AFTER ACTION REPORT
ALASKA GOOD FRIDAY EARTHQUAKE
27TH MARCH, 1964

Prepared for US Army Engineer Division North Pacific by the Alaska District January 1968

PART I

INTRODUCTION

1-01 AUTHORITY:

This after action report of the Alaska Good Friday Earthquake which occurred at 5:36 p.m. on 27 March 1964 in southwest Alaska has been prepared in accordance with paragraphs 73.60a and 73.60b of ER 500-1-1 and authority provided by letter ENGCW-OE dated 11 April 1966 from Office, Chief of Engineers.

1-02 SCOPE:

The report provides a consolidated coverage of the disaster assistance given by the Alaska District after the Alaska Earthquake. Included are cost summaries by agency, area, and by type of restoration. A comprehensive report on earthquake damage, restoration activities and technical information about the 1964 Alaska Earthquake is being prepared by the Alaska District for the National Academy of Sciences (NAS). It is the Alaska District's intention to finalize and bind the report and submit the same to the Chief of Engineers. Due to this NAS report, this after action report includes only certain topics and is not intended to cover completely the subject as the report would be as voluminous as the magnitude of the disaster indicates.

1-03 FEDERAL DISASTER ASSISTANCE:

Responsibility for disaster relief rests primarily with local and state governments. The Federal Government in case of natural disaster authorizes the Corps of Engineers' office in the area to use the resources at its command to aid civil authorities in preventing immediate human suffering, to mitigate destruction or damage to the public property of the United States, and to assist state and local governments in essential recovery operations. The Office of Emergency Planning (OEP) as the President's representative performs the function of directing and coordinating Federal disaster assistance. The Housing and Home Finance Agency, United States Geological Survey, Small Business Administration, United States Coast and Geodetic Survey, and others with type of assistance available are listed in Office of Emergency Planning publication,

"Types of Assistance Available to Alaska from Federal Departments and Agencies." The Federal Reconstruction and Development Planning Commission for Alaska was formed by the President on 2 April 1964 to coordinate the efforts of the Federal agencies and expedite the reconstruction of Alaska. Applicable public laws relating to disasters of this type are as follows:

a. Section 5 of the Flood Control Act of 18 August 1941, as amended by Public Law 99, 84th Congress and by Section 206 of the Flood Control Act of 1962 (33USC 701b), hereinafter referred to as Public Law 99.

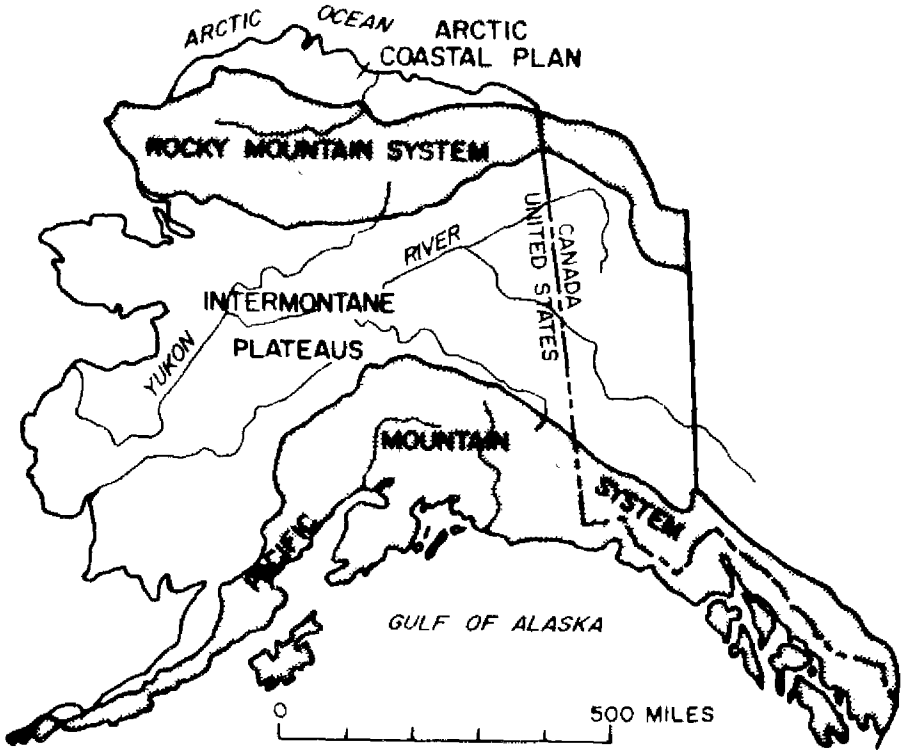
b. Public Law 875-81st Congress, Chapter 1125-2d Session, H.R. 8396, Federal aid in disasters.

