and the consensus of the marine experts who were involved in the ship handling simulations. In the original study, the specified wave height limit was considered the limiting condition in any wind and current condition, based on MSI vessel maneuvering simulation results, that is, approach and departure operations were not dependent on wind or current speed, and this is how the limits were applied in the present study. The reduction in wave height limit for the cross-wind case for approach was not modeled in the original study, and therefore not considered in the present study, although the impact of the reduced wave height limit for cross-wind cases is expected to have a more significant impact at the offshore sites. As for the original study, the departure limits have to be met only during the expected departure times, not while the LNG Carrier is moored alongside.

Side-by-side mooring: In the original study, it was concluded from the vessel motions analyses that the LNG Carrier moored alongside the FSRU was OK in almost all conditions that existed in Long Island Sound, so all limits listed in the above table have to be exceeded simultaneously to represent a no-go side-by-side mooring situation. This same check was applied in the present study; that is, Hs has to exceed 3m and wind speed has to exceed 39 knots and current speed has to exceed 0.9 knot, simultaneously. Additionally, the original study considered that the Hs, Vw, Vc combination limits were reduced for cross-wind cases, where the Hs limit was reduced by 0.5m. This criterion was also applied in the present study.

## 4.0 TASK 2: OBTAIN OPERATING METOCEAN CRITERIA

The objective of this task is to obtain the operating Metocean criteria from available public sources (USACE WIS stations and NDBC buoys) as shown in Figure 4-1 below. As shown in the table below, the following three WIS stations and one NDBC buoy are located closest to the two proposed alternative sites:

**Table 4-1: Public Sources for Metocean Data**

| Site Number | Station Number | Latitude | Longitude |
|---|---|---|---|
| Site-1 | | 40º 23' 00"N | 73º 37' 00"W |
| | WIS-A123 | 40º 25' 12"N | 73º 34' 48"W |
| | WIS-A124 | 40º 25' 12"N | 73º 40' 12"W |
| Site-2 | | 40º 20' 00"N | 73º 10' 05"W |
| | WIS-A119 | 40º 30' 00"N | 73º 15' 00"W |
| | NDBC 44025 | 40º 18' 00"N | 73º 12' 00"W |

This study obtains the Metocean data from all four stations and compares the differences. In the document from the Department of State for the State of New York, it used the Metocean data from WIS-A124 station and WIS-A119 station for the two proposed alternative sites. In fact, Site-1 is located near the middle of the two WIS stations (WIS-A123 and WIS-A124). The hindcast wave data at WIS-A124 was used for Alternative Site-1 in this study since it was used by Battelle in the New York Department of State's document. The wave heights at WIS-A124 are higher than those at WIS-A123 for no apparent explanations since WIS-A123 is located further offshore.

NDBC Buoy 44025 was used for Alternative Site-2 since it is closer to Site-2 than WIS-A119 and is expected to replicate the sea conditions at Alternative Site 2. The wave heights for the two alternative sites are higher than that at the original proposed LIS site since these two alternative sites are located in the open Atlantic Ocean. Buoy 44025 has the highest wave heights due to it is located further offshore than Site-1.

The WIS stations have hindcast wind and wave data for a period of twenty years from 1980 to 1999. However, the NDBC Buoy 44025 only has wave data starting 1991, even though the wind data is available starting 1975. Therefore, for this study, wind and wave statistics for WIS stations A119, A123, and A124 are determined for the entire twenty-year period from 1980 to 1999. For Buoy 44025, wind and wave data from 1991 to 1999 are used to determine the statistics and the time series for the downtime simulations.

It is noted that the wave statistics presented in this study are for the twenty years between 1980 and 1999. They are slightly different from those in the document from the State of New York which used the ten-year data from 1990 to 1999.

Metocean data and preliminary berth operability assessment based on WIS-A123 and WIS-A119 are presented in Appendix A for reference.

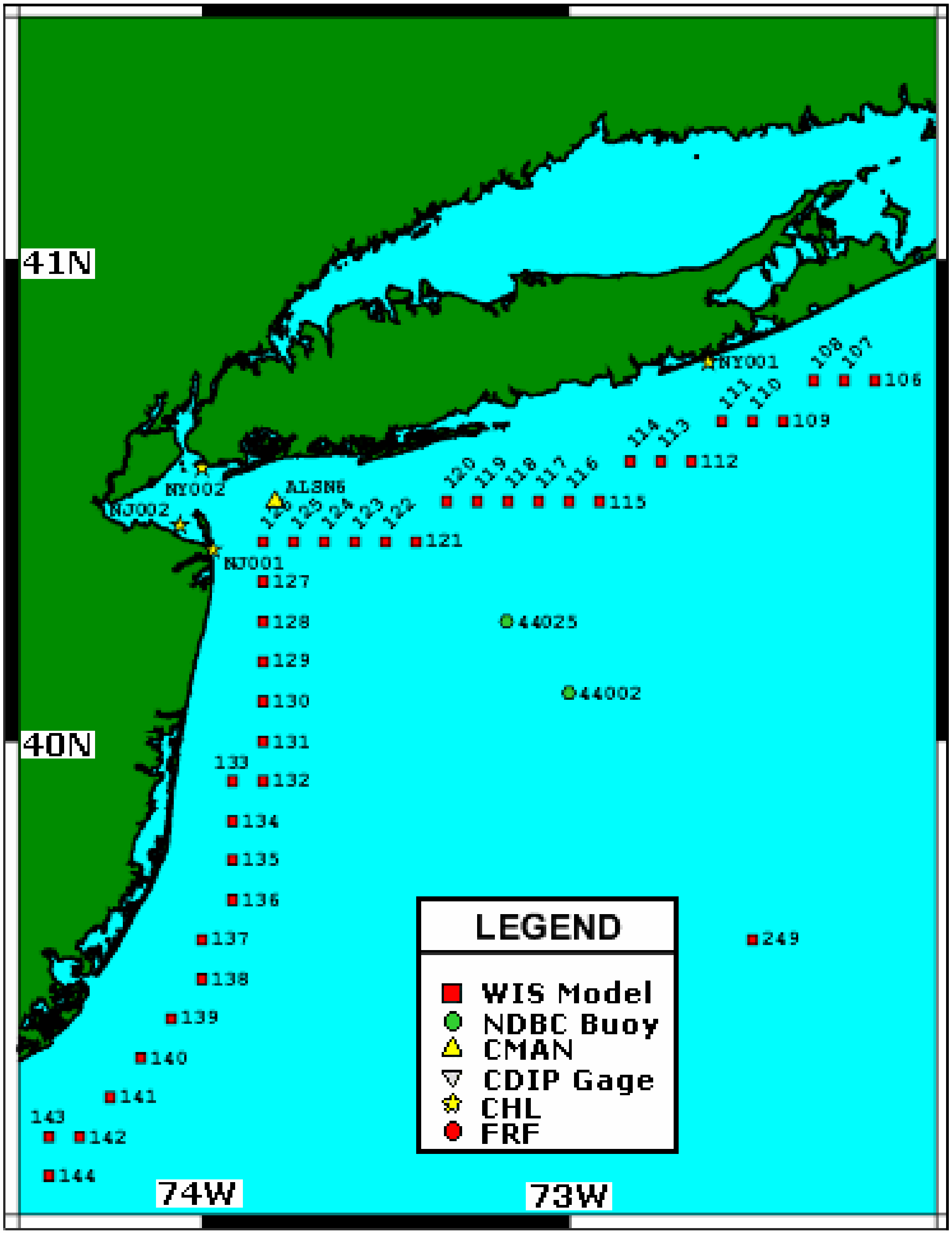



**Figure 4-1: Location Map for USACE WIS Stations and NDBC Buoys**

## 4.1 Wind and Wave Statistics for Alternative Site 1

Wind and wave statistics for WIS-A124 are used for Alternative Site 1 in this study. The hindcast data for the entire twenty year duration from 1980 to 1999 is used.

Table 4-2 provides the wave exceedance statistics with monthly distribution breakdowns for WIS-A124. It shows that the percent of exceedance for significant wave height (Hs) > 2.0m varies from 0.8% in July to 17.5% (i.e., about 5.4 out of 31 days) in March with an annul average of 9.3%. While, for Hs > 3.0m, it varies from 0.0% in June to 2.6% in January and February with an annul average of 1.2%.

**Table 4-2: Wave Statistics for WIS-A124**

**Alternative Site 1: WIS Station A124 - Wave Statistics - Monthly (1980-1999)**

**Percent of Exceedance**

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **> 0.5** | **> 1.0** | **> 1.5** | **> 2.0** | **> 2.5** | **> 3.0** | **> 3.5** | **> 4.0** | **> 4.5** | **> 5.0** |
| **Jan** | 94.0% | 66.5% | 37.2% | 16.7% | 6.8% | 2.6% | 0.5% | 0.2% | 0.1% | 0.0% |
| **Feb** | 95.6% | 66.5% | 37.5% | 17.0% | 6.6% | 2.6% | 0.8% | 0.1% | 0.0% | 0.0% |
| **Mar** | 94.0% | 63.5% | 37.9% | 17.5% | 7.2% | 1.9% | 0.6% | 0.1% | 0.0% | 0.0% |
| **Apr** | 93.9% | 62.0% | 31.5% | 10.5% | 2.7% | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% |
| **May** | 87.6% | 42.6% | 12.8% | 3.2% | 0.5% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| **June** | 84.9% | 27.8% | 6.5% | 1.2% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **July** | 71.0% | 11.4% | 1.9% | 0.8% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Aug** | 62.8% | 10.7% | 3.4% | 1.7% | 0.9% | 0.7% | 0.5% | 0.3% | 0.2% | 0.2% |
| **Sept** | 80.9% | 33.6% | 16.0% | 4.1% | 1.7% | 1.1% | 0.7% | 0.2% | 0.1% | 0.0% |
| **Oct** | 94.0% | 53.1% | 25.7% | 8.9% | 2.8% | 1.6% | 1.1% | 0.7% | 0.5% | 0.4% |
| **Nov** | 94.4% | 67.3% | 36.3% | 14.2% | 5.1% | 1.8% | 0.5% | 0.2% | 0.0% | 0.0% |
| **Dec** | 95.6% | 67.3% | 37.8% | 16.2% | 6.5% | 1.8% | 0.3% | 0.0% | 0.0% | 0.0% |
| **Annual** | 87.3% | 47.6% | 23.6% | 9.3% | 3.4% | 1.2% | 0.4% | 0.1% | 0.1% | 0.0% |

**Percent of Occurrence**

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **0.0 - 0.5** | **0.5 - 1.0** | **1.0 - 1.5** | **1.5 - 2.0** | **2.0 - 2.5** | **2.5 - 3.0** | **3.0 - 3.5** | **3.5 - 4.0** | **4.0 - 4.5** | **4.5 - 5.0** |
| **Jan** | 6.0% | 27.5% | 29.3% | 20.4% | 9.9% | 4.1% | 2.1% | 0.3% | 0.1% | 0.1% |
| **Feb** | 4.4% | 29.1% | 29.0% | 20.5% | 10.4% | 4.0% | 1.8% | 0.7% | 0.1% | 0.0% |
| **Mar** | 6.0% | 30.5% | 25.6% | 20.4% | 10.2% | 5.4% | 1.3% | 0.4% | 0.1% | 0.0% |
| **Apr** | 6.1% | 31.9% | 30.5% | 21.0% | 7.8% | 2.1% | 0.6% | 0.1% | 0.0% | 0.0% |
| **May** | 12.4% | 45.0% | 29.9% | 9.6% | 2.6% | 0.4% | 0.2% | 0.0% | 0.0% | 0.0% |
| **June** | 15.1% | 57.1% | 21.3% | 5.3% | 1.1% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| **July** | 29.0% | 59.6% | 9.5% | 1.1% | 0.5% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Aug** | 37.2% | 52.1% | 7.3% | 1.7% | 0.7% | 0.3% | 0.2% | 0.2% | 0.1% | 0.1% |
| **Sept** | 19.1% | 47.3% | 17.6% | 11.9% | 2.5% | 0.6% | 0.4% | 0.5% | 0.1% | 0.1% |
| **Oct** | 6.0% | 40.9% | 27.3% | 16.9% | 6.1% | 1.1% | 0.6% | 0.4% | 0.2% | 0.1% |
| **Nov** | 5.6% | 27.1% | 31.0% | 22.1% | 9.1% | 3.3% | 1.3% | 0.4% | 0.1% | 0.1% |
| **Dec** | 4.4% | 28.3% | 29.5% | 21.6% | 9.7% | 4.8% | 1.4% | 0.3% | 0.0% | 0.0% |
| **Annual** | 12.7% | 39.8% | 24.0% | 14.3% | 5.9% | 2.2% | 0.8% | 0.3% | 0.1% | 0.0% |

Table 4-3 provides the joint wind and wave statistics for WIS-A124. It shows that the percent of non-exceedance is 90.7% (or 9.3% exceedance) for wind speed Vs=35.0 kt and wave height Hs=2.0m and 98.8% for wind speed Vs=35.0 kt and wave height Hs=3.0m.

**Table 4-3: Joint Wind and Wave Statistics for WIS-A124**

Alternative Site 1: WIS Station A124 - Joint Wind & Wave Statistics - Annual (1980-1999)

Percent of Occurence

| | Significant wave height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Wind, kt | 0.0 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | 3.0 - 3.5 | 3.5 - 4.0 | 4.0 - 4.5 | 4.5 - 5.0 |
| 0.0 - 5.0 | 1.1% | 0.5% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 5.0 - 10.0 | 11.6% | 18.8% | 2.9% | 0.5% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 10.0 - 15.0 | 0.1% | 20.4% | 14.0% | 1.8% | 0.4% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| 15.0 - 20.0 | 0.0% | 0.1% | 6.9% | 9.8% | 1.6% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% |
| 20.0 - 25.0 | 0.0% | 0.0% | 0.0% | 2.2% | 3.2% | 1.3% | 0.3% | 0.0% | 0.0% | 0.0% |
| 25.0 - 30.0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.6% | 0.5% | 0.5% | 0.2% | 0.0% | 0.0% |
| 30.0 - 35.0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| 35.0 - 40.0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 40.0 - 45.0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 45.0 - 50.0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Total | 12.7% | 39.8% | 24.0% | 14.3% | 5.9% | 2.2% | 0.8% | 0.3% | 0.1% | 0.0% |
| Cum. | 12.7% | 52.4% | 76.4% | 90.7% | 96.6% | 98.8% | 99.6% | 99.9% | 99.9% | 100.0% |

Percent of Non-Exceedance (both wind and waves)

| | Significant wave height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Wind, kt | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 |
| 5 | 1.1% | 1.6% | 1.7% | 1.8% | 1.8% | 1.8% | 1.8% | 1.8% | 1.8% | 1.8% |
| 10 | 12.6% | 32.0% | 35.0% | 35.6% | 35.7% | 35.7% | 35.7% | 35.7% | 35.7% | 35.7% |
| 15 | 12.7% | 52.4% | 69.4% | 71.7% | 72.2% | 72.4% | 72.4% | 72.4% | 72.4% | 72.4% |
| 20 | 12.7% | 52.5% | 76.4% | 88.5% | 90.5% | 90.9% | 91.0% | 91.0% | 91.0% | 91.0% |
| 25 | 12.7% | 52.5% | 76.4% | 90.7% | 96.0% | 97.6% | 97.9% | 98.0% | 98.0% | 98.0% |
| 30 | 12.7% | 52.5% | 76.4% | 90.7% | 96.6% | 98.6% | 99.4% | 99.7% | 99.7% | 99.7% |
| 35 | 12.7% | 52.5% | 76.4% | 90.7% | 96.6% | 98.8% | 99.6% | 99.8% | 99.9% | 99.9% |
| 40 | 12.7% | 52.5% | 76.4% | 90.7% | 96.6% | 98.8% | 99.6% | 99.9% | 99.9% | 100.0% |
| 45 | 12.7% | 52.5% | 76.4% | 90.7% | 96.6% | 98.8% | 99.6% | 99.9% | 99.9% | 100.0% |
| 50 | 12.7% | 52.5% | 76.4% | 90.7% | 96.6% | 98.8% | 99.6% | 99.9% | 99.9% | 100.0% |

## 4.2 Wind and Wave Statistics for Alternative Site 2

Alternative Site 2 is located closer to NDBC Buoy 44025 than WIS station A119, which was used in the document from the State of New York. Wind and wave statistics for NDBC Buoy 44025 are used in this study. Since the NDBC Buoy 44025 is located further offshore, the wave statistics from Buoy 44025 are generally higher than those from WIS-A119.

Table 4-4 provides the wave exceedance statistics with monthly distribution breakdowns for NDBC Buoy 44025. It shows that the percent of exceedance for significant wave height (Hs) > 2.0m varies from 2.2% in July to 24.7% (or 7.6 out of 31 days) in January with an annul average of 14.0% (or 51 out of 365 days). While, for Hs > 3.0m, it varies from 0.1% in June and July to 6.0% in December with an annul average of 3.1%.

**Table 4-4: Wave Statistics for NDBC Buoy 44025**

**Alternative Site 2: NDBC Buoy 44025 - Wave Statistics - Monthly (1991-1999)**

Percent of Exceedance

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | > 0.5 | > 1.0 | > 1.5 | > 2.0 | > 2.5 | > 3.0 | > 3.5 | > 4.0 | > 4.5 | > 5.0 |
| Jan | 96.4% | 73.2% | 45.0% | 24.7% | 11.8% | 5.8% | 3.1% | 1.6% | 0.8% | 0.3% |
| Feb | 93.7% | 70.1% | 42.8% | 22.4% | 9.7% | 4.0% | 2.0% | 1.1% | 0.6% | 0.3% |
| Mar | 92.6% | 66.0% | 38.4% | 22.0% | 11.0% | 5.7% | 3.3% | 1.6% | 1.0% | 0.6% |
| Apr | 94.7% | 60.2% | 28.6% | 13.0% | 5.6% | 2.0% | 0.8% | 0.0% | -0.1% | -0.1% |
| May | 93.6% | 52.1% | 20.4% | 7.8% | 2.8% | 0.8% | 0.1% | 0.0% | 0.0% | 0.0% |
| June | 93.6% | 41.4% | 11.2% | 3.3% | 1.1% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| July | 93.6% | 36.9% | 9.8% | 2.2% | 0.5% | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% |
| Aug | 91.9% | 40.8% | 13.9% | 6.4% | 2.6% | 0.9% | 0.1% | 0.0% | 0.0% | 0.0% |
| Sept | 96.1% | 58.6% | 27.0% | 11.0% | 4.5% | 1.8% | 1.0% | 0.5% | 0.2% | 0.1% |
| Oct | 94.7% | 59.2% | 30.5% | 15.4% | 8.3% | 4.8% | 2.3% | 1.3% | 0.6% | 0.1% |
| Nov | 95.2% | 66.1% | 35.0% | 18.5% | 10.1% | 5.6% | 3.0% | 1.2% | 0.4% | 0.1% |
| Dec | 95.8% | 69.2% | 42.9% | 24.0% | 12.7% | 6.0% | 3.2% | 1.8% | 1.0% | 0.5% |
| Annual | 94.3% | 57.5% | 28.5% | 14.0% | 6.7% | 3.1% | 1.6% | 0.8% | 0.4% | 0.2% |

Percent of Occurrence

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 0.0 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | 3.0 - 3.5 | 3.5 - 4.0 | 4.0 - 4.5 | 4.5 - 5.0 |
| Jan | 3.6% | 23.2% | 28.2% | 20.3% | 12.8% | 6.0% | 2.7% | 1.5% | 0.8% | 0.5% |
| Feb | 6.4% | 23.6% | 27.3% | 20.4% | 12.7% | 5.8% | 2.0% | 0.9% | 0.5% | 0.3% |
| Mar | 7.5% | 26.5% | 27.6% | 16.5% | 10.9% | 5.3% | 2.4% | 1.7% | 0.7% | 0.4% |
| Apr | 5.3% | 34.4% | 31.6% | 15.6% | 7.3% | 3.7% | 1.2% | 0.7% | 0.1% | 0.0% |
| May | 6.4% | 41.5% | 31.8% | 12.6% | 5.1% | 2.0% | 0.7% | 0.1% | 0.0% | 0.0% |
| June | 6.4% | 52.3% | 30.2% | 7.9% | 2.2% | 1.0% | 0.1% | 0.0% | 0.0% | 0.0% |
| July | 6.5% | 56.6% | 27.2% | 7.6% | 1.7% | 0.4% | 0.1% | 0.0% | 0.0% | 0.0% |
| Aug | 8.1% | 51.1% | 26.9% | 7.5% | 3.8% | 1.7% | 0.8% | 0.1% | 0.0% | 0.0% |
| Sept | 3.9% | 37.5% | 31.6% | 16.1% | 6.4% | 2.7% | 0.8% | 0.6% | 0.3% | 0.1% |
| Oct | 5.3% | 35.5% | 28.7% | 15.1% | 7.2% | 3.5% | 2.5% | 1.0% | 0.7% | 0.5% |
| Nov | 4.8% | 29.1% | 31.1% | 16.5% | 8.4% | 4.5% | 2.6% | 1.8% | 0.9% | 0.3% |
| Dec | 4.2% | 26.6% | 26.3% | 18.9% | 11.3% | 6.7% | 2.8% | 1.4% | 0.8% | 0.5% |
| Annual | 5.7% | 36.8% | 29.0% | 14.4% | 7.4% | 3.6% | 1.5% | 0.8% | 0.4% | 0.2% |

Table 4-5 provides the joint wind and wave statistics for NDBC Buoy 44025. It shows that the percent of non-exceedance is 86.0% (or 14.0% exceedance) for wind speed Vs=35.0 kt and wave height Hs=2.0m and 96.8% for wind speed Vs=35.0 kt and wave height Hs=3.0m.

**Table 4-5: Joint Wind and Wave Statistics for NDBC Buoy 44025**

Alternative Site 2: NDBC Buoy 44025 - Joint Wind & Wave Statistics - Annual (1991-1999)

Percent of Occurence

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wind, kt** | **0.0 - 0.5** | **0.5 - 1.0** | **1.0 - 1.5** | **1.5 - 2.0** | **2.0 - 2.5** | **2.5 - 3.0** | **3.0 - 3.5** | **3.5 - 4.0** | **4.0 - 4.5** | **4.5 - 5.0** |
| **0.0 - 5.0** | 1.3% | 4.6% | 1.9% | 0.5% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **5.0 - 10.0** | 3.1% | 13.9% | 5.7% | 1.6% | 0.6% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| **10.0 - 15.0** | 1.2% | 14.1% | 8.8% | 2.5% | 1.0% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% |
| **15.0 - 20.0** | 0.1% | 4.0% | 9.7% | 4.1% | 1.3% | 0.6% | 0.2% | 0.1% | 0.0% | 0.0% |
| **20.0 - 25.0** | 0.0% | 0.2% | 2.9% | 4.4% | 2.2% | 1.0% | 0.3% | 0.1% | 0.0% | 0.0% |
| **25.0 - 30.0** | 0.0% | 0.0% | 0.2% | 1.2% | 1.8% | 1.0% | 0.5% | 0.2% | 0.1% | 0.0% |
| **30.0 - 35.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% | 0.4% | 0.3% | 0.2% | 0.1% | 0.1% |
| **35.0 - 40.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% | 0.1% | 0.1% |
| **40.0 - 45.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **45.0 - 50.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Total** | 5.7% | 36.8% | 29.0% | 14.4% | 7.4% | 3.6% | 1.5% | 0.8% | 0.4% | 0.2% |
| **Cum.** | 5.7% | 42.5% | 71.6% | 86.0% | 93.4% | 96.9% | 98.4% | 99.2% | 99.6% | 99.8% |

Percent of Non-Exceedance (both wind and waves)

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wind, kt** | **0.5** | **1** | **1.5** | **2** | **2.5** | **3** | **3.5** | **4** | **4.5** | **5** |
| **5** | 1.3% | 5.9% | 7.8% | 8.3% | 8.5% | 8.6% | 8.6% | 8.6% | 8.6% | 8.6% |
| **10** | 4.4% | 22.9% | 30.5% | 32.6% | 33.4% | 33.6% | 33.6% | 33.6% | 33.6% | 33.6% |
| **15** | 5.6% | 38.2% | 54.5% | 59.2% | 60.9% | 61.4% | 61.5% | 61.6% | 61.6% | 61.6% |
| **20** | 5.7% | 42.2% | 68.2% | 77.0% | 80.0% | 81.1% | 81.4% | 81.5% | 81.6% | 81.6% |
| **25** | 5.7% | 42.5% | 71.3% | 84.5% | 89.7% | 91.8% | 92.5% | 92.7% | 92.8% | 92.8% |
| **30** | 5.7% | 42.5% | 71.5% | 85.9% | 93.0% | 96.1% | 97.3% | 97.7% | 97.9% | 98.0% |
| **35** | 5.7% | 42.5% | 71.5% | 86.0% | 93.3% | 96.8% | 98.3% | 99.0% | 99.4% | 99.5% |
| **40** | 5.7% | 42.5% | 71.6% | 86.0% | 93.4% | 96.9% | 98.4% | 99.2% | 99.6% | 99.8% |
| **45** | 5.7% | 42.5% | 71.6% | 86.0% | 93.4% | 96.9% | 98.4% | 99.2% | 99.6% | 99.8% |
| **50** | 5.7% | 42.5% | 71.6% | 86.0% | 93.4% | 96.9% | 98.4% | 99.2% | 99.6% | 99.8% |

## 4.3 Comparison of Wave Height Statistics

Table 4-6 presents a comparison of the cumulative percent of occurrence for significant wave height (Hs) at WIS-A124 and NDBC Buoy 44025 with those at the original proposed site in Long Island Sound (LIS).

Wave heights at NDBC Buoy 44025 for Alternative Site-2 are the highest of all sites since it is located further offshore in the open Atlantic Ocean. Waves with Hs of 2.0m or less will occur 86.0% at Buoy 44025.

Wave heights at WIS-A124 for Alternative Site-1 are also higher than those at Long Island Sound. Waves with Hs of 2.0m or less will occur 90.7% at WIS-A124.

Wave heights are the lowest at the Long Island Sound site due to its protective environment. Waves with Hs of 2.0m or less will occur 99.7% at Buoy 44025.

**Table 4-6: Comparison of Cumulative Percent of Occurrence for Significant Wave Heights**

| | Original | Site-1 | Site-2 |
|---|---|---|---|
| **Hs (m)** | **LIS** | **WIS-A124** | **Buoy-44025** |
| <= 0.5m | 80.3% | 12.7% | 5.7% |
| <= 1.0m | 92.7% | 52.4% | 42.5% |
| <= 1.5m | 98.3% | 76.4% | 71.6% |
| <= 2.0m | 99.7% | 90.7% | 86.0% |
| <= 2.5m | 99.9% | 96.6% | 93.4% |
| <= 3.0m | 100.0% | 98.8% | 96.9% |
| <= 3.5m | 100.0% | 99.6% | 98.4% |

## 5.0 TASK 3: PERFORM PRELIMINARY OPERABILITY ASSESSMENT

The objective of this task is to perform a preliminary operability assessment of the two alternative sites using the same simplified approach as that used in the Department of State's document (prepared by Battelle), which utilized only the annual wave height statistics and the berthing/departure operating limits (2m and 3m) to assess the FSRU operability without accounting for the effects of duration and persistence of the wave heights. The simplified approach prepared by Battelle only provided a rough estimate of the overall operability of the FSRU.

The results of this task are simply used to verify the results presented in the Department of State's document. However, it is necessary to perform a complete operational downtime simulation as presented in Task 4 in order to assess the effects of wave duration and persistence.

Preliminary berth operability estimates presented in this section are based on the percent of exceedance from the wave height statistics presented in Section 4.0. These estimates provide the percent or days during each month that the berth will be unable to berth LNG Carriers due to wave heights exceeding the operating limit of Hs=2.0m or 3.0m.

## 5.1 Preliminary Operability Assessment for Alternative Site 1

Table 5-1 presents the preliminary berth unavailability estimates for Alternative Site 1. These estimates are based on the wave height statistics from WIS-A124 presented in Section 4.1.

The preliminary berth unavailability estimates based on WIS-A124 wave data and 2.0m operating wave limit indicate that the highest monthly unavailability will be 17.5% or 5.4 days in March and the annual downtime will be 9.3% or 33.9 days.

**Table 5-1: Preliminary Berth Unavailability Based on WIS-A124 Data**

| | Hs>2.0m | Hs>2.0m | Hs>3.0m | Hs>3.0m |
|---|---|---|---|---|
| **Month** | **%** | **Days** | **%** | **Days** |
| **Jan** | 16.7% | 5.2 | 2.6% | 0.8 |
| **Feb** | 17.0% | 4.8 | 2.6% | 0.7 |
| **Mar** | 17.5% | 5.4 | 1.9% | 0.6 |
| **Apr** | 10.5% | 3.2 | 0.6% | 0.2 |
| **May** | 3.2% | 1.0 | 0.2% | 0.1 |
| **June** | 1.2% | 0.4 | 0.0% | 0.0 |
| **July** | 0.8% | 0.3 | 0.1% | 0.0 |
| **Aug** | 1.7% | 0.5 | 0.7% | 0.2 |
| **Sept** | 4.1% | 1.3 | 1.1% | 0.3 |
| **Oct** | 8.9% | 2.7 | 1.6% | 0.5 |
| **Nov** | 14.2% | 4.3 | 1.8% | 0.6 |
| **Dec** | 16.2% | 5.0 | 1.8% | 0.5 |
| **Annual** | **9.3%** | **33.9** | **1.2%** | **4.5** |

## 5.2 Preliminary Operability Assessment for Alternative Site 2

Table 5-2 presents the preliminary berth unavailability estimates for Alternative Site 2. These estimates are based on the wave height statistics from NDBC Buoy 44025 presented in Section 4.2.

The preliminary berth unavailability estimates based on NDBC Buoy 44025 wave data and 2.0m operating wave limit indicate that the highest monthly unavailability will be 24.7% or 7.6 days in January and the annual downtime will be 14.0% or 51.1 days.

**Table 5-2: Preliminary Berth Unavailability Based on Buoy 44025 Data**

| | Hs>2.0m | Hs>2.0m | Hs>3.0m | Hs>3.0m |
|---|---|---|---|---|
| **Month** | **%** | **Days** | **%** | **Days** |
| **Jan** | 24.7% | 7.6 | 5.8% | 1.8 |
| **Feb** | 22.4% | 6.3 | 4.0% | 1.1 |
| **Mar** | 22.0% | 6.8 | 5.7% | 1.8 |
| **Apr** | 13.0% | 3.9 | 2.0% | 0.6 |
| **May** | 7.8% | 2.4 | 0.8% | 0.2 |
| **June** | 3.3% | 1.0 | 0.1% | 0.0 |
| **July** | 2.2% | 0.7 | 0.1% | 0.0 |
| **Aug** | 6.4% | 1.9 | 0.9% | 0.3 |
| **Sept** | 11.0% | 3.4 | 1.8% | 0.6 |
| **Oct** | 15.4% | 4.8 | 4.8% | 1.5 |
| **Nov** | 18.5% | 5.6 | 5.6% | 1.7 |
| **Dec** | 24.0% | 7.4 | 6.0% | 1.9 |
| **Annual** | **14.0%** | **51.1** | **3.1%** | **11.3** |

## 6.0 TASK 4: PERFORM OPERATIONAL DOWNTIME SIMULATION

The objective of this task is to investigate the effects of duration and persistence of wave heights on the operability of the two proposed alternative sites. This task is similar to the one performed in the earlier study.

Downtime is associated with a number of operations along the chain of activities involved in the delivery of LNG, such as maneuvering into the berth, berthing, mooring all fast, connecting unloading arms, LNG off-loading, disconnecting unloading arms, disconnecting lines and departure. Any of these operations may be affected by environmental conditions, such as wave and wind, and hurricane events.

M&N used the simulation model developed in 2005 from the earlier study. The simulations include detailed modeling of the operations at the FSRU and weather conditions that may result in terminal downtime. A database of environmental conditions (10-year time series of environmental data) was developed that includes, on an hourly basis, daylight hours, local wind speed and direction, and sea state (Hs, Tp, and direction of swell). The wind and sea-state data is based on the Metocean data obtained from Task 2. The marine operation steps and durations are listed in Table 3-6 of Section 3 and the operational limits that were applied in these down simulations are presented in Table 3-7 of the same section.

During the downtime simulations, an LNG Carrier arrives as soon as the pilot disembarks from the preceding carrier. At this point in time the weather forecast is carried out. A 31-hour weather window is required during which the operational limits must not be exceeded, which means that the LNG Carrier may not proceed unless prevailing conditions allow all operations to be completed without interruption. In other words, no unloading interruptions or re-berthings are permitted.

Table 6-1 illustrates the period over the 31-hour timeframe during which each of the limits discussed in Section 3 is applicable. In the case that a single parameter's limit is forecast to be exceeded during a single hour, the simulation clock is incremented by one hour and the check repeated until a 31-hour window is found that satisfies all conditions at the appropriate times. An underlying assumption in this procedure is that of perfect forecasting.

## Table 6-1: Forecast of Favorable Weather Window

| | Pilots board; start transit to the FSRU | Tugs made fast during final approach | Tugs push LNGC along-side; secure mooring lines | Connect arms, purge, safety checks; cool-down | Cargo Transfer | Drain, purge, disconnect arms; prepare for departure | Secure tugs to LNGC; release mooring lines | Pull LNGC clear of FSRU; release tugs | FSRU to Pilot Station |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| DURATION (hrs) | 0.5 | 1.5 | 1.5 | 3 | 20 | 3 | 0.5 | 0.5 | 0.5 |
| TOTAL TIME (hrs) | 0.5 | 2 | 3.5 | 6.5 | 26.5 | 29.5 | 30 | 30.5 | 31 |
| | | | | | | | | | |
| VISIBILITY | | | | | | | | | |
| DAYLIGHT | | | | | | | | | |
| APPROACH LIMITS | | | | | | | | | |
| SIDE-BY-SIDE LIMITS | | | | | | | | | |
| - MOORING LINE LIMIT | | | | | | | | | |
| - FENDER LIMIT | | | | | | | | | |
| - ROLL MOTION LIMIT | | | | | | | | | |
| - CONNECT/DISCONNECT LIMIT | | | | | | | | | |
| - LOADING LIMIT | | | | | | | | | |
| DEPARTURE LIMITS | | | | | | | | | |
| | | | | | | | | | |

A Base Case and two sensitivity simulations were completed for each of the two offshore sites. The operational limits for the three cases were presented in Table 3-7. Each simulation was run for a period of 100 years in order to provide a sufficient number of outcomes to perform statistical analysis.

Five output parameters were recorded throughout the simulations:

- Pilot to pilot time: from start of berth approach (from Pilot Boarding Station) to end of departure from Pilot Boarding Station
- Waiting time (or, downtime): the time spent waiting at Pilot Boarding Station for initial berth approach due to unfavorable weather forecast
- Inter-arrival time (or, ship at site): from arrival at Pilot Boarding Station to end of departure from Pilot Boarding Station
- Time between closures: from start of waiting time at Pilot Boarding Station until start of subsequent waiting time at Pilot Boarding Station
- Available slot: from arrival of the first carrier after a waiting period to departure of the last carrier before the next waiting period

Figure 6-1 was provided by Shell GS for the earlier study and gives a graphical description of the above terms. These are the same parameters that were recorded in the present study.

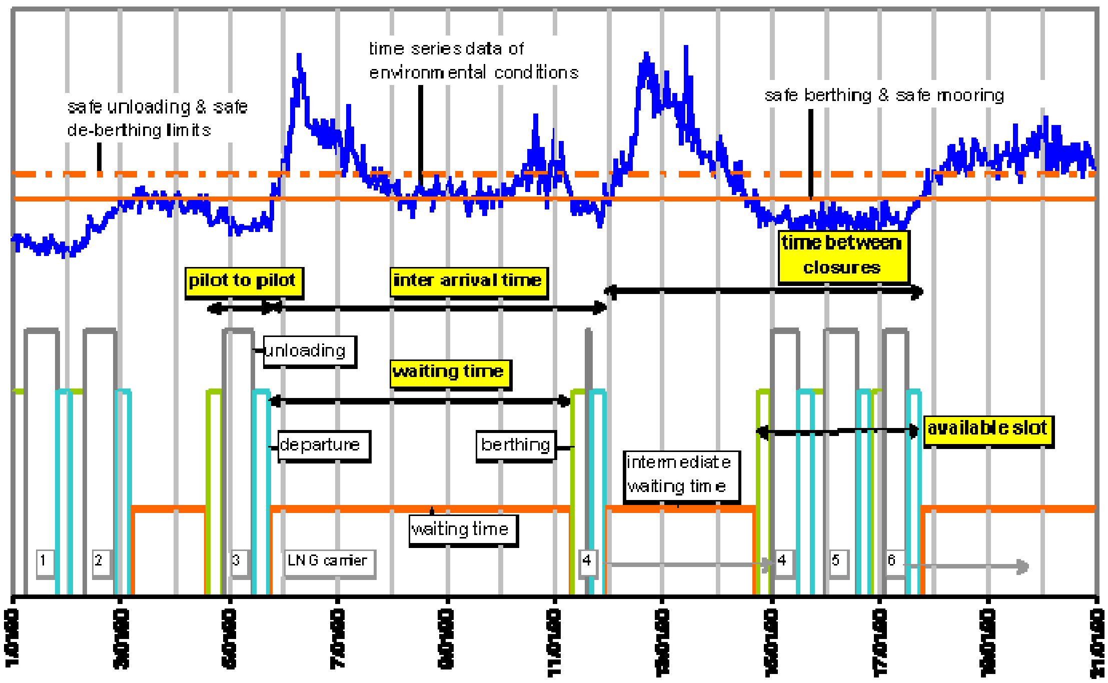



**Figure 6-1: Output Parameter Definitions**

## 6.1 Offshore Site 1

### *6.1.1 Base Case*

Operational limits for the Base Case are presented in Table 6-2.

**Table 6-2: Base Case Operational Limits**

| Operational Limit | Value |
|---|---|
| Approach Limits<br>- Hs | <br>2m |
| Side-by-Side Mooring Limits<br>- Hs<br>- Wind<br>- Current | <br>3m (1)<br>39 knots<br>0.9 knots |
| Departure Limits<br>- Hs | <br>2m |

(1) 2.5m for cross wind conditions

Annual exceedance curves for the four variable output parameters (waiting time, inter-arrival time, time between closures, and available slot), are presented in Figure 6-2 through Figure 6-5. At Site 1, the Base Case results in 91.5% of the carriers experiencing no waiting at all; or 8.5% of all carrier arrivals subject to a delay. This compares to 99.1% of carriers with no delay at the site in Long Island Sound. The largest recorded waiting time is 146 hours, although this is quite a rare occurrence. Downtime is typically associated with the tug limit being exceeded during approach or departure. The exceedance plots for inter-arrival time, time between closures and available slot follow that for downtime.

Figure 6-6 presents the monthly variation in downtime, for 7 levels of exceedance (0.5%, 1%, 2%, 5%, 10%, 50%, and 90%). For instance, 0.5% of vessels experience downtime in excess of 88 hours during January. The largest exceedance values are observed in the fall and winter months, and downtime is experienced in every single month. For the site in Long Island Sound, using the same operational limits, no downtime was recorded in the months of May through August.

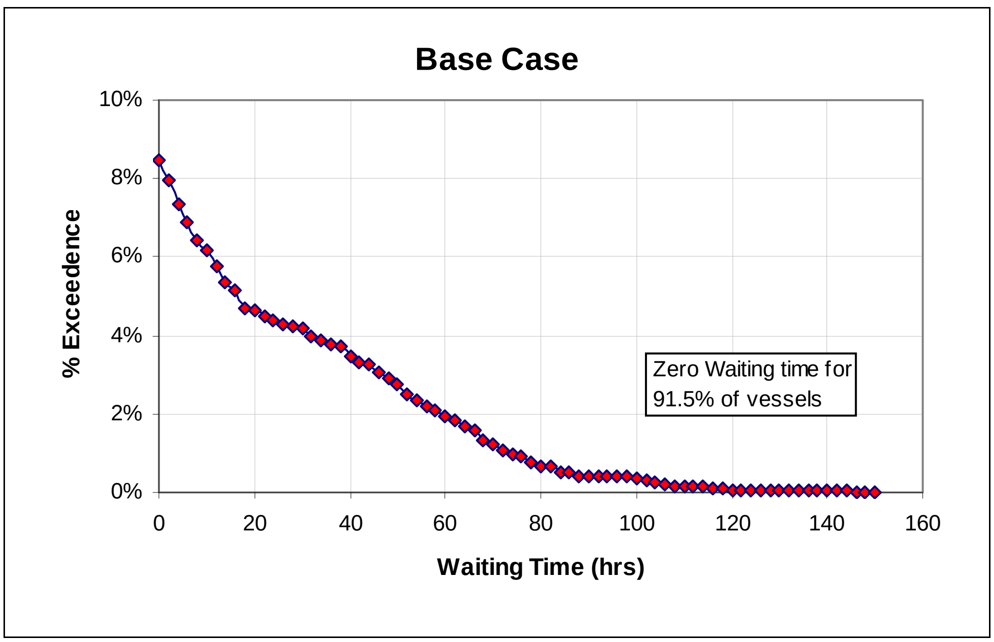



**Figure 6-2: Offshore Site 1, Base Case, Waiting Time**

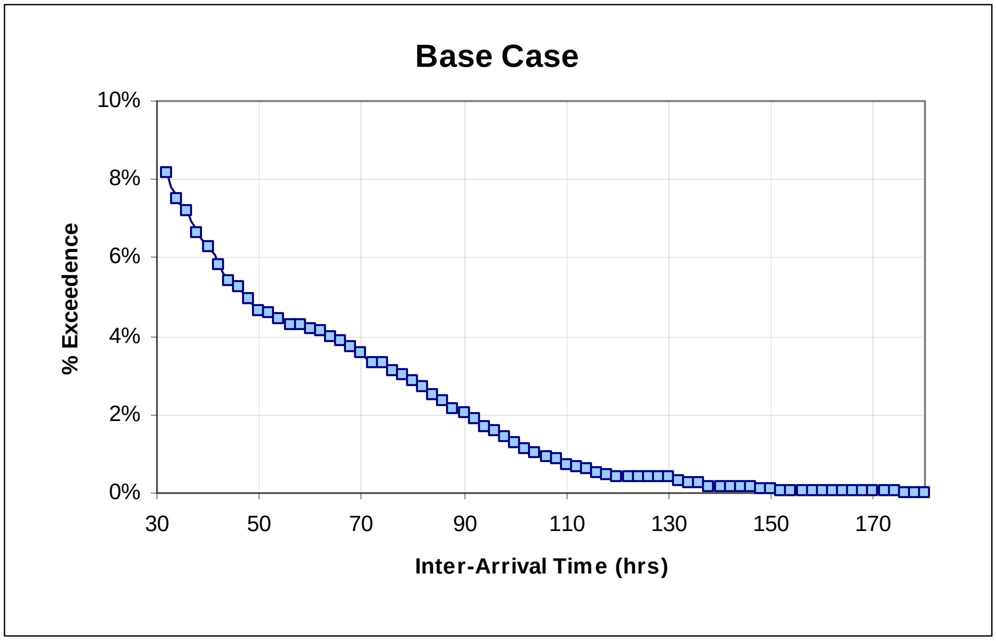



**Figure 6-3: Offshore Site 1, Base Case, Inter-Arrival Time**

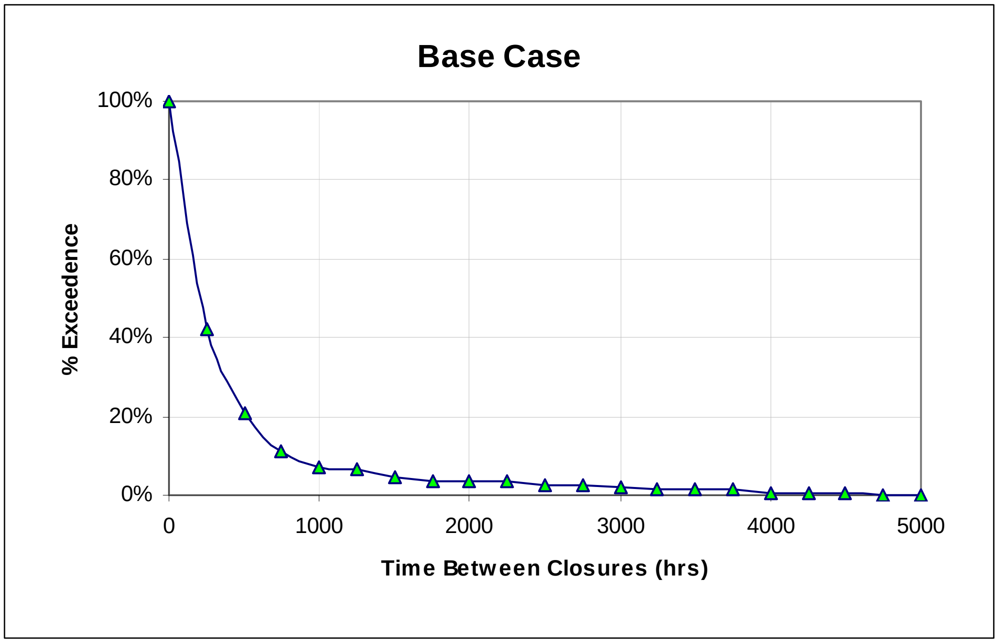



**Figure 6-4: Offshore Site 1, Base Case, Time Between Closures**

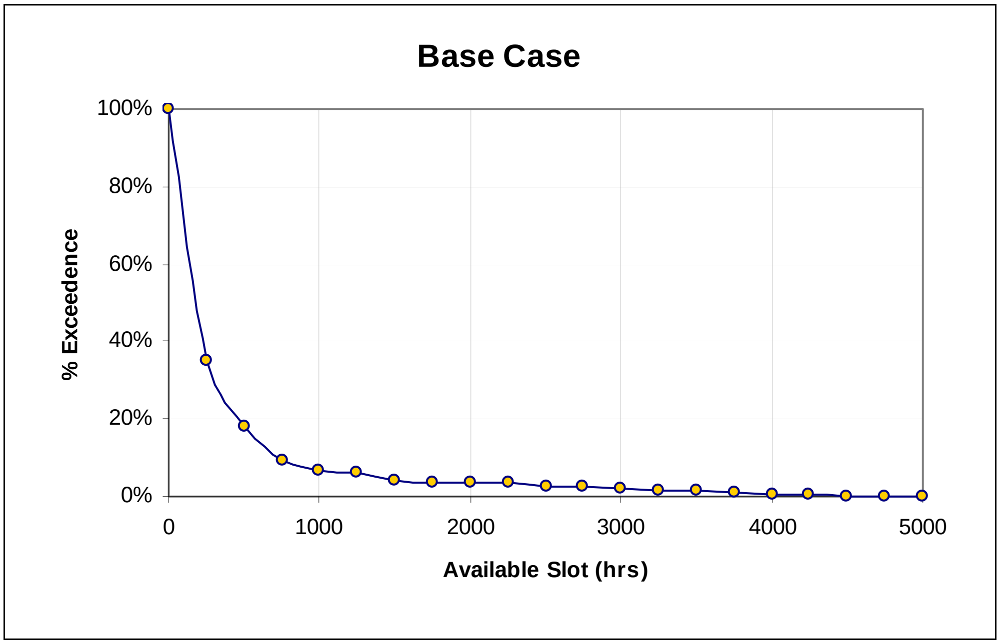



**Figure 6-5: Offshore Site 1, Base Case, Available Slot**

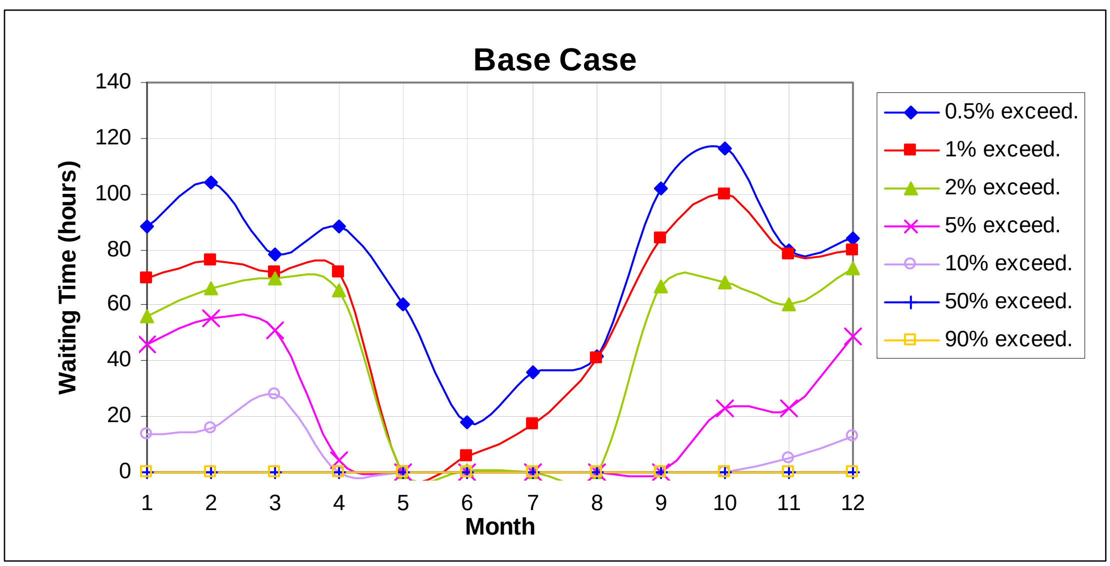



**Figure 6-6: Offshore Site 1, Base Case, Summary**

### *6.1.2 Sensitivity Case 1: Increase in Wave Height Limits*

Operational limits for Sensitivity Case 1 are presented in Table 6-3. This case assumes a half meter increase in wave height limits for approach and departure, as well as side-by-side operations.

