

**In The
Supreme Court of the United States**

DENVER BIBLE CHURCH, *et al.*,

Applicants,

— v. —

JARED POLIS, IN HIS OFFICIAL CAPACITY AS GOVERNOR OF THE STATE OF
COLORADO; AND JILL HUNSAKER RYAN, IN HER OFFICIAL CAPACITY AS EXECUTIVE
DIRECTOR OF THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT,

Respondents.

**To the Honorable Neil M. Gorsuch, Associate Justice of the United States
Supreme Court and Circuit Justice for the Tenth Circuit**

Respondents' Appendix

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**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLORADO**

Civil Action No. 1:20-cv-02362-DDD-NRN

DENVER BIBLE CHURCH,
PASTOR ROBERT ENYART,
COMMUNITY BAPTIST CHURCH,
PASTOR JOEY RHOADS

Plaintiffs

v.

ALEX M. AZAR II, in his official capacity as Secretary,
United States Department of Health and Human Services;
Department of Health and Human Services;
CHAD F. WOLF, in his official capacity as Acting Secretary,
United States Department of Homeland Security;
Department of Homeland Security;
STEVEN T. MNUCHIN, in his official capacity as Secretary
United States Department of the Treasury;
Department of the Treasury;
JARED POLIS, in his official capacity as
Governor, State of Colorado, and
JILL HUNSAKER RYAN, in her official
capacity as Executive Director of, together with the
Colorado Department of Health and
Environment

Defendants

**PLAINTIFFS' MOTION FOR TEMPORARY RESTRAINING ORDER
AND PRELIMINARY INJUNCTION**

Plaintiffs, Denver Bible Church, Pastor Robert Enyart, Community Baptist Church and Pastor Joey Rhoads ("Plaintiffs"), pursuant to Fed. R. Civ. P. 57 and 65, for their *Motion for Temporary Restraining Order and Preliminary Injunction* against the agencies and individual Defendants, listed above in their official capacities, respectfully submit:

CONFERRAL

The undersigned, under D.C.COLO.LCivR 7.1(a), on Friday, August 15, 2020, spoke with, and emailed courtesy copies of the complaint, together with this and related motions to attorneys with the offices of the United States Attorney for the District of Colorado and the Colorado Attorney General.

I. INTRODUCTION

Federal and State Defendants, acting together, have violated Plaintiffs' First Amendment rights without due process of law, affording Plaintiffs standing to bring claims against the agency defendants and individuals in their official capacities under 5 U.S.C. §702¹ and 42 U.S.C. § 1983,² as applicable, for declaratory and injunctive relief under 28 U.S.C. §§2201(declaratory) and 2202 (further relief). Federal Defendants implemented federal law under the CARES Act³ and the Stafford Act⁴ in violation of both the Religious Freedom Restoration Act ("RFRA")⁵ and non-discrimination provisions of the Stafford Act⁶

¹ The statute provides: "An action in a court of the United States seeking relief other than money damages and stating a claim that an agency or an officer or employee thereof acted or failed to act in an official capacity or under color of legal authority shall not be dismissed nor relief therein be denied on the ground that it is against the United States." *See Perry Capital LLC v. Mnuchin*, 864 F.3d 591 (D.C. Cir. 2017)

² The statute provides: "Every person who, under color of any statute, ordinance, regulation, custom, or usage, of any State or Territory or the District of Columbia, subjects, or causes to be subjected, any citizen of the United States or other person within the jurisdiction thereof to the deprivation of any rights, privileges, or immunities secured by the Constitution and laws, shall be liable to the party injured in an action at law, suit in equity, or other proper proceeding for redress, except that in any action brought against a judicial officer for an act or omission taken in such officer's judicial capacity, injunctive relief shall not be granted unless a declaratory decree was violated or declaratory relief was unavailable. For the purposes of this section, any Act of Congress applicable exclusively to the District of Columbia shall be considered to be a statute of the District of Columbia."

³ Coronavirus Aid, Relief and Economic Security Act, Pub. L. 116-136 (2020).

⁴ 42 U.S.C. §§5121 – 5207.

⁵ 42 U.S.C. §2000bb *et seq.*

⁶ 42 U.S.C. §5151.

and accompanying regulations.⁷ Federal Defendants wrongly approved allocations of federal resources in spite of State Defendants’ admitted discrimination against Plaintiffs. Said discrimination resulted from *ultra vires* executive and public health orders. Federal Defendants violated RFRA and the Stafford Act because State Defendants lacked appropriate legal authority under state statutes and the Colorado Constitution while also depriving Plaintiffs under 42 U.S.C. §1983 of their religious liberty without due process of law, all as set forth more fully, *infra*.

Plaintiffs seek a temporary restraining order and preliminary injunction based their likelihood of success on the merits against all Defendants. Under the doctrine of *Ex Parte Young*, the Eleventh Amendment does not bar suits against state officials for prospective equitable relief to end continuing violations of federal law. *Meiners v. Univ. of Kansas*, 359 F.3d 122, 1232 (10th Cir. 2004) (upholding suit for declaratory and injunctive relief against chancellor and provost in their official capacities). A federal district court errs to dismiss a claim because a state’s supreme court has not yet passed on a question. *Doud v. Hodge*, 350 U.S. 485 (1956). Notably, however, the Colorado Supreme Court has determined that Polis has no authority to violate the Colorado Constitution. *Ritchie v. Polis*, *infra*.

II. FACTS

Defendants’ discrimination against Plaintiffs’ religious freedom is not in dispute. State Defendants openly agree that many exceptions and exemptions⁸ exist that favor non-religious groups as to stay at home orders and restrictions on “mass gatherings.” Rather the

⁷ 44 C.F.R. §§206.11 and 206.36.

⁸ The admissions pertain to Executive Order D 2020 044 and Public Health Order 20-28 (now Eighth Amended PHO 20-28), as made in *High Plains Harvest Church v. Polis et al.*, no. 1:20-cv-01480-RM (pending, D. Colo.) (“*Harvest Church*”), Doc 25, Defs Resp, p. 17; Doc 48, Defs Resp, p. 8 and p. 2, n.1 (incorporating Doc. 39).

dispute here is, at one level, whether State Defendants had statutory and constitutional authority to issue the discriminatory orders.

At another level, the issue is whether Federal Defendants violated RFRA and the Stafford Act in approving requests for assistance where State Defendants' federal assistance is obtained by reliance upon *ultra vires* orders which also violate the Fourteenth Amendment and the Colorado Constitution. This court is authorized to determine whether Federal Defendants violated RFRA and the Stafford Act in response to Polis's request for assistance. The responsibility of determining the limits of statutory grants of authority is a judicial function entrusted to the courts by Congress. Under Article III, Congress established courts to adjudicate cases and controversies as to claims of infringement of individual rights whether by unlawful action of private persons or by the exertion of unauthorized administrative power. *See Stark v. Wickard*, 321 U.S. 288, 309-310 (1944) ("When Congress passes an Act empowering administrative agencies to carry on governmental activities, the power of those agencies is circumscribed by the authority granted.") This principle has been reaffirmed: "We ordinarily presume that Congress intends the executive to obey its statutory commands and, accordingly, that it expects the courts to grant relief when an executive agency violates such a command." *Bowen v. Michigan Academy of Family Physicians*, 476 U.S. 667, 681 (1986), *superseded on other grounds by* 42 U.S.C. §405; *See also Leedom v. Kyne*, 358 U.S. 184, 190 (1958) (concluding that Congress favors "judicial protection of rights it confers against agency action taken in excess of its powers.")

The claims for injunctive and declaratory relief against Federal Defendants arise under RFRA, which prohibits religious discrimination caused by the **implementation** of federal law, **statutory or otherwise**. *See* 42 U.S.C. 2000bb-1(a), (b). *See also Burwell v.*

Hobby Lobby Stores, Inc., 573 U.S. 682 (2014). Implementation of what was a federal disaster funding scheme required Federal Defendants, as well as State Defendants, to comply with both federal and state statutory and constitutional law. Because State Defendants' orders were *ultra vires*, Federal Defendants cannot meet a "compelling state interest" under RFRA and Plaintiffs are entitled to relief against all Defendants.

To obtain disaster relief funds from the federal government, Governor Polis attempted to declare that a disaster emergency existed in Colorado, along with governors for most of the other forty-nine states. Polis submitted a request for funds to the President of the United States through the regional administrator for FEMA's Region VIII. In a short time, Polis's office announced the federal government's approval of his request.

The federal project to send assistance to the states was launched by the president's declaration of a national emergency and a cabinet member's declaration of a public health emergency. After that, the money and supplies were allocated to the states which, in Colorado's case, amounted to more than \$2.2 billion dollars. Polis's press release highlights the federal nature of his effort, as opposed to it being a purely state-based initiative. Specifically, his press release quotes him linking his disaster declaration directly to federal funding, saying, "This declaration ensures that Colorado can be on a level playing field with other states that already have this status like New York and Washington when it comes to federal disaster funding and Federal Emergency Management Agency (FEMA) assistance."

In addition, in his written request for funding, Polis highlighted Public Health Order 20-23 issued March 19, 2020, order (an order that harms Plaintiffs by severely restricting religious gatherings to fewer than 10, now 50 persons), and listed his executive orders and

Ryan’s public health orders as “Actions Being Undertaken” to justify the federal assistance.⁹ The Stafford Act assistance is governed by a federally-required contract between Polis and FEMA. Specifically, “Upon the declaration of a major disaster or an emergency, the Governor, acting for the State, and the FEMA Regional Administrator or his/her designee, acting for the Federal Government, shall execute a FEMA-State Agreement. The FEMA-State Agreement states the understandings, commitments, and conditions for assistance under which FEMA disaster assistance shall be provided.” §44 C.F.R. § 206.44. In addition, the Colorado Disaster Emergency Act (“CDEA”) expressly contemplates receipt of federal disaster funds. Specifically, C.R.S. § 24-33.5-704(6.5)-(7)(j) authorizes the governor to “determine the sharing of non-federal costs as required by 42 U.S.C. 5121 *et seq.*, the Robert T. Stafford Disaster Relief and Emergency Assistance Act.”

On March 27, 2020, the President signed the Coronavirus Aid, Relief, and Economic Security Act (“CARES Act”). As Secretary of the Treasury, Mnuchin oversees the interpretation of the CARES Act and provides guidance on the permissible use of payments to government recipients out of the Coronavirus Relief Fund, available only for “costs that were incurred during the period that begins on March 1, 2020, and ends on December 30, 2020 (the “covered period”).

State Defendants’ orders exempt “a range of commercial and nonreligious activities” including, for example, “marijuana dispensaries, liquor stores, hardware stores, laundromats, banks, law offices, accounting offices.”¹⁰ State Defendants will likely contend that “emergency police powers” permit the issuance of orders according to the government’s unbridled discretion, without statutory authority and without due process, because State

⁹ Doc 1, cmpl, Ex 37, attached thereto, letter from Polis to Trump, pp. 3, 6, 7.

¹⁰ *Id.* at Doc 25, p.17.

Defendants have deemed religious and certain non-religious groups to be “comparable” to each other.”¹¹

In this *Motion*, however, neither the “generally applicable law” nor “compelling state interest” tests are involved as to State Defendants’ orders, because the orders are void by exceeding the scope of State Defendants’ authority under state statutory and constitutional law and under Fourteenth Amendment due process. As a result, Federal Defendants violated Plaintiffs’ rights in the implementation of federal law under the Stafford Act, CARES Act and RFRA without a compelling state interest.

III. STANDING

An association has standing if its members otherwise would have standing to sue, and the interests at stake are germane to the organization’s purpose, and neither the claim asserted nor the relief requested requires the participation of individual members in the lawsuit. *Lujan v. Defenders of Wildlife*, 504 U.S. 555, 560 (1992); see also *Wilderness Society v. Kane County*, 581 F.3d 1198 (10th Cir. 2009). In the case at bar, Plaintiffs have standing because: 1. Plaintiffs are suffering particular injuries, Doc 1, cmpl, Ex 36-37, affids Enyart and Rhoads; 2. Plaintiffs’ injuries are fairly traceable to Federal Defendants’ implementation of Stafford Act and CARES Act funding and State Defendants’ *ultra vires*, unconstitutional orders, and 3. this Court’s order in favor of Plaintiffs will redress their injuries. See *Nat’l Collegiate Athletic Assoc’n. v. Califano*, 612 F. 2d 1382, 1392 (10th Cir. 1980) (NCAA’s request for declaratory and injunctive relief was a remedy reasonably supposed to benefit is members actually injured).

IV. BURDEN OF PROOF

¹¹ *Id.* at p.13.

State and Federal Defendants bear the burden of proof that the orders are valid. “When the Government restricts speech, the Government bears the burden of proving the constitutionality of its actions.” *United States v. Playboy Entm’t Group, Inc.*, 529 U.S. 803, 816 (2000); *see also Pursley v. City of Fayetteville, Ark.*, 820 F.2d 951, 956 (8th Cir.1987) (in response to a First Amendment challenge, the proponent of the regulation must demonstrate that the government’s objectives will not be served sufficiently by means less restrictive of first amendment freedoms); *Casey v. City of Newport, R.I.*, 308 F.3d 106, 110-11 (1st Cir. 2002) (placing the burden of proof on the City to demonstrate its content-neutral restrictions were narrowly tailored); *Hays Cnty. Guardian v. Supple*, 969 F.2d 111, 118 (5th Cir.1992) (the government bears the burden of proof with regard to content-neutral regulations).

As a general matter, statutes and ordinances are given a presumption of constitutionality. *Gillmor v. Thomas*, 490 F.3d 791, 798 (10th Cir.2007). However, the presumption of constitutionality does not apply, even to a “duly enacted” statute, if it infringes upon First Amendment rights. *ACORN v. Municipality of Golden*, 744 F.2d 739, 746 (10th Cir.1984) (when a duly enacted law infringes on the exercise of First Amendment rights, its proponent bears the burden of establishing its constitutionality). In the case at bar, the orders are not entitled to a presumption of constitutionality for two reasons: they were not “duly enacted” by a legislative body and they infringe on the exercise of First Amendment rights.

The canon of “constitutional avoidance” does not apply in the case at bar. The canon is a judicial doctrine to avoid striking a law on constitutional grounds when the law is capable of an interpretation that does not trammel upon fundamental rights. However, the

canon of avoidance does not apply in the case at bar, first, because, the orders were not legislative enactments, but were issued by “lower tribunals,” i.e. State Defendants. *See San Christina Invest. Co., v. San Francisco*, 141 P. 384 (1914) (the conclusiveness of determinations by the general legislature is not only not applied to the proceedings of inferior tribunals, but is distinctly held to be non-applicable). More importantly, however, the orders are *ultra vires*, violate due process and discriminate against churches for their modes of worship.

V. ARGUMENT

Plaintiffs are likely to succeed on the merits of each claim, as follows:

1. First Claim - Declaratory Judgment that the Treasury and HHS Defendants Implemented the CARES Act in Violation of RFRA.

a. RFRA prohibits the government from substantially burdening the free exercise of religion unless the burden furthers a compelling state interest by the least restrictive means. 42 U.S.C. §2000bb-1.¹² The prohibition applies “to all Federal law, and the implementation of that law, whether statutory or otherwise ...” 42 U.S.C. §2000bb-3. Notably, the Ninth Circuit upheld a RFRA suit for injunctive and declaratory relief by Muslim residents of California against the FBI and its director, Christopher Wray, in claims for violations of the

¹² (a) In general -Government shall not substantially burden a person's exercise of religion even if the burden results from a rule of general applicability, except as provided in subsection (b).

(b) Exception - Government may substantially burden a person's exercise of religion only if it demonstrates that application of the burden to the person—

(1) is in furtherance of a compelling governmental interest; and

(2) is the least restrictive means of furthering that compelling governmental interest.

(c) Judicial relief - A person whose religious exercise has been burdened in violation of this section may assert that violation as a claim or defense in a judicial proceeding and obtain appropriate relief against a government. Standing to assert a claim or defense under this section shall be governed by the general rules of standing under article III of the Constitution.

Foreign Intelligence Surveillance Act (FISA). *Fazaga v. Federal Bureau of Investigation*, 916 F.3d 1202, 1242, 1244 (9th Cir. 2019) (holding that injunctive relief is available under the constitution and that the Privacy Act and RFRA, taken together, function as a remedial scheme to vindicate First Amendment rights).

b. Treasury and HHS Defendants¹³ are engaged in the “implementation of federal law” under the Stafford and CARES Acts and therefore, under RFRA. Treasury Defendants¹⁴ awarded Polis’s requested funds pursuant to 42 U.S.C. §247d and the CARES Act. For purposes of jurisdiction over the agencies, Federal Defendants’ approvals are final actions substantially burdening Plaintiffs, capable of judicial review. The exception to judicial review is confined to those rare “administrative decision[s] traditionally left to agency discretion.” *Department of Homeland Security v. Regents of Univ. of Calif.*, No. 18-587, p. 10 (Roberts, C.J.) (slip opin. June 18, 2020), *citing Lincoln v. Vigil*, 508 U. S. 182, 191 (1993).

c. State Defendants openly admit in *Harvest Church* that they are restricting the free exercise of religious beliefs.¹⁵ They also acknowledge that their orders discriminate. The orders give exemptions to “a range of commercial and nonreligious activities” including, for example, “marijuana dispensaries, liquor stores, hardware stores, laundromats, banks, law offices and, accounting offices.”¹⁶ At the same time, State Defendants admit¹⁷ that “houses of worship must still comply with social distancing and limits on gathering size,” and that the

¹³ Defendants Mnuchin, Treasury, Azar and HHS.

¹⁴ Defendants Treasury and Mnuchin.

¹⁵ See n. 8 thru 11, *supra*.

¹⁶ *Id.* Doc 25, p.17.

¹⁷ See n. 8 thru 11, *supra*.

“language has remained largely unchanged from the original Stay at Home order.”¹⁸ Polis’s original Stay at Home order was EO-17, issued March 25, 2020, accompanied by Ryan’s PHO 20-24, amended “several times.”¹⁹ Churches may only host “more than one ten-person gathering in the same building, at the same time, provided that the gatherings occur in separate rooms.” *Id.* State Defendants contended as of July 21, 2020, that church gathering rules have increased “permission” to hold gatherings of up to 50 people, though not more than 50% of the occupancy limit and only where “physical distancing of 6 feet is observed.”²⁰ Multiple 50-person gatherings are allegedly permitted in the same church building at the same time, provided they are in separate rooms. *Id.* at 9. “Large houses of worship” may host indoor gatherings of up to 100 people. *Id.* The affidavits of Pastors Enyart and Rhoads establish that they and their church members are being suppressed by these restrictions. Doc 1, cmpl, Ex 35-36, affidavits.

d. Congress did more than merely establish the balancing test used in the Free Exercise line of cases and provided even broader protection for religious liberty than in those cases. *Burwell v. Hobby Lobby, Inc.*, 134 S. Ct. 2051 (2014). Federal Defendants lack both a “compelling state interest” and a “least restrictive means” to implement the CARES Act because State Defendants’ admitted burden on Plaintiffs’ free exercise of religion lacks legal authority under Colorado’s state statutes, the state constitution, and the Fourteenth Amendment, as briefed, *infra*. Accordingly, Federal Defendants have no compelling state interest for violating Plaintiffs’ rights while implementing federal law.

¹⁸ *Id.*, State Defs Resp, Doc 25 at 10, filed 5/28/20.

¹⁹ *Id.* at 8.

²⁰ *Id.*, State Defs Resp, Doc 48 at 8, filed 7/21/20.

e. In the case at bar, Federal and State Defendants have made restrictions according to whether the “speakers” are businesses or religious “houses of worship.” “[T]he fact that a distinction is speaker based does not . . . automatically render the distinction content neutral. Because ‘[s]peech restrictions **based on the identity of the speaker** are all too often simply a means to control content,’ *Citizens United v. Federal Election Comm’n*, 558 U.S. 310, 340 (2010), we have insisted that ‘laws favoring some speakers over others demand strict scrutiny when the legislature’s speaker preference reflects a content preference’ [citation omitted]. Thus, a law limiting the content of newspapers, but only newspapers, could not evade strict scrutiny simply because it could be characterized as speaker based. Likewise, a content-based law that restricted the political speech of all corporations would not become content neutral just because it singled out corporations as a class of speakers [citation omitted].” *Reed v. Town of Gilbert*, 135 S. Ct. 2218, 1230-31(2015) (emphasis added). In the case at bar, Federal Defendants implemented federal law in violation of RFRA because the implementation includes State Defendants’ “speaker based,” religious discrimination against Plaintiffs, as well as other statutory and constitutional violations, *infra*.

f. Notably, an absence of subjective hostility by Federal Defendants is not relevant to the issue of whether the government violated the First Amendment and RFRA by approving the allocation of assistance to Polis. *Hassan v. City of New York*, 804, F.3d 277, 307-09 (2nd Cir. 2015).

g. Federal Defendants also lacked a compelling state interest to approve State Defendants’ religious discrimination against Plaintiffs because State Defendants issued *ultra vires* orders and deprived Plaintiffs of due process of law under the Fourteenth Amendment and the Colorado APA. “Necessity that is higher than the Constitution can safely have no

place in American jurisprudence.” *Travelers Ins. Co. v. Marshall*, 76 S.W.2d 1007, 1010 (Tex. 1934) (citations omitted) (holding that the Texas constitution prohibits impairment of contract despite a declared emergency). “‘However broad the scope of the police power, it is always subject to the rule that the legislature may not exercise any power that is expressly or impliedly forbidden to it by the state constitution.’” *Id.* (citations omitted). In the case at bar, neither the federal or state constitutions nor the state legislature authorized the disputed orders by State Defendants.

h. Finally, “federal statutory law” is subject to RFRA “unless such law **explicitly excludes** such application by reference to this chapter (emphasis added).” 42 U.S.C. § 2000bb-3(b). Importantly, neither the CARES Act nor the Stafford Act excludes the application of RFRA.

2. Second Claim - Declaratory Judgment that DHS Defendants Violated RFRA and the Stafford Act’s Prohibition against Religious Discrimination

a. To comply with the Stafford Act, DHS Defendants’ authority to approve Polis’s request required Polis to meet at least two conditions: (1) taking appropriate action under state law, and (2) complying with the Stafford Act’s nondiscrimination provision and regulations. Here, DHS Defendants violated their authority because Polis and Ryan failed both conditions: they did not take appropriate action under state law, and, as they have openly admitted to discrimination, Federal Defendants did not comply with the Stafford Act’s nondiscrimination regulations. In approving State Defendants’ EOs and PHOs, the DHS Defendants²¹ have substantially burdened Plaintiffs’ free exercise of religion²² in

²¹ Defendants Wolf and Department of Homeland Security.

²² Doc 1, cmpl, Ex 1-36, ¶14, affid Rhoads.

violation of the First Amendment, RFRA, the Stafford Act and its implementing regulations in 44 C.F.R. §§206.11 and 206.36.

b. The Stafford Act requires regulations insuring that relief activities “shall be accomplished in an equitable an impartial manner, **without discrimination** on the grounds of race, color, **religion**, nationality, sex, age, disability, English proficiency, or economic status.” 42 U.S.C. §5151(a) (emphasis added). The statute further requires “**as a condition** of participation in the distribution of assistance or supplies” that governmental bodies “comply with regulations relating to **nondiscrimination.**” 42 U.S.C. §5151(b) (emphasis added). In this case, the State of Colorado, acting through Polis, is a “governmental body” participating in the “distribution of assistance or supplies,” for which **nondiscrimination of religion is a condition of participation.**

c. Regulations promulgated pursuant to the Stafford Act require nondiscrimination by “all personnel carrying out Federal major disaster or emergency assistance functions...” 44 C.F.R. §206.11. In the case at bar, Defendants DHS and Wolf, together with Defendants HHS and Azar, representing the “lead agency” for disaster assistance by FEMA, are themselves “personnel” and employ “personnel” within the meaning of 44 C.F.R. §206.11.

d. Significantly, the regulations also require “[c]onfirmation that the Governor has taken **appropriate action under State law** and directed the execution of the State Emergency Plan (emphasis added).” 44 C.F.R. §206.36 (c)(1). However, as shown, *infra*, Polis violated this regulation because, in issuing and approving *ultra vires* EOs and PHOs, he failed to take “appropriate action under State law.”

e. State Defendants confirmed that their actions were not merely an intra-state initiative. On the contrary, the orders were issued to obtain approval for assistance from Federal

Defendants. Specifically, Ryan issued PHO 24 through 24D, declaring her “actions and prohibitions” were necessary, “due to...the Declaration of ... a National Emergency by the President of the United States on March 13, 2020.” Doc 1, cmpl, Ex 21 thru 25.

f. In addition, Polis’s EO 138 states: “I requested that the President of the United States declare a Major Disaster for the State of Colorado, pursuant to the Stafford Act. The President approved that request on March 28, 2020.” Doc 1, cmpl, Ex 15.

g. Furthermore, on March 25, 2020, Polis made a written request (“Polis Letter”) to the President of the United States, through the regional administrator for FEMA, under Section 401 of the Stafford Act, 42 U.S.C. §§ 5121-5207, asking the President to declare a major disaster in Colorado due to COVID-19 and to grant monetary financial assistance under various Stafford Act programs and another grant program under 42 U.S.C. §§ 5170c and 5172, implemented by 44 C.F.R. §206.266. Doc 1, cmpl, Ex. 37, Polis Letter, pp. 6-8, attached thereto.

h. The Polis Letter specifically justified its request for federal moneys upon what are *ultra vires*, discriminatory EOs and PHOs by State Defendants issued between March 11 and March 24, 2020. The EOs and PHOs were thus integral to Federal Defendants’ “implementation of federal law.” State Defendants are expected to admit that their EOs and PHOs deprive churches of the free exercise of religion. They are also expected to assert that the government has a right to act upon “raw police power” in an emergency. On the contrary, Defendants have no such raw power. Their power is limited by Colorado statutes, the Colorado Constitution, federal statutes, federal regulations and the United States Constitution.

i. Notably, the case that State Defendants have relied upon²³ previously, *Jacobson v. Massachusetts*²⁴ did not uphold “raw police power.” In fact, *Jacobson* concerned a state vaccination statute rather than state-issued executive and agency orders against churches and the First Amendment. However, *Jacobson*’s current use as support for “raw police power” is alarming because of *Jacobson*’s influence on Germany’s 1933 involuntary sterilization law. Germany’s law was adopted from laws in the United States.²⁵ The infamous ruling in *Buck v. Bell*,²⁶ which became the gateway to Germany’s gas chambers, directly cited *Jacobson* in upholding Virginia’s sterilization law, specifically: “The principle that sustains compulsory vaccination is broad enough to cover cutting the Fallopian tubes. *Jacobson v. Massachusetts*, 197 U.S. 11. **Three generations of imbeciles are enough.**” 274 U.S. 208 (emphasis added). In view of *Buck v. Bell*’s dark legacy,²⁷ *Jacobson*’s popular and dangerous citation today is deplorable. But irrespective of *Buck v. Bell*, *Jacobson* is certainly not authority for politicians to violate later enacted statutory protections such as RFRA, the Stafford Act’s nondiscrimination protections, and later decisional law upholding constitutional protections

²³ *Harvest Church*, Doc 48, p. 13.

²⁴ 197 U.S. 11 (1905).

²⁵ See generally Stefan Kuhl, *The Nazi Connection: Eugenics, American Racism, and German National Socialism*, p. 25 (Oxford University Press 1994) (“The importance of the United States for German eugenicists was revealed by the allusions in nearly every German medical dissertation about sterilization in the United States as the first country to enforce comprehensive eugenics legislation.”) (citations omitted).

²⁶ 274 U.S. 200, 208 (1927).

²⁷ See generally Robert Jay Lifton, *The Nazi Doctors: Medical Killing and the Psychology of Genocide*, p. 26-27 (Basic Books 1986) (“But the regime discouraged qualifications and **employed a rhetoric of medical emergency**: ‘dangerous patients’ and ‘urgent cases’ were people with hereditary taints but still in the prime of life...The clear implication was that one could be quick to label ‘feeble-minded’ a person seen as hostile to the Nazis. . .In association with the sterilization laws, and as a further expression of racial policy, steps were taken to establish a national card index of people with hereditary taints.”) (emphasis added).

for religious freedom and due process of law. On the contrary, *Jacobson* and *Buck v. Bell* are reasons to be more resolute than ever in upholding constitutional and legislative protections.

j. The “generally applicable law” and “compelling state interest” tests are not applicable to DHS Defendants’ violations of the Stafford Act and its regulations because Polis failed to take “appropriate action under State law” in violation of 44 C.F.R. §206.36(c)(1). Accordingly, DHS Defendants lacked a compelling state interest to violate the Stafford Act, 42 U.S.C. §5151(a), 44 C.F.R. §206.11, and 44 C.F.R. §206.36(c)(1) in approving aid requested by Polis.

3. Third Claim - Declaratory Judgment that CDEA Discriminates on its Face and as Applied against Plaintiffs

a. **CDEA’s Facial Discrimination.** On one hand, government may regulate religious activity without having to satisfy strict scrutiny so long as the regulation is a “neutral law” of “general applicability.” *Employment Division v. Smith*, 494 U.S. 872, 879 (1990). In *Smith*, a general law prohibited the possession of “controlled substances” and was deemed to be a law of “general applicability.” The statute in *Smith* did not target religious exercise. It obviously applied to everyone without exception. As such, it did not need to pass a strict scrutiny analysis. On the other hand, even after *Smith*, “[a] law burdening religious practice that is not neutral or is not of general application must undergo the most rigorous of scrutiny. It must be justified by a compelling state interest and must be narrowly tailored to advance that interest. Neutrality and general applicability are interrelated, and failure to satisfy one requirement is a likely indication that the other has not been satisfied. *Church of Lukumi Babalu Aye, Inc. v. City of Hialeah*, 508 U.S. 520, 546 (1993) (holding that the city’s interest in sanitation and improper disposal could have been achieved by a general regulation rather than by

prohibiting the killing of animals in religious ceremonies while exempting the same conduct for secular reasons); *see also* *McDaniel v. Paty*, 435 U.S. 618, 639 (1978) (government may not use religion as a basis of “classification for the imposition of duties, penalties, privileges or benefits”).

b. Facially, CDEA is not a “neutral law” of “general applicability.” “Under the Constitution, the government may not discriminate against religion generally or against particular denominations.” *Morris Cnty Bd. v. Freedom From Religion Fdn.*, 139 S. Ct. 909 (2019) (Kavanaugh, Alito, Gorsuch, J., dissenting), *citing* *Larsen v. Valente*, 456 U.S. 228, 244 (1982). On its face, however, CDEA contains “speaker” exemptions for activities involving the “course or conduct of a labor dispute,” the “dissemination of news or comment on public affairs,” police forces, fire-fighting forces, and armed forces. Notably, CDEA does not exempt other constitutionally protected rights or Plaintiffs’ First Amendment protected religious activities. C.R.S. §24-33.5-702(2). The fact that CDEA exempts thousands of people statewide within favored categories, while not exempting churches, negates the purported reasons for oppressing churches. CDEA fails the first *Smith-Lukumi* test because facially, CDEA **discriminates generally** against religion and **does not apply without exception to everyone**. Accordingly, CDEA must pass a rigorous, strict scrutiny facial analysis, which it fails.

c. The aim of the section of CDEA ostensibly applicable here, C.R.S. §24-33.5-703(4) (emergency epidemic), is negated by the statute’s facial exemptions for thousands of virus “spreaders.” To declare a state-wide “emergency epidemic,” the statute requires, in part, a “novel **and highly fatal** infectious agent.” *Id.* (emphasis added). Yet **CDEA exempts** “labor disputes” and “dissemination of news or comment on public affairs” and others. Obviously,

if a virus is “highly fatal,” death will not respect the many categories of statutorily exempted “spreaders” who can fatally infect others. On its face, CDEA’s exemptions negate any basis for depriving Plaintiffs of their First Amendment rights.

d. **CDEA discriminates, as applied.** CDEA exempts even more “spreaders,” as currently applied, than it facially exempts. State Defendants will likely admit that their orders exempt, “a range of commercial and nonreligious activities” including, for example, “marijuana dispensaries, liquor stores, hardware stores, laundromats, banks, law offices, and accounting offices.” This admission, however, is a vast understatement of State Defendants’ categorical “speaker based discrimination.” In fact, CDEA has been **applied** in this case to also exempt thousands of people working in **government** operations, favored **businesses** and **entire counties** obtaining variances. Doc 1, cmpl, ¶112. “PHO 28H favors non-churches, that is, it permits businesses, together with state and local government operations, to gather indoors with more than 50% of their posted occupancy and to gather outdoors **without** “working with the appropriate local authority to obtain approval....” *Id.* at ¶88 (emphasis added). As applied, CDEA also permits “any Colorado county” to request a variance. Doc 1, cmpl, Ex 41, PHO 28 “I,” pp. 19 -20. As applied in this case, CDEA grants favored status to “Critical Government Functions.” *See* Exhibit A, attached and incorporated (copied from Doc 1, cmpl, Ex 41, p.16, “Critical Businesses”). Critical Businesses are comprised of thirteen separate categories of operations listed in eight (8) pages of a separate appendix. Doc 1, cmpl, Ex 41, Appx. F, pp. 31-39.

e. As applied to Plaintiffs, CDEA is “speaker based” discrimination. “Because “[s]peech **restrictions based on the identity of the speaker** are all too often simply a means to control content,” [citation omitted] we have insisted that “**laws favoring some speakers over others**

demand strict scrutiny when the legislature's speaker preference reflects a content preference,” [citation omitted]. Thus, a law limiting the content of newspapers, but only newspapers, could not evade strict scrutiny simply because it could be characterized as speaker based. Likewise, a content-based law that restricted the political speech of all corporations would not become content neutral just because it singled out corporations as a class of speakers [citation omitted].” *Reed v. Town of Gilbert*, 135 S. Ct. 2218, 2230-31 (2015) (emphasis added).

f. Rather than discriminate against Plaintiffs, State Defendants could have provided assistance in obtaining voluntary preventative and therapeutic treatments as a less restrictive method for responding to potential and actual COVID-19 infections.

g. State Defendants, for persons who wish to protect themselves from airborne, molecular virus particles, could have urged voluntary protective face coverings as a less restrictive method than penalizing Plaintiffs for the free exercise of their religious rights.

4. Fourth Claim - Declaratory Judgment that Polis’ EOs Exceeded his Authority under the Colorado Constitution.

a. The Colorado Constitution provides robust protection for religious liberty: “The free exercise and enjoyment of religious profession and worship, without discrimination, shall forever hereafter be guaranteed; and no person shall be denied any civil or political right, privilege or capacity, on account of his opinions concerning religion; . . . **Nor shall any preference be given by law to any. . . . mode of worship.**” Colo. Const. art. II, § 4 (emphasis added). The preference clause contained within the Religious Freedom provision in Colorado’s Constitution protects against governmental preference being given to any “mode of worship.” *Id.* “The Colorado Constitution expressly guarantees to all persons the

right, in matters of religion, to choose their own course **free of any compulsion from the state**. To secure this right it removes from the political sphere **any form of compulsory support or preference** in matters of religion. In this respect Article II, Section 4 echoes the principle of constitutional neutrality underscoring the First Amendment. That principle prohibits the type of governmental involvement that leads to restraint on free choice in religious matters or to control of churches.” *Walz v. Tax Commission*, 397 U.S. 664, at 670–71 (1970) (emphasis added).

b. Polis’ EO 17, Stay at Home, “requires Coloradoans to stay at home” and orders Ryan to define exemptions. Polis violated Plaintiffs’ “mode of worship” by an order that prohibits church members from gathering at their place of religious exercise.

c. Polis’ EO 44, Safer at Home, para. H, requires Ryan to issue a PHO that “must” advise wearing face coverings, para. H, 1, and develop mandatory social distancing requirements by all employers. This EO 44 also violates Plaintiffs’ mode of worship by requiring social distancing and face covering contrary to Plaintiffs’ chose mode of worship.

d. Polis’ EO 138, orders “Non-Medical Face Coverings” for “all individuals over ten (10) years old” in any Public Indoor Space, defined, para. R, in a way that includes Plaintiffs and is contrary to their custom.

e. Plaintiffs have been deprived of their fundamental religious liberty to operate free from governmental preference for any mode of worship. “When a governmental body threatens an individual with deprivation of liberty or property, procedural due process requires, at a minimum, notice and the opportunity for a meaningful hearing before an impartial tribunal.” *Copley v. Robinson*, 224 P.3d 431 (Colo. App. 2009). The challenged EOs and PHOs were issued without procedural due process, prior to or after the orders.

f. In July 2020, the Colorado Supreme Court held that CDEA **does not authorize** the governor to suspend a constitutional requirement. “The Colorado Disaster Emergency Act authorizes the suspension of certain statutes, rules, and regulations, **but not of constitutional provisions.**” *Ritchie v. Polis*, 2020 CO 69, ¶18 July 1, 2020 (emphasis added). Exhibit B, attached hereto. “[A constitutional] requirement cannot be suspended by executive order, even during a pandemic.” *Id.* ¶19.

g. Defendants Polis and Ryan have, through EOs and PHOs, unlawfully suspended the constitutional requirements that protect Plaintiffs’ freedom of religion and mode of worship. The mask requirement prevents Plaintiffs’ congregations from their right to free expression as recognized under Article II §4 of the Colorado Constitution (and under the First Amendment), and it prefers a mode of worship whereby persons must worship while wearing an article that is of the government’s choosing. The “social distancing” requirement prefers a mode of worship whereby persons engage in religious activities at a distance that is not consistent with Plaintiff churches’ practices and is not the mode of Plaintiffs’ choosing, including, but not limited to, when they share the sacraments of holy communion, baptism, funerals, marriage, ordinations and prayer.

h. Accordingly, Plaintiffs are entitled to a temporary restraining order against State Defendants because they have exceeded their authority under the Colorado Constitution by preferring a mode of worship that is inconsistent with that of Plaintiffs.