PART II

EARTHQUAKE EFFECTS

2-01 GEOGRAPHICAL AREA

a. Alaska occupies the great northwestern peninsula of North America, which slopes and drains westward to the Bering and Chukchi Seas. Alaska may be divided into four major physiographic divisions: The Arctic Coastal Plain, the Rocky Mountain System, the Intermontane Plateaus and the Pacific Mountain System. Each division is a northwesterly extension of a major physiographic division of Canada and conterminous United States.



MAJOR PHYSIOGRAPHIC DIVISIONS OF ALASKA

Most of the State is mountainous or hilly although plains 20-100 miles wide abound. The central part, which slopes westward, consists of interspersed plains, plateaus, and rounded mountains, extending from beyond the Canadian border to the west coast; this part is bordered on the north and south by high rugged ranges which effectively cut off the bulk of the peninsula from the Arctic and Pacific Oceans.

The Arctic Mountains province of the Rocky Mountain System is the northern range, and is dominated by the Brooks Range with summit altitudes of 6,000 - 8,000 feet. The Arctic foothills, also part of the Rocky Mountain System, and the Arctic Coastal Plain, the northwestern extension of the Interior Plains, are north of this province. The southern mountain barrier, part of the Pacific Mountain System, is a pair of ridges separated by a line of discontinuous depressions, the Coastal Trough Province. The northern ridge of the pair is the Alaska - Aleutian Province; and the southern, the Pacific Border Ranges Province. Within the previously mentioned provinces are the highest peaks of North America, rising to an altitude of more than 20,000 feet. Mountains of 8,000 to 12,000 feet in altitude are not uncommon in these provinces.

The land between the Arctic Mountains and the Pacific Mountain System is a disordered assemblage of flat plains and rolling uplands, surmounted here and there by groups of low mountains. The whole region declines in altitude and relief toward the west. It is divided from east to west into five provinces: The Northern Plateaus Province, having uplands at altitudes of 3,000 - 5,000 feet, formed on crystalline and paleozoic rocks; the Western Alaska Province, having uplands at altitudes of 1,500 - 3,000 feet, formed on volcanic and late mesozoic sedimentary rocks; Seward Peninsula and the Ahklun Mountains, two distinctive relatively mountainous provinces; and the Bering Shelf, a nearly featureless plain, which is mostly submerged but has mountainous islands. Southeastern Alaska includes parts of the Coast Mountains, Coastal Trough, and Pacific Border Ranges; all provinces of the Pacific Mountain System.

The Yukon River, the largest river in Alaska, together with the Kuskokwim and other rivers which flow to the Bering and Chukchi Seas, drains all the Intermontane Plateaus and parts of the two mountain systems. The Bering-Chukchi-Arctic Ocean Divide is in the Arctic Mountains Province; and the Bering Sea-Pacific Ocean Divide is partly on the crest of the Alaska-Aleutian Province but for long stretches is in the lowlands of the Coastal Trough, where in places it follows eskers.

b. The earthquake was felt throughout nearly all of Alaska. For various reasons it was not felt in certain local areas distant from the epicenter. The level of intensity diminished appreciably northward from mountainous southern Alaska to the intermontane plateau of the interior. The geographic setting of the earthquake and land-level change

was confined largely to the southernmost division of Alaska, the Pacific Mountain System. Damage was restricted generally to an area within about 150 miles of Prince William Sound.

c. Southern Alaska and the adjoining Aleutian Island chain constitute one of the world's most active seismic zones. The Alaska Seismic Zone is a part of an active seismic belt that circumscribes the Pacific Ocean Basin. It is believed that about 7 percent of the seismic energy released annually on the globe originates in the Alaskan Seismic Zone. This very active zone is circumferential to the Gulf of Alaska and lies parallel to the Aleutian Trench.

d. The earthquake damage assesment of the provinces of the Pacific Mountain System is as follows.