**Table 6-3: Sensitivity Case 1 Operational Limits**

| Operational Limit | Value |
|---|---|
| Approach Limits<br>- Hs | <br>2.5m |
| Side-by-Side Mooring Limits<br>- Hs<br>- Wind<br>- Current | <br>3.5m (1)<br>39 knots<br>0.9 knots |
| Departure Limits<br>- Hs | <br>2.5m |

(1) 3m for cross wind conditions

Annual exceedance curves for the four variable output parameters are presented in Figure 6-7 through Figure 6-10, while monthly exceedance values for downtime are presented in Figure 6-11. This case results in less downtime than the Base Case: 3.1% of vessels experience some delay. The largest recorded waiting time is 108 hours, not as lengthy as for the Base Case, but a relatively rare occurrence, as for the Base Case. Downtime is experienced in all months of the year except for July; however the 0.5% exceedance value is 0 hours for the months of May through July and the durations of individual downtime occurrences are less.

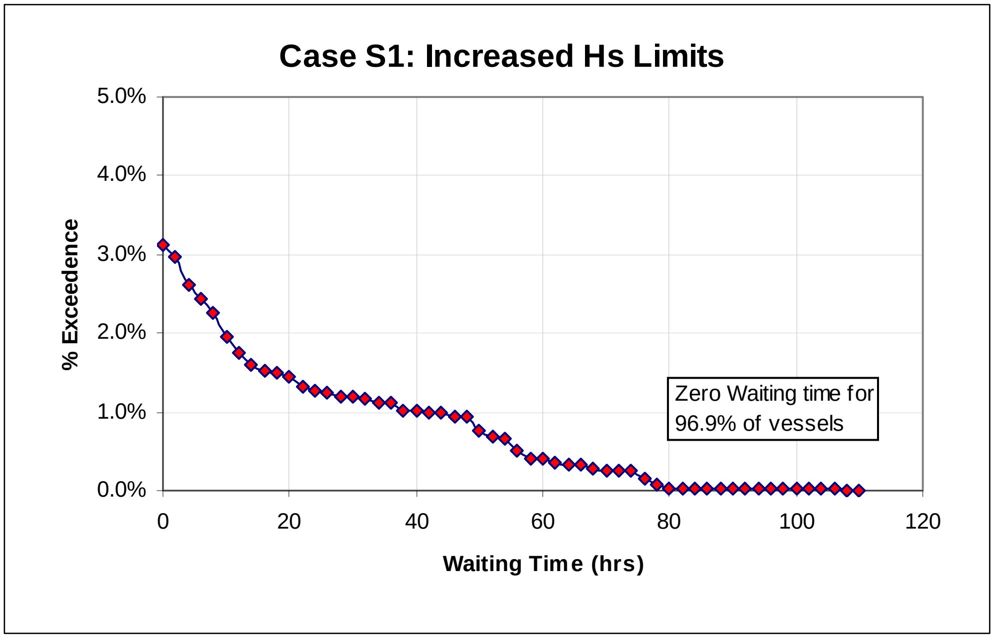



**Figure 6-7: Offshore Site 1, Case S1, Waiting Time**

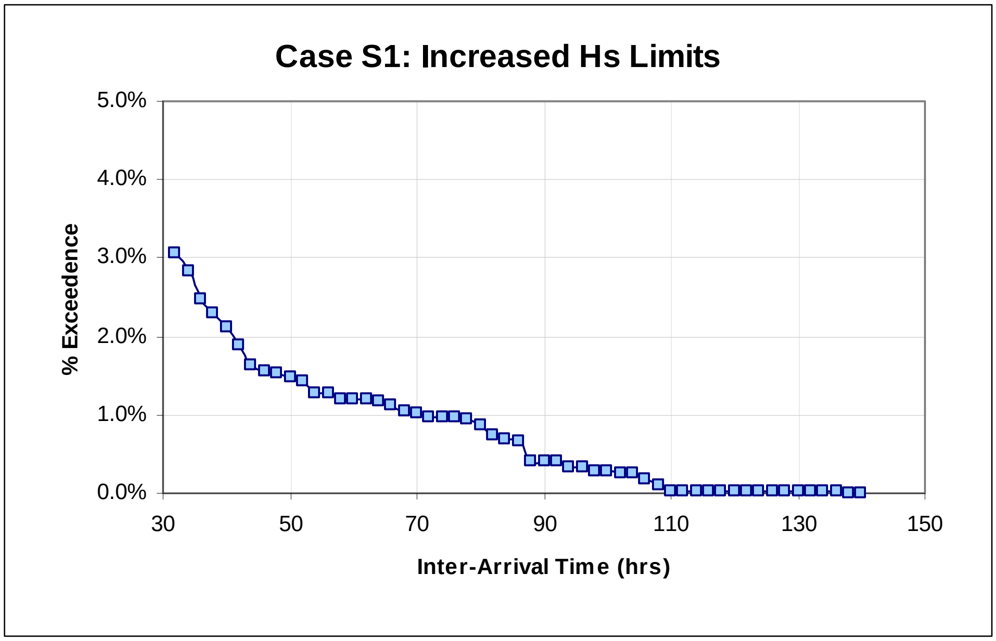



**Figure 6-8: Offshore Site 1, Case S1, Inter-Arrival Time**

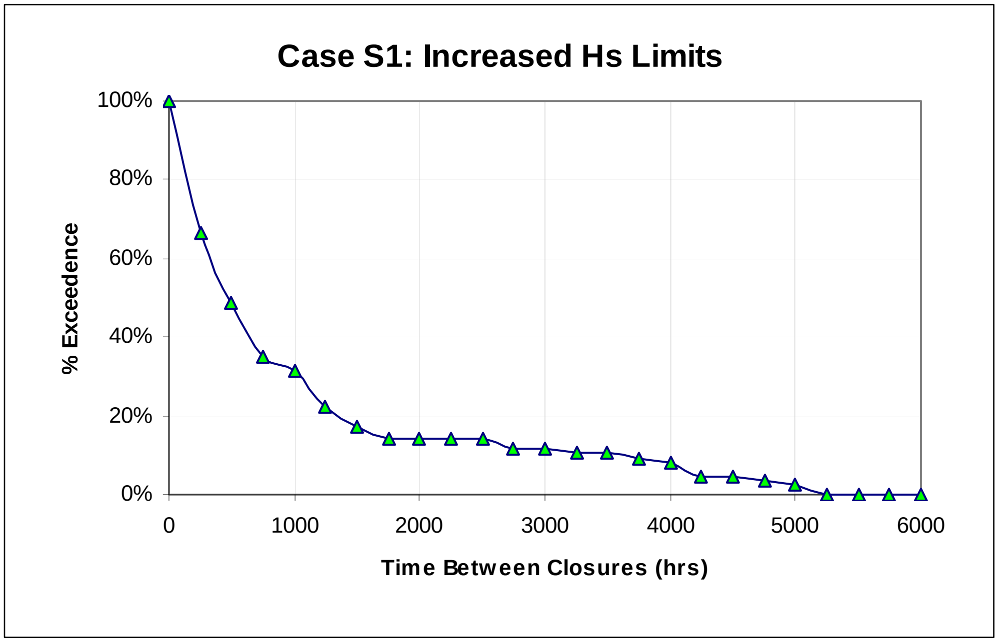



**Figure 6-9: Offshore Site 1, Case S1, Time Between Closures**

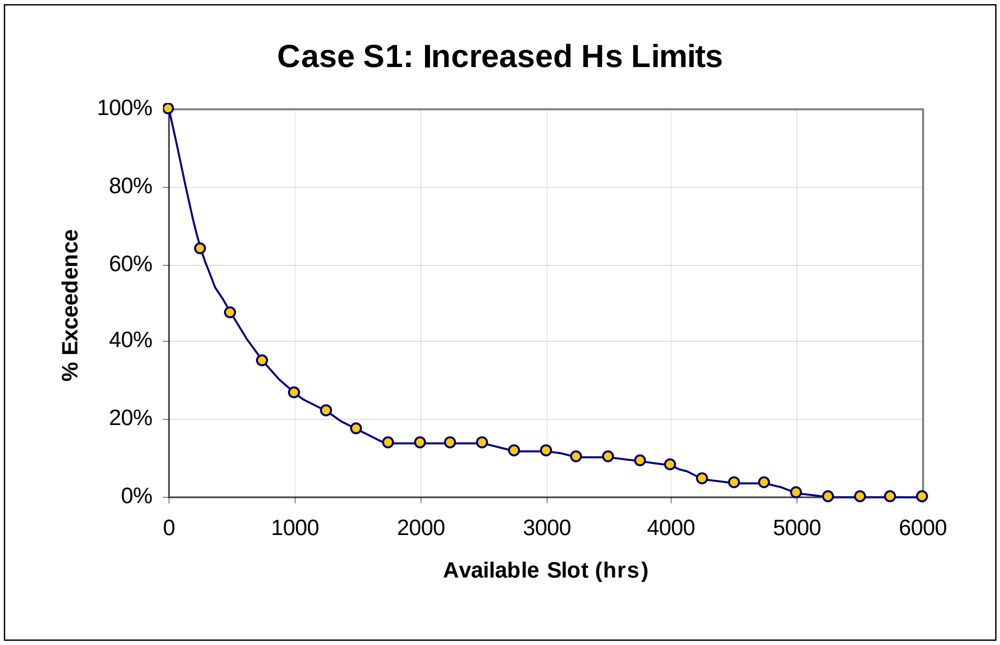



**Figure 6-10: Offshore Site 1, Case S1, Available Slot**

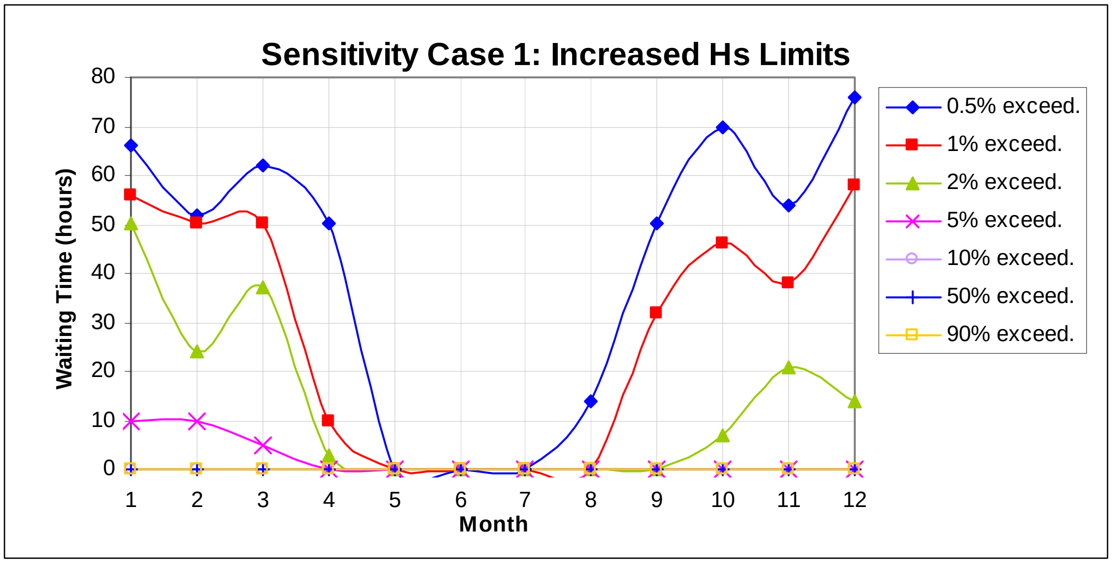



**Figure 6-11: Offshore Site 1, Case S1, Summary**

### *6.1.3 Sensitivity Case 2: Further Increase in Wave Height Limits*

Operational limits for Sensitivity Case 2 are presented in Table 6-4. This case assumes a further half meter increase in wave height limits for approach, departure, and side-by-side operations.

**Table 6-4: Sensitivity Case 2 Operational Limits**

| Operational Limit | Value |
|---|---|
| Approach Limits<br>- Hs | <br>3m |
| Side-by-Side Mooring Limits<br>- Hs<br>- Wind<br>- Current | <br>4m (1)<br>39 knots<br>0.9 knots |
| Departure Limits<br>- Hs | <br>3m |

(1) 3.5m for cross wind conditions

Annual exceedance curves for the four variable output parameters are presented in Figure 6-12 through Figure 6-15, while monthly exceedance values for downtime are presented in Figure 6-16. As expected, this case results in less downtime than the Base Case or Sensitivity Case 1, but nonetheless more downtime than the original Base Case for the location in Long Island Sound, which had more severe operational wave height limits, but experiences a more benign climate: 1.3% of vessel arrivals experience some downtime. The largest recorded waiting time is 92 hours, a relatively rare occurrence, and not as lengthy as for the Base Case or Sensitivity Case 1. For this case, no downtime is experienced in June or July.

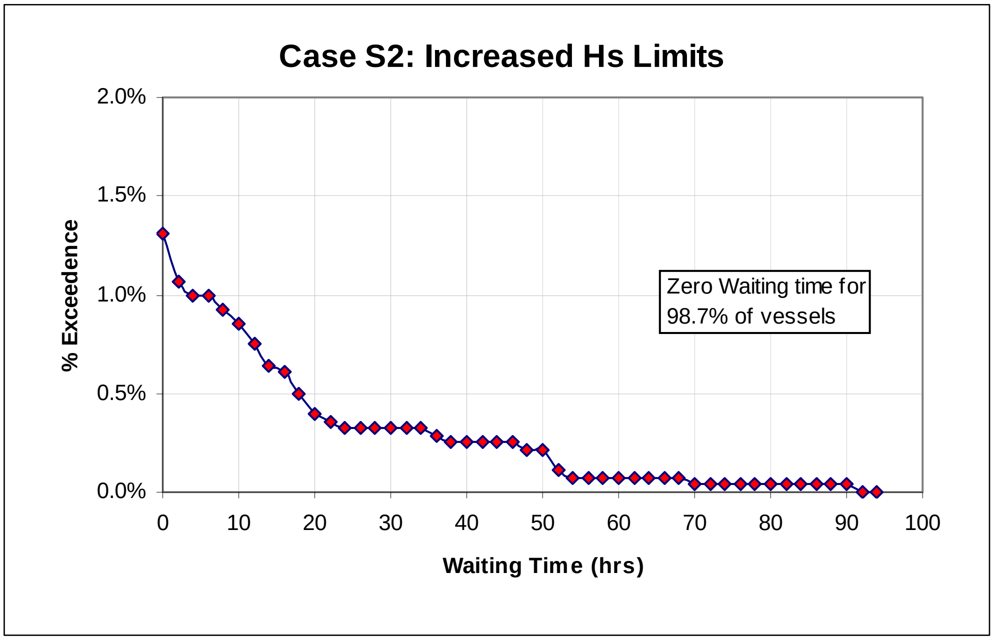



**Figure 6-12: Offshore Site 1, Case S2, Waiting Time**

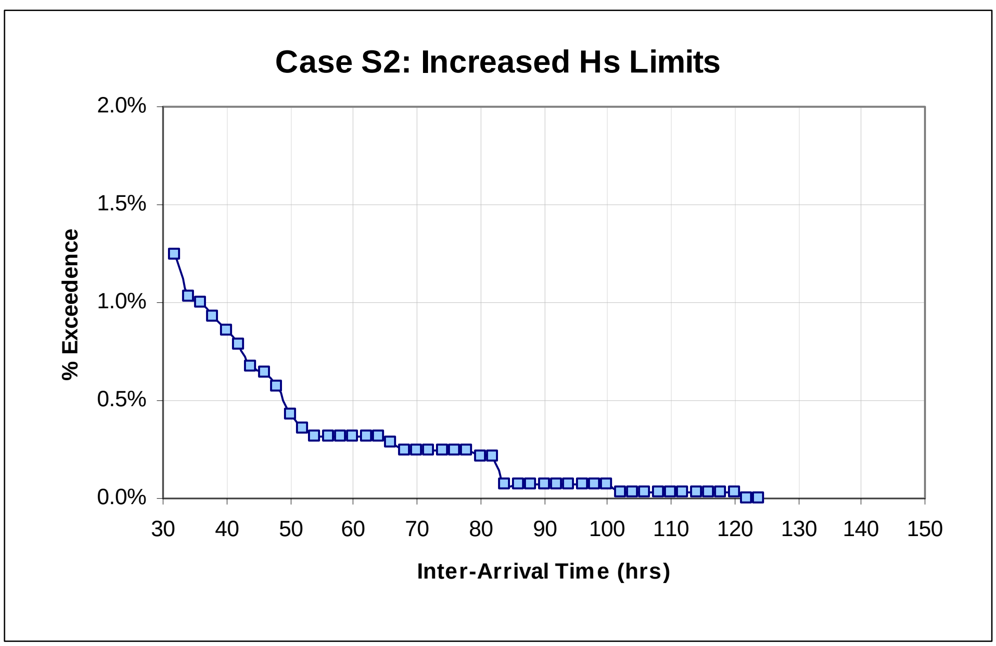



**Figure 6-13: Offshore Site 1, Case S2, Inter-Arrival Time**

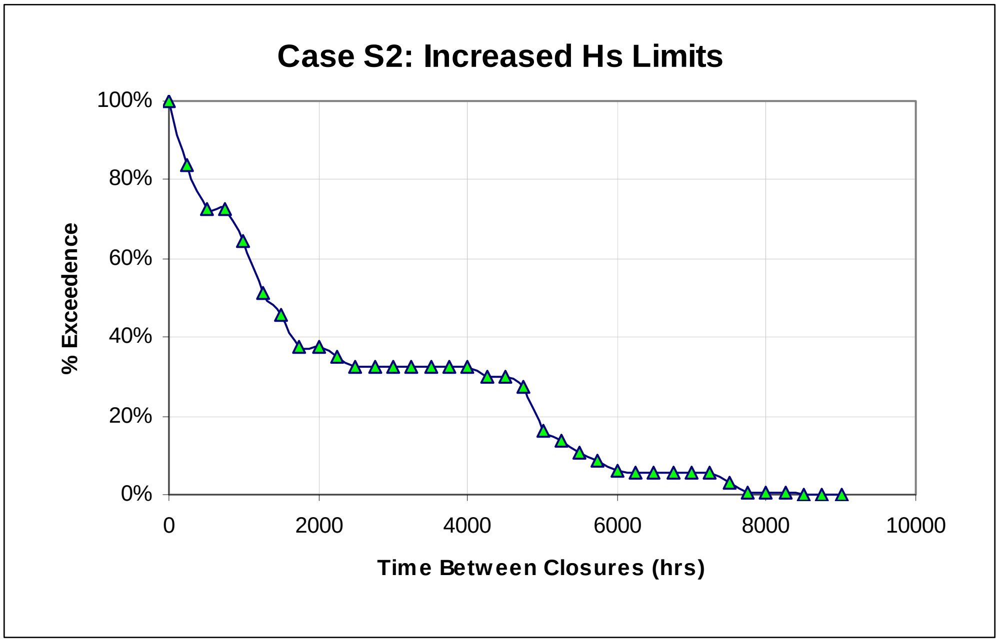



**Figure 6-14: Offshore Site 1, Case S2, Time Between Closures**

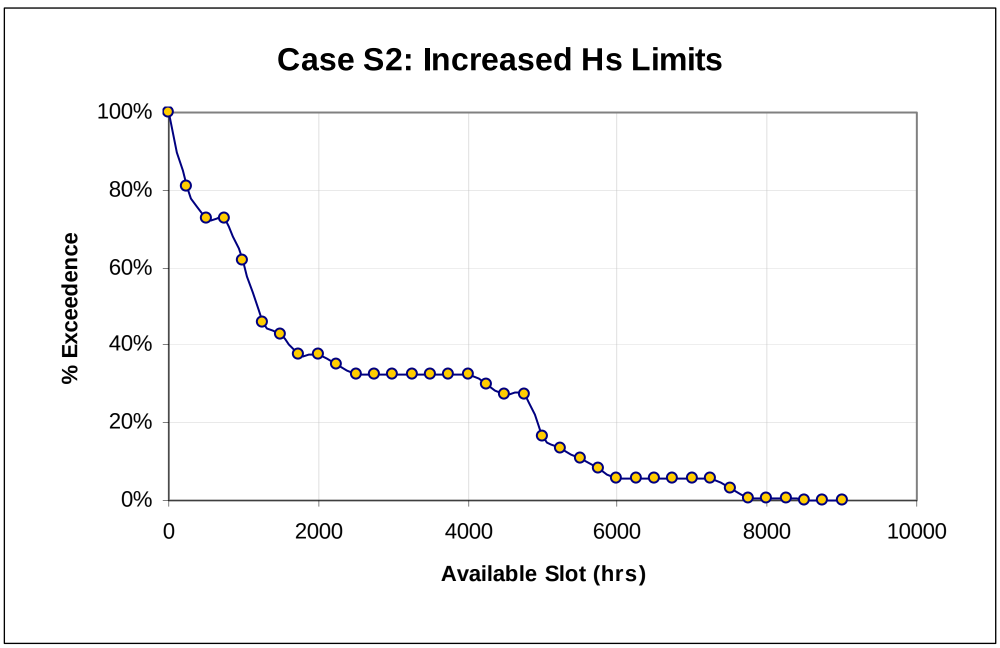



**Figure 6-15: Offshore Site 1, Case S2, Available Slot**

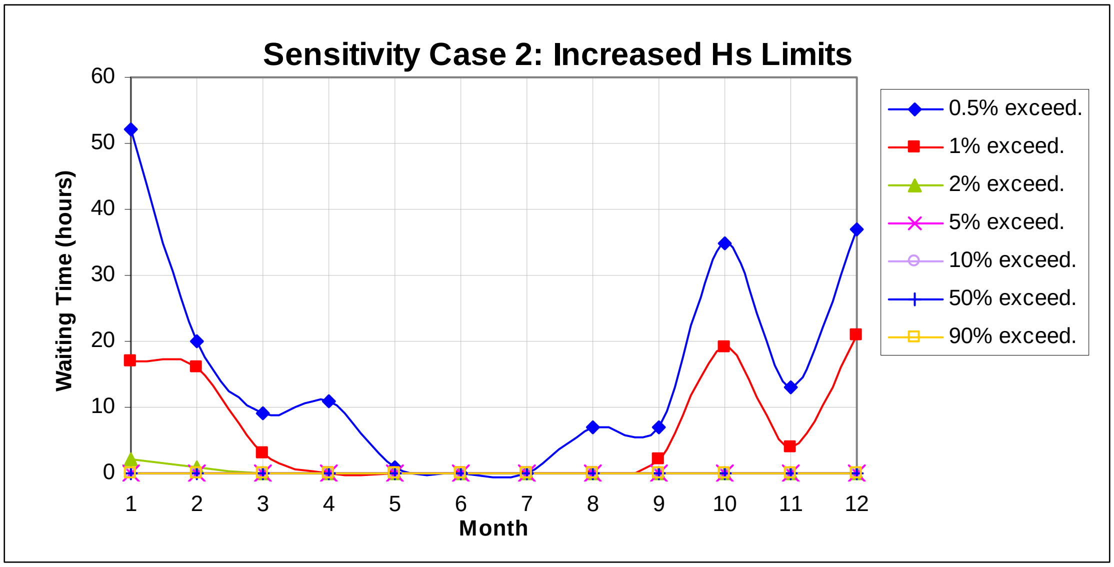



**Figure 6-16: Offshore Site 1, Case S2, Summary**

## 6.2 Offshore Site 2

### *6.2.1 Base Case*

Operational limits for the Base Case are identical to those presented in Section 6.1.1 for Site 1.

Annual exceedance curves for the four variable output parameters (waiting time, inter-arrival time, time between closures, and available slot), are presented in Figure 6-17 through Figure 6-20. At site 2 the Base Case operational limits result in 14.7% of all carrier arrivals subject to a delay. This compares to 0.9% of carriers experiencing a delay at the site in Long Island Sound and 8.5% of carriers at offshore site 1. The 0.5% exceedance value is 98 hours of delay. The exceedance plots for inter-arrival time, time between closures and available slot follow that for downtime.

Figure 6-21 presents the monthly variation in downtime, for 7 levels of exceedance (0.5%, 1%, 2%, 5%, 10%, 50%, 90%). The largest exceedance values are observed in the fall and winter months, and downtime is experienced in every single month.

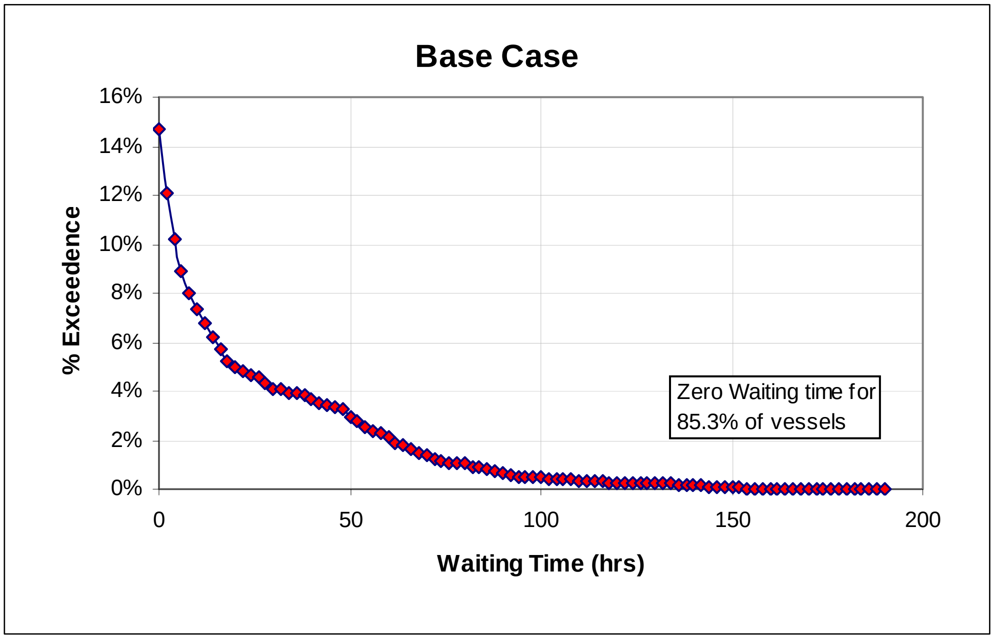



**Figure 6-17: Offshore Site 2, Base Case, Waiting Time**

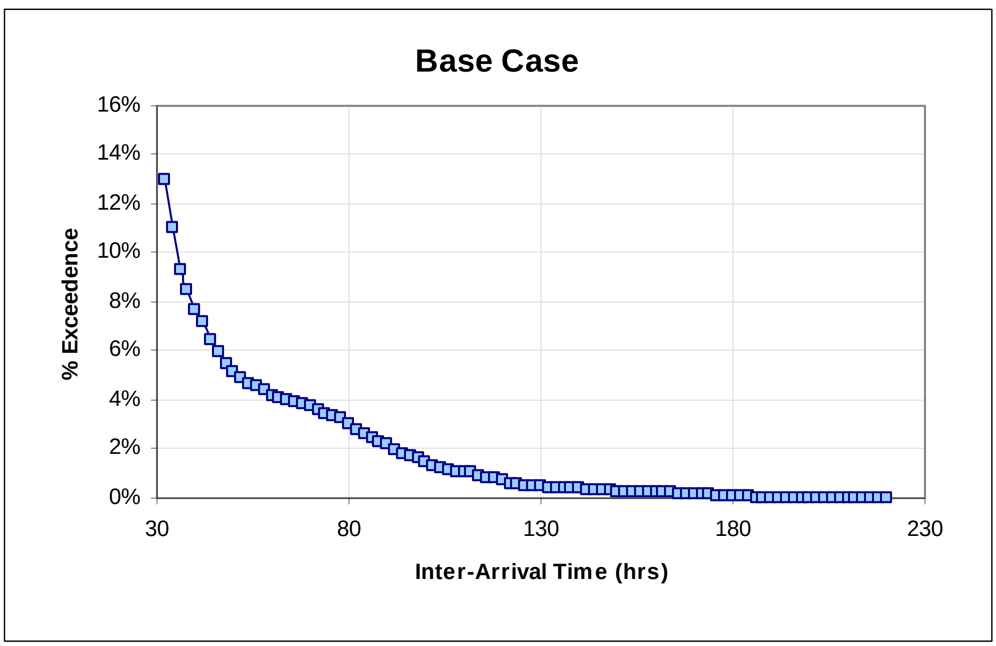



**Figure 6-18: Offshore Site 2, Base Case, Inter-Arrival Time**

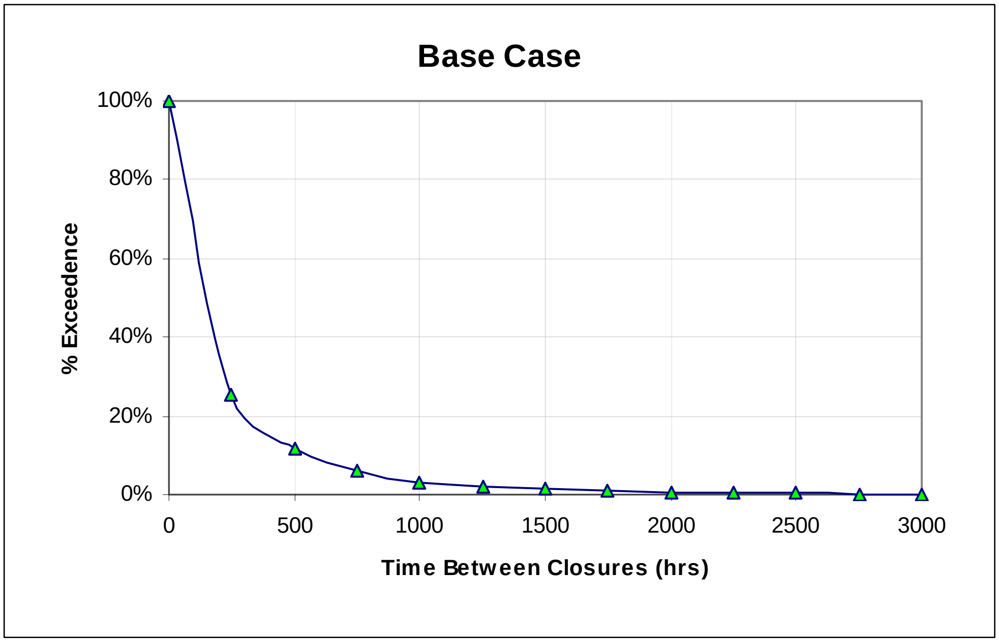



**Figure 6-19: Offshore Site 2, Base Case, Time Between Closures**

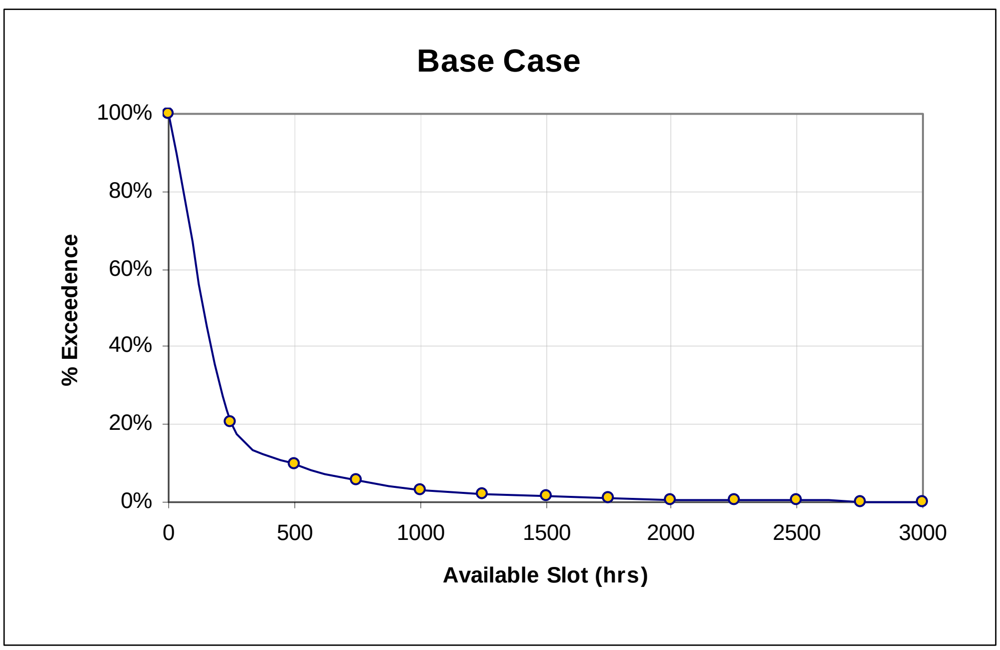



**Figure 6-20: Offshore Site 2, Base Case, Available Slot**

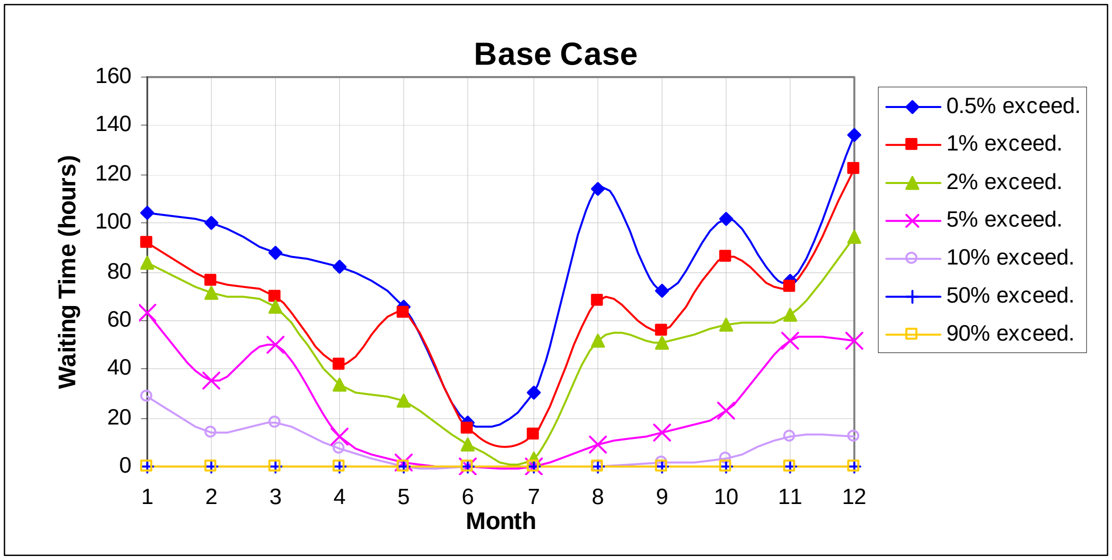



**Figure 6-21: Offshore Site 2, Base Case, Summary**

### *6.2.2 Sensitivity Case 1: Increase in Wave Height Limits*

Operational limits for Sensitivity Case 1 are identical for those shown for Site 1 in Table 6-3. This case assumes a half meter increase in wave height limits for approach, departure, and side-by-side operations.

Annual exceedance curves for the four variable output parameters are presented in Figure 6-22 through Figure 6-25, while monthly exceedance values for downtime are presented in Figure 6-26. As expected, this case results in less downtime than the Base Case: 8.4% (as opposed to 14.7%) of vessels experience some delay. The 0.5% exceedance value on an annual basis is 65 hours, not as lengthy as for the Base Case. Downtime is experienced in all months of the year.

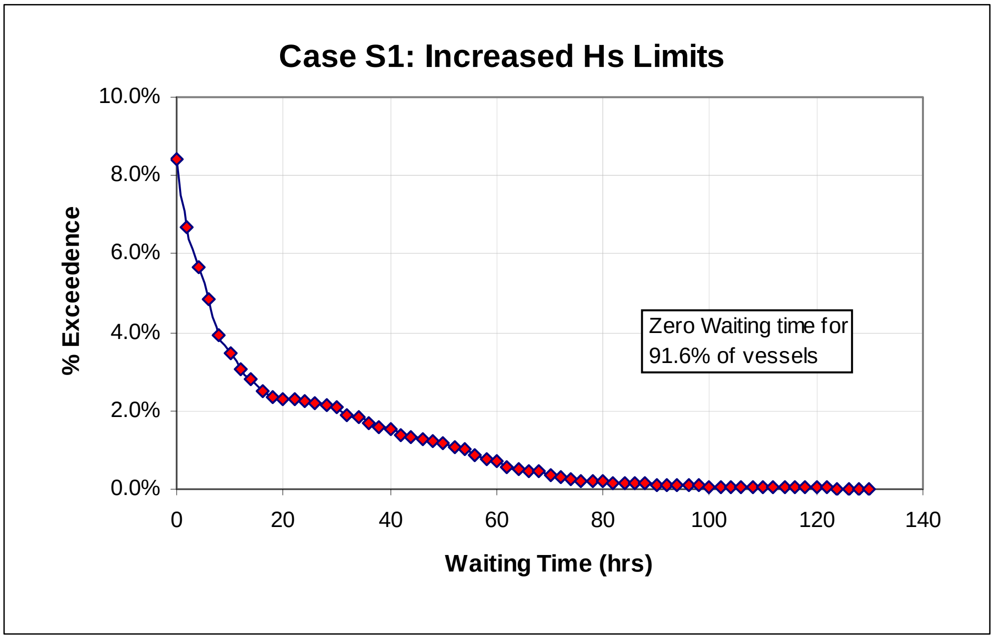



**Figure 6-22: Offshore Site 2, Case S1, Waiting Time**

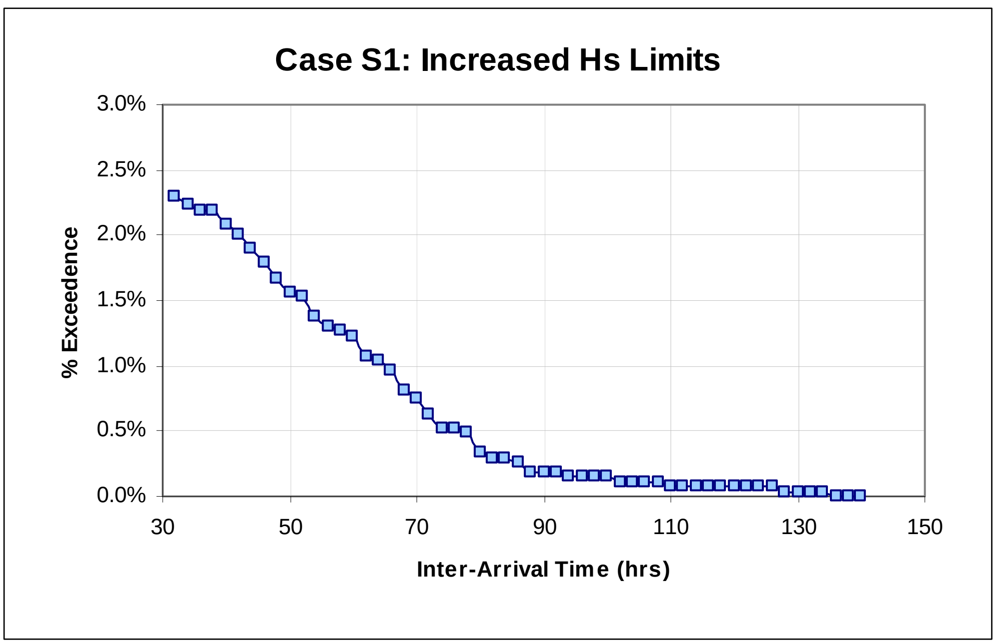



**Figure 6-23: Offshore Site 2, Case S1, Inter-Arrival Time**

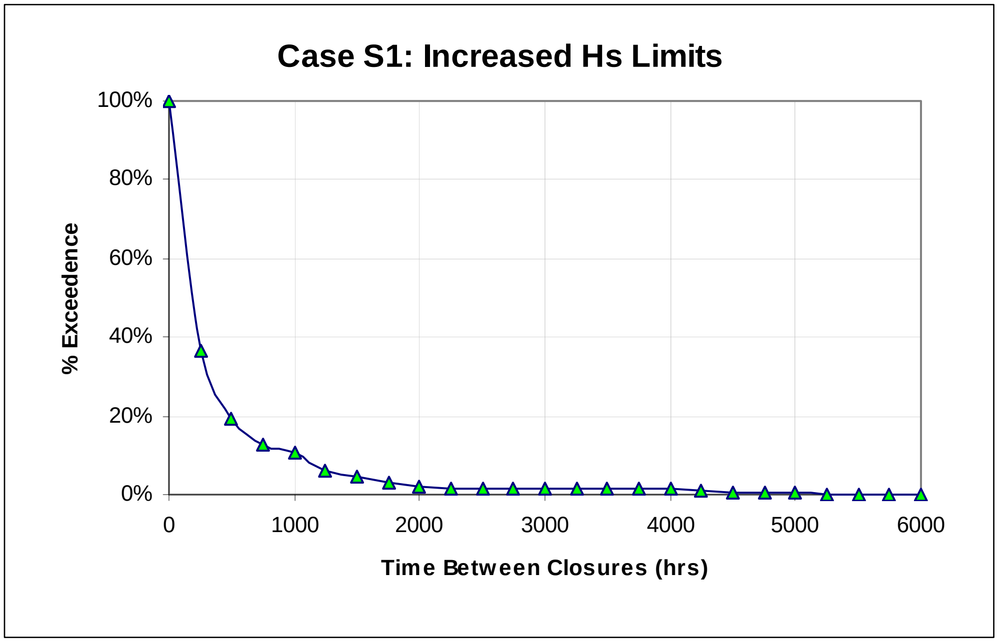



**Figure 6-24: Offshore Site 2, Case S1, Time Between Closures**

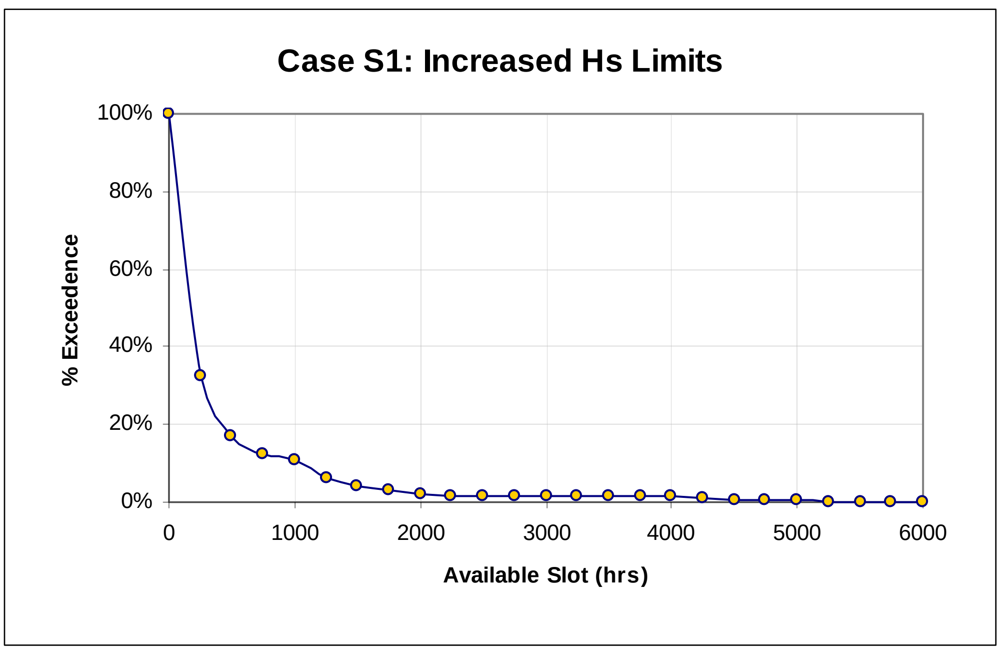



**Figure 6-25: Offshore Site 2, Case S1, Available Slot**

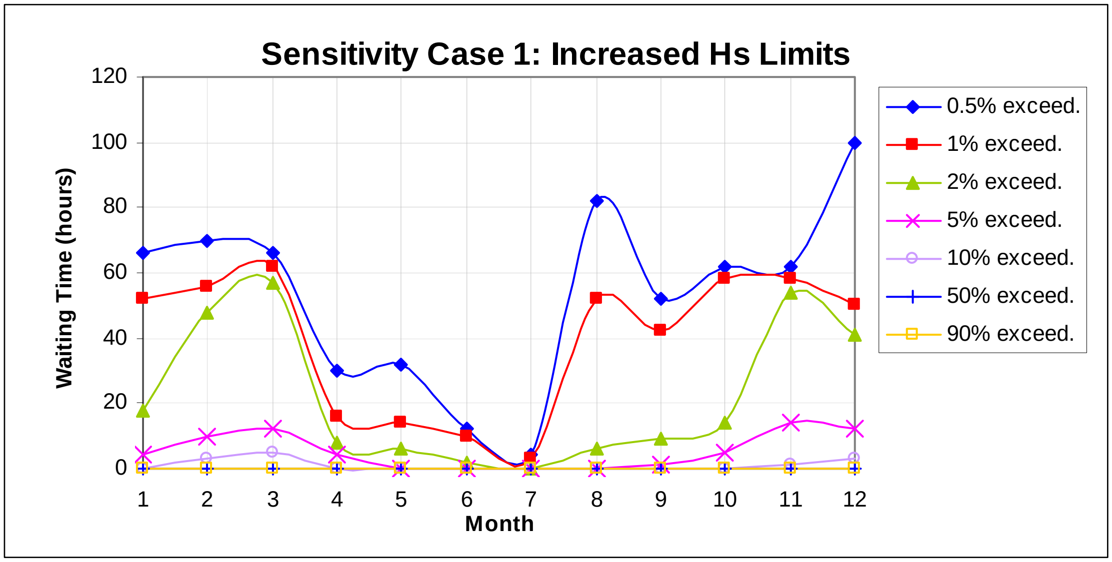



**Figure 6-26: Offshore Site 2, Case S1, Summary**

### *6.2.3 Sensitivity Case 2: Further Increase in Wave Height Limits*

Operational limits for Sensitivity Case 2 are identical to those presented in Table 6-4 for Site 1. This case assumes a further half meter increase in wave height limits for approach, departure, and side-by-side operations.

Annual exceedance curves for the four variable output parameters are presented in Figure 6-27 through Figure 6-30, while monthly exceedance values for downtime are presented in Figure 6-31. As expected, this case results in less downtime than the Base Case or Sensitivity Case 1, but nonetheless more downtime than the original Base Case for the location in Long Island Sound: 4.2% of vessel arrivals experience some downtime. The annual 0.5% exceedance value is 36 hours, smaller than for either the Base Case or Sensitivity Case 1 for this site. For this case, no downtime is recorded in the month of June.