5. Fifth Claim - Declaratory Judgment that Polis Violated CDEA’s Conditions to Declare a Disaster Emergency.

a. Where a plaintiff claims the government has exceeded its statutory authority, “[o]ur analysis beings and ends with the text [of the statute].” *Little Sister of the Poor v.*

Pennsylvania, 591 U.S. __ (slip opinion, July 8, 2020) (upholding agency’s exemption to its contraceptive mandate for religious organization). The text of CDEA does not authorize Polis’ disaster declaration in EO 03, as amended,²⁸ because he failed to satisfy the statute’s conditions to do so. “[A] Court is not at liberty to shut its eyes to an obvious mistake, when the validity of the law depends upon the truth of what is declared....A law **depending upon the existence of an emergency** or other certain state of facts to uphold may **cease to operate if the emergency ceases** or the facts change even though valid when passed.” *Chastleton Corp. v. Sinclair*, 264 U.S. 543, 548-49 (1924) (emphasis added). In the case at bar, Polis never made the initial finding of the necessary statutory facts in order to legally invoke his limited authority under the provisions of CDEA.

b. Polis invoked CDEA in EO 03, as amended, for an unauthorized purpose of maximizing the “**chances** of avoiding widespread disruptions to **our economy**.” Polis exceeded his statutory authority to declare a “disaster emergency,” Doc 1, *cmpl*, ¶39, because CDEA required Polis to find that “a disaster [i.e., the widespread loss of life] **has occurred** or that this occurrence or the threat **thereof is imminent**.”²⁹ Polis failed to declare that “widespread loss of life” from COVID-19 was “imminent.” C.R.S. §24-33.5-704(4) (emphasis added). *Id.*, *cmpl* ¶40. His declaration violated CDEA by merely conjecturing “widespread disruptions to the economy.” In fact, later disruptions were caused by Polis’s own “shut down” orders. Polis’s EO 03 appeared to be mimicking the statutory requirement for “widespread loss of life,” but he lacked statutory authority to substitute “the economy”

²⁸ Doc 1, *cmpl*, Ex 9. Ex 17 (“amended by Executive Orders D 2020 018, D 2020 032, D 2020 058, D 2020 076, D 2020 109, and D 2020 125”).

²⁹ See *People v. Brante*, 07 CA 0427, 14-15 (Colo. App. 2009) (speculative fears did not rise to the level of an impending injury requiring immediate action to prevent the occurrence of an “imminently impending injury”), citing *People v. Handy*, 603 P. 2d 941, 943 (1979) (“The threats must be shown to be definite, specific and imminent; mere speculation is not enough”).

for widespread “loss of life.” Also, under CDEA, §703(3.5), the “presumptive presence” of coronavirus disease violates the requirement of “the occurrence or **imminent** threat of widespread ... loss of life” as well as the statutory definition of “emergency,” which requires an “immediate response”. A statutory “disaster” **does not include disruptions to the economy** or “**strains** on the healthcare system” for purposes of invoking Polis’ authority under CDEA. Doc 1, compl ¶ 41.

c. It should go without saying that Goldman Sachs is not legal authority for Polis’s executive orders. However, Polis issued EO 138, a general order to all Coloradoans over ten years of age to “wear a non-medical face covering over their nose and mouth,” citing as authority a Goldman Sachs position that masks in Colorado would save the United States economy from a “hit.” Doc 1, compl, Ex 15, EO 138. At no time has Polis declared that COVID-19 posed an “imminent threat of widespread loss of life” as required by CDEA in C.R.S. §§24-33.5-703(3) and 704(4). Under §704(4), the governor is required to “find” the disaster as “occurred” or the “threat is imminent” of “widespread loss of life,” not that a virus is presumed to be in the state. *See People v. Handy, supra*, n.29. This requirement in the statute would be meaningless if the governor’s declaration were not subject to judicial review by this Court.

d. Accordingly, Polis’s attempted disaster declaration, as amended, is subject to judicial review. *See Chastleton*, 264 U.S. at 548 (“In our opinion it is open to inquiry whether the exigency still existed upon which the continued operation of the law depended”); *See also Home Building & Loan Assn. v. Blaisdell*, 29 U.S. 398 (1934) (upholding emergency statute changing foreclosure remedies where contracts were not rendered invalid but statute merely allowed homeowners to apply to state court to extend the period of redemption provided the

mortgagee was afforded notice and hearing and debtor met other conditions). In considering the Constitution's Contract Clause, the Court in *Blaisdell* noted, "while the declaration by the legislature as to the existence of the emergency was entitled to great respect, **it was not conclusive, and, further, that a law depending upon the existence of an emergency** or other certain state of facts to uphold it may cease to operate if the emergency ceases or the facts change even though valid when passed." *Id.* at 442 (emphasis added), *citing Chastleton*.

e. Nor did the mere allegation in EO 03 that "presumptive positive" cases existed in Colorado equate to an "imminent" and "widespread loss of life" under C.R.S. §24-33.5-703(3.5) inasmuch as "widespread loss of life" had not "occurred" in Colorado and such was only "modelled" for possible non-imminent occurrence. The virus was not a "disaster emergency" of "imminent" threat to "widespread loss of life," but admittedly, to other stated interests. "A declaration of **emergency** by the chief executive of the state is entitled to great weight **but is not conclusive.**" *Scheuer v. Rhoades Kraus*, 416 U.S. 232, 250 (1974) (emphasis added) (reversing dismissal where complaint against governor challenged his declaration of emergency), overruled on other grounds, *Davis v. Scheuer*, 468 U.S. 183 (1984). The award of assistance under the CARES and Stafford Acts creates an appearance of corruption or conflicting interests, as set forth, *supra*. Doc 1, cml ¶ 43. "**It does not follow** from the fact that the executive has this range of discretion, deemed to be a necessary incident of his power to suppress disorder, that every sort of action the Governor may take, no matter how unjustified by the exigency or subversive of private right and the jurisdiction of the courts, otherwise available, is conclusively supported by **mere executive fiat**. The contrary is well established." *Sterling v. Constantin*, 287 U.S. 378, 401 (1932) (emphasis added).

6. Sixth Claim - Declaratory Judgment that Polis' EOs Exceed the Scope of his Authority under CDEA.

a. As to orders restricting Plaintiffs speech, assembly and religious freedom, Polis's orders are *ultra vires* under Colorado statutes.³⁰ CDEA "authorizes the suspension of certain statutes, rules, and regulations, **but not of constitutional provisions.**" *Ritchie v. Polis*, *supra*, Exhibit B, attached hereto. Polis's EOs violate both the Colorado Constitution and the scope of his statutory legal authority. In turn, Ryan's PHOs lack legal authority because her source of authority was Polis's EOs.

b. The provisions of CDEA merely authorize a governor to activate "state, local and interjurisdictional disaster emergency plans" and the governor's role as commander-in-chief of "any organized and unorganized militia...." C.R.S. §24-33.5-704(5)-(6).³¹ However, the statute does not authorize Polis and Ryan to issue orders such as those in the case at bar and in the process, ignore the Administrative Procedure Act, fundamental due process and constitutional provisions that guarantee Plaintiffs' religious rights under the United States and Colorado Constitutions. *See Colo. Constn.*, art. II §4.

c. Specifically, the governor's statutory disaster authority under CDEA is to convene advisors, suspend certain described statutes and procedures "for the conduct of state business" if "strict compliance" would "prevent, hinder or delay" coping with the emergency," compel evacuations and routes of ingress/egress, control a disaster area, alcoholic beverages, firearms, explosives, and combustibles, and determine the sharing of non-federal costs as required by the Stafford Act. §704(6.5)-(7)(j).

³⁰ Doc 1, *cmpl*, Sixth Claim for Relief.

³¹ Doc 1, *cmpl*, ¶ 41.

d. Polis, under CDEA's framework, had no authority to give orders to Ryan to discriminate against Plaintiffs. Accordingly, Plaintiffs are entitled to an injunction that Polis's executive orders that exceed the scope of his authority under CDEA and as such, his executive orders are null and void.

7. Ninth Claim - Declaratory Judgment that Polis's Orders are Void for Vagueness.

a. Government regulation must be sufficiently clear so that ordinary people can understand what conduct is being prohibited and so that the regulation does not encourage arbitrary and discriminatory enforcement. *Chalmers v. City of Los Angeles*, 762 F.2d 753, 757 (9th Cir. 1985), citing *Grayned v. City of Rockford*, 408 U.S. 104, 108 (1972) and *Kolender v. Lawson*, 461 U.S. 352, 357 (1983); see also *Sessions v. Dimaya*, 138 S. Ct. 1204, 1227 (2018) (Gorsuch, J., concurring) ("Although today's vagueness doctrine owes much to the guarantee of fair notice embodied in the Due Process Clause, it would be a mistake to overlook the doctrine's equal debt to the separation of powers.")

b. The issue in *Chalmers* was that two city ordinances contained conflicting provisions. "Rather than covering a narrow subject, one ordinance sought to proscribe all vending activity in a broad city area," while another ordinance was "facially contradictory." *Chalmers*, 762 F. 2d. at 758. "Evidence at trial was that the City Attorney was not certain of the ordinances' meanings." *Id.* Moreover, "[t]he plaintiff did all she could reasonably be expected to do in determining the City's requirements before engaging in her [protected activity], even to the point of requesting clarification of the conflicting and vague ordinances. *Id.* The court in *Chalmers* upheld a jury verdict for the plaintiff whose problems rested "with lawmakers' creation of conflicting and inherently unclear ordinances." *Id.*

c. In the case at bar, Polis's orders are "inherently unclear." They lack a format that gives notice to ordinary persons as to what is prohibited or mandated and as to whom the orders apply. Polis has issued approximately 152 EOs, consisting of an estimated 395 pages, between February 2020 and August 4, 2020. Doc 1, cmpl, Ex 18. Changes to the EOs can only be verified by line-by-line comparisons. By way of example, EO-138 provides, "Except as modified by this Executive Order, **all Executive Orders or Public Health Orders**, including Public Health Order 20-31, issued due to COVID-19 and that are currently in effect shall remain in full force and effect as originally promulgated (emphasis added)." However, EO 138 **does not specify** which Public Health Orders and Executive Orders are "currently in effect." Plaintiffs and this Court can only guess at the meaning. Doc 1, cmpl ¶57.

d. In addition, EO 138, issued July 16, 2020, is titled, "Amending and Extending Executive Orders D 2020 039, D 2020 067, D 2020 092, and D 2020 110 Ordering Individuals in Colorado to Wear Non-Medical Face Coverings." Polis does not define "appropriate under industry standards" nor the industry involved for required masks.

8. Tenth Claim - Declaratory Judgment that Ryan's Orders are Void for Vagueness.

a. The guarantee of "fair notice" is the essence of due process. *See Sessions v. Dimaya*, *supra*. But "fair notice" is absent from Ryan's public health orders.

(1) the volume, frequency and unpredictable dates for issuance of new orders -- more than 500 pages issued since mid-March 2020 -- make them impossible for persons of ordinary intelligence to follow.

(2) the numbering of the orders is misleading because the content is subject to change even if the number stays the same when new orders are issued. PHO 28 is on its “Ninth Amended” iteration. Doc 1, cmpl, Ex 41.

(3) the naming of the orders is misleading because the content is not fairly described. “Safer at Home and in the Vast, Great Outdoors,” in its “Sixth Amended” iteration, included a wholly new litany of regulations for “houses of worship.” The title did not give notice that houses of worship were the subject of new regulations. On March 20, 2020, the title of Ryan’s PHO 23 referred to “social distancing.” But buried inside the text, para. 6, the order limited “gathering of individuals to no more than (10) people...” It expressly applied to “faith-based events,” para. I, and expressly exempted numerous organizations. Doc 1, cmpl, Ex 20, PHO 23.

(4) the absence of defined terms causes confusion. PHO 23 is void for vagueness in regard to the meaning of “mass gathering,” ostensibly being a “planned or spontaneous event with a large number of people in attendance that could strain the planning and response resources of the community hosting the event, such as a concert, festival, conference or sporting event.” However, PHO 23 does not define the meaning of “the community hosting the event,” nor the phrase, “strain the planning and response resources.”

(5) the language of the orders is a contradictory and confusing mix of permissive and mandatory language, but topped off with the threat of criminal prosecution. Doc 1, cmpl, Ex 32, PHO 28F. **Section II, M**, “Houses of Worship,” in **PHO 28H**, p. 13, contains a litany of minute regulatory orders with both mandatory and permissive language, i.e. “encouraged” and “should,” but also, “must” “shall” and “as authorized.” Doc 1, cmpl, Ex 34, PHO 28H.

(6) the use of hyperlinks adds to the volume of the orders and is confusing by incorporating links to permissive “guidance” or “guidelines.” Doc 1, cmpl, Ex 34.

(7) the single-spaced, lengthy nature of the orders requires line-by-line, even word-by-word, comparison to the previous order to ascertain changes that might have slipped in without warning. PHO 28H is 46 pages long (even longer than this motion). Doc 1, cmpl, Ex 34.

(8) the PHOs are only accessible to people who own cell phones or computers or otherwise have internet access.

b. **PHO 28H, Sec. II, M** restricts Plaintiffs’ “indoor congregations” to “50% of the posted occupancy limit indoors not to exceed 50 people, whichever is less, per room, while meeting the 6 feet distancing requirements....” Furthermore, for outdoor services, Plaintiffs must “work with the appropriate local authority to obtain approval....” This language constitutes a requirement for a type of “permit” to hold outdoor services. However, the “appropriate local authority” is **not defined**. In addition, the language ordering Plaintiffs “to work with the appropriate local authority” grants **unbridled discretion** to government officials to withhold or approve Plaintiffs’ outdoor services without any notice to Plaintiffs of the standards for approval, and without standards to guide officials in enforcing violations of such approval.

c. The United States Supreme Court struck down an ordinance that gave unbridled discretion to the government to restrict the right of free expression, but the same rule applies to Plaintiffs’ rights to assemble for religious worship:

A law subjecting the exercise of First Amendment freedoms to the prior restraint of a license, without narrow, objective, and definite standards to guide the licensing authority, is unconstitutional. "It is settled by a long line of recent decisions of this

Court that an ordinance which, like this one, makes the peaceful enjoyment of freedoms which the Constitution guarantees contingent upon the uncontrolled will of an official -- as by requiring a permit or license which may be granted or withheld in the discretion of such official -- is an unconstitutional censorship or prior restraint upon the enjoyment of those freedoms." *Staub v. Baxley*, 355 U.S. 313, 322. And our decisions have made clear that a person faced with such an unconstitutional licensing law may ignore it and engage with impunity in the exercise of the right of free expression for which the law purports to require a license. "The Constitution can hardly be thought to deny to one subjected to the restraints of such an ordinance the right to attack its constitutionality, because he has not yielded to its demands."

Shuttlesworth v. Birmingham, 394 U.S. 147, 150-151 (1969).

9. Eleventh Claim - Declaratory Judgment that Ryan's Orders Deprived Plaintiffs of the Right to Notice and Hearing Under the Fourteenth Amendment and Exceeded Her Authority under the Colorado APA .

a. "[A]n agency literally has no power to act. . . unless and until Congress confers power upon it." *Arlington v. FCC*, 569 U.S. 290, 317 (2013) (Roberts, C. J., dissenting), quoting *Louisiana Pub. Serv. Comm'n v. FCC*, 476 U.S. 355, 374 (1986). "When an agency exercises power beyond the bounds of its authority, it acts unlawfully." *Department of Homeland Security v. Regents of University of California*, no. 18-587, p. 8 (slip op., June 18, 2020) (Thomas, Alito and Gorsuch, J., concurring in part). Because Polis lacked authority to issue his orders to Ryan, she in turn had no authority to issue PHOs filled with rules without conducting rulemaking procedures set forth in C.R.S. §24-4-103. None of the rules in PHO 20-28 were published in the Colorado Register, March 10 through May 25, 2020, or subsequently. Therefore, the issuance of PHO 20-28 did not comply with the requirements of C.R.S. §24-4-103 (6)(a).

b. Nor did Ryan comply with statutory rulemaking requirements for an "epidemic" or "communicable disease" contained in C.R.S. §25-1.5-102 (1)(a)(II):

For the purposes of this paragraph (a), the board shall determine, by rule and regulations, those epidemic and communicable diseases and conditions that are dangerous to the public health. The board is authorized to require reports relating to such designated diseases in accordance with the provisions of section 25-1-122 and to have access to medical records relating to such designated diseases in accordance with the provisions of section 25-1-122.

c. The Wisconsin Supreme Court recently reviewed orders similar to Ryan's in *Wisconsin Legislature v. Secretary-Designee Palm*, 2020AP 42 (Wis. 2020). Unlike in the case at bar, the case did not challenge the governor's orders. *Id.*, para. 1, 41. However, the court held that Palm, as head of the state's department of health services "broke the law when she issued Emergency Order 28 after failing to follow emergency rule procedures . . . [and] exceeded her authority by ordering everyone to stay home., closing all "non-essential" businesses, prohibiting private gatherings of any number of people who are not part of a single household, and forbidding all "non-essential" travel." *Id.*, para. 2. The court noted that the disputed order was not within the exceptions for the definition of a "rule" of general application. *Id.*, para. 18. It also noted, "If we were to read the definition of "rule" as Palm suggests, one person, Palm, an unelected official, could create law applicable to all people during the course of COVID-19 and subject people to imprisonment when they disobeyed her order." *Id.*, para. 24 Palm's order confining all people to their homes, forbidding travel, closing businesses and any criminal penalties were declared unenforceable for exceeding her statutory authority. *Id.* para. 59.

d. Ryan's PHOs, by violating the Colorado APA, also violate the notice and hearing requirements of the Fourteenth Amendment of the United States Constitution. Ryan's PHOs violate the APA, C.R.S. §25-1.5-101 *et seq.*,³² and as a result, in directing her to issue orders, Polis did not "take appropriate action under state law" as required by the Stafford Act. Ryan

³² Doc 1, cml, ¶ 122.

has no statutory authority to issue orders to the public at large, or to segments of the public such as churches, without complying with fundamental statutory rulemaking or adjudicatory procedures. In this regard, Colorado's APA establishes basic due process of law in both rulemaking and adjudicatory proceedings. Where an agency establishes policy or procedure, it must comply with the APA, and if not, the rule is not enforceable. *Jefferson Sch. Dist. R-1 v. Div. of Labor*, 791 P.2d 1217 (Colo. App. 1990).

e. Colorado's APA provides: "The general assembly finds that an agency **should not regulate or restrict the freedom** of any person to conduct his or her affairs, use his or her property, or deal with others on mutually agreeable terms **unless it finds, after a full consideration of the effects** of the agency action, that the action would benefit the public interest and **encourage the benefits of a free enterprise** system for the citizen of the state. C.R.S. §24-4-101.5 (emphasis added).³³

f. Ryan issued PHOs containing numerous rules restricting Plaintiffs' religious freedom without fundamental due process. A "rule" is defined as being "the whole or any part of every agency statement of general applicability and future effect implementing, interpreting, or declaring law or policy or setting forth the procedure or practice requirement of any agency. "Rule" includes "regulation."³⁴ Ryan cites Polis's executive orders as her authority. CDEA does not grant authority to either Polis or Ryan to issue rules to the general public during an emergency.

g. In sum, Ryan violated the rulemaking procedures set forth in C.R.S. §24-4-103: "When any agency is required or permitted by law to make rules, in order to establish procedures and to accord **interested persons** an opportunity to participate therein, the

³³ Doc 1, compl, ¶ 116.

³⁴ C.R.S. §24-4-102(15).

provisions of this section shall be applicable (emphasis added).”³⁵ Plaintiffs are “interested persons” in the PHOs restricting their churches. However, State Defendants failed to accord Plaintiffs any opportunity to participate in Ryan’s issuance of the PHOs, in violation of the APA §24-4-103.

h. PHO 23 fell within APA §24-4-102(15) because it purported to have the “force of law and criminal sanctions.” PHO 23’s final paragraph states in bold print and in all capital letters: “Failure to comply with this order is subject to the penalties contained in Sections 25-1-114, C.R.S., including a fine of up to one thousand (1,000) dollars and imprisonment in the county jail for up to one year.” In addition, Ryan issued successive PHOs stating they were subject to a fine and imprisonment, including but not limited to PHOs 24 (3/22/20), 24A (3/26/20), 24B (4/1/20), 24C (4/9/20); PHO 28, p. 13 (4/26/20), 28A, p. 14 (5/4/20), 28B, p.14 (5/8/20), 28C, p. 14 (5/14/20), 28D, p. 14-15 (5/26/20), 28E, p. 16-17 (6/2/20), 28F, p. 17 (6/5/20), 28G, p. 18 (6-18-20), 28H, p. 19 (6/30/20).

i. Polis’s EOs and Ryan’s PHOs violate procedural due process protections required by the APA and the Fourteenth Amendment. They thus violate Plaintiffs’ free exercise rights under the First Amendment and violate the certification requirement of C.F.R. §206.36 requiring the governor to certify he took appropriate action under state law and did not discriminate.

10. Twelfth Claim – for Injunctive Relief Against All Defendants

a. A Substantial Threat of Irreparable Injury Exists.

The Tenth Circuit has held that “establishing a likely RFRA violation satisfies the irreparable harm factor.” *Hobby Lobby Stores, v. Sebelius*, 723 F.3d 1114, 1146 (10th Cir.

³⁵ Doc 1, compl, ¶118.

2013). Plaintiffs have shown likely RFRA violations in the implementation of the CARES Act and Stafford Act, and therefore, irreparable injury. A substantial threat of irreparable injury exists because Plaintiffs' free exercise is of central importance to who they are and to their spiritual identity and health. This point is substantiated by the presence of robust religious freedom protection in the Colorado Constitution.

b. Plaintiffs' Injuries Outweigh Any Harm to Defendants.

The deprivation of First Amendment freedoms, "for even minimal periods of time, unquestionably constitutes irreparable injury." *Elrod v. Burns*, 427 U.S. 347, 373 (1976). What Plaintiffs seek -- namely the restoration of their religious freedom -- is no different than the freedom State Defendants have "granted" to thousands of people in other groups by exemptions from the challenged orders. Those groups include many large retail outlets, including "big box stores" like The Home Depot and Lowes, as well as marijuana shops, liquor stores and government operations. So many establishments have been preferred to Plaintiffs that no injury will occur to Defendants, but almost no greater injury can be inflicted upon Plaintiffs than to deprive them of the right to gather together to worship according to their mode of so doing. Finally, "[I]t is always in the public interest to prevent the violation of a party's constitutional rights." *Hobby Lobby Stores v. Sebelius*, 723 F.3d 114, 1145 (10th Cir. 2013), *aff'd sub nom. Burwell v. Hobby Lobby Stores*, 573 U.S. 682 (2014) (quotations omitted).

Prayer for Relief

Wherefore, Plaintiffs pray for the following:

- a. an order temporarily restraining State Defendants from enforcing any executive and public health orders issued subsequent to March 11, 2020, against Plaintiffs,

- b. an order temporarily restraining Federal Defendants from providing further assistance to Polis under the CARES or Stafford Acts until further order of this Court,
- c. an order setting a hearing on this *Motion* for a temporary restraining order,
- d. an order setting a hearing on this *Motion* for a preliminary injunction, and for
- e. such other and further relief the Court deems just and proper.

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

This pleading is the subject of Plaintiff's *Motion for Excess Pages*, filed herewith, because this pleading exceeds the applicable type-volume limitations set forth in Judge Domenico's Practice Standards III, A(1).

CERTIFICATE OF SERVICE

I hereby certify that on August 17, 2020, I caused to be electronically filed the foregoing document with the Clerk of the Court for the U.S. District Court for the District of Colorado, using the electronic case filing system of the court. The electronic case filing system will send a "Notice of Electronic Filing" to attorneys of record who have consented in writing to accept this notice as service of this document by electronic means.

/s/ Rebecca R. Messall
Rebecca R. Messall

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLORADO**

Civil Action No. 1:20-cv-02362-DDD-NRN

DENVER BIBLE CHURCH,
PASTOR ROBERT ENYART,
COMMUNITY BAPTIST CHURCH,
PASTOR JOEY RHOADS

Plaintiffs

v.

ALEX M. AZAR II, in his official capacity as Secretary,
United States Department of Health and Human Services;
Department of Health and Human Services;
CHAD F. WOLF, in his official capacity as Acting Secretary,
United States Department of Homeland Security;
Department of Homeland Security;
STEVEN T. MNUCHIN, in his official capacity as Secretary
United States Department of the Treasury;
Department of the Treasury;
JARED POLIS, in his official capacity as
Governor, State of Colorado, and
JILL HUNSAKER RYAN, in her official
capacity as Executive Director of, together with the
Colorado Department of Health and
Environment

Defendants

PLAINTIFFS' MOTION FOR INJUNCTION PENDING APPEAL

Plaintiffs, under Fed. R. Civ. P. 62(d), request an injunction-pending-appeal ("*Motion IPA*") against State Defendants and Federal Defendants, and respectfully submit:

CERTIFICATE OF CONFERRAL

Undersigned counsel conferred with counsel for Defendants, who oppose this motion.

PROCEDURAL BACKGROUND

This *Motion IPA* arises from the Court’s order entered October 15, 2020, ECF 65 (“*Order PI*”) partially denying relief sought in Plaintiffs’ *Motion for Preliminary Injunction* (“*Motion PI*”). ECF 13. The *Order PI* enjoined State Defendants’ from enforcing capacity limits and mask dictates,¹ denied an injunction against other dictates, and denied an injunction against Federal Defendants. Plaintiffs filed a *Notice of Appeal*. ECF 74. Federal Defendants filed a *Motion to Dismiss*, not yet ruled upon. This *Motion* seeks injunctive relief pending appeal against any and all dictates by State Defendants as to Plaintiffs and an injunction against Federal Defendants to prohibit federal covid-19 aid, stimulus, or similar aid to State Defendants.²

Plaintiffs must first seek injunction here in order to seek an injunction pending appeal in the Tenth Circuit. Fed. R. App. P. 8(a)(1)(C).³ Notably, State Defendants have issued yet more versions of unconstitutional PHOs, the **current one** believed to be Third Amended PHO 20-36 (69 pages), issued December 7, 2020 (the “**Ryan PO**”). Ex. 2, attached hereto and incorporated.

STANDARD OF REVIEW

This Court may grant an injunction while an appeal is pending from its interlocutory order denying an injunction, Fed. R. Civ. P. 62(d).⁴ Plaintiffs meet the requirements for same. *Winter v. Natural Resources Defense Council, Inc.*, 555 U.S. 7, 20 (2008).

¹ On October 16, 2020, State Defendants appealed, and a stay was granted by the Tenth Circuit. State Defendants have moved to dismiss their appeal due to an opinion by the United States Supreme Court in *Roman Catholic Diocese of Brooklyn, NY v. Cuomo*.

² *Order PI* issued October 15, 2020 [ECF 65].

³ The instant *Motion IPA* incorporates Plaintiffs’ previous legal arguments and exhibits, submitted in lieu of hearings on Plaintiffs’ *Motion PI*. ECF 13, 45 and 56, with exhibits attached.

⁴ To obtain an injunction in the appellate court, a party must ordinarily move first in the district court for an order granting an injunction while an appeal is pending. Fed.R.App.P. 8(a)(1)(C).

Moreover, the timing of this *Motion IPA* is not because of any unreasonable delay by Plaintiffs or their counsel, and is not prejudicial to Defendants. After the *Order PI*, State and Federal Defendants filed various motions in this Court and in the Tenth Circuit necessitating Plaintiffs' responses.

FACTS

1. In the spring of 2020, Polis and Ryan began dictating limits on activities in the most minute aspects of personal freedom, including religion.⁵ Plaintiffs attested in twelve (12) affidavits to the multiple ways that State Defendants' dictates have burdened and are burdening the exercise of Plaintiffs' religious faith. Denied a hearing for a temporary restraining order and objecting to being denied any hearing for a preliminary injunction, ECF 38, Plaintiffs' undisputed, record testimony is too lengthy to be reiterated completely in this motion, but it is incorporated by reference to the record and excerpted in Exhibit 1, as attached and incorporated.⁶

2. The *Complaint*, ECF 1, the *Motion for TRO/Preliminary Injunction*, ECF 13, and the *Motion to Supplement the Complaint*, ECF 57, comprehensively ask for declaratory and injunctive relief as to **any** and **all** of the post-March 11, 2020 executive orders ("EOs") and public health orders ("PHOs") **applicable to Plaintiffs** for the reason that State Defendants are infringing upon

⁵ "[S]tate, local and county governments initiated a number of restrictions on residents, churches, and businesses including quarantine, stay-at-home, travel bans, shelter-in-place, lockdowns, or similar acts. Linda A. Sharp, 55 A.L.R. Fed. 3d Art. 3 "Covid-19 Related Litigation: Constitutionality of Stay-at-Home, Shelter-in-Place, and Lockdown Orders," (Westlaw 2020).

⁶ See *Complaint*, ECF 1, 1-35 (Enyart, R. 1st) and 1-36 (Rhoads 1st) and, as to this Court's minute order, ECF 51, and, as to State Defendants' supplemental brief, ECF 50, see Plaintiffs' responses, ECF 56, 56-1 (Enyart, R. 2nd), 56-2 (Rhoads 2nd), 56-4 (Enyart, N.), 56-5 (Hanks), 56-6 (Walker), 56-7 (Sutherland) and 56-8 (Wagner), and as to a brief and affidavit by State Defendants, ECF 41, 41-1 (Herlihy), see Plaintiffs' responses, ECF 45, 45-2 (Enyart, R. 1st), 45-3 (Rhoads 1st) and 45-9 (Ballentine), 45-10 (Craddock) and 45-11 (Troyer).

the First Amendment's Free Exercise Clause without any legal basis --- neither a compelling basis nor a rational basis --- and without procedural due process.

3. Under supplemental jurisdiction over state law issues,⁷ 28 U.S.C. §1367(a), and to further show that State Defendants lack a compelling state interest to infringe upon the First Amendment, Plaintiffs seek declaratory judgment, and here, an injunction pending appeal, in part because State Defendants lack any legal basis – and therefore lack a compelling basis --- to violate **Plaintiffs' federal rights**. Notably, Plaintiffs do not ask this court to issue a “mandatory injunction” to require State Defendants' compliance with state law.⁸ Rather, Plaintiffs seek a “prohibitory injunction” against any enforcement of the offending dictates including, but not limited to, those pertaining to social distancing, sanitization, hymnal dictates, restroom cleaning, handwashing, singing, sneezing, coughing and any other dictates threatening criminal prosecution arising from Plaintiffs' religious exercise in violation thereof.⁹

4. In the case at bar, the *Order PI*, ECF 65, made rulings upon the then-in-effect Second Amended PHO 20-35 (58 pages), issued October 8, 2020,¹⁰ subsequently superseded and replaced the “*Ryan PO*. The *Order PI* noted that continual amendments to State Defendants' executive and public health orders present “Plaintiffs and the Court with somewhat of a moving target.”¹¹ ECF

⁷ See ECF 1, *cmpl*, ¶5, “as well as supplemental state law questions.”

⁸ See ECF 65, *Order PI* at 38, incorrectly interpreting the *Complaint* as asking this court to instruct “state officials on how to conform their conduct to state law.”

⁹ In granting partial relief, Doc 65, the *Order PI* upheld the social distancing, sanitization and dictates other than for masks and occupancy caps, as being neutral and generally applicable, though the *Order PI* expressed uncertainty as to whether Plaintiffs' challenged these other dictates, despite the language seeking to enjoin any and all of State Defendants' orders applicable to Plaintiffs. ECF 65 at 4 (referring to “certain orders” rather than “any covid-19 related” or “all” such orders. See Doc 1 at 35 and Doc 13 at 35)

¹⁰ ECF 65, *order* at 6, fn 7.

¹¹ Plaintiffs object to the *PI Order's* description of continual amendments as being “commendable” because of the burdens imposed on religion and the other claims herein against the dictates.

65 at fn 7. Plaintiffs seek similar deference while they also challenge the lack of due process in criminal law as a “moving target.” The *Order PI* granted relief regarding mask dictates and occupancy limitations based on an equal protection comparison of secular burdens versus burdens on Free Exercise rights where no compelling interest exists for more favorable treatment of warehouses, schools, and food-processing facilities than for churches. *Id.* at 27.

The Ryan PO

1. The 69-page *Ryan PO* “enacts” a broad-spectrum criminal code. Its application includes, but is not limited to, individuals (Sec. I at 2-4), employers (Sec. III, C, 2-6), employees (Sec. III, C, 4), elected county officials, hospitals, law enforcement, county public health offices (Sec. II at 4-18), businesses (non-profit and for profit), government (including federal, state and local), outdoor events, recreation, sports and education. (Sec. III D. -R.).

2. The term “Critical Businesses” includes “Critical Services,” which includes, but is not limited to, “trash, compost, and recycling collection, processing and disposal,” as well as “self-serve laundromats and garment and linen cleaning services for critical businesses,” and “Houses of Worship and associated ceremonies such as weddings, funerals and baptisms (religious or secular). Ex 2, Appendix A, p. 38.

3. Notably, “News Media” is a “Critical Business,” but it is not grouped with laundromats, composting, and Houses of Worship. Rather, “News Media” is a separate category altogether, listing newspapers, television, radio and “other media services.” *Id.* Other “Critical Businesses” are grouped into similar categories such as “Construction,” “Financial and Professional Institutions,” “Defense,” and “Educational Institutions.” *Id.* at 38-40.

4. Plaintiffs were not provided with notice and hearing prior to being categorized with trash, compost and laundromat services. State Defendants have cited no legal basis for such a

categorization or such “lawmaking.” Houses of Worship might have been, but were not, categorized under a separate topic titled “Religious Expression,” listing gatherings for worship, prayer, music, shiva, bat mitzvah, bar mitzvah, minyan, baptism, wedding, funeral, wake, visitation, eucharistic adoration, reconciliation, veneration, confirmation, Bible study, religious education, individual pastoral counseling, marriage counseling, pre-Cana classes, business council meetings, special speakers and “other religious expression.”

5. The *Ryan PO*, *id.* at 28-9, requires that Houses of Worship (including but not limited to weddings, funerals and baptisms), *id.* at 38, obey the orders for Critical Businesses:

[Critical Businesses] **must comply** with the **guidance and directives** for maintaining a clean and safe work environment issued by the [CDPHE] and any applicable local health department [and] **must comply** with **Distancing Requirements** and all PHOs currently in effect **to the greatest extent possible** and **will be held accountable** for doing so. (Emphasis added and in original).

6. Notably, the *Ryan PO* does not identify where to locate “guidance and directives” by the CDPHE or local health departments, nor identify which PHOs are “currently in effect.” However, the *Ryan PO* itself, p. 30, includes the following definition:

E. Distancing Requirements. To reduce the risk of disease transmission, individuals shall maintain at least a **six-foot distance** from other individuals, wash hands with **soap and water for a least twenty seconds as frequently as possible** or using hand sanitizer, cover coughs or sneezes (into **sleeve or elbow, not hands**), regularly clean high-touch surfaces, and **not shake hands**.

7. In addition, the *Ryan PO*, Appendix A, requires as follows for Houses of Worship, under the labels of Critical Business, p. 36, and Critical Services, p. 38,

Any business . . . should follow all of the requirements **in this Order** for their sector, and **any applicable** CDPHE guidance, **unless doing so would make it impossible** to carry out **critical functions**, in which case **they may** exceed the sector restrictions **to the minimum** extent **necessary** to carry out critical functions.” *Ryan PO*, p. 36 (emphasis added). The phrase “critical functions” is not defined.

Critical Businesses **must comply** with the guidance and directive for maintaining a clean and safe work environment issued by the [CDPHE] and any applicable local health department.

Critical Businesses **must comply** with Distancing Requirements and all PHOs currently in effect to the greatest extent possible and **will be held accountable for doing so**. *Id.*, at 38 (emphasis added).

8. On one hand, the *Ryan PO*, p. 30, as to “Distancing Requirements,” *supra*, arguably states “permissive” rules for social distancing, sanitizing, coughing and sneezing by using the qualifying language “to the greatest extent possible,” “as frequently as possible,” and, “to the minimum extent necessary.” On the other hand, the *Ryan PO*, p. 29, states that Houses of Worship “will be held accountable.” Indeed, it states, p. 34, that it will be “enforced by all appropriate legal means” and that “[f]ailure to comply with this order could result in penalties, including jail time, and fines, and may also be subject to discipline on a professional license based upon the applicable practice act.” The due process issue is that the *Ryan PO* does not identify who decides whether “doing so would make it impossible to carry out critical functions.” In fact, it does not define “critical functions.” It does not identify who determines that a person illegally coughed into their hand instead of their elbow. These are not trivial problems with the vagueness and doublespeak in the *Ryan PO*. From personal knowledge, Pastor Enyart testifies, ECF 1, 1-35, ¶13; ECF 45-2, ¶13:

As a church, many of us feared that the government could hit us with fines in such a way that **we could actually lose our church entirely**. I am a **long-time friend of Mr. Jack Phillips of Masterpiece Cakes**. As such, I am very familiar with **his years of persecution by Colorado government officials** until he finally prevailed. On the third Sunday in May, 2020, I instructed the congregation that they should go overboard to comply with the government’s orders so that hopefully, **if anyone was fined, arrested or put in jail, it would only be myself and the church elders at risk**. Our fear of persecution for violating the government’s orders is **very real, considering what was done to my friend, Jack**.

9. Equally ambiguous is CDPHE’s website, last viewed December 29, 2020, titled “Places of worship and associated ceremonies.” Ex 3, attached and incorporated. This document is

conceivably what the *Ryan PO*, pp. 29 and 38, describes as “guidance and directives” that Houses of Worship “must follow.” **On one hand**, in this document, Ex 3, CDPHE more than once underlines the words “recommend” and “recommended,” and repeatedly, instead of using mandatory language, uses permissive phraseology such as, “these guidelines and recommendations.” **On the other hand**, one section is confusingly titled “Required Guidelines,” an oxymoron combining the permissive word, “guidelines” with the mandatory word, “required,” much like employees are “commanded” to “volunteer” with the comedic doublespeak word “voluntold.” The *Ryan PO*’s requirement that Plaintiffs “must follow” CDPHE “recommendations” is doublespeak that also fails to cite legal authority for the requirement.

