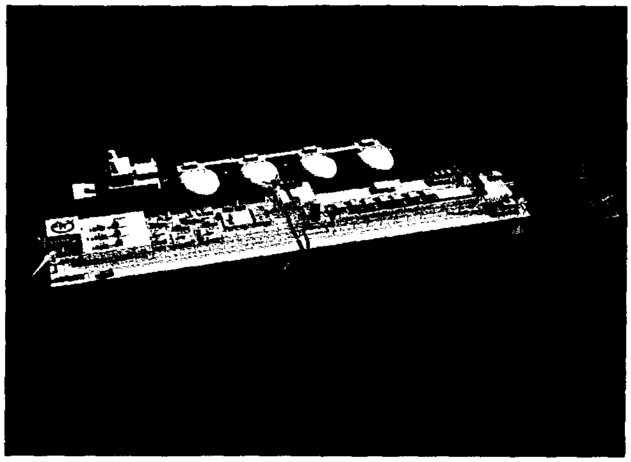
Appendix F
Biological Resources Tables



Gulf Landing Fast Facts

Item	Description	Metric Units (if applicable)
COMPANY AND OWNERSHIP		
Terminal owner	Gulf Landing LLC	
Address	1301 McKinney Suite 700	
	Houston TX 77010	
Telephone	(713) 230-3708	
TERMINAL LOCATION		
Terminal location	Offshore Louisiana	
Block	West Cameron 213	
Distance to shore	38 mi	61 km
Water depth	55 ft	16.8 m
STORAGE AND THROUGHPUT		
LNG net storage capacity	1,132,000 bbl	180,000 m^3
Number of tanks	2	
Average natural gas send-out rate	1 bcf/day	
Peak natural gas send-out	1.2 bcf/day	
Average LNG liquid rate	12,580 bbl/h	2,000 m^3/h
Peak LNG liquid rate	15,100 bbl/h	2,400 m^3/h
Annual LNG throughput		7.7 mtpa
SCHEDULE AND SERVICE LIFE		
Terminal service life	30 years	
Construction time (to commercial operations)	3½ years (42 months)	
Installation date	4Q 2008	
Start commercial operations	Jan 2009	
LNGCS AND MARINE		
LNGC sizes	786,000 – 1,006,000 bbl	125 – 160,000 m^3
Number of LNGCs per year	135	
Maximum LNG unloading rate (intermittent)	1,812,000 bbl/day	12,000 m^3/h
Terminal safety zone	0.31 mi	500 m
Terminal precautionary area	2 mi	3.22 km
PIPELINES		
Takeaway pipelines (send-out pressure/diameter/length)	psi/in/mi	bar/mm/km
Pipeline A	1,218/36/20.0	84/910/32.2
Pipeline B	1,145/24/13.0	79/610/20.9
Pipeline C	1,203/30/17.2	83/760/27.7
Pipeline D	1,218/16/1.7	84/410/2.7
Pipeline E	1,160/20/13.8	80/510/22.2
Meters	10 in	254 mm

Table F-1. Marine Mammals Present in the GOM

Species	Status	Occurrence	Typical Habitat			Additional Data
			Coastal	Shelf	Slope/Deep	
SUBORDER MYSTICETI (baleen whales)						
Family Balaenidae						
Northern right whale *(Eubalaena glacialis)*	E	1	--	X	X	♦ two right whales observed off New Pass, Sarasota, FL, in 1963
Family Balaenopteridae						
Blue whale *(Balaenoptera musculus)*	E	1	--	X	X	♦ two strandings between Freeport and San Luis, TX, in 1940
Bryde's whale *(Balaenoptera edeni)*	--	3	--	X	X	♦ northeastern Gulf, DeSoto Canyon to western FL ♦ near 328–ft (100-m) isobath
Fin whale *(Balaenoptera physalus)*	E	1	--	X	X	♦ three strandings, seven sightings, likely accidental occurrences
Humpback whale *(Megaptera novaeangliae)*	E	1	--	X	X	♦ various sightings, strandings, and soundings, but likely strays from Caribbean ♦ no resident population in GOM
Minke whale *(Balaenoptera acutorostrata)*	--	2	X	X	X	♦ ten confirmed strandings (most on eastern GOM beaches), no live sightings ♦ may be strays or winter migrants
Sei whale *(Balaenoptera borealis)*	E	1	--	X	X	♦ only five reliable records, four of which are strandings (3 in eastern LA and one on FL panhandle)

Table F-1. Marine Mammals Present in the GOM (continued)

Species	Status	Occurrence	Typical Habitat			Additional Data
			Coastal	Shelf	Slope/Deep	
SUBORDER ODONTOCETI (toothed whales and dolphins)						
Family Physeteridae						
Dwarf sperm whale *(Kogia simus)*	--	3	--	--	X	♦ northern GOM region ♦ shelf edge break/upper slope ♦ 328–6,562 ft (100–2,000 m)
Pygmy sperm whale *(Kogia breviceps)*	--	3	--	--	X	♦ northern GOM region ♦ nearshore and shelf edge break/upper slope 328–6,562 ft (100–2,000 m)
Sperm whale *(Physeter macrocephalus)*	E	4	--	--	X	♦ Mississippi Delta region ♦ between 328–6,562 ft (100–2,000 m) ♦ most concentrated at 3,280 ft (1,000 m)
Family Ziphiidae [3]						
Blainville's beaked whale *(Mesoplodon densirostris)*	--	2[1]	--	--	X	♦ distributed in water 3,280 ft (> 1,000 m) (unidentified ziphiids sighted in GulfCet survey)
Cuvier's beaked whale *(Ziphius cavirostris)*	--	2[1]	--	--	X	♦ distributed in water 3,280 ft (> 1,000 m) (unidentified ziphiids sighted in GulfCet survey)
Gervais' beaked whale *(Mesoplodon europaeus)*	--	3[1]	--	--	X	♦ distributed in water 3,280 ft (> 1,000 m) (unidentified ziphiids sighted in GulfCet survey)
Sowerby's beaked whale *(Mesoplodon bidens)*	--	1[1]	--	--	X	♦ one animal stranded alive in Gulf County, FL ♦ distributed in water 3,280 ft (> 1,000 m) (unidentified ziphiids sighted in GulfCet survey)

Table F-1. Marine Mammals Present in the GOM (continued)

Species	Status	Occurrence	Typical Habitat			Additional Data
			Coastal	Shelf	Slope/Deep	
Family Delphinidae						
Atlantic spotted dolphin *(Stenella frontalis)*	--	4	--	X	X	♦ 66–656 ft (20–200 m) ♦ some records out to 3,280 ft (1,000 m) ♦ concentrated around 328 ft (100 m)
Bottlenose dolphin *(Tursiops truncates)*	--	4	X	X	X	♦ coastal and oceanic populations ♦ depths less than 3,280 ft (1,000 m) ♦ most common species of coastal GOM
Clymene dolphin *(Stenella clymene)*	--	4	--	--	X	♦ central GOM ♦ > 328 ft (> 100 m)
False killer whale *(Pseudorca crassidens)*	--	3	--	--	X	♦ widely distributed throughout northern GOM ♦ 656–6,562 ft (200–2,000 m)
Fraser's dolphin *(Lagenodelphis hosei)*	--	4	--	--	X	♦ northwestern GOM ♦ water around 3,280 ft (1,000 m)
Killer whale *(Orcinus orca)*	--	3	--	--	X	♦ Mississippi Delta Region 328–6,560 ft (100–2,000 m)
Melon-headed whale *(Peponocephala electra)*	--	4	--	--	X	♦ northwestern Gulf ♦ 656–6,562 ft (200–2,000 m)
Pantropical spotted dolphin *(Stenella attenuate)*	--	4	--	--	X	♦ northern GOM ♦ 328–6,562 ft (100–2,000 m) ♦ most common cetacean in deep GOM waters
Pygmy killer whale *(Feresa attenuate)*	--	3	--	--	X	♦ strandings from FL to south TX ♦ northern GOM ♦ 1,640-3,280 ft (500-1,000 m)
Short-finned pilot whale *(Globicephala macrorhynchus)*	--	4	--	--	X	♦ central and western (northern) GOM ♦ 200–2000 m (656–6,560 ft)
Risso's dolphin *(Grampus griseus)*	--	4	--	--	X	♦ Northern GOM ♦ 150–2,000 m (492–6,560 ft)

Table F-1. Marine Mammals Present in the GOM (continued)

Species	Status	Occurrence	Typical Habitat			Additional Data
			Coastal	Shelf	Slope/Deep	
Rough-toothed dolphin (*Steno bredanensis)*	--	4	--	--	X	♦ northern GOM ♦ south of Mississippi Delta ♦ 656–5,020 ft (200–1,530 ft)
Spinner dolphin (*Stenella longirostris)*	--	4	--	--	X	♦ southeast of Mississippi River ♦ > 328 ft (> 100 m)
Striped dolphin (*Stenella coeruleoalba)*	--	4	--	--	X	♦ northern GOM ♦ > 200 m (656 ft) ♦ rare in extreme northwest
ORDER SIRENIA (dugongs and manatees)						
Family Trichechidae						
West Indian manatee (*Trichechus manatus)*	E	1	X	--	--	♦ rare except in Florida

Source: Adapted from Würsig et al. 2000
Notes:
[1] Status: E = endangered under the Endangered Species Act of 1973
[2] Occurrence: 1 = extralimital; 2 = rare; 3 = uncommon; 4 = common
[3] Beaked whales in the GOM might be uncommon or common rather than rare or extralimital. Their population status is uncertain because they are difficult to see and identify to species. Most surveys have been conducted in sea states that are not optimal for sighting beaked whales.

Table F-2. Aquatic and Marine Birds that can Occur in the ROI

Category/Common Name	Scientific Name
Seabirds	
Bonaparte's gull[1]	*Larus philadelphia*
Herring gull[1]	*Larus argentatus*
Kelp gull[2]	*Larus dominicanus*
Laughing gull[3]	*Larus atricilla*
Lesser Black-backed gull[1]	*Larus fuscus*
Ring-billed gull[1]	*Larus delawarensis*
Long-tailed jaeger[1]	*Stercorarius longicaudus*
Parasitic jaeger[1]	*Stercorarius parasiticus*
Pomarine jaeger[5]	*Stercorarius pomarinus*
Brown noddy[5]	*Anous stolidus*
Arctic tern[5]	*Sterna paridisaea*
Bridled tern[2]	*Sterna anaethetus*
Caspian tern[2,3]	*Sterna caspia*
Common tern[5]	*Sterna hirundo*
Gull-billed tern[3]	*Sterna nilotica*
Forster's tern[3]	*Sterna forsteri*
Least tern[5]	*Sterna antillarum*
Royal tern[3]	*Sterna maxima*
Sandwich tern[2]	*Sterna sandvicensis*
Sooty tern[2]	*Sterna fuscata*
Audubon's shearwater[2]	*Puffinus iherminieri*
Cory's shearwater[2]	*Calonectris diomedea*
Greater shearwater[2]	*Puffinus gravis*
Manx shearwater[5]	*Puffinus puffinus*
Sooty shearwater[5]	*Puffinus griseus*
Band-rumped storm-petrel[2]	*Oceanodroma castro*
Leach's storm petrel[5]	*Oceanodroma leucorhoa*
Wilson's storm petrel[2]	*Oceanites oceanicus*
American white pelican	*Pelecanus erythrorhynchos*
Brown pelican[4]	*Pelecanus occidentalis*
Shorebirds	
Black-bellied plover[1]	*Pluvilais dominica*
Piping plover[1,4]	*Charadrius melodus*
Semipalmated plover[1]	*Charadrius semipalmatus*
Snowy plover[1]	*Charadrius alexandrinus*
Wilson's plover[2]	*Charadrius wilsonia*
Killdeer[3]	*Charadrius vociferus*
American oystercatcher[3]	*Haematopus palliatus*

Table F-2. Aquatic and Marine Birds that can Occur in the ROI (continued)

Category/Common Name	Scientific Name
American avocet[1]	*Recurvirostra americana*
Black-necked stilt[3]	*Himantopus mexicanus*
Least sandpiper[1]	*Calidris minutilla*
Spotted sandpiper[1]	*Actitus macularia*
Western sandpiper[1]	*Calidris mauri*
Long-billed dowitcher[1]	*Limnodromus scolopaceus*
American woodcock[1]	*Scolopax minor*
Wilson's snipe[1]	*Gallinago gallinago*
Pin-tailed snipe	*Gallinago stenura*
Willet[3]	*Catoptrophorus semipalmatus*
Greater lesser[3]	*Tringa melanoleuca*
Yellow lesser[1]	*Tringa flavipes*
Marsh and Wading Birds	
American bittern[1]	*Botaurus lentiginosus*
Least bittern[2]	*Lxobrychus exilis*
Black-crowned Night heron[3]	*Nycticorax nycitcorax*
Great Blue heron[3]	*Ardea herodias*
Green heron[3]	*Butorides virescens*
Little Blue heron[3]	*Egreatta caerulea*
Yellow-crowned Night heron[2]	*Nyctanassa violacea*
Tri-colored heron[3]	*Egretta tricolor*
Cattle egret[3]	*Bubulcus ibis*
Great egret[3]	*Ardea alba*
Reddish egret[3]	*Egretta rufescens*
Snowy egret[3]	*Egretta thula*
Anhinga	*Anhinga anhinga*
Pied-billed grebe	*Podilymbus podiceps*
Glossy ibis[3]	*Plegadis falcinellus*
White-faced ibis[3]	*Plegadis chihi*
White ibis[3]	*Eudocimus albus*
Roseate spoonbill[2,3]	*Ajaia ajaja*
King rail[3]	*Rallus elegans*
Clapper rail[3]	*Rallus longirostris*
Virginia rail[1]	*Rallus limicola*
Yellow rail[1]	*Coturnicops noveboracenis*
Purple gallinule[2]	*Porphrula martinica*
Common moorhen[3]	*Gallinula chloropus*
American coot[3]	*Fulica americana*
Sandhill crane[1,3]	*Grus canadensis*

Table F-2. Aquatic and Marine Birds that can Occur in the ROI (continued)

Category/Common Name	Scientific Name
Waterfowl	
Greater white-fronted goose[1]	*Anser albifrons*
Snow goose[1]	*Chen caerulescens*
Ross's goose[1]	*Chen rossii*
Canada goose[1]	*Branta canadensis*
American wigeon[1]	*Anas americana*
Black-bellied whistling duck[2]	*Dendrocygna autumnalis*
Blue-winged teal[3]	*Anas discors*
Bufflehead[1]	*Bucephala albeola*
Canvasback[1]	*Aythya valisinera*
Common goldeneye[1]	*Bucephala clangula*
Fulvous whistling duck[2]	*Dendrocygna bicolor*
Gadwall[1]	*Anas strepera*
Greater scaup[1]	*Aythya marila*
Green-winged teal[1]	*Anas crecca*
Hooded merganser[1]	*Lophodytes cucullatus*
Lesser scaup[1]	*Aythya affinis*
Mallard[1]	*Anas platyrhychos*
Mottled duck[3]	*Anas fulvigula*
Northern pintail[1]	*Anas acuta*
Northern shoveler[1]	*Anas clypeata*
Red-breasted merganser[1]	*Mergus serrator*
Redhead[1]	*Aythya americana*
Ring-necked duck[1]	*Aythya collaris*
Ruddy duck[1]	*Oxyura jamaicensis*
Wood duck[3]	*Aix sponsa*