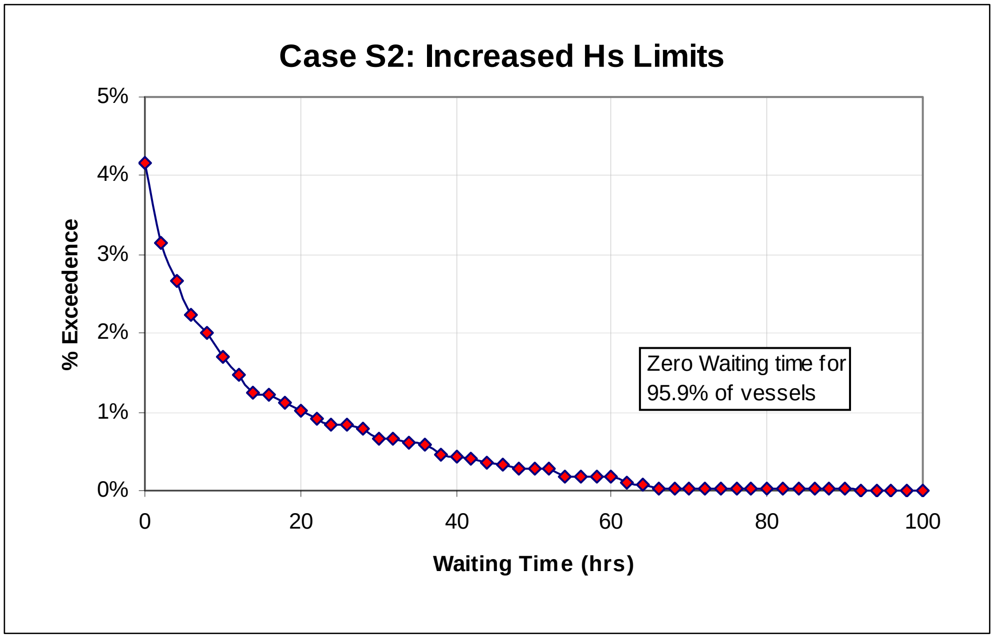



**Figure 6-27: Offshore Site 2, Case S2, Waiting Time**

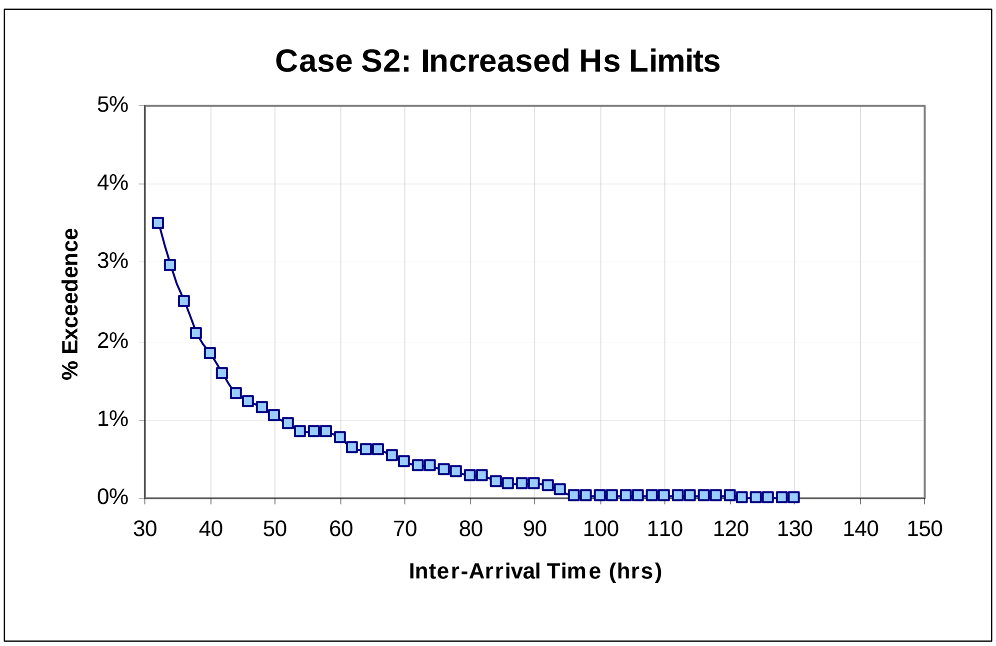



**Figure 6-28: Offshore Site 2, Case S2, Inter-Arrival Time**

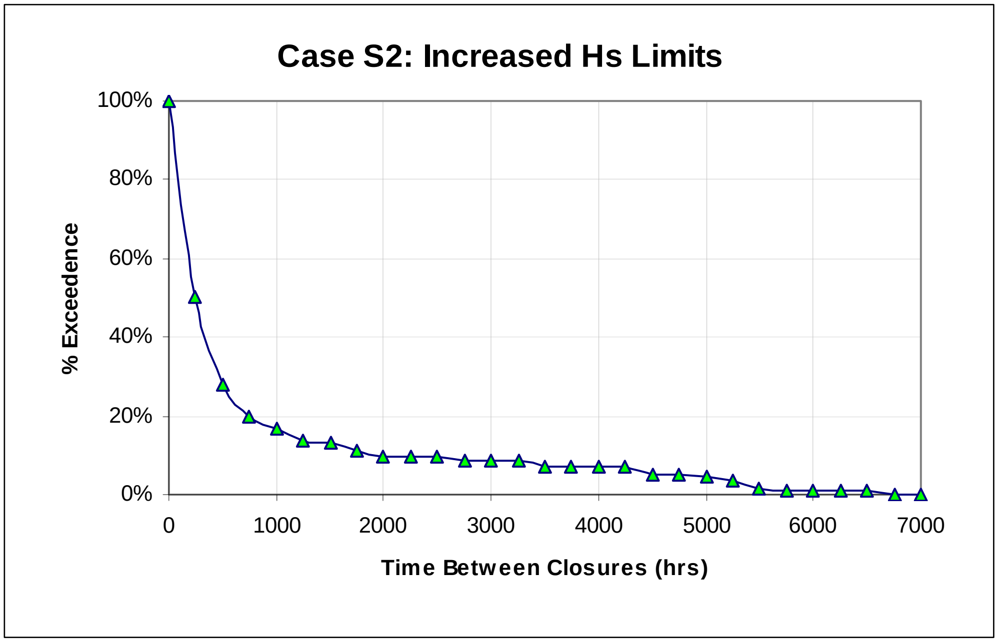



**Figure 6-29: Offshore Site 2, Case S2, Time Between Closures**

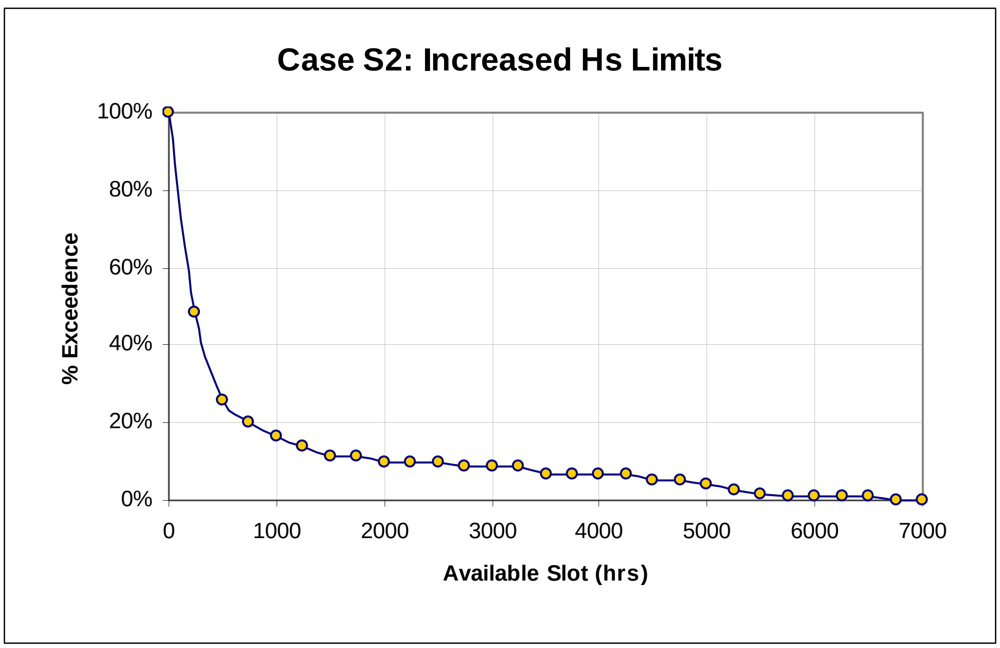



**Figure 6-30: Offshore Site 2, Case S2, Available Slot**

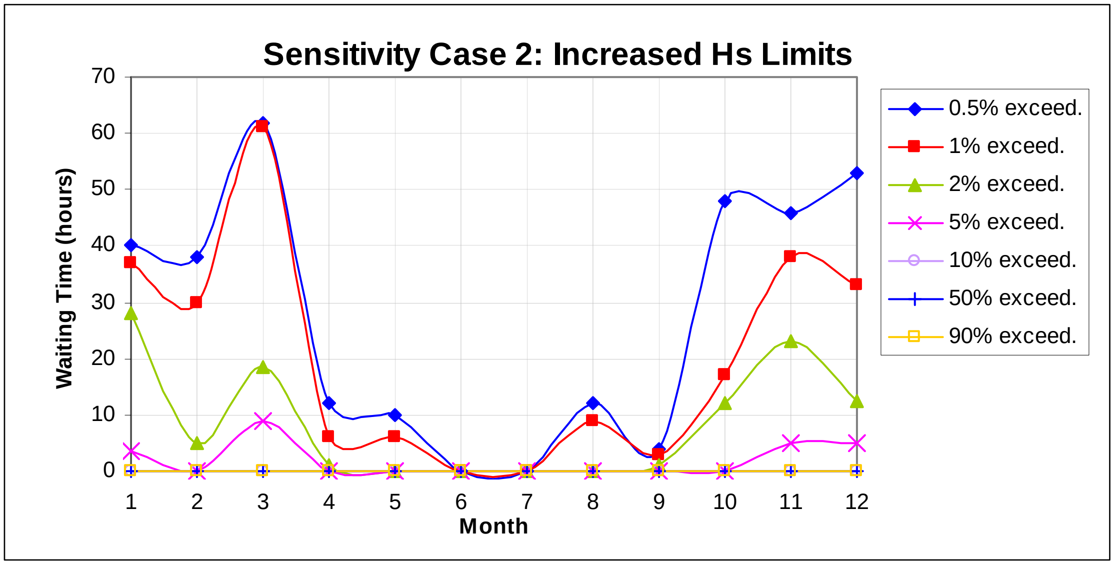



**Figure 6-31: Offshore Site 2, Case S2, Summary**

## 6.3 Comparison of Downtime at the Offshore Sites and at the Long Island Sound Site

A comparison of downtime, in terms of the percent of arriving LNG Carriers that incur a wait at the two offshore sites and at the original Long Island Sound site, is presented in Table 6-5. The downtime estimates for the two offshore sites are significantly higher than that for the proposed project site in Long Island Sound. Even when assuming higher wave height limits for tug operability at the offshore sites, the downtime estimates still exceed that for the Long Island site. Offshore site 2 gives the highest downtime.

**Table 6-5: Comparison of Downtime Estimates**

| | % of LNG Carrier Arrivals that Incur a Wait | | |
|---|---|---|---|
| | **Base Case** | **Case S1** | **Case S2** |
| Long Island Sound | 0.9% | na | na |
| Offshore Site 1 | 8.5% | 3.1% | 1.3% |
| Offshore Site 2 | 14.7% | 8.4% | 4.2% |

## 7.0 CONCLUSIONS

This study provides the estimated marine operability for the Broadwater FSRU at two alternative sites in the Atlantic Ocean, offshore New York Harbor entrance area.

There are differences in the Metocean data due to the site location. Wave heights for the two alternative sites are higher than that at the original proposed LIS site since these two sites are located in the open Atlantic Ocean. Buoy 44025 is located near Site-2 and it has the highest wave heights due to it is located further offshore than Site-1 and the LIS site.

A set of operational simulation analyses for the FSRU system has been performed to investigate the effects of duration and persistence of wave heights on the operability of the two proposed alternative sites. Three operating wave limits (Hs) are used in this study: Base-case with Hs=2.0m and two sensitivity cases with Hs=2.5m and 3.0m.

The results of the simulation analyses provide the estimated FSRU availability in term of percent of LNG vessels experiencing no waiting at all. The base-case results with 2.0m operating wave limit indicate that, at the original LIS site, there will be 99.1% of LNG vessels which will experience no waiting at all. At Site-1, there will be 91.5% of LNG vessels experiencing no waiting at all. At Site-2, there will be 85.3% of LNG vessels experiencing no waiting at all.

With the operating wave limit increases from 2.0m to 2.5m or 3.0m, the percent of LNG vessels experiencing no waiting at all will also increase. Overall, the results for Site-2 show the lowest percent of LNG vessels experiencing no waiting at all since it is located further offshore and the wave heights are the highest of all three sites.

## 8.0 REFERENCES

1. M&N Report (June 15, 2005): "Final Summary Report – Broadwater LNG Project FSRU marine Operability Study"

2. Battelle (April 2007): "Review of Ocean Conditions Data and their Impact on Project Feasibility"

# APPENDIX A

# METOCEAN DATA & PRELIMINARY OPERABILITY ASSESSMENT FOR WIS-A123 & WIS-A119

## A.1 Metocean Data for WIS-A123 and WIS-A119

This Appendix presents the Metocean data from WIS-A123 and WIS-A119 and the preliminary berth operability assessment using these Metocean data.

It is noted that the wave statistics presented in this study are for the twenty years between 1980 and 1999. They are slightly different from those in the document from the State of New York which used the ten-year data from 1990 to 1999.

### A.1.1 Wind and Wave Statistics for WIS-A123

Alternative Site 1 is located near the middle of two WIS stations (A123 and A124). Wind and wave statistics for WIS-A123 for the twenty year duration of 1980 to 1999 are presented here for reference. Wave heights at WIS-A123 are lower than those at WIS-A124 for no apparent explanations since WIS-A123 is located further offshore.

Table A-1 provides the wave exceedance statistics with monthly distribution breakdowns for WIS-A123. It shows that the percent of exceedance for significant wave height (Hs) > 2.0m varies from 0.4% in June to 10.4% (i.e., about 3.2 out of 31 days) in January with an annul average of 5.0%. While, for Hs > 3.0m, it varies from 0.0% in June to 1.8% in January with an annul average of 0.7%.

Table A-2 provides the joint wind and wave statistics for WIS-A123. It shows that the percent of non-exceedance is 95.0% (or 5% exceedance) for wind speed Vs=35.0 kt and wave height Hs=2.0m and 99.2% for wind speed Vs=35.0 kt and wave height Hs=3.0m.

## Table A-1: Wave Statistics for WIS-A123

**Alternative Site 1: WIS Station A123 - Wave Statistics - Monthly (1980-1999)**

**Percent of Exceedance**

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **> 0.5** | **> 1.0** | **> 1.5** | **> 2.0** | **> 2.5** | **> 3.0** | **> 3.5** | **> 4.0** | **> 4.5** | **> 5.0** |
| **Jan** | 89.6% | 54.6% | 24.4% | 10.4% | 4.3% | 1.8% | 0.9% | 0.4% | 0.1% | 0.0% |
| **Feb** | 87.4% | 50.5% | 21.0% | 7.0% | 2.8% | 1.0% | 0.3% | 0.1% | 0.0% | 0.0% |
| **Mar** | 83.4% | 46.4% | 18.5% | 7.7% | 3.2% | 1.3% | 0.6% | 0.4% | 0.2% | 0.1% |
| **Apr** | 78.0% | 38.0% | 13.4% | 4.2% | 1.3% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| **May** | 77.1% | 27.5% | 6.9% | 1.2% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **June** | 71.9% | 18.8% | 3.9% | 0.4% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **July** | 67.3% | 13.7% | 3.3% | 0.8% | 0.2% | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Aug** | 72.0% | 18.9% | 5.2% | 2.0% | 0.7% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Sept** | 80.2% | 34.4% | 9.8% | 2.7% | 1.0% | 0.5% | 0.2% | 0.0% | 0.0% | 0.0% |
| **Oct** | 81.1% | 37.4% | 13.3% | 5.3% | 1.9% | 0.8% | 0.3% | 0.1% | 0.1% | 0.0% |
| **Nov** | 88.7% | 52.7% | 22.4% | 9.2% | 3.7% | 1.4% | 0.3% | 0.1% | 0.1% | 0.0% |
| **Dec** | 87.9% | 52.2% | 21.5% | 9.2% | 2.9% | 1.4% | 0.7% | 0.3% | 0.2% | 0.1% |
| **Annual** | 80.4% | 37.0% | 13.6% | 5.0% | 1.9% | 0.7% | 0.3% | 0.1% | 0.1% | 0.0% |

**Percent of Occurrence**

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **0.0 - 0.5** | **0.5 - 1.0** | **1.0 - 1.5** | **1.5 - 2.0** | **2.0 - 2.5** | **2.5 - 3.0** | **3.0 - 3.5** | **3.5 - 4.0** | **4.0 - 4.5** | **4.5 - 5.0** |
| **Jan** | 10.4% | 35.0% | 30.2% | 14.0% | 6.0% | 2.5% | 0.9% | 0.5% | 0.3% | 0.1% |
| **Feb** | 12.6% | 37.0% | 29.5% | 14.0% | 4.2% | 1.8% | 0.7% | 0.2% | 0.1% | 0.0% |
| **Mar** | 16.6% | 37.0% | 27.9% | 10.8% | 4.4% | 2.0% | 0.7% | 0.2% | 0.2% | 0.1% |
| **Apr** | 22.0% | 40.1% | 24.6% | 9.2% | 3.0% | 1.0% | 0.2% | 0.0% | 0.0% | 0.0% |
| **May** | 22.9% | 49.7% | 20.6% | 5.7% | 0.9% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% |
| **June** | 28.1% | 53.2% | 14.9% | 3.5% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **July** | 32.7% | 53.6% | 10.4% | 2.4% | 0.6% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Aug** | 28.0% | 53.1% | 13.7% | 3.2% | 1.3% | 0.7% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Sept** | 19.8% | 45.8% | 24.6% | 7.2% | 1.6% | 0.6% | 0.3% | 0.1% | 0.0% | 0.0% |
| **Oct** | 18.9% | 43.7% | 24.1% | 8.0% | 3.4% | 1.1% | 0.5% | 0.2% | 0.1% | 0.0% |
| **Nov** | 11.3% | 36.0% | 30.3% | 13.2% | 5.5% | 2.4% | 1.0% | 0.2% | 0.0% | 0.0% |
| **Dec** | 12.1% | 35.8% | 30.7% | 12.3% | 6.3% | 1.5% | 0.7% | 0.4% | 0.1% | 0.1% |
| **Annual** | 19.7% | 43.4% | 23.4% | 8.6% | 3.1% | 1.2% | 0.4% | 0.2% | 0.1% | 0.0% |

## Table A-2: Joint Wind and Wave Statistics for WIS-A123

**Alternative Site 1: WIS Station A123 - Joint Wind & Wave Statistics - Annual (1980-1999)**

Percent of Occurence

| | Significant wave height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wind, kt** | **0.0 - 0.5** | **0.5 - 1.0** | **1.0 - 1.5** | **1.5 - 2.0** | **2.0 - 2.5** | **2.5 - 3.0** | **3.0 - 3.5** | **3.5 - 4.0** | **4.0 - 4.5** | **4.5 - 5.0** |
| **0.0 - 5.0** | 5.4% | 3.5% | 0.8% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **5.0 - 10.0** | 13.2% | 15.6% | 3.0% | 0.6% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **10.0 - 15.0** | 1.0% | 19.8% | 6.8% | 1.1% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **15.0 - 20.0** | 0.0% | 4.4% | 7.9% | 3.2% | 0.7% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| **20.0 - 25.0** | 0.0% | 0.1% | 4.4% | 1.9% | 1.1% | 0.5% | 0.1% | 0.0% | 0.0% | 0.0% |
| **25.0 - 30.0** | 0.0% | 0.0% | 0.6% | 1.4% | 0.5% | 0.2% | 0.2% | 0.1% | 0.0% | 0.0% |
| **30.0 - 35.0** | 0.0% | 0.0% | 0.0% | 0.2% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **35.0 - 40.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **40.0 - 45.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **45.0 - 50.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Total** | 19.7% | 43.4% | 23.4% | 8.6% | 3.1% | 1.2% | 0.4% | 0.2% | 0.1% | 0.0% |
| **Cum.** | 19.7% | 63.0% | 86.4% | 95.0% | 98.1% | 99.3% | 99.7% | 99.9% | 99.9% | 100.0% |

Percent of Non-Exceedance (both wind and waves)

| | Significant wave height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wind, kt** | **0.5** | **1.0** | **1.5** | **2.0** | **2.5** | **3.0** | **3.5** | **4.0** | **4.5** | **5.0** |
| **5** | 5.4% | 8.9% | 9.7% | 9.9% | 9.9% | 9.9% | 9.9% | 9.9% | 9.9% | 9.9% |
| **10** | 18.6% | 37.7% | 41.4% | 42.2% | 42.4% | 42.5% | 42.5% | 42.5% | 42.5% | 42.5% |
| **15** | 19.7% | 58.5% | 69.1% | 70.9% | 71.4% | 71.6% | 71.6% | 71.6% | 71.6% | 71.6% |
| **20** | 19.7% | 62.9% | 81.3% | 86.5% | 87.6% | 87.9% | 88.0% | 88.0% | 88.1% | 88.1% |
| **25** | 19.7% | 63.0% | 85.9% | 92.8% | 95.1% | 95.9% | 96.1% | 96.1% | 96.2% | 96.2% |
| **30** | 19.7% | 63.0% | 86.4% | 94.8% | 97.5% | 98.6% | 98.9% | 99.0% | 99.1% | 99.1% |
| **35** | 19.7% | 63.0% | 86.4% | 95.0% | 98.1% | 99.2% | 99.6% | 99.7% | 99.8% | 99.8% |
| **40** | 19.7% | 63.0% | 86.4% | 95.0% | 98.1% | 99.3% | 99.7% | 99.9% | 99.9% | 100.0% |
| **45** | 19.7% | 63.0% | 86.4% | 95.0% | 98.1% | 99.3% | 99.7% | 99.9% | 100.0% | 100.0% |
| **50** | 19.7% | 63.0% | 86.4% | 95.0% | 98.1% | 99.3% | 99.7% | 99.9% | 100.0% | 100.0% |

### A.1.2 Wind and Wave Statistics for WIS-A119

Alternative Site 2 is located closer to NDBC Buoy 44025 than WIS station A119, which was used in the document from the State of New York. Wind and wave statistics for WIS-A119 are presented here for reference. Metocean data for NDBC Buoy 44025 is used for Alternative Site 2 in this study since it is located closer to Alternative Site 2.

Table A-3 provides the wave exceedance statistics with monthly distribution breakdowns for WIS-A119. It shows that the percent of exceedance for significant wave height (Hs) > 2.0m varies from 0.9% in July to 16.7% in January with an annul average of 8.7%. While, for Hs > 3.0m, it varies from 0.1% in May to July to 1.8% in January with an annul average of 1.0%.

It is noted that the wave statistics presented in this study are for the twenty years between 1980 and 1999. They are slightly different from those in the document from the State of New York which used the ten-year data from 1990 to 1999.

Table A-4 provides the joint wind and wave statistics for WIS-A119. It shows that the percent of non-exceedance is 91.3% for wind speed Vs=35.0 kt and wave height Hs=2.0m and 99.0% for wind speed Vs=35.0 kt and wave height Hs=3.0m.

## Table A-3: Wave Statistics for WIS-A119

**Alternative Site 2: WIS Station A119 - Wave Statistics - Monthly (1980-1999)**

Percent of Exceedance

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | > 0.5 | > 1.0 | > 1.5 | > 2.0 | > 2.5 | > 3.0 | > 3.5 | > 4.0 | > 4.5 | > 5.0 |
| Jan | 92.4% | 63.3% | 35.4% | 16.7% | 6.1% | 1.8% | 0.4% | 0.2% | 0.1% | 0.0% |
| Feb | 94.1% | 61.6% | 35.3% | 15.5% | 5.4% | 1.3% | 0.3% | 0.2% | 0.0% | 0.0% |
| Mar | 92.3% | 59.5% | 33.9% | 15.0% | 5.6% | 1.5% | 0.3% | 0.1% | 0.0% | 0.0% |
| Apr | 92.3% | 57.9% | 29.5% | 9.4% | 2.5% | 0.5% | 0.1% | 0.0% | 0.0% | 0.0% |
| May | 85.8% | 40.0% | 13.4% | 3.4% | 0.5% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| June | 84.7% | 27.3% | 6.8% | 1.4% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| July | 72.9% | 12.0% | 2.1% | 0.9% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Aug | 63.4% | 10.1% | 3.2% | 1.6% | 1.1% | 0.6% | 0.5% | 0.3% | 0.1% | 0.1% |
| Sept | 80.1% | 30.4% | 13.8% | 3.6% | 1.4% | 0.9% | 0.6% | 0.1% | 0.0% | 0.0% |
| Oct | 90.9% | 47.7% | 24.4% | 8.2% | 2.8% | 1.2% | 0.6% | 0.4% | 0.3% | 0.2% |
| Nov | 92.0% | 61.5% | 34.1% | 14.2% | 5.4% | 1.7% | 0.5% | 0.2% | 0.0% | 0.0% |
| Dec | 94.4% | 64.2% | 36.8% | 15.3% | 5.8% | 1.7% | 0.2% | 0.0% | 0.0% | 0.0% |
| Annual | 86.2% | 44.5% | 22.3% | 8.7% | 3.1% | 1.0% | 0.3% | 0.2% | 0.1% | 0.1% |

Percent of Occurrence

| | Significant Wave Height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 0.0 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | 3.0 - 3.5 | 3.5 - 4.0 | 4.0 - 4.5 | 4.5 - 5.0 |
| Jan | 7.6% | 29.1% | 27.9% | 18.7% | 10.5% | 4.3% | 1.4% | 0.2% | 0.1% | 0.1% |
| Feb | 6.0% | 32.5% | 26.3% | 19.8% | 10.1% | 4.1% | 1.0% | 0.1% | 0.1% | 0.0% |
| Mar | 7.7% | 32.8% | 25.6% | 18.9% | 9.5% | 4.1% | 1.1% | 0.3% | 0.0% | 0.0% |
| Apr | 7.7% | 34.4% | 28.5% | 20.1% | 6.8% | 2.0% | 0.4% | 0.1% | 0.0% | 0.0% |
| May | 14.2% | 45.8% | 26.6% | 10.0% | 2.9% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% |
| June | 15.3% | 57.4% | 20.5% | 5.4% | 1.1% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| July | 27.1% | 60.9% | 9.8% | 1.2% | 0.6% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| Aug | 36.6% | 53.3% | 6.9% | 1.7% | 0.5% | 0.5% | 0.2% | 0.2% | 0.1% | 0.1% |
| Sept | 19.9% | 49.7% | 16.5% | 10.3% | 2.2% | 0.5% | 0.3% | 0.5% | 0.1% | 0.0% |
| Oct | 9.1% | 43.2% | 23.4% | 16.2% | 5.4% | 1.6% | 0.6% | 0.3% | 0.1% | 0.1% |
| Nov | 8.0% | 30.5% | 27.4% | 19.9% | 8.8% | 3.6% | 1.2% | 0.3% | 0.2% | 0.1% |
| Dec | 5.6% | 30.3% | 27.4% | 21.5% | 9.5% | 4.1% | 1.6% | 0.2% | 0.0% | 0.0% |
| Annual | 13.8% | 41.7% | 22.2% | 13.6% | 5.6% | 2.1% | 0.7% | 0.2% | 0.1% | 0.0% |

## Table A-4: Joint Wind and Wave Statistics for WIS-A119

**Alternative Site 2: WIS Station A119 - Joint Wind & Wave Statistics - Annual (1980-1999)**

Percent of occurence

| | Significant wave height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wind, kt** | **0.0 - 0.5** | **0.5 - 1.0** | **1.0 - 1.5** | **1.5 - 2.0** | **2.0 - 2.5** | **2.5 - 3.0** | **3.0 - 3.5** | **3.5 - 4.0** | **4.0 - 4.5** | **4.5 - 5.0** |
| **0.0 - 5.0** | 1.3% | 0.6% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **5.0 - 10.0** | 12.4% | 17.5% | 1.9% | 0.5% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **10.0 - 15.0** | 0.1% | 23.5% | 11.9% | 1.3% | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| **15.0 - 20.0** | 0.0% | 0.1% | 8.2% | 9.1% | 1.4% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| **20.0 - 25.0** | 0.0% | 0.0% | 0.1% | 2.8% | 2.9% | 1.1% | 0.2% | 0.0% | 0.0% | 0.0% |
| **25.0 - 30.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.8% | 0.6% | 0.3% | 0.1% | 0.0% | 0.0% |
| **30.0 - 35.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% |
| **35.0 - 40.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **40.0 - 45.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **45.0 - 50.0** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Total** | 13.8% | 41.7% | 22.2% | 13.6% | 5.6% | 2.1% | 0.7% | 0.2% | 0.1% | 0.0% |
| **Cum.** | 13.8% | 55.5% | 77.7% | 91.3% | 96.9% | 99.0% | 99.7% | 99.8% | 99.9% | 99.9% |

Percent of non-exceedance (both wind and waves)

| | Significant wave height, m | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wind, kt** | **0.5** | **1** | **1.5** | **2** | **2.5** | **3** | **3.5** | **4** | **4.5** | **5** |
| **5** | 1.3% | 2.0% | 2.1% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% | 2.2% |
| **10** | 13.7% | 31.9% | 33.9% | 34.4% | 34.5% | 34.5% | 34.5% | 34.5% | 34.5% | 34.5% |
| **15** | 13.8% | 55.4% | 69.4% | 71.2% | 71.6% | 71.7% | 71.8% | 71.8% | 71.8% | 71.8% |
| **20** | 13.8% | 55.5% | 77.6% | 88.5% | 90.3% | 90.7% | 90.7% | 90.7% | 90.7% | 90.7% |
| **25** | 13.8% | 55.5% | 77.7% | 91.3% | 96.1% | 97.5% | 97.8% | 97.8% | 97.8% | 97.8% |
| **30** | 13.8% | 55.5% | 77.7% | 91.3% | 96.9% | 98.9% | 99.5% | 99.6% | 99.6% | 99.7% |
| **35** | 13.8% | 55.5% | 77.7% | 91.3% | 96.9% | 99.0% | 99.7% | 99.9% | 99.9% | 99.9% |
| **40** | 13.8% | 55.5% | 77.7% | 91.3% | 96.9% | 99.0% | 99.7% | 99.9% | 99.9% | 100.0% |
| **45** | 13.8% | 55.5% | 77.7% | 91.3% | 96.9% | 99.0% | 99.7% | 99.9% | 99.9% | 100.0% |
| **50** | 13.8% | 55.5% | 77.7% | 91.3% | 96.9% | 99.0% | 99.7% | 99.9% | 99.9% | 100.0% |

## A.2 Preliminary Operability Assessment Using WIS-A123 & WIS-A119 Data

For reference only, this section presents the preliminary operability assessment results based on the Metocean data for WIS-A123 and WIS-A119 using the same simplified approach as that used in the Department of State's document (prepared by Battelle).

### A.2.1 Preliminary Operability Assessment Based on WIS-A123 Data

Table A-5 presents the preliminary berth unavailability estimates based on the wave height statistics from WIS-A123.

The preliminary berth unavailability estimates based on WIS-A123 wave data and 2.0m operating wave limit indicate that the highest monthly unavailability will be 10.4% or 3.2 days in January and the annual downtime will be 5.0% or 18.3 days.

**Table A-5: Preliminary Berth Unavailability Based on WIS-A123 Data**

| | Hs>2.0m | Hs>2.0m | Hs>3.0m | Hs>3.0m |
|---|---|---|---|---|
| **Month** | **%** | **Days** | **%** | **Days** |
| **Jan** | 10.4% | 3.2 | 1.8% | 0.6 |
| **Feb** | 7.0% | 2.0 | 1.0% | 0.3 |
| **Mar** | 7.7% | 2.4 | 1.3% | 0.4 |
| **Apr** | 4.2% | 1.3 | 0.2% | 0.1 |
| **May** | 1.2% | 0.4 | 0.1% | 0.0 |
| **June** | 0.4% | 0.1 | 0.0% | 0.0 |
| **July** | 0.8% | 0.3 | 0.1% | 0.0 |
| **Aug** | 2.0% | 0.6 | 0.1% | 0.0 |
| **Sept** | 2.7% | 0.8 | 0.5% | 0.1 |
| **Oct** | 5.3% | 1.6 | 0.8% | 0.3 |
| **Nov** | 9.2% | 2.8 | 1.4% | 0.4 |
| **Dec** | 9.2% | 2.9 | 1.4% | 0.4 |
| **Annual** | **5.0%** | **18.3** | **0.7%** | **2.6** |

### A.2.2 Preliminary Operability Assessment Based on WIS-A119 Data

Table A-6 presents the preliminary berth unavailability estimates based on the wave height statistics from WIS-A119.

The preliminary berth unavailability estimates based on WIS-A119 wave data and 2.0m operating wave limit indicate that the highest monthly unavailability will be 16.7% or 5.2 days in January and the annual downtime will be 8.7% or 31.9 days.

**TableA-6: Preliminary Berth Unavailability Based on WIS-A119 Data**

| | Hs>2.0m | Hs>2.0m | Hs>3.0m | Hs>3.0m |
|---|---|---|---|---|
| **Month** | **%** | **Days** | **%** | **Days** |
| **Jan** | 16.7% | 5.2 | 1.8% | 0.6 |
| **Feb** | 15.5% | 4.3 | 1.3% | 0.4 |
| **Mar** | 15.0% | 4.7 | 1.5% | 0.4 |
| **Apr** | 9.4% | 2.8 | 0.5% | 0.1 |
| **May** | 3.4% | 1.0 | 0.1% | 0.0 |
| **June** | 1.4% | 0.4 | 0.1% | 0.0 |
| **July** | 0.9% | 0.3 | 0.1% | 0.0 |
| **Aug** | 1.6% | 0.5 | 0.6% | 0.2 |
| **Sept** | 3.6% | 1.1 | 0.9% | 0.3 |
| **Oct** | 8.2% | 2.5 | 1.2% | 0.4 |
| **Nov** | 14.2% | 4.3 | 1.7% | 0.5 |
| **Dec** | 15.3% | 4.7 | 1.7% | 0.5 |
| **Annual** | **8.7%** | **31.9** | **1.0%** | **3.7** |

# APPENDIX B

# MONTHLY DOWNTIME TABLES

**Table B-1: Site 1 Base Case Monthly Downtime**

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| | | | | | | | | | | | | |
| 0 | 81.5% | 84.0% | 82.7% | 93.4% | 99.1% | 97.8% | 98.3% | 98.3% | 95.9% | 90.4% | 88.5% | 83.2% |
| 0< x <=2 | 2.0% | 0.5% | 1.5% | 0.5% | | 0.4% | | | | | 0.5% | 1.0% |
| 2< x <=4 | 1.0% | 1.1% | 1.0% | 0.9% | | 0.4% | | | | 1.0% | 0.5% | 1.9% |
| 4< x <=6 | 0.5% | 1.1% | 0.5% | | | 0.4% | | 0.4% | 0.5% | 1.0% | 1.4% | |
| 6< x <=8 | 1.5% | 1.1% | 0.5% | | | | | | | 0.5% | 0.5% | 1.4% |
| 8< x <=10 | | 0.5% | | 0.5% | | | | | | 0.5% | 1.0% | 1.0% |
| 10< x <=12 | 1.5% | 0.5% | 1.0% | | | | | | 0.5% | 1.0% | | 1.0% |
| 12< x <=14 | 2.1% | | | 0.4% | | | | | | | 1.4% | 1.0% |
| 14< x <=16 | | 1.1% | | | | | | | 0.5% | | 0.5% | 0.5% |
| 16< x <=18 | 1.0% | 0.5% | 1.0% | | | 0.4% | 0.8% | | | | 0.5% | 1.4% |
| 18< x <=20 | | | | | | | | | | 0.5% | | 0.5% |
| 20< x <=22 | 0.5% | | 0.5% | | | | | | | | | 0.5% |
| 22< x <=24 | | | | | | | | | | 0.5% | 0.5% | 0.5% |
| 24< x <=26 | | 0.5% | 0.5% | | | | | | | 0.5% | | |
| 26< x <=28 | | | 0.5% | | | | | | | | | |
| 28< x <=30 | | 0.5% | | | | | | | | | | |
| 30< x <=32 | 1.0% | | 0.5% | | | | | | 0.5% | 0.5% | | 0.5% |
| 32< x <=34 | | | 1.0% | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 34< x <=36 | | | 0.5% | | | | 0.4% | | | 0.5% | | |
| 36< x <=38 | | | | | | | | | | | 0.5% | |
| 38< x <=40 | 1.5% | 0.5% | 0.5% | 0.4% | | | | | | | | 0.5% |
| 40< x <=42 | | 1.1% | | | | | | 0.8% | | | | |
| 42< x <=44 | 0.1% | 0.5% | | | | | | | | | | |
| 44< x <=46 | 1.0% | | 1.0% | 0.4% | | | | | | | | |
| 46< x <=48 | 1.0% | | 0.5% | | | | | | | 0.5% | | |
| 48< x <=50 | | | 0.5% | | | | | | | | 1.0% | 0.5% |
| 50< x <=52 | 1.5% | | 1.0% | | | | | | | | 0.5% | |
| 52< x <=54 | | 1.1% | | | | | | | | | | 1.0% |
| 54< x <=56 | 0.5% | 1.1% | 0.5% | | | | | | | | 0.5% | |
| 56< x <=58 | | | | | | | | | | | | 1.0% |
| 58< x <=60 | | | 0.5% | | 0.4% | | | | | 0.5% | 0.5% | |
| 60< x <=62 | | | | 1.0% | | | | | | | | 0.5% |
| 62< x <=64 | | 1.6% | | | | | | | | | | |
| 64< x <=66 | | 0.5% | 0.5% | 0.5% | | | | | | | | |
| 66< x <=68 | | | 0.5% | 0.4% | | | 0.4% | 0.4% | 0.5% | 0.5% | 0.5% | |
| 68< x <=70 | 1.0% | | | | | | | | | | | |
| 70< x <=72 | | 0.5% | 1.5% | 0.4% | | | | | | | | |
| 72< x <=74 | | | | | | | | | | | | 1.0% |
| 74< x <=76 | | 0.5% | | | | | | | | 0.5% | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 76< x <=78 | | | 1.0% | | | | | | | | 0.5% | |
| 78< x <=80 | | | | | | | | | | | 1.0% | 0.5% |
| 80< x <=82 | | | | | | | | | | | | |
| 82< x <=84 | | | | | | 0.4% | | | 0.9% | | | 0.5% |
| 84< x <=86 | | | | | | | | | | | | |
| 86< x <=88 | 0.5% | | | 0.4% | | | | | | | | |
| 88< x <=90 | | | | | | | | | | | | |
| 90< x <=92 | | | | 0.5% | | | | | | | | |
| 92< x <=94 | | | | | | | | | | | | |
| 94< x <=96 | | | | | | | | | | | | |
| 96< x <=98 | | | | | | | | | | | | |
| 98< x <=100 | | | | | | | | | | 0.5% | | |
| 100< x <=102 | | | | | | | | | 0.5% | | | |
| 102< x <=104 | | 0.5% | | | 0.4% | | | | | | | |
| 104< x <=106 | | | | | | | | | | | | 0.5% |
| 106< x <=108 | | 0.5% | | | | | | | | | | |
| 108< x <=110 | | | | | | | | | | | | |
| 110< x <=112 | | | | | | | | | | | | |
| 112< x <=114 | | | | | | | | | | | | |
| 114< x <=116 | | | | | | | | | | 0.5% | | |
| 116< x <=118 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 118< x <=120 | | | | | | | | | 0.5% | 0.5% | | |
| 120< x <=122 | | | | | | | | | | | | |
| 122< x <=124 | | | | | | | | | | | | |
| 124< x <=126 | | | | | | | | | | | | |
| 126< x <=128 | | | | | | | | | | | | |
| 128< x <=130 | | | | | | | | | | | | |
| 130< x <=132 | | | | | | | | | | | | |
| 132< x <=134 | | | | | | | | | | | | |
| 134< x <=136 | | | | | | | | | | | | |
| 136< x <=138 | | | | | | | | | | | | |
| 138< x <=140 | | | | | | | | | | | | |
| 140< x <=142 | | | | | | | | | | | | |
| 142< x <=144 | | | | | | | | | | | | |
| 144< x <=146 | 0.5% | | | | | | | | | | | |

**Table B-2: Site 1 Sensitivity Case 1 Monthly Downtime**

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| | | | | | | | | | | | | |
| 0 | 91.6% | 93.2% | 93.4% | 97.8% | 99.6% | 99.6% | 100.0% | 99.2% | 98.7% | 97.0% | 96.4% | 95.2% |
| 0< x <=2 | | 1.0% | 0.4% | | | | | | | | | 0.4% |
| 2< x <=4 | 2.2% | | 0.4% | 0.4% | | | | | | | 0.4% | 0.9% |
| 4< x <=6 | | | 1.3% | | | | | | | 0.4% | | 0.4% |
| 6< x <=8 | 0.4% | | | 0.4% | | | | | | 0.9% | 0.4% | |
| 8< x <=10 | 0.9% | 1.0% | 0.4% | 0.4% | | | | | | | 0.4% | 0.4% |
| 10< x <=12 | 0.8% | 1.0% | | | | | | | | 0.4% | | 0.4% |
| 12< x <=14 | 0.9% | | | | | 0.4% | | 0.4% | | | | |
| 14< x <=16 | | | 0.4% | | | | | | | | | 0.4% |
| 16< x <=18 | 0.0% | | 0.4% | | | | | | | | | |
| 18< x <=20 | | 0.5% | | | | | | | | | | |
| 20< x <=22 | | 1.0% | 0.4% | | | | | | | | 0.4% | |
| 22< x <=24 | | 0.5% | | | | | | | | | | |
| 24< x <=26 | | | | | | | | 0.4% | | | | |
| 26< x <=28 | | | 0.4% | | | | | | | | | |
| 28< x <=30 | | | | | | | | | | | | |
| 30< x <=32 | | | | | | | | | 0.4% | | | |
| 32< x <=34 | | | | | | | | | | | 0.4% | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 34< x <=36 | | | | | | | | | | | | |
| 36< x <=38 | | 0.5% | 0.4% | | | | | | | | 0.4% | |
| 38< x <=40 | | | | | | | | | | | | |
| 40< x <=42 | | | 0.4% | | | | | | | | | |
| 42< x <=44 | | | | | | | | | | | | |
| 44< x <=46 | | | | | | | | | | 0.4% | | |
| 46< x <=48 | | | | | | | | | | | | |
| 48< x <=50 | 0.4% | 0.5% | 0.4% | 0.4% | | | | | 0.4% | | | |
| 50< x <=52 | 0.4% | 0.4% | | | | | | | | | | |
| 52< x <=54 | | | | | | | | | | | 0.4% | |
| 54< x <=56 | 0.9% | 0.5% | | 0.4% | | | | | | | | |
| 56< x <=58 | 0.4% | | | | | | | | | | | 0.9% |
| 58< x <=60 | | | | | | | | | | | | |
| 60< x <=62 | | | 0.4% | | | | | | | | | |
| 62< x <=64 | | | 0.4% | | | | | | | | | |
| 64< x <=66 | | 0.0% | | | | | | | | | | |
| 66< x <=68 | 0.4% | | | | | | | | | | | |
| 68< x <=70 | | | | | | | | | | 0.4% | | |
| 70< x <=72 | | | | | | | | | | | | |
| 72< x <=74 | | | | | | | | | | | | |
| 74< x <=76 | | | | | | | | | 0.4% | | 0.4% | 0.4% |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 76< x <=78 | 0.4% | | | | 0.4% | | | | | | | |
| 78< x <=80 | | | | | | | | | | | | 0.4% |
| 80< x <=82 | | | | | | | | | | | | |
| 82< x <=84 | | | | | | | | | | | | |
| 84< x <=86 | | | | | | | | | | | | |
| 86< x <=88 | | | | | | | | | | | | |
| 88< x <=90 | | | | | | | | | | | | |
| 90< x <=92 | | | | | | | | | | | | |
| 92< x <=94 | | | | | | | | | | | | |
| 94< x <=96 | | | | | | | | | | | | |
| 96< x <=98 | | | | | | | | | | | | |
| 98< x <=100 | | | | | | | | | | | | |
| 100< x <=102 | | | | | | | | | | | | |
| 102< x <=104 | | | | | | | | | | | | |
| 104< x <=106 | | | | | | | | | | | | |
| 106< x <=108 | | | | | | | | | | 0.4% | | |

**Table B-3: Site 1 Sensitivity Case 2 Monthly Downtime**

| **Waiting Time Bin (hours)** | **Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| | | | | | | | | | | | | |
| 0 | 97.0% | 97.7% | 98.3% | 99.2% | 99.2% | 100.0% | 100.0% | 99.2% | 98.7% | 98.3% | 98.7% | 97.9% |
| 0< x <=1 | | 0.4% | | | 0.4% | | | | | | | |
| 1< x <=2 | 1.3% | | | | | | | | 0.4% | 0.4% | | |
| 2< x <=3 | | | 0.4% | | | | | | | | | |
| 3< x <=4 | | | | | | | | | | | 0.4% | |
| 4< x <=5 | | | | | | | | | | | | |
| 5< x <=6 | | | | | | | | | | | | |
| 6< x <=7 | | | | | | | | 0.4% | 0.4% | | | |
| 7< x <=8 | | | | | | | | | | | | |
| 8< x <=9 | | | 0.8% | | | | | | | | | |
| 9< x <=10 | | | | | | | | | | | | |
| 10< x <=11 | | 0.5% | | 0.4% | | | | | | | | |
| 11< x <=12 | | | | 0.4% | | | | | | | | |
| 12< x <=13 | | | | | | | | | | | 0.4% | 0.4% |
| 13< x <=14 | | | | | | | | | | | | 0.4% |
| 14< x <=15 | | | | | | | | | | | | |
| 15< x <=16 | | 0.5% | | | | | | | | | | |
| 16< x <=17 | 0.4% | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 17< x <=18 | | | | | | | | 0.4% | | | 0.4% | |
| 18< x <=19 | | | | | 0.4% | | | | | 0.4% | | |
| 19< x <=20 | | 0.5% | | | | | | | | | | |
| 20< x <=21 | | | | | | | | | | | | 0.4% |
| 21< x <=22 | | | | | | | | | | | | |
| 22< x <=23 | | | 0.4% | | | | | | | | | |
| 23< x <=24 | | | | | | | | | | | | |
| 24< x <=25 | | | | | | | | | | | | |
| 25< x <=26 | | | | | | | | | | | | |
| 26< x <=27 | | | | | | | | | | | | |
| 27< x <=28 | | | | | | | | | | | | |
| 28< x <=29 | | | | | | | | | | | | |
| 29< x <=30 | | | | | | | | | | | | |
| 30< x <=31 | | | | | | | | | | | | |
| 31< x <=32 | | | | | | | | | | | | |
| 32< x <=33 | | | | | | | | | | | | |
| 33< x <=34 | | | | | | | | | | | | |
| 34< x <=35 | | | | | | | | | | 0.4% | | |
| 35< x <=36 | | | | | | | | | | | | |
| 36< x <=37 | | | | | | | | | | | | 0.4% |
| 37< x <=38 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 38< x <=39 | | | | | | | | | | | | |
| 39< x <=40 | | | | | | | | | | | | |
| 40< x <=41 | | | | | | | | | | | | |
| 41< x <=42 | | | | | | | | | | | | |
| 42< x <=43 | | | | | | | | | | | | |
| 43< x <=44 | | | | | | | | | | | | |
| 44< x <=45 | | | | | | | | | | | | |
| 45< x <=46 | | | | | | | | | | | | |
| 46< x <=47 | | | | | | | | | | | | |
| 47< x <=48 | | | | | | | | | | | | 0.4% |
| 48< x <=49 | | | | | | | | | | | | |
| 49< x <=50 | | | | | | | | | | | | |
| 50< x <=51 | | | | | | | | | | | | |
| 51< x <=52 | 1.3% | | | | | | | | | | | |
| 52< x <=53 | | 0.5% | | | | | | | | | | |
| 53< x <=54 | | | | | | | | | | | | |
| 54< x <=55 | | | | | | | | | | | | |
| 55< x <=56 | | | | | | | | | | | | |
| 56< x <=57 | | | | | | | | | | | | |
| 57< x <=58 | | | | | | | | | | | | |
| 58< x <=59 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 59< x <=60 | | | | | | | | | | | | |
| 60< x <=61 | | | | | | | | | | | | |
| 61< x <=62 | | | | | | | | | | | | |
| 62< x <=63 | | | | | | | | | | | | |
| 63< x <=64 | | | | | | | | | | | | |
| 64< x <=65 | | | | | | | | | | | | |
| 65< x <=66 | | | | | | | | | | | | 0.0% |
| 66< x <=67 | | | | | | | | | | | | |
| 67< x <=68 | | | | | | | | | | | | |
| 68< x <=69 | | | | | | | | | | | | |
| 69< x <=70 | | | | | | | | | 0.4% | | | |
| 70< x <=71 | | | | | | | | | | | | |
| 71< x <=72 | | | | | | | | | | | | |
| 72< x <=73 | | | | | | | | | | | | |
| 73< x <=74 | | | | | | | | | | | | |
| 74< x <=75 | | | | | | | | | | | | |
| 75< x <=76 | | | | | | | | | | | | |
| 76< x <=77 | | | | | | | | | | | | |
| 77< x <=78 | | | | | | | | | | | | |
| 78< x <=79 | | | | | | | | | | | | |
| 79< x <=80 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 80< x <=81 | | | | | | | | | | | | |
| 81< x <=82 | | | | | | | | | | | | |
| 82< x <=83 | | | | | | | | | | | | |
| 83< x <=84 | | | | | | | | | | | | |
| 84< x <=85 | | | | | | | | | | | | |
| 85< x <=86 | | | | | | | | | | | | |
| 86< x <=87 | | | | | | | | | | | | |
| 87< x <=88 | | | | | | | | | | | | |
| 88< x <=89 | | | | | | | | | | | | |
| 89< x <=90 | | | | | | | | | | | | |
| 90< x <=91 | | | | | | | | | | 0.4% | | |