10. The CDPHE webpage, Ex. 3, has a section on “Cleaning Practices,” stating, **on one hand**, “restrooms **should be** cleaned **at minimum** between each service” and “additional resources can be found at CDC” website for “faith-based organizations.” The word “should” implies a mandatory requirement. **On the other hand**, in a section titled, “touchless experience,” CDPHE uses permissive language, saying “**where possible**, places of worship **are encouraged** to create a plan which allows for worshippers to avoid all contact with surfaces.” (Emphasis added).

11. Under Frequently Asked Questions, the CDPHE webpage, Ex 3, **on one hand**, states an exception to 6-foot distancing where “doing so would make it **impossible to carry out critical functions.**” (Emphasis added). The phrase “critical functions” is, again, not defined. **On the other hand**, the FAQ pronounces that “birthdays, quinceaneras and graduations **do not meet** the definition of a critical activity or service and **must follow** the indoor and outdoor event requirements and guidelines.” (Emphasis added). The FAQ uses mandatory language that “receptions associated with these ceremonies are considered events, **not a critical service**, and **must follow** the same capacity restriction and guidelines as indoor.”

12. CDPHE does not state its statutory authority for defining, or failing to define, critical functions or services or for defining indoor and outdoor event “requirements” [*i.e.*, mandatory] versus “guidelines” [*i.e.*, permissive]. CDPHE does not use language putting Plaintiffs on notice of what conduct carries criminal penalties and what conduct is not a crime. By incorporating CDPHE guidelines and directives and by using double speak, the *Ryan PO* is void for vagueness. It is also *ultra vires* by violating the Colorado Constitution, the Colorado APA, and the First Amendment of the United States Constitution, as briefed in Plaintiffs *Motion PI*. ECF 13...

13. State Defendants’ executive and public health orders now amount to hundreds of individual proclamations and hundreds upon hundreds of pages, including in them the type of double speak, described above. For good reason, affiants testify to fear of prosecution for simply exercising their religious faith. One affiant testifies that “[t]he **government’s uncertain orders** made a concern about the virus **much worse...**”, ECF 56-4, ¶5 (Enyart, N.), and another affiant wonders if the church and members will be “**shut down, fined, or even arrested for violating** some aspect of a governmental order having to do with capacity limits, mask wearing, **social distancing, cleaning/sanitizing, or any other requirement.**” ECF 56-6, ¶7 (Walker) (emphasis added).

14. The Court’s *Order PI* denied Plaintiffs any relief from dictates involving “social distancing,” “sanitization,” and “vagueness.” The *Order PI*, despite the latest vagueness, ambiguity and doublespeak by State Defendants, affirmatively states that Plaintiffs “will, for example **have to enforce sanitization requirements, maintain social distancing between individuals and not permit shaking hands...**” ECF 65 at 26 (fn 18) and 29. The *Order PI* also denied injunctive relief against Federal Defendants’ aiding and abetting of State Defendants and for separately violating RFRA and the Stafford Act.

ARGUMENT

Likelihood of success on the merits. The *Complaint* and *Motion PI* seek to enjoin “any covid-19 related executive orders and public health orders issued on or subsequent to March 11, 2020.” ECF 1, *cmpl* at 35; ECF 13, *mtn* at 35, together with aid from Federal Defendants until Plaintiffs are granted relief from State Defendants’ oppressive orders. Plaintiffs are likely to succeed on the merits against all defendants, as follows:

A. CDEA¹² violates the First Amendment as applied by State Defendants¹³ and Federal Defendants acting together.¹⁴ The *Complaint* and *Motion PI* assert “as applied”¹⁵ First Amendment claims by reason of State Defendants’ implementation of CDEA and Federal Defendants’ actions in concert with them.¹⁶ Polis’ executive order (“EO”) on March 11, 2020, expressly cites CDEA as his statutory authorization to invoke emergency authority.¹⁷ In turn, Ryan applied CDEA to Plaintiffs by means of her PHO 20-35,¹⁸ as amended, ECF 55-1, issued 9-15-20, citing Polis’ EO as Ryan’s legal authority: “Governor Polis issued Executive Order D 2020 003 on March 11, 2020, declaring a disaster emergency in Colorado.” Plaintiffs’ First Amendment

¹² C.R.S. §24-33.5.701 *et seq.*

¹³ Doc 1, *cmpl*, Third Claim for Relief.

¹⁴ *Id.*, First, Second and Twelfth Claims for Relief. Federal Defendants also violate Fed. R. Civ. P. 65, RFRA and the Stafford Act.

¹⁵ The Third Claim for Relief, ECF 13, *cmpl*, ¶¶131-135, is expressly titled: “Declaratory Judgment that CDEA Discriminates on its Face and **as Applied.**” (emphasis added).

¹⁶ ECF 1, *cmpl* at 1; 13, *mtn PI* at 17. Federal Defendants simultaneously violate Fed. R. Civ. P. 65, RFRA and the Stafford Act. ECF 1, *cmpl* ¶¶99-105, 111-14, 123-24, 127-28, 133, 153.

¹⁷ See ECF 1, *cmpl*, ex 1-9, EO 2020-003 stating: “Pursuant to the authority vested in the Governor of the State of Colorado and, in particular, pursuant to Article IV Section 2 of the Colorado Constitution and **the relevant portions of the Colorado Disaster Emergency Act, C.R.S. §24-33.5-701 et seq.**, I Jared Polis, Governor of the State of Colorado, hereby issue **this Executive Order declaring a state of emergency** due to the presence of the corona virus disease 2019 (COVICD-19) in Colorado . . .”

¹⁸ PHO 20-35, issued 9-15-20, “supersedes and replaces Public Health Orders 20-22, 20-24, and 20-28, as amended.” [ECF 55-1 at 2].

challenges to the EOs and PHOs are not limited to a “disparate treatment” claim.¹⁹ “The First Amendment rights have been held to be fundamental and, therefore, the **classifications** in terms of the ability to exercise those rights are subject to **strict** judicial scrutiny.” Ronald D. Rotunda and John E. Nowak, Vol. 4, *Treatise on Constitutional Law: Substance and Procedure* Fifth Edition, p. 399 (Thomson Reuters 2013) (emphasis added). “Although the analysis of First Amendment classification under the equal protection guarantee is not common, it is important to remember that it is always permissible to review such laws under the guarantee.” In the case at bar, the *Order PI* utilized an equal protection analysis:

[The State] does not have the power to decide what tasks are a necessary part of an individual’s religious worship. And while religious exercise is subject to truly neutral and generally applicable regulations, once the State Begins creating exceptions for secular activities as it deems necessary, **then it is obligated to treat religious activities no less favorably, absent a compelling reason.**” ECF 65, *order* at 23 (emphasis added).

1. **In applying CDEA, State Defendants must be enjoined because they lack ANY legal basis --- compelling or rational --- for Plaintiffs’ First Amendment deprivation.** “A preliminary injunction may issue under 42 U.S.C. §1983 to enjoin the enforcement of a statute or ordinance that the court believes is unconstitutional, pending a final decision on the merits.”²⁰ Here, Plaintiffs seek to enjoin a statute, CDEA, **as applied** through unlawful EOs and PHOs. A

¹⁹ The *Order PI* correctly observes that Ryan’s PHO 20-35 “creates exemptions for a wide swath of secular institutions deemed “critical...” ECF 65, *Order PI* at 22. Moreover, the *Order PI* noted that Polis’ mask dictate (in EO 138) contains a total of eight exemptions, none of which apply to worship services. *Id.* at 23. Furthermore, regarding the occupancy limit, the *Order PI* states: “Colorado’s failure to offer a compelling reason why houses of worship are subject to greater restrictions than warehouses, schools, and restaurants violates the First Amendment’s guarantee of the free exercise of religion.” *Id.* at 29. This Court found: “So it is clear that the State’s orders [as to masks and occupancy caps] treat religious institutions less favorably than some secular institutions.” ECF 65, *Order PI* at 24.

²⁰ Vol. 2, *Civil Actions Against State and Local Governments* §14:9 at 14-24 and 25 (West 2002), citing *National People’s Action v. Village of Wilmette*, 914 F.2d 1008 (7th Cir. 1990) (injunction prohibiting enforcement of ordinance requiring door-to-door solicitors to be fingerprinted in violation of First Amendment).

court may issue a preliminary injunction “prohibiting the governmental entity from acting in an unlawful fashion until the matter can be fully adjudicated on the merits.”²¹ Under the doctrine of *Ex Parte Young*, the Eleventh Amendment does not bar suits against state officials for prospective equitable relief to end continuing violations of **federal law**. *Meiners v. Univ. of Kansas*, 359 F.3d 1222, 1232 (10th Cir. 2004) (upholding suit for declaratory and injunctive relief against chancellor and provost in their official capacities). In the case at bar, Plaintiffs seek a **prohibitory** injunction barring all defendants from violating federal law under the United States Constitution, RFRA and the Stafford Act. Notably, they do not seek a mandatory injunction that would require compliance with a state law.

a. Plaintiffs allege that the *ultra vires* character of State Defendants’ actions under state law requires a declaration that **no legal basis exists** --- compelling/strict or rational ---- for the undisputed infringement of Plaintiffs’ **federal** right to Free Exercise. By lacking legal authority under the state Constitution and/or the Colorado Administrative Procedure Act, State Defendants’ actions are not saved by simply extending unlawful actions to secular groups and then arguing that their unlawful actions apply equally to everyone. The *Complaint* and *Motion PI* seek to enjoin, as to Plaintiffs, “**any** covid-10 related executive orders and public health orders issued on or subsequent to March 11, 2020.” Doc 1, *cmpl* at 35; Doc 13, *mtn* at 35.

b. Colorado law requires that CDPHE engage in requisite “rulemaking” procedures. Under C.R.S. §24-4-102 (15), a “rule” is:

The whole or any part of every agency statement of general applicability and future effect implementing, interpreting, or declaring law or policy or setting forth the procedure or practice requirements of any agency. “Rule” includes “regulation.”

²¹ *Id.* at 14-25, *citing Spacco v. Bridgewater School Dept.*, 722 F. Supp. 834 (D. Mass. 1989) (enjoining school district to remove students from classroom space leased from Roman Catholic diocese in violation of separation of church and state).

c. The procedural requirements of “rulemaking” are set forth in C.R.S. §24-4-103.

Specifically, among other things, rulemaking requires publication. Sec. 103(3)(a):

Notice of proposed rule-making **shall be published** as provided in **subsection (11)** of this section and shall state the time, place, and nature of public rule-making proceedings that shall not be held less than twenty days after such publication, the authority under which the rule is proposed, and either the terms or the substance of the proposed rule or a description of the subjects and issues involved. (emphasis added)

d. The affidavit of attorney Branaugh shows that State Defendants failed to engage in rulemaking. ECF 45-4, *affid.* Branaugh. Requisites for “publication” are in C.R.S. §24-4-103(11) (a), providing in part:

There is hereby established the code of Colorado regulations for the **publication of rules of agencies of the executive branch and the Colorado register for the publication of notices of rule-making, proposed rules**, attorney general's opinions relating to such rules, and adopted rules

e. Rulemaking is in contrast to adjudication. If the government believes Plaintiffs have violated an existing “rule,” the procedural requirements for “adjudication” are set forth in C.R.S. §24-4-105. In the first paragraph, the statute states: “In order to assure that all parties to any agency adjudicatory proceeding are **accorded due process of law**, the provision of this section **shall** be applicable.” *Id.* at (1). A lengthy list of requirements for adjudications is contained in the statute. State Defendants, in failing to follow the rulemaking and adjudication requirements of the Colorado APA, have **no legal basis** --- therefore they neither a rational basis nor a compelling basis --- to issue the EOs and PHOs in the case at bar in violation of the First Amendment and Fourteenth Amendment due process.

f. “When a governmental body threatens an individual with deprivation of liberty or property, procedural due process requires, at a minimum, notice and the opportunity for a

meaningful hearing before an impartial tribunal.” *Copley v. Robinson*, 224 P.3d 431 (Colo. App. 2009). The challenged EOs and PHOs were issued without procedural due process, prior to or after the orders. Pastors Enyart and Rhoads testify to the lack of procedural due process. ECF 45-2, ¶12 *affid* (Enyart, R. 1st); 45-3, ¶13e, *affid* (Rhoads 1st).

g. In July 2020, the Colorado Supreme Court held that CDEA **does not authorize** the governor to suspend a state constitutional requirement. “The Colorado Disaster Emergency Act authorizes the suspension of certain statutes, rules, and regulations, **but not of constitutional provisions.**” *Ritchie v. Polis*, 2020 CO 69, ¶18 July 1, 2020 (emphasis added). “[A constitutional] requirement cannot be suspended by executive order, even during a pandemic.” *Id.* ¶19. Even adherence to the Colorado APA would not save the EOs and PHOs from unlawfulness under the Colorado Constitution’s prohibition against government infringement upon Plaintiffs’ “mode of worship.” Being unlawful under the Colorado Constitution eliminates **any** legal basis --- i.e., **any purported compelling or rational** basis --- for the EOs and PHOs and requires a finding that they violate the Free Exercise Clause of the United States Constitution

h Defendants Polis and Ryan have, through EOs and PHOs, unlawfully suspended Colorado’s constitutional protection for Plaintiffs’ freedom of religion and mode of worship. The mask requirement prefers a mode of worship whereby persons must worship while wearing an article that is of the government’s choosing. The social distancing requirement prefers a mode of worship inconsistent with Plaintiff churches’ practices. Affidavits are undisputed that social distancing, as with the occupancy requirement, infringes upon the sacraments of holy communion, baptism, funerals, marriage, ordinations and prayer. Pastor Rhoads attests to this at length. ECF 45-3, ¶¶2-5; *see* Ex 1, excerpts. Accordingly, Plaintiffs are entitled to an injunction pending appeal against State Defendants because, in acting without legal authority under the Colorado

Constitution by preferring a mode of worship inconsistent with that of Plaintiffs, State Defendants lack any basis --- either a compelling or rational basis --- for depriving Plaintiffs of their Free Exercise rights under the United State Constitution.

2. Even if the EOs and PHOs are neutral on their face, they violate the First Amendment because they unduly burden the Free Exercise of Religion, as applied. The record is undisputed that Plaintiffs live in fear that they can be arrested, or their church closed, simply by violating the EOs and PHOs. The *Order PI* erred in holding that the challenge to social distancing, sanitization and bans on coughing, sneezing, and hand shaking “would likely fail because these dictates are neutral and generally applicable, and thus likely constitutional under *Smith*.” ECF 65, *Order PI* at 21, 22, fn 17, 29. On the contrary, in *Church of Lukumi Babalu Aye v. City of Hialeah*, 508 U.S. 520 (1993), Justice Souter’s concurrence pointed out that even a law “neutral on its face,” under *Smith*, may nevertheless offend the Free Exercise Clause’s requirement for government neutrality **if the free exercise of religion is unduly burdened.**” *Id.* at 563-4 (emphasis added). “A secular law, applicable to all, that prohibits consumption of alcohol, for example, will affect members of religions that require the use of wine differently from members of other religions and nonbelievers, **disproportionately burdening** the practice of, say, Catholicism or Judaism.” *Id.*, at 561 (emphasis added). “[If] the Free Exercise Clause.... safeguards a right to engage in religious activity free from unnecessary governmental interference, the Clause requires substantive, as well as formal, neutrality.” *Id.*, at 562. On the contrary, the EOs and PHOs lack neutrality because they cut to the heart of Christian worship and unduly burden it with criminal penalties for limiting attendance to less than half of normal numbers through social distancing, prohibiting handshaking, and criminalizing the most innocuous reflexes of coughing and sneezing and criminalizing restroom cleaning routines.

a. The Seventh Circuit, in *Listecki v. Official Comm. of Unsecured Creditors*, 780 F.3d 731 (7th Cir. 2015) followed “a subsequent step after the *Smith* test, namely to consider whether a law “unduly burdens” the religious practice. If so, we revert back to the pre- *Smith* balancing test and ask whether the government has a compelling interest that is narrowly tailored to advance that interest.” *Id.*, at 735, citing *See Vision Church v. Vill. of Long Grove*, 468 F.3d 975, 996 (7th Cir. 2006). Notably, under this test, State Defendants --- having **no legal basis** to issue the EOs and PHOs under state law --- have neither a compelling state interest nor any rational basis to criminalize church attendance.

b. In the case at bar, the affidavits show that, as applied to Plaintiffs, the orders not only infringe upon a fundamental right, *i.e.*, religious exercise (“baptisms, praying by the laying on of hands, standing and sitting shoulder-to-shoulder with my fellow worshippers, and receiving holy communion according to our custom,” ECF 56-8, ¶ 11), but also, they cause Plaintiffs fear of punishment while they worship, and deter others from worshipping altogether. ECF 56-4 ¶6 (Enyart, N.) **Pastor Enyart attests**: “Our fear of persecution for violating the government’s orders is very real, considering what was done to my friend, Jack.” ECF 1, 1-35, ¶13; ECF 45-2, ¶13. **Hanks testifies**: “[T]he fear of being punished just for incorrect social distancing is a continuing source of **stress**.” *Id.*, 56-5, ¶5. **Nate Enyart attests**: “[V]iolations of the orders carry criminal penalties.” ECF 56-4, ¶6. **Walker attests**: “I attend church while wondering if we will be shut down, fined, or even arrested for violating some aspect of a governmental order having to do with capacity limits, mask wearing, social distancing, cleaning/sanitizing, or any other requirement.” ECF 56-6, ¶7.

c. Although the social distancing dictate purports to be neutral “on its face,” the dictate is applied, *de facto*, as an “occupancy” limit upon Plaintiffs’ small sanctuaries.

Accordingly, the social distancing dictate is invalid as applied to Plaintiffs' for the same reasons that the 50% occupancy limit lacks a compelling state interest.

d. *Cantwell v. Connecticut*, 310 U.S. 296 (1940), requires that **any infringement upon a fundamental right requires strict scrutiny**. It is not enough to say that, *de jure*, the PHOs require **everyone** to obey the social distancing dictate, where, **as applied** to Plaintiffs, the social distancing dictate prohibits more than fifty percent (50%) of the congregation from attending church without fear of criminal prosecution. Accordingly, strict scrutiny is required. Necessarily, strict scrutiny requires a determination of whether the orders are *ultra vires*, as set forth above and as the *Complaint* alleges. Strict scrutiny also requires review of the record. Pastor Enyart attests that in-person worship for the Sabbath (Sunday) is a Biblical requirement for all Christians. ECF 1-35 ¶9, *affid* Enyart. Another affiant attests :“Services with social distancing prevents many components of our pre-shutdown services, including baptisms, praying by the laying on of hands, standing and sitting shoulder-to-shoulder with my fellow worshippers, and receiving holy communion according to our custom.” ECF 56-8 ¶ 11, *affid* Wagner. *See also*, ECF 1, *cmpl* ¶2; see also ECF 45-4, ¶¶2-6, *affid* (Rhoads 1st).

e. “The Court has held that each of the guarantees of the First Amendment are a fundamental right and made applicable to the states through the due process clause of the Fourteenth Amendment. Thus, **whenever** a state burdens the freedom of religion,²² speech, press, assembly, or petition, the law must be analyzed under the **strict scrutiny** required by the First Amendment **as well as the general guarantees** of the **due process** and **equal protection** provisions.” Rotunda and Nowak, *supra* at 397 (footnotes shortened) (emphasis added). “The First

²² *Cantwell v. Connecticut*, 310 U.S. 296 (1940) (free exercise); *Everson v. Board of Education*, 330 U.S. 1 (1947) (establishment clause).

Amendment rights have been held to be fundamental and, therefore, the classifications in terms of the ability to exercise those rights are subject to strict judicial scrutiny.” *Id.* at 399. Importantly, “in passing upon constitutional questions **the statute must be tested by its operation and effect.**” *Near v. Minnesota*, 283 U.S. 697, 708 (1931) (striking down state libel statute). The record in the case at bar shows the severe burden that dictates for social distancing, sanitization, coughing, sneezing, and others have upon Plaintiffs’ religious exercise.

f. Because the challenged dictates burden the exercise of religion, they burden a fundamental right. As such they must be given strict scrutiny under *Cantwell*, rather than a rational relation test used for equal protection claims involving non-suspect classifications. *Compare Pennell v. City of San Jose*, 485 U.S. 1 (1988) (upholding rent control ordinance as rationally related to a legitimate state interest). In *Cantwell*, a state court denied an “as applied” First Amendment claim against a statute making a crime of soliciting donations. Notably, the statute equally punished soliciting for “religious causes” and soliciting for “charitable or philanthropic causes.” The state court upheld the statute because of a purportedly valid public purpose to prevent fraud:

It overruled the contention that the Act, **as applied to the appellants**, offends the due process clause of the Fourteenth Amendment because it abridges or denies **religious freedom and liberty of speech and press**. The court stated that it was **the solicitation** that brought the appellants within the **sweep of the Act, and not their other activities in the dissemination of literature**. It declared the legislation constitutional as an effort by the State **to protect the public against fraud** and imposition in the solicitation of funds for what purported to be religious, charitable, or philanthropic causes.

310 U.S. at 302 (emphasis added).

g. However, the United States Supreme Court rejected the state’s analysis. The statute punished the plaintiffs’ religious exercise. Period. It was irrelevant that the statute equally punished solicitations for similar groups like charities and philanthropies:

First. We hold that the statute, as construed and **applied to the appellants**, deprives them of their **liberty without due process** of law in contravention of the Fourteenth Amendment. The **fundamental concept of liberty embodied in that Amendment embraces the liberties guaranteed by the First Amendment**. The First Amendment declares that Congress shall make no law respecting an establishment of religion or **prohibiting the free exercise thereof**. The Fourteenth Amendment **has rendered the legislatures of the states as incompetent as Congress to enact such laws**.

310 U.S. at 303 (emphasis added).

3. The *Ryan PO* is void for vagueness because the guarantee of “fair notice” is the **essence of due process**. *See Sessions v. Dimaya*, 138 S. Ct. 1204 (2018).

a. But “fair notice” is absent from the *Ryan PO*.

(1) the language of the orders is a contradictory and confusing mix of **permissive and mandatory language**, but topped off with the **threat of criminal prosecution**.

(2) the volume, frequency and unpredictable dates for issuance of new orders -- more than 500 pages issued since mid-March 2020 -- make them impossible for persons of ordinary intelligence to follow.

(3) the numbering of the orders is misleading because the content is subject to change even if the number stays the same when new orders are issued.

(4) the naming of the orders is misleading because the content is not fairly described.

(5) the absence of defined terms causes confusion.

(6) the use of hyperlinks adds to the volume of the orders and is confusing by incorporating links to permissive “guidance” or “guidelines.” Doc 1, *cmpl*, Ex 34.

(7) the single-spaced, lengthy nature of the orders requires line-by-line, even word-by-word, comparison to the previous order to ascertain changes that might have slipped in without warning. ECF 1, *cmpl*, Ex 34.

(8) the PHOs are only accessible to people who own cell phones or computers or otherwise have internet access.

b. The United States Supreme Court struck down an ordinance that gave unbridled discretion to the government to restrict the right of free expression. *Shuttlesworth v. Birmingham*, 394 U.S. 147, 150-151 (1969). Similarly, the vagueness and doublespeak in the Ryan PO deprive Plaintiffs of due process by giving State Defendants unbridled discretion to define the meaning of the *Ryan PO*.

B. Treasury and HHS Defendants Implemented the CARES Act in Violation of RFRA.

1. On December 28, 2020, President Trump issued a proclamation in recognition of Thomas a Becket, martyred in his cathedral and remembered for the development of religious freedom from government control. Exhibit 4, attached. The proclamation is timely to consider in the case at bar. RFRA prohibits the federal government from substantially burdening the free exercise of religion unless the burden furthers a compelling state interest by the least restrictive means. 42 U.S.C. §2000bb-1.²³ The prohibition applies “to all Federal law, and the implementation of that law, whether statutory or otherwise ...” 42 U.S.C. §2000bb-3. Treasury and HHS Defendants are federal agencies engaged in the “implementation of federal law” under the Stafford and CARES acts. Therefore, RFRA applies to them for the purpose of their actions as they relate

²³ (a) In general -Government shall not substantially burden a person's exercise of religion even if the burden results from a rule of general applicability, except as provided in subsection (b).

(b) Exception - Government may substantially burden a person's exercise of religion only if it demonstrates that application of the burden to the person—

(1) is in furtherance of a compelling governmental interest; and

(2) is the least restrictive means of furthering that compelling governmental interest.

(c) Judicial relief - A person whose religious exercise has been burdened in violation of this section may assert that violation as a claim or defense in a judicial proceeding and obtain appropriate relief against a government. Standing to assert a claim or defense under this section shall be governed by the general rules of standing under article III of the Constitution.

to Plaintiffs’ constitutional rights. Federal Defendants work in concert with State Defendants to provide funds under the Stafford and CARES acts. Violations of Plaintiffs’ federally-protected rights occurred when Federal Defendants, in contravention of the Stafford and CARES acts, approved the conditions of mitigation submitted by Polis for allocation of federal resources and approved by Federal Defendants in spite of the State Defendants’ admitted discrimination against Plaintiffs.

2. Federal Defendants lack both a “compelling state interest” and a “least restrictive means” to implement the CARES Act because State Defendants’ admitted burden on Plaintiffs’ free exercise of religion lacks legal authority under Colorado’s state statutes, the state constitution, and the Fourteenth Amendment, as briefed in the original *Motion for Temporary Restraining Order and Preliminary Injunction*. ECF 13. Congress did more than merely establish the balancing test used in the Free Exercise line of cases and provided even broader protection for religious liberty than in those cases. *Burwell v. Hobby Lobby, Inc.*, 134 S. Ct. 2051 (2014)

3. Federal Defendants also lack a compelling state interest to approve State Defendants’ religious discrimination against Plaintiffs because State Defendants’ dictates are issued *ultra vires*, vague and deprive Plaintiffs of due process of law under the Fourteenth Amendment and the Colorado APA.

4. Finally, “federal statutory law” is subject to RFRA “unless such law explicitly excludes such application by reference to this chapter (emphasis added).” 42 U.S.C. §2000bb-3(b). Importantly, neither the CARES Act nor the Stafford Act excludes the application of RFRA.

C. DHS Defendants Violate RFRA and the Stafford Act’s Prohibition against Religious Discrimination.

1. To comply with the Stafford Act, DHS Defendants’ authority to approve Polis’s request required Polis to meet at least two conditions: (1) taking appropriate action under state law, and (2) complying with the Stafford Act’s nondiscrimination provision and regulations. Here, DHS Defendants violated their authority because Polis and Ryan failed both conditions: they did not take appropriate action under state law, and, as they have been found by this Court to have likely discriminated, Federal Defendants did not comply with the Stafford Act’s nondiscrimination regulations. In approving State Defendants’ EOs and PHOs, the DHS Defendants²⁴ have substantially burdened Plaintiffs’ free exercise of religion²⁵ in violation of the First Amendment, RFRA, the Stafford Act and its implementing regulations in 44 C.F.R. §§206.11 and 206.36.

2. The Stafford Act requires regulations insuring that relief activities “shall be accomplished in an equitable an impartial manner, without discrimination on the grounds of race, color, **religion**, nationality, sex, age, disability, English proficiency, or economic status.” 42 U.S.C. §5151(a) (emphasis added). The statute further requires “as a condition of participation in the distribution of assistance or supplies” that governmental bodies “comply with regulations relating to nondiscrimination.” 42 U.S.C. §5151(b) (emphasis added). In this case, the State of Colorado, acting through Polis, is a “governmental body” participating in the “distribution of assistance or supplies,” for which nondiscrimination of religion is a condition of participation. Yet, State Defendants admit to and have been found likely to have discriminated, as discussed herein. Regulations promulgated pursuant to the Stafford Act require nondiscrimination by “all personnel

²⁴ Defendants Wolf and Department of Homeland Security.

²⁵ ECF 1, *cmpl*, Ex 1-36, ¶14, *affid Rhoads*.

carrying out Federal major disaster or emergency assistance functions...” 44 C.F.R. §206.11. Significantly, the regulations also require “[c]onfirmation that the Governor has taken appropriate action under State law and directed the execution of the State Emergency Plan (emphasis added).” 44 C.F.R. §206.36 (c)(1). But he did not, as shown in the *Motion for Temporary Restraining Order and Preliminary Injunction*, ECF 13, and in this motion.

CONCLUSION

WHEREFORE, Plaintiffs pray for an injunction pending appeal prohibiting the enforcement of any EOs and PHOs against Plaintiffs issued subsequent to March 9, 2020 and an injunction prohibiting Federal Defendants from providing aid to State Defendants until further order of this Court, and that the Court will grant such other and further relief that the Court deems just and proper.

Respectfully submitted,

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Attorneys for Plaintiffs

CERTIFICATE OF COMPLIANCE

This pleading exceeds the 4000 word limit contained in Judge Domenico's Practice Standards III, A(1), having approximately 7,088 words, and is the subject of a Motion for Leave to File Excess Words, filed herewith.

s/ Rebecca R. Messall
Rebecca R. Messall

CERTIFICATE OF SERVICE

I hereby certify that on January 2, 2021, I caused to be electronically filed the foregoing document with the Clerk of the Tenth Circuit Court of Appeals, using the electronic case filing system of the court, which will send a "Notice of Docket Activity" to attorneys of record who have consented in writing to accept service of this document by electronic means.

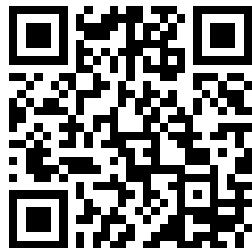
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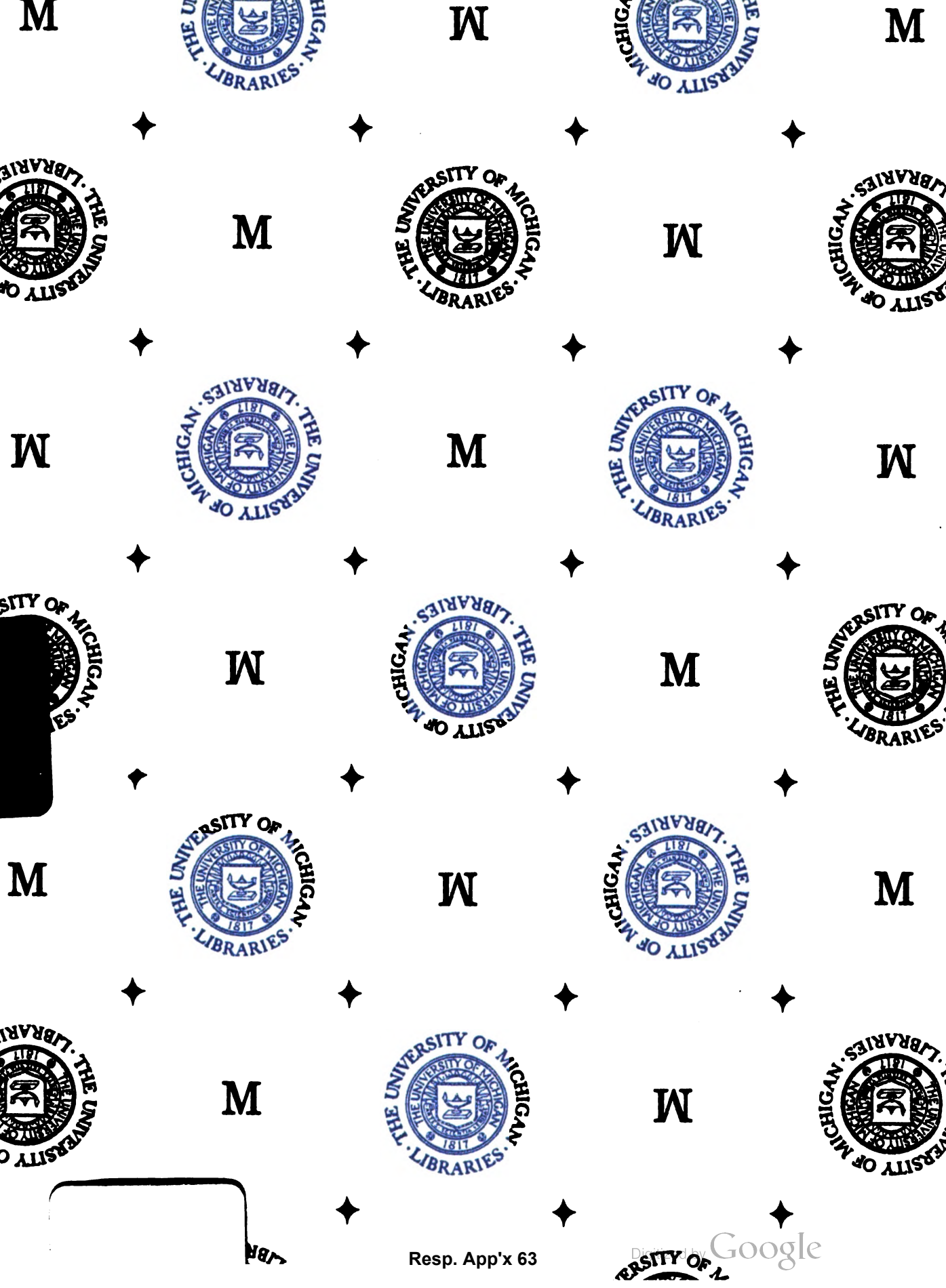
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Volume One
DISASTER PREPAREDNESS



“... we will seek to set clear and intelligent targets for research and development, so that our resources can be focused on projects where an extra effort is most likely to produce a breakthrough and where the breakthrough is most likely to make a difference in our lives. Our initial efforts will include new or accelerated activities aimed at . . . reducing the loss of life and property from earthquakes, hurricanes and other natural disasters . . .”

President Richard Nixon
“State of the Union”
January 20, 1972

Report to the Congress

DISASTER PREPAREDNESS

Executive Office of the President

United States, **Office of Emergency Preparedness**

January 1972

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Disaster preparedness is a task never completed. It represents an unbroken chain stretching from prevention through ultimate recovery and requires continuous effort at all levels of government.

*George A. Lincoln, Director
Office of Emergency Preparedness
Executive Office of the President*

Gen. 16412
DEPOSITED BY THE
UNITED STATES OF AMERICA
5/25/72

EXECUTIVE OFFICE OF THE PRESIDENT

OFFICE OF EMERGENCY PREPAREDNESS

WASHINGTON, D.C. 20504

OFFICE OF THE DIRECTOR

Honorable Spiro T. Agnew
President of the Senate

Honorable Carl Albert
Speaker of the House of Representatives

Sirs:

I am pleased to transmit to the Congress the enclosed report on Disaster Preparedness in response to Section 203(h) of Public Law 91-606.

The report reflects a comprehensive study of the types of major natural disasters experienced in the United States and offers findings and potential solutions to prevent or minimize the loss of life and damage to property. In the preparation of the study, careful consideration has been given to the views of Federal agencies, State and local governments, professional and trade associations, research and academic institutions, private volunteer organizations, and individual experts. The final analysis and findings, however, were developed independently by an Office of Emergency Preparedness Disaster Study Group under my direction.

The main thrust of this report points to the need for improvement in disaster preparedness at all levels. The findings contain potential initiatives for moving further toward an improved, concerted national disaster preparedness program. I commend them to the attention of the Congress; however, they should not be viewed as specific proposals for legislation or funds.

I am providing the report to all Federal agencies having an interest in the findings, with a request that each agency consider those pertinent to its responsibilities in the preparation of present and future programs. I have requested that these agencies keep my office informed of actions related to the findings, so that we may have a systematic record of progress in the field of disaster preparedness.

Respectfully,


G. A. Lincoln
Director

Enclosure

Acknowledgments

This report to the Congress has been prepared by the Office of Emergency Preparedness PL 91-606 Disaster Study Group. The Study Group was appointed by George Lincoln, Director, Office of Emergency Preparedness, and operated under the general supervision of George Grace, Assistant Director for Disaster Programs.

Authors of Volumes One and Three were Frank Bourgin, Rutlage Brazee, Charlene Dougherty, Gerald Fauss, Don Hammonds, Warren Hannum, Frank Iseman, Richard Letaw, Francis Manda, Philip McIntire, Charles McIntosh, Ugo Morelli, Marshall Sanders, Raymond Stralka, and Robert Schnabel. Preparation of Volume Two was directed by Frederick Zimmermann for the Council of State Governments. Its inclusion in this Report is not necessarily an endorsement of all its particulars.

Editors of the report were Ernest Atkin, Douglas Brown, Don Carbone, Francis Manda, Ugo Morelli, Marshall Sanders, and Robert Schnabel. The following reviewed and commented on the manuscript: William Crockett, George Grace, Raymond Karam, James Lewis, Haakon Lindjord, and Spence Perry.

Other members of the Study Group who conducted research and analyses were: Irving Goodman, Nancy

Irwin, Charles May, Beverly Rosenberg, Michael Tansey, Stephen Teichler, Timothy Vanderver, and Forrest Waller. Special mention is due Helen Makuck, who served as my administrative assistant.

Consultants to the Study Group were Charles Fritz (National Academy of Sciences and formerly with the Institute for Defense Analyses), J. Eugene Haas (University of Colorado), and Karl Steinbrugge (University of California, Berkeley).

Contributing to the study were more than a hundred Federal agencies, State and local governments, professional and trade associations, and volunteer disaster relief organizations. Specific contributing organizations are gratefully recognized and acknowledged below.

While the report largely reflects the substantial contributions of the many participants, the final analyses and findings of the report are attributable to the Study Group alone.