Source: NGS 2002

Notes:

[1] Winter range

[2] Breeding range, generally in spring and summer

[3] Year-round range

[4] Endangered Species

[5] Seabirds cited in the GulfCet I Survey

Table F-3. EFH of Federally Managed Fish Species in the ROI

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
Brown shrimp ♦ estuaries (where common, abundant, highly abundant) ♦ offshore areas (adult, spawning, and nursery areas) to depths of 110 m (361 ft), throughout the GOM	♦ demersal ♦ peak in fall and spring ♦ distribution similar to spawning adults ♦ hatch within 24 hours of spawning	♦ larvae – offshore ♦ post-larvae – estuaries from Apalachicola Bay, FL to Mexican border	♦ estuaries from Apalachicola Bay, FL to Mexican border ♦ shallow vegetated habitats ♦ silty, non-vegetated mud bottoms ♦ 0 – 70 ppt, marsh edge ♦ SAV, tidal creeks, inner marsh, shallow open water, oyster reefs	♦ abundance correlates positively with turbidity and negatively with hypoxia ♦ neritic GOM waters ♦ silt, muddy sand, sand substrates ♦ to depths of 110 m	♦ peak in fall and spring ♦ waters deeper than 64 m (210 ft)	♦ eggs ♦ larvae ♦ sub-adults ♦ adults
White shrimp ♦ estuaries (where common, abundant, highly abundant) ♦ offshore areas (adult, spawning, and nursery areas) to depths of 40 m (131 ft), in the coastal area extending from Florida's Big Bend area through Texas	♦ demersal ♦ spring to late fall ♦ distribution similar to spawning adults ♦ hatch 10 – 12 hours after spawning	♦ larvae – planktonic, nearshore ♦ post-larvae – upper 2 m (7 ft) of water column to mid-water depths ♦ benthic in estuaries ♦ shallow water, muddy sand bottom, ♦ estuaries from Suwanee River, FL to TX	♦ post-larvae-juvenile – muddy peat bottoms, decaying organic vegetative material ♦ juvenile – low salinity waters, tidal creeks estuaries ♦ move to coastal waters as approach maturity	♦ nearshore GOM waters to depths of 30 m (98 ft), Big Bend, FL to TX ♦ soft mud or silt	♦ spring to late fall, peak in summer ♦ waters 9 – 34 m (30 – 112 ft), mostly less than 27 m (89 ft)	♦ eggs ♦ larvae ♦ sub-adults ♦ adults
Red drum ♦ estuaries (where common, abundant, highly abundant – nearly all estuaries of GOM) ♦ offshore areas (adult, spawning, and nursery areas) ♦ shallow estuarine waters to depths of 40 m (131 ft)	♦ GOM	♦ estuaries	♦ reach maturity in estuaries	♦ some estuarine waters, mostly offshore	♦ deeper waters, mouths of bays, inlets and GOM side of barrier islands	♦ eggs ♦ larvae ♦ sub-adults ♦ adults

Table F-3. EFH of Federally Managed Fish Species in the ROI (continued)

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
RED SNAPPER ♦ demersal, sandy and rocky bottoms, around reefs and underwater objects ♦ 0 – 200 m (0 – 656 ft) and >1,200 m (3,936 ft) ♦ throughout GOM shelf ♦ abundant on Campeche Banks, in northern GOM ♦ particularly abundant on Campeche Banks in the northern GOM ♦ depths of 0 – 656ft (0 – 200m), and possibly beyond 3,917 ft (1200 m)	♦ offshore, summer and fall	♦ larvae, post-larvae, and early juveniles – shelf waters to depths 17 – 183 m (56 – 600 ft) ♦ through Nov in shelf waters ♦ depts. Of 56 – 600 ft (17 – 183 m)	♦ structure, objects or small burrows, barren sand and mud, late ♦ through Nov in shelf waters ♦ depths of 56 – 600 ft (17 – 183 m) ♦ associated with structures, objects or small burrows ♦ also found over barren sand and mud bottom ♦ late juveniles taken year round in depths 66 – 151 ft (20 – 46 m)	♦ favor deeper waters in Gulf ♦ concentrated off Yucatan, Texas, and Louisiana ♦ depths of 23 – 479 ft (7 – 146 m) ♦ most are abundant at depths of 131 – 361 ft (40 – 110 m) ♦ commonly occur over submarine gullies and depressions, and over coral reefs, rock outcroppings, and gravel bottoms	♦ offshore from May to Oct ♦ 17 – 183 m (560 – 600 ft) ♦ depths 59 – 121 ft (18 – 37 m)	♦ all life stages
GRAY SNAPPER ♦ shelf waters of GOM ♦ abundant off south and southwest Florida ♦ all estuaries in GOM ♦ most common in Florida inshore waters out to depths of 180 m (590 ft)	♦ pelagic, June through September ♦ offshore shelf waters ♦ near coral reefs	♦ planktonic ♦ peak – June through August ♦ offshore shelf waters ♦ near coral reefs ♦ FL through TX ♦ post-larvae – move into estuarine habitat, over dense seagrass beds, *Halodule* and *Syringodium*	♦ marine, estuarine, riverine habitats, including channels, bayous, ponds, grassbeds, marshes, mangrove swamps, freshwater creeks, *Thallassia* grass flats, marl bottoms, seagrass meadows, and mangrove roots	♦ demersal and mid-waters, marine, estuarine, and riverine habitat ♦ offshore to 32 km (17 NM) ♦ inshore to coastal plain and freshwater habitat, mangroves, sandy grassbeds, coral reefs, over muddy and rocky bottoms	♦ offshore around reefs and shoals, June to August	♦ eggs ♦ larvae ♦ adults

Table F-3. EFH of Federally Managed Fish Species in the ROI (continued)

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
LANE SNAPPER ♦ throughout shelf areas of GOM ♦ depths 0 – 130 m (0 – 426 ft) ♦ demersal ♦ occurs over all bottom types ♦ most common in reef areas and sandy bottoms	♦ present after spawning ♦ March through September with peak in July and August	♦ no data	♦ mangrove and grassy estuarine areas ♦ southern TX and FL ♦ shallow areas with sandy and muddy bottoms off all GOM states ♦ grass flats, reefs and soft bottom areas ♦ to depths of 20m (66 ft)	♦ offshore ♦ depths of 4 – 132 m (13 – 433 ft) ♦ sand bottom ♦ natural channels, banks, man-made reefs, and structures	♦ offshore waters, March – September (peak July – August)	♦ eggs ♦ juveniles ♦ adults
GREATER AMBERJACK ♦ throughout GOM coast to depths of 400 m (1312 ft)	♦ open Gulf ♦ 30 – 35 ppt	♦ assumed offshore open waters	♦ pelagic ♦ attracted to floating plants and debris ♦ offshore	♦ pelagic, epibenthic ♦ occurs over reefs and wrecks and around buoys	♦ northern GOM from May to July (may be as early as April) ♦ offshore – year round	♦ all life stages
LESSER AMBERJACK	♦ no data	♦ no data	♦ offshore, later summer and fall in northern GOM ♦ associated with oil and gas rigs and irregular bottom	♦ no data	♦ offshore, September – December, and February through March ♦ associated with oil and gas structures and irregular bottom	♦ all life stages

Table F-3. EFH of Federally Managed Fish Species in the ROI (continued)

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
GRAY TRIGGERFISH	♦ late spring, nests in sand near natural and artificial reefs, guarded by male or female	♦ larvae and post-larvae – pelagic ♦ upper water column	♦ associated with *Sargassum* and other flotsam ♦ may be found in mangrove estuaries	♦ offshore, waters greater than 10 m (33 ft) ♦ associated with artificial and natural reefs	♦ late spring and summer, waters greater than 10 m ♦ associated with artificial and natural reefs	♦ all life stages
KING MACKEREL ♦ shore to 200 m (65 ft) depths ♦ marine pelagic waters	♦ surface waters, pelagic ♦ 30 – 180 m (98 – 590 ft)	♦ water column ♦ marine waters throughout range	♦ use estuaries occasionally	♦ migrate to northern Gulf in spring ♦ migrate to eastern and western Gulf in fall ♦ oceanic waters <80 m (262 ft)	♦ throughout range, May to October	♦ eggs ♦ larvae ♦ juveniles ♦ adults
SPANISH MACKEREL ♦ pelagic to depths of 75 m (246 ft) ♦ throughout coastal zone of GOM	♦ surface waters	♦ water column ♦ estuaries and coastal waters, year round ♦ most frequent offshore over intercontinental shelf waters ♦ water depths 9 to 84 m (30 – 276 ft) ♦ most common less than 50m (164 ft)	♦ offshore, in beach surf ♦ occasionally in estuaries over clean sand	♦ neritic waters ♦ along coastal areas ♦ rare in estuaries, but in higher salinity estuarine areas during seasonal migrations	♦ offshore, May to October	♦ all life stages

Table F-3. EFH of Federally Managed Fish Species in the ROI (continued)

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
COBIA ♦ throughout coastal waters of GOM ♦ pelagic and epibenthic ♦ near wrecks, reefs, pilings, buoys, and floating objects ♦ occasionally enter estuaries ♦ shore to 20 m (66 ft) in eastern GOM ♦ shore to 40 m (131 ft) in northern GOM ♦ shore to 100 m (328 ft) in southern GOM	♦ surface waters ♦ pelagic, top meter of water column	♦ water column, May – September ♦ estuarine and offshore shelf waters of the northern GOM ♦ from the surface to depths of 300m	♦ April to July in coastal waters and the offshore shelf in the northern GOM ♦ May – October in coastal waters and the offshore shelf ♦ same as adult areas ♦ includes coastal areas, bays and river mouths	♦ year round, throughout GOM ♦ seasonal migrations ♦ March – October in northern GOM ♦ November – March in southern GOM	♦ spring, summer, in northern GOM throughout all adult areas, except estuaries ♦ April – September in nearshore and shelf waters	♦ all life stages
DOLPHIN ♦ throughout GOM, oceanic waters ♦ occasionally coastal waters with ocean strength salinity ♦ coastal waters of northern GOM during summer months ♦ epipelagic, aggregates below floating objects, especially *Sargassum*	♦ surface waters	♦ water column ♦ over depths of greater than 50 m (164 ft) ♦ most abundant over 180 m (590 ft) ♦ nursery areas year round in oceanic and coastal waters with high salinity	♦ inshore and offshore ♦ associated with *Sargassum* communities	♦ over depths out to 1,800 m (5,904 ft) ♦ most common over the 40 – 200 m (131 – 656 ft) depth contour	♦ throughout adult areas of open GOM, year round ♦ peaks in spring and early fall	♦ all life stages7
BLUEFISH ♦ pelagic species, in many GOM estuaries ♦ on the outer continental shelf, to depths of 200m (656 ft) ♦ most common along coasts of LA, MS, AL, FL	♦ surface waters	♦ water column ♦ inshore along beaches ♦ estuaries, inlets, and rivers	♦ inshore and offshore waters	♦ move north in spring and summer ♦ move south in fall and winter ♦ shallow waters up to 100 m (328 ft)	♦ generally along outer half of continental shelf ♦ April to November in northern GOM	♦ eggs ♦ adults

Table F-3. EFH of Federally Managed Fish Species in the ROI (continued)

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
LITTLE TUNNY ♦ distributed throughout the GOM ♦ usually depths less than 200 – 1,000 m (656 – 3,280 ft) ♦ pelagic ♦ most common in coastal areas with swift currents near shoals	♦ surface waters	♦ water column ♦ nursery areas – most coastal pelagic waters	♦ no data	♦ no data	♦ throughout species range, March through November	♦ all life stages
ATLANTIC BLUEFIN TUNA	♦ all waters from offshore Cape Canaveral at 28.25° N south around peninsular Florida to the U.S./Mexico border ♦ from 15 miles from shore to the EEZ boundary	♦ all waters from offshore Cape Canaveral at 28.25° N south around peninsular Florida to the U.S./Mexico border ♦ from 15 miles from shore to the EEZ boundary	♦ in the Florida Straits, from 27° N south around peninsular Florida to 81° W ♦ surface waters from the 200 m (656 ft) isobath to the EEZ boundary	♦ from offshore Terrebonne Parish, LA (90° W) to offshore Galveston, TX (95° W) ♦ from the 200 m (656 ft) isobath to the EEZ boundary	♦ all waters from offshore Cape Canaveral at 28.25° N south around peninsular Florida to the U.S./Mexico border ♦ from 15 miles from shore to the EEZ boundary	♦ eggs ♦ larvae ♦ spawning adults

Table F-3. EFH of Federally Managed Fish Species in the ROI (continued)

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
BONNETHEAD SHARK	♦ not applicable	♦ not applicable	neonate/early juveniles: ♦ in shallow waters on the Gulf side of the Florida Keys as far north as Cape Sable ♦ waters < 25 m (82 ft) ♦ shallow coastal bays and estuaries < 5m (16 ft), from Apalachee Bay to St. Andrews Bay, FL late juveniles/sub-adults: ♦ shallow coastal waters, inlets and estuaries from Miami around peninsular Florida as far north as Cedar Key in ♦ waters <25 m (82 ft) ♦ shallow coastal waters ♦ inlets and estuaries from the Mississippi River westward to the Rio Grande River (Texas/Mexico border)	♦ shallow waters around the Florida Keys ♦ shallow coastal waters from Mobile Bay, AL west to South Padre Island, TX ♦ 0 – 25 m (0 – 82 ft)	♦ no data	♦ juveniles ♦ adult

Table F-3. EFH of Federally Managed Fish Species in the ROI (continued)

Species and General EFH Description	Habitat Associations by Life Stage					EFH Life Stage Occurrence in the ROI
	Eggs	Larvae	Juvenile	Adults	Spawning Adults	
ATLANTIC SHARPNOSE SHARK	♦ not applicable	♦ not applicable	neonate/early juvenile: ♦ coastal areas including bays and estuaries ♦ out to the 25 m (82 ft) isobath ♦ Galveston Island south to the Rio Grande late juveniles/sub-adults: ♦ shallow coastal areas including bays and estuaries ♦ out to the 25 m (82 ft) isobath from Galveston Island south to the Rio Grande (Texas/Mexico border) ♦ off Louisiana from the Atchafalya River to Mississippi River Delta out to the 40 m (131 ft) isobath	♦ offshore St. Augustine, FL to Cape Canaveral, FL ♦ 0 – 100 m (0 – 328 ft) ♦ Mississippi Sound from Perdido Key to the Mississippi River Delta to the 50 m (164 ft) isobath ♦ coastal waters from Galveston to Laguna Madre, TX to the 50 m (164 ft) isobath	♦ no data	♦ juveniles

Source: GMFMC 1998 and NMFS 1999

Table F-4. Temperature Ranges and Associations of Fish and Shrimp Species with EFH in the ROI