**Table B-4: Site 2 Base Case Monthly Downtime**

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| | | | | | | | | | | | | |
| 0 | 76.5% | 76.5% | 77.9% | 82.8% | 93.0% | 96.5% | 96.2% | 90.2% | 87.3% | 85.8% | 79.0% | 75.8% |
| 0< x <=2 | 1.0% | 4.8% | 3.0% | 2.3% | 2.2% | 0.4% | 1.3% | 2.2% | 3.3% | 2.7% | 4.1% | 4.1% |
| 2< x <=4 | 3.1% | 4.3% | 3.0% | 1.4% | 0.9% | 0.9% | 0.8% | 0.4% | 1.4% | 3.7% | 1.0% | 2.6% |
| 4< x <=6 | 2.6% | 2.1% | 1.5% | 1.9% | | | | 1.3% | 1.4% | | 3.1% | 3.1% |
| 6< x <=8 | 1.0% | 0.5% | 0.5% | 3.3% | 0.9% | | 0.4% | 0.4% | | 1.4% | 0.5% | 1.5% |
| 8< x <=10 | 1.0% | 0.5% | 0.5% | 1.4% | | 0.4% | | 0.9% | 0.9% | | 0.5% | 1.5% |
| 10< x <=12 | 1.6% | 0.5% | | 1.9% | | | | | 0.5% | | 1.5% | 1.5% |
| 12< x <=14 | 1.0% | 0.5% | 1.0% | | 0.4% | | 0.4% | 0.9% | | 0.5% | 1.5% | 0.5% |
| 14< x <=16 | 0.5% | 0.5% | 0.5% | 0.9% | | 0.4% | | 0.9% | 0.5% | | | 1.5% |
| 16< x <=18 | 0.5% | 1.6% | 2.0% | 0.5% | | 0.9% | | | 0.5% | | | 0.5% |
| 18< x <=20 | | 0.5% | 0.5% | 0.5% | | | | 0.4% | 0.5% | | 0.5% | |
| 20< x <=22 | | 1.1% | 0.5% | | 0.4% | | | | | 0.5% | | |
| 22< x <=24 | 0.5% | | | | | | | | | 0.9% | 0.5% | |
| 24< x <=26 | | 0.5% | | | | | | | | | | 0.5% |
| 26< x <=28 | | | 1.0% | 0.5% | 0.4% | | | | 0.5% | | | 0.5% |
| 28< x <=30 | 1.0% | 0.5% | | 0.5% | | | 0.4% | | | | | |
| 30< x <=32 | | | | | | | | | | 0.5% | | |
| 32< x <=34 | 0.5% | | 0.5% | 0.5% | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 34< x <=36 | | 0.5% | | | | | | | | | | |
| 36< x <=38 | | | | | | | | | 0.5% | 0.5% | 0.5% | |
| 38< x <=40 | 0.5% | | 1.0% | | | | | | | 0.5% | | |
| 40< x <=42 | 0.5% | | 0.5% | 0.9% | | | | | | | | |
| 42< x <=44 | | | | | | | | | | | | 0.5% |
| 44< x <=46 | 0.5% | | | | | | | | | | 1.0% | |
| 46< x <=48 | | 0.5% | | | | | | | 0.5% | | | |
| 48< x <=50 | | 0.5% | 1.5% | | 0.4% | | | | | 0.5% | 0.5% | |
| 50< x <=52 | | | | | | | 0.4% | | 0.5% | 0.5% | 0.5% | 0.5% |
| 52< x <=54 | | 0.5% | | | | | | 0.9% | 0.5% | | 1.0% | |
| 54< x <=56 | 0.5% | | 0.5% | | | | | | 0.5% | | | 0.5% |
| 56< x <=58 | 0.5% | | | | | | | | | 0.5% | 0.5% | |
| 58< x <=60 | 1.0% | | | | | | | | | | 1.0% | |
| 60< x <=62 | | | 1.0% | | | | | | | | 0.5% | 1.0% |
| 62< x <=64 | 0.5% | | 0.5% | | 0.4% | | | | | | | |
| 64< x <=66 | | | 0.5% | | 0.4% | | | | | | 0.5% | |
| 66< x <=68 | | 0.5% | 0.5% | | | | | 0.4% | | 0.5% | | |
| 68< x <=70 | 0.5% | | 0.5% | | | | | | | | | |
| 70< x <=72 | 1.0% | 1.1% | | | | | | | 0.5% | | | |
| 72< x <=74 | | | | | | | | | | | 0.5% | 0.5% |
| 74< x <=76 | 0.5% | 0.5% | | | | | | | | | 0.5% | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 76< x <=78 | | | | | | | | | | | | |
| 78< x <=80 | | | | | | | | | | | | |
| 80< x <=82 | | | | 0.5% | | | | | 0.5% | | 0.5% | |
| 82< x <=84 | 0.5% | | | | | | | | | | | |
| 84< x <=86 | | | | | | | | | | 0.5% | | |
| 86< x <=88 | | | 0.5% | | | | | | | | | 0.5% |
| 88< x <=90 | 0.5% | | | 0.5% | | 0.4% | | | | | | |
| 90< x <=92 | 0.5% | | | | | | | | | | | |
| 92< x <=94 | | | 0.5% | | | | | | | | | 0.5% |
| 94< x <=96 | | | | | | | | | | | | |
| 96< x <=98 | | | | | | | | | | | | |
| 98< x <=100 | | 0.5% | | | | | | | | | | |
| 100< x <=102 | 0.5% | | | | | | | | | 0.5% | | |
| 102< x <=104 | 0.1% | | | | | | | | | | | |
| 104< x <=106 | | | | | | | | | | | | |
| 106< x <=108 | | | | | | | | | | | | |
| 108< x <=110 | | | | | | | | | | | | 0.5% |
| 110< x <=112 | | | | | | | | | | | | |
| 112< x <=114 | | | | | | | | 0.4% | | | | |
| 114< x <=116 | | | | | | | | | | | | |
| 116< x <=118 | | | | | | | | | | 0.5% | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 118< x <=120 | | | | | | | | | | | | |
| 120< x <=122 | | | | | | | | | | | | 0.5% |
| 122< x <=124 | | | | | | | | | | | | |
| 124< x <=126 | | | | | | | | | | | | |
| 126< x <=128 | | | | | | | | | | | | |
| 128< x <=130 | | | | | | | | | | | | |
| 130< x <=132 | | | | | | | | | | | | |
| 132< x <=134 | | | | | | | | | | | | |
| 134< x <=136 | | | | | | | | 0.4% | | | | 0.5% |
| 136< x <=138 | | | | | | | | | | | | |
| 138< x <=140 | | | | | | | | | | | | |
| 140< x <=142 | | | | | | | | | | | | |
| 142< x <=144 | | | | | | | | | | | | 0.5% |
| 144< x <=146 | | | | | | | | | | | | |
| 146< x <=148 | | | | | | | | | | | | |
| 148< x <=150 | | | | | | | | | | | | |
| 150< x <=152 | | 0.5% | | | | | | | | | | |
| 152< x <=154 | | | | | 0.4% | | | | | | | |
| 154< x <=156 | | | | | | | | | | | | |
| 156< x <=158 | | | | | | | | | | | | |
| 158< x <=160 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 160< x <=162 | | | | | | | | | | | | |
| 162< x <=164 | | | | | | | | | | | | |
| 164< x <=166 | | | | | | | | | | | | |
| 166< x <=168 | | | | | | | | | | | | |
| 168< x <=170 | | | | | | | | | | | | |
| 170< x <=172 | | | | | | | | | | | | |
| 172< x <=174 | | | | | | | | | | | | |
| 174< x <=176 | | | | | | | | | | | | |
| 176< x <=178 | | | | | | | | | | | | |
| 178< x <=180 | | | | | | | | | | | | |
| 180< x <=182 | 0.5% | | | | | | | | | | | |

**Table B-5: Site 2 Sensitivity Case 1 Monthly Downtime**

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| | | | | | | | | | | | | |
| 0 | 82.7% | 84.2% | 87.3% | 91.6% | 97.0% | 97.8% | 97.9% | 96.1% | 94.6% | 91.8% | 89.6% | 86.0% |
| 0< x <=2 | 4.2% | 4.9% | 1.4% | 2.2% | | | 0.4% | 0.5% | 1.3% | 1.3% | 1.9% | 3.2% |
| 2< x <=4 | 0.5% | 2.0% | 0.9% | 1.3% | 0.4% | 0.4% | 1.3% | 0.8% | 0.4% | 1.3% | 1.4% | 1.8% |
| 4< x <=6 | 1.4% | 2.0% | 1.4% | 0.9% | 0.4% | | 0.4% | 0.9% | 0.9% | 1.3% | | 0.5% |
| 6< x <=8 | 1.4% | 1.5% | 1.8% | 2.2% | 0.4% | 0.4% | | | 0.4% | 0.9% | 0.5% | 1.4% |
| 8< x <=10 | 0.0% | 0.5% | 0.9% | 0.4% | 0.4% | 0.4% | | | 0.4% | 0.4% | 0.5% | 1.4% |
| 10< x <=12 | 1.4% | | 1.4% | | | 0.4% | | | | | 0.9% | 0.9% |
| 12< x <=14 | 1.4% | | 0.5% | | 0.4% | | | | | 0.9% | | 0.5% |
| 14< x <=16 | 0.5% | 0.5% | 0.5% | 0.4% | | | | | | 0.4% | 0.9% | |
| 16< x <=18 | 0.5% | 0.5% | 0.5% | | | | | 0.4% | | | 0.5% | |
| 18< x <=20 | | | | | | | | | | | | 0.5% |
| 20< x <=22 | | | | | | | | | | | | |
| 22< x <=24 | 0.4% | | | | | | | | | | | 0.5% |
| 24< x <=26 | | | | | | | | | | | 0.5% | |
| 26< x <=28 | 0.5% | | | | | | | | | | | |
| 28< x <=30 | | | 0.5% | 0.4% | | | | | | | | |
| 30< x <=32 | 0.5% | 0.5% | | | 0.4% | 0.4% | | | | | | 0.5% |
| 32< x <=34 | | | 0.5% | | | | | | | | | 0.5% |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 34< x <=36 | | 0.5% | | | | | | | 0.4% | 0.4% | 0.5% | |
| 36< x <=38 | 0.5% | | | | | | | | | | | 0.5% |
| 38< x <=40 | 0.5% | | | | | | | | | | 0.5% | |
| 40< x <=42 | 0.5% | | 0.5% | | | | | | 0.4% | | | 0.5% |
| 42< x <=44 | | 0.5% | | | | | | | | | | |
| 44< x <=46 | 0.5% | | | | | | | | | | | 0.5% |
| 46< x <=48 | | 0.5% | | | | | | | | | | |
| 48< x <=50 | | | | | | | | | | | | 0.5% |
| 50< x <=52 | | 0.5% | | | | | | 0.4% | 0.4% | | | |
| 52< x <=54 | | | | | | | | | | | 0.5% | |
| 54< x <=56 | 0.9% | 0.5% | | | | | | | | | 0.5% | |
| 56< x <=58 | | | 0.5% | | | | | | | 0.4% | 0.5% | |
| 58< x <=60 | | | | | 0.4% | | | | 0.4% | | | |
| 60< x <=62 | | | 0.9% | | | | | | | 0.4% | 0.5% | |
| 62< x <=64 | | | | | | | | | | | 0.5% | |
| 64< x <=66 | | | 0.5% | | | | | | | | | |
| 66< x <=68 | | | | | | | | | | | | |
| 68< x <=70 | 1.4% | 0.5% | | | | | | | | | | |
| 70< x <=72 | 0.5% | | | | | | | | | | | |
| 72< x <=74 | | | 0.5% | | | | | | | | | |
| 74< x <=76 | | 0.5% | | 0.4% | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 76< x <=78 | | | | | | | | | | | | |
| 78< x <=80 | | | | | | | | | | | | |
| 80< x <=82 | | | | | | | | 0.4% | | | | |
| 82< x <=84 | | | | | | | | | | | | |
| 84< x <=86 | | | | | | | | | | | | |
| 86< x <=88 | | | | | | | | | | | | |
| 88< x <=90 | | | | | | | | | | 0.4% | | |
| 90< x <=92 | | | | | | | | | | | | |
| 92< x <=94 | | | | | | | | | | | | |
| 94< x <=96 | | | | | | | | | | | | |
| 96< x <=98 | | | | | | | | | | | | |
| 98< x <=100 | | | | | | | | | | | | 0.5% |
| 100< x <=102 | | | | | | | | | | | | |
| 102< x <=104 | | | | | | | | | | | | |
| 104< x <=106 | | | | | | | | | | | | |
| 106< x <=108 | | | | | | | | | | | | |
| 108< x <=110 | | | | | | | | | | | | |
| 110< x <=112 | | | | | | | | | | | | |
| 112< x <=114 | | | | | | | | | | | | |
| 114< x <=116 | | | | | | | | | | | | 0.5% |
| 116< x <=118 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 118< x <=120 | | | | | | | | | | | | |
| 120< x <=122 | | | | | | | | | | | | |
| 122< x <=124 | | | | | | | | 0.4% | | | | |

**Table B-6: Site 2 Sensitivity Case 2 Monthly Downtime**

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| | | | | | | | | | | | | |
| 0 | 92.7% | 94.9% | 89.9% | 97.8% | 98.3% | 100.0% | 99.6% | 98.3% | 97.4% | 96.1% | 92.4% | 92.1% |
| 0< x <=1 | 0.9% | 1.4% | 2.2% | | 0.4% | | 0.4% | | 0.9% | | 1.3% | 0.4% |
| 1< x <=2 | 0.4% | 0.5% | | 0.9% | | | | | 0.4% | 0.4% | 0.4% | 1.3% |
| 2< x <=3 | 0.9% | 0.5% | | | | | | | 0.4% | 0.0% | 0.4% | |
| 3< x <=4 | 0.4% | 0.5% | 0.9% | | | | | 0.4% | 0.4% | 0.4% | | 0.4% |
| 4< x <=5 | | 0.5% | | | | | | | | 0.4% | 0.4% | 0.9% |
| 5< x <=6 | 0.9% | | | 0.4% | 0.4% | | | | | 0.4% | | 0.9% |
| 6< x <=7 | 0.0% | | 0.4% | | | | | | | | | 1.3% |
| 7< x <=8 | | | 0.9% | | | | | | | | | |
| 8< x <=9 | | | 0.9% | | | | | 0.4% | 0.4% | | 0.4% | |
| 9< x <=10 | 0.4% | 0.5% | 0.4% | | 0.4% | | | | | 0.0% | | |
| 10< x <=11 | | | 0.4% | | | | | | | | 0.4% | 0.4% |
| 11< x <=12 | 0.4% | | | 0.4% | | | | 0.4% | | | | |
| 12< x <=13 | | | 0.4% | | | | | | | 0.4% | 0.4% | 0.4% |
| 13< x <=14 | | | 0.4% | | | | | | | | | 0.4% |
| 14< x <=15 | | | | | | | | | | 0.4% | | |
| 15< x <=16 | | | | | | | | | | | | |
| 16< x <=17 | | | 0.4% | | | | | | | 0.4% | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 17< x <=18 | | | 0.4% | | | | | | | | | |
| 18< x <=19 | | | 0.4% | | | | | | | | 0.4% | |
| 19< x <=20 | 0.4% | | | | | | | | | | | |
| 20< x <=21 | | | | | 0.4% | | | | | | 0.4% | |
| 21< x <=22 | 0.4% | | | | | | | | | | | |
| 22< x <=23 | | | | | | | | | | | 0.9% | |
| 23< x <=24 | | | | | | | | | | | | |
| 24< x <=25 | | | | | | | | | | | | |
| 25< x <=26 | | | | | | | | | | | | |
| 26< x <=27 | | | | | | | | | | | | |
| 27< x <=28 | | | 0.4% | | | | | | | | | |
| 28< x <=29 | 0.4% | | | | | | | | | | | |
| 29< x <=30 | 0.4% | 0.5% | | | | | | | | | 0.4% | |
| 30< x <=31 | | | | | | | | | | | | |
| 31< x <=32 | | | | | | | | | | | | |
| 32< x <=33 | | | | | | | | | | | | 0.4% |
| 33< x <=34 | | | | | | | | | | | | |
| 34< x <=35 | | | | | | | | | | | | |
| 35< x <=36 | | | | | | | | 0.4% | | | | |
| 36< x <=37 | 0.4% | | | | | | | | | | | |
| 37< x <=38 | | 0.5% | | | | | | | | | 0.4% | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 38< x <=39 | | | | | | | | | | | | |
| 39< x <=40 | 0.4% | | | | | | | | | | | |
| 40< x <=41 | 0.4% | | | | | | | | | | | |
| 41< x <=42 | | | | | | | | | | | | |
| 42< x <=43 | | | | | | | | | | | | |
| 43< x <=44 | | | | 0.4% | | | | | | | | |
| 44< x <=45 | | | | | | | | | | | | |
| 45< x <=46 | | | | | | | | | | | 0.4% | |
| 46< x <=47 | | | | | | | | | | | | |
| 47< x <=48 | | | | | | | | | | 0.4% | | |
| 48< x <=49 | | | | | | | | | | | | |
| 49< x <=50 | | | | | | | | | | | | |
| 50< x <=51 | | | | | | | | | | | | |
| 51< x <=52 | | | | | | | | | | | | |
| 52< x <=53 | | | | | | | | | | 0.4% | | 0.4% |
| 53< x <=54 | | 0.5% | | | | | | | | | | |
| 54< x <=55 | | | | | | | | | | | | |
| 55< x <=56 | | | | | | | | | | | | |
| 56< x <=57 | | | | | | | | | | | | |
| 57< x <=58 | | | | | | | | | | | | |
| 58< x <=59 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 59< x <=60 | | | | | | | | | | | | |
| 60< x <=61 | | | 0.4% | | | | | | | | | |
| 61< x <=62 | | | 0.4% | | | | | | | | | |
| 62< x <=63 | | | | | | | | | | | | |
| 63< x <=64 | | | | | | | | | | | 0.4% | |
| 64< x <=65 | | | 0.4% | | | | | | | | | |
| 65< x <=66 | | | | | | | | | | | | |
| 66< x <=67 | | | | | | | | | | | | |
| 67< x <=68 | | | | | | | | | | | | |
| 68< x <=69 | | | | | | | | | | | | |
| 69< x <=70 | | | | | | | | | | | | |
| 70< x <=71 | | | | | | | | | | | | |
| 71< x <=72 | | | | | | | | | | | | |
| 72< x <=73 | | | | | | | | | | | | |
| 73< x <=74 | | | | | | | | | | | | |
| 74< x <=75 | | | | | | | | | | | | |
| 75< x <=76 | | | | | | | | | | | | |
| 76< x <=77 | | | | | | | | | | | | |
| 77< x <=78 | | | | | | | | | | | | |
| 78< x <=79 | | | | | | | | | | | | |
| 79< x <=80 | | | | | | | | | | | | |

| Waiting Time Bin (hours) | Percent Occurrence (Percent of LNG Carrier Arrivals that Incur a Wait) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 80< x <=81 | | | | | | | | | | | | |
| 81< x <=82 | | | | | | | | | | | | |
| 82< x <=83 | | | | | | | | | | | | |
| 83< x <=84 | | | | | | | | | | | | |
| 84< x <=85 | | | | | | | | | | | | |
| 85< x <=86 | | | | | | | | | | | | |
| 86< x <=87 | | | | | | | | | | | | |
| 87< x <=88 | | | | | | | | | | | | |
| 88< x <=89 | | | | | | | | | | | | |
| 89< x <=90 | | | | | | | | | | | | |
| 90< x <=91 | | | | | | | | | | | | 0.4% |

# Supplemental Document II

Shell International LNG Supply

# Broadwater - Long Island Sound versus Atlantic alternatives Witness Modeling June 2008

| Revision No | A | B | C |
|---|---|---|---|
| Issue Purpose | Study Basis | Progress Report | Final Report |
| Date | 10th June 2008 | 27th June 2008 | 30th June 2008 |
| By | Aneta Blaszczyk | Aneta Blaszczyk | Aneta Blaszczyk |
| Checked | Justine Clark | Justine Clark | Justine Clark |
| Approved | Guy Nicholls | Guy Nicholls | Guy Nicholls |

Distribution: Guy Nicholls, Jimmy Culp

Copy available from: Justine Clark, Aneta Blaszczyk

Queries to: Justine Clark, Aneta Blaszczyk

## Objective

The purpose of this study is to understand the impact on the reliability of the base send-out that would occur if the planned Broadwater Floating Storage and Regasification Unit (FSRU) was moved from the benign waters of Long Island Sound to the Atlantic alternative locations proposed by the New York Department of State (NYDOS).

Additionally the study will

- Assess the potential shipping delays that would occur due to the increased down-time associated with the more exposed locations in the Atlantic ocean.
- Advise on the incremental storage that would be required in order for the reliability of send-out profile for the Atlantic alternative sites to become comparable to the Long Island site.

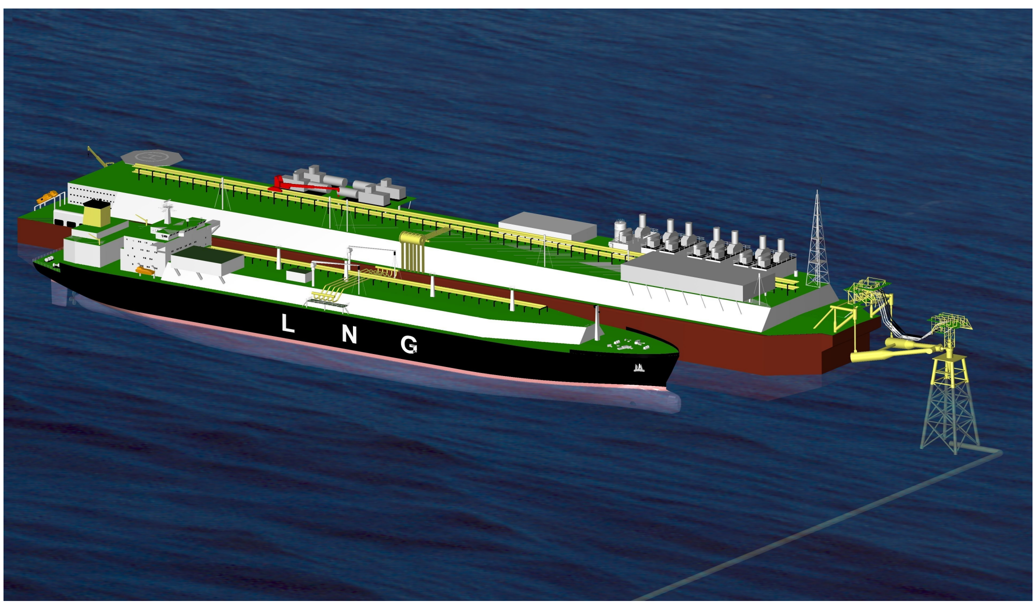



**Figure 1 Broadwater FSRU**

# 1. Executive Summary

Broadwater Energy, as part of its extensive site selection process, reviewed a number of locations, and various technologies for both onshore and offshore sites in the Long Island Sound area. The assessment concluded that the preferred option, in order to meet the identified objectives, was an FSRU located within Long Island Sound.

On April 10th 2008, the New York Department of State (NYDOS) announced their determination that the Broadwater LNG project was not consistent with the State's Coastal Zone Management policies under the Coastal Zone Management Act (CZMA) - effectively denying the required permit. As part of the consistency review and as described in the CZMA letter, the DOS described alternatives that, if adopted by Broadwater, would permit the proposed project to be conducted in a manner consistent with the enforceable policies of the NYSCMP. These alternatives focused upon two potential FSRU sites located in the Atlantic Ocean between 13 and 20 miles off the Southern shore of Long Island.

A simulation study has been carried out in order to assess the feasibility of the two proposed locations in comparison with the primary location.
Additionally, it was investigated what measures would have to be taken to bring the reliability of the send out at the Atlantic Locations to the same level as the Long Island Sound site. This report documents the findings in terms of the send out reliability and fleet usage including the turnaround time for arriving LNG Vessels at the FSRU.

Comparison of the **send out reliability** for each of the locations clearly indicates that the weather disruptions at the Atlantic Locations 1 and 2 significantly impact the send out reliability from the FSRU to the market. The required send out of **1bcf/d** can only be assured for

- **89% and 86.5% of time for the Atlantic Location 1 and 2,** respectively, when compared with **97.5% of time for the Long Island location.**
- It should be noted that these figures are on an annual basis, and the reliability figure for the winter months of October to March is drastically reduced to **87%** and **78.5%** respectively. This during the period when it is critical to have the firm reliable send-out required by the local market. This is very accurately demonstrated on figure 4 with the large fluctuating send out profile and numerous stock outs - i.e. periods where the FSRU actually runs out of gas due to the inability of vessels to berth and restock the FSRU with new supply. This is in direct comparison to the Long Island Sound site, where no stock-outs occur and the send out profile is almost flat at 1.0 bcf/d with no seasonal fluctuations

The turnaround time for LNG Vessels at the FSRU was compared for the three different locations, whereby turnaround time is defined as the amount of time it takes for the LNG carrier to safely arrive, moor, connect, discharge the LNG cargo, complete the required documentation disconnect, unmoor and depart the vicinity, The comparison of the 95th percentile turnaround times for each site shows that the LNG carrier would suffer significantly longer turn around times if the FSRU was located at one of the Atlantic Locations.

This turnaround time would increase from **1.3 days in Long Island** to **7.2 days** and **8.1 days for Atlantic Location 1 and 2 respectively.** This is mainly due to the inability to connect and/or slow discharging due to weather disruptions. These increased delays would lead to additional concerns:

- Reduced attractiveness to potential suppliers due to the under utilization of their fleets.
- Potential shut ins at the load port due to delays in the returning LNG vessel to pick up their next cargo.

On shipping costs alone, a re-located Atlantic site would introduce ~0.15 $/MMBTU incremental cost due to increased weather down time in the vicinity of the facility. Furthermore this would result in requiring one additional ship in the fleet.

Send out reliability was one of the prerequisites for choosing the location for the FSRU. The following conditions have to be fulfilled regarding required additional storage/buffer stock in order to attempt to make the Atlantic sites equivalent to the Long Island Sound send out reliability:

- For Atlantic Location 1, an additional 3 tanks of 40,000m3 gross containing buffer stock would have to be added.
- For Atlantic Location 2, an additional 4 tanks of 40,000m3 gross containing buffer stock would have to be added.

However, due to the more extreme weather conditions at these sites, the P95% turnaround times for the vessels would only be slightly reduced and even with the additional storage capacity, the requirement for one additional ship is maintained.

The cost of investment in the additional storage tanks and LNG for the buffer stock has not been considered here, and there are other concerns that Broadwater Energy would also have to address.

- Is there a shipyard big enough to build the new larger unit.
- The increased “weight” of the FSRU and the effect it will have on the mooring system – additional analysis would be required to ensure that the mooring system could still withstand the planned met ocean conditions.
- Increased power requirements – additional equipment would likely be required e.g. the stern thrusters may need upgrading in order to offset the additional weight, this would lead to additional emissions and potentially greater cooling water requirements.
- Additional ballast water to be taken on board.
- Additional costs – both Capex and Opex

In conclusion, looking both at the send out rate reliability and the turnaround times' analysis, Long Island is clearly a preferred location. If either one of the proposed Atlantic locations is chosen, then this will have a serious impact on the ability to serve the local market in a reliable way and will also have a significant impact to the shipping utilization and costs, a cost that will naturally have to be passed onto the end user of the product.

## 2. Introduction

The objective for the Broadwater project is to provide a source of reliable, long-term, and competitively priced natural gas to the New York, Long Island and Connecticut markets in order to meet growing market demand. To fulfill this purpose and need, a viable LNG import terminal concept and site must meet, at a minimum, the following specific criteria:

- Be technically and economically feasible, practicable, and implementable;
- Maximize the buffer between the Project and populated areas;
- Have significant environmental benefits over other alternatives;
- Be able to provide reliable natural gas deliveries to the Region via pipeline connections;
- Provide deepwater berthing to accommodate up to 250,000$m_3$ capacity LNG carriers, with a maximum draft requirement of 49 feet (15 m);
- Provide for storage and vaporization facilities for at least 1.0 bcfd of natural gas for an in-service date of 2010;
- Comprise a site that allows the terminal to maintain sufficient control and proprietary rights of operation;
- Comprise a site situated close to an existing pipeline system serving the Region with downstream takeaway capability greater than 1.0 bcfd; and
- Be able to ensure facility and connecting pipeline operability for a minimum 30-year project life.

Broadwater as part of its extensive site selection process reviewed a number of locations, and various technologies for both onshore and offshore in the Long Island Sound area. The analysis of these various options is fully discussed in Resource Report 10.[1] This was filed with the Federal Energy Regulatory Commission (FERC) as part of the projects application. This extensive assessment identified that the preferred option, in order to meet the identified objectives, was an FSRU located within Long Island Sound. It further defined that the optimum position was with the yoke-mooring tower located at a position of

| | |
|---|---|
| Latitude | 41° 06' 02.870" North |
| Longitude, | 72° 50' 44.56" West |

Further to this, Broadwater completed a simulation evaluation of the marine operations for the Project including extensive work with the local NE Pilots (NE Pilots) at Marine Simulation International (MarineSafety) in Middletwon Rhode Island. This evaluation is documented in Section 11.4.2.3 (LNG Carrier Berthing Considerations) of Resource Report 11 and resulted in an assessment of operational limits for LNG carrier operations.

These limits were assessed as the following combination of wind, wave and current conditions identified in Table 1 below:

[1] Section 10.5

**Table 1**

| Summary of Operational Limits | | | | | | |
|---|---|---|---|---|---|---|
| **Operational Limit** | **Significant Wave Height** | | **Wind Velocity** | | **Current Velocity** | |
| Approach Limits | **2m** | **6.6 ft** | **33 Kts** | **38 mph** | **0.9 Kts** | **1.5 ft/sec** |
| Side-by-Side Mooring Limits | **3m** | **9.8 ft** | **39 Kts** | **45 mph** | **0.9 Kts** | **1.5 ft/sec** |
| Departure Limits | **2m** | **6.6 ft** | **33 Kts** | **38 mph** | **0.9 Kts** | **1.5 ft/sec** |

On April 10th 2008, the New York Department of State (NYDOS) announced their determination that the Broadwater LNG project was not consistent with the State's Coastal Zone Management policies under the Long Island Sound Coastal Zone Management Act (CZMA) - effectively denying the required permit. In support of this decision the NYDOS supplied a 74-page document outlining its case.

As part of the consistency review and as described in the CZMA letter, the DOS described alternatives that, if adopted by Broadwater, would permit the proposed project to be conducted in a manner consistent with the enforceable policies of the NYSCMP. These alternatives focused upon two potential FSRU sites located in the Atlantic Ocean between 13 and 20 miles off the Southern shore of Long Island.

These locations, along with the original Broadwater site are identified in the figure 2 below

Site-1: 40º 23' 0"N & 73º 37' 0"W in about 80 feet of water; located 13 miles offshore south of Long Beach, NY, west of Cholera Bank

Site-2: 40º 20' 0"N & 73º 10' 5"W in about 130 feet of water; located in the Atlantic Ocean, 22 miles south of Fire Island Inlet.

The figure also highlights two other Project sites that have been announced - Safe Harbor and Blue Ocean Energy. Both of these projects have publicly stated that their primary objective is to bring a new source of gas into the New Jersey market [rather than the Broadwater's objective of supplying the New York market]

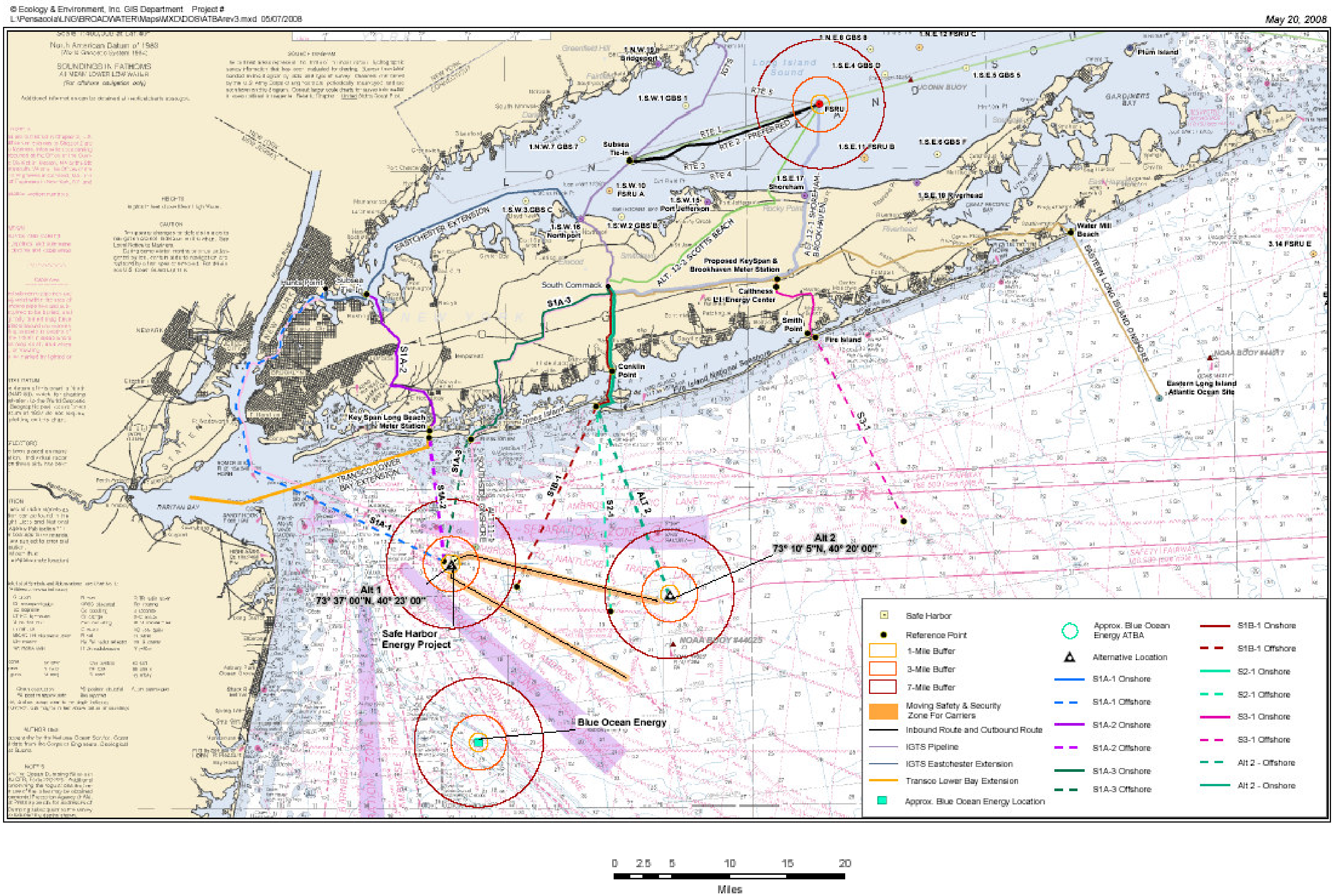
Broadwater had previously contracted Moffatt and Nicholl (www.moffattandnichol.com) to conduct a complete Met ocean analysis for the Long Island Sound site and this analysis assisted in establishing the operating criteria for the FSRU. The results of this study indicated that a FSRU located in the benign waters of Long Island Sound provided 99% uptime for vessels calling at the facility. Moffatt and Nichol have subsequently been contracted to complete a second analysis of the two potential Atlantic alternative sites. The data for these respective sites will be one of the main inputs into the Witness logistic model in order to provide comparative send-out data and shipping turn around data.[2] Additionally in order to fully compare the sites it is necessary to assume that the planned Broadwater FSRU is replicated in the Atlantic Alternative sites.

[2] The met-ocean data is contained in appendices 2, 3 and 4.

The Broadwater FSRU has the following main criteria

- Eight LNG storage tanks, giving a total capacity of 350,000m3.
- A base send-out rate into the Iroquois Gas Transmission network of 1.0 bcf/d.
- Is constructed to be served by any of the existing or planned world-wide fleet of LNG tankers.

**Figure 2**


© Ecology & Environment, Inc. GIS Department Project #
L:\Pensacola\LNG\BROADWATER\Maps\MXD\DOS\ATBArev3.mxd 05/07/2008
May 20, 2008
Alt 1
73° 37' 00"N, 40° 23' 00"
Alt 2
73° 10' 5"N, 40° 20' 00"
Safe Harbor
Energy Project
Blue Ocean Energy
FSRU
Subsea Tie-in
RTE 1
RTE 2 - PREFERRED
RTE 3
RTE 4
RTE 5
South Commack
Conklin Point
Smith Point
Fire Island
Water Mill Beach
Plum Island
Caithness LI Energy Center
Proposed KeySpan & Brookhaven Meter Station
Key Span Long Beach Meter Station
Hunts Point
Eastern Long Island Atlantic Ocean Site
EASTCHESTER EXTENSION
TRANSCO LOWER BAY EXTENSION
S1A-1
S1A-2
S1A-3
S1B-1
S2-1
S3-1
ALT 2
Safe Harbor
Reference Point
1-Mile Buffer
3-Mile Buffer
7-Mile Buffer
Moving Safety & Security Zone For Carriers
Inbound Route and Outbound Route
IGTS Pipeline
IGTS Eastchester Extension
Transco Lower Bay Extension
Approx. Blue Ocean Energy Location
Approx. Blue Ocean Energy ATBA
Alternative Location
S1A-1 Onshore
S1A-1 Offshore
S1A-2 Onshore
S1A-2 Offshore
S1A-3 Onshore
S1A-3 Offshore
S1B-1 Onshore
S1B-1 Offshore
S2-1 Onshore
S2-1 Offshore
S3-1 Onshore
S3-1 Offshore
Alt 2 - Offshore
Alt 2 - Onshore
0 2.5 5 10 15 20
Miles

## 3. Scope of the Broadwater Witness Model

The model simulates the FSRU supplied with LNG from the supply source and sending out LNG to the market with the average daily send out rate, the vessels arriving to the FSRU and discharging LNG. The vessels carry the cargoes from supply source, Qatar, which modeled in high level, to FSRU. Once the cargo is discharged, the LNG carrier comes back to Qatar to pick up next cargo. Figure 1 shows all the activities the LNG carrier goes through. This so called closed loop way of modeling the supply chain and it captures not only all the activities and delays at the FSRU but also all the activities and delays on the way from the supply source.

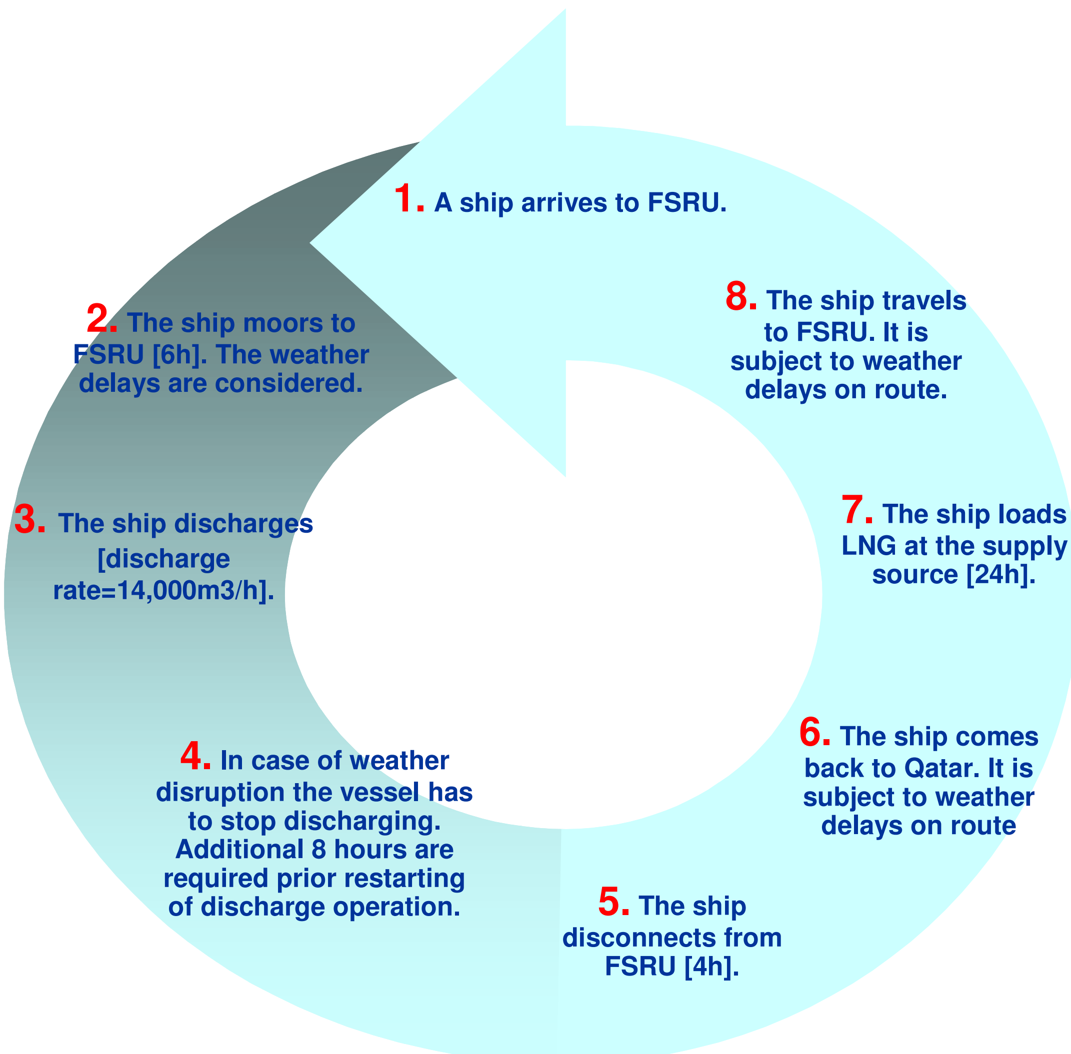



**Figure 3 LNG carrier's activities**

The inputs to the model are:

- Tank size at FSRU, vessel sizes (both gross and net capacity)
- Send out rate from the FSRU to the market
- LNG discharging rates from the LNG carrier to the FSRU
- Activities' durations at the FSRU and at the loading port (the latter one on high level only)
- Closure of the FSRU due to weather disruptions
- Durations of the voyages between FSRU and Qatar
- Laden and ballast speed of the LNG carrier
- Delays due to weather disruptions on the way from Qatar to FSRU

The outputs of the model are:

- The vessel's turnaround times at the FSRU
- The send out profile from the FSRU to the market
- Percent of the throughput lost due to weather disruptions

The model is run for the period of 6 years on the hourly basis. The first year is treated as a warm up period and output data from this year are excluded from the analysis.

All the parameters used in the model are discussed in the following section.

Closed loop modeling approach requires determining the fleet requirements for being able to serve demand from the supply source to the market. Fleet requirement is a function of the following components:

- Distance between the supply source and the market
- Demand/Send out rate
- LNG carrier's speed and discharging rate
- Duration of the activities at the supply source and FSRU
- Transiting Suez Canal

The detailed calculations for the fleet requirement for each of the cases are presented in Appendix 1. It has to be noted that the LNG carrier's speeds have been adjusted to obtain non-fractional number of LNG carriers. This is because Witness cannot deal with fractional fleet size or with vessel's utilization less than 100%. If the vessel's speed were 19.5 knots, a fractional number of vessels would be required. Then in Witness study it would be only possible to use fewer vessels than required, which would result in stocking out at the FSRU as not enough LNG was being delivered; or to use more vessels than required, which would result in extensive waiting time of the vessel for the free berth or in slow discharging as there would be not enough space in the FSRU tank. In order to analyze the impact of the location choice characterized by different weather disruptions, the shipping inefficiencies had to be removed from the model by using optimal fleet size.

## 4. Input Data and Assumptions

The Table below summarizes the input data and the assumptions used in the modeling work.

**Table 2: Input Data and Assumptions**

<table>
<tr><th>Data</th><th>General Description</th><th>Source</th></tr>
<tr><td>Load port</td><td>Qatar</td><td>Business decision</td></tr>
<tr><td>Distance from Load port</td><td>Distance between the loading port and the Long Island (case 1) location is 8042 nm.<br>Distance between the loading port and the Atlantic Location 1 (case 2) is 8042 nm.<br>Distance between the loading port and the Atlantic Location 2 (case 3) is 8007 nm.<br>As the vessels will require transiting the Suez canal when coming from Qatar, an additional day per ballast / laden voyage is allowed.</td><td>Distance Tables</td></tr>
<tr><td>Delays at Source/En-route</td><td>The load terminal is modeled on high level. It is assumed that it takes 24 hours for the LNG carrier to enter the load port, connect, load LNG, disconnect and leave the port.<br><br>The delays on route from the source to FSRU are based on the previous data supplied from STASCo.<br>For all the three cases the weather disruptions on the route from source to FSRU are the same.<br><br>
<table>
<tr><th></th><th>May-Oct</th><th>Nov- Apr</th></tr>
<tr><td>Mean Time Between Delay (hrs)</td><td>964</td><td>513</td></tr>
<tr><td>Min Delay (hrs)</td><td>10</td><td>2</td></tr>
<tr><td>Mode Delay (hrs)</td><td>19</td><td>4</td></tr>
<tr><td>Max Delay (hrs)</td><td>29</td><td>7</td></tr>
</table>
</td><td>STASCO</td></tr>
<tr><td>Weather (including wind and fog)</td><td>The operability criterion is set as identified in the introduction and which followed extensive analysis and simulations.<br><br>
<table>
<tr><th colspan="7">Summary of Operational Limits</th></tr>
<tr><th>Operational Limit</th><th colspan="2">Significant Wave Height</th><th colspan="2">Wind Velocity</th><th colspan="2">Current Velocity</th></tr>
<tr><td>Approach Limits</td><td>2m</td><td>6.6 ft</td><td>33 Kts</td><td>38 mph</td><td>0.9 Kts</td><td>1.5 ft/sec</td></tr>
<tr><td>Side-by-Side Mooring Limits</td><td>3m</td><td>9.8 ft</td><td>39 Kts</td><td>45 mph</td><td>0.9 Kts</td><td>1.5 ft/sec</td></tr>
<tr><td>Departure Limits</td><td>2m</td><td>6.6 ft</td><td>33 Kts</td><td>38 mph</td><td>0.9 Kts</td><td>1.5 ft/sec</td></tr>
</table>
<br>The basis of the weather delays, as defined, by Moffat and Nichol, is attached in appendices 2, 3 and 4.</td><td>As per the Moffat and Nichol Study 2005 and 2008.<br><br>Historical delays of</td></tr>
<tr><td>Delays at FSRU</td><td>It is assumed that it takes 6 hours for the inward transit until the commencement of discharge. During this period the vessel will be maneuvering, mooring, connecting the loading arms, completing essential safety tests and pre-operational documentation</td><td>STUSCO, Moffat & Nichol</td></tr>
</table>

| | | |
|---|---|---|
| | It is assumed that it takes 4 hours to disconnect the loading arms and do the outbound transit. During this period the vessel will be completing post operational documentation, disconnecting the loading arms unmooring and maneuvering away from the FSRU. Additionally the FSRU is subject to weather disruptions characteristic for each of the sites. Those weather disruptions are represented in the model with the probability distributions obtained from Moffat & Nichol and included in the Appendices 2, 3 and 4.<br><br>When the weather disruption happens during connecting, the activity is stopped for the time equal to the duration of the weather disruption. Once the weather disruption finishes the connecting activity is being continued.<br><br>If the weather disruption happens when the LNG is being discharged, the operation is stopped, the LNG carrier has to disconnect and sail away. Once the weather disruption is finished the LNG carrier has to sail bask to the FSRU and reconnect, which is assumed to take 8 hours which makes due allowance for returning to the FSRU and completing the steps identified above. | |
| Size of Vessel | The modeling has assumed the vessel size serving the FSRU as the Very Large LNG vessels currently being delivered for the various Qatar projects.<br><br>Due to the length of voyage distance this will maximize the efficiency of using large vessels over long distances.<br>The vessels currently being delivered have a capacity of +/- 265,000m3. Due to the current permit conditions the modeling will assume a delivered amount of 250,000m3. | STASCO |
| Restrictions on transit | None currently known, as the Vessel Traffic Management Plan or Regulated Navigation Area has not yet been defined for Long Island Sound. The Atlantic Alternative sites should also have any restrictions. | USCG Water Suitability Report (WSR) |
| Tide | The range of tide is 4 ft (1.2m) but will have no effect on operations as both the vessel and the FSRU are floating. The FSRU will weathervane around the yoke mooring tower. As such no tidal assist is required to make a safe transit.<br>*No impact on modeling* | NOAA Chart |
| Waiting for ullage | Ships will arrive at the FSRU regardless if there is enough spare storage to fully discharge that cargo. This could result in slow discharging. | |
| USCG Escort | It is expected that the Captain of the Port Long Island Sector will ensure that LNG vessels *are* escorted during the inbound and / or outbound transit. If required the place and time for the escort will be detailed in a COTP Order and communicated to the vessel by the agent.<br><br>*No impact on modeling.* | WSR and would be backed u by a future RNA identified in CFR 33 Part 165 |
| Moving Safety and security zone | The proposed moving safety zone enforced by the USCG is 2 miles ahead of the transiting LNG Vessel, one mile astern and 750 yards on either side of the LNG ship for Long Island Sound. | WSR and would be backed u by a future RNA |

[3] Telephone Conversation between Guy Nicholls and Mr Mark Prescott, Chief Deepwater Ports Standards Division May 27th 2008

| | | |
|---|---|---|
| | Currently the Atlantic alternative sites do not have a declared Safety and Security zone. However it should be noted that the Neptune LNG FEIS sections 2.1.1.2 states *"EBRV Safety and Security Zone – Pursuant to 33 CFR 165.110 a mandatory Safety and Security Zone would exist two miles ahead and one mile astern, and 500 yards on either side of any LNG Carrier vessel while underway within the Captain of the Port (COTP) Boston zone.*<br>Accordingly all arriving and departing LNG Vessels for their initial and final 35 miles of voyage will be subjected to a moving Safety and Security zone.<br>A FSRU placed at the Atlantic Alternative Location 1 site is likely to have a similar zone imposed on arriving / departing LNG vessels due to the amount of traffic in the vicinity. The zone would be dependent upon risk-based analysis but would be likely to be +/-20miles.[3]<br>*No impact on modeling.* | identified in CFR 33 Part 165 |
| Pilots | Always available. The Pilot for the Long Island Sound location would join at Point Judith Pilot Station A new Pilot station dedicated to the proposed Atlantic locations would be required to set up. Due to the inclement weather at these sites it is likely that there would be increased delays in getting a Pilot on board due to safety concerns. However in order to best compare the sites these potential delays have been ignored in the modeling.<br>*No impact to modeling.* | NE Marine Pilots |
| Tugs | The simulations at MSI have proven that 4 tugs with a minimum bollard pull of 65 tones would be required to safely berth a Very Large LNG Vessel, with a capacity of +/-250,000 m3 to the Broadwater FSRU.<br>For the Atlantic alternative sites, the effectiveness of the tugs will be greatly reduced due to the prevailing weather conditions – see SAFE TUG JIP.<br>However in order to best compare the sites these limitations have been ignored in the modeling process and are address elsewhere. | MSI simulations Safe tug JIP. Tug effectiveness reduced in seaways. |
| Berthing Restrictions - weather | As detailed above | Basis of Design Document |
| Berthing Restrictions – Physical size of vessels | The Broadwater facility has been designed to accommodate all of the existing and planned worldwide fleet of LNG tankers. As such regardless of location it will be able to accommodate the vessels of circa +/-250,000m3 capacity range regardless of location.<br><br>Additionally there is no draft restriction for the approaches in either the Long Island Sound or Atlantic alternative sites. | Basis of Design Document |
| Number of berths | One berth regardless of location. The vessels will berth to the Starboard side of the FSRU. | Basis of Design Document |
| Discharge rate | The FSRU is designed to accept a maximum discharge rate of 14,000m3/r. | Basis of Design Document |
| Safety / Security Zone | Long Island Sound - Whilst alongside a safety / security zone of 1210 yards centered around the Yoke Mooring Tower will be maintained.<br>Currently the Atlantic alternative sites do not have a declared Safety and Security zone but this is likely to be at least 750 yards with the potential for another Area to be Avoided zone due to the proximity of passing traffic.<br>*No impact to modeling.* | WSR and would be backed u by a future RNA identified in CFR 33 Part 165 |

| | | |
|---|---|---|
| Gas Quality | The effect of rich LNG quality being discharged with its requirement for nitrogen injection has not been modeled. This could affect the send out rate but is the same for the three locations. And therefore is ignored in the modeling. | |
| Send-out | 1 bcf/d | Basis of Design Document |
| Storage | Storage on the FSRU is 350,000m3 regardless of location.<br>The working volume in order to keep the FSRU cold is assumed to be 95% of this capacity ie 332,500m3. | Basis of Design Document |
| Contractual obligation and potential demurrage payments incurred | For the Long Island Sound location, due to the increased discharge rate and lack of inclement weather, a Very Large LNG Vessels would be expected to turn around PBS to PBS in 36 hours. This same time frame will be used for the Atlantic alternative sites. | |
| Conversions used | 1 unit of m3 LNG is equal to 0.0213 mscf/d of gas. | |

Comparison of the three different locations was based on the following performance measures:

- **Sent out reliability.**, One of the criteria for deciding upon the location of the FSRU was how reliably the local market can be supplied. The study investigates what is send-out reliability for each of the locations. For each of the locations, it has been evaluated how often the send out drops below 1bc/d due to the weather disruptions.