Robert E. Schnabel
Director, Disaster Study Group
Office of Emergency Preparedness

January 1972

Contributors to the Study

Federal Agencies

Executive Office of the President:

Office of Science and Technology
Office of Telecommunications Policy

Department of Defense:

National Communications System
Department of the Army
Office of Civil Defense
Corps of Engineers
Department of the Navy
Department of the Air Force
Civil Air Patrol

Department of the Interior:

Office of the Deputy Assistant Secretary for Territorial Affairs
Office of Oil and Gas
Geological Survey

Bureau of Land Management
Bureau of Reclamation
Bonneville Power Administration

Department of Agriculture:

Farmers Home Administration
Forest Service
Rural Electrification Administration
Soil Conservation Service
Food and Nutrition Service
Agricultural Stabilization and Conservation Service
Federal Crop Insurance Corporation

Department of Commerce:

Bureau of Domestic Commerce
Economic Development Administration
Maritime Administration
National Bureau of Standards
National Oceanic and Atmospheric Administration

Department of Labor**Department of Health, Education, and Welfare:**

Public Health Service
Food and Drug Administration
Health Services and Mental Health Administration
Office of Education
Social and Rehabilitation Service

Department of Housing and Urban Development:

Federal Housing Administration
Federal Insurance Administration

Department of Transportation:

Office of Emergency Transportation
U. S. Coast Guard
Federal Aviation Administration
Federal Highway Administration

Atomic Energy Commission

Environmental Protection Agency
General Services Administration
Interstate Commerce Commission
National Aeronautics and Space Administration
National Science Foundation
Small Business Administration

Smithsonian Institution:

Center for Short-Lived Phenomena
Science Information Exchange

Tennessee Valley Authority

Federal Council for Science and Technology, Interdepartmental Committee for Atmospheric Sciences

National Academy of Sciences—National Academy of Engineering—National Research Council
(Including 31 Boards and Committees)

State and Local Agencies

Alaska State Housing Authority
Council of State Governments
County of San Diego
National Association for Port Authorities
National Association of Insurance Commissioners
National Association of State Foresters
National League of Cities
National Waterways Conference
Port of Cleveland
U. S. Conference of Mayors

Institutions and Associations

American Association of Blood Banks
American Association of Public Health Physicians
American Chemical Society
American College of Surgeons
American Congress on Surveying and Mapping
American Forest Institute

American Forestry Association
American Geological Institute
American Geophysical Union
American Hospital Association
American Institute of Medical Climatology
American Insurance Association
American National Standards Institute
American Nuclear Society
American Psychiatric Association
American Public Works Association
American Society of Agricultural Engineers
American Society of Civil Engineers
American Society of Planning Officials
American Society of Safety Engineers
American Veterinary Medical Association
Association of American Railroads
Associated General Contractors of America
Edison Electric Institute
Forest Industries Radio Communications
Independent Natural Gas Association
Institute of Makers of Explosives
Legislative Council for Photogrammetry
Manufacturing Chemists' Association
Mobile Homes Manufacturers Association
National Air Tankers Association
National Association of Fire Investigators
National Association of Independent Insurers
National Association of Insurance
National Conference of Standard Laboratories
National Council on Radiation Protection and Measurements
National Forest Products Association
National Geographic Society
National LP-Gas Association
National Safety Council
National Society of Professional Engineers
National Waterways Conference, Inc.
Rachel Carson Trust for the Living Environment, Inc.
Reinsurance Association of America
Structural Engineers Association of Southern California
Transportation Research Foundation
U. S. Committee on Large Dams of the International Commission on Large Dams
U. S. Independent Telephone Association
Urban Land Institute
Water Pollution Control Federation
Volunteer Disaster Relief Organizations
The American National Red Cross
The Salvation Army

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PART I

INTRODUCTION

On December 31, 1970, the President signed Public Law 91-606, the Disaster Relief Act of 1970. In addition to providing for a comprehensive program of assistance in major disasters, the Act, in Section 203(h), directed that a full and complete investigation and study be conducted to determine what additional improvements could be made to prevent or minimize the loss of life and property due to major disasters.

The President in his State of the Union Message to Congress on January 20, 1972, did state that the Administration's efforts for marshalling science and technology will include new or accelerated activities aimed at reducing the loss of life and property from earthquakes, hurricanes, and other natural disasters. The expanded activities, as set forth in the President's FY 1973 budget, stemmed from a major review by the Administration during the past year of the problems and opportunities for American technology.

This report by the Director of the Office of Emergency Preparedness is in response to the Congressional requirements in PL 91-606; it has drawn significantly on that Administration review and is a contribution to the disaster preparedness program outlined in the State of the Union Message.

The report was prepared by an *ad hoc* study group appointed by the OEP director, George A. Lincoln. The study group conducted an intensive analysis of the nature of natural disasters occurring in the United States and the programs, both governmental and private, for protecting life and property in disasters. The report reflects contributions by and consultations with Federal, State, and local agencies; professional institutions, associations, and experts; and private volunteer disaster relief organizations. The findings are those of the Director of OEP.

Ten types of natural disasters are examined in this report: river floods, tornadoes and windstorms, hurricanes and storm surges, forest and grass fires, earthquakes, landslides, tsunamis, volcanoes, frosts and freezes, and droughts. Their causes, effects, and occurrences and the means for coping with them are discussed in the 10 chapters comprising Part VIII and published in Volume Three. These chapters are intended to provide a fuller appreciation of the differences among the various phenomena and specific disaster occurrences. The prob-

lems posed by these disasters, together with the associated countermeasures, reflect these differences.

Reprinted in Volume Two as Part VII of this report is the *Example State Disaster Act*. It consists of model legislation, with an Introduction and section-by-section Commentary, prepared by the Council of State Governments especially for this study. It is a product of the Council's detailed evaluation of disaster preparedness in each State and separate jurisdiction. The Example Act is also the subject of a special Council of State Governments report, *1972 Suggested State Legislation*.

The suggestions by the Council for legislative action to eliminate shortcomings in State and local disaster preparedness complement nationwide measures at the Federal level.

Volume One, organized into six parts and 18 chapters, contains the analyses and findings of the study with regard to the current status and the possibilities for improvement of disaster preparedness throughout the Nation.

Following this Introduction (Part I), a Summary of Findings (Part II) covers the general conclusions of the study. It stresses the overall theme of partnership among Federal, State, and local governments in achieving improved disaster preparedness and presents major findings relevant to the roles of government, science, and the public.

Part III consists of 11 chapters on Disaster Protection based upon vulnerability prevailing in the United States. One chapter deals with general measures applicable in all cases; the others deal with the specific measures for each of the 10 types of disasters covered in this study. Particular attention is given to (1) vulnerability, (2) prediction and warning capabilities, (3) preventive measures, and (4) preparations and readiness for governmental and public response to disasters. Considerable disparity exists among the types and frequencies of disasters and among the requirements and capabilities of the States and localities. However, several exemplary localized measures are highlighted for wider application.

Part IV, three chapters under the heading of Disaster Mitigation, concerns measures which may be taken to reduce the vulnerability of life and property to natural disasters. Regarding land use and construction, these are relatively long-term measures aimed at stricter local

regulation to bring about greater hazard reduction. Disaster insurance is examined in connection with hazard reduction objectives; it is found to be a potential incentive under certain conditions but a disincentive under others. Also discussed is the Federal Government's role in weather modification to avert or dissipate certain disaster-causing phenomena.

The application of science and technology is covered in the two chapters of Part V. These examine the forms and sources of disaster research, identify its potential contribution to disaster preparedness, and establish and amplify the relationship between research and evaluation. The importance of on-the-scene evaluations and postdisaster critiques is highlighted.

Included also are two chapters (Part VI) summarizing disaster legislation and program statistics: Volume One concludes with a bibliography of source materials used in the study.

In summary, this report establishes a broad-based and comprehensive analysis of disaster preparedness in the United States. While more intensive study is needed in several areas, a start has been made towards better preparedness. The Office of Emergency Preparedness has, as one of several steps, established a Disaster Preparedness Division to participate with other agencies in the implementation of a coordinated and concerted national program. To succeed, that program must have the support of the scientific and engineering professions, government at all levels, and the people.

PART II

SUMMARY OF FINDINGS

This part presents in summary form the major findings of the study. The more detailed findings appear in each chapter of Parts III, IV, and V.

Vulnerability Analysis

Vulnerability analysis is a prerequisite to effective disaster preparedness. The variety in types and frequency of natural disasters and the differences in effect and damage make it clear that an assessment of vulnerability must be made for each community as a first step in formulating regulations, plans, and programs to reduce hazards and prepare for disasters.

The assessment of vulnerability to river floods is well advanced, but investigation shows that improvements can be made by producing risk maps of a more useful scale and by increasing the pace of information and mapping programs. A program for risk mapping in selected hurricane-prone areas has been initiated and should be continued.

General areas vulnerable to tsunamis, ocean waves generated in the Pacific by earthquakes, are known, but there should be a further effort to prepare risk maps delineating the reasonably expected limits of inundation, particularly for populated coastlines.

Populated areas with high probability of earthquakes need increased seismic instrumentation to gain more knowledge of earthquake phenomena. With knowledge and seismic data, specific areas of vulnerability can be delineated, and a program of risk mapping can be pursued as an essential first step in developing preparedness plans and land-use and construction standards.

There is a need to encourage prudence in agricultural practice and in community development in those areas where recurring vulnerability to forest and grass fires, frosts and freezes, and droughts is well known. Vulnerability analysis should be taken into account before land development begins.

Over half of the population of the United States is located on or near its coastlines, and the percentage is increasing. These areas are the most vulnerable to catastrophic disasters—earthquakes on the West Coast and hurricanes on the Gulf and East Coasts—and are therefore being systematically analyzed to determine

vulnerability and to develop specific and realistic preparedness plans.

As populations become larger and more concentrated, timely and safe evacuation under threat of hurricane, flood, tsunami, or fire will become increasingly difficult. Officials responsible for population centers in high-risk locations must consider the expected warning time and the capability of evacuation routes to handle traffic that would be caused by mass evacuation.

The number of persons who must evacuate would also be determined, in part, by the shelter and protection available in the threatened area. For protection from hurricanes, floods, and tornadoes much more can and should be done to identify available public shelter and to provide for shelter in new construction.

Prediction and Warning

The value of past investment in prediction and warning capabilities is clearly demonstrable. Despite the increasing property losses, there has been a notable decline in lives lost when such capabilities have been established and used, notably for hurricanes and tornadoes. There is, however, considerable variation in capability within both the earth and the atmospheric sciences for predicting the occurrence of disaster-causing phenomena.

In the atmospheric sciences, despite substantial progress, there is still need for better understanding of the causes and mechanics of hurricanes and tornadoes. With new knowledge and improved methods, hurricane predictions can be significantly more accurate as to cause, landfall, and force. Emergency protection and evacuation, with such improvements, could be taken with greater confidence and thoroughness. Similarly, improvement should be sought in predicting the likelihood of tornadoes, as well as in detection and warning when these sudden phenomena do occur.

Precise prediction and warning of the timing and extent of earth disturbances—earthquakes, volcanoes, and landslides—and earthquake-generated tsunamis are not currently feasible, although the potential for such disaster in many areas is known. More instrumentation for monitoring and detecting dynamic forces within the

earth's mantle is needed to enable better understanding of these phenomena and formulation of a theory and system for prediction and warning. While progress has been made in instrumentation for earth disturbances, it has not been comparable to the progress in monitoring the atmosphere.

Since the possibility of discovering tsunami waves generated by a distant earthquake is quite good, the well-conceived, existing tsunami warning system can be significantly improved with relatively minor investments in sensors and communications. The data thus derived will further the needed research on tsunami phenomena and improve predictions of wave height and landfall.

Certain types of disasters, such as river floods, droughts, and forest and grass fires, are presaged by discernible weather factors and changes. Similarly, hurricane and tornado seasons can be anticipated. For many of these frequently recurring natural threats, the general conclusion is that existing prediction and warning systems are sound but require extension and modernization. The pertinent chapters describe the additional facilities, equipment, sensors, and communications, together with associated staffing, to improve detection of disaster-causing phenomena and enhance public warning.

Of the many problems in warning dissemination, the most obstinate is that of speedily warning each endangered individual, particularly for tornadoes and flash floods. A need exists for warning systems capable of being extended directly into every home and operating 24 hours a day to protect life in sudden disasters.

Public Information

Public awareness of the threats posed by the various natural disasters is essential to preparing for them and reducing their destructive effects. This awareness can be achieved by making information about disasters—and what to do if one occurs—readily available and easily understandable. Where appropriate, information campaigns should coincide with the peak time for “seasonal” occurrences, such as hurricanes, tornadoes, floods, and fires. However, knowing about the hazards and what to do in the event of a disaster provides only limited assurance that an individual will respond on the basis of his knowledge. Governments and individual citizens, therefore, have a shared responsibility to create conditions more likely to assure public responses that will reduce losses to life and property.

It was found that the public responds most readily to those sources of information that are used routinely and frequently, such as radio, television, newspapers, and the telephone book. For example, one page in the telephone book for Oahu provides a risk map and tells what to do in the event of a tsunami. This simple but effective procedure can be applied nationally for other types of disasters.

Disaster Legislation

The reduction of hazards and preparedness for disasters are government responsibilities as well as the concerns of every citizen. For this purpose, there must be, in keeping with the Nation's Federal system, appropriate disaster legislation for all levels of government. Only in this way can effective community and nationwide programs be realized. Legislation is required to regulate land-use and construction standards, to provide authority for prompt and effective emergency response, and to assure cooperation and assistance among government jurisdictions. In the past the emphasis was on postdisaster assistance; in the future it should be on predisaster preparedness. This theme is expressed throughout the Council of State Governments' 1972 *Suggested State Legislation*. It is also stressed throughout this report.

Disaster Plans

Planning is essential for any region or community likely to be affected by a disaster, in order to determine what preventive and protective measures can and should be taken before and at the time of a disaster. Planning requires cooperation from all levels of government. A prerequisite to such planning is a determination of vulnerability of a given area to particular types of disasters. In this regard, Federal agencies are helping—and can do more to assist—the States and local governments.

(State disaster planning is found to be uneven in coverage and quality.) It should, above all, be more concerned with the needs of local communities, with greater emphasis on preparedness or predisaster actions. Model or pilot plans, applicable to specific regions and types of disasters, have proved to be useful and should be used more widely.

The greatest need is at the local level, and several Federal efforts are aiding in this regard. The Corps of Engineers, for example, has been helpful to local communities with regard to flood preparedness, as has NOAA in connection with hurricanes and tornadoes. More recently, OEP has given an assignment to the Office of Civil Defense in the Department of the Army to assist in the development of local disaster preparedness.

To be confident that disaster planning is preparing government officials, volunteers, and the public to cope better with disasters, such plans must be exercised and evaluated. This is becoming a standard practice.

Emergency Operations

It is important that government emergency response to natural disasters be accomplished through existing organizational arrangements, augmented as necessary

This approach should result in greater identification of government officials with their constituencies during times of extraordinary need. It is a logical extension of governments' dealings with the day-to-day emergencies.

The main focus of emergency response to major disaster should be: (1) to expand routine emergency services, such as police, firefighting and sanitation; (2) to provide those things which the individual citizen takes care of by himself in normal times but which have been interrupted by the disaster, such as food, housing, and personal welfare; and (3) to make special provisions for medical care.

There is a favorable benefit-cost ratio in taking early measures when a disaster is imminent. Preparatory actions taken when spring floods have been forecast have resulted in substantial savings in postdisaster costs. For example, Operation Foresight in 1969 had an estimated 10-to-1 benefit-cost ratio.

Experience in fighting forest and grass fires shows that suppression of fires has about a 4-to-1 benefit-cost ratio. In other words, with early detection and suppression, the firefighting costs and the fire losses are one-fourth of what they are when small fires become big ones.

There is a need for continuous modernization of emergency equipment and techniques. A case in point is the air tanker fleet for aerial firefighting.

Application of Science and Technology

Research on the causes and characteristics of natural disasters and for the protection of people and property holds great promise and is a national imperative.

The most immediate need is to apply the scientific and technological knowledge already existing. The sheer number and variety of disaster-related research activities in the government and private sectors now make it difficult to coordinate and integrate these activities. Further development of the following actions taken during the past year will contribute to better coordination of research activities and wider application of research results:

- The OEP disaster research clearinghouse will enhance the exchange of information between the scientific community and public officials.
- An assessment of existing disaster-related research activities by the National Academy of Sciences should provide a basis for greater application of research results and also help to focus future research efforts.
- The National Science Foundation, through the "Research Applied to National Needs" program and others, will promote interdisciplinary disaster research and enhance practical applications to disaster preparedness.

It is recognized that an interdisciplinary approach to disaster research is needed. Most disaster-related research in government and private research centers remains compartmented within the various traditional disciplines

and organizations. Consideration should be given to the desirability and practicability of establishing a National Center for Disaster Research to serve as a focal point for liaison with the many specialized research activities.

The connecting link between new knowledge—acquired through both experience and research—and improved disaster preparedness is evaluation. On-the-scene disaster evaluation is essential to timely and accurate recording of facts and lessons. With both predisaster and postdisaster critiques as parts of an evaluation program, the basis can be laid for testing and improving preparedness plans and procedures. Predisaster efforts aid in assuring preparedness levels, while postdisaster critiques assure the benefit of lessons learned from experience. Since Hurricane Camille, postdisaster critiques have been held more regularly and have served as important steps in arriving at significant improvements in legislation and in programs for preparedness and response.

Disaster Mitigation

Like protection, disaster mitigation begins with an estimate and appreciation of an area's vulnerability to natural disasters. The objective of mitigation is to find ways to reduce the vulnerability of people and property to damaging effects.

It is clear that something must be done about the way land is used, the kind of structures built on it, and the materials and practices used in construction. At present, these determinations are too fragmented among many private and government agencies. Furthermore, the government authority to regulate land-use and construction practices is in the hands of many local jurisdictions (State, county, and municipal) which are often influenced by competing socio-economic interests. Hence, there is a need for a national program involving Federal, State, and local jurisdictions in avoiding the mistakes of the past and in gaining fuller consideration of natural hazards in regulating land use and construction. Such a national program should include (1) nationally recognized disaster mitigation criteria, (2) data on the vulnerabilities of localities in disaster-prone areas, (3) a national focal point for land-use planning and building standards, and (4) conditions on the use of Federal loans, grants, and lending guarantee powers so that local jurisdictions enact and enforce disaster mitigation regulations.

The financial losses of individuals to natural disasters can be alleviated through insurance. Disaster insurance, however, is often not available, because actuarially sound rates cannot be determined on the basis of current knowledge of the risks involved. However, even when insurance is available, individuals now tend to rely on disaster benefits from the Federal assistance program, if this is to their advantage, rather than on insurance. Consequently, any Federal Government initiative to encourage wider disaster insurance coverage should also insist that rates be based on risks or that communi-

act toward hazard reduction. A comprehensive disaster insurance program has many complex economic and public policy implications which need further careful study.

In surveying the causes of the natural disasters included in this study, it was determined that in some instances the means do now exist to prevent or alter climatic phenomena. Experiments in modifying the weather to reduce the wind intensity and perhaps change the direction of a hurricane, to alleviate drought, and to reduce the lightning from cumulus clouds (and thus

reduce a major cause of forest fires) should be pursued with high priority. However, the "down range" effects of weather modification are not fully predictable, and in many cases even the immediate effects are uncertain. Weather modification is a new and promising enterprise, offering untold possibilities but also unforeseen consequences. The possibilities and the consequences give rise to the need for management; because of interstate and international ramifications, consideration should be given to an expanded Federal role.

PART III.

DISASTER PROTECTION

Federal, State, and local government programs concerned with preparedness for and emergency response to disasters are discussed under this general heading of Disaster Protection. These programs involve general and specific measures to cope with the existing vulnerability of people and property to disaster occurring in the United States. In Part IV, Disaster Mitigation, consideration is given to measures to reduce such vulnerability. This rather arbitrary distinction between protection and mitigation is made to emphasize better the elements of a comprehensive approach to disaster preparedness.

In studying the natural disasters which occur in the United States and the existing vulnerability to these

events, it is clear that certain preparedness measures will afford protection in greater or lesser degree in different types of disasters. At the same time, it is also clear that the differences among the types of disasters dictate identification of the special measures required for protection against each. General and special measures alike are needed for optimum protection.

Of the 11 chapters in this part of the report, one is devoted to General Measures and the others discuss 10 specific types of natural disasters in terms of prevention or control, prediction and warning, preparedness plans, and emergency response by government and the public.

Chapter A. General Measures

Disaster protection begins with recognition and understanding of the kinds of natural disasters likely in a given area and the vulnerability of the area to those disasters. Based on this understanding, all levels of government can establish objectives for achieving protection against the threats. Under the Federal system of government it is essential that the disaster preparedness programs be a cooperative and concerted effort involving Federal, State, and local government. Programs resulting from such cooperative effort require the application of science and technology, development of plans and organizations, allocation of resources, and education of the public.

Vulnerability Analysis

There has been insufficient attention to systematic analysis of the vulnerability of communities or larger jurisdictions to natural disasters. As a consequence, State and local governments are often not as well prepared to cope with natural disasters as they could be. For example, some States' natural disaster plans are patterned after civil defense plans for recovery from nuclear attack—plans that assume outside help would not be available (because the whole country would be stricken) and evacuation would not be feasible (because of the lack of mobility due to nuclear damage and radioactive fallout). In natural disaster planning, the opposite assumptions apply: outside help could be made available immediately; there would be time to evacuate, if necessary, and a place to go to; and movement would not be impeded (as by nuclear damage and radioactivity).

Federal programs now underway can assist State and local governments in determining their disaster vulnerability. For example, the Corps of Engineers will prepare an analysis of a community's vulnerability to floods and suggest measures which can be taken locally; the decision to take measures based on the analysis rests with the local government.

The National Oceanic and Atmospheric Administration (NOAA) is conducting vulnerability surveys of coastal communities with high risk of hurricanes and providing advice for local disaster planning; again, action pursuant to this advice must be initiated by the local government. Also, NOAA, under contract with the Office of Emergency Preparedness (OEP), is making an earthquake vulnerability analysis of the San Francisco

Bay area. This analysis is a prototype study that might be applied to all locations with earthquake potential as well as form the basis for coordinated earthquake preparedness planning by Federal, State, and local governments.

While vulnerability studies are discussed more fully in succeeding chapters, it is important to realize that vulnerability analysis is essential for development of plans for disaster protection and preparedness.

Disaster Planning

Since October 1969, the Federal Government has provided matching funds for the development of State disaster plans. Fewer than one-third of the States were participating by the end of 1971. There are many reasons for this lack of participation: some States consider their plans to be adequate, some States must wait for legislative action, and some States have limited funds available for this purpose. In 1971, OEP contracted with the Council of State Governments to prepare an "Example State Disaster Act" (now part of the Council's *1972 Suggested State Legislation* and also included in Part VII of this report) and "Guidance for State Disaster Planning." The latter includes selections from various existing State plans to illustrate exemplary features, with special emphasis on those that reflect lessons learned from experience.

Concurrent with initiation of the earthquake vulnerability analysis, mentioned above, OEP has issued an "Outline Plan for Federal Response to a Major Earthquake." This planning document establishes planning assumptions and assigns planning responsibilities to Federal agencies. Upon completion of the earthquake vulnerability analysis, OEP will take steps to promote coordinated preparedness planning by Federal, State, and local agencies. This is viewed as the pilot project in integrated national planning for disasters.

Local plans and procedures to cope with disasters, large and small, are the keystone to the protection of life and property. However, few local governments can by themselves effectively prepare for, and cope with, major disasters; they need State and Federal assistance in preparation and recovery. Accordingly, local disaster plans should begin with an assessment of local capabilities for dealing with day-to-day emergencies; this constitutes a baseline. Then, local plans should identify

the major areas in which they will need local augmentation and outside assistance. Further, such planning should establish methods of coordination and control so that outside assistance can be efficiently applied.

Especially pertinent to an assessment of local government's role in disaster preparedness are the ideas expressed by Mayor Edwin W. Wade of Long Beach, California, in a recent speech describing that city's program. Excerpts from those remarks are included under Notes at the end of this chapter.

In the final analysis, all levels of government share responsibility for the development of mutually supporting disaster plans. OEP regards this premise as a basic principle for an integrated national disaster preparedness program. In this connection, OEP is establishing a coordinated Federal program, involving NOAA, the Corps of Engineers, the Office of Civil Defense (OCD), and other agencies, to provide specialized assistance in the development of local disaster preparedness plans.

In addition to the overall integrated national disaster plans, the following specialized supporting national plans have been or are being prepared:

- *Plan for Communications Support in Natural Disasters.* Joint efforts by OEP, the Office of Telecommunications Policy (OTP), and the Executive Agent for the National Communications System culminated in 1971 in the development of a national plan for communications support of Federal emergency response to major disasters. The plan prescribes the procedures for establishing communications to be used in coordinating Federal assistance to State and local governments when a major disaster threatens or occurs.

- *National Search and Rescue Plan.* The Departments of Defense, Commerce, and Transportation, the Federal Communications Commission, and the National Aeronautics and Space Administration coordinate their resources and responsibilities for emergency search and rescue (SAR) operations under a national SAR plan. The Air Force, Navy, and Coast Guard are the principal operating agencies. The SAR plan was last revised in 1969 and provides for coordinated sea and air operations in natural disasters and other emergencies.

- *Multi-Hospital Disaster Plan.* The San Fernando earthquake proved the lifesaving value of a coordinated area medical plan that had previously been established on a voluntarily basis by a number of hospitals in Los Angeles County. The experience of these hospitals has been reported in a film, "Date With Disaster," which depicts the development and execution of their plan. OEP has made this film available to communities and hospitals across the country as an example of what can be done through cooperative action.

Disaster Warning

Timely and accurate warning is a major factor in the protection of life and property in natural disasters. As

the following chapters show, the nature of the disaster and the timeliness of warning are basic considerations in the development of an effective disaster preparedness program.

Warning involves technological problems: (1) monitoring and detecting the precursor signs and signals of a developing disaster threat, (2) calculating and forecasting the time and place of the event, and (3) transmitting the warning to officials and the public. Timeliness and accuracy vary widely with different types of disasters—from virtually no practical warning capability in the case of earthquakes to rather significant capabilities in the case of hurricanes. Whatever the state of the art, timely and accurate warning and appropriate public response are central objectives.

OTP has conducted an intensive study to determine what technological improvements could be applied to natural disaster warning as well as enemy attack. The study recognized the desirability of implementing a national system to give a continuous capability for direct warning of the public. To this end, a program of studies and tests will be conducted to provide such a system and to assure that the cost of home receivers is brought within reach of the general public.

Emergency Resources

Natural disasters may often overwhelm local resources but are unlikely to overtax the Nation's resources. Because of the ready availability of outside assistance in natural disasters, it is more important to plan for receiving and distributing supplies from outside than to stockpile emergency supplies within a potential disaster area. An important exception is medical supplies; their immediate availability can be crucial. Packaged Disaster Hospitals, Natural Disaster Hospitals, and Hospital Reserve Inventories have been positioned throughout the country to supplement normal medical resources. Also, OEP and the Department of Housing and Urban Development are investigating the feasibility of stockpiling emergency and temporary housing resources.

Emergency Organization

The key to effective organization for response to natural disasters or any other emergency is simply to accelerate and reinforce existing, practiced governmental functions. An emergency is not the time to introduce a new and unfamiliar apparatus for coordination and control. The public looks to established political authorities to act quickly and effectively in an emergency.

OEP, on the basis of its experience in Hurricane Camille, has developed a concept for a field organization in which normal staffs are augmented by representatives of the principal Federal agencies involved in disaster operations and recovery assistance. This procedure has been practiced in subsequent disasters and was further

tested in carrying out Phase I of the Economic Stabilization Program in 1971. The concept is similarly applicable to State and local governments in meeting the emergencies of natural disasters.

Public Information

An informed public is essential to successful disaster protection and preparedness. The public must know when and how to prepare for an imminent disaster and what to do if it occurs. Unfortunately, there are practical difficulties raised by information and warning programs. For example, it is expensive in time and money to maintain a public alert for a disaster that does not happen, and such false alerts degrade public confidence in warnings. Or, as in the case of tsunamis, the alert may cause a curious public to endanger itself in its desire to see "the big wave." Elements of an effective public information program can sometimes be quite simple, for example, pages in the Oahu, Hawaii, telephone book giving ready reference for the tsunami danger area and evacuation routes. Infrequent disasters require theoretical explanations and case histories beyond the public's experience.

On the other hand, there are natural dangers—such as tornadoes and hurricanes—which occur more frequently in a given area and whose approach can usually be witnessed, thereby reinforcing the urgency of the warning. For these hazards, public knowledge and alertness can be reinforced as the season approaches. Thus, public information programs, to be effective, must be conceived for each individual type of disaster and for the particular threat to the community.

Disaster Legislation

Federal legislation has generally kept pace with the growing problems of disaster. (See Disaster Legislation, Part VI, Chapter A). This has not been the case with most State and local governments. State disaster laws have been changed in relatively few instances over the past two decades.

Most legislative effort has been directed to emergency measures in reaction to particular disasters; only recently has significant attention been given to State and local legislation intended to avoid or prepare for disasters. While continued attention must be given to strengthening State and local capabilities to react swiftly and effectively to disaster events, the primary thrust of legislative effort in the next few years should be aimed at enactment of land-use controls for areas particularly susceptible to disasters and enactment of building standards for structures subject to specific disaster threats. (See Land Use and Construction, Part IV, Chapter A.)

In general terms, effective response to disaster requires emergency allocation of resources and funds and

the establishment of priorities for their use. This, in turn, may require governmental officials, particularly at the local level, to exercise unusual control over, or assume the responsibility for, services normally provided by nongovernmental entities. Authority for these emergency actions, with such limitations and constraints as individual conditions dictate, should be included in State and local disaster acts and ordinances.

The Council of State Governments is devoting substantial attention to State legislation. The Example State Disaster Act is included in the Council's 1972 *Suggested State Legislation* and will be the basis of a concentrated effort by the Council to update State disaster legislation. The Example Act emphasizes the need for State preparedness actions and leadership, as well as for continuing and strengthening the authority of the Governor to respond to disaster emergencies. As part of its effort, the Council will assist States in analyzing their legislation and in drafting legislation to amend or augment existing State laws.

Findings

1. *Disaster vulnerability analysis is a prerequisite to formulating effective State and local disaster preparedness plans and programs.* The U.S. Army Corps of Engineers is doing such analysis with regard to floods, as are the Forest Service and Bureau of Land Management for forest fires and the National Oceanic and Atmospheric Administration for hurricanes. The OEP-NOAA earthquake study is designed to provide a prototype vulnerability analysis regarding earthquakes. These activities should be continued and should include other types of disasters that pose a high threat to life and property.

2. *Disaster preparedness plans and programs of many States and localities need to be improved.* To help accomplish this, PL 91-606 authorized matching funds for the development and maintenance of State disaster plans. The recent steps by OEP and the Council of State Governments to provide guidance and encouragement to the States to upgrade State and local disaster plans, with greater emphasis on preparedness, should lead to community and nationwide improvements.

3. *Public information is a vital element of disaster preparedness.* The most effective programs provide for quick and easy reference to essential information by the public when a disaster is imminent or occurs. Pages in the telephone book and emergency radio and TV broadcasts have been used effectively for this purpose in some areas and some types of disasters. These examples illustrate standard practices that should be developed in all regions for the sudden and life-threatening types of disasters they can expect.

4. The "Example State Disaster Act" formulated and suggested by the Council of State Governments for action in 1972 provides an excellent model for updating State disaster legislation and enhancing disaster pre-

paredness by all levels of government. The Council's subsequent program to assist individual States in drafting applicable legislative provisions should further enhance attainment of this objective.

Notes

The following excerpts are from an address on Anti-Disaster Measures in Cities by the Honorable Edwin W. Wade, Mayor of Long Beach, California, at the Second Plenary Session of the Japanese-American Conference of Mayors and Chamber of Commerce Representatives at Kyoto, Japan, October 23, 1971. (The entire text is available from OEP upon request.)

* * * * *

The City of Long Beach, which I represent, has made a concentrated effort during the past decade to develop an emergency preparedness program. I am satisfied that what we have accomplished will be of great benefit in a serious emergency, but the more I researched this subject in preparation for making this presentation today, the more I have become aware that much of the capacity inherent within our cities to deal with disasters lies dormant. I realize that even in the City of Long Beach much remains to be done before we can say that we have developed maximum readiness to help ourselves in time of disaster.

This matter of self-help is crucial to the development of a sound nationwide emergency preparedness program, because if a city is not willing to develop a capability of sustaining itself in a disaster situation then it must prematurely call for help from the outside. This process of determining when, how, and from whom to request help uses up time, and time is a precious commodity when citizens are in peril. Many lives can be lost in the confusion and disorganization that accompanies the lack of a full planning effort.

A city that fails to make a reasonable effort to develop its own capacity for survival thus allows itself to become a burden upon the higher echelons of government which must come to the rescue, and too often the rescue becomes a salvage type operation.

As I see it, every community has a choice to make, which, simply stated, is whether in time of emergency it chooses to be an asset to itself and its nation or whether it is willing to be a liability. I seriously doubt if there are many, if any, cities in either of our two great countries that can honestly say that they have fully developed their potential for the protection of life and property. I'm talking about the full utilization of resources that stand available within our communities but which lie dormant simply awaiting the type of organization and planning that will take full advantage of the existing potential.

Sustaining a high degree of readiness, of course, is not easy. There are expenses involved, but in Long Beach we have found that the cost need not be burdensome. Our full time emergency preparedness staff is quite small. We take advantage of the incentives offered by the Federal Government to communities willing to achieve the eligibility standards imposed as a condition for receiving such assistance. The staff in Long Beach is a coordinating group working in a staff capacity for the City Manager with the mission of developing a maximum coordinated disaster readiness effort within the total structure of city government with such augmentation as needed from the private sector.

Recognizing that there are limits to what a city can do to help itself, Long Beach is a part of a master mutual aid plan which pledges its help to sister communities when, because of the catastrophe, they have a need for outside help.

They, in turn, are pledged to help us if and when we, too, require such assistance.

Maintaining a high degree of disaster readiness, however, is largely a question of attitude, and the building of a proper attitude throughout the city governmental structure begins at the top where policy is established. It isn't enough for the legislative body of the community, in our case the City Council, to only pass an ordinance establishing an emergency preparedness program. The City Council must show an interest in the ongoing activities as well. It should require a good disaster plan to be submitted for its approval. It should insist that the plan is not only kept up to date, but fully utilizes the available resources as well. The Council should also make it possible for city personnel to receive a reasonable amount of training in carrying out their disaster assignments and insist that such training be realistic and of a team-building character. Disaster exercises should be held periodically. . . .

* * * * *

In my judgment, it is essential to have a central place such as a well-protected emergency operating center where timely decisions based on accurate information can be well coordinated and then disseminated. It is here at the Emergency Operating Center where actions are taken to ascertain what resources are available, where key officials with these various resources at their immediate command can put their heads together and make the extraordinary judgments required to overcome the extraordinary problems which make a disaster a disaster.

I do not think I can put too much stress on the need for good communications because without it you cannot even get started. In Long Beach, we tie our key hospitals into our radio system. We also work closely with our extensive group of amateur radio operators and with certain critical industries. But no communications system is complete unless it also provides a means to broadcast important information and instructions to the public. . . .

* * * * *

We accept the fact that good training offers the greatest return for the time and energy invested; and for that reason, merits the greatest staff effort.

You might be interested in our plans for providing shelter for people rendered homeless due to disaster. Of course, we count heavily on the Red Cross to furnish the leadership and much of the staffing, but we do not feel that it is proper to just dump the whole load in their laps. Our planning is worked out jointly as a team effort. We augment the Red Cross staff by making available the city's entire roster of recreational employees and librarians. This makes a total staff of over 1,000 trained personnel immediately available to man sufficient pre-designated elementary schools and recreational centers to house 10,000 disaster victims. All of the assigned facilities have cafeterias, toilets, and sleeping space to house the homeless in reasonable comfort. If necessary, the city's entire system of school facilities can be made available and with additional staffing provided by the various school faculties, it would be possible to house at least 100,000 more people. . . .

* * * * *

The need to shelter a large mass of people, of course, would mean that a sizable area of the city has been devastated. Under these conditions, our city ordinance provides for either the City Manager, in his capacity as Director of Emergency Services, or the City Council to proclaim the existence of a disaster. Such a declaration automatically bestows upon the Director of Emergency Services extraordinary power sufficient to enable him to deal with the situation. In this status, he can legally issue proclamations establishing curfews, and/or setting forth rules and regulations as necessary to meet the city's needs. As Director, he activates and takes charge of the Emergency Operating Center, and the entire disaster organization is at his disposal. If necessary, he can close down private or public businesses or activities. He can also requisition and obligate the city for such supplies, equipment, and personal services as he deems necessary. All of this can be done without referral to the City Council. However, the Council is privileged to formally convene in order to ratify or negate an action or to delegate further authority if deemed appropriate. By proclaiming a disaster, it also becomes possible to immediately impose any additional building, traffic, or safety regulations that the situation dictates. For example, damaged buildings, if unsafe for occupancy, could be condemned, and if necessary, even destroyed and removed.

Starting with the Great Alaskan earthquake of March 27, 1964 up through the devastating hurricane of last year known as

Camille, we have witnessed in the United States a series of legislative acts which have greatly expanded the Federal role in major disasters. The latest such legislation known as the Disaster Relief Act of 1970 considerably increases the scope of federal assistance especially to meet the needs of individual victims. This has been a considerable change from the policy that existed several years ago when the losses suffered by an individual were largely his own to endure. Although the Red Cross has always made every effort to meet the immediate needs of individuals, for the first time government has concerned itself with personal problems to include the long term recovery of disaster victims. Home loans, business loans, debris clearance, rental and food allowances, and other services are now available to the private citizen. This has brought a new dimension to disaster preparedness planning. . . .

* * * * *

Whereas the Federal Government now provides a considerable amount of assistance, it remains for the city to withstand the first massive onslaught of the disaster. The city stands alone during those first frightful hours or perhaps days, and it is during this initial period of time when the good building codes, the good communications, the good decision making, and the good planning pays off in terms of lives and property saved. What is done or what is not done during this early period more than anything else will determine how well the public trust has been preserved.

Chapter B. River Floods

Introduction

The flooding of land adjoining the normal course of a stream or river has been a natural occurrence since the earth took its present form. What makes a flood a disaster is man's occupancy of the flood plain. The economic attractiveness of the level, fertile land of the flood plain along these natural routes of communication has encouraged development of flood-prone areas despite their potential for disaster. As these lands have been developed, the public demand for protection from economic losses caused by the inevitable floods has grown.