Lifestage	Temperature Association
	SHRIMP SPECIES
Brown Shrimp	
Non-spawning adults (females > 140 mm total length [TL])	Survival is good between 50 – 98.6 °F in ponds; natural variability in temperature is less. Collected as low as 36 °F and as high as 90 °F; few collected below 50 °F; highest catches above 68 °F; temperatures 40 °F or below may cause narcosis and mortality (Lassuy 1983).
Spawning adults	No data.
Fertilized eggs (0.26 mm diameter)	Eggs do not hatch below 75.2 °F.
Larvae and presettlement post-larvae; developmental stages include 5 nauplier, 3 protozoel, 3 mysis, and post-larval (< 14 mm) stage	Optimal temperature for larval development between 82.4 – 86.0 °F; no growth below 61 °F.
Late post-larvae and juveniles (after settlement; 14 - 80 mm)	Survival is good between 44.6 – 95.0 °F, this temperature tolerance decreases at low salinities; growth increases up about 86.0 °F; post-larval burrow at low temperatures; catastrophic kills have occurred after cold fronts in shallow water; rapid change in temperature from 79 °F to 70 °F become inactive, convulsed, and develop muscular paralysis (Lassuy 1983).
Sub-adults	Cold fronts with air temperatures between 64.4 – 71.6 °F have been documented to cause mass mortality.
White Shrimp	
Non-spawning adults (females ≥ 165 mm TL; males ≥ 119 mm TL)	Tolerant of temperatures between 44.6 – 95.0 °F; 50% mortality at 46.4 °F; 100 mortality at or below 37.4 °F; more tolerant of high temperatures, less tolerant of low.
Spawning adults	Sudden temperature increases trigger spawning and rapid deceases in temperature associated with end of spawning.
Fertilized eggs (0.28 and 0.192 – 0.3 mm diameter)	No data.
Larvae and pre-settlement post-larvae; developmental stages include 5 nauplier, 3 protozoel, 3 mysis, and post-larval (<8 mm) stage (0.3 – 8 mm) (Muncy 1984)	*Penaeus* nauplier stages occurred in offshore waters 62.6 – 83.3 °F.
Late post-larvae and juveniles (after settlement; 8 – 90 mm)	Post larvae collected 55.4 – 87.8 °F; juveniles collected between 48.2 – 91.4 °F, and most abundant 59.0 – 91.4 °F. In laboratory juveniles grow and survive at constant 95 °F; catastrophic kills have occurred in shallow water after cold fronts.
Sub-adults	Cold fronts can cause mass mortality in South Carolina, survival requires minimum temperature of >42.8 °F.

Table F-4. Temperature Ranges and Associations of Fish and Shrimp Species with EFH in the ROI (continued)

Lifestage	Temperature Association
	FISH SPECIES
Red Drum	
Eggs (0.80 – 0.98 mm)	68.0 – 86.0 °F; 77.0 °F optimal.
Larvae (4 – 6 mm)	77.0 °F optimal; 64.9 – 87.8 °F.
Post-larvae (7 mm)	77.0 °F optimal; up to 86 °F; 64.9 – 87.8 °F.
Early juvenile	54.5 – 90 °F; can survive from 36 – 91°F if change in temperature is gradual; prefer 50 – 86 °F.
Juvenile (15 – 300 mm)	Temperatures within the upper 10 – 13 m range from 80.6 – 84.2 °F in August and September; 75.2 – 78.8 °F in October; 71.6 – 73.4 °F in early November; prefer 50 – 86 °F. Upper 33 – 43ft range from 81 – 84°F in August through October 75 – 79°F and in early November 72 – 73°F
Adult (305 – 750 mm)	Observed in 35.6 – 91.4 °F. Moves into deep water when extreme temperatures occur.
Spawning adults	Occurs from 68.0 – 86.0 °F; may continue spawning for 90 days or more.
Red Grouper	
Eggs	Hatch in 30h at 75.2 °F
Larvae	Optimum report at 81.3 – 83.8 °F
Early juveniles (benthic)	60.9 – 88.2 °F
Adults	59 – 86 °F; most common at 66 – 77 °F
Early Juveniles	54.5 – 90 °F; 35.6 – 91.4 °F if change in temperature is gradual; 35.6 – 94.8 °F; prefer 50.0 – 86 °F.
Late Juveniles	Temperatures within the upper 10 – 13 m range from 80.6 – 84.2 °F in August and September; 75.2 – 78.8 °F in October; 71.6 – 73.4 °F in early November; prefer 50 – 86 °F.
Adults	Observed in 35.6 – 91.4 °F. Moves into deep water when extreme temperatures occur.
Spawning Adults	Occurs from 68.0 – 86.0 °F; may continue spawning for 90 days or more.
Red Snapper	
Eggs (0.77 – 0.85 mm)	No data.
Larvae (2.2 mm)	Taken at temperatures ranging from 63.1 – 85.5 °F.
Post-larvae	Taken at temperatures ranging from 63.1 – 85.5 °F.
Early juveniles (4 mm)	Taken at temperatures ranging from 63.1 – 85.5 °F.
Late juveniles (22 mm)	No data.
Adults	Taken from area with bottom temperatures ranging from 57.2 – 86.0 °F. Lower tolerance level 55 °F and upper tolerance level 92 °F.
Spawning adults	Spawned in water ranging from 73 – 77 °F.

Table F-4. Temperature Ranges and Associations of Fish and Shrimp Species with EFH in the ROI (continued)

Lifestage	Temperature Association
Gray Snapper	
Eggs (0.4 – 0.6 mm)	No data.
Larvae (transforms to juveniles between 6.3 – 9.6 mm)	Occurs in temperatures ranging from 60 – 81 °F.
Post-larvae	No data.
Adults	Occur in water temperatures from 56.1 – 90.5 °F. Lower lethal limit range between 51.8 – 57.2 °F.
Tilefish	
Eggs	Usually hatch in 40 h at 71.6 – 76.3 °F in lab
Larvae	No data
Juveniles	No data
Adults	Usually found at 48 – 58°F
Spawning Adults	No data
Greater Amberjack	
Eggs	No data.
Larvae	Most likely warm, summer temperatures.
Post-larvae	No data.
Juveniles	No data.
Adults	Become more scarce in the northern GOM under 64.4 – 68.0 °F in fall.
Spawning adults	No data.
Lesser Amberjack	
Eggs	No data.
Larvae	No data.
Post-larvae	No data.
Juveniles	No data.
Adults	No data.
Spawning adults	Appears to be a cessation of spawning during coldest month (December – January) in the northern GOM.
Gray Triggerfish	
All life stages	No data.
King Mackerel (endothermic)	
Eggs	Hatch in 18 – 21 h at 81°F.
Larvae (2.0 – 2.9 mm SL)	68 – 88 °F.
Early juveniles	No data.
Late juveniles	No data.
Adults	The temperature considered the main trigger for seasonal migration is 68.0 °F.
Spawning adults	68.0 °F.

Table F-4. Temperature Ranges and Associations of Fish and Shrimp Species with EFH in the ROI (continued)

Lifestage	Temperature Association
Spanish Mackerel	
Eggs	Hatch in 25h at 78.8 °F.
Larvae	Collected at 68.0 – 89.6 °F.
Early juveniles	Most collected at 77.0 °F.
Late juveniles	No data.
Adults	68.0 °F; usually taken at 69.8 – 98.6 °F.
Spawning adults	77.0 °F.
Cobia	
Eggs fertilized (1.2 – 1.5 mm diameter; pelagic)	Highest hatchery rates (lab); 82.6 – 85.5 °F.
Larvae (2.0 – 2.6 mm SL)	75.6 – 89.6 °F; high is 98.1 °F.
Pre-juvenile (20 – 25 mm SL)	78.6 – 86.5 °F; 67.3 – 77.4 °F; > 86 °F.
Early juvenile	62.2 – 77.4 °F.
Late juvenile	No data.
Adult	73.4 – 82.4 °F; 67.3 – 77.4 °F (southern Atlantic).
Spawning adult	73.4 – 82.4 F.
Dolphin	
Eggs	Hatch in 40 hours at 79 °F; 38 hours at 77 °F.
Larvae	Most abundant at 75 °F and above; reared at 77 – 84 °F in hatchery.
Early juveniles	78.8 – 84.2 °F (culture experiments).
Late juveniles	No data.
Adults	68°F isotherm considered northern distributional limit; more numerous at 77 – 79 °F.
Spawning Adults	Usually at >75 °F; successfully spawned at 75 – 84 °F in culture experiments.
Bluefish	
Eggs	Occur in the wild from 64.4 – 79.3 °F.
Larvae	Collected in northern GOM at a mean temp of 76.3 °F with a range of 72.3 – 80.4 °F.
Adults	Range between 64.4 °F and 69.8 °F but can survive temperatures as low as 45.5 °F temporarily. Have been recorded in temps ranging from 58.6 °F to 88.2 °F.
Spawning adults	Optimal temperature for spawning in GOM is 78.1 °F.
Little Tunny	
All life stages	No data.
Atlantic Bluefin Tuna	
Life stage no specified	Constrained by 54.0 °F isotherm; individuals can dive to 43.0 – 46.0 °F to feed.

Table F-4. Temperature Ranges and Associations of Fish and Shrimp Species with EFH in the ROI (continued)

Lifestage	Temperature Association
Bonnethead Shark	
Age One	Found in temperatures of 61.0 – 88.7 °F.
Atlantic Sharpnose Shark	
Nenoates (newborns)	Found in temperatures 75.2 – 87.3 °F.
Larger juveniles	Found in temperatures of 63.0 – 91.9 °F.

Source: Adapted from NMFS 1999 and GMFMC 2003

Table F-5. Larval Densities by Taxon in the WC-213 Samples

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Atlantic bumper	*Chloroscombrus chrysurus*	6.09	303	29	87.9
Tonguefish	*Symphurus* spp.	5.04	227	30	90.9
Anchovies and sardines	Engraulidae	4.64	227	27	81.8
Atlantic thread herring	*Opisthonema oglinum*	3.45	265	19	57.6
Gobies	Gobiidae	3.11	151	26	78.8
Bony fish	Unidentified fish	2.87	189	20	60.6
Spanish mackerel	*Scomberomorus maculatus*	2.61	265	14	42.4
Flyingfishes	Exocoetidae	2.15	151	19	57.6
Blennies	Blenniidae	2.15	189	17	51.5
Sand seatrout	*Cynoscion arenarius*	2.15	189	17	51.5
Herrings, anchovies, and sardines	Clupeiformes	2.1	189	17	51.5
Drums and croakers	Sciaenidae	2.01	151	18	54.5
Butterfish	*Peprilus paru*	1.93	189	14	42.4
Cusk-eels	Ophidiidae	1.89	151	18	54.5
Scaled sardine	*Harengula jaguana*	1.89	189	14	42.4
Atlantic croaker	*Micropogonias undulatus*	1.79	189	12	36.4
Kingfish	*Menticirrhus* spp.	1.74	189	14	42.4
Puffer	*Sphoeroides* spp.	1.63	227	10	30.3
Fringed flounder	*Etropus crossotus*	1.6	189	13	39.4
Dusky flounder	*Syacium papillosum*	1.51	151	15	45.5
Herrings	Clupeidae	1.45	189	11	33.3
Flounder	*Etropus* spp.	1.43	189	10	30.3
Silver seatrout	*Cynoscion nothus*	1.42	151	12	36.4
Searobin	*Prionotus* spp.	1.27	151	11	33.3
Lizardfishes	Synodontidae	1.26	114	14	42.4
Little tunny	*Euthynnus alletteratus*	1.25	151	12	36.4
Left-eye flounders	Bothidae	1.24	151	11	33.3
King mackerel	*Scomberomorus cavalla*	1.22	189	9	27.3
Perciformes	Perciformes	1.21	151	10	30.3
Flounders	*Syacium* spp.	1.2	151	11	33.3
Codlet	*Bregmaceros* spp.	1.17	189	9	27.3
Sand perch	*Diplectrum* spp.	1.07	151	9	27.3

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Appendix E
Gulf Landing Fast Facts

USCG-2004-16860-38

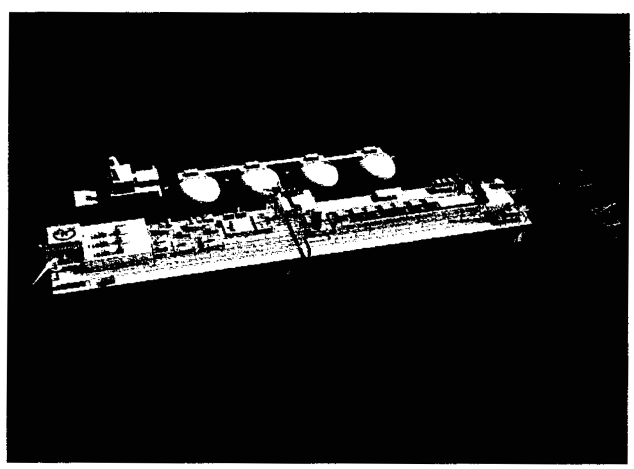


Table F-5. Larval Densities by Taxon in the WC-213 Samples (continued)

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Sea basses	Serranidae	0.95	151	9	27.3
Spanish sardine	*Sardinella aurita*	0.94	189	7	21.2
Flounder	*Citharichthys* spp.	0.93	189	7	21.2
Mackerel and tunas	Scombridae	0.89	189	6	18.2
Red drum	*Sciaenops ocellata*	0.87	416	3	9.1
Seatrout	*Cynoscion* spp.	0.85	151	7	21.2
Snake eels	Ophichthidae	0.84	114	9	27.3
Pygmy sea bass	*Serraniculus plumilio*	0.83	114	9	27.3
Mojarras	Gerreidae	0.78	151	7	21.2
Bullet mackerel	*Auxis* spp.	0.72	151	7	21.2
Conger eels	Congridae	0.7	151	7	21.2
Spadefish	*Chaetodipterus faber*	0.7	151	7	21.2
Round scad	*Decapterus punctatus*	0.7	151	7	21.2
Barracuda	*Sphyraena* spp.	0.69	114	8	24.2
Butterfish	*Peprilus* spp.	0.67	151	6	18.2
Red snapper	*Lutjanus campechanus*	0.67	114	9	27.3
Worm eels	Microdesmidae	0.66	114	8	24.2
Gulf butterfish	*Peprilus burti*	0.65	151	6	18.2
Scorpionfishes	Scorpaenidae	0.64	151	6	18.2
Pipefishes	*Syngnathus* spp.	0.64	151	6	18.2
Moray eels	Muraenidae	0.62	151	6	18.2
Blue runner	*Caranx crysos*	0.61	114	7	21.2
Leatherjackets and triggerfish	Balistidae	0.53	151	5	15.2
Bay whiff	*Citharichthys spilopterus*	0.53	151	5	15.2
Wrasse	Labridae	0.52	151	5	15.2
Snappers	*Lutjanus* spp.	0.5	151	5	15.2
Spiny flounder	*Engyophrys senta*	0.48	151	5	15.2
Eels	Anguilliformes	0.46	151	4	12.1
Silversides	Atherinidae	0.45	303	2	6.1
Puffers	Tetraodontidae	0.45	303	2	6.1
Bluefish	*Pomatomus saltatrix*	0.44	189	3	9.1
Vermilion snapper	*Rhomboplites aurorubens*	0.43	151	4	12.1
Flounders	Pleuronectiformes	0.42	114	6	18.2
Jacks	Carangidae	0.42	114	6	18.2
Menhaden	*Brevoortia* spp.	0.4	189	3	9.1