- **Turnaround time at the FSRU**. A Very Large LNG Vessel has (contractually) 36 hrs to turnaround. In case of weather delay, discharging operation has to be stopped - it takes longer for the cargo to be discharged. This has impact on the overall turnaround time and what follows on the unit freight cost. Therefore the turnaround times of the vessels have been compared for all the three sites. To enable consistent comparisons, the turnaround times at the FSRU are recorded from start of connection to disconnection (including any weather delays/ queuing/ discharge/ slow discharge).

# 5. Results

This chapter summarizes the impact of the FSRU location choice on the send out reliability and the turnaround times.

**Send out reliability assessment**

Figure 4 summarizes the send out frequency for each of the selected locations.

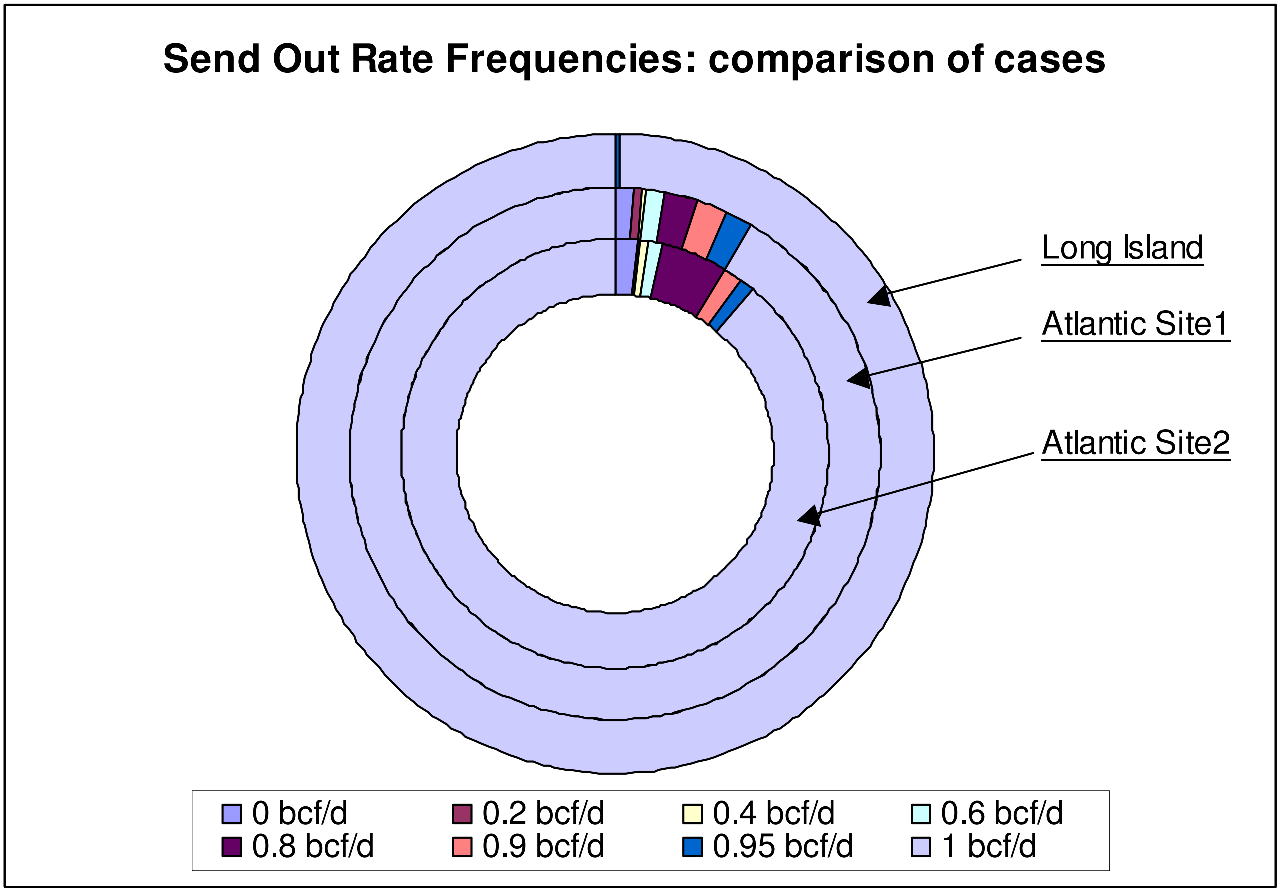



**Figure 4 Comparison of send out frequencies for each of the locations**

The comparison of the send out rate reliability for each of the cases is presented in the Figure 5.

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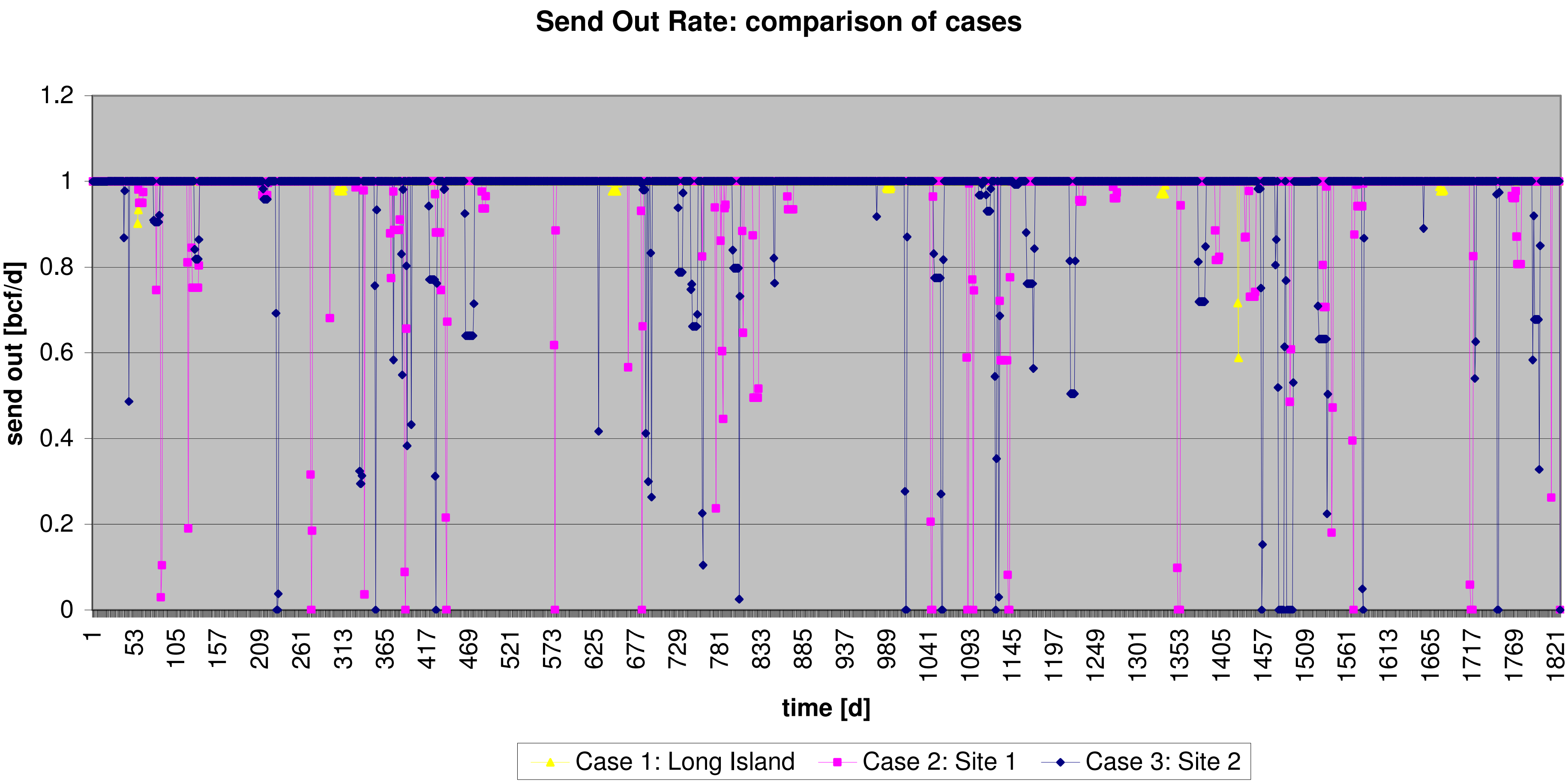


**Figure 5: Comparison of send out profiles**

**Table 3**

| | **Long Island** | **Atlantic Loction 1** | **Atlantic Loction 2** |
|---|---|---|---|
| percentile | send out [bcf/d] | send out [bcf/d] | send out [bcf/d] |
| 2.00% | 0.988 | 0.479 | 0.267 |
| **2.50%** | **1.000** | 0.576 | 0.342 |
| 3.00% | 1.000 | 0.587 | 0.505 |
| 4.00% | 1.000 | 0.731 | 0.632 |
| 5.00% | 1.000 | 0.805 | 0.662 |
| 10.50% | 1.000 | 0.986 | 0.920 |
| **11.00%** | 1.000 | **1.000** | 0.941 |
| 13.00% | 1.000 | 1.000 | 0.996 |
| **13.50%** | 1.000 | 1.000 | **1.000** |
| 30.00% | 1.000 | 1.000 | 1.000 |
| 95.00% | 1.000 | 1.000 | 1.000 |
| 100.00% | 1.000 | 1.000 | 1.000 |

Detailed comparison of send out reliability for each of the locations (Table 3) clearly indicates that the weather disruptions at the Atlantic Locations1 and 2 significantly impact the send out reliability from the FSRU to the market. Required send out of 1bcf/d can be assured only for **89% and 86.5%** of time for the Atlantic Location 1 and 2 respectively as opposed to **97.5%** of time for the Long Island location as highlighted in Table 3 above.

It should be noted that these figures are on an annual basis, and the reliability figure for the winter months of October to March is drastically reduced to **87%** and **78.5%** respectively. This during the period when it is critical to have the firm reliable send-out required by the local market. This is very accurately demonstrated in Table 4 on Figure 4 with the large fluctuating send out profile and numerous stockouts - ie periods where the FSRU actually runs out of gas due to the inability of vessels to berth and restock the FSRU with new supply. This is in direct comparison to the Long Island Sound site, where no stock-outs occur and the send out profile is almost flat at 1.0 bcf/d with no seasonal fluctuations

**Table 4**

| | **Atlantic Loction 1 (October-March)** | **Atlantic Loction2 (October-March)** |
|---|---|---|
| percentile | send out [bcf/d] | send out [bcf/d] |
| 2.00% | 0.241 | 0.000 |
| 2.50% | 0.542 | 0.000 |
| 3.00% | 0.582 | 0.115 |
| 4.00% | 0.650 | 0.303 |
| 12.50% | 0.984 | 0.775 |
| **13.00%** | **1.000** | 0.787 |
| 21.00% | 1.000 | 0.995 |
| 21.30% | 1.000 | 0.999 |
| 21.40% | 1.000 | 0.999 |
| **21.50%** | 1.000 | **1.000** |
| 22.00% | 1.000 | 1.000 |
| 100.00% | 1.000 | 1.000 |

## Turnaround time assessment

The comparison of results for the turnaround times is presented in Figure 5 and Table 5. The turnaround time at the FSRU is defined as the sum of the following activities:

- Connection to the FSRU
- Discharging
- Weather disruption duration
- Disconnection for the FSRU

**Table 5**

| Percentile | Turnaround time at Atlantic Location 2 [h] | Turnaround time at Atlantic Location 1 [h] | Turnaround time at Long Island [h] |
|---|---|---|---|
| 20% | 27.86 | 27.86 | 27.86 |
| 50% | 47.88 | 35.57 | 27.86 |
| 90% | 152.67 | 137.16 | 27.87 |
| 95% | 195.49 | 173.88 | 31.82 |
| 96% | 206.45 | 182.20 | 31.94 |
| 97% | 222.96 | 191.90 | 37.86 |
| 98% | 368.22 | 200.24 | 41.86 |
| 99% | 430.81 | 212.31 | 46.77 |
| 100% | 583.86 | 223.22 | 49.86 |

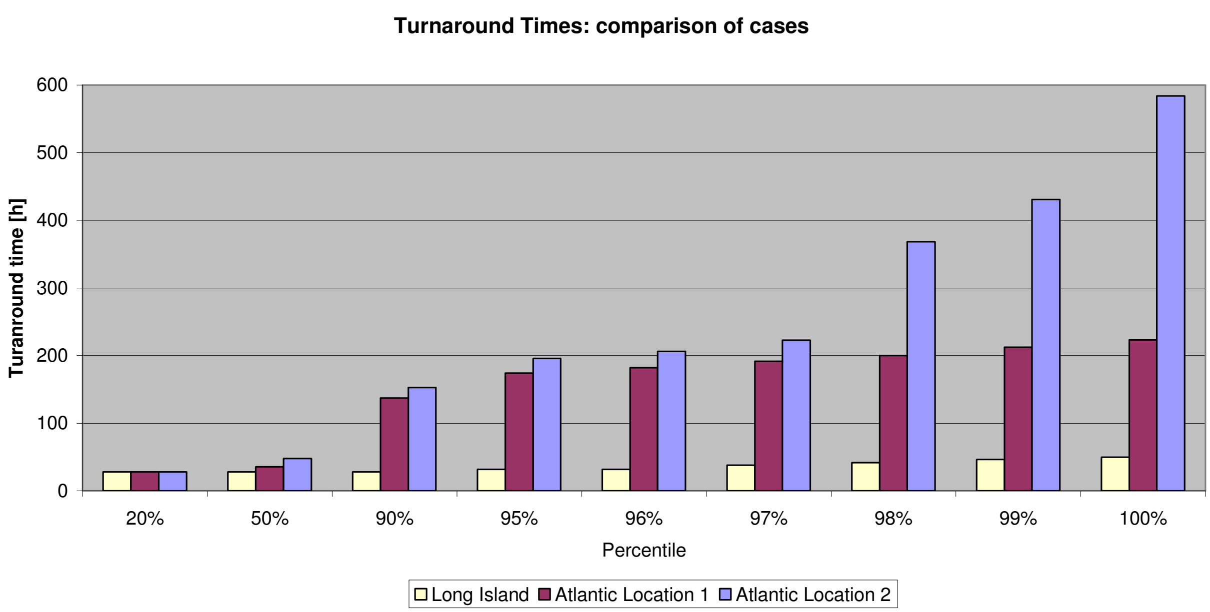


**Figure 6 Comparison of turnaround times at the FSRU**

Weather disruptions significantly influence the amount of time that the vessel has to spend at the FSRU to discharge the cargo.

For Atlantic Location 2 for 95% of cases the turnaround time is lower or equal to 195.49 hours (8.1 days). According to the contractual obligations of the 36 - hour turnaround time at the FSRU, in 64% of cases this limit would be exceeded and the demurrage payment would have to be incurred.

For Atlantic Location 1 for 95% cases the amount of time that the vessel spends at the FSRU is lower or equal to 173.88 hours (7.2 days). According to the contractual obligations of the 36 - hour turnaround time at the FSRU, in 50% of cases this limit would be exceeded and the demurrage payment would have to be incurred.

Long Island site is significantly better. For 95% of cases the turnaround of 31.82 hours (1.3 days) can be guaranteed. This is in line with the contractual obligations of 36 hours of expected turnaround time at the FSRU for the very large vessel. In 3% of cases only the 36 hours limitation of the turnaround time was exceeded and demurrage payment would have to be incurred for the Long Island case which is a very acceptable business risk.

| | **Atlantic Location 2** | **Atlantic Location 1** | **Long Island** |
|---|---|---|---|
| **Percentage of vessels with turnaround time of more than 36 hours** | 63% | 50% | 3% |

**Table 6 Percentage of vessels incurring demurrage payments for each location**

In conclusion, looking both at the send out rate reliability and the turnaround times analysis, Long Island is clearly a preferred location. If either one of the proposed Atlantic locations is chosen, then this will have a serious impact on the ability to serve the local market in a reliable way and will also have a significant impact to the shipping utilization and costs, a cost that will naturally have to be passed onto the end user of the product..

### Atlantic Site Location Sensitivity

As the above analysis shows, the Atlantic Site Locations result in far worse send-out performance than the Long Island Sound base case. This then raises the question of what would need to be adjusted in the supply chain to achieve the same consistency of send out with the Atlantic locations as per that obtained in the Long Island case.

An obvious adjustment would be to increase the FSRU storage, and therefore work with a larger buffer stock to cover those periods of longer delay. However when this was tested in the model, it became evident that this alone is not sufficient to achieve a higher level of send out reliability.

The following Table 7 compares the number of cargoes delivered per annum. for the Long Island Sound base case and Atlantic Site 1:

**Table 7**

| | Number of cargoes delivered p.a. | | |
|---|---|---|---|
| | Long Island Sound with 350k-m3 storage | Atlantic Site 1 with 'infinite' storage | Delta |
| Year 1 | 68 | 66 | -2 |
| Year 2 | 69 | 65 | -4 |
| Year 3 | 68 | 69 | +1 |
| Year 4 | 69 | 67 | -2 |
| Year 5 | 60* | 59* | -1 |
| **Total** | **334** | **326** | **-8** |
| Average Delay at FSRU (hrs) | 1.3 | 21.3 | |

* There are fewer cargoes recorded in the Year 5 as the Witness model does not log the cargo until it has finished discharging, and the simulation finishes before all have finished their last cargo for the year.

With the Atlantic Site 1 case, the number of cargoes delivered quickly falls into deficit with the 8 ship fleet due to the higher frequency and longer delays experienced – this means that the fleet simply cannot deliver enough cargoes.
The maximum number of cargoes the fleet can deliver in this configuration is ~69, hence there is no ability to "catch up" on deficit cargoes.

Therefore to address this issue with storage alone, a buffer of ~8 cargoes would be required, which is not a sensible solution. Alternatively, 8 spot cargoes would need to be delivered or ~2 cargoes p.a. This would help to address the deficit but would pose challenges with working the spot cargoes into the scheduling, and consequently additional storage would likely still be required.

Another alternative would be to increase the ship speeds so that they are able to deliver more cargoes in one year - as long as the increase in speed does not take the ship speeds above their guaranteed speed of ~19.5 kts.

However this alone does not achieve a send out rate reliability equivalent to the Long Island Sound base case, so the storage has also been increased, with a buffer of multiples of 40000m3.

To analyze what it takes to obtain the same send out profile in the Atlantic Sties as in the Long Island Location the following steps has been followed:

1. Increasing of the vessels speeds for the Atlantic Sites case. This allowed delivering the same amount of cargoes per year as per the Long Island Sound case and mitigated some of the impacts of the weather events.

2. Increasing storage space by adding tanks of multiples of 40,000m3 gross and introducing the initial stock of multiples of 40,000m3 gross. This enabled reliable send out in case of the extreme weather delays.

The additional investment in the additional storage, buffer stock and shipping to bring the send out of the Atlantic Locations equal/ similar to the send out profile at Long Island are summarized in the Table 8 below.

**Table 8**

| | Additional Storage Space | Buffer Stock | Turnaround Time 95th Percentile [h] |
|---|---|---|---|
| **Long Island** | none | none | 32 |
| **Atlantic Location 1** | 120km3 gross | 120km3 gross | 173 |
| **Atlantic Location 2** | 160km3 gross | 160km3 gross | 193 |

## Economic Analysis

Shipping costs are calculated on a Unit Freight Cost (UFC) basis – see appendix 5 for detailed input assumptions. The UFCs are calculated using the LNG Shipping Economics Model, which uses the P95% turnaround times from Witness to price out the round voyage times. The UFC is based on no spare shipping capacity, i.e. it is assumed that if a part number of ships are required for the volumes then suitable charter-in optimization can take place to minimize additional cost from excess shipping capacity.

**Table 9**

| MOD Flat | Base Case: Long Island Sound | Atlantic Site 1 | Atlantic Site 2 |
|---|---|---|---|
| UFC ($/MMBTU MOD FLAT) | 1.41 | 1.55 | 1.56 |
| Delta from Base Case | **-** | **0.14** | **0.15** |
| Number of ships | 7.82 | 8.97 | 9.11 |
| Delta from Base Case | **-** | **1.15** | **1.29** |

NB. These fleet sizes are different from Witness as here it is assumed that each cargo turns around at the 95th percentile turnaround duration, while in the Witness model there will be a range of turnaround times according to randomly generated delays.

On shipping costs alone, a re-located Atlantic site could introduce ~0.15 $/MMBTU incremental cost due to increased weather down time in the vicinity of the facility. Furthermore this could result in requiring **one additional ship** in the fleet.

## Atlantic Site Location Sensitivity

Using the P95% turnaround times from the Witness Sensitivity runs for the Atlantic Locations, the UFCs reduce slightly, but the over all result is essentially unchanged from a shipping cost perspective (i.e. one additional ship would be required).

**Table 10**

| MOD Flat | Base Case: Long Island Sound | Atlantic Site 1 | Atlantic Site 2 |
|---|---|---|---|
| UFC ($/MMBTU MOD FLAT) | 1.41 | 1.54 | 1.56 |
| Delta from Base Case | **-** | **0.13** | **0.15** |
| Number of ships | 7.82 | 8.96 | 9.09 |
| Delta from Base Case | **-** | **1.14** | **1.27** |

Note: The cost of investment in the additional storage tanks and LNG for the buffer stock is not included in the UFC calculations.

# Appendix 1: Fleet requirements calculations for each location

| Fleet Requirements Calculations | Long Island | Atlantic Site 1 | Atlantic Site 2 | |
|---|---|---|---|---|
| maximum speed | 17.46 | 17.46 | 17.38 | knots |
| guaranteed speed | 17.46 | 17.46 | 17.38 | knots |
| distance FSRU-Qatar | 8042 | 8042 | 8007 | nm |
| LNG carrier gross size | 250,000 | 250,000 | 250,000 | m3 |
| LNG carrier net size | 250,000 | 250,000 | 250,000 | m3 |
| connect to FSRU | 6 | 6 | 6 | h |
| disconnect from FSRU | 4 | 4 | 4 | h |
| discharging rate at FSRU | 14,000.00 | 14,000.00 | 14,000.00 | m3/h |
| target send out | 1 | 1 | 1 | bcf/d |
| Loading at Qatar (d) | 1 | 1 | 1 | |
| Laden from Qatar to FSRU(d) | 19.20 | 19.20 | 19.20 | |
| Discharge at FSRU (d) | 1.16 | 1.16 | 1.16 | |
| Ballast from FSRU to Qatar (d) | 19.20 | 19.20 | 19.20 | |
| Delay | 0.00 | 0.00 | 0.00 | |
| Suez Channel | 1.00 | 1.00 | 1.00 | |
| Total (d) | 42.6 | 42.6 | 42.6 | |
| Total (h) | 1021 | 1021 | 1021 | |
| Round Voyage Time (d) | 42.55 | 42.55 | 42.55 | |
| Number of RVT per ship per annum | 8.58 | 8.58 | 8.58 | |
| Number of cargoes required for target send out per annum | 68.62 | 68.62 | 68.62 | |
| Number of ships required | 8.00 | 8.00 | 8.00 | |

# Appendix 2: Weather delays at the FSRU for the Long Island site (source: [Moffat & Nichol])

| **Long Island Sound Site, Base Case** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Waiting Time | | | | | | Percent Occurrence | | | | | | |
| Bin (hours) | | | | | | | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 0 | 98.0% | 98.8% | 97.3% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 99.4% | 98.9% | 97.7% | 99.5% |
| 0< x <=2 | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 2< x <=4 | 0.5% | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.6% | 0.0% | 0.6% | 0.0% |
| 4< x <=6 | 0.0% | 0.6% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.1% | 0.0% |
| 6< x <=8 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 8< x <=10 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 10< x <=12 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 12< x <=14 | 0.5% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 14< x <=16 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 16< x <=18 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 18< x <=20 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 20< x <=22 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.6% | 0.0% |
| 22< x <=24 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 24< x <=26 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 26< x <=28 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 28< x <=30 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 30< x <=32 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 32< x <=34 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 34< x <=36 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 36< x <=38 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 38< x <=40 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 40< x <=42 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 42< x <=44 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 44< x <=46 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 46< x <=48 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 48< x <=50 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 50< x <=52 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 52< x <=54 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 54< x <=56 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 56< x <=58 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 58< x <=60 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 60< x <=62 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% |

# Appendix 3: Weather delays at the FSRU for the Atlantic Site1 (source: [Moffat & Nichol])

| **Weather delays ( Atlantic Site 1)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Waiting Time | Percent Occurrence | | | | | | | | | | | |
| Bin (hours) | | | | | | | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 0 | 81.5% | 84.0% | 82.7% | 93.4% | 99.1% | 97.8% | 98.3% | 98.3% | 95.9% | 90.4% | 88.5% | 83.2% |
| 0> x <=2 | 2.0% | 0.5% | 1.5% | 0.5% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 1.0% |
| 2> x <=4 | 1.0% | 1.1% | 1.0% | 0.9% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 1.0% | 0.5% | 1.9% |
| 4> x <=6 | 0.5% | 1.1% | 0.5% | 0.0% | 0.0% | 0.4% | 0.0% | 0.4% | 0.5% | 1.0% | 1.4% | 0.0% |
| 6> x <=8 | 1.5% | 1.1% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 1.4% |
| 8> x <=10 | 0.0% | 0.5% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 1.0% | 1.0% |
| 10> x <=12 | 1.5% | 0.5% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 1.0% | 0.0% | 1.0% |
| 12> x <=14 | 2.1% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.4% | 1.0% |
| 14> x <=16 | 0.0% | 1.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.5% | 0.5% |
| 16> x <=18 | 1.0% | 0.5% | 1.0% | 0.0% | 0.0% | 0.4% | 0.8% | 0.0% | 0.0% | 0.0% | 0.5% | 1.4% |
| 18> x <=20 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.5% |
| 20> x <=22 | 0.5% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 22> x <=24 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 0.5% |
| 24> x <=26 | 0.0% | 0.5% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 26> x <=28 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 28> x <=30 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 30> x <=32 | 1.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 0.0% | 0.5% |
| 32> x <=34 | 0.0% | 0.0% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 34> x <=36 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 36> x <=38 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% |
| 38> x <=40 | 1.5% | 0.5% | 0.5% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 40> x <=42 | 0.0% | 1.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| 42> x <=44 | 0.1% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 44> x <=46 | 1.0% | 0.0% | 1.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 46> x <=48 | 1.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 48> x <=50 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% | 0.5% |
| 50> x <=52 | 1.5% | 0.0% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% |
| 52> x <=54 | 0.0% | 1.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% |
| 54> x <=56 | 0.5% | 1.1% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% |
| 56> x <=58 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% |
| 58> x <=60 | 0.0% | 0.0% | 0.5% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 0.0% |
| 60> x <=62 | 0.0% | 0.0% | 0.0% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 62> x <=64 | 0.0% | 1.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 64> x <=66 | 0.0% | 0.5% | 0.5% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 66> x <=68 | 0.0% | 0.0% | 0.5% | 0.4% | 0.0% | 0.0% | 0.4% | 0.4% | 0.5% | 0.5% | 0.5% | 0.0% |
| 68> x <=70 | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 70> x <=72 | 0.0% | 0.5% | 1.5% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 72> x <=74 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% |
| 74> x <=76 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 76> x <=78 | 0.0% | 0.0% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% |
| 78> x <=80 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% | 0.5% |
| 80> x <=82 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 82> x <=84 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.9% | 0.0% | 0.0% | 0.5% |
| 84> x <=86 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 86> x <=88 | 0.5% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 88> x <=90 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 90> x <=92 | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 92> x <=94 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 94> x <=96 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 96> x <=98 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 98> x <=100 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100> x <=102 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% |
| 102> x <=104 | 0.0% | 0.5% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 104> x <=106 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 106> x <=108 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 108> x <=110 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 110> x <=112 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 112> x <=114 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 114> x <=116 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 116> x <=118 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 118> x <=120 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 0.0% | 0.0% |
| 120> x <=122 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 122> x <=124 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 124> x <=126 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 126> x <=128 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 128> x <=130 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 130> x <=132 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 132> x <=134 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 134> x <=136 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 136> x <=138 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 138> x <=140 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 140> x <=142 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 142> x <=144 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 144> x <=146 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

# Appendix 4: Weather delays at the FSRU for the Atlantic Site2 (source: [Moffat & Nichol])

| **Weather delays (Atlantic Site 2)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bin (hours) | | | | | | Percent Occurrence | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 0 | 0.765 | 0.765 | 0.779 | 0.828 | 0.93 | 0.965 | 0.962 | 0.902 | 0.873 | 0.858 | 0.79 | 0.758 |
| 0> x <=2 | 1.0% | 4.8% | 3.0% | 2.3% | 2.2% | 0.4% | 1.3% | 2.2% | 3.3% | 2.7% | 4.1% | 4.1% |
| 2> x <=4 | 3.1% | 4.3% | 3.0% | 1.4% | 0.9% | 0.9% | 0.8% | 0.4% | 1.4% | 3.7% | 1.0% | 2.6% |
| 4> x <=6 | 2.6% | 2.1% | 1.5% | 1.9% | 0.0% | 0.0% | 0.0% | 1.3% | 1.4% | 0.0% | 3.1% | 3.1% |
| 6> x <=8 | 1.0% | 0.5% | 0.5% | 3.3% | 0.9% | 0.0% | 0.4% | 0.4% | 0.0% | 1.4% | 0.5% | 1.5% |
| 8> x <=10 | 1.0% | 0.5% | 0.5% | 1.4% | 0.0% | 0.4% | 0.0% | 0.9% | 0.9% | 0.0% | 0.5% | 1.5% |
| 10> x <=12 | 1.6% | 0.5% | 0.0% | 1.9% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 1.5% | 1.5% |
| 12> x <=14 | 1.0% | 0.5% | 1.0% | 0.0% | 0.4% | 0.0% | 0.4% | 0.9% | 0.0% | 0.5% | 1.5% | 0.5% |
| 14> x <=16 | 0.5% | 0.5% | 0.5% | 0.9% | 0.0% | 0.4% | 0.0% | 0.9% | 0.5% | 0.0% | 0.0% | 1.5% |
| 16> x <=18 | 0.5% | 1.6% | 2.0% | 0.5% | 0.0% | 0.9% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.5% |
| 18> x <=20 | 0.0% | 0.5% | 0.5% | 0.5% | 0.0% | 0.0% | 0.0% | 0.4% | 0.5% | 0.0% | 0.5% | 0.0% |
| 20> x <=22 | 0.0% | 1.1% | 0.5% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 22> x <=24 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.9% | 0.5% | 0.0% |
| 24> x <=26 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 26> x <=28 | 0.0% | 0.0% | 1.0% | 0.5% | 0.4% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.5% |
| 28> x <=30 | 1.0% | 0.5% | 0.0% | 0.5% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 30> x <=32 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 32> x <=34 | 0.5% | 0.0% | 0.5% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 34> x <=36 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 36> x <=38 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 0.5% | 0.0% |
| 38> x <=40 | 0.5% | 0.0% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 40> x <=42 | 0.5% | 0.0% | 0.5% | 0.9% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 42> x <=44 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 44> x <=46 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% | 0.0% |
| 46> x <=48 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% |
| 48> x <=50 | 0.0% | 0.5% | 1.5% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 0.0% |
| 50> x <=52 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 0.0% | 0.5% | 0.5% | 0.5% | 0.5% |
| 52> x <=54 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.9% | 0.5% | 0.0% | 1.0% | 0.0% |
| 54> x <=56 | 0.5% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.5% |
| 56> x <=58 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% | 0.0% |
| 58> x <=60 | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% | 0.0% |
| 60> x <=62 | 0.0% | 0.0% | 1.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 1.0% |
| 62> x <=64 | 0.5% | 0.0% | 0.5% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 64> x <=66 | 0.0% | 0.0% | 0.5% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% |
| 66> x <=68 | 0.0% | 0.5% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 0.0% | 0.5% | 0.0% | 0.0% |
| 68> x <=70 | 0.5% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 70> x <=72 | 1.0% | 1.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% |
| 72> x <=74 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.5% |
| 74> x <=76 | 0.5% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% |
| 76> x <=78 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 78> x <=80 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 80> x <=82 | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.5% | 0.0% |
| 82> x <=84 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 84> x <=86 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 86> x <=88 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 88> x <=90 | 0.5% | 0.0% | 0.0% | 0.5% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 90> x <=92 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 92> x <=94 | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 94> x <=96 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 96> x <=98 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 98> x <=100 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100> x <=102 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 102> x <=104 | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 104> x <=106 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 106> x <=108 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 108> x <=110 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 110> x <=112 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 112> x <=114 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| 114> x <=116 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 116> x <=118 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| 118> x <=120 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 120> x <=122 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 122> x <=124 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 124> x <=126 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 126> x <=128 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 128> x <=130 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 130> x <=132 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 132> x <=134 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 134> x <=136 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.5% |
| 136> x <=138 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 138> x <=140 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 140> x <=142 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 142> x <=144 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% |
| 144> x <=146 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 146> x <=148 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 148> x <=150 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 150> x <=152 | 0.0% | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 152> x <=154 | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 154> x <=156 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 156> x <=158 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 158> x <=160 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 160> x <=162 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 162> x <=164 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 164> x <=166 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 166> x <=168 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 168> x <=170 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 170> x <=172 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 172> x <=174 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 174> x <=176 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 176> x <=178 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 178> x <=180 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 180> x <=182 | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

# Appendix 5: Economic Assumptions

## Generic Assumptions

| | |
|---|---|
| Base date | 1st Jul 2008 |
| Discount Factor | 1.0914 |
| First date of ship in project | 1st Jan 2013 |
| Project duration | 30 years |
| Bunker price HFO (USD/tonne RT07) | 310.2 |
| Port charges escalator (% per annum) | 2 |
| Boil-off gas (USD/MmBtu) | 0 |
| Emissions cost (USD/tonne RT07) | 40 |
| Fuel equivalent of boil off (tonnes/m3) | 0.525 |
| Cargo C.V. (MmBtu/m3) | 22.87 |
| Cargo S.G. | 0.44 |
| Bunker region | Arabian Gulf |

## Large Vessel Assumptions

| **255k DRL** | |
|---|---|
| Gross capacity (m3) | 255,000 (98.5% loading limit) |
| Propulsion | Slow Speed Diesel with Reliquefaction |
| Operating days per year | 353 |
| Speed laden (knots) | 19.5 |
| Speed ballast (knots) | 20.0 |
| Minimum heel (m3) | 800 |
| Boil-off (% of gross capacity per day) | 0 |
| Discharge time (hours) – generated from Witness simulations | P95%:<br>Long Island Sound: 31.8<br>Atlantic Site 1: 174.8<br>Atlantic Site 2: 195.3 |
| Loading time (hours) | 24 |
| Laden Consumption (tonnes/day) | 174 |
| Ballast Consumption (tonnes/day) | 167 |
| Port charges (USD/visit) | Ras Laffan: 114,065<br>FSRU: 162,500 (default) |
| Charter rate (USD/d) | 115,800 |

## Voyage Assumptions

| **Ras Laffan to Long Island Sound/Atlantic Site 1** | |
|---|---|
| Distance (nm) | 8,042 |
| Weather / voyage delays (days) | 2 |

| **Ras Laffan to Atlantic Site 2*** | |
|---|---|
| Distance (nm) | 8,007 |
| Weather / voyage delays (days) | 2 |

* Distance between Ras Laffan and Atlantic Site 2 is reduced by 35 nm, as it is further out to sea (and therefore more exposed to weather down time).

# Supplemental Document III

BROADWATER

# BROADWATER ENERGY

# ALTERNATE PIPELINE ROUTES

# COST ESTIMATE

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| A | 6/13/2008 | Final Submission | LP | JR | LP |
| Issue | Date | Description | Preparer | QA Check | Approval |

SD124

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## Appendices:

## 1.0 Introduction

Broadwater Energy (Broadwater) is evaluating two alternate locations for the Broadwater project as described in the New York State Department of State's (NYSDOS) review of the project dated April 10, 2008. Broadwater has retained Project Consulting Services, Inc. (PCS) to evaluate two pipeline routes extending from the two alternate platform sites in the Atlantic Ocean south of Long Island, NY. PCS has prepared the scope, schedule and cost estimate for each of the routes. The activities associated with this work include the following.

1. Evaluate the NYSDOS proposed routes from the two alternate FSRU locations. The alternate sites are shown on the route maps in Appendices A and B. Alternate 1 will depart from the Alt 1 site and tie-in an existing Transco pipeline approximately one mile south of the shoreline near Long Beach, NY. Alternate 2 will depart from the Alt 2 site and tie-in to the existing Iroquois lateral at South Commack, NY after passing Fire and Captree Islands and crossing the Long Island shoreline near Conklin Point, NY.

2. Develop construction methods for the planned pipelines. Emphasize differences between the Long Island Sound route and these routes.

3. Identify the survey requirements for permitting, design and constructability inclusive of surveys for the HDDs along each route.

4. Develop a bill of materials for each route for pricing purposes.

5. Estimate the project management, design and inspection costs for each route.

6. Develop a project schedule from present time through commissioning for each route.

7. Produce a cost estimate inclusive of construction, materials, PMT and survey. Include a discussion of potential project risks.

8. Compile the above into a single, brief report.

## 2.0 Report Objective

The proposed alternative routes will be evaluated. A summary of the construction methods, a high level schedule, the estimated cost and potential risks associated with the development of the two alternative pipeline routes will be presented. The estimate will include allowances for the detailed engineering, procurement and construction phases of the pipeline alternates.

## 3.0 Specific Project Assumptions

The two pipeline alternates will be evaluated independently.

**Alternate 1:**

The 30” OD pipeline from the Alternate 1 FSRU location extends to an interconnection with a Transco pipeline approximately 1 mile south of Long Beach, NY. The FSRU is located at 73 degrees, 37 minutes west longitude and 40 degrees, 23 minutes north latitude. The route passes through the shipping fairways and separation zone between Ambrose Channel, NY and Nantucket, MA. There is a subsea interconnect to an existing riser at the offshore structure and a hot-tap and interconnecting tie-in at the Transco pipeline.

The assumed burial methodologies along the route are outlined in the table in Section 4 below. A review of other offshore pipeline projects in the northeastern United States resulted in the assumptions described in the table. In particular, the HubLine Pipeline, a 30” OD pipeline in Massachusetts Bay, was noted to traverse a variety of shipping channels and anchorages. The burial requirements in the channels and anchorages included lowering the pipeline to a target depth of 10 feet below the seabed using two passes of the post-lay plow and multiple passes of a jetting sled, a minimum of 5.5 feet of rock cover placed over the pipeline and a final pass of the backfill plow. That methodology has been adopted for the crossing of the two fairways and the separation zone between the two fairways along the Alternate 1 route. Along other portions of the route, a minimum depth of 3 feet has been assumed. This depth is consistent with the HubLine depth of lowering and cover. The pipeline will be lowered by post-lay plowing (two passes) and covered with a single pass of a backfill plow along these segments.

There are multiple cable crossings along the route. For those crossings outside of the shipping fairways, a conventional crossing is planned, similar in design to the crossings along the original route in Long Island Sound. However, for crossings of cables in the shipping fairways and the separation zone, additional jetting will be required to transition the pipeline between the deeper depth of lowering in these segments and the cable crossing. There will likely be issues regarding how to cross these cables and the resolution will depend upon the actual depth of the cables along these segments. This report assumes they have only been lowered 3 feet below the seabed so a humped crossing is required to cross them.

Jetting methods, by towed jet sled and/or diver hand jetting, will be required at each transition area, which for purposes of this estimate is assumed to be 750' per transition. Supplemental backfill is then assumed to refill the jetted trench.

**Alternate 2:**

The 30” OD pipeline from the Alternate 2 FSRU location will deliver natural gas to the existing Iroquois pipeline at South Commack, NY. The pipeline route extends approximately 20 miles through the Atlantic Ocean to a shoreline crossing at Fire Island, NY. The pipeline then crosses Fire Island, Jones Island and Captree Island and traverses Great South Bay to a shoreline crossing onto Long Island at Conklin Point. The route then extends an additional 11 miles to the Iroquois interconnect. The FSRU is located at 73 degrees, 10 minutes west longitude and 40 degrees, 20 minutes north latitude and is located within a shipping fairway. The route passes through the shipping fairways and separation zone between Ambrose Channel, NY and Nantucket, MA. There is a subsea interconnect to an existing riser at the offshore structure.

The assumed burial methodologies along the marine route segment are outlined in the table in Section 4 below. As mentioned in Alternate 1 above, a review of other offshore pipeline projects in the northeastern United States resulted in the assumptions described in the table. In particular, the HubLine Pipeline, a 30" OD pipeline in Massachusetts Bay, was noted to traverse a variety of shipping channels and anchorages. The burial requirements in the channels and anchorages included lowering the pipeline to a target depth of 10 feet below the seabed using two passes of the post-lay plow and multiple passes of a jetting sled, a minimum of 5.5 feet of rock cover placed over the pipeline and a final pass of the backfill plow. That methodology has been adopted for the crossing of the two fairways and the separation zone between the two fairways along the Alternate 2 route as well. Along other portions of the route, a minimum depth of 3 feet has been assumed. This depth is consistent with the HubLine depth of lowering and cover. The pipeline will be lowered by post-lay plowing (two passes) and covered with a single pass of a backfill plow along these segments.

There are multiple cable crossings along the route. For those crossings outside of the shipping fairways, a conventional crossing is planned, similar in design to the crossings along the original route in Long Island Sound. However, for crossings of cables in the shipping fairways and the separation zone, additional jetting will be required to transition the pipeline between the deeper depth of lowering in these segments and the cable crossing. There will likely be issues regarding how to cross these cables and the resolution will depend upon the actual depth of the cables along these segments. This report assumes they have only been lowered 3 feet below the seabed so a humped crossing is required to cross them.

Jetting methods, by towed jet sled and/or diver hand jetting, will be required at each transition area, which for purposes of this estimate is assumed to be 750' per transition. Supplemental backfill is then assumed to refill the jetted trench.

All shoreline crossings are proposed for installation via Horizontal Directional Drilling (HDD) methods with the HDD product pipeline string fabricated offshore then pulled through the borehole by the drill rig. The HDD lengths have been assumed to be as shown in the route segments table below and have been chosen to maximize the length of HDD construction so as to minimize environmental impacts along the route. A flanged, fabricated bend will be installed at the end of the HDD pipe string to accommodate the change from the HDD exit angle to the horizontal and to facilitate the joining of the HDD pipe string to the adjacent offshore pipeline segment via flanged spool connections. Therefore, minimal dredging of the HDD exit hole will be required.

Dredging is limited to the excavation of the exit holes for three HDDs and for the crossing of Great South Bay. The spoil at each of these locations will be stored in hopper barges and returned to the trench upon completion of pipelay and/or tie-ins. The pipeline will be installed below the mudline (seafloor) to a target depth of three feet with a minimum of two feet cover along the segment of the route through Great South Bay.

Onshore construction will follow the general route outlined in the NYSDOS document. The use of road bores and HDD construction techniques have been introduced along the route to minimize the impact of construction on the environment and on the general public. The approximate construction type and segment length along the route is outlined in the Alternate 2 route table shown in Section 4.

The onshore route is assumed to result in a class 3 designation for the pipeline. Mainline valves with blowdowns have been assumed at four (4) locations along the route and a meter/regulator station with pigging capabilities has been assumed at the interconnect with the Iroquois system.

## 4.0 Route Description

The proposed installation methods for each route, by segment, are described in detail in the tables below.