Despite efforts over the years to provide protection for developed areas, losses from floods continue to mount. Since 1936, more than \$9 billion of Federal funds have been spent on flood protection and prevention measures.¹ The Water Resources Council, in its First National Assessment (1968), predicted that flood losses would increase to an annual \$5 billion by the year 2020—barring any major improvements in existing flood protection and prevention programs.² The annual losses in recent years have been variously estimated as from \$1.5 to \$2 billion. The steady increase in the annual flood losses has been attributed mainly to expanded investment in flood-prone areas. There is, moreover, considerable evidence that new protective works, while providing protection from floods normally expected, actually encourage this expansion and increase the potential for loss from the occasional floods that exceed the design criteria of the works.³

A case in point is the development of the Trinity River flood plain at Dallas, Texas. A flood control project essentially completed in 1957, it provides protection for some 10,000 acres of the flood plain against a flood equalling the greatest since the first gauge recording in 1903.⁴ With the assurance of this protection, development of the protected areas has been rapid and continuing, from an estimated property value of \$172 million in 1939 to well over a billion today. Should a future flood, exceeding the magnitude of the maximum flood of record, top the levees, the damage would be over six times the damage of a comparable flood in 1939.⁵

Measures taken to provide protection from floods, or more properly to reduce the losses from floods, fall into

two categories: flood control measures and flood emergency measures.

As discussed here, flood control measures are those of a permanent nature, deliberately planned and executed over a period of time and based on the expectancy of floods of various magnitudes. These measures include land treatment in the watersheds to abate water runoff; engineering works such as dams and reservoirs to regulate the river flow and levees, channel treatment, and floodways to keep flood waters out of specific areas; and finally, regulations for land use to insure the most economical use of the flood plain, considering the hazard involved.

Flood emergency measures are those of a temporary nature, taken on an emergency basis when warning is received of impending floods that endanger unprotected areas or that will exceed the protection afforded by permanent works. Included are emergency land treatment of watersheds suddenly denuded by fire or other natural causes; emergency engineering measures such as building temporary levees or improving permanent levees, clearing channels by reducing obstacles or ice jams, and flood-fighting actions after arrival of the flood; evacuation of people and property from endangered areas; and rescheduling of production, transportation, and other service activities to minimize interruptions and loss from the flood.

Vital to the effectiveness of emergency measures are timely and accurate *prediction and warning* of the flood event and the *preparedness*—the know-how and the wherewithal—of the endangered communities and populace to take the appropriate actions.

The warning time varies by type and location of flooding. In mountainous or other areas where the runoff is rapid and subject to flash floods, forewarning may be only an hour or so at the most and often less. In areas where the terrain will retard the runoff or where flooding results from melting snowpack, the warning time can be days and even weeks.

The amount of warning has a direct relation to the emergency measures which can be taken. With short forewarning, it may be possible only to evacuate people to high ground. With longer warning, property can be evacuated or protected, and even emergency engineering protective works can be constructed. Ultimately, however, it is the planning, training, and education of the

local populace that determine the state of readiness and hence the effectiveness of any emergency measures.

The following discussion covers existing programs for flood control, prediction and warning, emergency measures, and preparedness along with means for improving these programs.

Evolution of Federal Interest

The Federal Government's interest in providing protection from floods was first manifested in 1879 by the establishment of the Mississippi River Commission as a permanent agency of the War Department and charged with planning and implementing flood control on the lower Mississippi River. This Federal action was prompted by the total failure of the uncoordinated levee systems constructed by private groups and the resultant abandonment of much of the fertile land of the flood plain of the lower Mississippi.

Initially confined to repairing and strengthening old levees, the program was expanded in 1928 after the disastrous Mississippi floods of 1927 to one of matching funds with States, local districts, or private groups for construction of new levee systems under standards set by the Commission. All of these measures were ostensibly to improve and protect navigation and were concerned primarily with levees. However, this 1928 legislation did show a growing Congressional interest in Federal participation in national flood control, in that a provision of the law directed preliminary flood surveys by the U.S. Army Corps of Engineers in other areas to be designated by Congress.⁶

By the Flood Control Act of 1936, Congress declared "that it is the sense of the Congress that flood control on navigable waters or their tributaries is a proper activity of the Federal Government."⁷ With this Act, Congress established Federal interest in flood protection on a national scale. This Act, along with the earlier Tennessee Valley Authority Act of 1933, also heralded a change in concept from one of local protection to one of integrating local protection with river flow regulation by watershed treatment and regulatory dams and reservoirs. This concept had evolved from a long series of Congressionally directed surveys and investigations starting with the Flood Control Act of 1928. Projects related to river flow regulation were conceived as multipurpose projects contributing benefits to other programs such as conservation, irrigation, water supply, hydroelectric power, navigation, and recreation.⁸

Under the 1936 Act, Federal participation in all flood control projects was on a cost-sharing basis with State and local governments. However, by the Flood Control Act of 1938, the Federal Government assumed the total cost for construction, operation, and maintenance of regulatory dams and reservoirs on "navigable waters or their tributaries."⁹ Present policy still requires State or

local contribution toward the cost of local protective works in the form of easements and rights-of-way and maintenance.¹⁰

Also, the 1938 Act recognized the possibility of a change of land use as an alternative to protective works. The Act authorized the Chief of Engineers, in lieu of constructing local protective works, to contribute funds equivalent to the Federal cost of the works to local entities that preferred to relocate threatened development onto higher ground.¹¹

Flood Control Programs

Watershed Program. Major objectives of watershed programs are to (1) reduce water and sediment runoff, (2) maintain desirable stream flow conditions, (3) protect water quality, and (4) maintain soil quality at a high level and control erosion. Methods employed to obtain these results include (1) protection from forest and grass fires,¹² (2) protection of vegetation from grazing damage, (3) restoration of vegetative cover by seeding, (4) timber management methods which minimize water runoff and erosion, and (5) structural measures such as water storage facilities, debris and sediment basins, grade stabilization, and stream channel improvement.¹³

Except in the Tennessee Valley, the U.S. Department of Agriculture (USDA) has the major Federal role in programs for watershed improvement. USDA's primary programs are carried out under authorities derived from the Flood Control Act of 1944 and the Watershed Protection and Flood Prevention Act of 1954. Those of TVA are conducted pursuant to the TVA Act of 1933, as amended, and the Flood Control Act of 1944.

The USDA programs under the two Acts are generally the same except for the geographical area covered. The earlier Act of 1944 limited watershed improvement projects to 11 designated watersheds in various parts of the country. The 1954 Act (Public Law 566, 83rd Congress) authorized projects in watersheds up to 250,000 acres in size anywhere in the Nation.¹⁴ The TVA programs are limited to the watershed of the Tennessee River.

USDA has responsibility for small watershed programs on Federal lands, except lands under the jurisdiction of the Department of the Interior where projects are developed by that agency. Programs on non-Federal lands are conducted by USDA on a cooperative cost-sharing basis with State governments, local entities, and private landowners. USDA provides technical advice and gives financial assistance for projects related to agriculture, fish, wildlife, and recreation.¹⁵

At present, approximately 75 projects under these authorities are being initiated each year.¹⁶

Engineering Works. Engineering works give protection through a combination of river regulatory works and local protective works. The former consist of dams and reservoirs to store and release water in regulated amounts and of channel improvements to increase the river capacity. The purpose is to reduce flood heights by regulating the amount of water and controlling its flow. Local protective works consist of levee systems to keep the floodwaters out of selected areas, pumping stations to dispose of water from behind the levees, and diversion channels¹⁷ to pass floodwaters around the area to be protected.

The criterion for providing flood protection by engineering works is that the benefits must exceed the cost of the works. Studies made in the Tennessee Valley indicate that for every community where it is economically feasible to provide protection by engineering works there are another 20 where it is not.¹⁸

Complete flood protection can almost never be economically justified. In most cases the criterion for the design of protective works is the maximum flood of record or the so-called "standard project flood," which is about 50 percent of the maximum probable flood.¹⁹

The Golden Triangle area of Pittsburgh, Pennsylvania, except for the lower "point" area, is protected by upstream reservoirs and local works against the recurrence of the 1936 flood, a 200-year-flood.²⁰ This means that there is a 0.5 percent chance that a flood equalling or exceeding the 1936 flood will occur in any given year—or, perhaps more significantly, a 10 percent chance that it will occur in a 20-year mortgage period.²¹ Thus, the risk area has a 90 percent chance of escaping in a normal mortgage period. In fact, however, buildings in the area are provided protection against at least another 10 feet of floodwaters by floodproofing measures on individual buildings.²²

The U.S. Army Corps of Engineers has the primary statutory responsibility nationwide for the development and construction of engineering flood control projects and for the operation of river regulatory works on "tributaries of navigable rivers" except in the areas of the Tennessee Valley Authority and certain areas in the West that are the responsibility of the Department of the Interior.

The Corps of Engineers' responsibility for flood control projects is carried out through a field organization of 10 Divisions corresponding to the major watersheds of the Nation, each of which is subdivided into a number of Districts responsible for specific river systems. This same organization is used to carry out the Corps' services for flood plain management as discussed below.

All flood control projects undertaken by the Corps of Engineers must be specifically authorized by Congress. However, the Chief of Engineers has "continuing authority" to study and request funds for projects under \$1 million at his own discretion. Projects over \$1 million

(major projects) must have individual authorization of Congress for study and subsequently for construction.²³

The process by which major projects are initiated and developed is shown in Table 1.²⁴ It should be noted that the impetus for Congressional authorization for a study by the Corps of Engineers must come from the local electorate. The Corps can and does give technical advice to local entities on the need for and practicability of the project.

The time in the first sequence (steps 1 through 3) is primarily due to the backlog of authorized studies awaiting funding, currently running between 300 and 400 at any given time.²⁵

The time required for the second sequence (steps 4 through 9) is affected by the funding levels, study complexity, and coordination of the individual studies. Improvements recently made by the Corps to reduce the time for study and reporting have been offset by growing requirements for coordination and assessment of the environmental and social impact. On the average, 200 studies involving flood projects are underway at any given time.²⁶

The time required for the third sequence (steps 10 and 11, Table 1) is again due to funding and the growing requirement for coordination of environmental and social impacts of the project.²⁷ The number of authorized projects of over \$1 million and awaiting funding for construction, as of March 1971, was 282.²⁸ Further delay in starting construction of local projects may be encountered in obtaining formal assurance of local cooperation, as required by law.

Projects under \$1 million, which may be recommended by the Chief of Engineers under continuing authorities, benefit from lump-sum funding and from fewer levels of coordination and review. With adequate funding, studies for these smaller projects can be completed in 2 to 3 years. Further, these smaller projects fare better in the construction funding process; at present the backlog is only 12 projects.

The Tennessee Valley Authority (TVA) is responsible, under the TVA Act of 1933, for flood protection in the Tennessee River Valley. Functions are vested in a three-member Board of Directors reporting to the President, with operational responsibility vested in a General Manager.

Flood protection by TVA combines an extensive multipurpose river regulatory system and local engineering works. The regulatory system consists of 29 TVA-constructed dams and one dam acquired by TVA. This system provides complete protection from the maximum flood of record for some 107,800 acres of privately owned land and partial protection for another 149,000 acres along 750 miles of the river system. In addition, the TVA system provides a measure of flood control on the Mississippi River below Cairo, Illinois, by impounding waters of the Tennessee River and releasing them so

Table 1.—Steps Leading to the Construction of Major Flood Control Projects (over \$1 million) by the U.S. Army Corps of Engineers.

STEP	ACTION	AVERAGE TIME
1.	Request by local citizens through their Congressional representation.	6 years
2.	Consideration by Public Works Committees and recommendation to the Congress. Passage of Act directing study.	
3.	Initial funding of authorized study.	
4.	Conduct of the study to determine feasibility and economic justification. Includes considerations of engineering, environmental, and social aspects as well as all possible alternatives for accomplishing the objective of the project. Entailed are extensive public hearings and coordination with other Federal, State, and local agencies.	7 years
5.	Review of the study report by Board of Engineers for River and Harbors or the Mississippi River Commission* (depending on jurisdiction), including additional public hearings as necessary.	
6.	Formal coordination of the proposed report of the Chief of Engineers with affected State and Federal agencies.	
7.	Consideration of State and Federal agency comments and submission of the report to the Office of Management and Budget.	
8.	Submission of report to Congress by the Secretary of the Army.	
9.	Congressional review, including desirable additional public hearings, and final authorization by Act of Congress.†	
10.	Funding of authorized project.	5 years
11.	Preparation of detailed plans, specifications, and cost estimates and commitment by local authorities of cooperative participation. Award of contract.	
Total Average Time		18 years

*Independent agencies established by law to advise the Secretary of the Army and the Chief of Engineers.

†The Public Works Committees of Congress may authorize projects under \$10 million without referral to the entire Congress.

as to be staggered with crests from the Ohio, Missouri, and upper Mississippi Rivers.²⁹

TVA authority for local protective construction is statutory; no Congressional approval of surveys or proposals is required. TVA, in cooperation with State and local governments, works out a coordinated plan and an agreed cost-sharing formula. The project is then included in the TVA budget request for Congressional appropriation of construction funds. Project costs for such local protective works in the TVA area generally run between \$600,000 and \$3 million.³⁰

The Department of the Interior, through its Bureau of Reclamation, constructs and operates systems of dams, reservoirs, and water conveyance systems in 17

Western States and Hawaii. Their multipurpose nature provides regulatory features for flood control.³¹

USDA's Soil Conservation Service constructs engineering works for flood control in watershed areas (as discussed previously) and advises in rural areas on works for local protection.

Flood Plain Management. Flood plain management seeks to further reduce flood losses, beyond what can be economically afforded by watershed treatment and engineering works. This supplemental approach to flood control has gained wide acceptance only within the past decade. It entails regulation of the flood plain through local codes and ordinances by restricting nonessential

development in flood-prone areas or requiring flood-proofing of structures.

The establishment and enforcement of land-use regulations are functions of State and local government. The Federal Government can provide encouragement, funds, and advice. It can also place restrictions on the use of channels, floodways, and portions of the flood plain as conditions for Federal support of flood control projects. Generally, however, Federal influence is by example. Executive Order 11296, issued in 1966, requires a recognition of flood hazards in all Federal decisions in disposal of lands, awarding of grants or loans, and construction of Federal buildings. Further, the National Flood Insurance Act of 1968 (Public Law 90-448, Title XIII), limits Federal subsidy of insurance to those localities that have adopted permanent land-use and control measures consistent with the criteria prescribed in the Act. (The provisions of this Act are discussed in detail in Part IV, Chapter B, Disaster Insurance.)

Basic to any flood plain use program is information concerning areas subject to flooding. TVA provides, on request by communities, a local flood hazard report, with the expected frequency of damaging floods and corresponding topographical maps, and helps communities to draw up local plans and regulations. As of June 1971, 130 of the 150 Valley communities with flood problems have requested and been furnished complete reports; the rest have been given partial data to meet current needs.³²

Congress in 1960 authorized the Corps of Engineers to conduct a similar program nationwide.³³ The Flood Plain Management Service of the Corps of Engineers was established and with the assistance of Federal, State, and local agencies initially identified some 5,200 localities with flood problems. By the summer of 1971, the Corps had completed 440 Flood Plain Information Reports covering 1,300 localities. Also, the Corps responds to thousands of requests each year (some 4,500 in FY 71) for interim information on specific development sites and short stretches of streams or coast. Many of these requests are from Federal agencies, prompted by the requirements of Executive Order 11296 previously mentioned.³⁴

There are still a large number of localities with flood problems for which reports have not been made. San Diego County, California, for example, has been concerned about potential floods since serious brush fires in 1970. A Corps report for the county has been funded, but the scheduled completion date is several years away.³⁵

Until recently, the annual authorization for this program has been \$7 million dollars. A 1970 authorization increased this ceiling to \$11 million.³⁶

Under authorities of the Watershed Protection and Flood Prevention Act of 1954, the Soil Conservation

Service (SCS), USDA, provides similar flood hazard information to rural communities having an urgent need for such technical data in their land-use planning. SCS carries out flood hazard analyses upon request of the responsible State agency to which the local community has applied. This USDA program is complementary to that of the Corps of Engineers and is closely coordinated therewith. Initiated in 1968, the program currently includes studies in 17 States. Final reports will have been completed in eight communities by the end of FY 1972.

The flood plain reports of both TVA and the Corps include topographic maps delineating the hazardous area. Figure 1, a portion of a map for Burkesville, Kentucky, illustrates this service. These maps are prepared under a cooperative program of the Corps of Engineers, the U.S. Geological Survey of the Department of the Interior, and the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce. Currently, the largest-scale map provided under this program scales one inch to 1,000 feet (1" = 1,000'). Figure 1 is 1" = 2,000', and it can be seen that even on a 1" = 1,000' map it would be difficult to determine precisely the threat to individual buildings. TVA, from long experience with its flood plain information program, has recognized this drawback and feels the scale of 1" = 400' should be minimum standard for urban and urbanizing areas.³⁷

There is no doubt that the technical programs to provide communities with advice and information on flood plain management are helpful. Of those communities that have been furnished complete reports, at least 85 percent have used the information for effective action of some type. Further, the reports have been used by Federal and State development agencies to ensure that projects avoid the flood hazard. As an example, at Lewisburg, Tennessee, the Veterans Administration and the Federal Housing Administration would not support development of two subdivisions in areas shown by the TVA report for the area to be subject to serious flooding. Seven months later a flood covered the area with 5 feet of water.³⁸

Worthy as these programs may be, they are only conducted on a "when requested" basis. For example, the Mouse River had not seriously flooded the area of Minot, North Dakota, for 40 years prior to 1969. In the interim, Minot had expanded on the flood plain; over the years, the Corps of Engineers at local meetings had warned of the potential danger, but nothing was done by the community. In the spring of 1969, however, the Mouse flooded major portions of the town with waters which reached 5 feet and remained for over a month.³⁹

River Basins Commissions. The Water Resources Planning Act of 1965 authorized the formation of the National Water Resources Council and the establishment

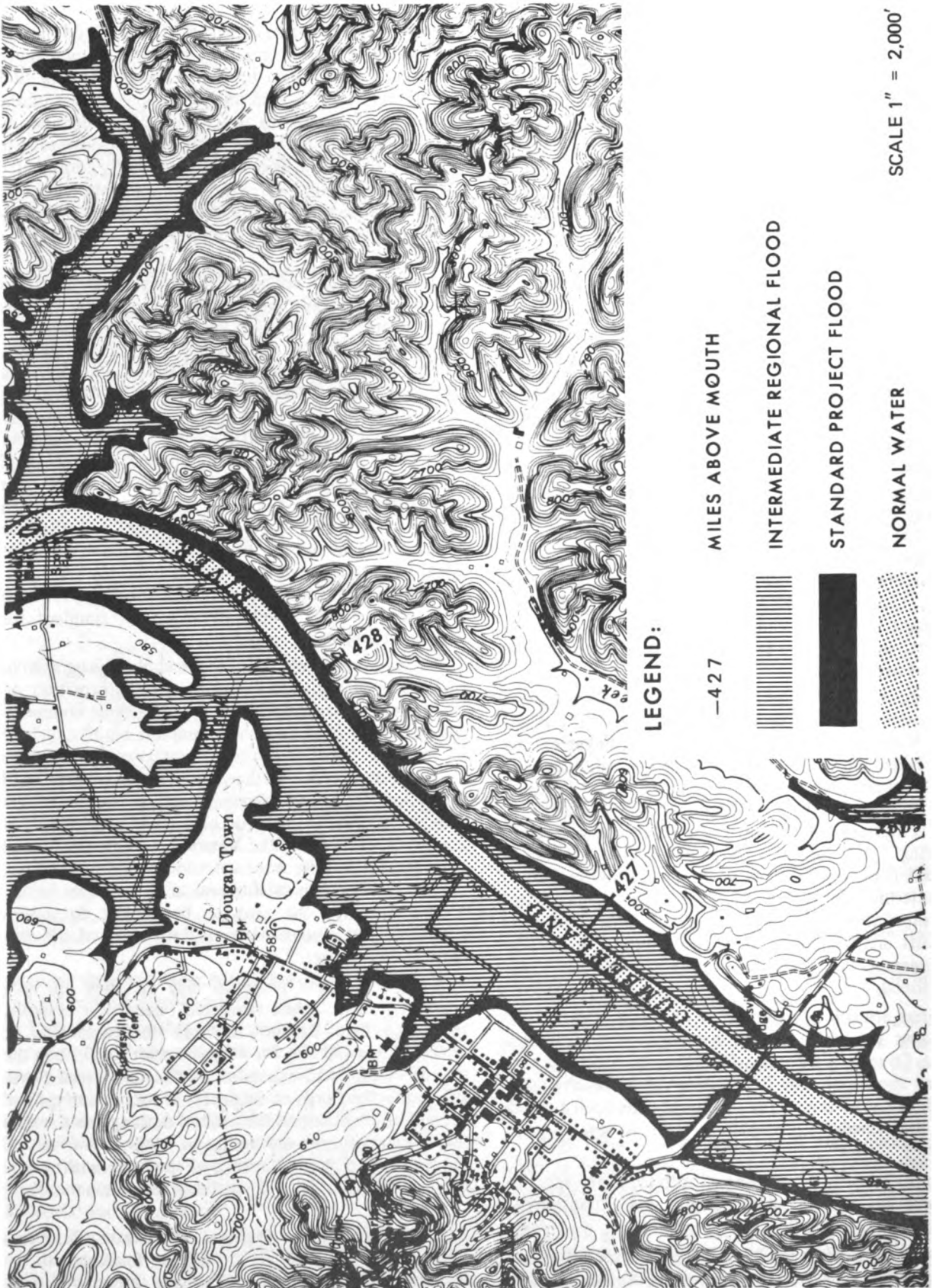


Figure 1.—Flooded Area Map, Burkesville, Kentucky—U.S. Army Corps of Engineers, Nashville District.

of interstate commissions for interstate river systems.⁴⁰ To date, seven River Basins Commissions have been or are in the process of being established: the New England, the Pacific Northwest (Columbia River and tributaries), the Great Lakes, the Souris-Red-Rainy (North Dakota and upper Minnesota), the Ohio, the Missouri, and the Upper Mississippi. Figure 2 shows the New England River Basins Commission membership, typical of these.⁴¹

These Commissions consider the problems of flood hazards on a regional rather than a local basis and are concerned with the whole spectrum of water control and related land use to provide integrated management on a regional basis.

This regional approach to comprehensive water and related land-use planning has been used successfully by TVA since 1933. All levels of government are involved in a coordinated approach to the management of water and related land resources, including the reduction of loss from floods. The New England River Basins Commission, established in 1967, is just now completing its initial appraisal with publication of "New England Framework." This document presents water and related land resource characteristics and estimates of future demands, and identifies the management measures required to meet these demands. Future efforts will include the development of water and related land "management plans" for each State and for interstate subregions, with recommended 10-to-25-year action

programs for flood control, water supply and quality control, recreation, and fish and wildlife preservation.

Weather Modification. Weather modification measures may offer means of reducing the severity of floods. Two current research projects show promise. One involves the creation of high-level cirrus clouds to reduce incoming radiation, thereby retarding the snowmelt; the other involves heavy seeding of cumulus clouds with artificial ice nuclei to reduce the amount of rainfall from these clouds.⁴²

Prediction and Warning Programs

Flood prediction and warning for the Nation has been a statutory responsibility of the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, and its predecessors, since 1871. The National Weather Service (NWS) of NOAA has the responsibility for preparing the official forecast and issuing *public* warnings of floods in all areas of the United States⁴³—except in the Tennessee River basin, where TVA (under the TVA Act of 1933) has the responsibility for flood prediction through cooperative agreement with NWS.⁴⁴

Floods are of two types: those that develop and crest over a period of some 12 hours or more, and those that develop suddenly and crest within several hours or even minutes. The term "flood" as used here means

CHAIRMAN		
INTERSTATE	STATE AGENCIES	FEDERAL
● New England Interstate Water Pollution Control Commission	● Connecticut	● Department of Agriculture
	● Maine	● Department of the Army
● Interstate Sanitation Commission		● Department of Commerce
	● Massachusetts	● Department of Health, Education and Welfare
● Atlantic States Marine Fisheries Commission	● New Hampshire	● Department of Housing and Urban Development
		● Department of the Interior
● Connecticut River Valley Flood Control Commission	● New York	● Department of Transportation
	● Rhode Island	● Federal Power Commission
● Merrimack River Valley Flood Control Commission		● Atomic Energy Commission
	● Vermont	● Environmental Protection Agency
● Thames River Valley Flood Control Commission		

Figure 2.—New England River Basins Commission.

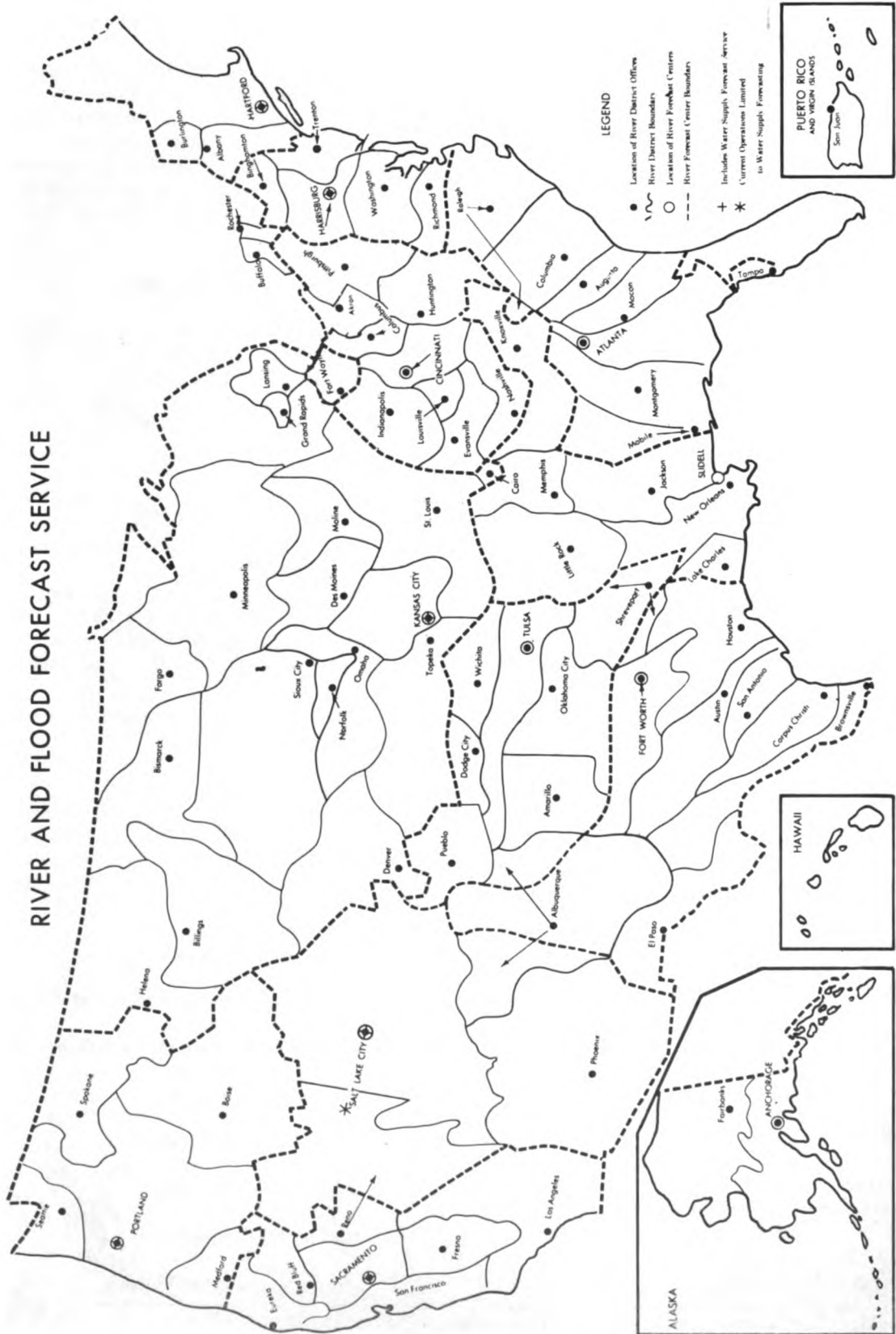


Figure 3.—River Forecast Centers and River District Offices—National Weather Service map.

those floods with a relatively long period of development. The term "flash flood" is used for those of relatively sudden onset. Since forecasting for the two types differs, the systems for each type are discussed separately.

Floods

Organization. NWS provides flood prediction and warning service to the Nation through its River and Flood Forecast and Warning System. The system consists of two levels—the River Forecast Centers and the River District Offices. The 12 River Forecast Centers (RFC) cover 97 percent of the United States, including Alaska. The Centers' areas of responsibility generally conform to the major river basins. Associated with these 12 RFC's are 82 River District Offices covering river systems within the major basins; certain areas not yet covered by RFC's are served by independent River District Offices. (See Figure 3.)

Although this system covers 97 percent of the Nation, important areas are not provided with a complete river and flood forecasting service. For example, Arizona, Utah, Nevada, and large portions of Wyoming, Colorado, and New Mexico are served by a River Forecast Center at Salt Lake City that forecasts only water supply. Existing plans to rectify this situation are being implemented.

Also, the River Forecast Centers have personnel sufficient only to operate a 40-hour week, plus limited coverage during flood periods. Routine extra coverage would permit fuller use of computer capability in combination with automated data networks and thus provide forecasts several hours earlier.⁴⁵

Data Acquisition. Prediction of river floods involves estimating water runoff into tributary streams and eventually into the rivers. Estimates are based on:

- Precipitation in the form of rain or snow that has fallen in the watershed,
- The degree of soil saturation in the watershed,
- The amount of water flowing in tributaries upstream from the river forecast point,
- Atmospheric conditions that influence the continuation and intensity of rainfall or the rate of snowmelt.

The River District Offices maintain networks of stations reporting rainfall, snowpack, and river stage. Other Federal and State agencies and private organizations maintain similar networks in connection with the operation of water resource facilities under their jurisdiction. Across the Nation in these networks, there are some 5,500 rainfall and river gauges, of which about 15 percent are automated to transmit readings on demand. The remainder must be read by private-citizen observers, who transmit the readings verbally.⁴⁶

The number of rainfall and river gauges is generally adequate in river watersheds such as those controlled by TVA⁴⁷ and by the Corps of Engineers in parts of the Columbia Basin. There are, however, other areas where the coverage is inadequate,⁴⁸ particularly the eastern slopes of the Rocky Mountains and the intermountain area between the Rockies and the Sierra Nevada Mountains. In addition, with only 15 percent of the gauges being automated, the reliance on private-citizen observers leaves the forecast and warning system vulnerable from late evening to early morning. Further, it is becoming more difficult to obtain reliable observers in remote rural areas, because the rural population is declining and the meager sums paid are no longer sufficient motivation.

The limitations of manual networks were demonstrated in the Camille floods in central Virginia during August 19-21, 1969. On August 19, the NWS afternoon prediction was for the weakening storm to move to the northeast during the night from its location over eastern Kentucky. As a result, no special instructions were issued to the extensive manual observer system in the mountains of central Virginia, where the storm unexpectedly intensified. Standard instructions to observers called for readings at 1 p.m., 6 p.m., 1 a.m., and 7 a.m. When the storm reached disaster proportions before midnight, observers were unable to reach the gauges, or found that they had been destroyed, or were unable to transmit their reports because of interrupted telephone communications. During the night, only one observer report of excessive rain was received by the Weather Service. The scattered reports received the following morning were insufficient to provide an accurate forecast of flood crests on the lower river and contributed to the damage downstream.⁴⁹

An expanded hydrologic network, with additional gauges and with more of them automated, would provide a capability for more accurate and timely forecasts. The NOAA Geostationary Operational Environmental Satellite (GOES), scheduled for early 1973, will overcome many communications difficulties hindering the use of automated gauges, by providing a single relay station between the gauges and the River Forecast Centers.⁵⁰

Flood Forecasting. Each River District Office collects the hydrologic data from all sources in its district and transmits them to its associated River Forecast Center. The RFC combines these data with other data, such as those received from meteorological and radar stations and from weather satellite pictures, to produce a river and flood forecast. The resulting forecasts predict river conditions at specified primary points on the river systems. Forecasts of river conditions are made on a continuing basis for selected points to provide information required by water management agencies for such activities as water supply, waste

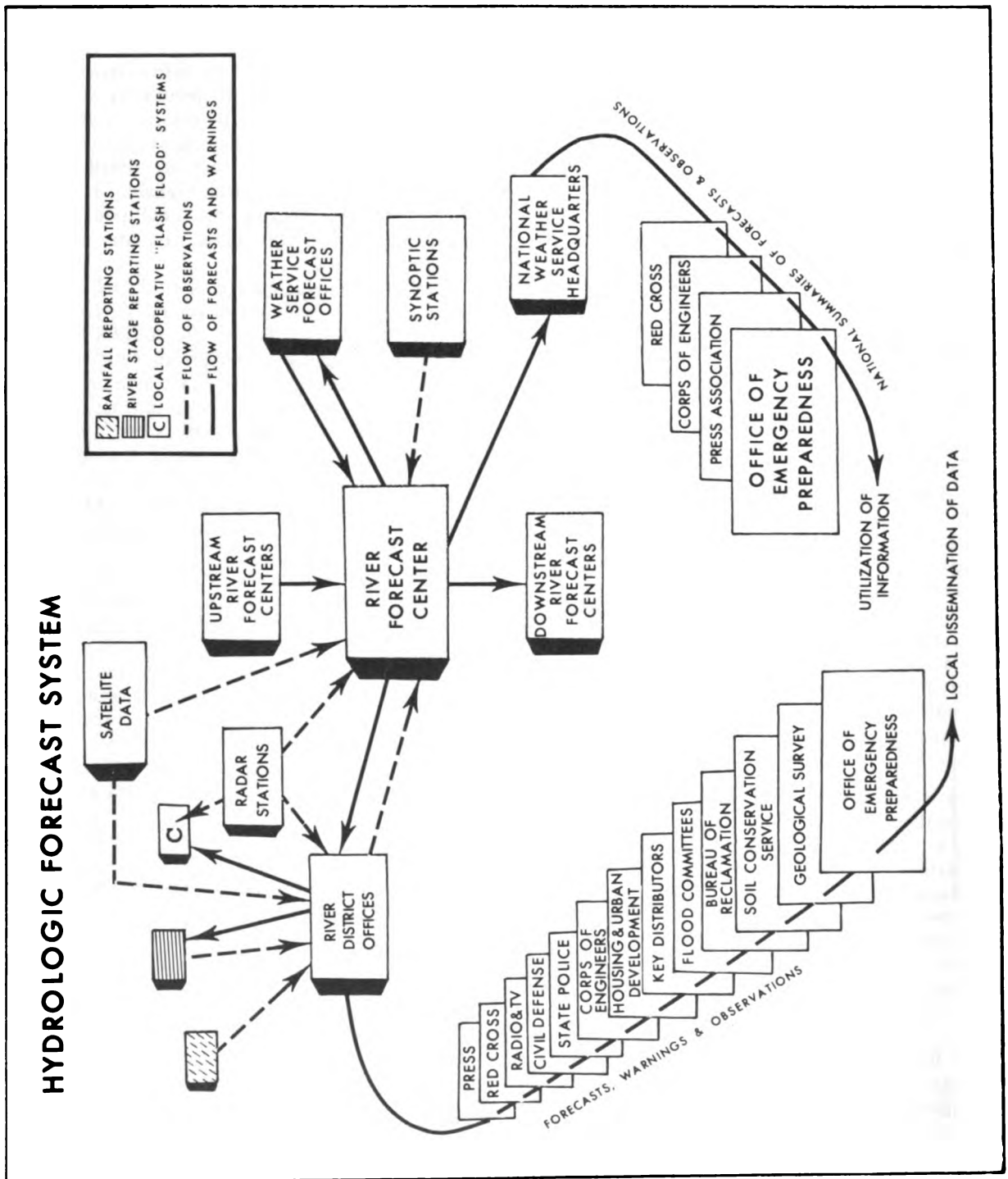


Figure 4.—River and Flood Forecast and Warning Service Information Flow—National Weather Service.

disposal, power generation, navigation, river-related construction, and recreation. In times of threatening floods, they provide warning of expected heights of the river above flood stage at stated points and times.

The processing of the forecasting data is accomplished by computer at all RFC's except at Salt Lake City and Anchorage. The use of computers has greatly enhanced the capability to prepare more timely and accurate forecasts. However, the capacities of the computers available to some River Forecast Centers are insufficient, resulting in flood forecasts not being as timely as they could be.⁵¹

A second concern involves the mathematical hydrologic forecasts model currently in use. This model was developed from computations used in the manual production of forecasts and does not incorporate the more sophisticated computer computations that are too time consuming to be done manually. It gives reasonably adequate results for crest forecasts but does not adequately describe a continuous hydrograph, which is necessary for effective operation of water control dams and reservoirs.⁵² The National Weather Service is currently field testing a promising new model. If the tests show a qualitative improvement of forecasts, computers at all RFC's will be programmed to accept this model.

Flood Warning. Based on flood forecasts transmitted to River District Offices, flood forecasts and warnings are transmitted over the NOAA National Weather Wire Service (NWWS) and the NOAA VHF/FM Radio Transmission Service to organizations and individuals that have leased or acquired receiving equipment. Other organizations are notified by telephone or telegraph. Public dissemination is by the press, radio, and television. (See Figure 4.)

There are serious shortcomings to these means of dissemination of flood warnings:⁵³

- The Weather Wire Service is not available to all areas of the Nation, although there are plans for phased extension of the wire system as funds become available. The areas to which the Weather Wire does not extend involve 12 States. In Virginia, for example, the wire does not extend to Portsmouth, Danville, Mansville, Lynchburg, or Roanoke and thus leaves the southern portion of the State without direct service; in other cases, the unserved areas may cut across State lines.
- Many smaller communities and smaller broadcasting stations cannot afford to pay about \$100 a month for lease of terminal equipment for such a specialized service. The smaller stations rely on their subscription to news services and receive general weather summaries inadequate for local forecasts.
- Disseminating warnings by commercial telephone or telegraph to numerous recipients is slow and takes valuable time from other duties of the limited Weather Service staff.