ALASKA-ALEUTIAN PROVINCE:

Little damage to manmade structures is known even though extensive ground cracking occurred in the alluvial flats of most rivers and some lake deltas of the Aleutian Range. Most of the Alaska Range was outside the area affected by the earthquake, although strong motion was felt north of the range and releveling suggests a possible uplift of nearly a foot (U. S. Coast and Geodetic Survey, 1965a, p.16).

COASTAL TROUGH PROVINCE:

The Coastal Trough Province sustained severe damage in the earthquake. Extensive damage to properties and manmade structures was a result of relatively high local population density and the behavior of certain Pleistocene formations that underlay part of the area. Landslides, subsidence, ground cracks, and vibrations were the chief causes of damage.

PACIFIC BORDER RANGES PROVINCE:

The Pacific Border Ranges Province contained the epicenter of the earthquake. Only the Kodiak Mountains, Kenai-Chugach Mountains, and the Gulf of Alaska coastal section were significantly involved in the earthquake. Most of Kodiak Island subsided during the earthquake. Many avalanches, snowslides and rockslides were caused by the earthquake.

GULF OF ALASKA COASTAL SECTION:

Avalanches, slides and slumps were associated with the earthquake.

2-02 SUMMARY OF DAMAGE:

At about 5:36 p.m., Friday, 27 March 1964, an earthquake rocked and jarred Alaska. This was to be the most violent earthquake to occur in North America this century, and has become renowned for its savage destructiveness, for its long duration, and for the great breadth of its damage zone. Its magnitude has been computed by the U. S. Coast and Geodetic Survey as 8.3 - 8.4 on the Richter scale. Another observation in Berkeley calculated its magnitude as 8.5 - 8.75. Few earthquakes in history have been as large. In just minutes, thousands of people were made homeless, over a hundred lives were lost, and the entire earth vibrated like a tuning fork. Seismic sea waves swept the Pacific Ocean from the Gulf of Alaska to Antarctica and caused extensive damage in British Columbia and California. Wave heights of 1 foot at Japan, and 7 feet at Hawaii were reported, but caused little damage. The Oregon coast was struck by 10 to 14-foot waves which killed a family of four and caused a minimum property damage of 500,000 dollars (Geological Survey Professional Paper 541, pg 37). In California 12 lives were lost at Crescent City and heavy property damage was sustained of which 1 million dollars occurred at San Rafael. Seiches were generated in various places remote from Alaska by amplification of direct seismic vibrations. The Gulf of Mexico off Texas was affected - waves damaged small craft.

Water level fluctuations were noted in wells throughout the continental United States and at Denmark, Puerto Rico, and the Virgin Islands.

Geologists have determined that the earthquake tilted an area of at least 52,000 square miles in south-central Alaska. East of a line extending northeastward from the southeast coast of Kodiak Island through the western part of the Prince William Sound. land masses were thrust up at local areas as high as 33 feet. To the west of this imaginary line, the land in some areas sank as much as 8 feet. Subsidence and uplift of the auto and rail routes along the coast line disrupted transportation facilities. Navigable waterways and harbors were damaged along with port facilities in some communities.

Most inland damage was caused by landslides, ground subsidence and fissures resulting from the violent ground motion of the earthquake.

Coastal area damage generally resulted from submarine landslides, slide-induced waves and tsunami effects.

Only the State's low population density prevented catastrophic loss of life and property.

Areas receiving major damage are listed hereinafter. Photographs of pre-earthquake, earthquake and wave damage, and restoration of certain major disaster areas are given in Part V of this report.

ANCHORAGE AND VICINITY:

Principal damage to the Anchorage area was caused by landslides, ground subsidence and fissures resulting from the earthquake. The city of Anchorage was not affected by tidal waves. Major destruction occurred in the main business district along Fourth Avenue; in the Turnagain Heights residential area overlooking Cook Inlet; in the K to L Street area west of the business district; and the Government Hill area adjoining Elmendorf Air Force Base. Damage to waterfront facilities was sustained, with both the City Dock and the Army Ocean Dock receiving major damage. The Army Dock was written off as a total loss.

CHENEGA:

Chenega was an Indian village on the south side of Chenega Island in Prince William Sound. The village consisted of 20 residences with a school on a hill behind the houses and about 82 inhabitants. The people obtained their living primarily from fishing. No deep draft docking facilities or float facilities for small boats had been built and the tide range for the waterfront was 20 feet as a maximum to a mean of about 8 feet.