**ALTERNATE 1: ROUTE SEGMENTS AND CONSTRUCTION METHODOLOGY**

| Route Segment | Length | MP Start | MP End | Burial Method |
|---|---|---|---|---|
| | (feet) | (miles) | (miles) | |
| | | | | |
| Origination at FSRU | 0 | 0 | 0 | Tie-in to Existing Riser, jet transitions from plowing to tie-in, use concrete mats and protective cage over pipeline and interconnect piping, supplemental backfill at jetted area. |
| FSRU to Southern Boundary of Outbound Ambrose to Nantucket Fairway | 6864 | 0 | 1.30 | 2 passes post-lay plow and 1 pass of backfill plow |
| Southern Boundary of Outbound Ambrose to Nantucket Fairway to Crossing No. 1 | 5333 | 1.30 | 2.31 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Crossing No. 1 (In Fairway) | 1500 | 2.31 | 2.59 | Jet transitions from plowing to crossing, use concrete mats over pipeline and for bridge supports. Extend |

| | | | | |
|---|---|---|---|---|
| | | | | transitions to deeper burial elevations, supplemental backfill at jetted area |
| Crossing No. 1 to Northern Boundary of Outbound Ambrose to Nantucket Fairway | 1985 | 2.59 | 2.97 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Northern Boundary of Outbound Ambrose to Nantucket Fairway to Southern Boundary of Inbound Nantucket to Ambrose Fairway (Separation Zone) | 7022 | 2.97 | 4.34 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Crossing No. 2 (In Fairway) | 1500 | 4.34 | 4.58 | Jet transitions from plowing to crossing, use concrete mats over pipeline and for bridge supports. Extend transitions to deeper burial elevations, supplemental backfill at jetted area |
| Crossing No. 2 to Northern Boundary of Inbound Nantucket to Ambrose Fairway | 6368 | 4.58 | 5.79 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Northern Boundary of Inbound Nantucket to Ambrose Fairway to Crossing No. 3 | 301 | 5.79 | 5.85 | 2 passes post-lay plow, 1 pass backfill plow |
| Crossing No. 3 | 1500 | 5.85 | 6.13 | Jet transitions from plowing to crossing, use concrete mats over pipeline and for bridge supports, supplemental backfill at jetted area |
| Crossing No. 3 to Crossing No. 4 | 13548 | 6.13 | 8.70 | 2 passes post-lay plow and 1 pass of backfill plow |
| Crossing No. 4 | 1500 | 8.70 | 8.98 | Jet transitions from plowing to crossing, use concrete mats over pipeline and for bridge supports, supplemental backfill at jetted area |
| Crossing No. 4 to Crossing No. 5 | 2566 | 8.98 | 9.47 | 2 passes post-lay plow and 1 pass of backfill plow |

| | | | | |
| --- | --- | --- | --- | --- |
| Crossing No. 5 | 1500 | 9.47 | 9.75 | Jet transitions from plowing to crossing, use concrete mats over pipeline and for bridge supports, supplemental backfill at jetted area |
| Crossing No. 5 to Southern Boundary of Fish Haven Obstruction (auth min 40 ft.) | 2355 | 9.75 | 10.20 | 2 passes post-lay plow and 1 pass of backfill plow |
| Southern Boundary to Northern Boundary of Fish Haven Obstruction (auth min 40 ft.) | 1162 | 10.20 | 10.42 | 2 passes post-lay plow and 1 pass of backfill plow |
| Northern Boundary of Fish Haven Obstruction to Crossing No. 6 | 3379 | 10.42 | 11.06 | 2 passes post-lay plow and 1 pass of backfill plow |
| Crossing No. 6 | 1500 | 11.06 | 11.34 | Jet transitions from plowing to crossing, use concrete mats over pipeline and for bridge supports, supplemental backfill at jetted area |
| Crossing No. 6 to Crossing No. 7 | 1668 | 11.34 | 11.66 | 2 passes post-lay plow and 1 pass of backfill plow |
| Crossing No. 7 | 1500 | 11.66 | 11.94 | Jet transitions from plowing to crossing, use concrete mats over pipeline and for bridge supports, supplemental backfill at jetted area |
| Crossing No. 7 to Southern Boundary of Pipeline Area | 2936 | 11.94 | 12.50 | 2 passes post-lay plow and 1 pass of backfill plow |
| Southern Boundary of Pipeline Area to Transco Pipeline | 581 | 12.50 | 12.61 | 2 passes post-lay plow and 1 pass of backfill plow |
| Hot tap tie-in to Transco Pipeline (30' W.D.) | 0 | 12.61 | 12.61 | Jet transitions from plowing to tie-in, use concrete mats over pipeline and interconnect piping, supplemental backfill at jetted area |
| | | | | |
| **Total Length** | **66565** | **12.61** | | |

**ALTERNATE 2: ROUTE SEGMENTS AND CONSTRUCTION METHODS**

| Route Segment | Length | MP Start | MP End | Burial Method |
|---|---|---|---|---|
| | (feet) | (miles) | (miles) | |
| | | | | |
| **Marine Segments** | | | | |
| Origination at FSRU (within Outbound Ambrose to Nantucket Fairway) | 0 | 0 | 0 | Tie-in to Existing Riser, jet transitions from plowing to tie-in, use concrete mats and protective cages over pipeline and interconnect piping, supplemental backfill at jetted area |
| FSRU to Crossing No. 1 | 20539 | 0 | 3.89 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Crossing No. 1 (In Fairway) | 1478 | 3.89 | 4.17 | Jet transitions from plowing to crossing, use concrete mats over pipeline. Extend transitions to deeper burial elevations, supplemental backfill at jetted area |
| Crossing No. 1 to Northern Boundary of Outbound Ambrose to Nantucket Fairway | 4382 | 4.17 | 5.00 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Northern Boundary of Outbound Ambrose to Nantucket Fairway to Southern Boundary of Inbound Nantucket to Ambrose Fairway (Separation Zone) | 19008 | 5.00 | 8.60 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Southern Boundary of Inbound Nantucket to Ambrose Fairway to Crossing No. 2 | 15365 | 8.60 | 11.51 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |
| Crossing No. 2 (In Fairway) | 1478 | 11.51 | 11.79 | Jet transitions from plowing to crossing, use concrete mats over pipeline. Extend transitions to deeper burial elevations, supplemental backfill at jetted area |
| Crossing No. 2 to Northern Boundary of Inbound Nantucket to Ambrose Fairway | 12197 | 11.79 | 14.1 | 2 passes post-lay plow, 2 passes jet sled, imported rock backfill placement, 1 pass backfill plow |

| | | | | |
|---|---|---|---|---|
| Northern Boundary of Inbound Nantucket to Ambrose Fairway to Crossing No. 3 | 7392 | 14.1 | 15.50 | 2 passes post-lay plow and 1 pass of backfill plow |
| Crossing No. 3 | 1478 | 15.50 | 15.78 | Jet transitions from plowing to crossing, use concrete mats over pipeline, supplemental backfill at jetted area |
| Crossing No. 3 to Southern Boundary of Fish Haven Obstruction | 17846 | 15.78 | 19.16 | 2 passes post-lay plow and 1 pass of backfill plow |
| Southern Boundary of Fish Haven to HDD Exit Point South of Fire Island | 3485 | 19.16 | 19.82 | 2 passes post-lay plow and 1 pass of backfill plow |
| Fire Island HDD Exit Hole and Transition | 300 | 19.82 | 19.88 | Bucket dredge, store spoil in hopper barge, backfill with spoil |
| Fire Island to Offshore HDD | 4000 | 19.88 | 20.63 | Land-to-water HDD will originate on Fire Island and extend to offshore exit hole |
| | | | | |
| **Barrier Islands Crossings Segments** | | | | |
| Onshore Tie-in | 200 | 20.63 | 20.67 | Interconnect tie-in between HDDs |
| Jones Island to Fire Island HDD | 4600 | 20.67 | 21.54 | Land-to-land HDD beneath Fire Island Inlet |
| Onshore Tie-in | 200 | 21.54 | 21.58 | Interconnect tie-in between HDDs |
| Captree Island to Jones Island HDD | 4200 | 21.58 | 22.38 | Land-to-land HDD beneath Ocean Parkway |
| Captree Island ROW | 3000 | 22.38 | 22.95 | Open Cut |
| Captree Island to Offshore Great South Bay | 3000 | 22.95 | 23.51 | Land-to-water HDD will originate on Captree Island and extend to offshore exit hole in Great South Bay |
| Captree Island HDD Exit Hole and Transition | 300 | 23.51 | 23.57 | Bucket dredge, store spoil in hopper barge, backfill with spoil |
| Captree Island HDD Exit Hole to Conklin Point HDD Exit Hole | 3200 | 23.57 | 24.18 | Bucket dredge, store spoil in hopper barge, backfill with spoil |
| Conklin Point HDD Exit Hole and Transition | 300 | 24.18 | 24.23 | Bucket dredge, store spoil in hopper barge, backfill with spoil |
| Conklin Point HDD | 4700 | 24.23 | 25.12 | Land-to-water HDD will originate on Long Island and extend to offshore exit hole in Great South Bay |
| | | | | |
| **Onshore Long Island Segments** | | | | |

| | | | | |
|---|---|---|---|---|
| Robert Moses Causeway ROW | 3800 | 25.12 | 25.84 | Open Cut |
| Route 27A Interchange cloverleaf crossing | 80 | 25.84 | 25.86 | Conventional Road Bore |
| Robert Moses Causeway ROW | 170 | 25.86 | 25.89 | Open Cut |
| Route 27A Interchange cloverleaf crossing | 80 | 25.89 | 25.91 | Conventional Road Bore |
| Robert Moses Causeway ROW | 415 | 25.91 | 25.98 | Open Cut |
| Route 27A Interchange crossing | 200 | 25.98 | 26.02 | Conventional Road Bore |
| Robert Moses Causeway ROW | 500 | 26.02 | 26.12 | Open Cut |
| Route 27A Interchange cloverleaf crossing | 120 | 26.12 | 26.14 | Conventional Road Bore |
| Robert Moses Causeway ROW | 285 | 26.14 | 26.19 | Open Cut |
| Route 27A Interchange cloverleaf crossing | 130 | 26.19 | 26.22 | Conventional Road Bore |
| Robert Moses Causeway ROW | 4650 | 26.22 | 27.10 | Open Cut |
| Long Island Railroad crossing | 300 | 27.10 | 27.16 | Conventional Railroad Bore |
| Robert Moses Causeway ROW | 4020 | 27.16 | 27.92 | Open Cut |
| Sunrise Highway cloverleaf interchange HDD | 1700 | 27.92 | 28.24 | Horizontal Directional Drill |
| Robert Moses Road Crossing | 220 | 28.24 | 28.28 | Conventional Road Bore |
| Robert Moses Causeway ROW | 2420 | 28.28 | 28.74 | Open Cut |
| Southern State Parkway HDD | 2780 | 28.74 | 29.27 | Horizontal Directional Drill |
| Southern State Parkway | 3100 | 29.27 | 29.85 | Open Cut |
| Sagtikos Parkway | 8180 | 29.85 | 31.40 | Open Cut |
| Pine Aire Road Crossing | 180 | 31.40 | 31.44 | Conventional Road Bore |
| Sagtikos Parkway | 230 | 31.44 | 31.48 | Open Cut |
| Long Island Railroad Crossing | 200 | 31.48 | 31.52 | Conventional Railroad Bore |
| Sagtikos Parkway | 7120 | 31.52 | 32.87 | Open Cut |
| Cross Campus Road Crossing at Pilgrim State Psychiatric Center | 120 | 32.87 | 32.89 | Conventional Road Bore |
| Sagtikos Parkway | 1440 | 32.89 | 33.16 | Open Cut |
| Sagtikos Parkway Exit roads (2) | 200 | 33.16 | 33.20 | Conventional Road Bore |
| Sagtikos Parkway | 430 | 33.20 | 33.28 | Open Cut |
| Crooked Hill Road Crossing | 80 | 33.28 | 33.30 | Conventional Road Bore |
| Sagtikos Parkway | 1100 | 33.30 | 33.50 | Open Cut |
| Sagtikos Parkway Road Crossing | 275 | 33.50 | 33.56 | Conventional Road Bore |
| Sagtikos Parkway | 460 | 33.56 | 33.64 | Open Cut |
| Sagtikos Parkway Exit Road Crossing | 250 | 33.64 | 33.69 | Conventional Road Bore |
| Sagtikos Parkway | 290 | 33.69 | 33.75 | Open Cut |
| Long Island Expressway (LIE) cloverleaf interchange HDD. | 2000 | 33.75 | 34.12 | Horizontal Directional Drill |
| Sagtikos Parkway | 820 | 34.12 | 34.28 | Open Cut |
| Sagtikos Parkway Road Crossing | 80 | 34.28 | 34.29 | Conventional Road Bore |
| Sagtikos Parkway | 1835 | 34.29 | 34.64 | Open Cut |
| Northern State Parkway cloverleaf interchange HDD | 2090 | 34.64 | 35.04 | Horizontal Directional Drill |

| | | | | |
|---|---|---|---|---|
| Sagtikos Parkway | 2810 | 35.04 | 35.57 | Open Cut |
| New Highway Road Crossing | 200 | 35.57 | 35.61 | Conventional Road Bore |
| Turn West at New Highway in South Commack to the terminus of the IGTS | 590 | 35.61 | 35.72 | Open Cut |
| Meter and Regulator Station at IGTS Site | 0 | 35.72 | 35.72 | |
| | | | | |
| **Total Length** | **188600** | **35.72** | | |
| **Marine Subtotal** | 108950 | 20.63 | | |
| **Barrier Islands Crossings Subtotal** | 23700 | 4.49 | | |
| **Onshore Long Island Subtotal** | 55950 | 10.60 | | |

**Construction Activity Summary: Alternate 1**

| Activity | Length (Feet) |
|---|---|
| Pipe Lay - Offshore | 66,565 |
| Plow | 56,065 |
| Jet | 20,708 |
| Crossings (7) | 10,500 |

**Construction Activity Summary: Alternate 2**

| Activity | Length (Feet) |
|---|---|
| Pipe Lay - Offshore | 108,950 |
| Pipe Lay – Bay + HDDs (2) | 11,500 |
| Pipe Lay - Onshore | 68,150 |
| Plow | 104,050 |
| Jet | 71,491 |
| Crossings (3) | 4,434 |
| Dredge | 4,100 |
| HDD – Land-to-Land | 17,370 |
| HDD – Land-to-Water | 11,700 |

## 5.0 Materials

A preliminary bill of materials has been developed for the project and is provided in the attached Estimate. The assumptions on which this bill of materials is based include the following:

- Linepipe and coating are as originally specified for the original Long Island Sound route. No changes have been assumed in pipeline design. The onshore route uses the same pipe although wall thickness and concrete requirements would vary in actual design. The changes were deemed inconsequential for the purposes of this evaluation.

- HDD pipe is new to the Alternate 2 route when compared to the original route but is assumed to be of similar cost to the remaining line pipe.
- HDD-to-mainline tie-in materials and the materials for the mainline valve stations and the M&R station on Alternate 2 have been included.

## 6.0 Schedule

The high level project schedule has been updated to reflect changes associated with each of the alternate routes. The schedules are included in Appendices C and D.

The original route required a Phase I construction period of approximately 6.5 months. Alternate 1 requires approximately 10 months. The main reason for the extended duration relates to the increased burial requirements and the increase in the number of crossings. This duration is extended despite the fact the overall route is shorter than the original route. Alternate 2 requires approximately 11 months. The extended duration for this alternate is caused by the substantially increased burial requirements, the introduction of the barrier island and onshore route segments that include HDD requirements and the onshore route construction need.

## 7.0 Basis of the Cost Estimate

A cost estimate and schedule have been developed for the project alternatives based upon the assumed construction methodologies described in this report. These estimates are attached to this report.

The installation methodology described in this report and used as the basis for the construction estimate is based upon the methodologies, practices, procedures and restrictions that have been developed for similar projects by regulatory agencies and other stakeholders in the Northeast U.S. The assumptions on which this estimate is based include the following as a minimum and apply to each route alternate:

- The costs associated with materials, marine construction, surveying, project management and other costs that were utilized in 2005 to estimate the cost of the original Long Island Sound route have been used for similar materials, marine construction, etc. contained in the 2008 alternate routes. The only 2008 cost values used in the estimates are found in the onshore and HDD construction and ROW estimates.
- The estimate includes a complete Marine Archeological and Hazard survey of the proposed centerline and anchor corridor to identify obstructions, cultural resources, existing utilities, seabed morphology and bathymetry using side scan sonar, subbottom profilers, magnetometers, and echo-sounders (single beam and multibeam). The survey scope also includes a video survey of the route centerline by Remote Operated Vehicle (ROV) and the collection and geotechnical evaluation of vibracores along the pipeline route

and borings for the marine portion of the HDDs. For the onshore route segment of Alternate 2, a complete Geophysical survey of the proposed ROW including the route centerline and existing utilities will be performed. Geotechnical data collection and evaluation along the ROW and at the HDDs will be performed.

- The estimate assumes that a field office will be established to manage the construction activities. The estimate includes leasing office space and a full compliment of personnel to manage the work.
- The estimate accounts for inspection requirements at the mill during the manufacture and FBE coating of the line pipe, concrete weight coating and loadout of the pipe, onshore fabrication, and all construction activities identified in the scope.
- Union labor will be utilized for the onshore construction phase and on marine construction vessels, onshore support and pipe yard loadout.
- Pipeline lay, dredging, plowing and jetting durations are based on utilizing typical Gulf of Mexico vessels and support services.
- It is assumed one laybarge can execute the lay obligations in the offshore area and that water depths are sufficient in the near shore area to accommodate the vessel's draft.
- The estimate excludes costs for blasting the marine pipeline trenches. There is an allowance in the onshore estimate for blasting.
- A 10% route length increase has been added to the marine segments to account for routing around obstructions, sensitive seabed or other issues.
- The estimate includes tie-ins between the HDD segment and the adjacent marine pipeline segment
- The estimate includes the cost to hydrotest, dewater and dry the pipeline. The cost for running a caliper pig through the completed pipeline is included.
- The estimate includes hopper barges to store the dredged spoil during construction.
- Four mainline valve stations and one meter/regulator station have been included on the onshore segment of Alternate 2.
- The marine construction estimate includes a 33% allowance for weather, mechanical downtime and other delays.

## 8.0 Project Risks

As with any pipeline project, there are risks associated with the design, permitting, contracting and execution of the work. Many of the items raised in 2005 and reported in the "Identification of Potential Impacts to Schedule and Budget" apply to these estimates. A few additional items to consider follow:

**Design**

- <u>Burial depth:</u> It is assumed that the stated burial methods will meet regulatory requirements. If different lowering methods are stipulated, then the price and schedule would likely be impacted.
- <u>Dredging and Pipelay in Great South Bay:</u> It is assumed that conventional shallow water lay and burial techniques are acceptable in the Bay.

- Backfill Requirements - The estimate assumes that imported backfill will be required in all jetted areas. Imported backfill is required through each of the offshore shipping fairways and the separation zones. The Neptune cable project was not required to backfill the dredged trench through the Ambrose Channel but this was thought to be because of the depositional nature in that area. Similar depositional qualities are not confirmed in the Atlantic Ocean in the vicinity of the pipeline routes. Elimination of the imported backfill requirement would result in significant cost and schedule savings.
- Soil conditions: The soil conditions along the marine route may be found to be an issue for pipeline burial or for HDD operations thereby requiring either a reroute or abandonment of a certain construction methodology. Contaminated sediments are not thought to be present in the area. Therefore upland disposal of dredged spoil has not been assumed. In addition, no impediments to jetting have been assumed. Approximately 10% of the onshore route has been assumed to contain rock or problematic soils.
- Onshore Routing: It has been assumed that the pipeline can be routed adjacent to the parkways on Long Island as described in the NYSDOS document. If this routing is rejected by the regulatory agencies, significant increases in cost will occur since most of the region has been previously developed with residential development being most prevalent. It is noted that the Iroquois pipeline route appears to follow a similar route adjacent to the parkways.

**Permitting**

- Time of Year: The cost estimate does not consider the risk of limits imposed due to time of year restrictions. The permitted window for construction activities may be in a poor weather season or may be too short to complete all work in one season. There would be a risk that the smaller vessels could not work during certain winter months and that onshore construction would be hindered by snow cover.
- Restoration: Restoration of the seabed to pre-construction contours with dimensional requirements rather than operational requirements (such as one pass of the backfill plow) may result in additional cost and schedule impacts.
- Cultural/Archaeological Resources: Discovery during pre-permitting survey and/or during construction could have an adverse effect on either the routing or the work.
- Turbidity: Limitations on allowable sediment plumes may impact drilling or burial plans. Costs for turbidity monitoring during construction are not included in this estimate.

**Contracting**

- Contracting: The relevant costs and risks assumed when the project was originally estimated in 2005 have been utilized for this estimate. Subsequent pricing and risk changes in the marketplace have not been included in this estimate.

**Execution**

- HDD/Pipeline Interface: This estimate assumes there will be restrictions which result in the decoupling of the HDD work from the pipelay work. This requires the additional spool tie-ins at each HDD connection in lieu of a backunder-and-weld approach.
- Plowing: The estimate assumes plowing can be accomplished by a foreign plow contractor. The foreign company would need to work with an American flag vessel to comply with US Jones Act. This requirement may complicate the contractual arrangement with potential contractors. Restrictions associated with shallow water plowing may increase the difficulty of the activity. The laybarge is assumed to be capable of plowing. If another vessel is required, the cost of mobilization would be a project risk.
- DP Lay or Bury Vessels: If a dynamically-positioned vessel is required, the mobilization and daily operating costs will be significantly increased.
- Labor Issues: The use of union labor in a relatively new construction location may limit the available contractor pool.
- Third Party Utility Crossings – The proposed pipeline routes are heavily congested with utilities. Although current NOAA charts were used to establish existing utilities, other utilities may exist. Along the onshore route, no crossings are assumed although it is very likely utilities cross the ROW.
- Navigation Hazard: Elevation of the existing utility crossings may result in the proposed line and protective matting protruding 4-6 feet above original grade. May need to consider lowering of existing utility or alternate installation technique.
- Fish Area and Haven: The routes traverse these designated zones. The impact is unknown. Conventional lay and burial techniques are assumed to be acceptable.
- Anchor Moored Vessels: The number of channel crossings and vessel traffic may impede the contractor's ability to lay/plow/jet/backfill plow through the area. Special techniques may need to be employed to minimize anchoring across the channels.
- Route length risk: The proposed route is essentially a straight line. The hazard survey could dictate revision to the proposed route thereby increasing the estimated installation cost. An allowance of 10% has been added for this purpose. A recent project in the northeast experienced a 45% increase in route length from the conceptual stage to final route design. Additionally, the Alternative 2 site is located within a fairway (as dictated by NYSDOS). It is likely it would be moved out of the fairway which would lengthen the route.

## 9.0 Variance to Original Route

In developing the alternate routes and the estimate for each, several items are noted as differences when compared to the original Long Island Sound route.

Alternate 1:

- Time of year: Possible inability to execute all the work within any designated time of year window.
- Deeper burial: burial through fairways requires significantly deeper burial using jetting, a construction method known to produce greater environmental impacts, supplemental non-native rock backfill, likely requirement to utilize the backfill plow, greater durations for anchored vessels to occupy the shipping fairways.

- More utility crossings: At least 7 utilities on this route create a greater number of hard-bottom conversion issues and likely issues related to crossing utilities in the fairways.
- Shorter route: 14 miles vs. 22 miles

Alternate 2:

- Time of year: Possible inability to execute all the work within any designated time of year window. In addition to offshore impacts, will also affect nearshore/bay and onshore locations.
- Deeper burial: burial through fairways requires significantly deeper burial using jetting, a construction method known to produce greater environmental impacts, supplemental non-native rock backfill, likely requirement to utilize the backfill plow, greater durations for anchored vessels to occupy the shipping fairways
- Deep burial utility crossings: Likely issues related to crossing utilities in the fairway.
- Longer Route: Includes crossing sensitive barrier islands, nearshore bay and over 10 miles of ROW along New York's parkway system.
- Onshore route: largely along a ROW bordering residences and the parkway system

## 10.0 Summary

Broadwater requested an evaluation of two alternate pipeline routes. The two routes originated at two offshore locations in the Atlantic Ocean south of Long Island, NY. Maps of each route were prepared. The construction methods required to develop each pipeline were determined. A list of materials was developed. A schedule of project activities was prepared. A cost estimate for each route inclusive of engineering, surveys, project management, materials and construction was developed.

The assumptions associated with the preparation of each estimate were reported as were the various risk elements associated with each of the pipeline routes. Routing of the pipelines along the requested routes appears feasible when the various issues identified to-date are considered. From a construction perspective, the pipe lay, tie-in, hydrotesting and commissioning pose no critical issues to the viability of the project. As is common on marine projects in the northeastern United States, the burial of the pipeline is the critical construction activity. This report considers many burial options in the methods analysis including HDD, dredging, plowing, jetting, backfilling with native material, backfilling with imported material, backfill plowing and covering with mats.

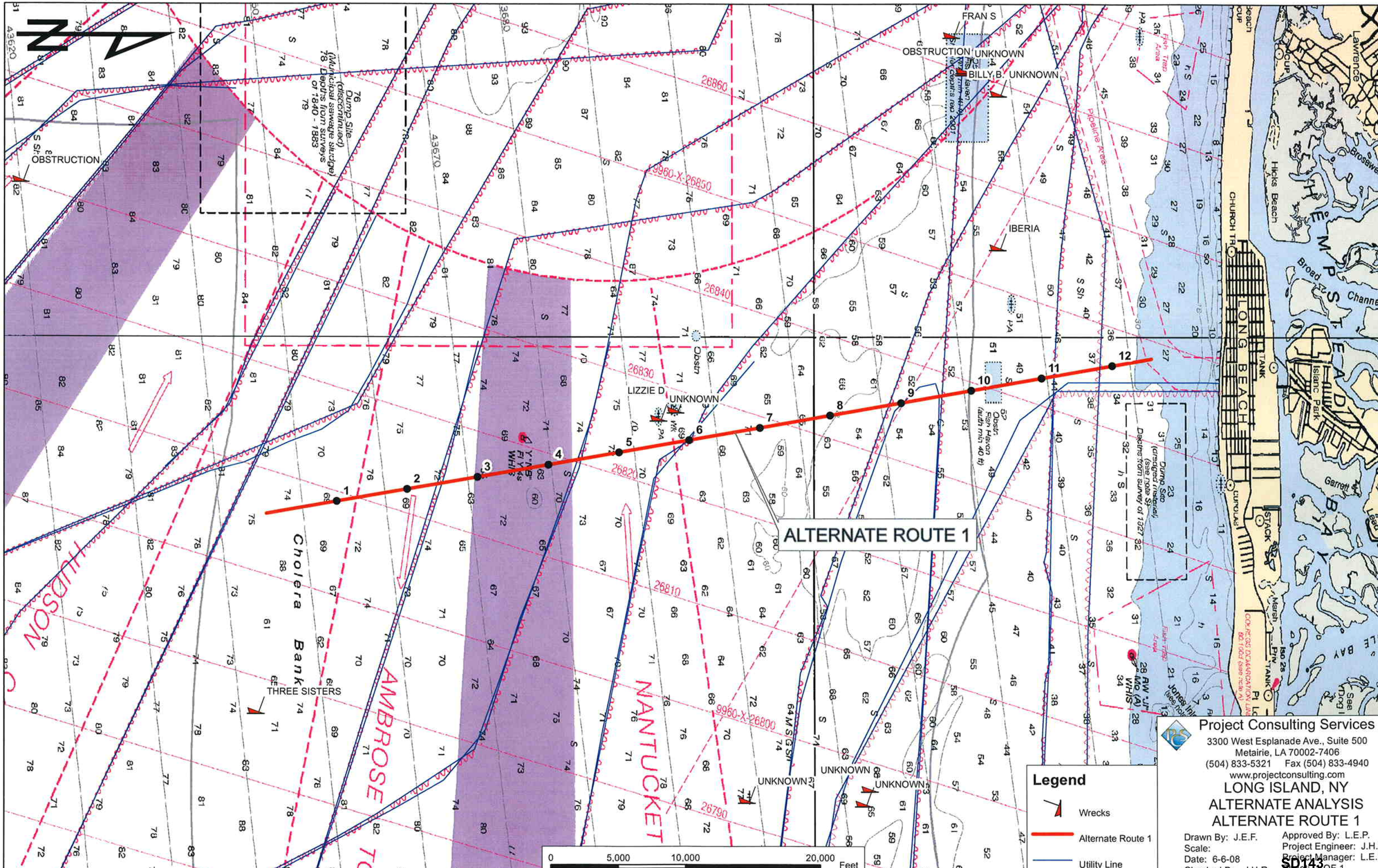
This report has addressed the materials required for the project. The consideration given to the material requirements are consistent with the original Broadwater marine pipeline design. Project management, design and inspection costs have been prepared and addressed. The survey requirements for project design and environmental permitting have been evaluated and estimated.

Further work, primarily related to burial issues and right-of-way acquisition, will be required to increase the validity of the work plan, schedule and cost estimate.

**Appendix A:**

**Route ALT 1 Drawing**

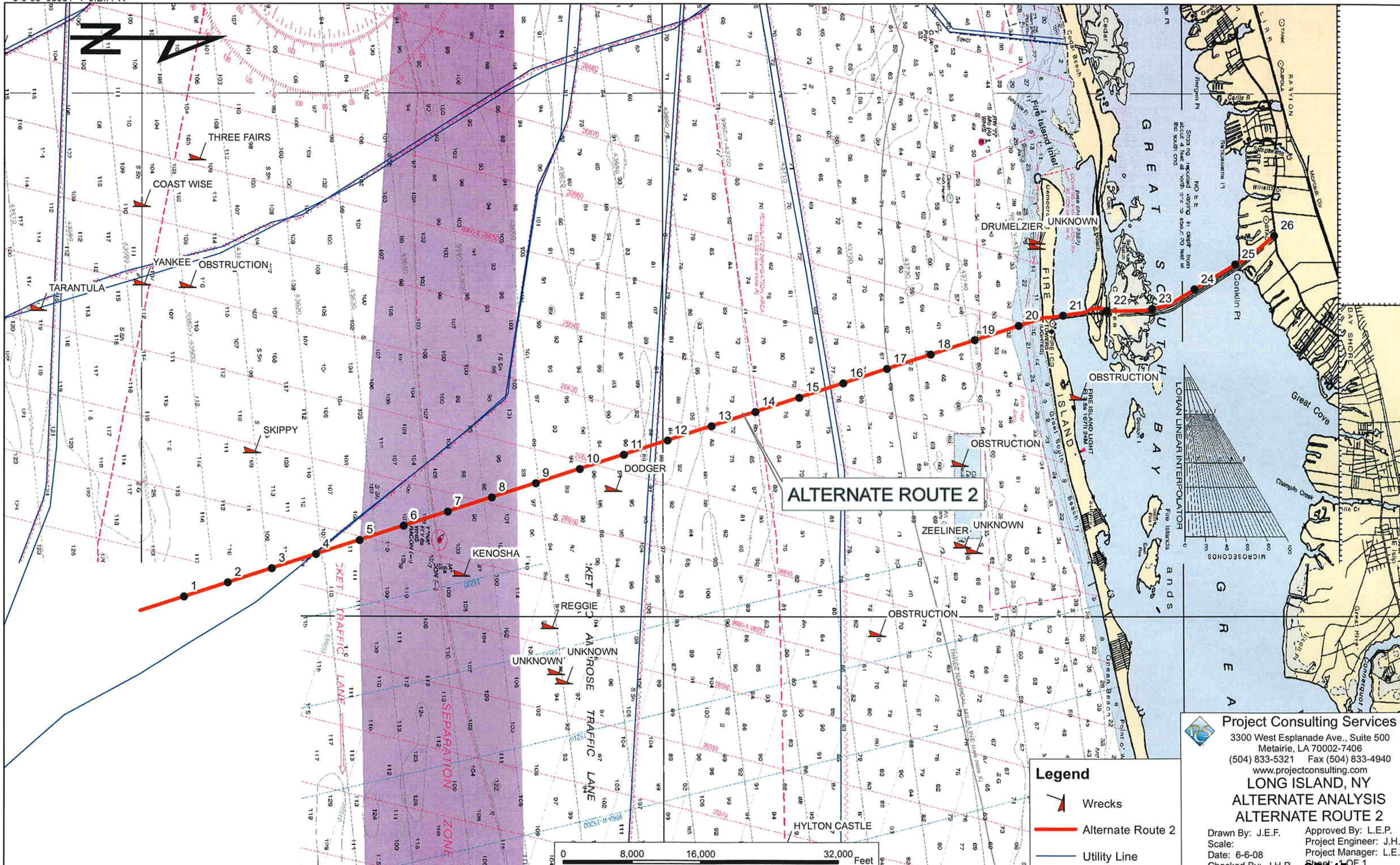
6-6-08 08081 1 J.E.F. A

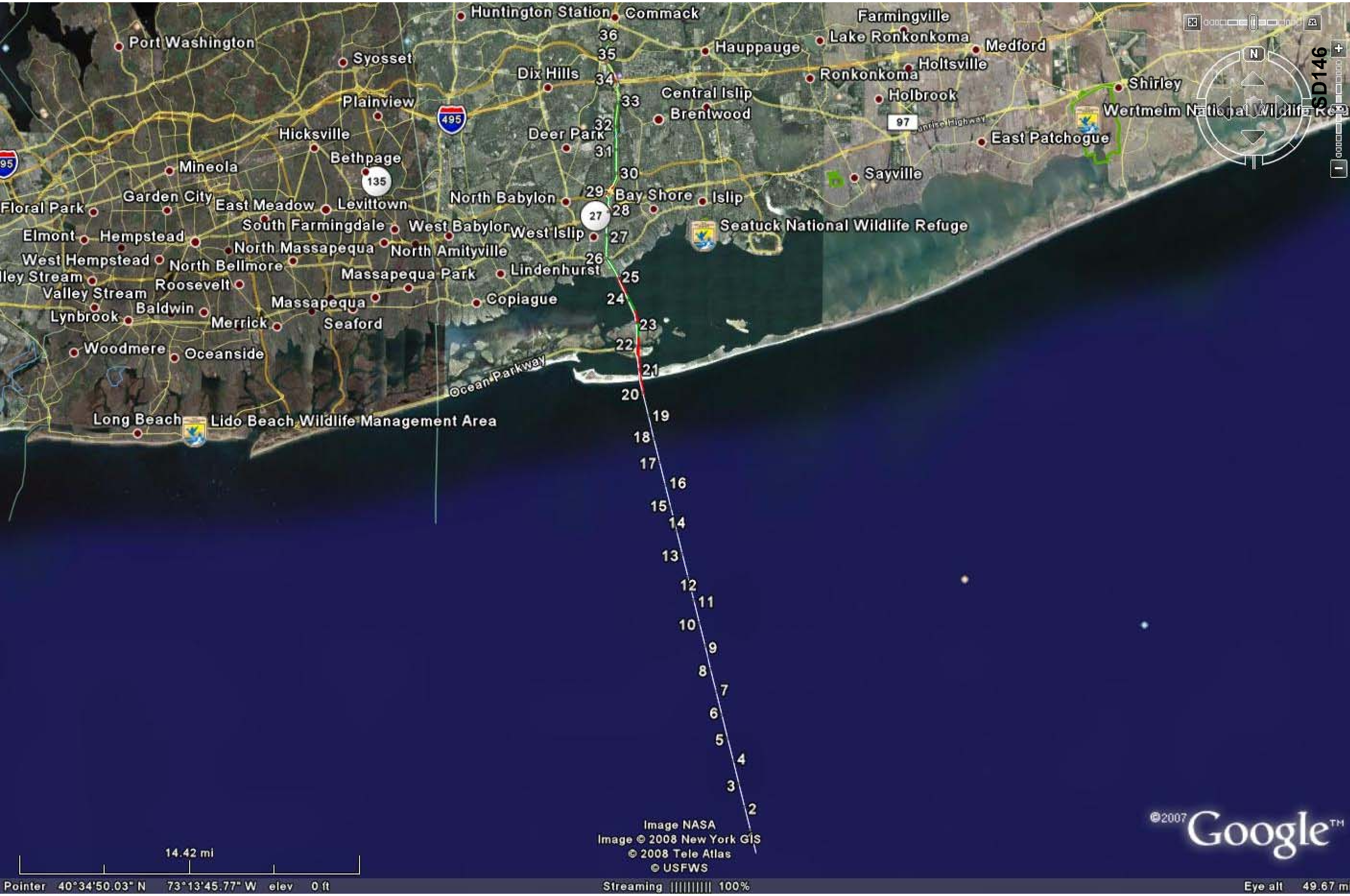


**Appendix B:**

**Route ALT 2 Drawing**

6-6-08 08081 1 J.E.F. A

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Commack
Farmingville
Lake Ronkonkoma
Medford
Hauppauge
Holtsville
Ronkonkoma
Shirley
Dix Hills
Plainview
Central Islip
Brentwood
Holbrook
Wertmeim National Wildlife Refug
East Patchogue
Hicksville
Bethpage
Deer Park
Mineola
Sayville
Garden City
East Meadow
Levittown
North Babylon
Bay Shore
Islip
Floral Park
South Farmingdale
West Babylon
West Islip
Seatuck National Wildlife Refuge
Elmont
Hempstead
North Massapequa
North Amityville
West Hempstead
North Bellmore
Massapequa Park
Lindenhurst
Valley Stream
Roosevelt
Copiague
Massapequa
Lynbrook
Baldwin
Merrick
Seaford
Woodmere
Oceanside
Ocean Parkway
Long Beach
Lido Beach Wildlife Management Area
Image NASA
Image © 2008 New York GIS
© 2008 Tele Atlas
© USFWS
14.42 mi
Pointer 40°34'50.03" N 73°13'45.77" W elev 0 ft
Streaming 100%
Eye alt 49.67 mi
©2007 Google™
SD146

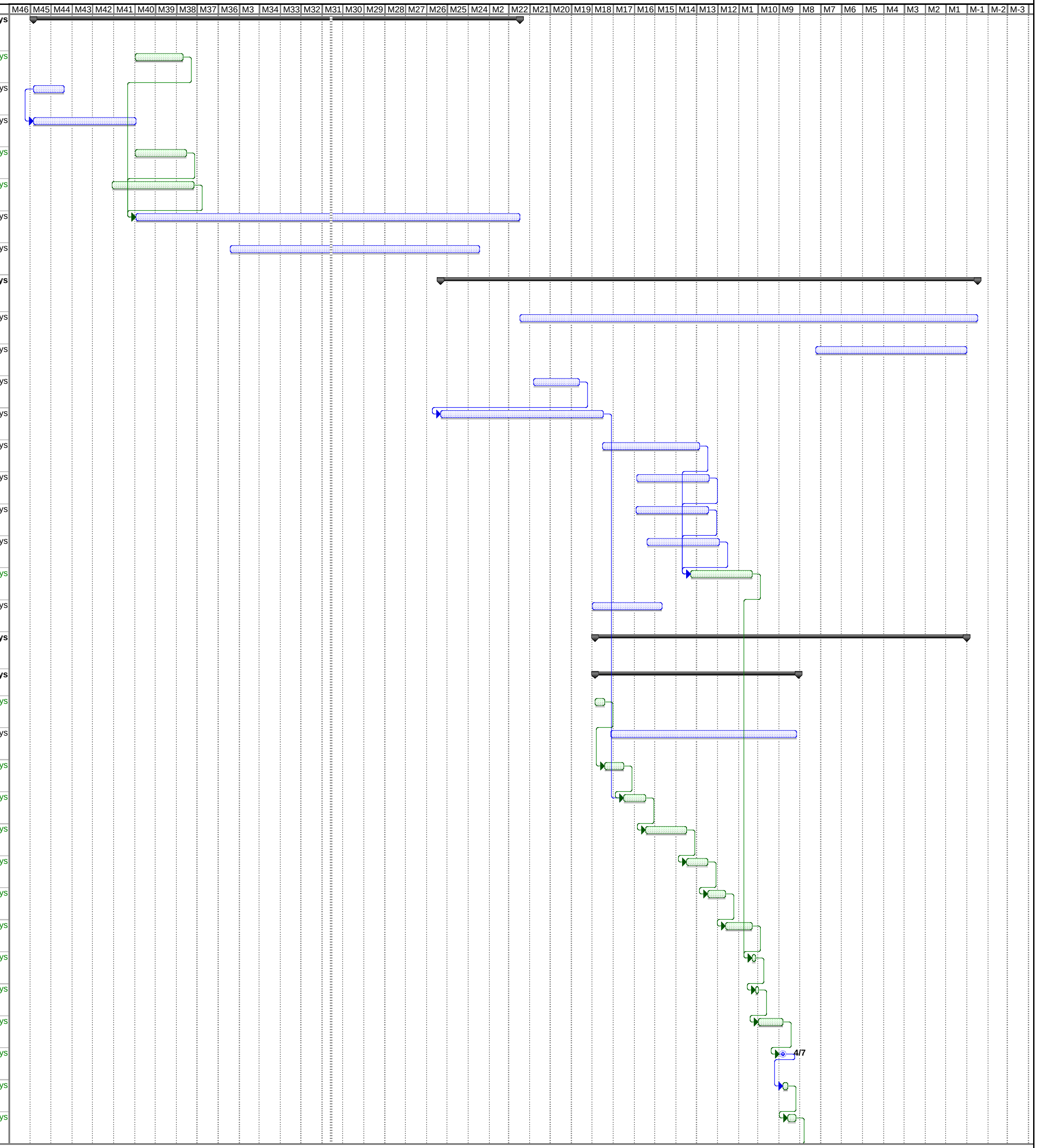
**Appendix C:**

**High Level Schedule ALT 1**

BROADWATER

# Broadwater Construction Plan
## High Level Schedule
## Alternate Route 1

| ID | Task Name | Duration |
|---|---|---|
| 1 | **I. Post FERC Certificate** | **712 days** |
| 2 | Geotechnical Deep Coring | 70 days |
| 3 | Geophysical Route Surveying | 45 days |
| 4 | Cable Crossing Agreements | 150 days |
| 5 | Trial Plow | 75 days |
| 6 | Diver Surveys | 120 days |
| 7 | Engineering Support | 562 days |
| 8 | Contractor Services | 365 days |
| 9 | **II. Procurement, Fabrication, Transportation of Materials** | **786 days** |
| 10 | Project Site Office | 670 days |
| 11 | On-site Storage Facility | 221 days |
| 12 | Anodes | 67 days |
| 13 | Linepipe | 238 days |
| 14 | Valves | 142 days |
| 15 | Flanges | 106 days |
| 16 | Pipeline Bends & Tees | 106 days |
| 17 | Pig Receiver | 106 days |
| 18 | Fabrication of Spools and Protection Structures | 90 days |
| 19 | Miscellaneous Parts | 102 days |
| 20 | **III. Installation** | **544 days** |
| 21 | **Phase 1 - Main Pipelay Activity** | **298 days** |
| 22 | Transco Hot-Tap Installation (Excavation, Installation, and Protection) with DSV | 14 days |
| 23 | Survey Vessel | 272 days |
| 24 | Prelay Diving Operations with DSV | 28 days |
| 25 | Pipelay Operations with Laybarge | 32 days |
| 26 | Pipeline Lowering (Plow) with Laybarge | 60 days |
| 27 | Pipeline Lowering (Jetting) with Jetbarge | 31 days |
| 28 | Pipeline Backfill (Rock) with Jetbarge | 26 days |
| 29 | Pipeline Backfill (Backfill Plow) with Laybarge | 39 days |
| 30 | Hot-Tap Connecting Spool (Spool #1) with Lay Barge | 5 days |
| 31 | FSRU Pipeline Tie-in Spool (Spool #3) with Lay Barge | 4 days |
| 32 | Crossing Completion and Cover Placement with DSV | 36 days |
| 33 | Additional Construction Requirements with DSV | 0 days |
| 34 | Filling, Treating, and Cleaning with 2 Support Vessels | 7 days |
| 35 | Check and Isolation Valve Spool (Spool #4) with DSV | 12 days |




Broadwater High Level Schedule | Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External MileTask | Split



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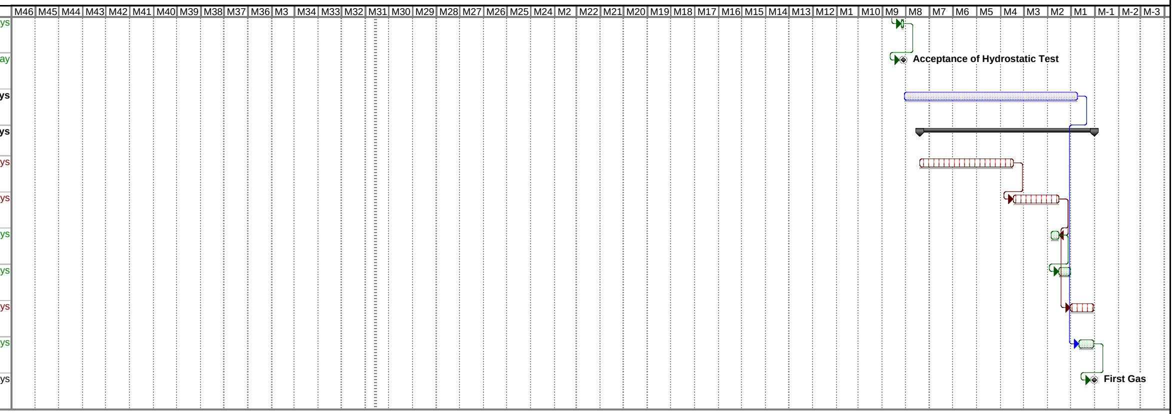
# Broadwater Construction Plan
# High Level Schedule
# Alternate Route 1

| ID | Task Name | Duration |
|---|---|---|
| 36 | Hydrostatically Test Pipeline with Treated Water with 2 Vessels | 3 days |
| 37 | Acceptance of Hydrostatic Test | 1 day |
| 38 | Pipeline Storage Duration Until Completion of YMS/FSRU Installation | 224 days |
| 39 | Phase 2 - Remaining Tie-ins | 226 days |
| 40 | FSRU and YMS Transport | 121 days |
| 41 | YMS Installation | 59 days |
| 42 | Transco Pipeline Tie-in Spool (Spool #2) with Dive Support Vessel | 10 days |
| 43 | FSRU Tie-in (Spool #1 and Spool #2) with Dive Support Vessel | 15 days |
| 44 | FSRU Installation & Commissioning | 30 days |
| 45 | Dewatering & Drying (Pre-Commissioning and Commissioning) with 2 Vessels | 19 days |
| 46 | First Gas | 0 days |




Broadwater High Level Schedule | Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External MileTask | Split



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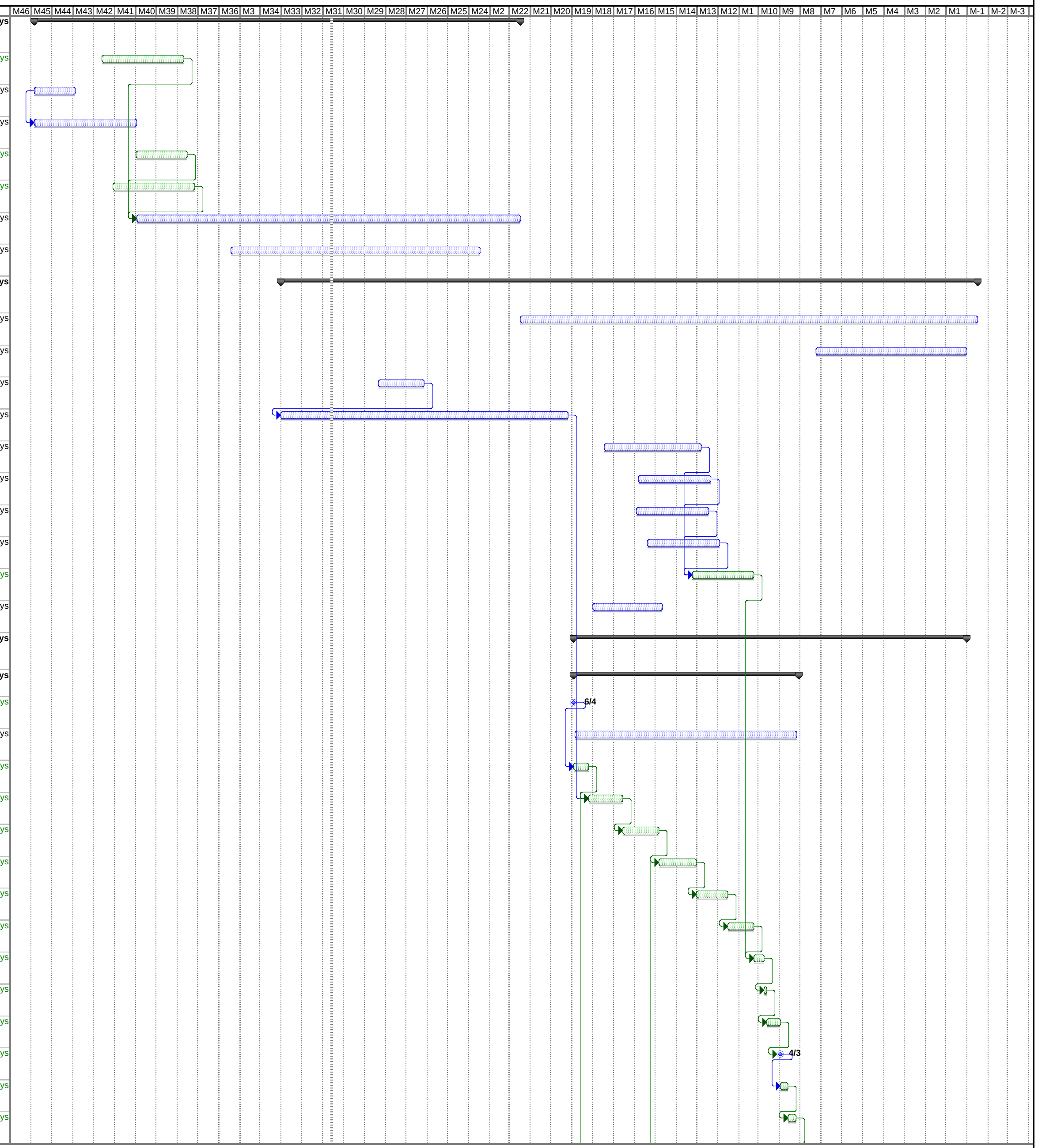
**Appendix D:**