- Neither the Weather Wire Service nor commercial wire reaches directly to the general public. The press, broadcast stations, or locally devised arrangements must be used to relay the warning.

- The NOAA VHF/FM Radio Transmission Service can provide a direct link to the general public. However, the recipient must purchase a compatible receiver, which costs \$60 to \$150. Though the Radio Transmission Service has been available for some years, there are only an estimated 180,000 receivers throughout the Nation. They are owned mainly by boat owners and organizations with special interest in continuous weather and river forecasts.

The problem of dissemination of disaster warnings, including positive warning of the general public, was addressed by the Office of Telecommunications Policy in a recent study (see Chapter A of this Part). The NOAA VHF/FM Radio Transmission Service was considered as one alternative but was found deficient in capability to give continuous direct warning to the public. The study found in favor of a system, currently in development by the Office of Civil Defense, that would provide selective voice or radio-teletype broadcasts to dedicated receivers, including home receivers for public warning. If found feasible, this system would provide an alternative to the Weather Wire Service and also provide a direct link to the general public.

Warnings of flash floods, which are discussed below, share these shortcomings in means of dissemination.

Flash Floods. In the upper reaches of river basins, the flood crest on tributary streams can occur in a matter of hours, or even minutes, from the onset of a heavy rain. In such cases (flash flooding), it is not possible to record the rainfall and relate it to stream stage and other information at a River Forecast Center in time to forecast flood conditions. (The heavy rains generated by Hurricane Camille in 1969 over the Blue Ridge Mountains of Virginia caused flash flooding in the streams, which crested up to 20 feet or more above the normal flood stage in 4 to 8 hours. The resulting disaster took the lives of at least 150 persons in the mountain and foothill areas and caused an estimated \$112 million in property damage.⁵⁴)

(An estimated 2,500 communities throughout the Nation are subject to flash flooding.⁵⁵) The NWS employs three basic approaches to providing these communities with prediction and warning of flash floods:

- **Community Flash Flood Warning System (CFFWS).** A local network of rainfall and stream-stage reporting stations is established upstream from the community. Under threatening conditions, reports from these stations are made directly to a locally appointed community forecasting-warning representative, who prepares a forecast using a simplified procedure provided him by

NWS. On his own initiative and based on his own forecast he alerts his community through a prearranged system.⁵⁶ Currently, 140 of these systems have been installed.⁵⁷

At the time of the Virginia floods of 1969, Covington, Virginia, was the only community in the mountain area with such a local warning system. The system had a local forecasting-warning representative receiving reports from upstream observers and from a river gauge and a rainfall gauge in the community itself. During the storm, because of telephone outages, the local representative received only one report from upstream. As a result, he could not accurately predict the flood heights, but he alerted the community in time to evacuate threatened areas and prevent the loss of a single life in Covington.⁵⁸

There are several problems connected with the establishment of this system. First is the need for NWS experts to determine locations for observer stations and gauges, to prepare charts and graphs for forecasting in the particular area, to supervise the installation of the system, to train the local people involved, and to supervise the upkeep of established systems. NWS, under its program as now funded, provides this assistance for only about 14 new systems each year.⁵⁹ Other agencies such as the Corps of Engineers and TVA, while having expertise, have no statutory authority or responsibility for prediction and warning on nonregulated streams (where flash floods occur) and therefore have no programs in this area.

Secondly, there is the problem of finding an individual willing and able to serve as the local forecaster. This job requires a person able to understand the forecasting charts and graphs and perform the necessary computations. In many communities, one of the local officials, such as the town engineer, is given the job as an additional duty.⁶⁰

Finally, there is reluctance on the part of some communities to finance the system. The cost of this system varies considerably due to the number and type of gauges required and the willingness of local people to volunteer. However, as an example, for La Follette, Tennessee, the 1964 cost estimate was some \$9,000 for installation and \$3,000 annual operating costs.⁶¹ As a rule of thumb, under current practices the Federal share is about two-thirds of the installation cost and about one-third of the operation and maintenance. Experience has shown, however, that communities unable to finance installation of the system are also generally the ones unable to maintain it, thus making it ineffective when the emergency comes.⁶²

• *Automatic Flash Flood Alarm System* relies on an unattended water-level detecting device, emplaced upstream, which activates an alarm in the community when the stream level reaches the danger point.⁶³ The alarm system is a recent development, and 10 are currently being installed.⁶⁴ These systems will be maintained by NWS.

Although this is a very effective means of providing warning, it can only give warning that a flash flood is imminent; it cannot provide information on the height of flood waters. Further, such a system is not feasible in all situations, particularly where the stream channel is not well defined, as in the dry arroyos of the Southwest.⁶⁵

• *Conventional Weather Warning System* relies on the expertise and alertness of the weather forecaster in the local area Weather Service Office. The forecaster issues a generalized prediction and warning of possible flash flooding, based on satellite, radar, or telemetered rainfall gauge information available to him and his own subjective estimate of the future movement, duration, and intensity of the storm.⁶⁶

This third approach is illustrated by the action taken at the local Weather Service Offices (WSO's) in Phoenix and Flagstaff, Arizona, in the prediction and warning of heavy rains and flash floods in central Arizona over the Labor Day weekend of September 1970. The weather forecasters in Phoenix and Flagstaff alerted the public in their areas on Friday to the possibility of flash floods over the weekend. These local forecasts were based upon subjective analyses of synoptic weather information, satellite photographs of a dying Mexican tropical storm, and indications of a cold front moving in from the Pacific Northwest. As observer reports of heavy rains were received on Saturday morning, the local weather forecasters issued flash flood warnings for specific counties. The unprecedented rainfall of that Saturday created the greatest natural disaster in the history of the State; 23 lives were lost, principally weekend campers, and many roads and bridges were washed away. However, the actions of the local WSO's are credited with saving hundreds of other lives by discouraging many from a camping weekend and alerting others to seek high ground.⁶⁷

Flash flood predictions by the local WSO's can at best provide information on the probability of flash floods in a general area over a general time period. Definitive prediction of stages at specific points and times are not possible through this system. Nonetheless, such predictions are of value in saving lives.

The weather radar network which can provide vital information for flash flood prediction and warning is at present deficient in two respects. First, the radar coverage is not adequate for all areas of the country, particularly west of the Rocky Mountains. Second, the special radar facsimile network that transmits composite radar pictures has not been extended to all WSO's.

For example, although weather radar coverage of the 1970 Arizona Labor Day weekend storm was available through a joint NOAA-FAA air route traffic control system, data from the system in usable form (composite pictures) was not available to the Arizona WSO's.⁶⁸ Specific area warnings were therefore delayed until

ground observer reports were received. Earlier warnings might have saved some of the 23 lives lost.

Weather satellite pictures are valuable for predicting conditions that could lead to flash floods. The satellite pictures available to the Phoenix WSO on the afternoon of Friday, September 4, alerted the forecaster to the possibility that remnants of a tropical storm might move across Arizona over the weekend and prompted his further evaluation of the storm threat.⁶⁹

There is, however, a major weakness in the current weather satellite program: present orbital weather satellites can provide representation of the U.S. weather situation only twice daily. Weather satellite pictures of the remnants of Hurricane Camille were taken early in the afternoon of August 19 and showed nothing to conflict with the predicted northeast movement of the storm center. However, the storm intensified and changed direction in the late afternoon; weather satellite pictures reflecting these changes were not taken until the following day. As a result, NWS attention during the night was directed at northwest Virginia and Maryland and not at central Virginia, where the heavy rains actually developed.⁷⁰ The NOAA geostationary weather satellite (GOES) scheduled for launch in 1973 is intended to correct this weakness and initiate a system for near continuous viewing of weather features.⁷¹

Flood Emergency Programs

Emergency measures taken to reduce losses from imminent flooding involve (1) emergency watershed land treatment and temporary protective works, (2) evacuation of people and material from areas subject to flooding, and (3) rescheduling of production activities and services to minimize the disruptive effects of the flood.⁷²

An accurate forecast and advance warning can enable prepared communities to reduce potential losses by taking suitable emergency actions. A study of the March 5-9, 1967, Pittsburgh River District flood, which caused damage of \$6.8 million, attributed savings of \$6.1 million to emergency actions taken as a result of advance warning.⁷³

U.S. Army Corps of Engineers. Under PL 84-99, the Chief of Engineers is authorized to supplement local emergency measures if such assistance is requested by local authorities and assurance given that local resources are being reasonably committed. This supplementary support includes technical advice, construction of temporary flood control structures and repair and strengthening of existing ones, channel clearance, advice on removal of ice jams, and issuance or loan of supplies and equipment such as sand bags, polyethylene sheets, and pumps.⁷⁴

U.S. Department of Agriculture. Under the Flood Control Act of June 28, 1938, as amended, the

Secretary of Agriculture has authority to expend a total of \$300,000 annually "to undertake emergency measures . . . to safeguard lives and property from floods and the products of erosion on any watershed whenever fire or any natural element or force has caused a sudden impairment of that watershed." Such measures may include technical assistance, seeding of denuded land, sloping of dangerously steepened banks, construction of protective diversions, debris removal, and channel clearance. This program is extremely important in certain areas such as the West Coast, where floods are almost a certainty during a rainy season after fires have seriously denuded mountains and hills.

The current annual limitation of \$300,000 was established by the Flood Control Act of 1950, which raised the limitation from \$100,000 established earlier by the Flood Control Act of 1938.⁷⁵ This authority is reasonably adequate to carry out necessary projects in most years. In the past 10 years, 41 projects have been undertaken. In only three of these years was the emergency fund inadequate, thus requiring supplemental funding as follows: 1965—\$900,000, 1969—\$4 million, 1970—\$3.7 million.⁷⁶

The American National Red Cross. Under its Congressional Charter, the Red Cross continually renders assistance in flood emergencies in the planning and execution of evacuation measures and the sheltering and feeding of evacuees and flood workers.

Operation Foresight. Operation Foresight was carried out under the direction of the Office of Emergency Preparedness first in 1969 and again in 1971. The former case especially provides a prime example of cooperative emergency measures taken at all levels to avert a major imminent flood disaster.

During the winter of 1968-69, NWS expressed concern over the possibility of serious spring floods. A cooperative snow survey by NWS and other Federal agencies, using satellite as well as ground observations, confirmed in February that there was a real potential for disastrous floods, particularly in the northern Midwest. Accordingly, during late February, President Nixon instructed the OEP Director to coordinate a major effort by Federal agencies to take all feasible actions to supplement State and local preparations to reduce or alleviate the potential flood damage and human suffering. Thus Operation Foresight was launched.

The NWS River Forecast Center at Kansas City, Missouri, issued preliminary crest forecasts on March 13 for 225 points in the threatened areas. These forecasts proved remarkably accurate for most forecast points and provided the flood fighters with the fundamental information needed to determine the protection required. The forecasts were continually updated on the basis of

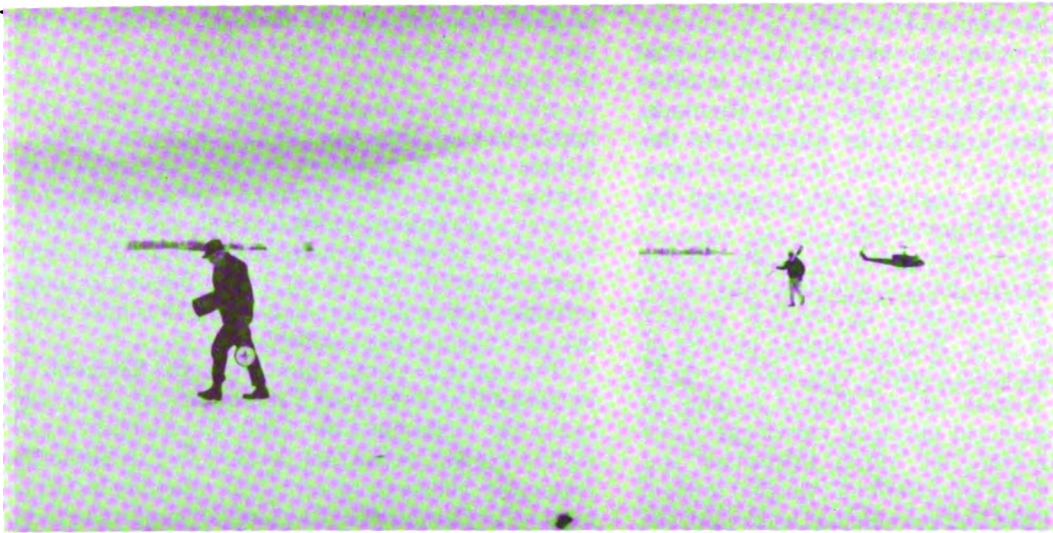


Figure 5.—Operation Foresight 1969. Above: a ground-observer team is landed by U.S. Army helicopter on a remote South Dakota plain to measure snow depth and water content. Below: heavy equipment works on a temporary levee being built atop the northbound lane of U.S. 169 at North Mankato, Minnesota.—Photos from *National Geographic*, October 1969 (pp. 578-579, 584-585), Photographer Thomas Defeo, (c) 1969 National Geographic Society, reprinted with permission.



data provided by an intensified collection effort employing weather satellite and aircraft photography plus ground observers in remote areas (Figure 5).

The Corps of Engineers helped State and local officials to get protective measures underway before the flooding occurred. It carried out reconnaissance of rivers and streams to identify obstructions to free flow. It staffed information centers to expedite handling of requests for information and on-site technical assistance. It strengthened communications nets with additional Corps equipment. Corps experts were transferred from other sections of the country to assist.

Corps of Engineers funds, under PL 84-99 authority, were made available to protect vulnerable areas where local finances were inadequate. To qualify for the use of PL 84-99 funds, a community had to demonstrate that it had a feasible protection plan and could furnish the necessary rights-of-way and labor for the construction of levees.

The Corps awarded contracts for levee construction and supplied sandbags, polyethylene sheets, pumps, and lumber to local work gangs. It provided technical assistance to survey potential trouble spots and supervise contracts. It contracted for cropduster planes to dust lake and river ice with dark inert material to absorb the solar heat and accelerate melting ahead of expected normal thaws. It gave advice and assistance in ice-blasting projects.

Local chapters of the Associated General Contractors of America, under their "Plan Bulldozer," coordinated the availability of men, materials, and equipment for contractors working on emergency engineering projects (Figure 5).

The Coast Guard moved in boats and helicopters for the evacuation of flood victims from unprotected areas.

The Department of Agriculture advised farmers on preemergency actions to minimize losses of livestock, machinery, and stored crops. It also provided inspectors to supervise postflood cleanup operations in grocery stores, restaurants, and other food handling and storage establishments.

The Interstate Commerce Commission provided priorities for transport to move grain out of flood plains.

The Red Cross prepared for evacuation, emergency shelters, and feeding.

The Salvation Army prepared to assist flood victims and feed the flood workers on the job.

States declared emergencies so that all State resources could be brought to bear in assisting local communities. Essential public services were rescheduled to ensure their continuation during the emergencies. The National Guard provided heavy equipment to build levees and helped in emergency evacuation, patrolled flooded areas, and manned traffic control points. State Highway Commissions provided trucks to evacuate property and help in levee construction. Civil defense

personnel established emergency operating centers as focal points to coordinate actions within the community.

Local officials developed emergency plans to construct or raise levees. They recruited labor (volunteer and paid) for sandbagging, levee security patrols, and evacuation of goods and property.

The local populace turned out to help in the fight. Housewives and schoolgirls helped fill sandbags and men of all ages worked to build sandbag protections (Figure 6). Figure 7 is a sketch showing the multiple threats for which each community had to be alert and prepared to fight.

Operation Foresight⁷⁷ proved dramatically that emergency measures can play a major role in reducing flood damage. The Corps estimated that \$250 million damage was prevented at a cost to Federal, State, and local governments of about \$36 million. Additionally, many of the temporary levees and works constructed during the operation have since been incorporated into the permanent flood protection works of the communities.

Local Preparedness Plans and Training

In the final analysis, the responsibility for flood-fighting measures within the community rests with local officials. Technical advice, materials, and equipment may be supplied from outside, but the actual preparations and emergency operations must be carried out by the local community.

The key to the effectiveness of the community's effort is its readiness achieved through prior planning and training. Combined with warning, this readiness can mean the difference between minor loss and major disaster.

Communities which have experienced frequent flooding have, for the most part, fairly complete emergency plans. For example, Richmond, Virginia, had a flood emergency plan in being at the time of the 1969 Camille flood on the James River. With only 36 hours warning before the arrival of the crest, necessary actions were taken quickly and successfully. Flood gates were closed, sandbagging accomplished, unprotected areas evacuated, and other emergency measures taken. Richmond escaped with relatively little damage and no casualties.⁷⁸

Businesses in the city of Pittsburgh, Pennsylvania, are particularly flood conscious. Downtown buildings in the Golden Triangle have detailed procedures for "buttoning up" their floodproofing systems. Flood manuals are used to acquaint employees with the flood program and to designate specific tasks in an emergency. A thorough check of the state of readiness is conducted annually.⁷⁹

The Camille flood experience in the Blue Ridge Mountains spurred several small communities to adopt flood emergency plans. On the other hand, at the present time, more than 2 years after the flood, two of the harder hit communities still have no plans.⁸⁰ Many

Figure 6.—Operation Foresight 1969. Right: women of North Mankato join the fight and fill sandbags for protective works—OEP photo. Below: teenagers and older men of North Mankato anchor sheets of polyethylene with sandbags to prevent current scouring of the temporary levee—photo from *National Geographic*, October 1969 (pp. 580-581), Photographer Thomas Defeo, (c) 1969 National Geographic Society, reprinted with permission.



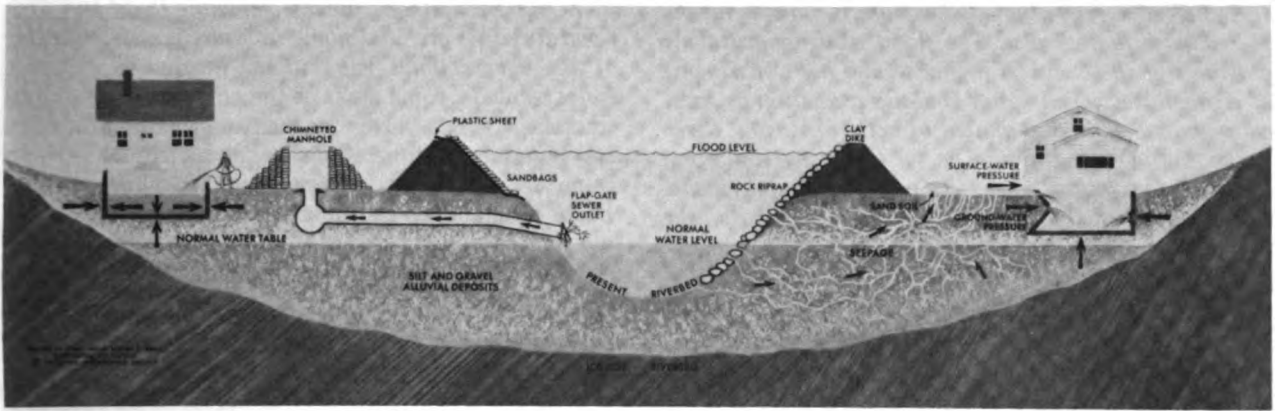


Figure 7.—Multiple Threats. Even though the river has not topped the levee, there are still threats to which the community must be alert. At left, a flood-wise homeowner fills his basement with water to counteract ground-water pressures, and a sandbag “chimney” contains flood water entering the sewer after debris jams open its flag gate. Across the river, seepage has created a “boil” behind the levee—although a “chimney” could have contained the boil—and the basement of a house on the flood plain is collapsed by surface-water and ground-water pressures.—From *National Geographic*, October 1969 (pp. 586-587), Staff Artist Robert C. Magis, (c) 1969 National Geographic Society, reprinted with permission.

communities realize the need for improved readiness but feel they lack local technical expertise to develop their programs.⁸¹

Federal expertise is available, however, to communities that request it. The Corps of Engineers provides extensive assistance through its Flood Plain Management Service, discussed above in the section on Flood Control. The Flood Plain Information Report provided as part of this service gives the community information on potential flooding, including depth of water to be expected from floods of varying probable frequency, the speed of onset, current velocities, and duration of flooding. TVA and USDA provide similar information to communities in their areas of responsibility. The Corps also provides a Flood Emergency Manual containing information on floodfighting techniques, and Corps experts are available for consultation on local plans.

Local Red Cross chapters also have extensive programs for training and orienting volunteers in emergency response, with particular emphasis on the types of disasters likely in the local area.

Public Education

To further public knowledge, NOAA prepares and distributes a number of short pamphlets describing the flood warning service, encouraging community action, and listing simple emergency rules. USDA has a similar program for the rural community and farm population.

The information provided by the Corps of Engineers can be used by the community to educate its people concerning local flood hazards and individual emergency actions. The local Red Cross chapters are always a source for public educational materials and instructors.

State and local programs vary from area to area, with those areas of recent flood experience being better prepared. In the fall of 1968, after fire had burned some 100,000 acres of the chaparral on the slopes of the San Gabriel Mountains overlooking the densely populated areas of Los Angeles County, California, these communities needed little urging to hold meetings to educate the public on emergency actions in the floods and slides that could be expected with the rains in the following months.⁸²

Findings

1. Major flood control projects are, along with appropriate regulation of land use, the most effective means of making significant improvement in flood control. The statutory and regulatory process leading to construction of these projects now averages 18 years from the initial local request to the start of construction. Possible ways to reduce this developmental period are:

- Authorizing the Chief of Engineers to recommend surveys of major projects that appear to have a high potential for reducing flood losses;
- Revising the procedures for interagency coordination of the survey report to accelerate the coordination process;
- Increasing the \$10 million ceiling under which the Public Works Committees may authorize projects by resolution;
- Increasing the \$1 million limitation placed on the size of the projects that may be surveyed and recommended for funding by the Chief of Engineers under continuing authorities.

2. *Effective regulation of land use is a major means of reducing flood losses. The flood plain management programs of the Corps of Engineers and the Department of Agriculture, which foster land-use regulation by local communities and development of action plans by River Basins Commissions should be pursued to permit communities to comply with the eligibility requirements of the National Flood Insurance Act. Similarly, the joint flood mapping program (Corps of Engineers, National Oceanic and Atmospheric Administration, and U.S. Geological Survey) should be emphasized, with a capability to permit production of maps on the scale of one inch to 400 feet (1"=400') for urban and urbanizing areas.*

3. *The Small Watershed Programs of the Department of Agriculture have not been adequately funded in past years. The funding level of the 1972 budget is, however, considered adequate. Adequate funding of these programs should be continued, to enhance the beneficial effects on flood abatement as well as on the environment.*

4. *Inadequate staffing of the River and Flood Forecast and Warning System of the National Weather Service results in a lack of flood forecast and warning service in some areas of the country and marginal service in others. Further, even where full service is available, it is not as timely as it could be because the River Forecast Centers normally have only a one-shift operational capability. Consideration should be given to staffing the River Forecast and Warning System as required to expand services to all geographical areas and to ensure that all River Forecast Centers can give extended hours of service when necessary.*

5. *The hydrologic data networks of the National Weather Service do not provide adequate coverage and rely mainly on manual reading and reporting of data. Data from many remote areas where floods originate are not available. Increased coverage and automation of the NWS hydrologic networks would ensure more complete and timely data and improve the accuracy and timeliness of flood forecasts. A complete network would be an expansion from 5,500 to 10,000 river and precipitation gauges, with 2,500 gauges automated through the NOAA Geostationary Operational Environmental Satellite (GOES) system and another 2,500 automated using ground communications.*

6. *Computer service available to some River Forecast Centers is inadequate. Two centers are without computer service and some others must rely on early-generation equipment with limited core memory and slow speed. An improved mathematical hydrologic forecast computer model is now being perfected and, coupled with modern computer systems, should increase the accuracy and timeliness of the forecasts.*

7. *Current methods for disseminating flood and flash flood forecasts are inadequate to insure positive warning of the general public. The National Weather Wire Service is not available to all areas of the country, and terminal equipment is too costly for many smaller communities and broadcast stations. Commercial telephone and telegraph, as the means to disseminate warnings to individual communities and broadcast stations, are slow and too time consuming for the Weather Service. Neither the National Weather Wire nor commercial wire directly reaches the general public.*

The NOAA VHF/FM Radio Transmission service reaches only the limited public segment that has invested in receivers, and the receivers now in use do not have an automatic switch-on capability.

The warning system which a 1971 study, chaired by the Office of Telecommunications Policy, recommended for development and test could provide a capability for dissemination directly to the general public through a home warning device and could also offer an attractive alternative to the National Weather Wire Service. For this reason, extension of the Weather Wire Service should be considered in light of progress in development of this new system.

8. *The flash flood prediction and warning program has a limited capability to provide technical assistance in establishing local community systems and lacks qualified personnel in many Weather Service Offices to prepare general forecasts of flash floods. Staffing of the National Weather Service should take into account the desirability of:*

- Establishing a two-man flash flood team at each River Forecast Center to provide expertise for setting up community flash flood programs.
- Stationing flash flood prediction specialists at local Weather Service Offices serving areas vulnerable to flash floods.

9. *Weather radar surveillance, and associated radar facsimile service, for local Weather Service Offices in many areas prone to flash floods can be significantly improved. Improvements in these aids for flash flood prediction would provide local Weather Service Offices with the capability to issue more definitive warnings and in many instances would obviate delays in ground observer reporting on location and intensity of rainfall. Consideration should be given to:*

- Expanding the National Weather Service's radar network by some 25 radar stations and providing remote readout from selected Federal Aviation Administration radar facilities.
- Extending the National Weather Service's radar facsimile network (RAFAX) to local Weather Service Offices in areas vulnerable to flash floods and now without this service.

Notes

¹A *Unified National Program for Managing Flood Losses*, Report by the Task Force on Federal Flood Control Policy, August 1966, House Document No. 465, 89th Cong., 2d Sess., p. 5. Also, communication with R. M. Edwards, Chief of Construction Branch, Directorate of Civil Works, Office of the Chief of Engineers, January 1972.

²National Waterways Conference, Inc., letter to Chief, OEP PL 91-606 Disaster Study Group, May 26, 1971.

³Robert W. Kates, *Hazard and Choice Perception in Flood Plain Management* (Chicago: University of Chicago, 1962), p. 4. Also, A *Unified National Program for Managing Flood Losses*, pp. 5, 9.

⁴R. A. Hertzler, "Corps of Engineers Experience Relating to Flood Plain Regulation," *Papers on Flood Problems*, Gilbert F. White (ed.) (Chicago: The University of Chicago Press, 1961), p. 187. Also, Gilbert F. White et al., *Changes in Urban Occupance of Flood Plains in the United States* (Chicago: University of Chicago, November 1958), p. 122.

⁵Hertzler, *loc. cit.*

⁶Gilbert F. White, *Human Adjustment to Floods* (Chicago: University of Chicago, 1945), pp. 5, 7.

⁷*Ibid.*

⁸*Ibid.*, pp. 6, 11.

⁹*Ibid.*, p. 14.

¹⁰A *Unified National Program for Managing Flood Losses*, p. 12.

¹¹White, *op. cit.*, pp. 14, 15.

¹²This activity is covered in detail in Chapter E of this Part.

¹³U.S. Department of Agriculture, letter (with enclosures) to Chief, OEP PL 91-606 Disaster Study Group, April 7, 1971.

¹⁴*Ibid.*

¹⁵*Ibid.*

¹⁶Communication with James Ferris, Office of Deputy Administrator for Watersheds, Soil Conservation Service, USDA, December 1971 (updated).

¹⁷A levee enclosed route over unoccupied land which can be intentionally flooded to divert a portion of the floodwaters from the main channel.

¹⁸James E. Goddard, "The Cooperative Program in the Tennessee Valley," *Papers on Flood Problems*, p. 148.

¹⁹Bill S. Eichert, "Flood Protection and Risk Evaluation," a paper presented to the California State Conference on Earthquake Risks, Monterey, California, September 23, 1971 (Davis, Calif.: The Hydrologic Engineering Center, 1971).

²⁰Francis C. Murphy, *Regulating Flood Plain Development* (Chicago: University of Chicago, November 1958), p. 3.

²¹George R. Phippen, "A New Course to Ararat," *Water Spectrum*, Department of the Army, Corps of Engineers (Summer 1971), p. 12.

²²Murphy, *op. cit.*, p. 34.

²³Office of the Chief of Engineers, "Disaster Relief Study," memorandum (with attachments) to OEP PL 91-606 Disaster Study Group, May 26, 1971.

²⁴*Ibid.* Also, "Survey Investigation and Reports," Pamphlet No. 1120-2-1, Department of the Army, Office of the Chief of Engineers (May 1, 1967).

²⁵Communication with Earl Jones, Chief Planning Development and Management Branch, Planning Division, Directorate of Civil Works, Office of the Chief of Engineers, December 1971.

²⁶Office of the Chief of Engineers, May 26, 1971, memorandum.

²⁷*Ibid.*

²⁸Project status data in this paragraph and the following paragraph are from Jones, December 1971 communication.

²⁹*Flood Study, Disaster Relief Act of 1970, Phase I Survey* (Knoxville: Tennessee Valley Authority, June 1971), Part II, pp. 6-7.

³⁰Communication with Philip Ericson, Office of the General Manager, TVA, December 1971.

³¹General Services Administration, National Archives and Records Service, Office of the Federal Register, *United States Government Organization Manual 1971/72* (Washington, D.C.: U.S. Government Printing Office, 1971), pp. 232-233. Also, U.S. Department of the Interior, letter (with enclosures) to OEP PL 91-606 Disaster Study Group, May 1971.

³²*Flood Study, . . . Phase I Survey*, Part II, p. 9.

³³*Ibid.*, Part II, p. 10.

³⁴Phippen, *op. cit.*, pp. 12-13.

³⁵County of San Diego, Washington, D.C. Office, letter (with enclosures) to Chief, OEP PL 91-606 Study Group, May 21, 1971.

³⁶Phippen, *op. cit.*, pp. 13-15.

³⁷*Flood Study, Disaster Relief Act of 1970, Phase II, Phase III* (Knoxville: Tennessee Valley Authority, September 1971), Part II, p. 7.

³⁸Goddard, *op. cit.*, p. 165.

³⁹Peter T. White, "Satellites Gave Warning of Midwest Floods," *National Geographic*, Vol. 136, No. 4 (October 1969), pp. 586-592.

⁴⁰R. Frank Gregg, "A New Kind of Institution," *Water Spectrum*, Department of the Army, Corps of Engineers (Spring 1971), pp. 26-32.

⁴¹*Ibid.*

⁴²Richard A. Schleusener, "Weather Modification for Disaster Relief," draft document for NOAA Weather Modification Report to Office of Emergency Preparedness (Rapid City: South Dakota School of Mines and Technology, October 1971), p. 11.

⁴³U.S. Department of Commerce, "PL 91-606 Disaster Study, Phase I," memorandum (with attachments) to Chief, OEP PL 91-606 Disaster Study Group, May 26, 1971.

⁴⁴*Flood Study, . . . Phase I Survey*, Part I, p. 1.

⁴⁵U.S. Department of Commerce, letter (with enclosures) to Chief, OEP PL 91-606 Disaster Study Group, June 7, 1971.

⁴⁶U.S. Department of Commerce, May 26, 1971, letter.

⁴⁷Tennessee Valley Authority, letter (with enclosures) to Chief, OEP PL 91-606 Disaster Study Group, August 25, 1971.

⁴⁸U.S. Department of Commerce, June 7, 1971, letter.

⁴⁹*The Virginia Floods*, ESSA/PI 690035 (U.S. Department of Commerce, September 1969).

⁵⁰U.S. Department of Commerce, June 7, 1971, letter.

⁵¹Observations in this paragraph and the following paragraph are based on communications with M. M. Richards, Chief of Hydrologic Services, NOAA, August-December 1971.

⁵²See also *Flood Study, . . . Phase II, Phase III*, Part I, p. 3.

⁵³U.S. Department of Commerce, letter to Chief, OEP PL 91-606 Disaster Study Group, September 24, 1971; communication with Office of Telecommunications Policy, January 1972.

⁵⁴William Buchanan et al., *The 100 Year Flood, Reactions to Hurricane Camille in Nelson, Amherst and Rockbridge Counties, Virginia*; Contract No. OEP-D-70 3; Lexington, Va.: Washington and Lee University, September 1, 1970), p. 1.

⁵⁵*A Plan for Improving the National River and Flood Forecast and Warning Service*, U.S. Department of Commerce (Silver Spring, Md.: Office of Hydrology, December 1969), p. 44.

⁵⁶*Ibid.*

⁵⁷From Richards.

⁵⁸*The Virginia Floods*, p. 5.

⁵⁹From Richards.

⁶⁰From Richards.

⁶¹Gilbert F. White, *Choice of Adjustment to Floods* (Chicago: The University of Chicago Press, 1964), p. 70.

⁶²From Richards.

⁶³*A Plan for Improving . . .*, p. 44.

⁶⁴From Richards.

⁶⁵*A Plan for Improving . . .*, p. 44.

⁶⁶*Ibid.*

⁶⁷*Arizona Floods of September 5 and 6, 1970*, NOAA NDSR 70-2 (Rockville, Md.: U.S. Department of Commerce, July 1971), pp. v, 1.

⁶⁸*Ibid.*, pp. 22-23.

⁶⁹*Ibid.*, p. v.

⁷⁰*The Virginia Floods*, p. 12.

⁷¹*First Five Years of the Environmental Satellite Program—A Report to the Administrator of NOAA*, National Environmental Satellite Service (U.S. Department of Commerce, February 1971), p. 5.

⁷²Robert W. Kates, *op. cit.*, p. 108.

⁷³*A Plan for Improving . . .*, pp. 13, 15.

⁷⁴Office of the Chief of Engineers, May 26, 1971 memorandum.

⁷⁵U.S. Department of Agriculture, letter (with enclosures) to Chief, OEP PL 91-606 Disaster Study Group, May 1971.

⁷⁶From Ferris, December 1971.

⁷⁷More detailed information about Operation Foresight 1969 is contained in Robert M. Tarbox, "Operation Foresight: A Valuable Precedent," *Water Spectrum*, Department of the Army, Corps of Engineers (Summer 1969), pp. 19, 26; in *ESSA and Operation Foresight*, ESSA/PI 690030 (U.S. Department of Commerce, May 1969); and in Peter T. White, *op. cit.*, pp. 574, 592.

⁷⁸*Federal Response to Hurricane Camille (Part 3)*, Hearings before the Special Subcommittee on Disaster Relief of the Committee on Public Works, Roanoke, Va., February 1970 (U.S. Senate, 91st Cong., 2d Sess. 1970), pp. 1047, 1147, 1186, and 1194.

⁷⁹John R. Sheaffer et al., *Introduction to Flood Proofing* (Chicago: Center for Urban Studies, University of Chicago, April 1967), pp. 31, 33.

⁸⁰Buchanan et al., *op. cit.*, p. 35, and communication with OEP Region 3, December 1971.

⁸¹United States Conference of Mayors, letter (with enclosure) to Chief, OEP PL 91-606 Disaster Study Group, June 15, 1971.

⁸²Nathaniel T. Kenney, "Southern California's Trial by Mud and Water," *National Geographic*, Vol. 136, No. 4 (October 1969), pp. 560-561.

Chapter C. Tornadoes and Windstorms

General

Tornadoes are the most violent weather phenomena known to man. Their funnel-shaped clouds, rotating at velocities of up to 500 miles per hour, generally affect areas of from $\frac{1}{4}$ to $\frac{3}{4}$ of a mile wide and seldom more than 16 miles long. However, they have been known to travel over areas measuring up to 1 mile wide and 300 miles long. Weather conditions that produce tornadoes also manifest themselves as a less violent phenomenon, the severe windstorm. Tornadoes and violent windstorms are treated as essentially the same, for the purposes of this chapter, since in many ways the same prediction and warning systems and preparedness measures apply to both.

The violently destructive effects of tornadoes and windstorms have made them the "number one" natural disaster killers in the United States. (During the past 50 years, tornadoes have killed almost 9,000 persons, while violent windstorms have killed an additional 9,500.¹ By comparison, the other two prime killers, hurricanes and floods, have killed about 5,000 and 4,000 persons, respectively, during this period.²)

However, the annual average number of deaths resulting from tornadoes has decreased by 42 percent³ since the National Weather Service Tornado Warning System was instituted in 1953 (Figure 1). During this period, the population in tornado-prone areas has increased by 27 percent.⁴ There are also indications that even when tornadoes now strike urban areas, as they did in Topeka, Kansas, in 1966 and Lubbock, Texas, in 1970, the loss of life tends to be moderate in proportion to the total exposed population. This is attributed to improved warning and more effective precautionary measures.⁵

(Broad estimates of property damage resulting from tornadoes show that in 6 of the past 10 years annual losses have exceeded \$50 million, and in 4 years exceeded \$5 million. During this period, windstorm losses have exceeded \$500 million in 5 years and \$50 million in the remaining 5 years (Tables 1 and 2).

Where more precise estimates are available, in cases of individual tornado disasters, the high cost in property damage is shown more precisely. For example, the tornado in Lubbock in May 1970 produced \$135 million in damages.⁶ As with other types of disasters, people and property have become more vulnerable to tornadoes

as urban areas have increased in numbers, size, and population.

(Tornadoes have been recorded in every State, but the Midwest and Southeast are the most vulnerable areas (Figure 2). While tornadoes have been known to occur throughout the year, weather conditions from April through June generally spawn the greatest number (Figure 3).