Table F-5. Larval Densities by Taxon in the WC-213 Samples (continued)

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Shrimp eel	*Ophichthus gomesi*	0.4	114	5	15.2
Planehead filefish	*Monacanthus hispidus*	0.35	151	3	9.1
Deep-sea angler	Ceratioidei	0.35	151	3	9.1
Spot	*Leiostomus xanthurus*	0.34	151	3	9.1
Banded drum	*Larimus fasciatus*	0.33	151	3	9.1
Atlantic cutlassfish	*Trichiurus lepturus*	0.33	114	4	12.1
Goatfishes	Mullidae	0.32	114	4	12.1
Snappers	Lutjanidae	0.31	76	5	15.2
Anchovies	*Anchoa* spp.	0.31	151	3	9.1
Star drum	*Stellifer lanceolatus*	0.3	416	1	3
Flounder	*Bothus* spp.	0.27	114	3	9.1
Harvestfish	*Peprilus alepidotus*	0.25	189	2	6.1
Dolphin	*Coryphaena hippurus*	0.24	151	2	6.1
Diminutive worm eel	*Pseudomyrophis fugesae*	0.23	114	3	9.1
King snake eel	*Ophichthus rex*	0.21	151	2	6.1
Bigeye scad	*Selar crumenophthalmus*	0.21	114	3	9.1
Blotched snake eel	*Callechelys muraena*	0.2	151	2	6.1
Silver perch	*Bairdiella chrysoura*	0.2	265	1	3
Lanternfishes	Myctophidae	0.2	151	2	6.1
Mullets	*Mugil* spp.	0.19	151	2	6.1
Blackfin tuna	*Thunnus atlanticus*	0.19	151	2	6.1
Dragonets	Callionymidae	0.19	76	3	9.1
Filefish	*Monacanthus* spp.	0.19	114	2	6.1
Spadefishes	Ephippidae	0.18	227	1	3
Sea bass	*Centropristis* spp.	0.17	114	2	6.1
Cobia	*Rachycentrum canadum*	0.17	114	2	6.1
Feather blenny	*Hypsoblennius hentzi*	0.16	114	2	6.1
Spagetti eels	Moringuidae	0.16	114	2	6.1
Lookdown	*Selene vomer*	0.15	114	2	6.1
Scads	*Trachinotus* spp.	0.14	114	2	6.1
Lanternfish	*Diaphus* spp.	0.13	189	1	3
Seahorse	*Hippocampus* spp.	0.13	189	1	3
Porgies	Sparidae	0.13	76	2	6.1
Chubs	Kyphosidae	0.12	151	1	3
Snake eel	*Myrichthys* spp.	0.12	151	1	3
Filefish	*Aluterus* spp.	0.11	151	1	3

Table F-5. Larval Densities by Taxon in the WC-213 Samples (continued)

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Filefish	*Stephanolepis* spp.	0.11	151	1	3
Pompano dolphin	*Coryphaena equisetis*	0.1	151	1	3
Flounder	*Engyophrys* spp.	0.1	151	1	3
Puffers	Tetraodontiformes	0.1	151	1	3
Pinfish	*Lagodon rhomboides*	0.1	151	1	3
Gulf Stream flounder	*Citharichthys arctifrons*	0.09	114	1	3
Weakfish	*Cynoscion regalis*	0.09	114	1	3
Trunkfish	*Lactophrys* spp.	0.09	114	1	3
Sailfin eel	*Letharchus velifer*	0.09	114	1	3
Croaker	*Micropogonias* spp.	0.09	114	1	3
Threadfins	Polynemidae	0.09	114	1	3
Red hake	*Urophycis chuss*	0.09	114	1	3
Frogfishes	Antennariidae	0.08	114	1	3
Sooty eel	*Bascanichthys bascanium*	0.08	114	1	3
Mackerels	*Scomberomorus* spp.	0.08	114	1	3
Lookdown/moonfish	*Selene* spp.	0.08	114	1	3
Sargassumfish	*Histrio histrio*	0.08	114	1	3
Cardinalfishes	Apogonidae	0.08	114	1	3
Tripletail	*Lobotes surinamensis*	0.07	114	1	3
Pygmy filefish	*Stephanolepis setifer*	0.07	114	1	3
Searobins	Triglidae	0.06	76	1	3
Needlefishes	Belonidae	0.05	76	1	3
Short-maned sand eel	*Phaenomonas longissimus*	0.05	76	1	3

Source: Adapted from GL 2003a

Table F-6. Larval Densities by Taxon in WC-183 Samples

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Atlantic bumper	*Chloroscombrus chrysurus*	7.734	382	38	76
Anchovy	Engraulidae	6.615	329	38	76
Atlantic thread herring	*Opisthonema oglinum*	5.68	314	34	68
Tonguefish	*Symphurus* spp.	5.556	299	35	70
Herring/anchovy/ menhaden	*Clupeiformes*	4.115	299	26	52
Sand seatrout	*Cynoscion arenarius*	4.001	269	28	56
Unidentified fish	Unidentified fish	3.694	238	29	58
Spanish mackerel	*Scomberomorus maculatus*	3.384	265	24	48
Kingfish	*Menticirrhus* spp.	3.038	220	26	52
Drums	Sciaenidae	2.802	212	25	50
Red drum	*Sciaenops ocellata*	2.784	307	17	34
Blennies	Blenniidae	2.624	235	21	42
Scaled sardine	*Harengula jaguana*	2.525	318	15	30
Gobies	Gobiidae	2.457	265	16	32
Atlantic croaker	*Micropogonias undulatus*	2.426	231	20	40
Herrings	Clupeidae	2.269	284	16	32
Star drum	*Stellifer lanceolatus*	1.403	204	13	26
Puffer	*Sphoeroides*	1.395	238	11	22
Mojarras	Gerreidae	1.285	185	13	26
Spadefish	*Chaetodipterus faber*	1.283	212	11	22
Fringed flounder	*Etropus crossotus*	1.28	174	13	26
American harvestfish	*Peprilus paru*	1.232	185	13	26
Silver seatrout	*Cynoscion nothus*	1.229	201	12	24
Flounder	*Etropus* spp.	1.225	212	11	22
Flyingfishes	Exocoetidae	1.197	231	10	20
Spanish sardine	*Sardinella aurita*	1.178	201	11	22
Cusk-eels	Ophidiidae	1.135	307	7	14
Searobin	*Prionotus* spp.	1.092	227	9	18
Silversides	Atherinidae	1.017	216	8	16
Pipefish	*Syngnathus* spp.	0.959	212	9	18
Seatrout	*Cynoscion* spp.	0.923	204	8	16

Table F-6. Larval Densities by Taxon in WC-183 Samples (continued)

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Perciformes	*Perciformes*	0.898	227	8	16
Butterfish	*Peprilus* spp.	0.87	189	9	18
Jacks	*Carangidae*	0.8	163	8	16
Left-eye flounders	*Bothidae*	0.796	151	10	20
Dusky flounder	*Syacium papillosum*	0.757	216	7	14
King mackerel	*Scomberomorus cavalla*	0.716	178	8	16
Little tunny	*Euthynnus alletteratus*	0.698	223	6	12
Spot	*Leiostomus xanthurus*	0.682	216	6	12
Menhaden	*Brevoortia* spp.	0.636	299	4	8
Mackerel	Scombridae spp.	0.632	238	5	10
Leatherjacket	*Oligoplites saurus*	0.546	182	4	8
Soles	Soleidae spp.	0.468	170	5	10
Bay whiff	*Citharichthys spilopterus*	0.467	204	5	10
Codlet	*Bregmaceros* spp.	0.456	220	4	8
Flounder	*Syacium* spp.	0.451	174	5	10
Searobin	Triglidae spp.	0.444	170	5	10
Spadefish	Ephippidae spp.	0.44	208	4	8
Flounders	Pleuronectiformes	0.44	208	4	8
Flounders	*Citharichthys* spp.	0.388	208	4	8
Halfbeak spp.	Hemiramphidae	0.366	170	4	8
Moray eels	Muraenidae	0.334	125	5	10
Amberjack	*Seriola* spp.	0.297	280	2	4
Snake eels	Ophichthidae	0.283	132	4	8
Porgies	Sparidae	0.278	174	3	6
Planehead filefish	*Monacanthus hispidus*	0.276	257	2	4
Lizardfishes	Synodontidae	0.271	129	4	8
Gulf butterfish	*Peprilus burti*	0.266	250	2	4
Atlantic cutlassfish	*Trichiurus lepturus*	0.258	242	2	4
Spotted seatrout	*Cynoscion nebulosus*	0.252	238	2	4
Eels	Anguilliformes	0.244	231	2	4
Sand perch	*Diplectrum* spp.	0.243	151	3	6
Silver perch	*Bairdiella chrysoura*	0.236	223	2	4
Pinfish	*Lagodon rhomboides*	0.201	121	2	4
Spotted snake eel	*Myrophis punctatus*	0.201	379	1	2
Feather blenny	*Hypsoblennius hentzi*	0.183	379	1	2
Worm eels	*Microdesmidae*	0.181	174	2	4

Table F-6. Larval Densities by Taxon in WC-183 Samples (continued)

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Snapper	*Lutjanus* spp.	0.175	114	3	6
Lane snapper	*Lutjanus synagris*	0.175	163	1	2
Blennies	*Blennioidei*	0.168	163	2	4
Fringed filefish	*Monacanthus ciliatus*	0.168	329	1	2
Pompano/permit	*Trachinotus* spp.	0.168	314	1	2
Leatherjackets and triggerfish	*Balistidae*	0.165	314	1	2
Sea basses	*Serranidae*	0.161	314	1	2
Wrasses	Labridae	0.149	155	2	4
Pygmy sea bass	*Serraniculus plumilio*	0.131	151	2	4
Lanternfishes	Myctophidae	0.13	140	2	4
Snipe eels	Nettastomodatidae	0.122	125	2	4
Sargassumfish	*Histrio histrio*	0.118	72	1	2
Pygmy filefish	*Monacanthus setifer*	0.118	231	1	2
Bullet mackerel	*Auxis* spp.	0.112	223	1	2
Bluefish	*Pomatomus saltatrix*	0.112	223	1	2
Tripletail	*Lobotes surinamensis*	0.11	212	1	2
Puffers	Tetraodontidae	0.106	212	1	2
Scorpionfishes	Scorpaenidae	0.102	102	2	4
Pipefishes	Syngnathidae	0.096	98	2	4
Cero mackerel	*Scomberomorus regalis*	0.094	95	2	4
Halfbeak	*Hemiramphus* spp.	0.091	182	1	2
Harvestfish	*Peprilus alepidotus*	0.091	178	1	2
Snappers	Lutjanidae	0.091	170	1	2
Round herring	*Etrumeus teres*	0.089	170	1	2
Banded drum	*Larimus fasciatus*	0.089	87	2	4
Mackerels	*Scomberomorus* spp.	0.089	167	1	2
Fourspot flounder	*Paralichthys oblongus*	0.089	167	1	2
Mullets	*Mugil* spp.	0.087	167	1	2
Weakfish	*Cynoscion regalis*	0.087	167	1	2
Round scad	*Decapterus punctatus*	0.087	167	1	2
Sharksuckers	Echeneidae	0.065	163	1	2
Cardinalfishes	Apogonidae	0.057	83	2	4
Spiny flounder	*Engyophrys senta*	0.057	140	1	2
Short-maned sand eel	*Phaenomonas longissimus*	0.056	121	1	2

Table F-6. Larval Densities by Taxon in WC-183 Samples (continued)

Common Name	Scientific Name	Percent Composition	Mean Larvae/Million Gallons of Water	Occurrence in Total Number of Samples	Percent Occurrence
Sculpins	Cottidae	0.05	106	1	2
Blenny	*Hypsoblennius*	0.05	106	1	2
Bigscales	Melamphaidae	0.05	106	1	2
Lookdown/moonfish	*Selene* spp.	0.05	95	1	2
Moonfish	*Selene setapinnis*	0.05	95	1	2
Blackcheek tonguefish	*Symphurus plagiusa*	0.05	95	1	2
Driftfish	Stromateidae	0.039	95	1	2
Blue runner	*Caranx crysos*	0.038	95	1	2
Bristlemouth	*Cyclothone*	0.012	95	1	2
Lanternfish	*Diaphus* spp.	0.012	76	1	2
Lanternfish	*Diogenichthys atlanticus*	0.012	23	1	2
Lanternfish	*Diplospinus multistriatus*	0.012	23	1	2
Bristlemouth	Gonostomatidae	0.012	23	1	2
Temperate bass	*Howella*	0.012	23	1	2
Lanternfishes	*Hygophum* spp.	0.012	23	1	2
Lanternfishes	*Lampanyctus* spp.	0.012	23	1	2
Lightfish	*Maurolicus muelleri*	0.012	23	1	2
Lanternfishes	*Myctophum* spp.	0.012	23	1	2
Barracudina	Paralepididae	0.012	23	1	2
Lightfish	*Vinciguerria attenuata*	0.012	23	1	2
Oceanic lightfish	*Vinciguerria nimbaria*	0.012	23	1	2

Source: Adapted from GL 2003a

Table F-7. Summary of the Proposed Action Impacts on EFH

Proposed Action Component/ Impact	EFH Type			
	Water Column	Sediments	Shoals and Topographic Relief	*Sargassum*
Placement of Terminal	▪ temporary increase in turbidity - not significant	▪ displacement of sediments – not significant ▪ secondary impact to prey species – not significant	▪ no expected impact	▪ no expected impact
Pipeline Installation	▪ temporary increase in turbidity - not significant	▪ displacement of sediments – not significant ▪ secondary impact to prey species – not significant	▪ minor adverse impacts	▪ no expected impact
LNG Vaporization-Intake	▪ impingement/ entrainment - localized impact reduced to insignificant through utilization of best available technology	▪ no expected impact	▪ no expected impact	▪ no expected impact
LNG Vaporization-Discharge	▪ 7.8 °F decrease in water temperature - not significant ▪ potential increase in turbidity - not significant	▪ displacement of sediments – not significant	▪ no expected impact	▪ no expected impact
Treated Water Discharge	▪ impact to water quality - not significant	▪ impact on sediment quality – not significant	▪ no expected impact	▪ no expected impact
Vessel and Aircraft Noise	▪ no expected impacts	▪ no expected impact	▪ no expected impact	▪ no expected impact
Terminal Lighting	▪ might attract ichthyoplankton - not significant	▪ no expected impact	▪ no expected impact	▪ no expected impact

Table F-7. Summary of the Proposed Action Impacts on EFH (continued)