**High Level Schedule ALT 2**

BROADWATER

# Broadwater Construction Plan
# High Level Schedule
# Alternate Route 2

| ID | Task Name | Duration |
|---|---|---|
| 1 | **I. Post FERC Certificate** | **712 days** |
| 2 | Geotechnical Deep Coring | 120 days |
| 3 | Geophysical Route Surveying | 60 days |
| 4 | Cable Crossing Agreements | 150 days |
| 5 | Trial Plow | 75 days |
| 6 | Diver Surveys | 120 days |
| 7 | Engineering Support | 562 days |
| 8 | Contractor Services | 365 days |
| 9 | **II. Procurement, Fabrication, Transportation of Materials** | **1021 days** |
| 10 | Project Site Office | 670 days |
| 11 | On-site Storage Facility | 221 days |
| 12 | Anodes | 67 days |
| 13 | Linepipe | 421 days |
| 14 | Valves | 142 days |
| 15 | Flanges | 106 days |
| 16 | Pipeline Bends & Tees | 106 days |
| 17 | Pig Receiver | 106 days |
| 18 | Fabrication of Spools and Protection Structures | 90 days |
| 19 | Miscellaneous Parts | 102 days |
| 20 | **III. Installation** | **576 days** |
| 21 | **Phase 1 - Main Pipelay Activity** | **330 days** |
| 22 | Transco Hot-Tap Installation (Excavation, Installation, and Protection) with DSV | 0 days |
| 23 | Survey Vessel | 325 days |
| 24 | Prelay Diving Operations with DSV | 22 days |
| 25 | Pipelay Operations with Laybarge | 50 days |
| 26 | Pipeline Lowering (Plow) with Laybarge | 53 days |
| 27 | Pipeline Lowering (Jetting) with Jetbarge | 55 days |
| 28 | Pipeline Backfill (Rock) with Jetbarge | 46 days |
| 29 | Pipeline Backfill (Backfill Plow) with Laybarge | 38 days |
| 30 | HDD Connecting Spool (Spool #1) with Lay Barge | 15 days |
| 31 | FSRU Pipeline Tie-in Spool (Spool #3) with Lay Barge | 4 days |
| 32 | Crossing Completion and Cover Placement with DSV | 20 days |
| 33 | Additional Construction Requirements with DSV | 0 days |
| 34 | Filling, Treating, and Cleaning with 2 Support Vessels | 11 days |
| 35 | Check and Isolation Valve Spool (Spool #4) with DSV | 12 days |




| Broadwater High Level Schedule | Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External MileTask | Split |
|---|---|---|---|---|---|---|---|---|---|

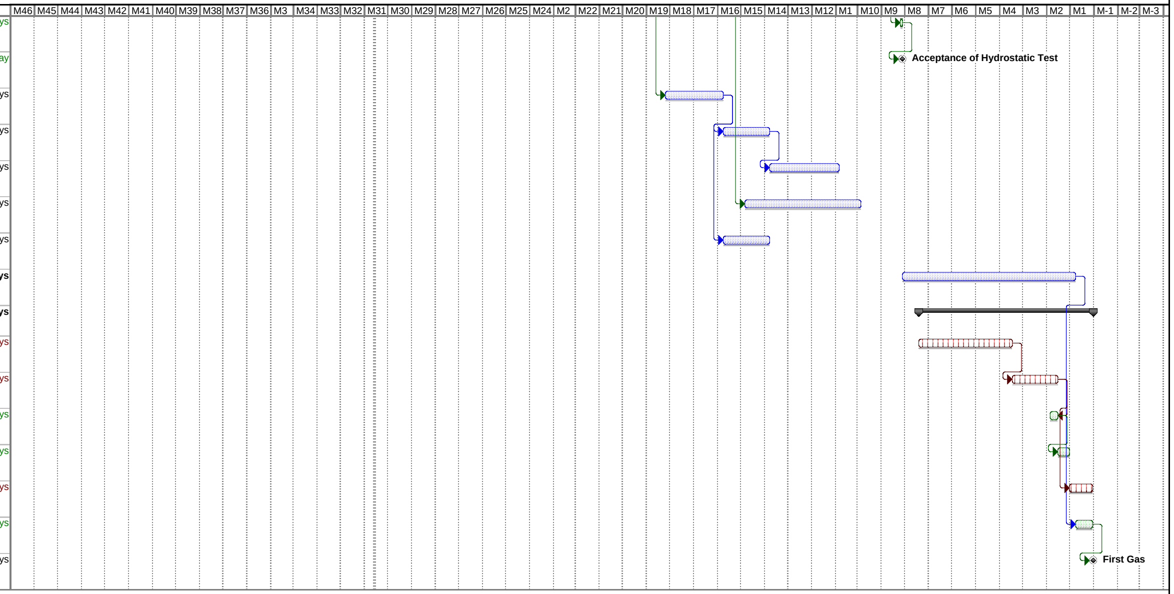


SD151

# Broadwater Construction Plan
## High Level Schedule
## Alternate Route 2

BROADWATER

| ID | Task Name | Duration |
|---|---|---|
| 36 | Hydrostatically Test Pipeline with Treated Water with 2 Vessels | 3 days |
| 37 | Acceptance of Hydrostatic Test | 1 day |
| 38 | Fire Island HDD | 75 days |
| 39 | Captree Island HDD | 60 days |
| 40 | Conklin Point HDD | 90 days |
| 41 | Onshore Pipeline Construction | 150 days |
| 42 | Barrier Island Pipeline Construction | 60 days |
| 43 | Pipeline Storage Duration Until Completion of YMS/FSRU Installation | 224 days |
| 44 | Phase 2 - Remaining Tie-ins | 226 days |
| 45 | FSRU and YMS Transport | 121 days |
| 46 | YMS Installation | 59 days |
| 47 | Pipeline Tie-in Spool to HDD with Dive Support Vessel | 10 days |
| 48 | FSRU Tie-in (Spool #1 and Spool #2) with Dive Support Vessel | 15 days |
| 49 | FSRU Installation & Commissioning | 30 days |
| 50 | Dewatering & Drying (Pre-Commissioning and Commissioning) with 2 Vessels | 22 days |
| 51 | First Gas | 0 days |




| Broadwater High Level Schedule | Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External MileTask | Split |
|---|---|---|---|---|---|---|---|---|---|

**Appendix E:**

**Alternative Pipeline Routes Cost Estimates**

BROADWATER

## REVISED PIPELINE COST ESTIMATE ±15% (P-50 Costing)

## BASE CASE GAS ON 4Q, 2010 - ORIGINALLY PRESENTED SEPTEMBER, 2005

BROADWATER

## ALTERNATE PIPELINE COST ESTIMATE

## ALTERNATE 1: FSRU TO TRANSCO PIPELINE

BROADWATER

## ALTERNATE PIPELINE COST ESTIMATE

## ALTERNATE 2: FSRU TO IROQUOIS INTERCONNECT

| Item | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt. 1 Unit Cost | Alt. 1 Qty | Alt. 1 Cost | Alt. 2 Unit Cost | Alt. 2 Qty | Alt. 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pipeline Length (miles) = | 22.33 | | LINEPIPE REQUIREMENT-Route 2 =22.33 miles: **1)**115,000-feet (21.78 miles) of X-65 x 0.600-inch WT x 30-inch diameter. Contingency for realignment, allowance for buckles, welding and welder procedures, startup/lay-down heads etc 2,300-feet (2%). TOTAL LENGTH OF X65 LINEPIPE = 117,300-feet (22.22 miles). **2)** 600-feet of X-70 x 0.600-inch WT x 30-inch diameter. **3)** Combined length = 117,300' + 600' =117,900' (22.33 miles) | | Pipeline Length (miles) = | 13.87 | | Pipeline Length (miles) = | 39.29 |
| | | | 30" O.D. x 0.600" w.t x X-65 grade = | 188.60 (lb/ft) | | | | 30" O.D. x 0.600" w.t x X-65 grade = | 188.60 (lb/ft) | | 30" O.D. x 0.600" w.t x X-65 grade = | 188.60 (lb/ft) |
| | | | Assumed Anode Spacing = | 720 ft | | | | Assumed Anode Spacing = | 720 ft | | Assumed Anode Spacing = | 720 ft |
| **1.0 MATERIALS** | | | | | | | | | | | | |
| **1.1 Pipeline Material** | | | | | | | | | | | | |
| 1 Linepipe | $ 1,300 | per ton | 11,118 | tons (2000 US lbs) | $ 14,453,655 | PRICE OF LINEPIPE - TCPL Calgary advises that they receive the same non-committal responses to the question of forward projection for linepipe costs as our PCS Material Management group. However they presently do not see any indication that today's prices are likely to reduce. Based on this discussion and our own industry feed-back, we are adopting a rate of $1300/US-Short TON for this edition of the OME. | | 6906 | $ 8,978,195.76 | | 19563 | $ 25,432,288.08 |
| 2 Transport from Linepipe to Coating yard | $ 3.43 | per ft | 117,902 | ft | $ 404,405 | Assumes transport from Berg (Florida) to Bayou (Louisiana) coating yard. Both corrosion and weight coating at Bayou | | 73238.88 | $ 251,209.36 | | 207461.76 | $ 711,593.84 |
| 3 Pipeline Anodes | $ 780 | each | 163 | unit | $ 127,140 | Assumes 390 lb unit at a 720-spacing. Quotation from Galvatec. | | 102 | $ 79,342.12 | | 288 | $ 224,750.24 |
| 4 External Coating | $ 6.65 | per ft | 117,902 | ft | $ 784,051 | Cost per foot ex Bayou Coating assuming 16 mils nominal, 14 mils minimum, plus 2.5 mils rough coat | | 73238.88 | $ 487,038.55 | | 207461.76 | $ 1,379,620.70 |
| 5 Internal Coating | $ 3.80 | per ft | 117,902 | ft | $ 448,029 | Assumes 38 microns. Quotation from Bayou Coating. | | 73238.88 | $ 278,307.74 | | 207461.76 | $ 788,354.69 |
| 6 Concrete Weight Coating | $ 35.60 | per ft | 117,902 | ft | $ 4,197,325 | Assumes full adhesive and 2 wires for CWC. Quotation ex Bayou Coating. | | 73238.88 | $ 2,607,304.13 | | 207461.76 | $ 7,385,638.66 |
| 7 Barge CWC pipe to Northeast | $ 33.86 | per ft | 117,902 | ft | $ 3,992,175 | Assume 22.15 miles of linepipe = 2960 joints to ship to NY Assume 275 joints (5 bays x 55 joints x 4 joints high) per a 250 class barge (250' x 72'), Therefore : Total loads = 11, $8000 per barge per day, assume 45 days. | | 73238.88 | $ 2,479,868.48 | | 207461.76 | $ 7,024,655.19 |
| 8 30" Ball Valves (end of pipeline) | $ 54,733 | each | 2 | unit | $ 109,466 | ANSI 600, WE x WE API 6D with Monogram, Full Open Gear Operated | | 2 | $ 109,466.00 | | 7 | $ 383,131.00 |
| 9 Mobilize and Construct Broadwater Load out Facility/Yard | $ 500,000 | each | 1 | unit | $ 500,000 | Including: site upgrades (wharf, civil works, and office facility). | | 1 | $ 500,000.00 | | 1 | $ 500,000.00 |
| 10 Operation of Broadwater Load out Facility/Yard for Linepipe | $ 5,000 | per day | 114 | day | $ 570,000 | Assume cost for rental and operation of load out facility. | | 73 | $ 366,194.40 | | 207 | $ 1,037,308.80 |
| | | | Pipeline Material | Subtotal | $ 25,586,247 | | | | $ 16,136,927 | | | $ 44,867,341 |
| **1.2 Spool Piece Materials (6 Spools)** | | | | | | | | | | | | |
| **A. IGTS Tie-In** | | | | | | | **Transco** | | | **Tie-in to HDDs** | | |
| 1 Hot-Tap Connecting Spool (Spool #1) | $ 351,252 | each | 1 | unit | $ 351,252 | See tab Spool Materials for cost breakdown | | | $ 351,252 | | | |
| 2 Pipeline Tie-In Spool (Spool #2) | $ 124,600 | each | 1 | unit | $ 124,600 | See tab Spool Materials for cost breakdown | | | $ 124,600 | $ 124,600 | 3 | $ 373,800 |
| 3 The Pig Receiver Spool (Spool #3) | $ 135,000 | each | 1 | unit | $ 135,000 | See tab Spool Materials for cost breakdown | | | $ 135,000 | $ 135,000 | 2 | $ 270,000 |
| **B. FSRU Tie-In** | | | | | | | | | | | | |
| 1 Battery Limit Spool (Spool #1 | N/A | each | N/A | unit | $ - | YMS Contractor's Scope Of Work | | | | | | |
| 2 Intermediate Spool (Spool #2 | $ 87,200 | each | 1 | unit | $ 87,200 | See tab Spool Materials for cost breakdow | | | $ 87,200 | | | $ 87,200 |
| 3 Pipeline Tie-In Spool (Spool #3 | $ 87,200 | each | 1 | unit | $ 87,200 | See tab Spool Materials for cost breakdow | | | $ 87,200 | | | $ 87,200 |
| 4 Check and Isolation Valve Spool (Spool #4) | $ 230,000 | each | 1 | unit | $ 230,000 | See tab Spool Materials for cost breakdown. For Spool piece approximately 2000ft West of YMS | | | $ 230,000 | | | $ 230,000 |
| **C. Additional Materials** | | | | | | | | | | | | |
| 1 Includes Additional Materials for Spool Fabricatio | $ 100,000 | each | 1 | unit | $ 100,000 | | | | $ 100,000 | | | $ 100,000 |
| **D. Transportation of Spools to Fabrication Yard** | | | | | | | | | | | | |
| 1 Transport of all Materials to Fabrication Yar | $ 50,000 | each | 1 | unit | $ 50,000 | | | | $ 50,000 | | | $ 50,000 |
| | | | Spool Piece Materials | Subtotal | $ 1,165,252 | | | | $ 1,165,252 | | | $ 1,198,200 |
| | | | | **MATERIALS TOTAL** | **$ 26,760,000** | | | | **$ 17,310,000** | | | **$ 46,070,000** |

## 2.0. MARINE PIPELINE INSTALLATION

NOTE: **1) Unit rates for various spreads based on previous recent pipelay operations in the general area using union labour and other items similar to the Broadwater project.**
**2) OME assumes Route 2 selected for installation with two only cable crossings**

| Item | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt. 1 Unit Cost | Alt. 1 Qty | Alt. 1 Cost | Alt. 2 Unit Cost | Alt. 2 Qty | Alt. 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2.1 Pre-Installation Investigations** | | | | | | | | | | | | |
| **A. Continuation of FSRU MET-Ocean Study - PRE-PERMIT ACTIVITY** | | | | | | | | | **Same** | | | **Same** |
| 1 Continuation of FSRU MET-Ocean Data Gathering | $100,000 | each | 1 | units | $ 100,000 | This assumes that the equipment has been purchased and installed. | | | | | | |
| | | | Continuation of FSRU MET-Ocean Study | Subtotal | $ 100,000 | | | | $ 100,000 | | | $ 100,000 |
| **B. Trial Plow - POST PERMIT ACTIVITY** | | | | | | | | | | | | |
| 1 Mob/Demob DP DSV | $ 390,000 | LS | 1 | units | $ 390,000 | | | | **Same** | | | **Same** |
| 2 Mob/Demob of Test/Trial Plow | $ 100,000 | LS | 1 | units | $ 100,000 | | | | | | | |
| 3 Trial Plow Operation across the Middle Ground | $ 65,000 | per day | 5 | days | $ 325,000 | | | | | | | |
| 4 Rental of Trial/Test Plow & Personnel | $ 10,000 | per day | 5 | days | $ 50,000 | | | | | | | |
| 5 Trial Plow Operation at AT & T Location | $ 65,000 | per day | 5 | days | $ 325,000 | | | | | | | |
| 6 Rental of Trial/Test Plow & Personnel | $ 10,000 | per day | 5 | days | $ 50,000 | | | | | | | |
| | | | Trial Plow | Subtotal | $ 1,240,000 | | | | $ 1,240,000 | | | $ 1,240,000 |
| **C. Diver Surveys- POST PERMIT ACTIVITY** | | | | | | | **Crossings** | | | **Crossings** | | |

BROADWATER

**REVISED PIPELINE COST ESTIMATE ±15% (P-50 Costing)**

**BASE CASE GAS ON 4Q, 2010 - ORIGINALLY PRESENTED SEPTEMBER, 2005**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 1: FSRU TO TRANSCO PIPELINE**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 2: FSRU TO IROQUOIS INTERCONNECT**

| | | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt. 1 Unit Cost | Alt. 1 Qty | Alt. 1 Cost | Alt. 2 Unit Cost | Alt. 2 Qty | Alt. 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Diver Investigations at AT & T Crossing | $ 65,000 | per day | 1 | days | $ 65,000 | DSV Mob/Demob included in in 2.1, A.1. Progress is continuous and does not require separate Mobilization | $ 65,000 | 7 | $ 455,000 | $ 65,000 | 3 | $ 195,000 |
| 2 | Diver Investigations at Cross Sound Cable Crossing | $ 65,000 | per day | 1 | days | $ 65,000 | | | | | | | |
| 3 | Diver Investigations at IGTS Hot-Tap Location | $ 65,000 | per day | 2 | days | $ 130,000 | | | | $ 130,000 | | | |
| 4 | Diver Investigations at FSRU/YMS Location | $ 65,000 | per day | 1 | days | $ 65,000 | | | | $ 65,000 | | | $ 65,000 |
| 5 | Diver Investigations at Archeological Sites | $ 65,000 | per day | 2 | days | $ 130,000 | Number of sites to be determined | | | $ 130,000 | | | $ 130,000 |
| | | | | **Diver Surveys** | **Subtotal** | **$ 455,000** | | | | **$ 780,000** | | | **$ 390,000** |
| **D.** | **Geotechnical Deep Coring- POST PERMIT ACTIVITY** | | | | | | | | | | | | |
| 1 | Mob/Demob Specialized Coring Vessel | $ 100,000 | LS | 1 | units | $ 100,000 | Assume regional mobilization | | | $ 100,000 | | | $ 100,000 |
| 2 | Core at FSRU | $ 50,000 | per day | 5 | days | $ 250,000 | Core approximately 250-feet deep | | | $ 250,000 | | | $ 250,000 |
| 3 | Core at Cross Sound Cable | $ 50,000 | per day | 2 | days | $ 100,000 | Core approximately 20-feet deep | 7 | $ 100,000 | $ 700,000 | 3 | $ 100,000 | $ 300,000 |
| 4 | Core at AT & T | $ 50,000 | per day | 2 | days | $ 100,000 | Core approximately 20-feet deep | | | | | | |
| 5 | Core at IGTS Hot-Tap | $ 50,000 | per day | 2 | days | $ 100,000 | Core approximately 30-feet dee | | | $ 100,000 | | | |
| 6 | Marine cores at each land-to-water HDD on Alternate 2 Route (3 per HDD), plus test/repor | | | | | | | | | | 9 | $ 125,000 | $ 1,125,000 |
| 7 | Core at each HDD on Alternate 2 Route (4 cores per HDD plus 2 cores for land-to-water HDDs), plus test/report | | | | | | | | | | 30 | $ 30,000 | $ 900,000 |
| 8 | Core at each Road or Railroad Bore (2 ea.), plus test/report | | | | | | | | | | 32 | $ 5,000 | $ 160,000 |
| | | | | **Geotechnical Deep Coring** | **Subtotal** | **$ 650,000** | | | | **$ 1,150,000** | | | **$ 2,835,000** |
| **2.2** | **Hot-Tap Contractor** | | | | | | | | | | | | |
| **A.** | **Hot-Tap Installation** | | | | | | | | | **Same** | | | **N/A** |
| 1 | Excavation Spread Mob/Demob with submersible pump | $ 75,000 | LS | 1 | units | $ 75,000 | Includes rig-up and mobilization of a work barge containing craneage and a suitable sand or mud pump to remove soil at the location of the IGTS hot-tap in preparation for the placement of the tie-in skid unit. | | | | | | |
| 2 | Excavation at Iroquois Hot-Tap | $ 30,000 | per day | 4 | days | $ 120,000 | Operation of spread at hot-tap location. | | | | | | |
| 3 | Hot-Tap DSV Mob/Demob | $ 240,000 | LS | 1 | units | $ 240,000 | Typical mob cost for equipment and personnel from a Gulf of Mexico location | | | | | | |
| 4 | Hot-Tap DSV Operation | $ 65,000 | per day | 5 | days | $ 292,500 | Estimate based on previous hot-tap operation. | | | | | | |
| 5 | Hot-Tap DSV Weather and Other D/T | $ 65,000 | per day | 2 | days | $ 97,500 | D/T 33%. | | | | | | |
| 6 | Hot-Tap DSV Protective Cover Installation | $ 65,000 | per day | 2 | days | $ 130,000 | | | | | | | |
| 7 | Procure Hot-Tap Saddle & Flange, Supports & Valves | $ 370,000 | each | 1 | units | $ 370,000 | Hot tap = $245,000 (Oil States): Valves and supports = $100,000 ; Misc = $25,000. | | | | | | |
| | | | | **Hot-Tap Installation** | **Subtotal** | **$ 1,325,000** | | | | **$ 1,325,000** | | | |
| **2.3** | **Primary Contractor** | | | | | | | | | | | | |
| **A.** | **Survey Vessel and Services** | | | | | | | **13.87 miles vs 22.33 miles (12.61 miles x 1.10)** | | | **27.63 miles vs 22.33 miles (25.12 miles x 1.10)** | | |
| 1 | Mobilize Survey Vessel | $ 50,000 | LS | | units | | Mobilize specialized survey/investigation vessel to LIS complete with crew and equipment including rig-up and trials. Similar to University of Connecticut vessel using a long-term rate. | $ 50,000 | 1 | $ 50,000 | $ 50,000 | 1 | $ 50,000 |
| 1a | Geophysical Survey: Route, Archy, Biological | $ 15,000 | per day | | | | | $ 15,000 | 45 | $ 675,000 | $ 15,000 | 60 | $ 900,000 |
| 2 | Mobilize Survey Vessel | $ 50,000 | LS | 1 | units | $ 50,000 | Mobilize specialized survey/investigation vessel to LIS complete with crew and equipment including rig-up and trials. Similar to University of Connecticut vessel using a long-term rate. | $ 50,000 | 1 | $ 50,000 | $ 50,000 | 1 | $ 50,000 |
| 2a | Pre-Construction Survey | $ 15,000 | per day | 37 | days | $ 555,000 | A pre-construction survey is performed prior to mobilization of the lay barge to the field to ensure that the route is clear for acceptance of the pipeline | $ 15,000 | 20 | $ 300,000 | $ 15,000 | 45 | $ 675,000 |
| 3 | Survey Support During Construction | $ 15,000 | per day | 44 | days | $ 660,000 | Survey vessel performs monitoring surveys and anchor checks during the pipelay operation | $ 15,000 | 32 | $ 480,000 | $ 15,000 | 65 | $ 975,000 |
| 4 | As-Installed Survey | $ 15,000 | per day | 4 | days | $ 60,000 | | $ 15,000 | 3 | $ 45,000 | $ 15,000 | 6 | $ 90,000 |
| 5 | Survey Support During Lowering | $ 15,000 | per day | 44 | days | $ 660,000 | Required for the duration thru to acceptance of the pipeline. | $ 15,000 | 220 | $ 3,300,000 | $ 15,000 | 215 | $ 3,225,000 |
| 6 | As Lowered Survey | $ 15,000 | per day | 4 | days | $ 60,000 | | $ 15,000 | 3 | $ 45,000 | $ 15,000 | 6 | $ 90,000 |
| 7 | Survey Support During Backfilling | $ 15,000 | per day | 22 | days | $ 330,000 | | $ 15,000 | in above | $ - | $ 15,000 | in above | $ - |
| 8 | As-Built Survey | $ 15,000 | per day | 20 | days | $ 300,000 | | $ 15,000 | 15 | $ 225,000 | $ 15,000 | 25 | $ 375,000 |
| | | | | **Survey Vessel and Services** | **Subtotal** | **$ 2,675,000** | | | | **$ 5,170,000** | | | |
| 9 | Onshore Route Surveys: Routing, Final Design, Construction, As-builts | | | | | | | | | | | | $ 750,000 |
| | | | | | | | | | | | | | **$ 7,180,000** |
| **B.** | **Prelay Diving Operations** | | | | | | | **7 Crossings, 1 Hot-Tap** | | | **3 Crossings** | | |
| 1 | Cross Sound Cable Crossing Preparation | $ 65,000 | per day | 4 | days | $ 260,000 | No mobilization cost. Assume same mobilization as Hot-Tap Installation. Diving crew and specialized diver/construction vessel to locate and install crossing structures or mattresses in addition to the concrete mats. | $ 660,000 | 5 | $ 3,300,000 | shallow $ 660,000 | 1 | $ 660,000 |
| 2 | Install concrete mats for crossing bridge at Cross Sound Cable | $ 8,000 | ea. | 50 | units | $ 400,000 | Procure and Install 50 pieces of flexible concrete mats at CSC location. Assume 4 days for installation of 50 mats | $ 920,000 | 2 | $ 1,840,000 | deep $ 920,000 | 2 | $ 1,840,000 |
| 3 | AT & T Crossing Preparation | $ 65,000 | per day | 4 | days | $ 260,000 | Diving crew and specialized diver/construction vessel to locate and install crossing structures or mattresses in addition to the concrete mats. | | | | | | |
| 4 | Install concrete mats for crossing bridge at AT & T Crossing | $ 8,000 | ea. | 50 | units | $ 400,000 | Procure and Install 50 pieces of flexible concrete mats at AT & T location. Assume 4 days for installation of 50 mats | | | | | | |
| 5 | Install concrete mats for crossings for IGTS Pipeline protection | $ 8,000 | ea. | 50 | units | $ 400,000 | Diving crew and specialized diver/construction vessel to locate and install protection mattresses for the final pipeline cable laydown over the IGTS Pipeline. Assume 4 days for installation of 50 mats. | | | $ 400,000 | | | |

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**REVISED PIPELINE COST ESTIMATE ±15% (P-50 Costing)**

**BASE CASE GAS ON 4Q, 2010 - ORIGINALLY PRESENTED SEPTEMBER, 2005**

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**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 1: FSRU TO TRANSCO PIPELINE**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 2: FSRU TO IROQUOIS INTERCONNECT**

| Item | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt. 1 Unit Cost | Alt. 1 Qty | Alt. 1 Cost | Alt. 2 Unit Cost | Alt. 2 Qty | Alt. 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Prelay Diving Operations Subtotal** | | | | | **$ 1,720,000** | | | | **$ 5,540,000** | | | **$ 2,500,000** |
| **C. Pipelay** | | | | | | | **Offshore Pipelay 13.87 miles vs 22.33 miles (12.61 miles x 1.10)** | | | **Offshore Pipelay 22.69 miles vs 22.33 miles (20.63 miles x 1.10)** | | |
| 1 Laybarge Mob/Demob | $ 5,500,000 | each | 1 | units | $ 5,500,000 | Assuming a 400-ft x 100-ft (typical) laybarge spread with pipe tension and anchoring capability for installing 30-inch OD pipe with CWC in 100 fsw. Also includes welding procedures, development of procedures, transit time/rig up of barge support vessels and crew | | | $ 5,500,000 | | | $ 5,500,000 |
| 2 Mob/Demob of six (6) pipe haul spreads | $ 25,000 | each | 6 | units | $ 150,000 | Mobilize six (6) pipe haul spreads (6 tugs and 6 x 250 class barges to LIS). | | | $ 150,000 | $ 25,000 | 6 | $ 150,000 |
| 3 Infield rig-up and preparation of barge | $ 240,000 | per day | 5 | days | $ 1,200,000 | After mobilization, period for lay barge to relocate to site, mobilize additional personnel and complete all safety checks, crew orientations, JSA requirements and welding out of the start up string and head | | | $ 1,200,000 | | | $ 1,200,000 |
| 4 Pipelay Operational 0.75 miles (100 joints) per day average | $ 265,000 | per day | 29 | days | $ 7,685,000 | Installed pipeline length assumed as 21.70 x 1.01 = 21.91 miles = 2930 joints (assuming134 joints of pipe per mile with 39.5-ft average length per joint) | $ 265,000 | 21 | $ 5,530,815 | $ 265,000 | 29 | $ 7,685,000 |
| 5 Pipelay Weather and Other Downtime | $ 240,000 | per day | 8 | days | $ 1,920,000 | Assume laybarge downtime is 25% for a winter operation | $ 240,000 | 6 | $ 1,552,260 | $ 240,000 | 8 | $ 1,920,000 |
| 6 Pipe Haul Spreads(six each 250 class mat'l barges w/ tugs) | $ 48,000 | per day | 42 | days | $ 2,016,000 | Duration of the set up and operation of the laybarge spread. Assumed pipe storage in Quonset point Rhode Island. Each "spread" $8,000/day | $ 48,000 | 32 | $ 1,552,260 | $ 48,000 | 42 | $ 2,016,000 |
| **Pipelay Subtotal** | | | | | **$ 18,471,000** | | | | **$ 15,485,335** | | | |
| 7 Lay and Hydrotest Fire Island HDD string, plus 25% weather | | | | | | | | | | $ 265,000 | 7.5 | $ 1,987,500 |
| 8 Mobilize Shallow Water Laybarge | | | | | | | | | | | | $ 2,000,000 |
| 9 Lay and Hydrotest Captree Island and Conklin Point HDD strings, plus 25% weather | | | | | | | | | | $ 250,000 | 15 | $ 3,750,000 |
| | | | | | | | | | | | | **$ 26,208,500** |
| **D. Pipeline Lowering** | | | | | | | **Includes time to jump 7 crossings** | | | **Includes time to jump 3 crossings** | | |
| 1 Equipment Spread Mob/Demob | $ 1,600,000 | LS | 1 | units | $ 1,600,000 | Rig-up and transportation of the lowering equipment to LIS | | | $ 1,600,000 | | | $ 1,600,000 |
| 2 Infield rig-up and preparation of lay barge to lowering barge | $ 220,000 | per day | 3 | days | $ 660,000 | Rig -up and conversion of the pipelay spread into a lowering spread including the demobilization of some of the pipelay crew. Day rate reduced to reflect the smaller crew on the barge. Same tug support and other vessels. Includes infield mobilizations and change to back-filling mode. | | | $ 660,000 | | | $ 660,000 |
| 3 Pipeline Plowing Operational FIRST PASS | $ 220,000 | per day | 15 | days | $ 3,300,000 | FIRST PASS. (1.5 miles per day for 21.7 miles). | $ 220,000 | 23 | $ 5,114,413.33 | $ 220,000 | 21 | $ 4,647,866.67 |
| 4 Pipeline Plowing Weather and Other D/T FIRST PASS | $ 220,000 | per day | 5 | days | $ 1,100,000 | D/T OF 33% ON FIRST PASS. | $ 220,000 | 8 | $ 1,687,756.40 | $ 220,000 | 7 | $ 1,533,796.00 |
| 5 Pipeline Plowing Operational SECOND PASS | $ 220,000 | per day | 13 | days | $ 2,860,000 | SECOND PASS. (1.75 miles per day for 21.7 miles). | $ 220,000 | 22 | $ 4,823,782.86 | $ 220,000 | 19 | $ 4,172,457.14 |
| 6 Pipeline Plowing Weather and Other D/T SECOND PASS | $ 220,000 | per day | 4 | days | $ 880,000 | D/T OF 33% ON SECOND PASS. | $ 220,000 | 7 | $ 1,591,848 | $ 220,000 | 6 | $ 1,376,911 |
| **Pipeline Lowering Subtotal** | | | | | **$ 10,400,000** | | | | | | | |
| 7 Convert Plow Vessel to Jetting Vessel | | | | | | | $ 220,000 | 7 | $ 1,540,000 | $ 220,000 | 7 | $ 1,540,000 |
| 8 Jet Pipeline in Deep Burial Areas (4.3 miles, 14.9 miles), jump crossings | | | | | | | $ 220,000 | 8 | $ 1,760,000 | $ 220,000 | 17 | $ 3,740,000 |
| 9 Second Jet Pass in Deep Burial Areas | | | | | | | $ 220,000 | 8 | $ 1,760,000 | $ 220,000 | 17 | $ 3,740,000 |
| 10 Pipeline Jetting Weather and other D/T | | | | | | | $ 220,000 | 8 | $ 1,669,800 | $ 220,000 | 14 | $ 2,976,600 |
| 11 Convert Jetting Vessel to Backfill Plow Vessel | | | | | | | $ 220,000 | 7 | $ 1,540,000 | $ 220,000 | 7 | $ 1,540,000 |
| 12 Backfill Pipeine Route at 1.5 miles per day, jump crossings | | | | | | | $ 220,000 | 21 | $ 4,547,855 | $ 220,000 | 20 | $ 4,318,307 |
| 13 Pipeline Backfill Weather and other D/T | | | | | | | $ 220,000 | 9 | $ 2,008,992 | $ 220,000 | 9 | $ 1,933,241 |
| 14 Derig Vessel and Prepare for Demob | | | | | | | $ 220,000 | 2 | $ 440,000 | $ 220,000 | 2 | $ 440,000 |
| | | | | | | | | | **$ 30,744,448** | | | |
| **15** Mobilize Dredge, with Hopper Barges (3 | | | | | | | | | | | | $ 1,000,000 |
| **16** Dredge Fire Island HDD exit hole and Backf | | | | | | | | | | $ 125,000 | 14 | $ 1,750,000 |
| **17** Dredge Captree Island HDD exit hole and Backf | | | | | | | | | | $ 125,000 | 14 | $ 1,750,000 |
| **18** Dredge Conklin Point HDD exit hole and Backf | | | | | | | | | | $ 125,000 | 14 | $ 1,750,000 |
| **19** Standby Time | | | | | | | | | | $ 125,000 | 20 | $ 2,500,000 |
| **20** Dredge and Backfill 3,200' in Great South Ba | | | | | | | | | | $ 125,000 | 20 | $ 2,500,000 |
| **21** Weather and other D/T for Dredge | | | | | | | | | | $ 125,000 | 27 | $ 3,382,500 |
| | | | | | | | | | | | | **$ 48,851,679** |
| **E. Fabrication Yard** | | | | | | | | **Same** | | **Same plus add Spools for HDD tie-ins** | | |
| 1 Spool Fabrication Yard | $ 4,800 | per day | 90 | days | $ 432,000 | Estimated day rate for fabrication, personnel, and site | | | | $ 4,800 | 120 | $ 576,000 |
| 2 Consumables and equipment | $ 50,000 | each | 1 | unit | $ 50,000 | | | | | | | $ 50,000 |
| **Fabrication Yard Subtotal** | | | | | **$ 482,000** | | | | **$ 482,000** | | | **$ 626,000** |
| **F. Hot-Tap Connecting Spool (Spool #1) with Lay Barge at IGTS** | | | | | | | | **Same** | | **Same plus add HDD Tie-ins** | | |
| 1 Install Spool #1 with Lay Barge | $ 265,000 | per day | 4 | days | $ 1,060,000 | Duration based on previous hot-tap operation | | | | | | |
| 2 Spool #1 with Lay Barge Weather and Other D/T | $ 265,000 | per day | 1 | days | $ 265,000 | D/T 33%. | | | | | | |
| 3 Transportation Barge/Tug | $ 8,000 | per day | 15 | days | $ 120,000 | One 250 class mat'l barges w/ tugs = $8,000/day | | | | | | |
| **Hot-Tap Connecting Spool (Spool #1) with Lay Barge at IGTS Subtotal** | | | | | **$ 1,445,000** | | | | **$ 1,445,000** | | | $ 1,445,000 |
| **4 Tie-ins to HDDs in Great South Bay** | | | | | | | | | | $ 75,000 | 10 | $ 750,000 |
| | | | | | | | | | | | | **$ 2,195,000** |
| **G. Pipeline Tie-in Spool ( Spool #3) with Lay Barge at FSRU** | | | | | | | | **Same** | | | **Same** | |
| 1 Relocate Barge to FSRU Site | $ 265,000 | per day | 1 | days | $ 265,000 | Duration based on previous spool piece installation | | | | | | |
| 2 Prepare location and fabricate Spool #3 on barge | $ 265,000 | per day | 2 | days | $ 530,000 | | | | | | | |
| 3 Install Spool #3 with Lay Barge | $ 265,000 | per day | 1 | days | $ 265,000 | | | | | | | |

BROADWATER

**REVISED PIPELINE COST ESTIMATE ±15% (P-50 Costing)**

**BASE CASE GAS ON 4Q, 2010 - ORIGINALLY PRESENTED SEPTEMBER, 2005**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 1: FSRU TO TRANSCO PIPELINE**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 2: FSRU TO IROQUOIS INTERCONNECT**

| Item | Description | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt 1 Unit Cost | Alt 1 Qty | Alt 1 Cost | Alt 2 Unit Cost | Alt 2 Qty | Alt 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Transportation Barge/Tug | $ 8,000 | per day | 10 | days | $ 80,000 | One 250 class mat'l barges w/ tugs = $8,000/day | | | | | | |
| | **Pipeline Tie-in Spool ( Spool #3) with Lay Barge at FSRU Subtotal** | | | | | **$ 1,140,000** | | | | **$ 1,140,000** | | | **$ 1,140,000** |
| **H.** | **Crossing Completion and Cover Placement** | | | | | | | **7 Crossings** | | | **3 Crossings** | | |
| 1 | Mob/Demob Dive Support Vessel | $ 390,000 | unit | 1 | units | $ 390,000 | | | | $ 390,000 | | | $ 390,000 |
| 2 | AT & T Crossing Completion | $ 65,000 | per day | 4 | days | $ 260,000 | Assume 4 day duration for completing the lowing of pipeline in th AT & T area | $ 540,000 | 5 | $ 2,700,000 | $ 540,000 | 1 | $ 540,000 |
| 3 | Install concrete mats over AT & T Crossing | $ 8,000 | each | 35 | mats | $ 280,000 | Procure and Install 35 pieces of flexible concrete mats at AT & T location. Assume 3 days | $ 950,000 | 2 | $ 1,900,000 | $ 950,000 | 2 | $ 1,900,000 |
| 4 | Cross Sound Cable Crossing Completion | $ 65,000 | per day | 4 | days | $ 260,000 | Assume 4 day duration for completing the lowing of pipeline in th AT & T area | | | | | | |
| 5 | Install concrete mats over Cross Sound Cable Crossing | $ 8,000 | each | 35 | mats | $ 280,000 | Procure and Install 35 pieces of flexible concrete mats at CSC location. Assume 3 days | | | | | | |
| 6 | Transportation Barge/Tug | $ 8,000 | per day | 15 | days | $ 120,000 | One 250 class mat'l barges w/ tugs = $8,000/day | | | $ 120,000 | | | $ 120,000 |
| | **Crossing Completion and Cover Placement Subtotal** | | | | | **$ 1,590,000** | | | | **$ 5,110,000** | | | **$ 2,950,000** |
| **I.** | **Additional Construction Requirements** | | | | | | | **Dump Rock for 4.3 miles + 7 crossings + FSRU** | | | **Dump Rock for 14.9 miles + 3 crossings** | | |
| 1 | Rock and sand dumping spread Mob/Demob | $ 600,000 | LS | 1 | units | $ 600,000 | Rig-up and mobilization of a suitable material placement spread t LIS. | | | $ 600,000 | | | $ 600,000 |
| 2 | Rock / Sand Dumping operation | $ 100,000 | per day | 12 | days | $ 1,200,000 | Assume one 1 mile of pipeline that cannot be lowered and requires rock coverage, plus two 2 cable crossings of a half-mile each, plus check/isolation valve spool, and expansion loops. Includes backfilling at IGTS and FSRU tie-in locations. Also includes 2 miles of backfill near the FSRU. Durations estimated. A reduced day rate may be possible if rock dumping is confined to the crossings. | $ 100,000 | 20 | $ 1,960,000 | $ 100,000 | 35 | $ 3,480,000 |
| 3 | Rock / Sand Dumping Downtime | $ 100,000 | per day | 4 | days | $ 400,000 | D/T 33%. | $ 100,000 | 6 | $ 646,800 | $ 100,000 | 11 | $ 1,148,400 |
| 4 | Rock Dumping Material | $ 500,000 | per mile | 5 | miles | $ 2,500,000 | Assume one 1 mile of pipeline that cannot be lowered and requires rock coverage, plus two 2 cable crossings of a half-mile each, plus check/isolation valve spool, and expansion loops. Includes backfilling at IGTS and FSRU tie-in locations. Also includes 2 miles of backfill near the FSRU. Durations estimated. A reduced day rate may be possible if rock dumping is confined to the crossings | $ 500,000 | 9 | $ 4,400,000 | $ 500,000 | 16.4 | $ 8,200,000 |
| 5 | Install additional concrete mats | $ 8,000 | each | 90 | mats | $ 720,000 | Includes possible additional locations requiring protection. DSV Mob/Demob included in in H. 1. Progress is continuous and doe not require separate Mobilization. Assume 2 days for 30 mats at various locations and 4 days for 60 mats for the 2 miles near the FSRU. | | | $ 720,000 | | | $ 720,000 |
| | **Additional Construction Requirements Subtotal** | | | | | **$ 5,420,000** | | | | **$ 8,326,800** | | | **$ 14,148,400** |
| **J.** | **Filling, Gauging, Treating, Cleaning and Hydrostatic Testing** | | | | | | | | | | | | |
| 1 | Fill, Verify Pipe Diameter, and Clean Pipeline with Treated Water, Hydrostatically Test with Treated Water, Bleed Of Pressure for Storage, & Close Valves, Disconnect Hoses Install Protection, and Secure for Storag | $ 65,000 | per day | 11 | days | $ 715,000 | DSV Mob/Demob included in in 2.3 H. 1. Progress is continuous and does not require separate Mobilization. | $ 65,000 | 7 | $ 455,000 | $ 65,000 | 11 | $ 715,000 |
| 2 | Mob/Demob of DSV for Filling, Treating, and Hydrotestin | $ 50,000 | LS | 1 | unit | $ 50,000 | | | | $ 50,000 | | | $ 50,000 |
| 3 | DSV for Filling, Treating, and Hydrotesting | $ 20,000 | per day | 11 | days | $ 220,000 | | $ 20,000 | 7 | $ 140,000 | $ 20,000 | 11 | $ 220,000 |
| | **Filling, Gauging, Treating, Cleaning and Hydrostatic Testing Subtotal** | | | | | **$ 985,000** | | | | **$ 645,000** | | | **$ 985,000** |
| **K.** | **Check Valve and Isolation Valve (Spool #4)** | | | | | | | | **Same** | | | **Same** | |
| 1 | DSV remove dummy spool & complete metrology | $ 65,000 | per day | 2 | days | $ 130,000 | DSV Mob/Demob included in in 2.3 H. 1. Progress is continuous and does not require separate Mobilizatior | | | | | | |
| 2 | Standby for spool fabricatior | $ 65,000 | per day | 1 | days | $ 65,000 | | | | | | | |
| 3 | Install spool and valves | $ 65,000 | per day | 6 | days | $ 390,000 | | | | | | | |
| 4 | Test and Install Sand Bags | $ 65,000 | per day | 3 | days | $ 195,000 | | | | | | | |
| 5 | Demobilize vesse | $ - | LS | | | $ - | Demob cost is included in the mobilization cos | | | | | | |
| | **Check Valve and Block Valve Subtotal** | | | | | **$ 780,000** | | | | **$ 780,000** | | | **$ 780,000** |
| | **Break in Pipeline Construction Program for YMS and FSRU Installation and Commissioning** | | | | | | | | | | | | |
| **L.** | **IGTS Pipeline Tie-in Spool (Spool #2)** | | | | | | | | **Same** | | | **Tie-in to Fire Island HDD** | |
| 1 | Mob/Demob Dive Support Vessel | $ 390,000 | unit | 1 | units | $ 390,000 | | | | | | | |
| 2 | Excavate Area and Install Spool #2 | $ 65,000 | per day | 8 | days | $ 520,000 | | | | | | | |
| 3 | Weather and Other Downtime | $ 65,000 | per day | 2 | days | $ 130,000 | | | | | | | |
| 4 | Transportation Barge/Tug | $ 8,000 | per day | 15 | days | $ 120,000 | One 250 class mat'l barges w/ tugs @ $8,000/day | | | | | | |
| | **IGTS Pipeline Tie-in Spool (Spool #2) Subtotal** | | | | | **$ 1,160,000** | | | | **$ 1,160,000** | | | **$ 1,160,000** |
| | | | | | | **NOTE:** | **OME extends to the Battery Limit which is defined as the swivel flange face downstream of the Check Valve. The procurement and fabrication of the Check Valve, umbilicals and spool piece are not included. Installation time for the Check Valve and connecting spool is included.** | | | | | | |
| **M.** | **FSRU Subsea Tie-In (Spool #1 and Spool #2)** | | | | | | | | **Same** | | | **Same** | |
| 1 | Mob/Demob | $ - | LS | $0 | unit | $ - | Progress is continuous, follows IGTS Spool #2, and does not require separate mobilization | | | | | | |
| 2 | DSV/Diver Operational for Spool #1 & Spool #2 | $ 65,000 | per day | 11 | days | $ 715,000 | Includes installation and connections of both spools and SSSV valve and umbilical | | | | | | |
| 3 | DSV/Diver Weather and Other D/T | $ 65,000 | per day | 4 | days | $ 260,000 | D/T 33%. | | | | | | |
| 4 | Transportation Spread | $ 8,000 | per day | 30 | days | $ 240,000 | One 250 class mat'l barges w/ tugs @ $8,000/day | | | | | | |