Tornadoes differ significantly from other types of weather-caused disasters in the measures that must be taken to prepare for them. The following quotation from a tornado-area resident illustrates the basic preparedness problems presented by the tornado phenomenon:

We heard this warning, saying there was a twister on the ground on the road. We immediately looked out our southwest window. As near as I could tell this twister was 300 feet from us. We took our bird—and the cage—and made it to the basement. Just barely got down on the floor in the southwest corner when it hit. It just really broke loose when it did hit. And as soon as it was over we came out of the basement and found the house next door, where the Wolfes had lived, almost completely gone. It just picked up the house and carried it across the road and dropped it. They didn't have warning enough. If they had even 30 seconds they could have made it to our basement. They always said they would so I'm sure they didn't get any warning. [It was too late; the Wolfes were dead.]⁷

No other weather disaster strikes with such suddenness, making timely warning a necessity for saving lives. In view of the relatively short warning period, immediately available shelter becomes an equally critical factor. Residents of flood- and hurricane-threatened areas generally have ample time to evacuate the danger area. (The suddenness and the erratic path of the tornado seldom afford an opportunity to evacuate.) Under these conditions, people must seek nearby protective shelter. This necessity must be fully appreciated by the public and its officials so that proper precautionary measures are taken.

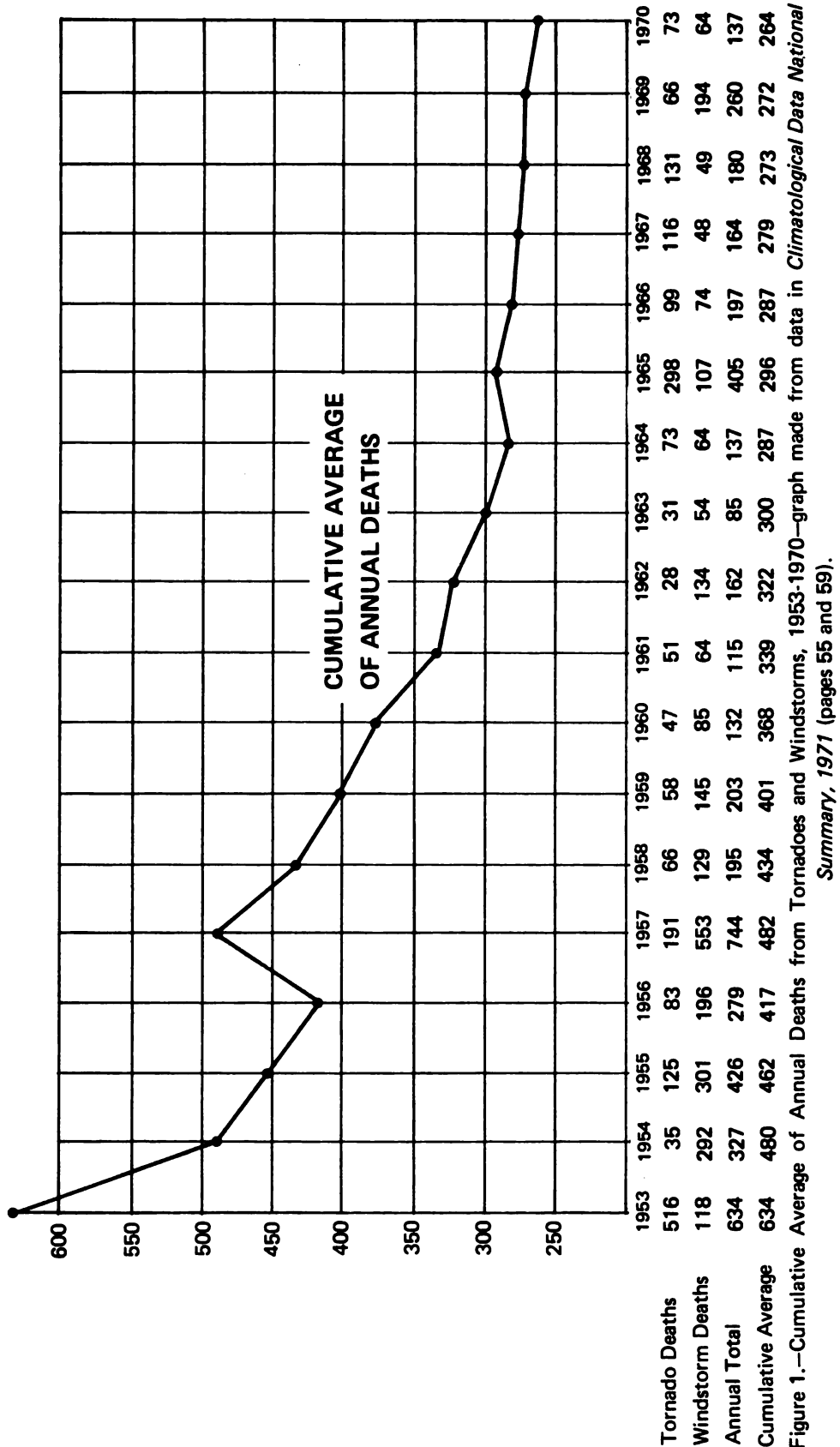


Table 1.—Number of Tornadoes and Resulting Losses by Years, 1921-1970—from *Climatological Data National Summary, 1971* (page 55), NOAA, Environmental Data Service.

YEAR	Number tornadoes	Total Deaths	Total property losses †	Number of tornadoes causing losses † in		
				category 5	category 6	category 7 & over
1921	105	202	7	22	3	0
1922	108	135	7	27	5	0
1923	102	109	6	21	1	0
1924	130	376	7	26	11	1
1925	119	794	7	34	2	1
1926	111	144	6	28	0	0
1927	163	540	7	42	9	1
1928	203	92	7	40	7	0
1929	197	274	7	48	4	0
1930	192	179	7	38	6	0
1931	94	36	6	14	1	0
1932	151	394	7	23	1	1
1933	258	362	7	46	9	0
1934	147	47	6	10	3	0
1935	180	70	6	29	0	0
1936	151	552	7	17	5	1
1937	147	29	6	24	0	0
1938	213	183	7	29	6	0
1939	152	87	7	21	3	0
1940	124	65	7	13	2	0
1941	118	53	6	24	1	0
1942	167	384	7	42	10	0
1943	152	58	7	28	8	0
1944	169	275	7	50	9	0
1945	121	210	7	21	10	1
1946	106	78	7	29	7	0
1947	165	313	7	46	7	1
1948	183	140	7	62	11	2
1949	249	212	7	54	13	0
1950	199	70	7	47	9	0
1951	272	34	7	35	11	2
1952	236	230	7	53	19	0
1953	437	516	8	63	18	7
1954	549	35	7	63	8	1
1955	593	125	7	74	13	1
1956	532	83	7	83	24	1
1957	864	191	8	129	26	3
1958	565	66	7	70	8	1
1959	589	58	7	70	4	1
1960	618	47	7	65	11	1
1961	682	51	7	103	21	1
1962	658	28	7	51	10	0
1963	461	31	7	77	15	1
1964	713	73	7	113	17	5
1965	899	298	8	126	30	11
1966	570	99	8	79	13	4
1967	912	116	8	125	33	8
1968	661	131	8	82	26	6
1969	604	66	8	98	16	3
1970	649	73	8	97	24	6
Means: 1953-70	642	116	-	87	18	3

NOTE: The above estimated losses are based on values at time of occurrence.

† Storm damages in categories:
 5. \$50,000 to \$500,000 7. \$5,000,000 to \$50,000,000
 6. \$500,000 to \$5,000,000 8. \$50,000,000 and over.

Prediction and Warning Programs

Prediction and warning of tornadoes require the participation of governments at all levels and the cooperation of citizens. The existing prediction and warning system ideally is characterized by two distinct echelons of responsibility (Figure 4).

The first echelon (Prediction and Forecasting) is responsible for monitoring the prevailing weather situation to identify those conditions that can produce

Table 2.—Windstorm Losses for Past 50 Years (other than tornadoes). No definitive data on number of windstorms and on number of deaths per storm were available for this study—from *Climatological Data National Summary, 1971* (page 59).

Year	Total loss of life	Total property loss (category)*	Year	Total loss of life	Total property loss (category)*
1921	65	7	1947	117	8
1922	133	7	1948	52	8
1923	68	7	1949	102	8
1924	78	7	1950	210	8
1925	88	7	1951	289	8
1926	357	8	1952	137	8
1927	64	7	1953	118	8
1928	1,947	8	1954	292	9
1929	46	7	1955	301	8
1930	49	7	1956	196	8
1931	17	7	1957	553	8
1932	306	7	1958	129	8
1933	156	8	1959	145	7
1934	109	7	1960	85	8
1935	461	7	1961	64	8
1936	121	7	1962	134	9
1937	43	7	1963	54	9
1938	630	8	1964	64	9
1939	60	6	1965	107	9
1940	251	7	1966	74	8
1941	43	7	1967	48	8
1942	68	7	1968	49	8
1943	61	7	1969	194	9
1944	448	8	1970	64	8
1945	85	7			
1946	70	7	Total	9,402	

*Storm damages are placed in categories varying from 1 to 9 as follows:

- 1—Less than \$50
- 2—\$50 to \$500
- 3—\$500 to \$5,000
- 4—\$5,000 to \$50,000
- 5—\$50,000 to \$500,000
- 6—\$500,000 to \$5 million
- 7—\$5 million to \$50 million
- 8—\$50 million to \$500 million
- 9—\$500 million to \$5 billion

Note: The above estimated losses are based on values at time of occurrence.

severe windstorms and tornadoes. This echelon also is responsible for local observation (radar or human) of weather conditions to detect the occurrence of torna-

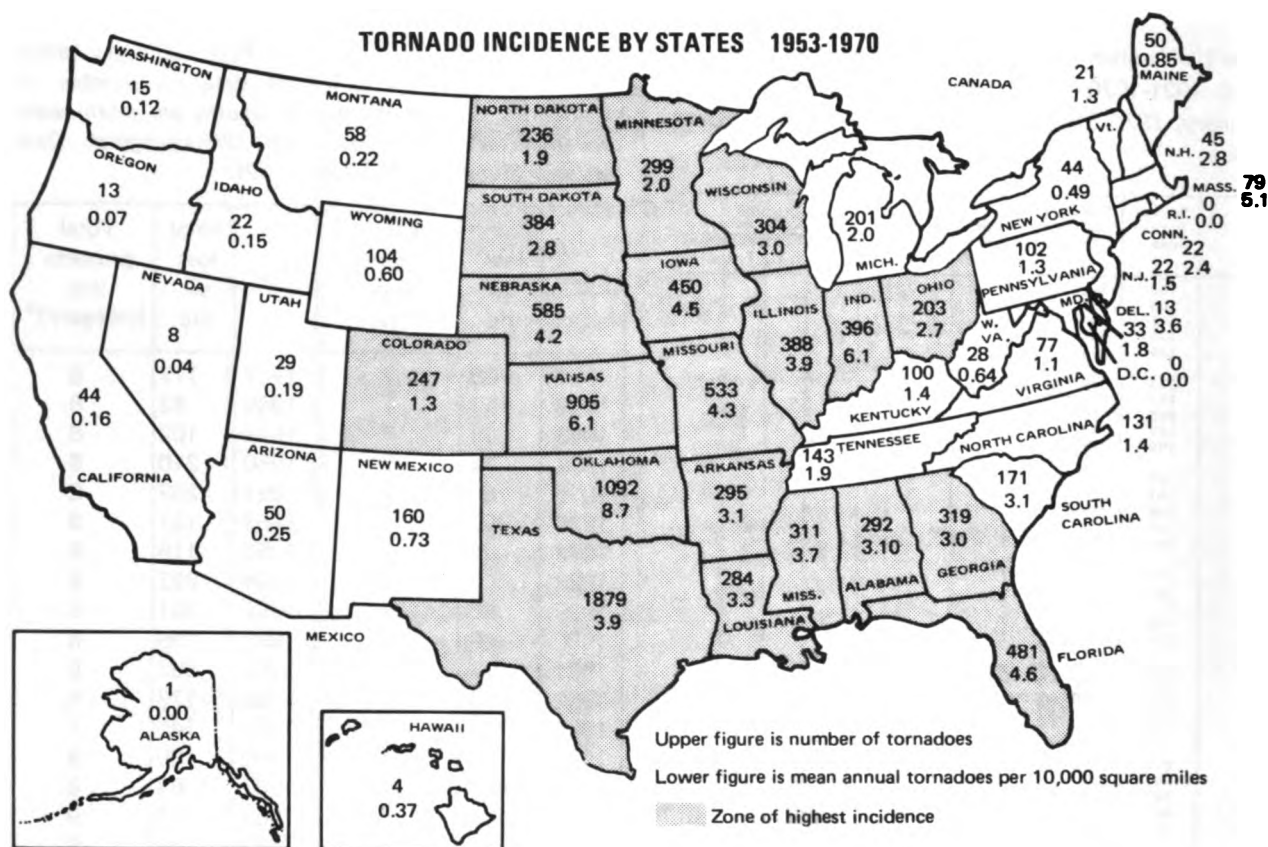


Figure 2.—Tornado Incidence by States (1953-1970)—National Weather Service (updated).

does or windstorms. When potential threats are identified, a *tornado watch* is issued. The watch places the public on alert to the possibility of tornadoes occurring within a specific area and time period. When a tornado has been sighted by an observer or identified by radar, a *tornado warning* is issued. The warning indicates the tornado location at the time of sighting and its expected path of travel. The issuance of a warning means that persons in the path of the storm should seek protective shelter.

When tornado watches or warnings are issued by the first echelon of the system, the second echelon (Public Warning) is activated. This echelon is responsible for final dissemination of the alert to the general public.

The composition and functioning of the two echelons are discussed below. They will be assessed against the following characteristics of what might be considered an ideal tornado warning system:

- The system must provide timely warning. Warning received only a few minutes before the tornado may not give its recipient time to take adequate precautions.
- It must appeal to more than one human sense. A person not looking may be listening, and vice versa.
- It must be as mechanically foolproof as possible, with its human element having a similar degree of infallibility.

- The warning must be understandable, convincing in language and tone, and issued by sources the public considers to be reliable.
- It must deliver the warning message to every citizen in the affected area regardless of the hour.

Prediction and Forecasting. At the Federal level, the National Weather Service of the National Oceanic and Atmospheric Administration (NOAA) is responsible for detecting tornado-producing weather conditions and for generating watch and warning messages to be transmitted to the public.

The NOAA Tornado Weather Program involves three organizational levels: the National Meteorological Center (NMC) in Suitland, Maryland; the National Severe Storms Forecast Center (NSSFC) in Kansas City, Missouri; and the local National Weather Service Offices (WSO's). Analyses, forecasting, warning, and dissemination are performed progressively through these organizational levels (Figure 4).

The NMC, through largely computerized operations, provides broad-scale weather analyses and predictions for a 72-hour period in graphic form covering the Northern Hemisphere, with detailed analyses of the continental United States and surrounding oceans. These are distributed to the NSSFC and the WSO's by facsimile.

The NSSFC, through its Severe Local Storms Unit, is responsible for predicting on a continuing basis the areas most likely to experience severe thunderstorms or tornadoes and to identify the area (usually about 27,000 square miles) expected to experience the severest weather. The severe weather watch is normally issued 1 hour, but on occasion 2 to 3 hours, before the storm or tornado is expected to strike an area and specifies the period during which the extreme weather is most likely to occur. The NOAA Weather Wire Service, the Radar Report and Warning Coordination System (a teletypewriter communication system for emergency dissemination of weather observation data between WSO's), the Office of Civil Defense National Warning System (dedicated telephone circuit), the national press service wires, and other communications systems are used to disseminate the warning.

After the NSSFC notification is received, the local WSO detects and tracks the severe weather and issues the warning measure to the news media, to amateur radio operators, and to law enforcement, civil defense, and other emergency agencies, which, in turn, relay the information to the public.

Forecasting that a tornado will or will not occur under given meteorological conditions, or that the funnel will strike at a particular location, is not within present capabilities. Not enough is known about the basic nature of the phenomenon to permit this type of exact forecast. The National Weather Service can only predict general areas where the probability of occurrence is greatest and notify those areas of the threat. When the area of possible occurrence is established, the tornado is actually detected by radar or human sighting. The tornado develops rapidly and is often short lived. The possibility that it might be obscured by rain is high.

Radar Detection. Although most of the weather radar system has modern radar equipment, World War II vintage radars are still used. These older sets provide accurate information on general atmospheric conditions that produce tornadoes. However, because of their age and limited numbers, they are less accurate than newer radars in detecting the development, intensity, and movement of specific severe storms and tornadoes. To identify and track a tornado by radar is most difficult even with the newest equipment.

Moreover, many WSO's with natural disaster warning responsibilities have no radar capability and must rely on telephoned information from radar sites at other locations. These deficiencies were noted in a 1965 Environmental Science Services Administration study⁸ and still persist even though some modern sets have been acquired since then. The need for radar to fill gaps not adequately covered by the present network still exists. The need also exists for repeater scopes which can be installed in local WSO's to monitor the observations of a remotely located radar.

Project Skywarn. Since radar can only be relied upon to detect tornado-producing weather conditions and does not, in most cases, detect the tornado itself, the human observer is important in the detection process. Accordingly, a network of volunteer spotters (Project Skywarn) has been developed to augment the detection capabilities of local Weather Service Offices. These spotters, consisting of thousands of public-spirited citizens and organizations trained in recognizing the characteristics of severe thunderstorms and tornadoes, volunteer their time and services. Their primary responsibility is to sight and report the existence of these phenomena to the nearest WSO or law enforcement agency. In addition, these spotters help to fill the gaps in the basic meteorological data reporting networks and aid in the detection of tornadoes that often evade radar because of their relatively small size and short life span.

The tornado observers who make up the "Skywarn" observer network may have their vision obscured by darkness, rainfall, structures, or landscape. Consequently, their sightings of tornadoes may occur only as the funnel approaches a populated area. In March 1963,

TORNADO INCIDENCE BY MONTHS 1953-1970

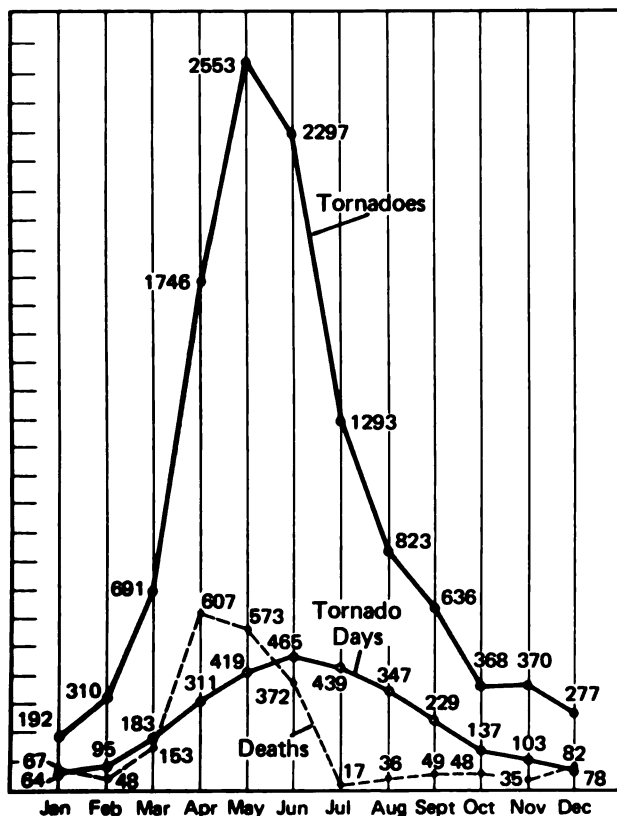


Figure 3.—Tornado Incidence by Months (1953-1970)—National Weather Service (updated).

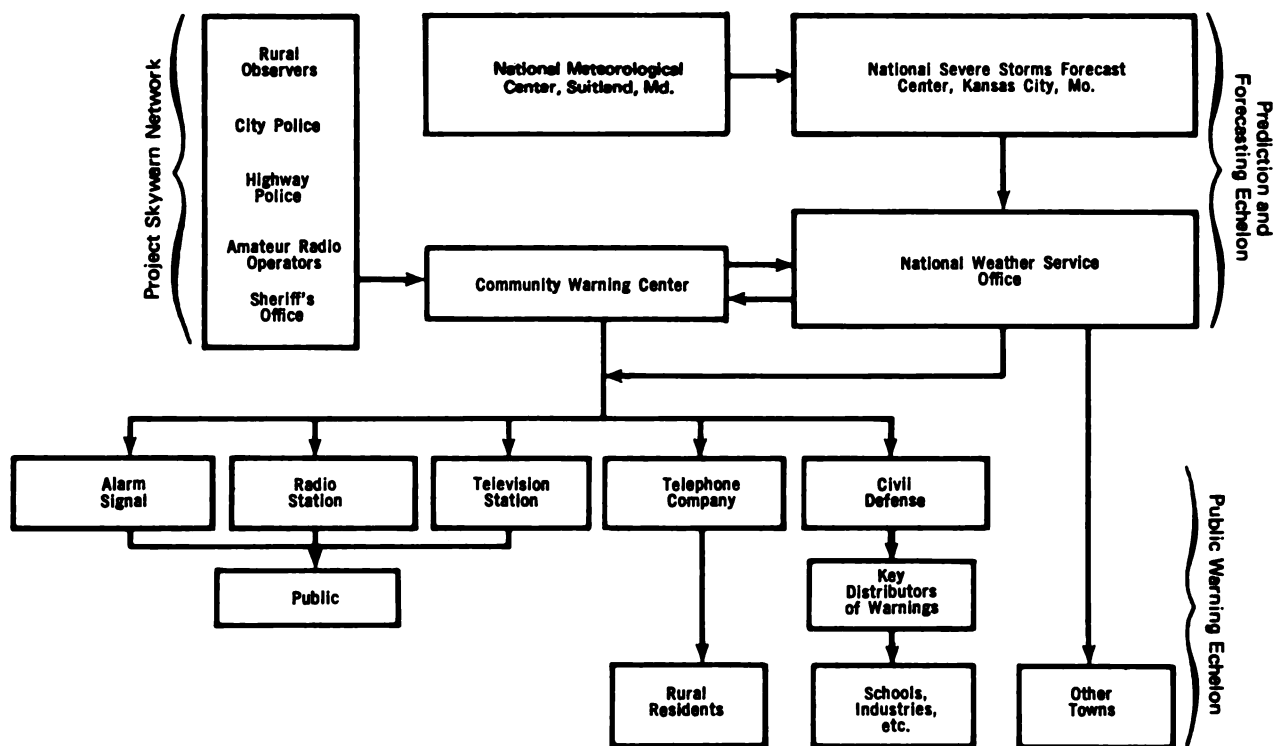


Figure 4.—NOAA/NWS Tornado Warning System—from *Tornado*, NOAA.

NOAA VHF WEATHER RADIO BROADCASTS



Figure 5.—NOAA's Radio Network Serves Areas Inhabited by About 30 Million Persons—National Weather Service.

a tornado killed 43 persons on the outskirts of Jackson, Mississippi. The first reported sighting of this tornado occurred only 3 minutes before it slammed into this populated area.] A tornado watch broadcast earlier was credited with preventing the loss of many more lives.⁹

In May 1968, a tornado struck Jonesboro, Arkansas, at 10 p.m. Pounding rains and darkness precluded observation of the tornado and drowned out its characteristic roar. Thirty-six persons were killed in a city of 20,000. In this instance, no tornado watch was issued by local broadcasters.¹⁰

Public Warning. Since timely observation and tracking of tornadoes cannot always be depended upon, notifying the public that tornado conditions exist becomes of paramount importance. As noted above, notification of the existence of tornado conditions over specified areas is generally available well before actual occurrence and is transmitted to those governmental entities or persons responsible for final dissemination to the public as a "tornado watch." At this point in the warning process, a variety of organizations enter the picture (Figure 4).

Disaster surveys indicate that a vast majority of the people in disaster-threatened areas over the past decade have relied on television and radio for information concerning tornado conditions.¹¹ Immediately upon receipt of watch or warning messages, either from a Weather Service Office or other sources, broadcast stations generally interrupt scheduled programs to transmit the warning to the public. In many cases, these stations will cancel programming to maintain a continuous watch. Federal Communications Commission regulations permit stations to stay on the air past normal "sign off" times when a major emergency threatens.¹² Radio is probably the more effective of the two broadcast modes in disseminating tornado warnings; its greater flexibility allows more rapid coverage of unanticipated events.¹³

In addition to commercial broadcast, NOAA's VHF FM Radio Network continuously broadcasts severe weather information to the general public and responsible authorities (on 162.55 and 162.4 megaHertz). It provides a reliable and authentic source of warning information, and its capability to activate muted receivers when critical messages are transmitted adds to its effectiveness. This system, however, is largely dependent on commercial power sources, which may be disrupted by a tornado. At present, the system serves areas inhabited by about 30 million people (Figure 5), with potential expansion to another 150 million or more by the end of this decade. The relatively few receivers now available (180,000), limit its use, however.

Although the broadcast media constitute the principal mode for disseminating warnings to the public, there have been cases where the media have not fully appreciated this critical role. A survey conducted after tornadoes struck Minneapolis in May 1965 concluded that TV programming reportedly was not altered in any

major way after the receipt of tornado information from the Weather Bureau. All watch and warning bulletins were transmitted as they were received, but most stations quickly returned to regular programming. By so doing, these stations reinforced the public's belief that nothing serious was at hand. Radio and TV stations that switched totally to tornado coverage impressed their audiences with the seriousness of the situation by this action alone.¹⁴

During the tornado warning period preceding the Lubbock, Texas, tornadoes of May 1970, one station left the air because it was unaware that FCC regulations allowed it to remain on the air past normal "sign off" in an emergency.¹⁵

Since the vast majority of people affected by a threat rely upon TV and radio¹⁶ for tornado information, it is essential that these media contribute their fullest to convincing the public that precautions should be taken when a watch or warning is issued.

It is not unusual for communities to use other warning means, too. The method used in warning of a tornado in Leedy, Oklahoma, in 1947 is an example:

... almost half an hour before [the tornado] struck, the funnel was sighted in the distance by a local telephone official. He immediately sounded the fire alarm, which brought all the volunteer firemen to a central point. Also, [it was] announced over a high-powered public address system that a tornado was approaching and people were advised to go to storm cellars. In addition, volunteer firemen and other able-bodied men canvassed the town, spreading the warning and assisting old people and invalids to places of safety. As a result, almost the total population was in storm cellars when the tornado struck ... [leaving] ... two-thirds of the town ... completely devastated.¹⁷

Some communities, upon receipt of warning from Weather Service Offices, use a civil defense siren, which produces a distinctive signal. Bell or light signals are used to supplement sirens. The siren is especially effective in spurring persons to tune in to the broadcast media.¹⁸ However, unless the siren's signal is unusual, it can be taken as just another fire or police vehicle. Sirens are usually tested under weather and noise conditions quite different from those of the howling winds, driving rains, and hail associated with tornadoes.

The telephone is important to the public warning system. Public officials receive warning from Weather Service Offices and Skywarn observers by telephone and in turn relay this warning to lower echelons. Telephone landlines are, however, extremely vulnerable to a tornado.

The warning message itself has contributed to the problem of disseminating the warning to the public. As received from the Weather Service, these messages are couched in the terms of the forecaster. If transmitted verbatim, they can be misinterpreted because of their matter-of-fact tone. Conversely, if the messages are

dramatic and emotional, panic could develop; if the tornado does not strike, the warning system could be made less credible. Interview teams from NOAA turned up significant numbers of persons in Lubbock who contended they had received no warning of the May 1970 tornado. Further inquiry, however, revealed that they had heard radio or viewed television but had found nothing in these broadcasts that "warned" them to do anything. These individuals believed that a warning was an instruction to take cover. They felt that a siren or police loudspeaker was a warning but not some broadcast announcing that tornadoes were expected and that precautionary measures must be taken.¹⁹

It was established at the beginning of this discussion that a tornado warning must reach every resident of a threatened area if the warning system is to be totally effective. What, then, is to be done if residents are asleep or have turned off their radio or television; or, if power failure or destruction of telephone lines remove the means for transmitting reports of tornado sightings?

The south-central Mississippi tornadoes of January 1969 struck at 6 a.m. while people were asleep.²⁰ A home-installed device similar to that in the national system now under consideration would have provided warning.

In the Palm Sunday 1965 tornadoes, electric power and telephone lines in Indiana were downed, precluding the timely receipt in many instances of relevant information. Provision of auxiliary power sources in this instance would have permitted relay of the warning from one community to the next along the anticipated path of the tornado.

Tornado Shelter

Safety rules published by the National Weather Service to guide individual behavior during a period of tornado warning virtually discount evacuation or movement away from the tornado as a lifesaving means. In fact, movement away from the path of a tornado is prescribed only if the individual is located in open country. For those caught in the open or who realize their home offers no protection, ditches and areas under culverts and bridges are recommended as shelters. Persons in cities or towns, and those attending school, are admonished to seek shelter in the structure they are occupying or nearby. The rapidity with which a tornado develops and approaches leaves little alternative but to seek the best nearby shelter and prepare to "ride it out."

Tornado shelter exists in several forms. A house with a basement has a ready shelter. In some cases, shelters are built separate from the dwellings and normally serve other purposes, such as crop storage. Interior hallways or lower levels of office buildings and schools are also used as shelters. In homes without basements, one should seek cover under heavy furniture located in the center of the house:

Pow! Down came the whole fireplace and chimney all in one piece. It glanced off the end of the piano, and I heard the legs go crack crack! I felt a little bit of panic in the pit of my stomach, and I thought, "The legs are going to give way, and we will have the piano on top of us." But it only takes a minute 'til you realize they've held, so the panic subsides.²²

As part of its continuing effort to foster community tornado preparedness, the National Weather Service provides general instructions for tornado shelter construction.²³ However, providing storm shelter is a matter of community programs and individual enterprise.

Data concerning the extent to which storm shelters exist in tornado-threatened areas are not complete. There are, nevertheless, some general indicators of the adequacy of shelters. For example, in most areas of the Midwest, basements are commonplace. Residences without basements usually are equipped with outside storm shelters. In tornado-prone areas in the Southeast, basement construction is often infeasible because of unfavorable soil conditions or high water tables. Indications that suitable shelter generally is lacking in this area were confirmed as recently as July 1971. Federal surveys conducted after the Mississippi Delta tornadoes of February 1971 concluded that, although persons in the stricken area were familiar with safety precautions, they could not find adequate nearby shelter. Houses did not have basements and available ditches were in some cases filled with water. Many sought shelter in houses that were subsequently destroyed.²⁴

Preparedness Activities

Tornado preparedness involves planning, training, and public education. It consists essentially of making advance arrangements for warning and response prior to the arrival of the tornado and for conducting lifesaving operations in the aftermath.

The National Oceanic and Atmospheric Administration has taken steps to foster development of community tornado preparedness plans. This effort consists largely of making tornado preparedness planning guidance available to communities and giving advice, through local Weather Service Offices, on the techniques of adapting this guidance to a particular local situation.

An important corollary to tornado preparedness planning is training of public officials in the execution of the plan. The planning process itself is an excellent training vehicle for those involved. Further training is obtained in the conduct of exercises based on the preparedness plan. For example, during November 1970, a tornado exercise named "Big Hummer" was conducted by the Mississippi State Civil Defense Office in Jackson.²⁵ None of the February 1971 tornadoes struck Jackson; however, it is quite likely that Jackson was much better prepared than communities that did not exercise their preparedness plans.

The efforts of NOAA and the local communities to foster tornado preparedness planning are supplemented by other Federal agencies and State governments. For the past several years, the Office of Emergency Preparedness Regional Office in Denver has sponsored annual disaster exercises based on the hypothetical occurrence of a severe tornado. Federal, State, and local officials are invited to attend these sessions.

To be responsive to the effects of tornadoes, preparedness actions must be undertaken by local governments. This requirement raises a question as to the capacity of local governments to accomplish the planning job. In many smaller communities, in particular, professional planning assistance is usually not available, since there is little day-to-day need. Furthermore, there has been no systematic evaluation of the adequacy of local government tornado preparedness planning. However, it is believed that there is room for improvement, and that there is a need to survey the requirements and encourage action where indicated.

As described above, NOAA's efforts to foster local planning have been reasonably effective. OEP is developing a program for organizing an increased Federal effort to support local preparedness efforts; this should be helpful to communities attempting to cope with the tornado threat.

Public Education. The most extensive and sophisticated warning systems in existence are of little use if citizens are not sufficiently aware of the meaning of the warning and the measures that must be taken to protect themselves. When years pass without a tornado threat to a particular community, or when repeated watches are issued without the appearance of a tornado or severe storm, the public tends to become complacent about warning procedures and safety precautions.²⁶

To counter this situation, NOAA has developed an extensive program for informing the public at large, as well as public officials, concerning community preparedness for the tornado threat. This program includes:

- Seminars and planning conferences with local officials,
- The development of tornado preparedness committees, which in turn organize public participation in such activities,
- Distribution of printed materials and films designed to inform the public of warning procedures and precautionary measures,
- Distribution of tornado preparedness planning instructions,
- Direct professional assistance to communities in developing such preparedness plans.

This effort is complemented by the efforts of other governmental and private organizations. For example, the Federal Office of Civil Defense (OCD) has also

produced films and printed materials for informing the public of the tornado threat, and has developed a disaster operations handbook for use by local officials.²⁷ States and communities in most tornado-prone areas sponsor special conferences to commence preparations for upcoming tornado seasons. This education effort usually is a cooperative venture involving all levels of government and all segments of the public.

As the tornado season approaches, local Weather Service Offices intensify efforts to insure that residents and public officials in their areas of responsibility are aware of the tornado threat and the safety rules to follow. An example of these efforts is found in the Mississippi Delta area. In the 2 years preceding the occurrence of the violently destructive tornadoes of February 1971, the WSO at Jackson, Mississippi:²⁸

- Participated in 15 State Civil Defense Agency-sponsored disaster preparedness conferences and exercises,
- Held four Tornado Preparedness Planning Conferences,
- Participated in 19 meetings with various professional and citizens' associations and other groups interested in fostering tornado preparedness,
- Prepared and distributed communications and warning plans for 29 communities and counties.

In addition, a Red Cross film is shown by TV stations in vulnerable areas in conjunction with tornado watch and warning announcements. The broadcast media cooperate by providing spot tornado preparedness announcements and showing tornado films. Newspapers donate public service space for tornado preparedness announcements.

Despite the efforts to educate the public in the precautionary steps, there is evidence that a warned public has at times failed to take such steps. For example, in the aftermath of the Palm Sunday tornadoes of April 11, 1965, which swept through the Midwest and killed 266 persons, researchers from Ohio State University found that many persons who had received an early tornado warning took no steps to seek shelter. Public officials also failed to act upon, or disseminate, warnings.²⁹

More recently, however, during the Mississippi Delta tornadoes of February 1971, the mayor of a small community attempted to evacuate people to shelter several miles away but could persuade no one to leave. Seventeen persons were killed when the tornado struck.³⁰

Failure to take action must be partially attributed to inadequacies in the public education program. This has been confirmed by surveys conducted after the occurrence of tornadoes. These surveys show that public education on the implications of tornado warning and on precautionary steps to be taken must be intensified.³¹

Findings

1. *The first and perhaps most crucial means of life-protection from tornadoes is timely and accurate warning. Past technological applications have resulted in a decline in the loss of life; however, there are new technological opportunities that offer substantial improvement in tornado prediction and warning.* At present, tornado warning is limited because of obsolescent equipment, a lack of area radar and communications coverage, and large dependence upon volunteer "sky spotters."

• *An increased number and improved quality of radar installations would improve detection of development, intensity, and movement of severe storms, which is the basis for tornado prediction.* However, the best radars now available cannot, except in rare instances, clearly and reliably identify specific tornadoes and thus provide precise warning.

• *The planned Geo-stationary Operational Environmental Satellite will improve early observation of severe storm developments and thereby enhance the forecasting of possible tornadoes.* Nevertheless, this advancement will not do much to improve tornado warning *per se*.

• *Expansion of NOAA's communications facilities would improve tornado warning service:* specifically, (1) the Weather Wire Service, which provides warning messages to the news media, and (2) the VHF FM Radio Network, which provides continuous severe weather broadcasts. Also, additional OCD National Warning System circuits, planned for installation in Weather Service Offices and communities, will provide interstate connections for speeding the warning process when tornadoes cross State boundaries.

• *Adoption of a low-cost national warning system, such as the Civil Defense Decision Information Distribution*

System (DIDS), including installation of home receivers, *would be especially useful in tornado warning.*

• *Alternative means for transmission of tornado information and independent emergency power sources are essential* because of frequent disruptions during severe storms.

2. *The second means of lifesaving in tornadoes is protective shelter.* Given the suddenness of tornadoes and the short—if any—warning, *there is only one realistic response—seek cover immediately!* In the Midwest, where basements are more prevalent, a ready source of cover is available. This source is generally lacking in the Southeast because of unfavorable soil conditions and high water tables. Where feasible, tornado shelter should be incorporated into new construction. The Federal Government could foster this by providing for improved tornado protection in appropriate new Federal structures and in federally assisted construction.

3. *The Federal Government has been helpful, but could improve its assistance programs* for tornado preparedness *by providing financial assistance and technical advice to the States*, through NOAA, for the establishment of tornado preparedness training programs for local government officials and members of volunteer service organizations.

4. *The sudden and destructive onslaught of tornadoes requires a high degree of alertness and quick, positive response by the public to tornado warnings.* With short warning, timely action is vital to protecting lives. A concerted public information program should be conducted in all vulnerable areas preceding the annual tornado season. Information concerning tornado watch and warning and response actions needs to be in a convenient ready-reference form during the season.

Notes

¹U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, *Climatological Data National Summary*, Vol. 21, No. 13, Year 1970 (Asheville, N.C., 1971), pp. 55-59.

²*Ibid.*, pp. 68 and 94.

³*Ibid.*, pp. 55-59.

⁴U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the U.S.* (Washington, D.C.: U.S. Government Printing Office, 1971), pp. 12-13.

⁵"A Case Study of Warning Systems," Appendix to *The Warning System in Disaster Situations: A Selective Analysis*, Series No. 9 (Columbus: Ohio State University Disaster Research Center, 1970), pp. 58-69. Also, U.S. Department of Commerce, *The Lubbock, Texas, Tornado, May 11, 1970*, Natural Disaster Survey Report 70-1 (Rockville, Md., 1970), p. 17.

⁶*The Lubbock, Texas, Tornado*, p. 17.