The earth shocks did little damage to the village but the tsunami, which was estimated to be 80 feet high, took 25 lives and destroyed all the homes and buildings of the village except for the school house.

Immediately after the tsunami, the surviving residents of Chenega were transported to Cordova for food and shelter. It was decided that the village would not be rebuilt in the same location. The Bureau of Indian Affairs constructed new housing with force account labor for the surviving residents of Chenega at the village of Tatitlek.

CORDOVA:

Damage to the city resulted from earthquake-induced uplift of about 6 feet, local fracturing of the ground surface, and a tidal wave which floated boats, houses, destroyed pier and dock facilites, and damaged canneries.

KODIAK:

The damage to Kodiak occurred in three stages. The first stage was the earthquake itself; the second was a series of tsunamis that swept through the waterfronts and low lying areas of town; and the third was 100-knot winds occurring several days later.

Little damage occurred during the earthquake except for minor appurtenances, and an approximate 10-foot settlement of southwest breakwater and 6-foot settlement of the city.

The tsunamis following the earthquake caused the major loss of life and property. During the tsunamis 25 people were killed, the boat harbor destroyed, 40 percent of the business district destroyed, three of four canneries lost, the city dock damaged and 77 fishing boats destroyed, damaged or missing.

Three days after the earthquake, a storm with winds of around 100 knots hit the island during the night causing extensive damage to the remaining fishing fleet.

OLD HARBOR:

Old Harbor, an Indian village on the south side of Kodiak Island, received little damage from the earthquake directly. However, most of the homes were destroyed by the tsunami.

The day following the earthquake, the villagers were taken to the Kodiak Naval Station and then to Anchorage for temporary housing. New houses were constructed at Old Harbor by the villagers of both Kaguyak and Old Harbor, with materials which were furnished by the Red Cross and the Bureau of Indian Affairs.

SEWARD:

Submarine slides and tidal waves destroyed Seward's industrial area along the waterfront. The seismic shocks ruptured the petroleum products storage tanks and turned a

half mile of waterfront into a flaming holocaust. The petroleum offloading facilities, canneries, municipal dock, railroad dock and other facilities along the waterfront were destroyed. The submarine landslides caused subsidence of about 4,000 feet of the waterfront and a 30-foot-high tidal wave was generated by the earthquake. Between the two destructive forces the industrial area along the waterfront was completely destroyed.

VALDEZ:

Valdez, located approximately 45 miles east of the earthquake epicenter, was the nearest civilian community to the epicenter. The pre-earthquake townsite was situated at tidewater on a glacial outwash plain at the head of the Valdez Bay. Ground shocks cracked buildings, opened fissures in the streets, and ruptured waterlines and sewerlines. The most catastrophic event experienced in Valdez was caused by the earthquake-induced submarine slide, and the resulting waves which virtually destroyed the waterfront structures, harbor, small-boat harbor, fuel storage terminal and half of the downtown business area. The submarine slide that destroyed the waterfront was estimated to be about 4,000 feet long and 600 feet wide. A hydrographic survey of the waterfront area after the slide shows the water depth at the dock face to be increased from 35 feet to 110 feet. An area near the small-boat basin formerly exposed at low tide, was covered with approximately 10 feet of water. Thirty lives were lost when the dock area disappeared and the waves generated by the slide swept onto the Valdez waterfront from the bay. Except for two fishing boats which were out to sea, the entire fishing fleet was destroyed.

In most communities the earthquake occurred at a time when the majority of the population in such communities were in transit from their jobs or schools. Unlike these communities, the dock at Valdez was in the full state of activity associated with the discharging of cargo from the Alaska Steamship Vessel, SS Chena, when the earthquake and resulting submarine slide occurred. A series of waves created further destruction to the waterfront structures and advanced into town causing additional property damage. The main area of property damage was confined to waterfront structures and the business district, which was located immediately shoreward of the waterfront structures. The Corps of Engineers under the sponsorship of the Office of Emergency Planning and others made studies and subsurface investigations of the area. The initial subsurface investigations substantiated the fact that the delta on which Valdez was

situated consisted of saturated, fine outwash soil subject to liquefaction and sliding under seismic conditions. Based upon the investigations, the Scientific and Engineering Panel recommended to the Federal Reconstruction and Development Planning Commission that the town of Valdez be relocated to Mineral Creek Site. The recommendation was endorsed by the Federal and State Commissions, and a plan for relocation was presented to the city, which accepted the plan for reconstruction. The new site called the Mineral Creek Site is about 4 miles west of the old site.