BROADWATER

**REVISED PIPELINE COST ESTIMATE ±15% (P-50 Costing)**

**BASE CASE GAS ON 4Q, 2010 - ORIGINALLY PRESENTED SEPTEMBER, 2005**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 1: FSRU TO TRANSCO PIPELINE**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 2: FSRU TO IROQUOIS INTERCONNECT**

| | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt. 1 Unit Cost | Alt. 1 Qty | Alt. 1 Cost | Alt. 2 Unit Cost | Alt. 2 Qty | Alt. 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FSRU Subsea Tie-In (Spool #1 and Spool #2) Subtotal** | | | | | **$ 1,215,000** | | | | **$ 1,215,000** | | | **$ 1,215,000** |
| **N. Logistics Support** | | | | | | | | | | | | |
| 1 Helicopter | $ 500,000 | LS | 1 | units | $ 500,000 | Assumed cost. | | | $ 500,000 | | | $ 500,000 |
| 2 Security Vessel x 2 | $ 3,000 | per day | 457 | days | $ 1,371,000 | Assumed $1500 for each 12 shifts (2 shifts per day) for duration of pipelay | $ 3,000 | 400 | $ 1,200,000 | $ 3,000 | 475 | $ 1,425,000 |
| 3 Service and Support Boat | $ 3,000 | per day | 212 | days | $ 636,000 | Assumed local vessel cost | $ 3,000 | 200 | $ 600,000 | $ 3,000 | 250 | $ 750,000 |
| 4 Lobster Trap Clearance and Observation | $ 3,900 | per day | 301 | days | $ 1,173,900 | Assume $1500 per day for one lobster vessel for duration of work on LIS and assume $600 per day per LIS lobsterman observer. Assume 4 observers. Both rates are based on previous lobsterman work completed on Broadwater Geophysical and Geotechnical Surveys | $ 3,900 | 300 | $ 1,170,000 | $ 3,900 | 330 | $ 1,287,000 |
| 5 Project Management Site Office and Utilities | $ 3,000 | per month | 22 | months | $ 66,000 | | | | $ 66,000 | | | $ 66,000 |
| 6 Local administrative staff, vehicle, and support cost | $ 1,000 | per day | 670 | days | $ 670,000 | Support for duration of pipelay | | | $ 670,000 | | | $ 670,000 |
| **Logistics Support Subtotal** | | | | | **$ 4,416,900** | | | | **$ 4,206,000** | | | **$ 4,698,000** |
| **2.4 Dewatering and Commissioning Contractor** | | | | | | | | | | | | |
| **A. Pre-Commissioning** | | | | | | | | | | | | |
| 1 Mob/Demob Dewatering and Drying Spread to FSRU | $ 500,000 | LS | 1 | units | $ 500,000 | Estimates based on recent projects of a similar nature | | | $ 500,000 | | | $ 500,000 |
| 2 Mob/Demob Dive Support Vessel to IGTS | $ 200,000 | LS | 1 | units | $ 200,000 | Estimates based on recent projects of a similar nature | | | $ 200,000 | | | $ 200,000 |
| 3 Vessel for Drying to -45 degree F. | $ 65,000 | per day | 9 | days | $ 585,000 | | $ 65,000 | 7 | $ 455,000 | $ 65,000 | 10 | $ 650,000 |
| 4 Weather and Other Downtime | $ 65,000 | per day | 3 | days | $ 195,000 | D/T 33%. | $ 65,000 | 2.31 | $ 150,150 | $ 65,000 | 3.3 | $ 214,500 |
| 5 DSV for diving operations to operate valves and remove pigs at the IGTS location as required | $ 20,000 | per day | 9 | days | $ 180,000 | | $ 20,000 | 7 | $ 140,000 | $ 20,000 | 10 | $ 200,000 |
| 6 Weather and Other Downtime | $ 20,000 | per day | 3 | days | $ 60,000 | D/T 33%. | $ 20,000 | 2.31 | $ 46,200 | $ 20,000 | 3.3 | $ 66,000 |
| 7 Pipeline Pre-Commissioning Equipment | $ 20,000 | per day | 12 | days | $ 240,000 | | $ 20,000 | 9.31 | $ 186,200 | $ 20,000 | 13.3 | $ 266,000 |
| **Pre-Commissioning Subtotal** | | | | | **$ 1,960,000** | | | | **$ 1,677,550** | | | **$ 2,096,500** |
| **B. Commissioning** | | | | | | | | **Same** | | | **Same** | |
| 1 Commissioning Vessel | $ 65,000 | per day | 9 | days | $ 585,000 | Estimates based on recent projects of a similar nature | | | | | | |
| 2 DSV for diving operations to operate valves and remove pigs at the IGTS location as required | $ 20,000 | per day | 9 | days | $ 180,000 | Assumed local vessel with minimum crew. | | | | | | |
| 3 Pipeline Drying consumables | $ 500,000 | LS | 1 | units | $ 500,000 | Estimates based on recent projects of a similar nature | | | | | | |
| **Dewatering and Commissioning Subtotal** | | | | | **$ 1,265,000** | | | | **$ 1,265,000** | | | **$ 1,265,000** |
| **MARINE PIPELINE INSTALLATION TOTAL** | | | | | **$ 58,800,000** | | | | **$ 88,990,000** | | | **$ 122,570,000** |
| **2.5 ONSHORE AND BARRIER ISLAND CONSTRUCTION** | | | | | | | | | | | | |
| 1 Onshore Construction: 50' permanent/40' temporary work space | 10.60 | miles | | | | | | | | $ 455 | 55950 | $ 25,457,250 |
| 2 Barrier Island Construction: 50' permanent/40' temporary work space | 2.31 | miles | | | | | | | | $ 455 | 12200 | $ 5,551,000 |
| 3 Conventional Road Bore - Dirt (Assume 8) | | | | | | | | | | $ 150 | 1835 | $ 275,250 |
| 4 Conventional Road Bore - Rock (Assume 8) | | | | | | | | | | $ 700 | 880 | $ 616,000 |
| 5 HDD - Dirt (Assume 3) | | | | | | | | | | $ 400 | 10500 | $ 4,200,000 |
| 6 HDD - Rock (Assume 3) | | | | | | | | | | $ 1,000 | 6870 | $ 6,870,000 |
| 7 Xray services | | | | | | | | | | $ 460,000 | 1 | $ 460,000 |
| 8 Additional Site-Specific Environmental Controls | | | | | | | | | | $ 500,000 | 1 | $ 500,000 |
| 9 Traffic Controls | | | | | | | | | | $ 200,000 | 1 | $ 200,000 |
| 10 Mainline Valve Construction | | | | | | | | | | $ 250,000 | 4 | $ 1,000,000 |
| 11 Metering Station Construction | | | | | | | | | | $ 800,000 | 1 | $ 800,000 |
| 12 Mob/Demob HDD Rig + Jackup + Marine Equipment | | | | | | | | | | $ 3,500,000 | 1 | $ 3,500,000 |
| 13 Fire Island Land to Water HDD | 4000' | | | | | | | | | $ 2,000 | 4000 | $ 8,000,000 |
| 14 Captree Island Land to Water HDD | 3000' | | | | | | | | | $ 1,500 | 3000 | $ 4,500,000 |
| 15 Conklin Point Land to Water HDD | 4700' | | | | | | | | | $ 1,500 | 4700 | $ 7,050,000 |
| | | | | | | | | | | | | **$ 68,979,500** |
| **ONSHORE AND BARRIER ISLAND CONSTRUCTION TOTAL** | | | | | | | | | | | | **$ 68,979,500** |
| **3.0 ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT (CONTRACT)** | | | | | | | | | | | | |
| **3.1 Engineering Design and Permitting** | | | | | | | | **Same** | | | **Same** | |
| 1 Permitting support for the period through permit approval | $ 90 | $ / m-hr | 2,300 | m-hrs | $ 207,000 | 1 person at 50% utilization for 23 months. 100 hours per month | | | | | | |
| 2 Additional engineering support services for the period through permit approval | $ 90 | $ / m-hr | 1,150 | m-hrs | $ 103,500 | 1 person at 25% utilization in the period from permit submission thru approval. 50 man hours/month for 23 months | | | | | | |
| **Engineering Design and Permitting Subtotal** | | | | | **$ 310,500** | | | | **$ 310,500** | | | **$ 310,500** |
| **3.2 Detailed Engineering Design** | | | | | | | | **Same** | | | **Same + Onshore (x2)** | |
| 1 Detailed Design Engineering Phase | $ 90 | $ / m-hr | 4,800 | m-hrs | $ 432,000 | 6 months of detailed design engineering. 4 persons x 200 m-hours per person per month. | | | | | | |
| 2 Engineering Support Through Construction | $ 90 | $ / m-hr | 6,400 | m-hrs | $ 576,000 | 16 months construction engineering. 2 persons in the home office at 200 m-hours per month per person. | | | | | | |
| **Detailed Engineering Design** | | | | | **$ 1,008,000** | | | | **$ 1,008,000** | | | **$ 2,016,000** |
| **3.3 Construction Management** | | | | | | | | **Same** | | | **Same + Onshore (x2)** | |
| 1 Project Management support services for the period permit approval through project completion in 4th quarter 2010 | $ 90 | $ / m-hr | 6,400 | m-hrs | $ 576,000 | 1 person full-time for 40 months to assist Broadwater after permit approval and to administer construction contracting and planning. 160 man hours per month | | | | | | |
| 2 Project and Construction Management | $ 90 | $ / m-hr | 23,100 | m-hrs | $ 2,079,000 | 22 months installation management. 3 persons in the field office x 350 m-hours per person per month | | | | | | |

BROADWATER

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BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 1: FSRU TO TRANSCO PIPELINE**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 2: FSRU TO IROQUOIS INTERCONNECT**

| No. | Item | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt. 1 Unit Cost | Alt. 1 Qty | Alt. 1 Cost | Alt. 2 Unit Cost | Alt. 2 Qty | Alt. 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Administrative support and additional project assistance during construction phase and reporting | $ 60 | $ / m-hr | 7,680 | m-hrs | $ 460,800 | 6 months for two persons @ 160 hours per month per person. | | | | | | |
| 4 | Procurement support | $ 90 | $ / m-hr | 2,500 | m-hrs | $ 225,000 | 1 person for 10 month procurement phase 250 m/hours x 100% utilization | | | | | | |
| 5 | DOT Documentation, Development, and Submission | $ 90 | $ / m-hr | 640 | m-hrs | $ 57,600 | 2 persons for 2 months @ 160 hours per month per person. | | | | | | |
| 6 | Travel and Expenses | $ 40,000 | each | 1 | unit | $ 40,000 | | | | | | | |
| | **Construction Management Subtotal** | | | | | **$ 3,438,400** | | | | **$ 3,438,400** | | | **$ 6,876,800** |
| **3.4** | **Inspection** | | | | | | | | | | | | |
| 1 | Pipe Fabrication Inspection | $ 750 | $ / m-day | 80 | man-days | $ 60,000 | 2 persons for 40 days. | $ 750 | 80 | $ 60,000 | $ 750 | 80 | $ 60,000 |
| 2 | Component Manufacturing Inspection | $ 750 | $ / m-day | 45 | man-days | $ 33,750 | 1 person for 180 days at 25% utilization | $ 750 | 90 | $ 67,500 | $ 750 | 90 | $ 67,500 |
| 3 | Pipe FBE and CWC Coating Inspection | $ 750 | $ / m-day | 160 | man-days | $ 120,000 | 2 persons for 80 days. | $ 750 | 125 | $ 93,750 | $ 750 | 225 | $ 168,750 |
| 4 | Fabrication Inspection | $ 750 | $ / m-day | 180 | man-days | $ 135,000 | 2 persons for 90 days. | $ 750 | 180 | $ 135,000 | $ 750 | 180 | $ 135,000 |
| 5 | Pipelay Inspection | $ 750 | $ / m-day | 496 | man-days | $ 372,000 | 8 persons for pipelay duration plus 20 days | $ 750 | 416 | $ 312,000 | $ 750 | 680 | $ 510,000 |
| 6 | Pipeline Lowering Inspection | $ 750 | $ / m-day | 102 | man-days | $ 76,500 | 2 persons for pipelay lowering operations plus 10 days | $ 750 | 259 | $ 194,212 | $ 750 | 509 | $ 381,493 |
| | Onshore/Barrier Islands Inspection | $ 850 | $ / m-day | | | | 6 persons plus 10 days + HDD inspectors | | | | $ 850 | 930 | $ 790,500 |
| 7 | Survey Vessel Inspection | $ 750 | $ / m-day | 364 | man-days | $ 273,000 | 2 persons for survey vessel operations plus 10 days | $ 750 | 586 | $ 439,500 | $ 750 | 724 | $ 543,000 |
| 8 | Dive Vessel Inspection | $ 750 | $ / m-day | 388 | man-days | $ 291,000 | 2 persons for diving operations plus 20 days. Considers all Dive Vessel Operations and Tie-Ins, including: IGTS Hot-Tap Installation, Prelay Diving Operations, Hot-Tap Connection Spool, IGTS Pipeline Tie-in Spool, Crossing Completion, Additional Construction Requirements, Filling Gauging, Treating, Cleaning, and Hydrotesting, Check and Isolation Valve, IGTS Pipeline Tie-i Spool, FSRU Tie-in Spool, and Dewatering and Drying. | $ 750 | 466 | $ 349,500 | $ 750 | 418 | $ 313,500 |
| 9 | Inspector Travel Expenses | $ 500 | each | 61 | man-month | $ 30,250 | One $500 ticket per man-month | $ 500 | 73 | $ 36,699 | $ 500 | 128 | $ 63,928 |
| 10 | Personnel per diem | $ 150 | per day | 1,217 | days | $ 182,550 | Does not include per diem for pipelay and pipe lowering inspectors. | $ 150 | 1,527 | $ 229,050 | $ 150 | 2,647 | $ 397,050 |
| | **Inspection Subtotal** | | | | | **$ 1,574,050** | | | | **$ 1,917,211** | | | **$ 3,430,721** |
| | **ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT (CONTRACT) TOTAL** | | | | | **$ 6,340,000** | | | | **$ 6,680,000** | | | **$ 12,640,000** |
| **4.0** | **TAXES** | | | | | | | | | | | | |
| **4.1** | **Sales Tax** | | | | | | | | | | | | |
| 1 | Materials | | Sum mat'l costs | $ 26,760,000 | 8% | $ 2,140,800 | Calculation from TCPL Calgary. Based on previous work from Richard Johnson - property tax dept | $ 17,310,000 | 8% | $ 1,384,800 | $ 46,070,000 | 8% | $ 3,685,600 |
| 2 | Sub-Contractors (8% of 20% of cost) | | Sum subcont costs | | % | $ - | | | | | | | |
| | **Sales Tax Subtotal** | | | | | **$ 2,140,800** | | | | **$ 1,384,800** | | | **$ 3,685,600** |
| | **TAXES TOTAL** | | | | | **$ 2,150,000** | | | | **$ 1,390,000** | | | **$ 3,690,000** |
| | **CAPEX ESTIMATE TOTAL** | | | | | **$ 94,050,000** | Sum of line items 1 through 4 per Broadwater request | | | **$ 114,370,000** | | | **$ 253,949,500** |
| **5.0** | **OTHER DIRECT COSTS** | | | | | | | | | | | | |
| **5.1** | **Right-of-Way** | | | | | | | | | | | | |
| 1 | Offshore Easement NY State | $85,219 | per mile | 22 | miles | $ 1,849,257 | New York currently charges $ 16. 14 per linear foot ($85,219 per mile) for easements for underwater gas pipelines. The one-time fee is (1) for an easement 30 feet wide, (2) paid at the time of application and (3) good for 25 years. Provided by Stephen Marr of Broadwater | $85,219 | 14 | $1,182,076 | $85,219 | 23 | $1,933,879 |
| 2 | Onshore Temporary Workspace | | per acre | 0 | acres | $ - | no land base operation included in estimate | | | | $ 5,000 | 16 | $ 80,000 |
| 3 | Onshore Fee Lands | | per acre | 0 | acres | $ - | no land base operation included in estimate | | | | $ 500 | 4827 | $ 2,413,500 |
| 4 | Fisheries Compensation | | per mile impacted | 0 | miles | $ - | unknown at this time | | | | | | |
| | **Right-of-Way Subtotal** | | | | | **$ 1,849,257** | | | | **$1,182,076** | | | |
| 5 | ROW Acquisition Services | | | | | | | | | | $ 30 | 79650 | $ 2,389,500 |
| 6 | Wareyard, staging areas | | | | | | | | | | $ 6,000 | 13 | $ 78,000 |
| 7 | Access Roads | | | | | | | | | | $ 3 | 35000 | $ 105,000 |
| 8 | Mainline Valve Sites | | | | | | | | | | $ 10,000 | 5 | $ 50,000 |
| 9 | HDD setup and staging sites | | | | | | | | | | $ 15,000 | 15 | $ 225,000 |
| 10 | Dump Sites | | | | | | | | | | $ 5,000 | 14 | $ 70,000 |
| 11 | Meter Station site | | | | | | | | | | $ 10,000 | 1 | $ 10,000 |
| | | | | | | | | | | | | | **$ 7,354,879** |
| **5.2** | **Line Pack** | | | | | | | | | | | | |
| 1 | Line Pack | $7 | per Mcf | 41,000 | Mcf | $ 287,000 | Volume calculations per TCPL Calgary Cost Est. Program. See line pack calculation tab | | | $ 178,279 | | | $ 505,007 |
| | **Line Pack Subtotal** | | | | | **$ 287,000** | | | | **$ 178,279** | | | **$ 505,007** |
| | **OTHER DIRECT COSTS TOTAL** | | | | | **$ 2,140,000** | | | | **$ 1,370,000** | | | **$ 7,860,000** |
| | **TOTAL DIRECTS (1 thru 5):** | | | | | **$ 96,190,000** | | | | **$ 115,740,000** | | | **$ 261,810,000** |
| **6.0** | **INDIRECT COSTS** | | | | | | | | | | | | |
| **6.1** | **Contingency** | | | | | | | | | | | | |
| 1 | Allowance for Indeterminates | | ALL | $96,190,000 | 15% | $ 14,428,500 | Manny Samson and Inder Garg of TCPL Calgary recommend to use 15% at this stage of the project | $ 115,740,000 | 15% | $ 17,361,000 | $ 261,810,000 | 15% | $ 39,271,500 |
| | **Contingency Subtotal** | | | | | **$ 14,428,500** | | | | $ 17,361,000 | | | $ 39,271,500 |

BROADWATER

**REVISED PIPELINE COST ESTIMATE ±15% (P-50 Costing)**

**BASE CASE GAS ON 4Q, 2010 - ORIGINALLY PRESENTED SEPTEMBER, 2005**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 1: FSRU TO TRANSCO PIPELINE**

BROADWATER

**ALTERNATE PIPELINE COST ESTIMATE**

**ALTERNATE 2: FSRU TO IROQUOIS INTERCONNECT**

| Item | Unit Cost | Unit | Qty | Units | Cost | Assumptions | Alt. 1 Unit Cost | Alt. 1 Qty | Alt. 1 Cost | Alt. 2 Unit Cost | Alt. 2 Qty | Alt. 2 Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TOTAL | $ 14,430,000 | | | | $ 17,370,000 | | | $ 39,280,000 |
| | | | | PROJECT TOTAL | $ 110,620,000 | | | | $ 133,110,000 | | | $ 301,090,000 |
| **6.2 Financial Costs** | | | | | | TCPL Calgary estimating group advises that AFUDC, Risk Insurance, and Escalation should be added after the contingency is built in. | | | | | | |
| 1 AFUDC | | | $110,620,000 | 6.3% | $6,969,060.00 | Calculations from Manny Samson of TCPL Calgary | $ 133,110,000 | 6.30% | $ 8,385,930.00 | $ 301,090,000 | 6.30% | $ 18,968,670.00 |
| 2 Builder's Risk Insurance | | | $110,620,000 | 1.5% | $1,659,300.00 | Calculation of 1.5 % of material and installation from TCPL Calgary assumption based on historical data | $ 133,110,000 | 1.50% | $ 1,996,650.00 | $ 301,090,000 | 1.50% | $ 4,516,350.00 |
| | | | | **PROJECT GRAND TOTAL** | **$ 119,250,000** | **Based upon start up Q1,2005** | | | **$ 143,492,580.00** | | | **$ 324,575,020.00** |
| | | | | | **2005 $$$** | | | | **2005 $$$** | | | **Marine 2005 $$$**<br>**Onshore/HDD 2008 $$$** |
| **7.0 Escalation** | | | | | | | | | | | | |
| Escalation - 2% per year<br>Materials by 10% ( 4.5 years 2% per year)<br>Installation by 10% ( 4.5 years 2% per year)<br>Remainder by 5% ( 2.5 years 2% per year) | | | | | **$129,830,000** | **Based upon start up Q1/Q2 2010**<br>Comments by Manny Samson and Inder Garg of TCPL Calgary | | | **$156,400,000** | | | **$349,900,000** |
| **OPEX Costs**<br>1 Operations Cost | $ 110,620,000 | ALL | 1 | 0.75% | $ 829,650 | 0.75% of CAPEX, per TCPL estimating department. | | | | | | |
| | | | Escalated Dollars | | | | Escalated Dollars | | | Escalated Dollars | | |
| | | | $120,429,000 | | $120,429,000 | | $145,080,500 | | $145,080,500 | $324,576,500 | | $324,576,500 |
| | | | $120,429,000 | 6.3% | $7,587,027.00 | | $145,080,500 | 6.3% | $9,140,071.50 | $324,576,500 | 6.3% | $20,448,319.50 |
| | | | $120,429,000 | 1.5% | $1,806,435.00 | | $145,080,500 | 1.5% | $2,176,207.50 | $324,576,500 | 1.5% | $4,868,647.50 |
| | | | | | $129,822,462<br>Start up- Q1/Q2 2010 | As Spent | | | $156,396,779<br>Start up- Q1/Q2 2010 | | | $349,893,467<br>Start up- Q1/Q2 2010 |

# Supplemental Document IV

COASTAL FISH & WILDLIFE HABITAT RATING FORM

| | |
|---|---|
| Name of Area: | **Great South Bay-West** |
| Designated: | **March 15, 1987** |
| County: | **Suffolk** |
| Town(s): | **Babylon, Islip** |
| 7½' Quadrangle(s): | **Amityville, NY; Bay Shore West, NY; Bay Shore East, NY; West Gilgo Beach, NY** |

| **Score** | **Criterion** |
|---|---|
| **64** | Ecosystem Rarity (ER)<br>One of the largest coastal wetland ecosystems in New York State. |
| **57.8** | Species Vulnerability (SV)<br>Least tern (E), common tern (T), northern harrier (T), black rail (SC), short-eared owl (SC), and diamondback terrapin (SC). Additive division: 36 + 25/2 + 25/4 + 16/8 + 16/16 = 57/75. |
| **20.5** | Human Use (HU)<br>Commercial hard clam industry of regional significance, sportfishing of statewide significance, and waterfowl hunting of regional significance. Additive division: 16 + 9/2 = 20.5 |
| **16** | Population Level (PL)<br>This area supports some of the largest concentrations of wintering waterfowl, nesting harriers, black rails, hard clams, and estuarine fish in New York State. |
| **1.2** | Replaceability (R)<br>Irreplaceable. |

SIGNIFICANCE VALUE = [( ER + SV + HU + PL ) X R] = **190**

*****SIGNIFICANT COASTAL FISH AND WILDLIFE HABITAT*****

**PROJECT DESCRIPTION**

# GREAT SOUTH BAY - WEST

LOCATION AND DESCRIPTION OF HABITAT:

Great South Bay-West is located along the south shore of Long Island, east of South Oyster Bay, in the Towns of Babylon and Islip, Suffolk County (7.5' Quad-rangles: Amityville, N.Y.; West Gilgo Beach, N.Y.; Bay Shore West, N.Y.; and Bay Shore East, N.Y.). This approximate 32,000 acre area is generally defined by the mean high water elevation the north and south sides, by the Gilgo Cut boat channel on the west, and by the Islip-Brookhaven town line to the east. The fish and wildlife habitat is the entire western half of Great South Bay, which includes extensive areas of undeveloped salt marsh, tidal flats, dredge spoil islands, and a variety of open water areas. Water depths in this area are generally less than 6 feet below mean low water, except in Fire Island Inlet and in some dredged navigation channels. Tidal fluctuations in the bay average approximately 1.4 feet at the western end and approximately 4.1 feet at the inlet. The bay is bordered on the north by dense residential and commercial development, including extensive marina and harbor facilities.

The remainder of the area is bordered by State parklands, open water, and low density residential development on Fire Island.

FISH AND WILDLIFE VALUES:

Great South Bay-West comprises approximately one-half of the largest protected, shallow, coastal bay area in New York State. A tremendous diversity of fish wildlife species occur in this vast wetland area. Many species of migratory birds nest among the salt marshes and spoil islands in Great South Bay-West. In recent years, common terns (T) have been confirmed nesting on Elder Island, Seganus Thatch, on a marsh island north of Gilgo Beach and on the southeastern end of Captree Island. An estimated 315 breeding pairs of common terns were observed in Great South Bay-West in 1985 and 340 pairs in 1984, with the largest concentra-tions in both years located on Seganus Thatch. Least terns (E) nested on Nazeras Island (a large spoil island east of Cedar Island) in 1982 and 1983, but were absent in 1984 and 1985. Approximately 65 pairs of least terns nested there in 1983. Other bird species which nest in Great South Bay-West include Canada goose, herring gull, great black-backed gull, American oystercatcher, black skimmer, black duck, mallard, gadwall, willet, Virginia rail, clapper rail, marsh wren, sharp-tailed sparrow, and seaside sparrow. Several heronries have been located on islands within Great South Bay-West, including Gilgo Island, Sexton Island, Seganus Thatch, and an unnamed spoil island southwest of Nazeras Island. Species nesting in these areas include great egret, snowy egret, yellow-crowned night heron, black-crowned night heron, green-backed heron, little blue heron, tri-colored heron, and glossy ibis, with the largest concentrations in 1984 on the island southwest of Nazeras Island.

Several pairs of northern harrier (T) have been confirmed nesting in the northeastern end of Gilgo State Park, between Cedar Island and Oak island. This locality is one of the largest areas of unditched salt marsh on Long Island; it is the only area in New York State where black rails (SC) have been regularly found, and is the only documented breeding location for soras on Long Island. Northern harriers and short-eared owls (SC) are common winter residents of the marshes in Great South Bay-West.

The vast salt marshes, intertidal flats, and shallows in this area provide valuable feeding areas for birds throughout the year, including species nesting in the area and large concentrations of shorebirds during migration. In addition, Great South Bay-West is one of the most important waterfowl wintering areas (November - March) on Long Island, especially for brant and scaup. Mid-winter aerial surveys of waterfowl abundance for the ten year period 1975-1984 indicate average concentrations of over 2,900 birds in the bay each year), 1,400 scaup (12,000 in peak year) and 330 black ducks (900 in peak year), along with lesser numbers of Canada goose, common goldeneye, red-breasted merganser, mallard, oldsquaw, and bufflehead. Based on these surveys, it appears that Great South Bay-West supports one of the largest concentrations of wintering waterfowl in New York State. Waterfowl use of the bay during winter is influenced in part by the extent of ice cover each year. Generally, brant and geese feed in open water areas through midwinter, while later in spring (prior to migration), the birds feed extensively in the salt marshes. Concentrations of waterfowl also occur in the area during spring and fall migrations (March - April and October - November, respectively). Nearly all of Great South Bay-West is open to the public for waterfowl hunting, and the area supports regionally significant hunting pressure.

In addition to having significant bird concentrations, Great South Bay-West is an extremely productive area for marine finfish, shellfish, and other wildlife. Much of this productivity is directly attributable to the extensive salt marshes and tidal flats within the area. Great South bay-West serves as a major nursery and feeding area (April - November, generally) for bluefish, winter flounder, summer flounder, kingfish, tautog, scup, blue claw crab, and forage fish species such as Atlantic silverside, mummichog, striped killifish, northern pipefish, and sticklebacks. A total of 56 fish species were collected during an intensive survey of the bay in 1981. Fire Island Inlet is an especially significant component of the habitat; as a corridor for fish migrations, as a source for the exchange and circulation of bay waters, and as an area where feeding by many fish and wildlife species is concentrated. As a result of the abundant fisheries resources in the bay (summer flounder especially), Great South Bay-West receives heavy recreational fishing pressure, of statewide significance. Commercial baitfisheries have been established in shoal areas near Fire Island Inlet. The entire bay area is inhabited by hard clams, and the islands along the south shore support soft clams and ribbed mussels. Most of the bay waters are certified for shellfishing, resulting in a commercial and recreational harvest of statewide significance. Clam Pond, on the north shore of Fire Island, also contains a population of bay scallops which have been reintroduced to the area. Diamondback terrapin (SC) reside among the salt marsh islands in the bay, and utilize sandy areas along the south shore for egg-laying.

IMPACT ASSESSMENT:

Any activity that would substantially degrade the water quality in Great South Bay-West would adversely affect the biological productivity of this area. All species of fish and wildlife would be affected by water pollution, such as chemical contamination (including food chain effects), oil spills, excessive turbidity and waste disposal. It is essential that high water quality be maintained in the area, through control of sewage discharges from recreational boats and upland sources. Alteration of tidal patterns in Great South Bay-West, by modification of inlet configurations or other means, would have major impacts on the fish and wildlife communities present. Excavation of new navigation channels in the bay should be minimized. Dredging to maintain existing boat channels (including the inlet) should be scheduled in late summer and fall to minimize potential impacts on aquatic organisms, and to allow for spoil disposal when wildlife populations are least sensitive to disturbance. Elimination of salt marsh and intertidal areas, through excavation or filling, would result in a direct loss of valuable habitat area.

Unregulated dredge spoil disposal in this area would be detrimental, but such activities may be designed to maintain or improve the habitat for certain species of wildlife. Nesting birds inhabiting the marshes and islands of Great South Bay-West are highly vulnerable to disturbance by humans form mid-April through July. Recreational activities (e.g., boat landing, picnicking) in the vicinity of bird nesting areas should be minimized during this period, through the use of annual posting or fencing. Construction of shoreline structures, such as docks, piers, bulkheads, or revetments, in areas not previously disturbed by development (i.e., natural beach, tidal flats, or salt marsh), may result in the loss of productive areas which support the fish and wildlife resources of Great South Bay-West.

**KNOWLEDGEABLE CONTACTS:**

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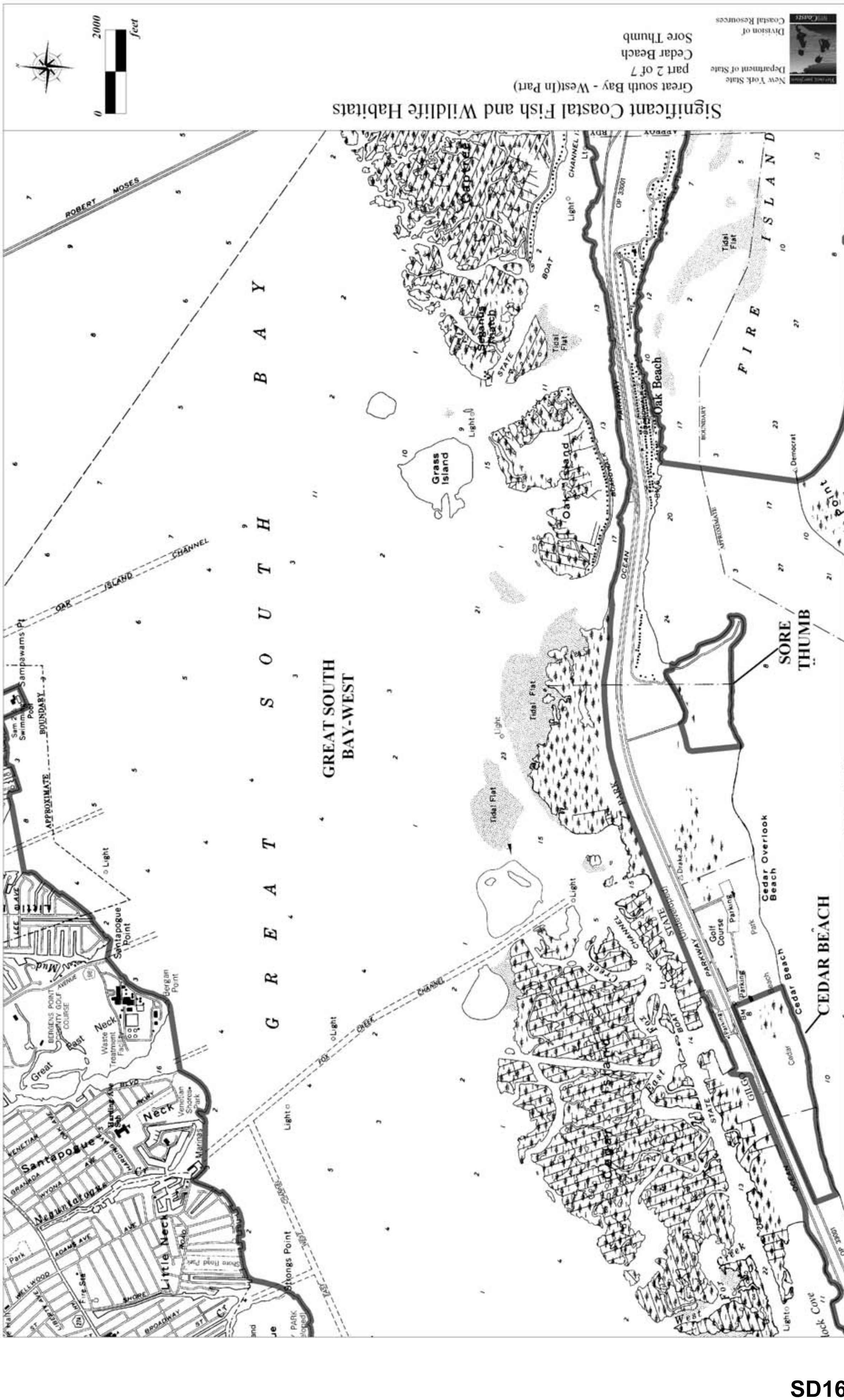
**SD165**


Significant Coastal Fish and Wildlife Habitats
Great south Bay - West(In Part)
part 2 of 7
Cedar Beach
Sore Thumb
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GREAT SOUTH BAY
GREAT SOUTH BAY-WEST
SORE THUMB
CEDAR BEACH
FIRE ISLAND
Oak Beach
Grass Island
Tidal Flat
Cedar Overlook Beach
Cedar Beach
Golf Course
Parking
Santapogue Point
Bergen Point
Sampawams Pt
Waste Treatment Facility
Venetian Shores Park
Little Neck
Democrat Point
ROBERT MOSES
OCEAN PARKWAY
APPROXIMATE BOUNDARY
OAK ISLAND CHANNEL

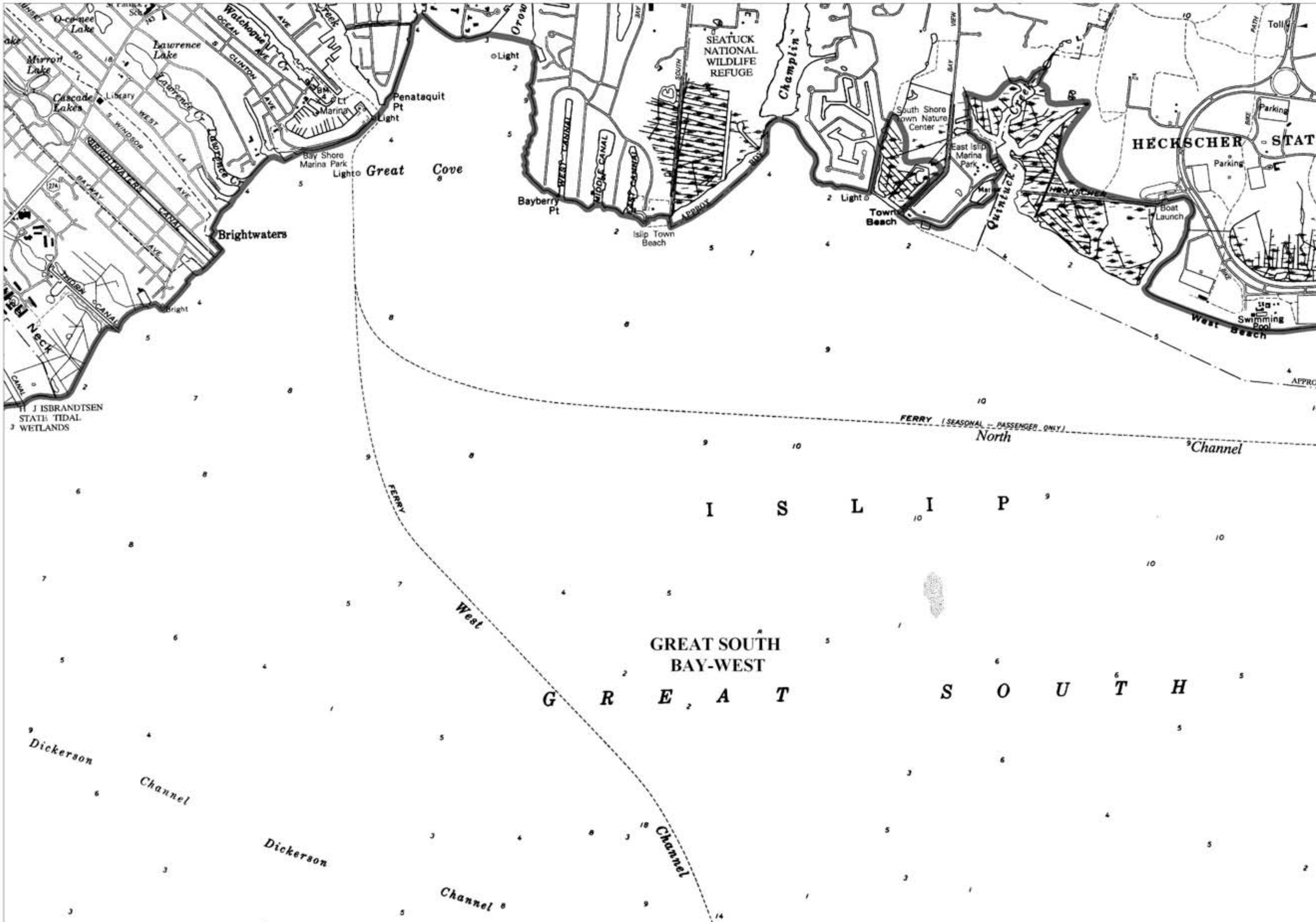

# Significant Coastal Fish and Wildlife Habitats

Great South Bay - West(In Part)

part 3 of 7

New York State Department of State

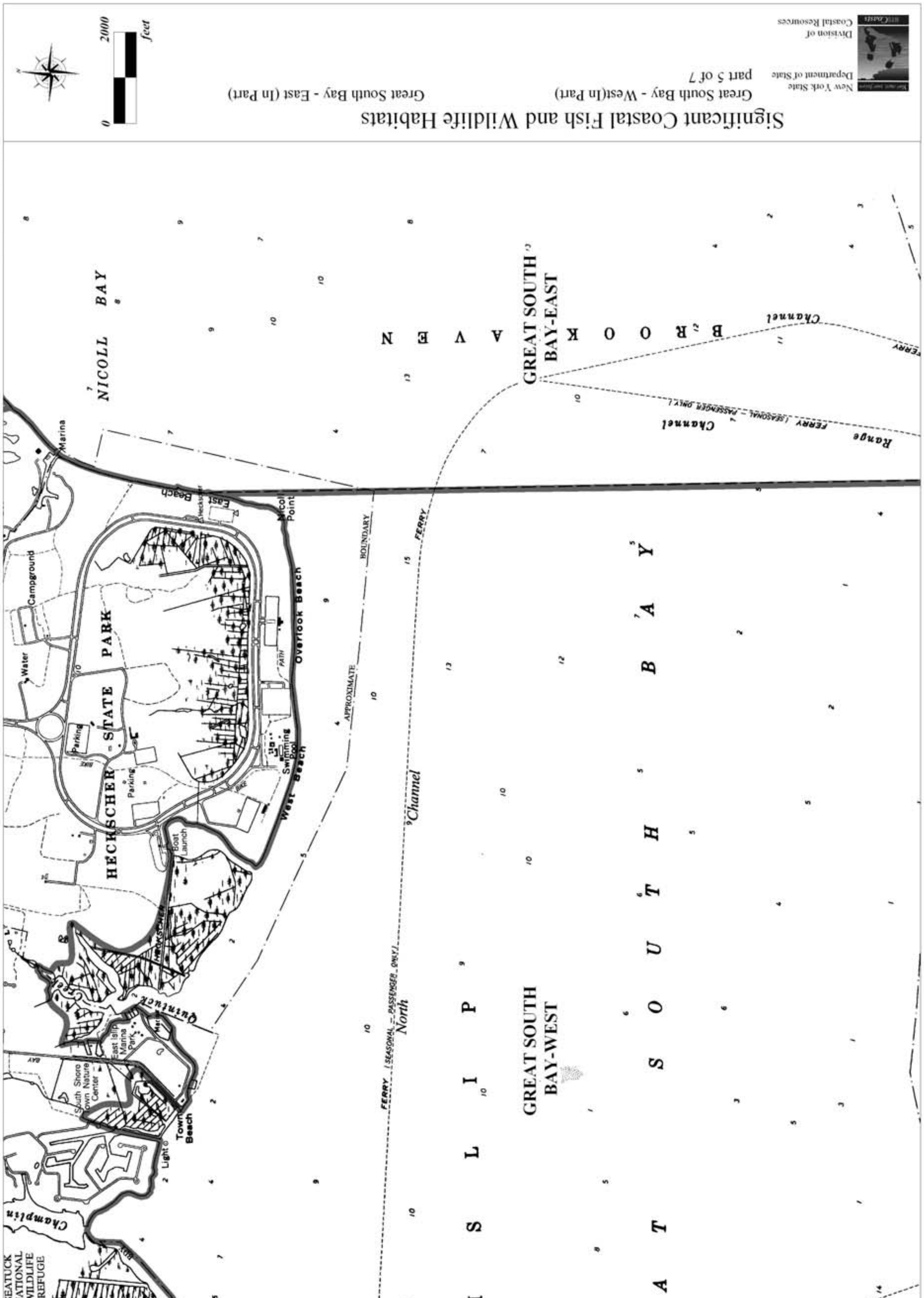
Division of Coastal Resources




# Significant Coastal Fish and Wildlife Habitats

Great South Bay - West(In Part)
part 4 of 7

New York State
Department of State
Division of
Coastal Resources



Significant Coastal Fish and Wildlife Habitats
Great South Bay - West(In Part)
Great South Bay - East (In Part)
part 5 of 7
New York State Department of State Division of Coastal Resources
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NICOLL BAY
GREAT SOUTH BAY-EAST
GREAT SOUTH BAY-WEST
B R O O K H A V E N
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HECKSCHER STATE PARK
SEATUCK NATIONAL WILDLIFE REFUGE
South Shore Town Nature Center
East Islip Marina Park
Islip Town Beach
Town Beach
Campground
Parking
Swimming Pool
Boat Launch
West Beach
Overlook Beach
East Beach
Nicoll Point
Marina
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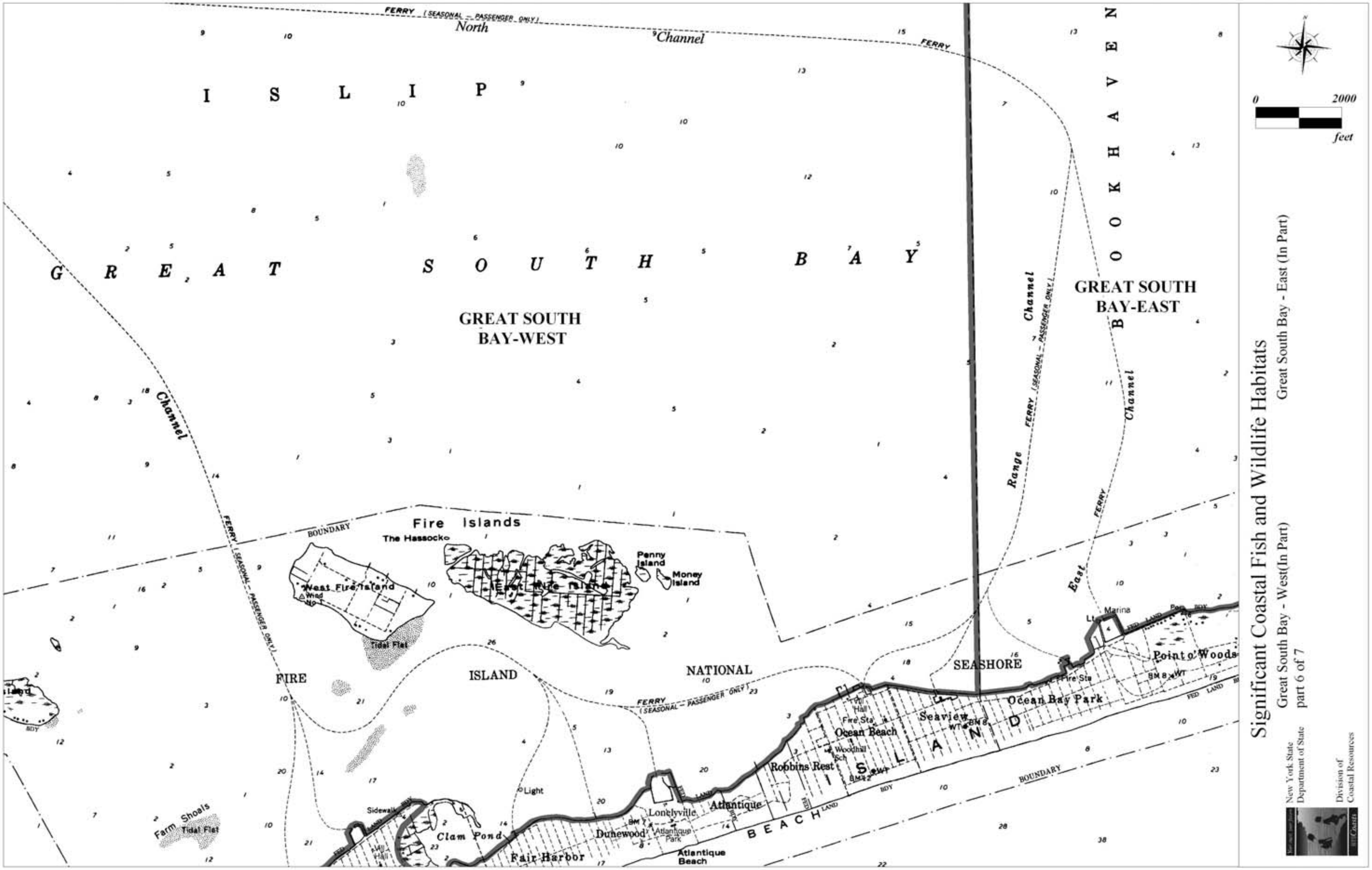
FERRY (SEASONAL - PASSENGER ONLY)
North Channel
Range Channel
Champlin
Quintuck


Significant Coastal Fish and Wildlife Habitats
Great South Bay - West(In Part)
Great South Bay - East (In Part)
part 6 of 7
New York State
Department of State
Division of
Coastal Resources
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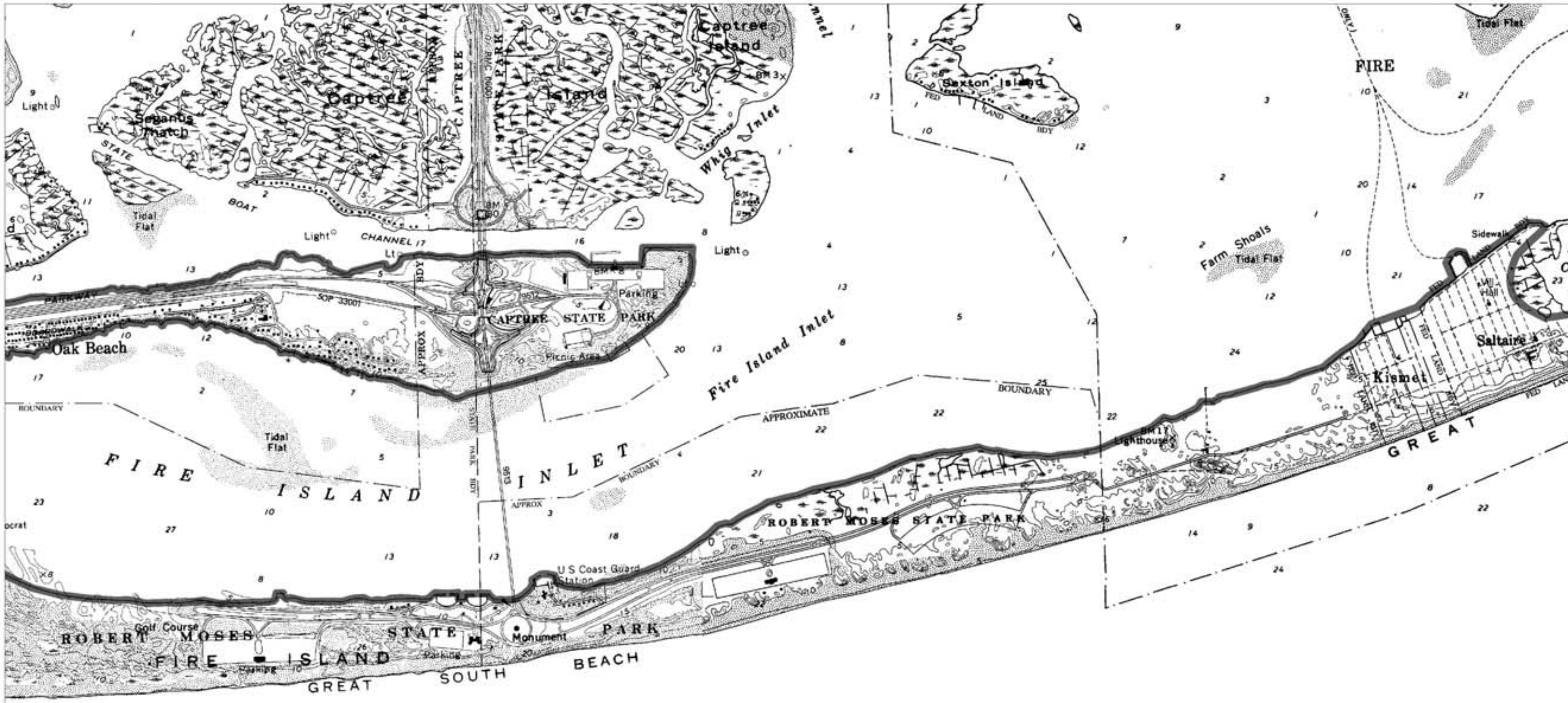
GREAT SOUTH BAY
ISLIP
BROOKHAVEN
GREAT SOUTH BAY-WEST
GREAT SOUTH BAY-EAST
North Channel
FERRY (SEASONAL – PASSENGER ONLY)
East Channel
Range Channel
Channel
Fire Islands
The Hassock
West Fire Island
East Fire Island
Penny Island
Money Island
Tidal Flat
Farm Shoals
FIRE ISLAND NATIONAL SEASHORE
FIRE ISLAND BEACH
BOUNDARY
Point o' Woods
Ocean Bay Park
Seaview
Ocean Beach
Robbins Rest
Atlantique
Lonelyville
Dunewood
Atlantique Beach
Fair Harbor
Clam Pond
Marina
Light




# Significant Coastal Fish and Wildlife Habitats

Great South Bay - West(In Part)

part 7 of 7

New York State
Department of State

Division of
Coastal Resources

**CERTIFICATE OF SERVICE**

I hereby certify that the foregoing Motion to Supplement the Decision Record was served this 7th day of July 2008, by first-class mail unless otherwise indicated, on the following persons at the addresses listed below.

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