Proposed Action Component/ Impact	EFH Type			
	Water Column	Sediments	Shoals and Topographic Relief	*Sargassum*
Presence of Terminal	▪ would provide artificial reef for colonization – positive impact ▪ proposed Safety Zone would provide refuge from fishing – positive impact	▪ displacement of sediments – not significant ▪ would provide artificial reef for colonization - positive impact ▪ proposed Safety Zone would provide refuge from fishing – positive impact	▪ would provide artificial reef for colonization - positive impact ▪ proposed Safety Zone would provide refuge from fishing – positive impact	▪ no expected impact
Increased Vessel Traffic	▪ no expected impact	▪ no expected impact	▪ no expected impact	▪ no expected impact
Marine Debris	▪ no expected impact	▪ no expected impact	▪ no expected impact	▪ no expected impact
Accidental Release	▪ Minor release o no expected impact ▪ Unlikely, catastrophic release o freezing of tissue – localized significant, short-term impact	▪ Minor release o no expected impact ▪ Unlikely, catastrophic release o no expected impact	▪ Minor release o no expected impact ▪ Unlikely, catastrophic release ▪ no expected impact	▪ Minor release o no expected impact ▪ Unlikely, catastrophic release o no expected impact
Decommissioning	▪ If explosives need to be used to remove platforms o increase in turbidity – not significant o direct physical damage from explosion – not significant o noise impact – not significant	▪ If explosives need to be used to remove platforms o increase in turbidity – not significant o direct physical damage from explosion – not significant	▪ If explosives need to be used to remove platforms o increase in turbidity – not significant o direct physical damage from explosion – not significant	▪ If explosives need to be used to remove platforms o increase in turbidity – not significant o direct physical damage from explosion – not significant

Table F-8. Age-1 Equivalent Loss Analysis - Eggs Summary

Estimate of Age-1 Equivalent Losses for Eggs in the W-213 Samples

	m^3	Million Gallons
Mean Number of Eggs [(a)]	2.873	10,875
Standard Deviation	5.548	
Standard Error (Standard Deviation/sqrt(sample size))	0.966	3,656
Adjusted Mean (mean*3) [(b)]	8.619	32,626
Adjusted Standard Deviation (3*Standard Deviation)	16.644	
Adjusted Standard Error (Adjusted SD/sqrt(sample size))	2.897	10,968
Adjusted Mean Upper Confidence Limit (Adjusted Mean +2 Adjusted Standard Errors) [(c)]	14.414	54,562
Adjusted Mean Lower Confidence Limit (Adjusted Mean +2 Adjusted Standard Errors) [(c)]	2.824	10,691

Eggs Input [(d)]

Estimated Number of Eggs Potential Entrained Per Year - Upper	**2,08,38,254**
Estimated Number of Eggs Potential Entrained Per Year - Lower	**530,07025**

Results - Eggs

Upper Confidence Limits

		Age-1 Equivalent Losses
Most Conservative Model	Bay Anchovy Life History Table	152,851
Least Conservative Model	Red Snapper Life History Table	4,351

Lower Confidence Limits

		Age-1 Equivalent Losses
Most Conservative Model	Bay Anchovy Life History Table	29,950
Least Conservative Model	Red Snapper Life History Table	853

Table F-8. Age-1 Equivalent Loss Analysis - Larval Summary

Scientific Name	Mean Larvae/m^3 [(a)]	Mean per Million Gallons of Sea water [(a)]	Adjusted Mean per Million Gallons of Sea water [(b)]	Potentially Entrained per Day Using the Adjusted Mean [(e)]	Potentially Entrained per Year Using the Adjusted Mean [(e)]	Life History Table Used to Estimate Age-1 Equivalent Losses	Results		
							Lower	Upper	Larvae
Sciaenops ocellatus	0.11	416	1,249	219,856	80,247,452	Croaker	7,998	23,057	--
Sciaenidae	0.04	151	454	79,948	29,180,892	Croaker	2,908	8,384	--
Anchoa	0.04	151	454	79,948	29,180,892	Bay Anchovy	5,232	30,222	--
Engraulidae	0.06	227	681	119,921	43,771,337	Bay Anchovy	[illegible]	[illegible]	--
Clupeiformes	0.05	189	568	99,935	36,476,114	Bay Anchovy	[illegible]	[illegible]	--
Clupeiformes	0.05	189	568	99,935	36,476,114	Menhaden	--	--	13,857
Clupeidae	0.05	189	568	99,935	36,476,114	Menhaden	--	--	13,857
Brevoortia sp.	0.05	189	568	99,935	36,476,114	Menhaden	--	--	13,857
Lutjanus sp	0.04	151	454	79,948	29,180,892	Red Snapper ()	[illegible]	881	--
Lutjanus campechanus	0.03	114	341	59,961	21,885,669	Red Snapper ()	59	[illegible]	--
Lutjanidae	0.02	76	227	39,974	14,590,446	Red Snapper ()	39	[illegible]	--

Table F-8. Age-1 Equivalent Loss Analysis - Eggs

Calculations Using Upper Confidence Interval

Menhaden Life History Table [h]

State	Natural Mortality per stage	Duration Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.04	2	2.08	0.125	0.222111933	**2,708,438,254**	4.26035E-05	115,389
Larvae	0.077	60	4.62	0.010	0.019513331		0.000379879	
Juvenile	0.013	303	3.939	0.019	0.038191839		0.038191839	

Bay Anchovy Life History Table[g]

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858	**2,708,438,254**	5.64351E-05	**152,851**
Yolk Sac Larvae	0.783	2	1.566	0	1.566	0.209	0.345574742		0.000179292	
Post Yolk Sac Larvae	0.196	32	6.272	0	6.272	0.002	0.003769777		0.001035688	
Juvenile	0.003915	21	0.082215	0	0.082215	0.921	0.958915639		0.286021821	
Juvenile	0.003915	22	0.08613	0	0.08613	0.917	0.956961603		0.311113647	
Juvenile	0.003915	33	0.129195	0	0.129195	0.879	0.935492202		0.346077525	
Juvenile	0.003915	254	0.99441	0	0.99441	0.370	0.540083801		0.540083801	

Red Snapper Life History Table [i]

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858	**2,708,438,254**	1.60647E-06	**4,351**
Yolk Sac-Larvae	0.783	2	1.566	0	1.566	0.209	0.345574742		5.10369E-06	
Larvae	0.196	20	3.92	0	3.92	0.020	0.038910169		2.89628E-05	
Juvenile	0.021	343	7.203	0	7.203	0.000744349	0.001487592			

Croaker Life History Table [f]

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	0.4984	2	0.9968	0	0.9968	0.369	0.539142089	**2,708,438,254**	4.07803E-05	**110,451**
Yolk Sac-Larvae	0.1645	4	0.658	0	0.658	0.518	0.682378054		9.9664E-05	
Ocean Larvae	0.09	45.5	4.095	0	4.095	0.017	0.032765754		0.000287322	
Estuarine Larvae	0.0387	53.5	2.07045	0	2.07045	0.126	0.224004549		0.015573665	
Early Juvenile	0.009867	75	0.740025	0	0.740025	0.477	0.645997354		0.094135516	
Late Juvenile	0.009867	180	1.77606	0.15	1.92606	0.146	0.25437464		0.25437464	

Table F-8. Age-1 Equivalent Loss Analysis - Eggs

Calculations Using Lower Confidence Limits

Menhaden Life History Table [h]

State	Natural Mortality per Stage	Duration Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.04	2	2.08	0.125	0.222111933	**530,707,025**	4.26035E-05	**22,610**
Larvae	0.077	60	4.62	0.010	0.019513331		0.000379879	
Juvenile	0.013	303	3.939	0.019	0.038191839		0.038191839	-

Bay Anchovy Life History Table [g]

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858	**530,707,025**	5.64351E-05	**29,950**
Yolk Sac Larvae	0.783	2	1.566	0	1.566	0.209	0.345574742		0.000179292	
Post Yolk Sac Larvae	0.196	32	6.272	0	6.272	0.002	0.003769777		0.001035688	
Juvenile	0.003915	21	0.082215	0	0.082215	0.921	0.958915639		0.286021821	
Juvenile	0.003915	22	0.08613	0	0.08613	0.917	0.956961603		0.311113647	
Juvenile	0.003915	33	0.129195	0	0.129195	0.879	0.935492202		0.346077525	
Juvenile	0.003915	254	0.99441		0.99441	0.370	0.540083801		0.540083801	

Red Snapper Life History Table [i]

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858	**530,707,025**	1.60647E-06	**853**
Yolk Sac-Larvae	0.783	2	1.566	0	1.566	0.209	0.345574742		5.10369E-06	
Larvae	0.196	20	3.92	0	3.92	0.020	0.038910169		2.89628E-05	
Juvenile	0.021	343	7.203	0	7.203	0.000744349	0.001487592			

Croaker [f]

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [d]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	0.4984	2	0.9968	0	0.9968	0.369	0.539142089	**530,707,025**	2.35891E-06	**1,252**
Yolk-Sac	0.1645	4	0.658	0	0.658	0.518	0.682378054		5.76499E-06	
Ocean Larvae	0.09	45.5	4.095	0	4.095	0.017	0.032765754		1.662E-05	
Estuarine Larvae	0.0387	53.5	2.07045	0	2.07045	0.126	0.224004549		0.000900848	
Early Juvenile	0.009867	75	0.740025	1	1.740025	0.176	0.298619518		0.006842206	
Late Juvenile	0.009867	180	1.77606	2	3.77606	0.023	0.044799108		0.044799108	

Table F-8. Age-1 Equivalent Loss Analysis - Red Drum and Sciaenidae[f]

INPUTS

	Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
Red Drum	Red drum	*Sciaenops ocellatus*	0.11	416	73,285	26,749,151	**80,2[illegible]2**

Results:	Equivalent Age-Losses	
	Upper	Lower
	7,998	23,057

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality *per Stage*	Total Mortality *per Stage*	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	0.4984	2	0.9968	0	0.9968	0.369	0.539142089		4.07803E-05	
Yolk Sac Larvae	0.1645	4	0.658	0	0.658	0.518	0.682378054	80,247,452	9.9664E-05	7,998
Post Yolk Sac Larvae	0.09	45.5	4.095	0	4.095	0.017	0.032765754	80,247,452	0.000287322	23,057
Estuarine Larvae	0.0387	53.5	2.07045	0	2.07045	0.126	0.224004549		0.015573665	
Early Juvenile	0.009867	75	0.740025	0	0.740025	0.477	0.645997354		0.094135516	
Late Juvenile	0.009867	180	1.77606	0.15	1.92606	0.146	0.25437464		0.25437464	

Table F-8. Age-1 Equivalent Loss Analysis - Red Drum and Sciaenidae [f]

INPUTS

	Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
	Drum	Sciaenidae	0.04	151	26,649	9,726,964	**29,180,891.52**

Results:	Equivalent Age-Losses	
	Upper	Lower
	2,908	8,384

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	0.4984	2	0.9968	0	0.9968	0.369	0.539142089		4.07803E-05	
Yolk Sac Larvae	0.1645	4	0.658	0	0.658	0.518	0.682378054	29,180,892	9.9664E-05	2,908
Post Yolk Sac Larvae	0.09	45.5	4.095	0	4.095	0.017	0.032765754	29,180,892	0.000287322	8,384
Estuarine Larvae	0.0387	53.5	2.07045	0	2.07045	0.126	0.224004549		0.015573665	
Early Juvenile	0.009867	75	0.740025	0	0.740025	0.477	0.645997354		0.094135516	
Late Juvenile	0.009867	180	1.77606	0.15	1.92606	0.146	0.25437464		0.25437464	

Table F-8. Age-1 Equivalent Loss Analysis - *Anchoa sp.*, Engraulidae, Clupeiformes [g]

Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
Anchovy	*Anchoa*	0.04	151	26,649	9,726,964	29,180,892
Anchovy	Engraulidae	0.06	227	39,974	14,590,446	43,771,337
Herrings and Anchovies	Clupeiformes	0.05	189	33,312	12,158,705	36,476,114

Age-1 Equivalent Loss Analysis - *Anchoa sp.*

INPUTS:

Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
Anchovy	*Anchoa*	0.04	151	26,649	9,726,964	29,180,892

Results:	Equivalent Age-Losses	
	Upper	Lower
	5,232	30,222

Anchoa sp.

	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858		5.64351E-05	
Yolk Sac Larvae	0.783	2	1.566	0	1.566	0.209	0.345574742	29,180,892	0.000179292	5,232
Post Yolk Sac Larvae	0.196	32	6.272	0	6.272	0.002	0.003769777	29,180,892	0.001035688	30,222
Juvenile	0.003915	21	0.082215	0	0.082215	0.921	0.958915639		0.286021821	
Juvenile	0.003915	22	0.08613	0	0.08613	0.917	0.956961603		0.311113647	
Juvenile	0.003915	33	0.129195	0	0.129195	0.879	0.935492202		0.346077525	
Juvenile	0.003915	254	0.99441	0	0.99441	0.370	0.540083801		0.540083801	

Table F-8. Age-1 Equivalent Loss Analysis - *Anchoa sp.*, Engraulidae, Clupeiformes [g]

Age-1 Equivalent Loss Analysis - Engraulidae

INPUTS:

Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
Anchovy	Engraulidae	0.06	227	39,974	14,590,446	43,771,337

Results:	Equivalent Age-Losses	
	Upper	Lower
	7,848	45,333

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858		5.64351E-05	
Yolk Sac Larvae	0.783	2	1.566	0	1.566	0.209	0.345574742	43,771,337	0.000179292	7,848
Post Yolk Sac Larvae	0.196	32	6.272	0	6.272	0.002	0.003769777	43,771,337	0.001035688	45,333
Juvenile	0.003915	21	0.082215	0	0.082215	0.921	0.958915639		0.286021821	
Juvenile	0.003915	22	0.08613	0	0.08613	0.917	0.956961603		0.311113647	
Juvenile	0.003915	33	0.129195	0	0.129195	0.879	0.935492202		0.346077525	
Juvenile	0.003915	254	0.99441		0.99441	0.370	0.540083801		0.540083801	

Table F-8. Age-1 Equivalent Loss Analysis - ***Anchoa sp.*****, Engraulidae, Clupeiformes** [(g)]

Age-1 Equivalent Analysis - Clupeiformes

INPUTS:

	Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [(e)]
	Herrings and Anchovies	Clupeiformes	0.05	189	33,312	12,158,705	36,476,114

Results:	Equivalent Age-Losses	
	Upper	Lower
	6,540	37,778

Clupeiformes

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [(e)]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858		5.64351E-05	
Yolk Sac Larvae	0.783	2	1.566	0	1.566	0.209	0.345574742	36,476,114	0.000179292	6,540
Post Yolk Sac Larv	0.196	32	6.272	0	6.272	0.002	0.003769777	36,476,114	0.001035688	37,778
Juvenile	0.003915	21	0.082215	0	0.082215	0.921	0.958915639		0.286021821	
Juvenile	0.003915	22	0.08613	0	0.08613	0.917	0.956961603		0.311113647	
Juvenile	0.003915	33	0.129195	0	0.129195	0.879	0.935492202		0.346077525	
Juvenile	0.003915	254	0.99441		0.99441	0.370	0.540083801		0.540083801	

Table F-8. Age-1 Equivalent Loss Analysis - Clupeidae, *Brevoortia sp.*, and Clupeiformes [g]

INPUTS:

Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
Herrings	Clupeidae	0.05	189	33,312	12,158,705	**36,476,114**
Menhaden	Brevoortia	0.05	189	33,312	12,158,705	**36,476,114**
Herrings	Clupeiformes	0.05	189	33,312	12,158,705	**36,476,114**

Results:

Equivalent Age-Losses
Larvae
13,857

Same for Clupeiformes, Clupeidae, Brevoortia

State	Natural Mortality per Stage	Duration Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.04	2	2.08	0.125	0.222111933		4.26035E-05	
Larvae	0.077	60	4.62	0.010	0.019513331	**36,476,114**	0.000379879	**13,857**
Juvenile	0.013	303	3.939	0.019	0.038191839		0.038191839	

Table F-8. Age-1 Equivalent Loss Analysis - Red Snapper (*Lutjanus campechanus*), snapper (*Lutjanus* spp.), and Snappers (*Lutjanidae*) [i]

Inputs:

	Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
	Snapper	*Lutjanus*	0.04	151	26,649	9,726,964	**29,180,892**

Results:	Equivalent Age-Losses	
	Yolk Sac Larvae	Post-Yolk Sac Larvae
	78	881

Lutjanus

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858		7.65704E-07	
Yolk Sac-Larvae	0.783	3	2.349	0	2.349	0.095	0.174290581	**29,180,892**	2.68446E-06	**78**
Larvae	0.196	20	3.92	0	3.92	0.020	0.038910169	**29,180,892**	3.02051E-05	**881**
Juvenile	0.021	341	7.161	0	7.161	0.000776278	0.001551351			
Age 1+										
Total										

Table F-8. Age-1 Equivalent Loss Analysis - Red Snapper (*Lutjanus campechanus*), snapper (*Lutjanus* spp.), and Snappers (*Lutjanidae*) [i]

INPUTS:

	Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
	Red snapper	*Lutjanus campechanus*	0.03	114	19,987	7,295,223	**21,885,669**

Results:	Equivalent Age-Losses	
	Yolk Sac Larvae	Post-Yolk Sac Larvae
	59	661

Lutjanus campechanus

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per Stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858		7.65704E-07	
Yolk Sac-Larvae	0.783	3	2.349	0	2.349	0.095	0.174290581	**21,885,669**	2.68446E-06	**59**
Larvea	0.196	20	3.92	0	3.92	0.020	0.038910169	**21,885,669**	3.02051E-05	**661**
Juvenile	0.021	341	7.161	0	7.161	0.000776278	0.001551351			
Age 1+										
Total										

Table F-8. Age-1 Equivalent Loss Analysis - Red Snapper (*Lutjanus campechanus*), snapper (*Lutjanus* spp.), and Snappers (*Lutjanidae*) [i]

Inputs (Lutjanidae):

Common Name	Scientific Name	Mean Larvae/m^3	Mean per Million Gallons of Sea water	Potentially Entrained per Day	Potentially Entrained per Year	Adjusted [e]
Snapper	Lutjanidae	0.02	76	13,325	4,863,482	**14,590,446**

Results:	Equivalent Age-Losses	
	Yolk Sac Larvae	Post-Yolk Sac Larve
	39	441

State	Instantaneous Mortality	Duration (Days)	Natural Mortality per stage	Fishing Mortality per Stage	Total Mortality per Stage	Fraction Surviving	Correction	Number Potentially Entrained [e]	Fraction Surviving to Age 1+	Number that would have survived to Age 1+
Egg	1.044	1	1.044	0	1.044	0.352	0.520757858		7.65704E-07	
Yolk Sac-Larvae	0.783	3	2.349	0	2.349	0.095	0.174290581	**14,590,446**	2.68446E-06	**39**
Larvea	0.196	20	3.92	0	3.92	0.020	0.038910169	**14,590,446**	3.02051E-05	**441**
Juvenile	0.021	341	7.161	0	7.161	0.001	0.001551351			
Age 1+										
Total										

Table F-8. Equivalent Loss Analysis – Table Notes

(a) The mean density of eggs and larvae in a cubic meter of seawater in the WC-213 and in a million gallons of seawater (calculated by multiplying the mean density of eggs or larvae in a cubic meter of seawater in the WC-213 samples by 3,785.4 samples) (GL 2003a).

(b) The adjusted mean density of eggs or larvae in the WC-213 samples multiplied by 3 to account for gear inefficiency as suggested by NOAA Fisheries (Thompson 2004).

(c) To account for the variability of the data, the range of all eggs potentially entrained by ORV operations was calculated by using the upper and lower confidence limits. The confidence limits were calculated using the adjusted mean (mean number of eggs potentially entrained in a year multiplied by 3) and an adjusted measure of variability (adjusted standard error=standard deviation times 3/square root of the sample size).

(d) Eggs are not identified in the SEAMAP data. Additionally, there is no reasonable way to assign the eggs in the WC-213 samples to specific taxa (Lyczkowski-Shultz 2004). Because we do not know which taxa are represented by the eggs, the age-1 equivalent losses were calculated for each life history table, assuming 100 percent of the eggs belong to that taxon. This was a conservative approach, considering that the eggs most likely represent an unknown number of taxa. Age-1 equivalent losses for the most conservative and the least conservative life history tables for the range of eggs potentially entrained by ORV operations are reported in Table 4-Y.

(e) Estimates of larvae (potentially entrained by ORV operations) used to calculate age-1 equivalent losses by taxon are the adjusted mean for each taxa (mean larvae potentially entrained in a year in the WC-213 samples multiplied by 3).

(f) ***Red Drum Life History Table Assumptions.*** Because Atlantic croaker (*Micropogonias undulatus*) and red drum (*Sciaenops ocellatus*) are both from the same Family Sciaenidae and have similar early life histories (egg to age-1), life history parameters for Atlantic croaker was used to calculate the age-1 equivalent losses (entrained eggs or larvae that would have survived to age-1) for red drum and the Family Sciaenidae. The stage durations and daily mortality rates for each early life history stage were from a population model of croaker configured for the Gulf of Mexico; this model was based on analysis of long-term field data and laboratory studies (Rose 2004). Total survival from egg to age-1 was similar to total survival from egg to age-1 estimated by USEPA (2004) for black drum. Larvae in the SEAMAP data are not measured or aged. As such, potentially entrained larvae were assumed as both 100 percent yolk sac larvae and 100 percent post yolk sac larvae, because they were collected in SEAMAP samples offshore. The following life history parameters were used to calculate the age-1 equivalent losses for the following taxa in the WC-213 samples: red drum (*Sciaenops ocellatus*) and Family Sciaenidae.

Stage	**Duration (days)**	**Mortality (1/day)**
Egg	2	0.4984
Yolk sac larvae	4	0.1645
Post yolk sac larvae	45.5	0.09
Estuarine larvae	53.5	0.0387
Early juvenile	75	0.009867
Late juvenile	180	0.009867

(g) ***Bay Anchovy Life History Table Assumptions.*** The bay anchovy life history table (EPRI 2004, PSEG 1999) was used to calculate equivalent losses for potentially entrained larvae for the following taxa in the WC-213 samples: anvhovies (*Anchoa sp.*), Family Engraulidae, and Order Clupeiformes. The Order Clupeiformes is a large order that includes herring and anchovies (important forage fish). As such, age-1 equivalents were estimated for Clupeiformes using both the bay anchovy life history table and the menhaden life history table. This shows a range of impacts for the order, but these should not be double counted. Entrained larvae were assumed to be both 100 percent yolk sac larvae and 100 percent post-yolk-sac larvae. The following are the life history parameters used for bay anchovy life history table.

Stage	Duration (days)	Mortality (1/day)
Egg	1	1.04
Yolk sac larvae	2	0.783
Post yolk sac larvae	32	0.196
Juvenile	21	0.82215
Juvenile	22	0.08613
Juvenile	33	0.129195
Juvenile	254	0.99441

(h) ***Red Snapper Life History Table Assumptions.*** The red snapper life history table was developed by using a combination of sources. Stage durations for red snapper used with bay anchovy egg, yolk sac larval, and post yolk sac larval daily mortality rates were used for red snapper (Rose 2004). The daily mortality rate for the juvenile stage for red snapper was then calculated to obtain an overall egg to age-1 survival rate that matched the maximum egg to age-1 survival rate of the red snapper spawner-recruit relationship used in a recent stock assessment (Schirripa and Legault 1999).. The estimate of total survival from egg to age-1 was 71.2 X 10^{-8} (this is the fraction of fish that are expected to survive from egg to age 1). This maximum survival value was the slope of the spawner-recruit relationship at the origin where stock biomass is very low and therefore survival from egg to age-1 very high. Entrained larvae were assumed to be both 100 percent yolk sac larvae and 100 percent post-yolk-sac larvae. The following life history parameters were used to calculate equivalent losses for potentially entrained larvae for the following taxa in the WC-213 samples: snappers (*Lutjanus sp.*), red snapper (*Lutjanus campechanus*), and Family Lutjandidae.

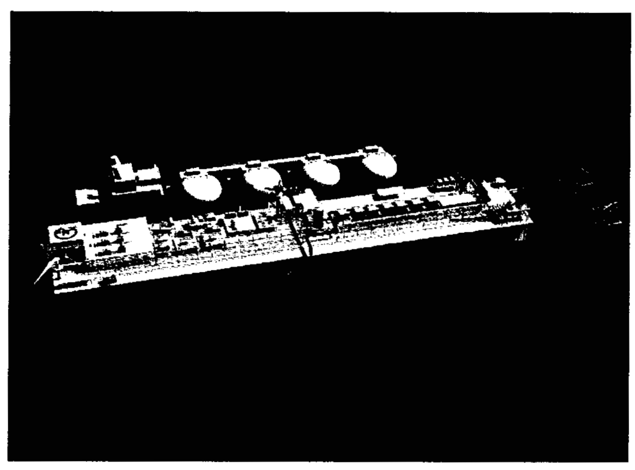
Stage	Duration (days)	Mortality (1/day)
egg	1	1.044
yolk sac larvae	3	0.783
post yolk sac larvae	20	0.196
juvenile	341	0.021

(i) ***Menhaden Life History Table Assumptions.*** The menhaden life history table in USEPA (2004) was used to create the menhaden life history table used in this analysis. The egg stage duration and instantaneous mortality rate were used directly from USEPA (2004). The larval stage instantaneous mortality rate was calculated using the egg to age-1 survival (2.39 X 10^{-5} is the fraction of eggs and larvae that would survive to age-1) in the menhaden life history table from USEPA (2004). An assumed larval stage duration of 60 days (6-10 weeks) was taken from Deegan and Thompson (1987) and a juvenile mortality rate of 0.013/day was taken from Deegan

(1990) (Rose 2004). Entrained larvae were assumed to be larvae. The following is the life history information used in the menhaden life history table to calculate age-1 equivalent losses for the following taxa in the WC-213 samples: menhaden (*Brevoortia sp.*), Family Clupeidae, and Order Clupeiformes.

Stage	**Duration (days)**	**Mortality (1/day)**
Egg	2	1.04
larvae	60	0.077
juvenile	303	0.013

Appendix G
Air Quality Information



Shell Gulf Landing LNG Project Air Emissions
CALPUFF v.5.7 Modeling
Gravity Based Structure Air Emissions
With SOLAR Titan 130 Turbines

To estimate the onshore environmental impacts of air emissions from the proposed Shell Gulf Landing LNG Project, a Lagrangian atmospheric dispersion model was exercised in the so-called "screening" mode. The conservative screening approach is believed to result in the over prediction of impacts. Results from the screening procedure are then compared to the Environmental Protection Agency's (EPA) Modeling Significance Levels to determine if more "refined" modeling would be required.

The non-steady state CALPUFF/CALMET/CALPOST (version 5.7, level 030402) modeling system, (http://www.src.com/calpuff/calpuff1.htm), was utilized. The CALPUFF modeling system has three main components: CALMET (a diagnostic three dimensional meteorological model), CALPUFF (the transport and dispersion model), and CALPOST (a post processing package). CALPUFF has been adopted by the EPA as the preferred technique for assessing long range transport of pollutants and their impacts on Federal Class I areas (68 ***Federal Register*** 18439 – 18482, April 15, 2003). The adoption is codified in Appendix A of the ***Guideline on Air Quality Models*** (published as Appendix W of 40 CFR Part 51). CALPUFF is also under consideration by the Department of Interior's (DOI) Minerals Management Service (MMS) as a regulatory model.

The modeling approach used is found in the ***Guide for Applying the EPA Class I Screening Methodology with the CALPUFF Modeling System*** (Earth Tech, Inc., January 2002). This methodology is referred to as "CALPUFF-lite" because it bypasses the need to generate a full 3-D wind field with CALMET. Instead, an Industrial Source Complex Short Term (ISCST3) single station meteorological field is used. The nearest EPA Class I area, the Breton National Wilderness Area (BNWA), is 245 statute miles (394 kilometers) NE of the project location. Since the BNWA is beyond 200 km from the project, no review of the project's emissions will likely be required. All other areas onshore are considered to be EPA Prevention of Significant Deterioration (PSD) Class II areas. EPA has set PSD Class II Increments for PM_{10} , SO_2 , and NO_2 .

Shell Gulf Landing LNG Project air emissions were quantified using a Microsoft Excel Workbook developed by the Gulf of Mexico offshore oil industry and the MMS (http://www.gomr.mms.gov/homepg/regulate/environ/airquality/Docd_aq.xls). Project Air Emission Computation Factors and Air Emission Calculations workbook worksheets are on the following four pages. Flare and fugitive emissions were included; however, they were not modeled because of their very small contribution to modeled sources on a year round basis. The flare emissions are based on 2% of downtime per year (8 days) with 4 mmscf/d of boil off gas being flared (0.1% wt/d of storage capacity). Also not modeled are crane, emergency firewater pump drivers, standby natural gas turbine, and emergency generator emissions that are in operation only a very small portion of the operating year. Mobile operations (LNG Carrier and Tug Boats) emissions are detailed on the third worksheet. Note the use of load factors for tug boat operations which have been applied in the calculation of the estimated tons per year of the criteria emissions. The fourth worksheet contains the detailed calculations of emissions from the

AIR EMISSION CUMPUTATION FACTORS

Fuel Usage Conversion Factors	Natural Gas Turbines		Natural Gas Engines		Diesel Recip. Engine		REF.	DATE
	SCF/hp-hr	9.524	SCF/hp-hr	7.143	GAL/hp-hr	0.0483	AP42 3.2-1	4/76 & 8/84

Equipment/Emission Factors	Units	PM	SOx	NOx	VOC	CO	REF.	DATE
SOLAR Titan 130-19501S Turbine	gms/hp-hr	0.18771	0.01517	0.40134	0.0139	0.48856	Vendor Estimate	Sep-03
NG 2-cycle lean	gms/hp-hr		0.00185	10.9	0.43	1.5	AP42 3.2-1	10/96
NG 4-cycle lean	gms/hp-hr		0.00185	11.8	0.72	1.6	AP42 3.2-1	10/96
NG 4-cycle rich	gms/hp-hr		0.00185	10	0.14	8.6	AP42 3.2-1	10/98
Diesel Recip. < 600 hp.	gms/hp-hr	1	1.468	14	1.12	3.03	AP42 3.3-1	10/96
Diesel Recip. > 600 hp.	gms/hp-hr	0.32	1.468	11	0.33	2.4	AP42 3.4-1	10/96
Diesel Boiler	lbs/bbl	0.084	2.42	0.84	0.008	0.21	AP42 1.3-12,14	9/96
NG Heaters/Boilers/Burners	lbs/mmscf	7.6	0.593	100	5.5	84	P42 1.4-1, 14-2, & 14	7/98
NG Flares	lbs/mmscf		0.593	71.4	60.3	388.5	AP42 11.5-1	9/91
Liquid Flaring	lbs/bbl	0.42	6.83	2	0.01	0.21	AP42 1.3-1 & 1.3-3	9/98
Tank Vapors	lbs/bbl				0.03		E&P Forum	1/93
Fugitives	lbs/hr/comp.				0.0005		API Study	12/93
Glycol Dehydrator Vent	lbs/mmscf				6.6		La. DEQ	1991
Gas Venting	lbs/scf				0.0034			

Sulfur Content Source	Value	Units
Fuel Gas	3.33	ppm
Diesel Fuel	0.4	% weight
Produced Gas(Flares)	3.33	ppm
Produced Oil (Liquid Flaring)	1	% weight

LNG Tanker Steam Turbine [1]	NOx	VOC	CO	SOx [2]	PM	Units	Fuel Consumption (GAL/hr)	
Hotelling (700 liters/hr)	3.06	0.27	0	0.61	0.84	kg/hr	185	
Maneuver (3,850 liters/hr)	25.8	0.32	1.59	3.31	9.24	kg/hr	1017	
Full Power (7,000 liters/hr)	53.41	1.44	6.1	6.01	47.46	kg/hr	1849	

[1] Reference: Gulf of Mexico Air Quality Study, Final Report, Volume III: Inventory Preparation, Appendices N-P, OCS Study MMS 95-0040, Table C-1, page N-89.