WHITTIER:

Whittier, an ice-free seaport serving as a terminus for the Alaska Railroad, was virtually shut down prior to the earthquake. Damage was mostly due to a tsunami and fire that occurred on 27 March 1964. The commercial petroleum industry at the port was severely damaged as were the Alaska Railroad facilities. The emergency work consisted of the removal of debris caused by the earthquake. Restoration of the damaged railroad facilities was done by the Alaska Railroad.

CRESCENT CITY - CALIFORNIA

Crescent City bore the brunt of the wave damage in California. Twelve lives were lost, boats sunk, destroyed and missing, and heavy damage sustained by the harbor facilities, docks, and the seawall. Many homes and businesses were destroyed and damaged by the waves and following fires. The fifth seismic sea wave to arrive at Crescent City was the one which caused the damage and took all of the lives. This wave came in on a high tide and combined the natural high tide with the seismic sea wave to demolish the city.

PARTIAL LISTING OF INITIAL ESTIMATED EARTHQUAKE DAMAGE OF MAJOR DISASTER AREAS IS AS FOLLOWS:

a. FEDERAL AGENCIES

Air Force

Elmendorf Air Force Base

Buildings & Structures	-	$ 9,298,700
Utilities & Streets	-	1,026,900
Coastal Installations	-	----
Airfields	-	696,200
Total		$11,021,800

Army		
Ft Richardson		
Buildings & Structures	-	$14,617,590
Utilities & Streets	-	650,000
Coastal Installations	-	400,000
Airfields	-	----
Total		$15,667,590
Port of Whittier		
Buildings & Structures	-	$ 2,888,000
Utilities & Streets	-	629,324
Coastal Installations	-	260,000
Total		$ 3,777,324
Wildwood		
Buildings & Structures	-	$ 193,000
Utilities & Streets	-	207,000
Total		$ 400,000
Seward		
Buildings & Structures	-	$ 157,075
Utilities & Streets	-	11,000
Coastal Installations	-	394,200
Total		$ 562,285
Ft Wainwright		
Buildings & Structures	-	$ 15,100
Utilities & Streets	-	44,450
Total		$ 59,550
Ft Greely		
Utilities & Streets	-	$ 1,100
Alaska Railroad		
Seward		
Coastal Installations	-	$ 7,800,000
Whittier		
Coastal Installations	-	$ 700,000
Seward to Anchorage		
Buildings & Structures	-	$ 2,050,000
Anchorage to Portage		
Buildings & Structures	-	$ 375,000
Utilities & Streets	-	5,000,000
Total		$ 5,375,000

Portage to Whittier		
Buildings & Structures	-	$ 50,000
Utilities & Streets	-	300,000
	Total	$ 350,000
Portage to Seward		
Buildings & Structures	-	$ 690,000
Utilities & Streets	-	2,500,000
	Total	$ 3,190,000
Anchorage to Palmer		
Buildings & Structures	-	$ 700,000
Utilities & Streets	-	1,365,000
	Total	$ 2,065,000
Palmer to Fairbanks		
Buildings & Structures	-	$ 350,000
General		
Utilities & Streets	-	$ 2,850,000

Total listed damage for Federal Agencies $56,719,639

b. STATE OF ALASKA

City of Anchorage		
Buildings & Structures	-	$ 255,000
City of Seward		
Buildings & Structures	-	$ 300,000

Total listed damage for State of Alaska $ 555,000

c. CITIES AND OTHER LOCAL AGENCIES

City of Anchorage		
Buildings & Structures	-	$38,783,000
Utilities & Streets	-	9,112,000
Coastal Installations	-	3,120,000
Airfields	-	900,000
	Total	$51,915,000
City of Cordova		
Buildings & Structures	-	$ 6,857
Coastal Installations	-	687,845
	Total	$ 694,702

City of Seward		
Buildings & Structures	-	$13,499,544
Utilities & Streets	-	----
Coastal Installations	-	602,000
Airfields	-	5,000
Total		$14,106,554
City of Kodiak		
Buildings & Structures	-	$ 2,655,062
Utilities & Streets	-	846,499
Coastal Installations	-	3,760,087
Airfields	-	1,897,931
Total		$ 9,159,579
Total listed damage for Cities and other Local Agencies		$75,775,835

d. PRIVATE

Anchorage & Vicinity		
Buildings & Structures	-	$33,460,000
City of Cordova		
Buildings & Structures	-	$ 39,780
Boats	-	166,000
Total		$ 205,780
City of Seward		
Buildings & Structures	-	$ 439,000
Boats	-	301,000
Total		$ 740,000
Total listed Private damages		$34,405,780

e. SUMMARY OF EARTHQUAKE PROPERTY DAMAGE ESTIMATES

Public Property:

Federal:

Military	-	$ 35,610,000
Nonmilitary	-	35,641,000

Non-Federal:		
State & local	$107,373,000	
Highways	- 55,568,000	
		$234,192,000
Private Property:		
Real	- $ 77,000,000	
Personal	- (No Data)	
		$ 77,000,000
		$311,192,000

PART III

APPLICABLE AUTHORITIES AND ADMINISTRATIVE PROCEDURES

3-01 AUTHORITIES

a. Public Law 99, the administration of which is a Corps of Engineers' responsibility states:

"That there is hereby authorized an emergency fund in the amount of $15,000,000 to be expended in flood emergency preparation; in flood fighting and rescue operations, or in the repair or restoration of any flood control work threatened or destroyed by flood, including the strengthening, raising, extending, or other modifications thereof as may be necessary in the discretion of the Chief of Engineers for the adequate functioning of the work for flood control; in the emergency protection of federally authorized hurricane or shore protection being threatened when in the discretion of the Chief of Engineers such protection is warranted to protect against imminent and substantial loss to life and property; in the repair and restoration of any federally authorized hurricane or shore protection structure damage or destroyed by wind, wave, or water action of other than ordinary nature when in the discretion of the Chief of Engineers such repair and restoration is warranted for the adequate functioning of the structure for hurricane or shore protection. The appropriation of such moneys for the initial establishment of this fund and for its replenishment on an annual basis is hereby authorized; provided, that pending the appropriation of said sum, the Secretary of the Army may allot, from existing flood control appropriations, such sums as may be necessary for the immediate prosecution of the work herein authorized, such appropriations to be reimbursed from the appropriation herein authorized when made. The Chief of Engineers is authorized, in the prosecution of work in connection with rescue operations, or in conducting other flood emergency work, to acquire on a rental basis such motor vehicles, including passenger cars and buses, as in his discretion are deemed necessary."

This law in coordination with Public Law 875 and administrative orders and regulations authorize use of PL 99 funds for restoration of Corps of Engineer facilities damaged in a natural emergency and support of disaster assistance requested by the Office of Emergency Planning.

b. Public Law 875 sets forth the condition under which Federal assistance can be provided to state and local governments upon declaration of a major disaster by the President of the United States. The law reads as follows:

"AN ACT
To authorize Federal assistance to States and local governments in major disasters, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is the intent of Congress to provide an orderly and continuing means of assistance by the Federal Government to States and local governments in carrying out their responsibilities to alleviate suffering and damage resulting from major disasters, to repair essential public facilities in major disasters, and to foster the development of such State and local organizations and plans to cope with major disasters as may be necessary.

Sec. 2. As used in this Act, the following terms shall be construed as follows unless a contrary intent appears from the context:

(a) "Major disaster" means any flood, drought, fire, hurricane, earthquake, storm, or other catastrophe in any part of the United States which, in the determination of the President, is or threatens to be of sufficient severity and magnitude to warrant disaster assistance by the Federal Government to supplement the efforts and available resources of States and local governments in alleviating the damage, hardship, or suffering caused thereby, and respecting which the governor of any State (or the Board of Commissioners of the District of Columbia) in which such catastrophe may occur or threaten certifies the need for disaster assistance under this Act, and shall give assurance of expenditure of a reasonable amount of the funds of the government of such State, local governments therein, or other agencies, for the same or similar purposes with respect to such catastrophe;

(b) "United States" includes the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Trust Territory of the Pacific Islands;

(c) "State" means any State in the United States, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Trust Territory of the Pacific Islands;