[2] Assuming 4.5% sulfur in heavy residual fuel oil

AIR EMISSION CALCULATIONS - FIRST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT			PHONE	REMARKS					
Shell Gulf Landing LNG R	West Cameron	253														
OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS (Load Factors Applied)				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/H R	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
CONSTRUCTION / INSTALLATION																
	GBS Installation															
Construction at Graving Dock	Tug Boat >600hp diesel (10% load)	12000	579.6	13910.40	4	10	8.46	38.80	290.75	8.72	63.44	0.02	0.08	0.58	0.02	0.13
	Tug Boat >600hp diesel (10% load)	12000	579.6	13910.40	4	10	8.46	38.80	290.75	8.72	63.44	0.02	0.08	0.58	0.02	0.13
	Tug Boat >600hp diesel (10% load)	12000	579.6	13910.40	4	10	8.46	38.80	290.75	8.72	63.44	0.02	0.08	0.58	0.02	0.13
	Tug Boat >600hp diesel (10% load)	12000	579.6	13910.40	4	10	8.46	38.80	290.75	8.72	63.44	0.02	0.09	0.58	0.02	0.13
	Tug Boat >600hp diesel (10% load)	9000	434.7	10432.80	4	10	6.34	29.10	218.06	6.54	47.58	0.01	0.06	0.44	0.01	0.10
Transporting Caissons to the Offshore Terminal Location	Tug Boat >600hp diesel (75% load)	12000	579.6	13910.40	24	21	8.46	38.80	290.75	8.72	63.44	1.60	7.33	54.95	1.65	11.99
	Tug Boat >600hp diesel (75% load)	12000	579.6	13910.40	24	21	8.46	38.80	290.75	8.72	63.44	1.60	7.33	54.95	1.65	11.99
	Tug Boat >600hp diesel (75% load)	12000	579.6	13910.40	24	21	8.46	38.80	290.75	8.72	63.44	1.60	7.33	54.95	1.65	11.99
	Tug Boat >600hp diesel (75% load)	12000	579.6	13910.40	24	21	8.46	38.80	290.75	8.72	63.44	1.60	7.33	54.95	1.65	11.99
	Tug Boat >600hp diesel (50% load)	9000	434.7	10432.80	24	21	6.34	29.10	218.06	6.54	47.58	0.80	3.67	27.48	0.82	5.99
Positioning and Holding Caissons While They are Installed	Tug Boat >600hp diesel (60% load)	12000	579.6	13910.40	24	15	8.46	38.80	290.75	8.72	63.44	0.91	4.19	31.40	0.94	6.85
	Tug Boat >600hp diesel (60% load)	12000	579.6	13910.40	24	15	8.46	38.80	290.75	8.72	63.44	0.91	4.19	31.40	0.94	6.85
	Tug Boat >600hp diesel (60% load)	12000	579.6	13910.40	24	15	8.46	38.80	290.75	8.72	63.44	0.91	4.19	31.40	0.94	6.85
	Tug Boat >600hp diesel (60% load)	12000	579.6	13910.40	24	15	8.46	38.80	290.75	8.72	63.44	0.91	4.19	31.40	0.94	6.85
	Tug Boat >600hp diesel (60% load)	9000	434.7	10432.80	24	15	6.34	29.10	218.06	6.54	47.58	0.69	3.14	23.55	0.71	5.14
	Solid Ballast Installation															
Standby While Supporting Solid Ballast Installation	Tug Boat >600hp diesel (10% load)	3600	173.88	4173.12	14	45	2.54	11.64	87.22	2.62	19.03	0.08	0.37	2.75	0.08	0.60
	Tug Boat >600hp diesel (10% load)	3600	173.88	4173.12	14	45	2.54	11.64	87.22	2.62	19.03	0.08	0.37	2.75	0.08	0.60
	Tug Boat >600hp diesel (10% load)	3600	173.88	4173.12	14	45	2.54	11.64	87.22	2.62	19.03	0.08	0.37	2.75	0.08	0.60
Working to Support Solid Ballast Installation	Tug Boat >600hp diesel (80% load)	3600	173.88	4173.12	10	45	2.54	11.64	87.22	2.62	19.03	0.46	2.10	15.70	0.47	3.43
	Tug Boat >600hp diesel (80% load)	3600	173.88	4173.12	10	45	2.54	11.64	87.22	2.62	19.03	0.46	2.10	15.70	0.47	3.43
	Tug Boat >600hp diesel (80% load)	3600	173.88	4173.12	10	45	2.54	11.64	87.22	2.62	19.03	0.46	2.10	15.70	0.47	3.43
	Scour Protection Installation															
Scour Protection Installation Standby and Working	Tug Boat >600hp diesel (10% load)	4200	202.86	4868.64	12	45	2.96	13.58	101.76	3.05	22.20	0.08	2.24	2.75	0.08	0.60
	Tug Boat >600hp diesel (80% load)	4200	202.86	4868.64	12	45	2.96	13.58	101.76	3.05	22.20	0.84	2.93	21.98	0.66	4.80
Scour Protection Installation - Derrick Barge	Small Lift Vessel/Derrick Barge (100% load)	10000	483	11592.00	24	45	7.05	32.33	242.29	7.27	52.86	3.81	17.46	130.84	3.93	28.55
	Ancillar y Structure Installation															
Ancillary Structure Installation - Derrick Barge	Small Lift Vessel/Derrick Barge (100% load)	10000	483	11592.00	24	15	22.03	32.33	308.37	24.67	66.74	3.96	5.82	55.51	4.44	12.01
	Suppl y Vessel															
Supply Vessel Standby and Working	Supply Vessel >600hp diesel (10% load)	3600	173.88	4173.12	12	32	2.54	11.64	87.22	2.62	19.03	0.05	0.22	1.67	0.05	0.37
	Sup.Vessel >600hp diesel (75% load)	3600	173.88	4173.12	12	32	2.54	11.64	87.22	2.62	19.03	0.37	1.68	12.58	0.38	2.74
PIPELINE INSTALLATION																
Installation of Five Natural Gas Takeaway Pipelines	Tug Boat >600hp diesel (10% load)	5600	270.48	6491.52	16	165	3.95	18.11	135.68	4.07	29.60	0.52	2.39	17.91	0.54	3.91
	Tug Boat >600hp diesel (10% load)	4200	202.86	4868.64	16	165	2.96	13.58	101.76	3.05	22.20	0.39	1.79	13.43	0.40	2.93
	Tug Boat >600hp diesel (75% load)	5600	270.48	6491.52	8	165	3.95	18.11	135.68	4.07	29.60	1.95	8.96	67.16	2.01	14.65
	Tug Boat >600hp diesel (75% load)	4200	202.86	4868.64	8	165	2.96	13.58	101.76	3.05	22.20	1.47	6.72	50.37	1.51	10.99
Installation of Five Natural Gas Takeaway Pipelines	Derrick Barge (100% load)	15000	724.5	17388.00	24	165	10.57	48.50	363.44	10.90	79.30	20.93	96.03	719.60	21.59	157.00
2003 YEAR TOTAL							200.21	849.76	6433.48	208.42	1403.13	47.39	206.91	1548.33	49.23	337.72
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES 37.6											1252.08	1252.08	1252.08	1252.08	38159.63

AIR EMISSION CALCULATIONS - FIRST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT			PHONE	REMARKS					
Shell Gulf Landing LNG	West Cameron	213														
OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
PRODUCTION	Crane <600hp diesel	338	16.3254	391.81	1	52	0.74	1.09	10.42	0.83	2.26	0.02	0.03	0.27	0.02	0.06
	Crane <600hp diesel	338	16.3254	391.81	1	52	0.74	1.09	10.42	0.83	2.26	0.02	0.03	0.27	0.02	0.06
	Crane <600hp diesel	338	16.3254	391.81	1	52	0.74	1.09	10.42	0.83	2.26	0.02	0.03	0.27	0.02	0.06
	Emergency FW Driver - 1100 hp	1100	53.13	1275.12	1	52	0.78	3.56	26.65	0.80	5.81	0.02	0.09	0.69	0.02	0.15
	Emergency FW Driver - 1100 hp	1100	53.13	1275.12	1	52	0.78	3.56	26.65	0.80	5.81	0.02	0.09	0.69	0.02	0.15
	SOLAR Titan 130-19501S Axial	16400	156193.6	3748646.40	24	365	6.78	0.55	14.50	0.50	17.65	29.70	2.40	63.50	2.20	77.30
	SOLAR Titan 130-19501S Axial	16400	156193.6	3748646.40	24	365	6.78	0.55	14.50	0.50	17.65	29.70	2.40	63.50	2.20	77.30
	SOLAR Titan 130-19501S Axial	16400	156193.6	3748646.40	24	8	6.78	0.55	14.50	0.50	17.65	0.65	0.05	1.39	0.05	1.69
	Sales Gas Heater - Natural Gas	20	19047.619	457142.86	24	365	0.14	0.01	1.90	0.10	1.60	0.63	0.05	8.34	0.46	7.01
	Emergency Generator - 1100 hp	1100	53.13	1275.12	24	8	0.78	3.56	26.65	0.80	5.81	0.07	0.34	2.56	0.08	0.56
	Emergency Generator - 1100 hp	1100	53.13	1275.12	24	8	0.78	3.56	26.65	0.80	5.81	0.07	0.34	2.56	0.08	0.56
	MISC	BPD	SCF/HR	COUNT												
	TANK-	1			0	365				0.00					0.01	
	FLARE-		166667		24	8		0.10	11.90	10.05	64.75		0.01	1.14	0.96	6.22
	PROCESS VENT-									0.00					0.00	
	FUGITIVES-			20000.0		365				10.00					43.80	
2003 YEAR TOTAL							25.82	19.26	195.17	27.36	149.32	60.93	5.87	145.19	49.94	171.11
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES											1252.08	1252.08	1252.08	1252.08	38159.63
	37.6															

AIR EMISSION CALCULATIONS - FIRST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT				PHONE	REMARKS				
Shell Gulf Landing LNG	West Cameron	213														
OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS (Load Factors Applied)				
	Diesel En gines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/H R	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
MOBILE OPERATIONS																
LNG CARRIER	LNGC Approach 90% vap., 10% RFO	89	84761.90	2034285.71	2	135	0.64	0.05	8.48	0.47	7.12	0.08	0.01	1.03	0.06	0.96
	LNGC Berthing 90% vap., 10% RFO	89	84761.90	2034285.71	3	135	0.64	0.05	8.48	0.47	7.12	0.12	0.01	1.54	0.08	1.44
	LNGC Unloading Prep 100% vap.	89	84761.90	2034285.71	2	135	0.64	0.05	8.48	0.47	7.12	0.08	0.01	1.03	0.06	0.96
	LNGC Unloading 100% RFO	34980	185	4440.00	14	135	1.85	1.34	6.73	0.59	0.00	1.75	1.27	6.36	0.56	0.00
	LNGC Departure Prep 100% vap.	89	84761.90	2034285.71	5	135	0.64	0.05	8.48	0.47	7.12	0.20	0.02	2.57	0.14	2.40
	LNGC to Pilot Station 90% vap., 10% RF	89	84761.90	2034285.71	3	135	0.64	0.05	8.48	0.47	7.12	0.12	0.01	1.54	0.08	1.44
	LNGC Dismissed 90% vap., 10% RFO	89	84761.90	2034285.71	2	135	0.64	0.05	8.48	0.47	7.12	0.08	0.01	1.03	0.06	0.96
TUG BOATS	LNGC Approach															
Approach Facility	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
Idling	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.05	0.22	1.64	0.05	0.36
	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.05	0.22	1.64	0.05	0.36
	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.05	0.22	1.64	0.05	0.36
	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.05	0.22	1.64	0.05	0.36
	LNGC Berthin g															
Escort LNGC	Tug Boat >600hp diesel (50% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.24	1.09	8.18	0.25	1.78
	Tug Boat >600hp diesel (50% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.24	1.09	8.18	0.25	1.78
Connect Towlines	Tug Boat >600hp diesel (75% load)	10000	483	11592.00	2	135	7.05	32.33	242.29	7.27	52.86	0.71	3.27	24.53	0.74	5.35
	Tug Boat >600hp diesel (75% load)	10000	483	11592.00	2	135	7.05	32.33	242.29	7.27	52.86	0.71	3.27	24.53	0.74	5.35
	Tug Boat >600hp diesel (75% load)	10000	483	11592.00	2	135	7.05	32.33	242.29	7.27	52.86	0.71	3.27	24.53	0.74	5.35
Standby	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	2	135	7.05	32.33	242.29	7.27	52.86	0.24	1.09	8.18	0.25	1.78
	LNGC Unloadin g Preparation															
Dismissed	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
Standby	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	19	135	7.05	32.33	242.29	7.27	52.86	0.90	4.15	31.07	0.93	6.78
	LNGC Departure Preparation															
Approach Facility	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
Idling	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.05	0.22	1.64	0.05	0.36
	Tug Boat >600hp diesel (10% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.05	0.22	1.64	0.05	0.36
Unberthing	Tug Boat >600hp diesel (60% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.29	1.31	9.81	0.29	2.14
	Tug Boat >600hp diesel (60% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.29	1.31	9.81	0.29	2.14
	Tug Boat >600hp diesel (60% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.29	1.31	9.81	0.29	2.14
Dismissed	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	LNGC to Pilot Station															
Escort LNGC	Tug Boat >600hp diesel (50% load)	10000	483	11592.00	1	135	7.05	32.33	242.29	7.27	52.86	0.24	1.09	8.18	0.25	1.78
Dismissed	Tug Boat >600hp diesel (80% load)	10000	483	11592.00	4	135	7.05	32.33	242.29	7.27	52.86	1.52	6.98	52.33	1.57	11.42
	Tug Boat Essen. Gen.<600 hp	500	24.15	579.60	14	135	1.10	1.62	15.42	1.23	3.34	1.04	1.53	14.57	1.17	3.15
	Tug Boat Essen. Gen.<600 hp	500	24.15	579.60	14	135	1.10	1.62	15.42	1.23	3.34	1.04	1.53	14.57	1.17	3.15
	Tug Boat Essen. Gen.<600 hp	500	24.15	579.60	14	135	1.10	1.62	15.42	1.23	3.34	1.04	1.53	14.57	1.17	3.15
	Tug Boat Essen. Gen.<600 hp	500	24.15	579.60	14	135	1.10	1.62	15.42	1.23	3.34	1.04	1.53	14.57	1.17	3.15
SUPPLY VESSEL	Supply Vessel>600hp diesel	3120	150.698	3616.70	6	52	2.20	10.09	75.59	2.27	16.49	0.34	1.57	11.79	0.35	2.57
	Sup.Vessel @Idle>600hp diesel	1040	50.232	1205.57	8	52	0.73	3.36	25.20	0.76	5.50	0.15	0.70	5.24	0.16	1.14
2003 YEAR TOTAL							217.46	959.27	7246.49	222.14	1811.10	30.48	117.09	695.08	30.36	200.06
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES 37.9											1252.08	1252.08	1252.08	1252.08	38159.63

construction and installation of the gravity based structure and the installation of pipelines Mobile and construction/pipeline installation operations were also not modeled.

The default emission factors for natural gas turbines in the Microsoft Excel Workbook have been changed to those supplied by the SOLAR Titan 130-19501S Axial turbine manufacturer. The Air Emission Calculations worksheet contains a distance-from-shore "exemption calculation." MMS uses the calculation to determine if air dispersion modeling would be required to obtain approval of a proposed offshore project's Development Operations Coordination Document. Note that none of the estimated yearly emissions exceed the calculation.

Hourly surface and upper-air meteorological data was obtained from the EPA's Support Center for Regulatory Modeling (SCRAM) on EPA's Technical Transfer Network website (http://www.epa.gov/scram001/tt24.htm). The National Weather Service (NWS) station at the Lake Charles Regional Airport was the source of the meteorological data. NWS Station Number LA03937 is located at 30.117 degrees N latitude and 93.217 degrees W longitude in Greenwich Mean Time (GMT) Zone 6. Station elevation is 4.6 m. The latest full year of ASCII data for both the surface and twice daily radiosonde soundings was 1991. The ASCII data file was expanded using the program MET144.EXE to output data in the NWS CD144 format. Finally, the CD144 data was converted into the ISCST3 data file by the "CALPUFF-RAMMET" program CPRAMMET.EXE contained in the CALPUFF modeling suite. Output from CPRAMMET was the meteorological data file input to the CALPUFF modeling.

The Air Emissions Calculation worksheet was used to determine the maximum pounds per hour of SO_2 , PM_{10} , and NO_2 being emitted by the major sources on the proposed gravity based facility. Using these numbers gives the emitting sources so-called "worst case" emissions, as if the source was operating 24-hrs per day, 365 days per year, at 100% load. Because of this "worst case" approach, small temporary emitting sources were not included in the screening CALPUFF modeling. These sources included diesel crane engines, emergency firewater pump diesel engines, standby SOLAR Titan 130 – 19501S Axial turbine, and emergency diesel generator sources. Three emitting sources included in the modeling were as follows:

P1 SOLAR Titan 130 - 19501S Axial Turbine
P2 SOLAR Titan 130 - 19501S Axial Turbine
P3 Sales Gas Heater

In CALPUFF, the modeling grid was centered on the proposed Shell gravity based structure in WC Block 213. Two rings of discrete receptors (one degree separation) with radii of 37.6 and 72.7 miles were included. The entire modeling domain is 170 x 170 km. The structure is centered at X = 0 km and Y = 0 km and the grid origin is at X = -170 km and Y = -170 km. The discrete receptor No. 360 (X = 0.000 km and Y = 60.500 km) represents the nearest onshore location, while receptor No. 720 (X = 0.000 km and Y = 117.000 km) represents due N beyond Lake Charles, Louisiana.

CALPUFF was exercised with the three emitting sources every hour for the entire year (8760 hours) of 1991. The CALPOST model (version 5.4, level 030402) was used to determine peak SO2 values for 1-hr / 3-hr / 24-hr / Annual averages; peak NO2 values for 1-hr and Annual averages; and peak PM10 values for 1-hr / 24-hr / Annual averages, for all discrete receptors (720).

CALPUFF/CALPOST Modeling Results

Attached on CD are the following input and output files used in the subject modeling:

Air Emissions Calculations Workbook (GulfLanding_LNG_Terminal_Air Emissions_GBS_Rev1.xls – 361 KB)
Air Emissions Calculations Workbook (GulfLanding_LNG_Terminal_Air Emissions_Mobile.xls – 410 KB)
Air Emissions Calculations Workbook (GulfLanding_LNG_Terminal_Air Emissions_Construction.xls – 396 KB)
CALPUFF ISCST3 Meteorological Data (wc182.met – 428 KB)
CALPUFF Input Data (WC213NOX.INP – 118 KB)
CALPUFF Model Setup List File (WC213LONOXPUFVIS.LST – 311 KB)
CALPUFF Output Data (WC213LONOXCONC.DAT– 28,174 KB)
CALPOST SO_2 Input Data (WCNOXSO.INP – 20 KB)
CALPOST NO_2 Input Data (WCNOXNO.INP – 20 KB)
CALPOST PM_{10} Input Data (WCNOXPM.INP – 20 KB)
CALPOST SO_2 Output Data (WCLONOXSO.LST – 231 KB)
CALPOST NO_2 Output Data (WCLONOXNO.LST – 143 KB)
CALPOST PM_{10} Output Data (WCLONOXPM.LST – 187 KB)
Shell Gulf Landing LNG CALPUFF Modeling Report_GBS_Titan130.doc 107 KB

Some of the files are too large to be read with Microsoft Notepad but can be read in Microsoft WordPad or Microsoft Word. The following are regulatory thresholds for the subject air pollutants modeled:

EPA - National Ambient Air Quality Standards (NAAQS)

PM_{10}	Annual	50 micrograms per cubic meter ($\mu g/m^3$)
	24-hr	150
SO_2	Annual	80
	24-hr	365
NO_2	Annual	100

EPA - Class 2 PSD Increments

PM_{10}	Annual	17 $\mu g/m^3$
	24-hr	30
SO_2	Annual	20
	24-hr	91
	3-hr	512
NO_2	Annual	25

EPA - Modeling Significance Levels

PM_{10}	Annual	1 μg/m³
	24-hr	5
SO_2	Annual	1
	24-hr	5
	3-hr	25
NO_2	Annual	1

CALPUFF/CALPOST modeling results for the particular case are as follows:

SO_2 Highest 1-hr Average
Receptor No. 360 1.0825E-02 μg/m³
Receptor No. 720 3.4469E-03

SO_2 Highest 3-hr Average (Modeling Significance Level = 25)
No. 360 8.5246E-03
No. 720 3.1477E-03

SO_2 Highest 24-hr Average (Modeling Significance Level = 5)
No. 360 2.3355E-03
No. 720 1.0012E-03

SO_2 Annual Average (Modeling Significance Level = 1)
No. 360 2.3434E-04
No. 720 9.1770E-05

NO_2 Highest 1-hr Average
No. 360 3.0351E-01
No. 720 9.5819E-02

NO_2 Annual Average (Modeling Significance Level = 1)
No. 360 6.6370E-03
No. 720 2.5685E-03

PM_{10} Highest 1-hr Average
No. 360 1.3363E-01
No. 720 4.2542E-02

PM_{10} Highest 24-hr Average (Modeling Significance Level = 5)
No. 360 2.8837E-02
No. 720 1.2360E-02

PM_{10} Annual Average
No. 360 2.8935E-03
No. 720 1.1328E-03

These modeling results should be rounded to two significant digits, since air pollution monitoring equipment is not capable of measuring pollutants at such low detectable limits. These results show that the closest value to a regulatory threshold is the NO_2 Modeling Significance for the Annual Average (1 microgram per cubic meter) and receptor No. 360's annual average of 0.007 micrograms per cubic meter.

A point of caution is in order, the screening model approach used only one somewhat distant "onshore" surface and upper-air meteorological station. When any future refined modeling is conducted, it will be run with CALMET utilizing many offshore MET data, which will greatly influence the wind fields to better reflect air dispersion over the Gulf of Mexico. The refined modeling will also utilize numerous meteorological stations near the coastline to define the complex wind fields involved with land and sea breezes.

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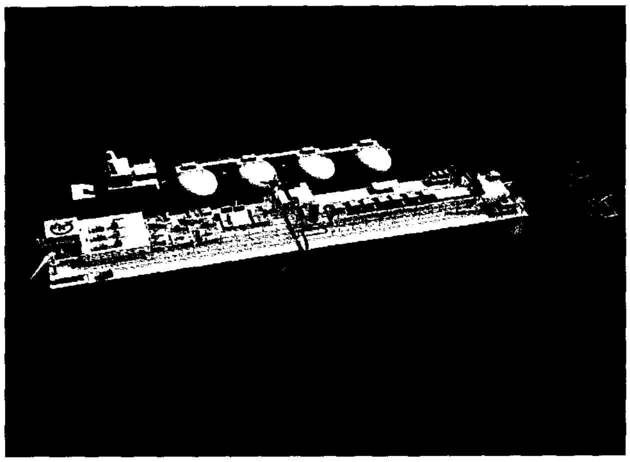
Appendix H
Major LNG Incidents



Major LNG Incidents

Incident Year	Ship/Facility Name	Location	Ship Status	Injuries/ Fatalities	Ship/ Property Damage	LNG Spill/ Release	Comment
1944	East Ohio Gas LNG Tank	Cleveland, Ohio, U.S.	NA	128 deaths	NA	NA	LNG peakshaving facility. Tank failure and no earthen berm. Vapor cloud formed and filled the surrounding streets and storm sewer system. Natural gas in the vaporizing LNG pool ignited.
1965		Canvey Island, UK	Transfer operation	1 seriously burned		Yes	
1965	Jules Vernet		Loading	No	Yes	Yes	Overfilling. Tank covered and deck fractures.
1965	Methane Princess		Disconnectin g after discharge	No	Yes	Yes	Valve leakage. Deck fractures.
1971	LNG ship Esso Brega, La Spezia LNG Import Terminal	Italy	Unloading LNG into the storage tank	NA	NA	Yes	First documented LNG rollover incident. Tank developed a sudden increase in pressure. LNG vapor discharged from the tank safety valves and vents. Tank roof slightly damaged. No ignition.
1973	Texas Eastern Transmission, LNG Tank	Staten Island, NY, U.S.	NA	40 killed	No	No	Industrial incident unrelated to the presence of LNG (construction incident). During the repairs, vapors associated with the cleaning process apparently ignited the mylar liner. Fire caused temperature in the tank to rise, generating enough pressure to dislodge a 6-in thick concrete roof, which then fell on the workers in the tank.
1973		Canvey Island, UK	NA	No	Yes	Yes	Glass breakage. Small amount of LNG spilled on a puddle of rainwater, and the resulting flameless vapor explosion, an RPT, caused the loud "booms." No injuries resulted.
1974	Massachusetts		Loading	No	Yes	Yes	Valve leakage. Deck fractures.
1974	Methane Princess		In port	No	Yes	No	Touched bottom at Arzew.

Major LNG Incidents (continued)

Incident Year	Ship/Facility Name	Location	Ship Status	Injuries/ Fatalities	Ship/ Property Damage	LNG Spill/ Release	Comment
1975	Philadelphia Gas Works		NA	No	Yes	NA	Not caused by LNG. An iso-pentane intermediate heat transfer fluid leak caught fire and burned the entire vaporizer area.
1977	Arzew	Algeria	NA	1 worker frozen to death	NA	Yes	Aluminum valve failure on contact with cryogenic temperatures. Wrong aluminum alloy on replacement valve. LNG released, but no vapor ignition (LNG liquefaction facility).
1977	LNG Aquarius		Loading	No	No	Yes	Tank overfilled.
1979	Columbia Gas LNG Terminal	Cove Point, Maryland, U.S.	NA	1 killed, 1 seriously injured	Yes	Yes	An explosion occurred within an electrical substation. LNG leaked through LNG pump electrical penetration seal, vaporized, passed through 200 ft of underground electrical conduit, and entered the substation. Since natural gas was never expected in this building, there were no gas detectors installed in the building. The normal arcing contacts of a circuit breaker ignited the natural gas-air mixture, resulting in an explosion. (LNG regasification terminal)
1979	Mostefa Ben-Boulaid Ship		Unloading	No	Yes	Yes	Valve leakage. Deck fractures.
1979	Pollenger Ship		Unloading	No	Yes	Yes	Valve leakage. Tank cover plate fractures.
1979	El Paso Paul Kayser Ship		At sea	No	Yes	No	Stranded. Severe damage to bottom, ballast tanks, motors water damaged, bottom of containment system set up.
1980	LNG Libra		At sea	No	Yes	No	Shaft moved against rudder. Tail shaft fractured.
1980	LNG Taurus		In port	No	Yes	No	Stranded. Ballast tanks all flooded and listing. Extensive bottom damage.

Major LNG Incidents (continued)

Incident Year	Ship/Facility Name	Location	Ship Status	Injuries/ Fatalities	Ship/ Property Damage	LNG Spill/ Release	Comment
1984	Melrose		At sea	No	Yes	No	Fire in engine room. No structural damage sustained - limited to engine room.
1985	Gradinia		In port	No	Not reported	No	Steering gear failure. No details of damage reported.
1985	Isabella		Unloading	No	Yes	Yes	Cargo valve failure. Cargo overflow. Deck fractures.
1989	Tellier		Loading	No	Yes	Yes	Broke moorings. Hull and deck failures.
1990	Bachir Chihani		At sea	No	Yes	No	Sustained structural cracks allegedly caused by stressing and fatigue in inner hull.
1993	Indonesian liquefaction facility	Indonesia	NA	No	NA	NA	LNG leak from open rundown line during a pipe modification project. LNG entered an underground concrete storm sewer system and underwent a rapid vapor expansion that overpressured and ruptured the sewer pipes. Storm sewer system substantially damaged.
2002	LNG ship Norman Lady	East of the Strait of Gibraltar	At sea	No	Yes	No	Collision with a U.S. Navy nuclear-powered attack submarine, the U.S.S. Oklahoma City. In ballast condition. Ship suffered a leakage of seawater into the double bottom dry tank area.
2004	Skikda I	Algeria	NA	27 killed 56 injured (The casualties are mainly due to the blast, few casualties due to fire)	NA	NA	In January 2004: No wind, semi-confined area (cold boxes, boiler, control room on three sides). The fire completely destroyed the train 40, 30, and 20, although it did not damage the loading facilities or three large LNG storage tanks also located at the terminal. Complete details are pending until completion of ongoing accident investigation.

Source: UH IELE 2003; Sonatrach 2004

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