⁷James B. Taylor et al., *Tornado, A Community Responds to Disaster* (Seattle: University of Washington Press, 1970), pp.

⁸U.S. Department of Commerce, Environmental Science Services Administration, *A Proposed Nationwide Natural Disaster Warning System* (Washington, D.C., 1965), pp. 72-73.

⁹J. A. Riley, *Disaster—Storm Ahead*, The Hogg Foundation for Mental Health (Austin: University of Texas, 1971), p. 54.

¹⁰*Ibid.*

¹¹*Ibid.*

¹²*The Lubbock, Texas, Tornado*, p. 16.

¹³David Adams, *The Minneapolis Tornadoes, May 6, 1965: Notes on the Warning Process*, Research Report No. 16 (Columbus: Ohio State University Disaster Research Center, 1965), p. 19.

¹⁴*Ibid.*, pp. 20-21.

¹⁵*The Lubbock, Texas, Tornado*, p. 16.

¹⁶Riley, *op. cit.*, p. 20.

¹⁷L. Logan et al., *A Study of the Effect of Catastrophe on Social Disorganization* (Chevy Chase, Md.: Operations Research Office, 1952), quoted in John Brouillette, *A Tornado Warning*

System: Its Functioning on Palm Sunday in Indiana, Research Report No. 15 (Columbus: Ohio State University Disaster Research Center, 1966), p. 37.

¹⁸Brouillette, *op. cit.*, pp. 37-38.

¹⁹*The Lubbock, Texas, Tornado*, p. 16.

²⁰Riley, *op. cit.*, p. 55.

²¹Brouillette, *op. cit.*, pp. 34-35.

²²Taylor et al., *op. cit.*, pp. 26-27.

²³U.S. Department of Commerce, National Oceanic and Atmospheric Administration, *Tornado* (Washington, D.C.: U.S. Government Printing Office, 1970), p. 15.

²⁴U.S. Department of Commerce, *Mississippi Delta Tornadoes of February 21, 1971* (Rockville, Md., July, 1971), p. 39.

²⁵*Ibid.*, p. 43.

²⁶U.S. Department of Commerce, Environmental Science Services Administration, *Tornado Preparedness Planning* (Washington, D.C.: U.S. Government Printing Office, 1968), p. 14.

²⁷*Disaster Operations—A Handbook for Local Government*, Department of Defense, Department of the Army, Office of Civil Defense, 1971.

²⁸*Mississippi Delta Tornadoes*, pp. 43-44.

²⁹Brouillette, *op. cit.*, pp. 35-37.

³⁰*Mississippi Delta Tornadoes*, p. 39.

³¹*Ibid.* Also, *The Lubbock, Texas, Tornado*, p. vi.

Chapter D. Hurricanes and Storm Surges

General

The mature tropical cyclonic storm is, by any name, deadly and devastating. An Indian Ocean cyclone in 1970 killed 200,000 in East Pakistan, according to official estimates, with unofficial estimates as high as 500,000.¹ The Pacific Ocean has the world's highest incidence of the tropical storms known there as typhoons. In the Western Hemisphere, these storms are known as hurricanes.

The hurricane brings devastation by wind, flood-producing rain, and—most lethal of all—the storm surge.

Since the beginning of this century, the toll in lives exacted by hurricanes in the United States has lessened despite the increasing population density along the Gulf and Atlantic Coasts. In effect, lives are being saved by improved prediction and warning, while property losses continue to rise. (There is a growing concern, however, that increasing population density, inadequate evacuation routes, ineffective building codes, and insufficient safe refuge may lead to a major hurricane catastrophe along the Atlantic and Gulf Coasts.)²

The greatest loss of life associated with hurricanes is from drowning, by a ratio of about nine to one.³ A secondary but serious danger is electrocution caused by fallen power lines. Often accompanying hurricanes are tornadoes, adding their characteristically severe winds to those of the storm. In addition, a hurricane that has spent its initial force may still bring damaging precipitation and dangerous flash floods.

(Hurricane Betsy in 1965 ushered in the era of the billion dollar hurricane, causing \$1,420,500,000 in property damage—slightly exceeded in 1969 by Camille, with \$1,420,700,000 in damage.)⁴ Hurricane Camille, perhaps more than any other disaster, prompted a thorough reappraisal of the country's preparedness for disasters and in particular for hurricanes. The experience of Camille was the primary impetus to legislative study culminating in the enactment of Public Law 91-606, the Disaster Relief Act of 1970.

Prediction and Warning

Predict and warn—these two words succinctly define the purpose of the hurricane warning service. A brief synopsis of the structure and organization of this dedicated service will lead to an examination of its

capabilities, limitations, and deficiencies in fulfilling its mission.

Responsibilities. The National Hurricane Center (NHC) at Miami has the overall responsibility for operations and meteorological analyses related to the position, intensity, and movement of hurricanes in the Atlantic, the Caribbean, and the Gulf of Mexico.⁵ NHC coordinates four Hurricane Warning Offices (HWO's), which are responsible for maintaining a close watch on potential hurricane development in their areas of responsibility and for issuing advisories and bulletins to the general public and to disaster and rescue agencies in threatened areas. The Pacific Hurricane Centers at San Francisco and Honolulu provide similar forecast and warning services for the Eastern and Central Pacific.

Procedures. Large-scale surface and upper-air analyses and forecasts are prepared manually and by computer every 6 hours at the National Meteorological Center. These surface and upper-air observations, with those from other agencies and governments, form the backbone of the analyses. This information is supplemented with additional weather data reported from ships, aircraft, and weather satellites. Special reconnaissance flights also seek out and penetrate the hurricane. A detailed hurricane forecast is then prepared by NHC or by an HWO after consultation with NHC. This forecast is based upon NHC statistical and dynamic techniques and programmed for the computer. Once a hurricane nears landfall, a coastal radar network extending from Maine through Texas keeps constant surveillance of the hurricane's position and movement.

Public advisories and bulletins by the Warning Offices give the hurricane's position, intensity, direction, and rate of movement, as well as the areas declared under a hurricane watch or warning. They also include a statement of the effects to be expected from the storm. Marine, aviation, and military advisories are prepared to provide needed special information.

Forecasts and warnings are given immediate and widespread distribution by all available communications, including teletypewriter, radio, telephone, newspapers, and television. Warnings and advisories are available simultaneously at all weather stations on the Gulf and Atlantic Coasts by special hurricane teletypewriter circuits. Local weather offices are responsible for ensuring

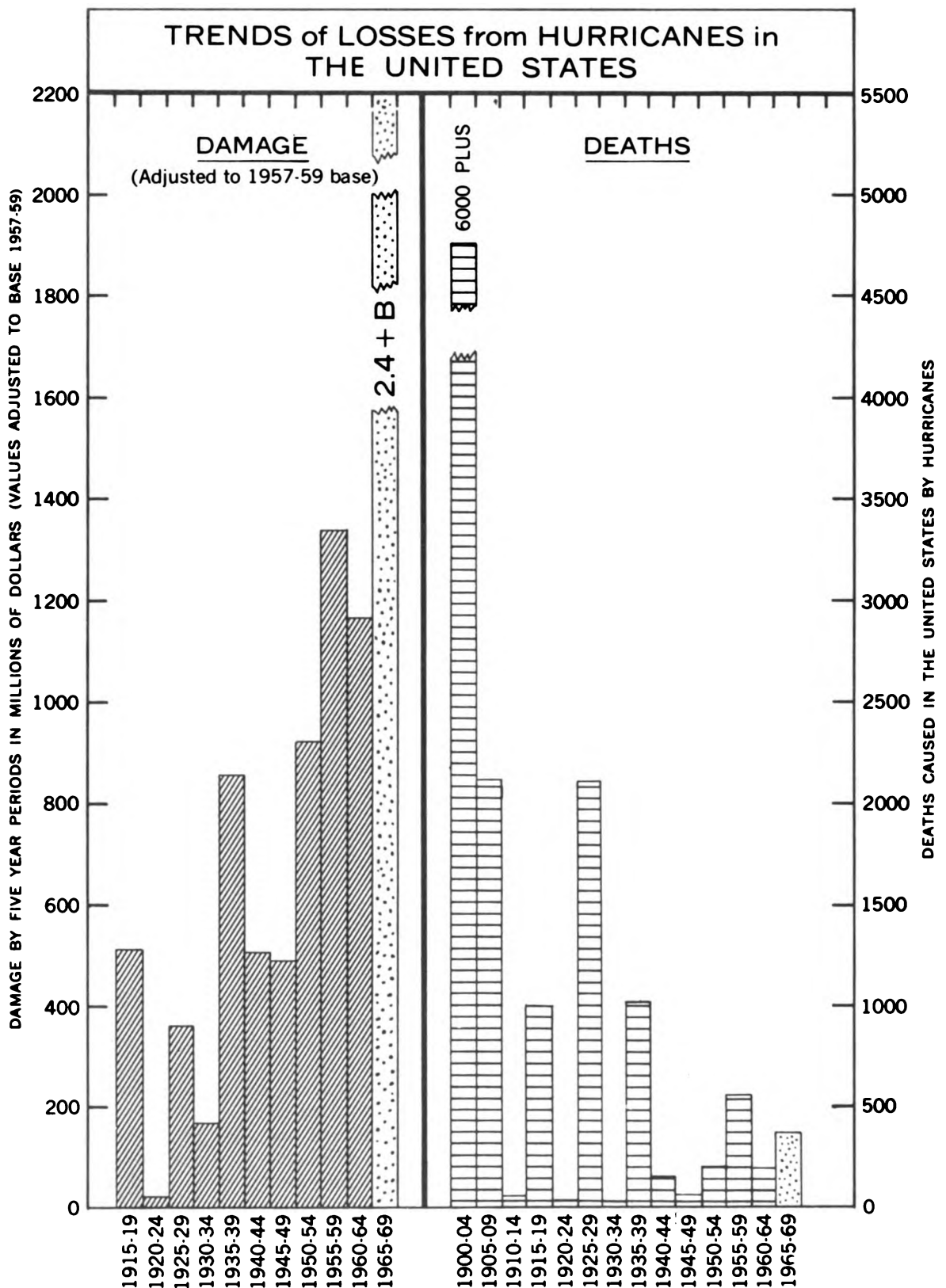


Figure 1.—Hurricane Damage and Deaths—from *Project Stormfury—1970*, U.S. Department of Commerce, 1970.

local distribution of advisories and bulletins and for preparation of statements on local effects of the hurricane.

Definitions. As mentioned above, there are four kinds of notifications issued through the hurricane warning service—advisories, bulletins, watches, and warnings. These are defined as follows:

- *Hurricane Advisory*—a formal advisory message from a National Weather Service Hurricane Warning Office giving warning information with details on location, intensity, and movement, and the precaution that should be taken. When pertinent, the advisory contains specific coastal warnings for all marine interests.
- *Hurricane Bulletin*—a public release for press, radio, and television by a National Weather Service Hurricane Warning Office, issued at times other than when Hurricane Advisories are required. The bulletin is similar to the advisory but contains more general or newsworthy information.
- *Hurricane Watch*—an announcement to specific areas that a hurricane or incipient hurricane condition *poses a threat* to coastal and inland communities so that they may take stock of their preparedness requirements, keep abreast of the latest advisories and bulletins, and be ready for quick action in case a hurricane warning is issued.
- *Hurricane Warning*—a warning that one or more of the following dangerous effects of a hurricane *are expected* in a specified coastal area within 24 hours or less: hurricane-force winds (74 m.p.h. or more); dangerously high water; or dangerously high water and exceptionally high waves, even though winds expected may be less than hurricane force at that location.

Capabilities. The existing hurricane warning capability is substantial. The decreasing trend in loss of lives in the face of rapidly mounting coastal population, while property damage continues to climb, attests to this fact (Figure 1). The contrasting death tolls from two hurricanes striking Corpus Christi, Texas, provide cases in point. In 1919 a hurricane with gusts estimated at 110 m.p.h. and a storm tide of 16 feet struck the city, taking more than 300 lives and causing property damage of \$20.3 million.⁶ In 1970, Celia, the most devastating hurricane (in dollars) ever to strike Texas, hit the city with winds gusting to 161 m.p.h. and a storm tide of 9-10 feet. This time the damage was \$453 million, but the loss of life totaled 11.⁷ Between the two hurricanes, the Corpus Christi population increased from 11,000 to 200,000. Better public awareness of the danger and the improvements in protection measures—both strongly fostered by the National Weather Service (NWS)—undoubtedly contributed to the saving of lives, but the major share of the credit belongs to improvements in prediction and warning dissemination achieved in the interim.

Nonetheless, today's capability is not without deficiencies. Two major gaps are in predicting (1) the distance to be covered by a hurricane in 24 hours and (2) the landfall location. The 4-year mean error in predicting movement (regardless of distance from the coastline) during 1968-1971 was 106 nautical miles—improved from 158 during 1956-1959.⁸ Fortunately, the error becomes smaller as the storm approaches the coast and is monitored more closely—especially by land-based radar. The average *landfall* error for a 24-hour prediction is approximately 100 nautical miles.⁹ This can easily result from a 10-degree error in direction of motion (e.g., 310 instead of 320°).

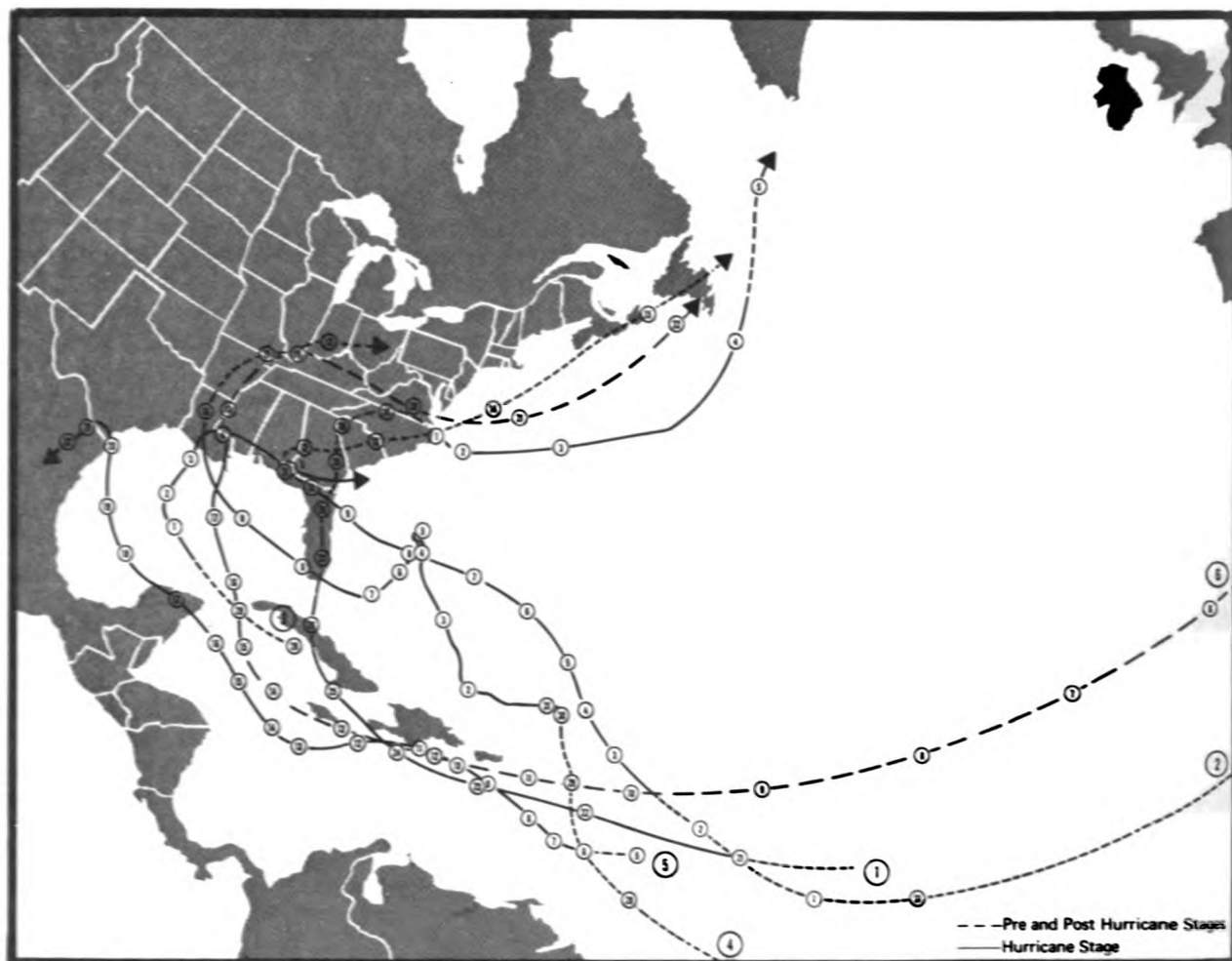
In any event, the initial difficulty is further complicated by inability to pinpoint the exact center of the hurricane. Reviews of hurricane forecasts reveal the average error in positioning the storm center to be 20 to 30 miles. In 1970, it was 23 miles for all storms; the preceding year, 31.¹⁰ Errors are attributed mainly to imprecisions in fixing the location of the monitoring aircraft and identifying the center of a hurricane.

With time, accurate aircraft positions can be obtained by replacing obsolete navigational equipment aboard the "Hurricane Hunter" aircraft. Better airborne instruments to collect meteorological information on the profile of the hurricane—wind, temperature, pressure—are well within the state of the art. Complementary functions are performed by radars, which detect and define the approaching storm, and by weather stations, which measure essential weather variables. Satellites, which are coming into greater use, not only will observe the larger weather picture but will serve as vital transmission links for digitized data reporting from remote and automated weather monitors. These data, when transmitted by high speed, reliable communications for computer processing, could begin to resolve present ambiguities in locating the hurricane's center and in predicting its intensity and movement.

More basic knowledge of the atmosphere, and of hurricanes in particular, is needed. The latest generations of computer, communication, and display systems should be utilized for real-time assimilation of inputs and information processing to advance understanding and improve forecasts and warnings.

It is estimated that by eliminating the need for costly preparedness measures, such as property protection and public evacuation, as much as \$7 million could be saved.¹¹ These actions, though prudent in terms of potential dollar losses, can themselves be very costly; a warning for just the Palm Beach-to-Miami area could cause upwards of \$2 million to be spent.¹²

Present-day hurricane warnings are issued to cover about 200 to 250 miles of coastline. The segment of coastline identified as subject to storm surge is usually 100 to 125 miles long. A warning is disseminated, whenever possible, to allow up to at least 12 hours of daylight for emergency protection of property and for



DATES OF HURRICANE	AREAS MOST AFFECTED	DEATHS (U.S. only)	DAMAGE BY CATEGORY
1. August 20-September 5, 1964 CLEO	Southern Florida, Eastern Virginia		8
2. August 28-September 16, 1964 DORA	Northeastern Florida, Southern Georgia	5	8
3. September 28-October 5, 1964 HILDA	Louisiana	38	8
4. August 27-September 12, 1965 BETSY	Southern Florida, Louisiana	75	9
5. September 5-22, 1967 BEULAH	Southern Texas	15	8
6. August 14-22, 1969 CAMILLE	Mississippi, Louisiana, Alabama, Virginia, West Virginia	255 (68 missing 11-10-69)	9
7. July 30-August 5, 1970 CELIA	Texas, New Mexico	11	8

Figure 2.—Devastating Hurricanes Affecting the United States, 1964-1970. The track for Celia is not shown. Category-8 damage ranges from \$50 million to \$500 million, category 9 from \$500 million to \$5 billion—updated from *Some Devastating North Atlantic Hurricanes of the 20th Century*, U.S. Department of Commerce, 1970.

population evacuation before the hurricane strikes. New systems are being developed that may, within the next 10 years, reduce the warning area to about 100 to 150 miles.¹³ In confining the hurricane warning to a smaller area, costly emergency actions would be eliminated in safe areas, the number of evacuees would be reduced, and the disruption of business and daily living would be minimized.

Hurricane Seeding

Research into means for moderating the maximum winds and storm surges of hurricanes has been conducted by Federal agencies over the years since 1947, when the first attempts at seeding with dry ice were made. These early efforts were followed by Project Stormfury, initiated in the 1960's.¹⁴ Experiments were made to test the theory that seeding will alter the cloud structure and thereby change the balance of wind-controlling forces near the hurricane's center. Theoretically, the result should be a chain reaction in the physical properties of the storm, leading to a lessening of wind force.

Much more work is needed to develop a seeding technology and mathematical models which will offer prospects of significant results. Studies must be made using data provided by instrumented aircraft and satellites, as well as by conventional surface and upper-air collection means. The National Oceanic and Atmospheric Administration (NOAA) has cognizance of Project Stormfury, with the participation of the Department of Defense.

Federal Preparedness Activities

In addition to the functions necessary for alerting communities to hurricanes, Federal agencies pursue many programs designed to assist communities in meeting hurricane emergencies. A hurricane's effects are seldom confined to small areas or even within a single State's boundaries; the destructive swath is on the average about 100 miles wide, and gale force winds (above 40 miles per hour) are felt on a path of about 400 miles.¹⁵ Clearly, a hurricane emergency will affect many communities and involve several jurisdictions. Figure 2 illustrates the scope of concern in recent cases. Federal agencies assist the States and localities by coordinating advance planning and, when a hurricane emergency occurs, marshalling evacuation and rescue resources to augment those locally available.

Some States vulnerable to hurricanes do not have statutory authority to order evacuation on the scale and at the time a hurricane advisory might indicate the need to be urgent. Among the many provisions of the suggested State legislation,¹⁶ developed by the Council of State Governments in consultation with the Office of Emergency Preparedness (OEP) for consideration by the

several States, is one conferring power on a State Governor to direct evacuation from a threatened area. The suggested legislation is, of course, a compendium of proposed statutory provisions dealing with disasters, but the power to order evacuation is of particular importance under the threat of a hurricane.

Threat Identification. NOAA has an important role in this field of hurricane preparedness, operating through its several specialized services and centers. Officials of the NHC have recently reiterated their concern for the safety of the increasing populations along the Atlantic and Gulf Coasts, where many areas lie less than 10 feet above sea level. Storm surges along these flat coasts can spell disaster. Hurricane Camille, for example, had surge heights exceeding 23 feet,¹⁷ whipped by winds up to 230 miles per hour near the hurricane's eye.¹⁸ Extended pounding by massive wind-driven waves weighing 1,700 pounds per cubic yard had a sledgehammer effect, demolishing any structure not specifically designed to withstand such forces. With the population growth in these vulnerable areas, more and more lives and property are at risk. Officials have warned that in a hurricane emergency 10 years from now, unless proper planning is done to prevent population concentration and to provide for evacuation, the limited capacity of escape routes could cost 20,000 to 50,000 lives.¹⁹

NOAA and OEP have recognized the need to identify all coastal areas where population densities are exceeding the available means of evacuation. The NHC Director has named the Miami, Charleston, and New Orleans areas as among those tentatively considered as most critical.²⁰ A preliminary step already underway is a program under the National Ocean Survey to provide better analysis of evacuation routes. NWS advisories generally recommend evacuation from elevations based on a given mean sea level (MSL). Storm evacuation maps are now being developed by the National Oceanic Survey (Coastal Mapping Division) for populated coastal areas subject to hurricanes. At the present pace, these will take a number of years to complete. A two-man team has recently completed mapping the Mobile-New Orleans area, to be followed by the Galveston-Houston, Corpus Christi, and Charleston-Savannah areas.

Also, NHC is developing a Disaster Potential scale expressing the intensity of a hurricane from 0 to 5 and indicative of the pattern of damage expected.

Planning Guidance. NOAA provides planning guidance for local preparedness by various means. The basic elements are contained in the NWS booklet *The Homeport Story* (formerly *A Model Hurricane Plan for Coastal Communities*).²¹ The model plan stresses the importance of local leadership and community action to develop emergency plans and public understanding of the threat and suggests procedures to be followed. Recommended steps in local planning are discussed in this chapter.

NOAA has proposed placing Community Preparedness Specialists in all 50 States. At present, five such specialists have been assigned, one each to the NWS Offices in Miami, New Orleans, San Juan, Boston, and Washington, D.C.—all Warning Offices under NHC—and NOAA is currently taking action to fulfill this requirement. Besides working with State officials on disaster plans and procedures, Community Preparedness Specialists will advise local officials concerning the hurricane warnings and assist in developing plans in hurricane risk areas.

Prior to the annual hurricane season, NWS conducts hurricane preparedness conferences at the NHC (Miami) and at a number of communities along the hurricane-prone coasts to upgrade local preparedness plans and to increase public awareness.

NOAA also assists States and localities in improving public understanding with a number of films depicting hurricane experiences and explaining the warning system. These films range from short spots to 25-minute documentaries. Prior to the onset of the 1971 hurricane season, OEP Director George A. Lincoln and NHC Director R. H. Simpson were filmed against background footage of Hurricane Camille as they spoke of the importance of hurricane preparedness and individual compliance with hurricane advisories. The 60-second spot was widely distributed and shown by TV stations serving coastal areas vulnerable to hurricanes. A Red Cross TV film, "Hurricane Action," is also available.

NOAA also provides informational pamphlets such as the excellent *Hurricane—The Greatest Storm on Earth*.²²

Emergency Assistance. Based on lessons learned in Hurricane Camille, OEP revised its field organization for disasters. Public Law 91-606 subsequently authorized the OEP Director to form emergency support teams of Federal personnel in major disasters. The disaster field organization has been tested in several major disasters and revised with slight modifications gained from experience. For this field organization, emergency support teams may be activated by OEP to work with a designated Federal Coordinating Officer (FCO). Members of the FCO's staff are designated by participating Federal agencies.

All Federal agencies with facilities in or near coastal communities are to be prepared to respond as quickly as possible to support local lifesaving and life-sustaining operations. Commanders of Department of Defense facilities have been given authority to provide disaster support services to nearby communities. These services include (among others) search and rescue, emergency transportation, appropriate evacuation assistance, emergency feeding, and sanitation and medical assistance.

Through direct communication facilities, NWS provides warning information to the American National Red Cross Headquarters and Red Cross Area Offices in threatened coastal regions. The National Red Cross

Hurricane Action Plan provides for three phases of hurricane action: Phase 1, Hurricane Watch; Phase 2, Hurricane Warning; and Phase 3, Hurricane Hit. Actions are keyed to the three phases and include movement of administrative teams and designated staff into the threatened area before hurricane landfall. Local Red Cross chapters take immediate emergency action to assist hurricane victims and evacuees—as they did during Hurricane Camille, for example, when the Red Cross staffed and managed 248 shelters, in Louisiana and Mississippi, caring for 77,358 hurricane evacuees.²³

Local Preparedness

Leadership in preparation for hurricane emergencies depends upon the initiative and foresight of State and local authorities. They direct State and community planning, control most of the emergency facilities, and have the detailed knowledge of and immediate responsibility for their jurisdictions.

Community Planning. The model hurricane plan for coastal communities, referred to previously, presents a comprehensive collection of sample plans for an imaginary city of 25,000, but the principles are applicable to a wide variety of situations. The Model Plan recommends a permanent Hurricane Preparedness Committee be organized to plan and carry out community protection from hurricanes. The committee should be chaired by the head of local government or his personal representative. This committee should include the heads of departments such as Police, Engineering, Public Works, Fire, Civil Defense, Streets, Public Transit, and Health and Welfare; the managers of local telephone, electric, gas, water, sanitation, and medical services; and radio and TV stations. Organizations such as the Red Cross, Salvation Army, and Mennonite Disaster Service should also be represented. The Committee should request appropriate State and Federal officials to consult and provide liaison with the committee.

Assessment of the Threat. The first order of business should be to appraise the potential danger and assess the community's vulnerability. Major coastal hurricanes of recent years should be reviewed, with special attention to storm surges and associated flooding. Highest waters of record for the community should be determined but should not be considered as the maximum in future hurricanes.

Assumptions for tidal surge heights in average, moderate, and major hurricanes should then be developed. Maps to cover the entire community should be drawn to show areas to be evacuated when the assumed hurricane tide height is, for example, 4 to 8 feet (average), 9 to 12 feet (moderate), 13 to 16 feet (major) above mean sea level.²⁴ Locations of shelters, medical

facilities, bus loading points, evacuation routes, and other emergency features should also be shown.

Central Emergency Control. An emergency control position should be established in a safe location with redundant communications to all agencies concerned with the emergency. The position should have auxiliary power generators and equipment to assure operation of communications and lighting. The location, where feasible, should take advantage of the established facilities of the local government.

Safe Shelter. Using evacuation maps and construction criteria, buildings should be designated as hurricane shelters and classified in terms of three or more expected wind speeds and associated surge heights. If the designated shelters are not sufficient to accommodate the number of people to be evacuated, arrangements should be made with nearby inland communities—and their Red Cross Chapters—for the shelters necessary to accommodate the overflow. The usual structures selected for safe shelter are schools, armories, and other large public or private buildings. With the rapid residential development in coastal metropolitan areas, hundreds of high-rise dwellings and office buildings are going up. The inner corridors of these buildings could serve as mass shelters. Engineering surveys should be made to assess their structural resistance, and appropriate buildings and levels should be selected.

Until there are sufficient shelters in the community to accommodate evacuees under the worst hurricane tide heights projected, future public buildings should be so constructed that they can also serve as hurricane shelters.

Public Utilities. The city water-supply plants should be checked for vulnerability at the three assumed levels of hurricane floods. If normal purity of water or continued operation of the plant cannot be guaranteed, provisions should be made for emergency supply or rationing of water.

(If the water plant, the power plant, and other essential utilities are in vulnerable locations, they should, if possible, be relocated.) Otherwise, floodproofing measures should be stressed. Future facilities should be built on safe ground wherever feasible. New sewers and septic tanks should be designed and located to minimize health hazards associated with malfunctioning during hurricane tides or flooding. Wells should be designed and located to minimize risks of pollution from malfunctioning sewers and septic systems.

Evacuation Bottlenecks. State and local authorities should determine whether there are potential traffic bottlenecks on evacuation routes. If so, each jurisdiction should take all practicable steps to remove impediments to quick egress and ingress and should develop plans which would expedite traffic.

Public Education. It is quite apparent that public understanding of the threat and of preparedness measures to meet the hurricane emergency is the basis for effective response. Programs for public education, carried out at local levels with Federal and State assistance, will promote the greatest savings of lives.

Persons who have experienced severe hurricanes have greater respect for the threat, and generally more comply with warnings and evacuation advisories. For example, after the residents of Lower Cameron Parish, Louisiana, had experienced Hurricane Audrey in 1957, 75 percent evacuated in the path of 1958's Tropical Storm Ella (even though advisories at that time did not advise evacuation) and 97 percent evacuated in accordance with warnings issued for Hurricane Carla in 1961.²⁵

A survey immediately following Hurricane Camille found that those who evacuated comprehended the danger of a storm surge much better than did those who stayed behind.²⁶ Several studies have found that, where there is a generally low level of understanding of the danger of hurricanes, the number of voluntary evacuees is relatively low.

The possible means of upgrading public understanding and cooperation are as varied as are the modern information media. In addition to programs linked to the public school systems, information campaigns prior to each hurricane season should be carried by newspapers, radio, and television. State and local "hurricane preparedness" days can be declared and used for intensive informational programs. Materials should be prepared and distributed which give the citizens essential information in handy reference form; the tsunami inundation maps placed in Hawaii telephone books are a good example of what can be made available for ready reference in a disaster emergency.

Findings

1. More exact prediction of a hurricane's course, landfall, and destructive potential is needed so that evacuation and emergency measures can be taken with greater confidence and executed with maximum thoroughness. The current goal of reducing the warning area to 150 miles or less within 10 years should be considered a minimum requirement; for 24-hour predictions, the landfall error should be reduced from the present average of 100 to about 75 nautical miles, the length of coastlines alerted for storm surge should be reduced by 25 percent, and sustained wind-speeds should be estimated within 10 percent of maximum. Populations and property at risk are increasing at a rate that dictates accelerated effort to achieve forecasting objectives. While no one can calculate the exact dollars and lives that more accurate forecasts can save inside the area of destruction, many millions of the annual sum now spent for emergency measures could be saved by reducing the

current 200-250 mile warning area to less than 150 miles.

2. The clear fact emerges that timely and efficient evacuation of endangered residents is the best emergency measure at hand to protect lives. Improvements in evacuation procedures and evacuation measures can best be achieved at State and local levels with continued and intensified assistance and guidance by Federal agencies.

The Example State Disaster Act of 1972, prepared by the Council of State Governments and contained in Part VII, is commended to those States whose legislation could be modified to enhance hurricane preparedness, including provisions for mandatory evacuation when required.

3. Much of today's capability to forecast a hurricane event fails to be translated into effective reaction simply because the specific vulnerabilities and resources of local areas are not adequately assessed. The program directed by NOAA for elevation mapping should be furthered, and cooperative arrangements, with appropriate incentives and assistance, should be made with State jurisdictions to speed the effort.

4. The problem of population density versus means of evacuation requires study and cooperative action by responsible agencies at all levels to overcome present and future limitations to escape, and to establish requirements for hurricane shelter.

A committee of the Dade County, Florida, Federal Executive Board is analyzing hurricane vulnerability of the Miami area (including Broward and Dade Counties). This study may provide a model approach for assisting other vulnerable coastal areas. The committee is identifying population at risk from hurricanes of various intensities and planning relocation to temporary refuge generally within walking distance. To accomplish this objective, there is a need to rely upon structurally sound high-rise apartments and office buildings, assured use of which in a hurricane emergency may involve legal and other difficulties.

5. Public-information programs can and should be improved in significant measure by existing public and private agencies with facts already known. Public appreciation of the threat to life and property is indispensable

to hurricane preparedness. This appreciation can be gained either through experience or through information; clearly, the former is more expensive than the latter.

6. In view of the enormous benefits that would come from modification or neutralization of hurricanes, research in the field of weather modification may have a very favorable cost-benefit potential. The present state of the art for hurricane seeding indicates a 10 percent reduction of hurricane damage may be achievable. Federal projects in weather modification can be reinforced. NOAA and its partners in Project Stormfury should seek to develop a seeding technology and associated mathematical models of hurricanes as a preliminary to an operational capability.

7. All jurisdictions should give priority attention to construction and land-use laws, regulations, and policies which take full cognizance of the hurricane threat now and in the future.

Future construction, especially in the rapidly growing and urbanizing areas of the vulnerable coastlines, can either compound the risk of death or damage or, with proper guidelines, serve to alleviate the danger. As a matter of public policy, new buildings should not be allowed to increase the hazard to citizens of hurricane-stricken areas; indeed, new buildings, whether public or private, should be so constructed that they add to the community's inventory of shelters. New public service facilities must be so constructed as to ensure continuation of essential services in hurricane emergencies.

Since there is no assurance that science and technology can substantially reduce the hurricane's destructive forces in the foreseeable future, zoning and construction standards should be established with particular concern for the long term.

8. Despite substantial progress, there is still need for better understanding of the causes and mechanics of hurricanes. NOAA's hurricane research programs and operations units are sound, but further scientific investigation is needed to develop improvements in prediction, warning, and protection. These will require equipment for data collection, real-time relay and processing, and computer analysis on a large scale.

Notes

¹*Hurricane—The Greatest Storm on Earth*, NOAA/PA 70021, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, (Washington, D.C.: U.S. Government Printing Office, 1971), p. 16.

²Robert H. Simpson, "Hurricane: Yes or No," *NOAA*, Vol. 1, No. 3 (July 1971), p. 17. Also, communication with Arnold L. Sugg, Deputy Director, National Hurricane Center.

³*Ibid.*, p. 19.

⁴Arnold L. Sugg, Leonard G. Pardue, and Robert L. Carrodus, *Memorable Hurricanes of the United States Since 1873*, NOAA Technical Memorandum NWS SR-56 (Fort Worth, Tex.: U.S. Department of Commerce, April 1971), p. 3.

⁵*Hurricane—The Greatest Storm on Earth*, p. 22.

⁶Sugg, Pardue, and Carrodus, *op. cit.*, p. 25.

- ⁷Simpson, *loc. cit.*
- ⁸NWS data.
- ⁹Simpson, *op. cit.*, p. 16.
- ¹⁰*Ibid.*
- ¹¹Arnold L. Sugg, "Economic Aspects of Hurricanes," *Monthly Weather Review*, Vol. 95, No. 3 (March 1967), p. 145.
- ¹²Simpson, *op. cit.*, p. 15.
- ¹³*Ibid.*
- ¹⁴R. H. Simpson et al., *A Cloud Seeding Experiment in Hurricane Esther, 1961*, NHRL Report No. 60 (Washington, D.C.: U.S. Department of Commerce, Weather Bureau, 1963), and R. H. Simpson and J. S. Malkus, "Experiments in Hurricane Modification," *Scientific American*, No. 211 (1964), p. 27.
- ¹⁵*Hurricane—The Greatest Storm on Earth*, p. 12.
- ¹⁶Example State Disaster Act of 1972; see Part VII of this report.
- ¹⁷U.S. Army Corps of Engineers, *After Action Report—Hurricane Camille, 17-18 August 1969*, (Mobile, Ala., February 1970), Plate 3.
- ¹⁸Simpson, *op. cit.*, p. 15.
- ¹⁹*Ibid.*, p. 17.
- ²⁰Robert H. Simpson, discussions with OEP representatives, June 24, 1971.
- ²¹*The Homeport Story*, NOAA/PA 70028, U.S. Department of Commerce (Washington, D.C.: U.S. Government Printing Office, 1971).
- ²²NOAA/PA 70021 (revised 1971).
- ²³From American National Red Cross inputs to OEP for "Report by Interagency Work Group for Study of Operation Camille," 1969.
- ²⁴*The Homeport Story*, p. 9.
- ²⁵J. A. Riley, *Disaster—Storm Ahead*, The Hogg Foundation for Mental Health (Austin: University of Texas, 1971), p. 49.
- ²⁶K. P. Wilkinson and P. J. Ross, *Citizen Response to Warnings of Hurricane Camille*, Report 35, Social Science Research Center, Mississippi State University (State College, Miss., October 1970).

Chapter E. Forest and Grass Fires

In purely economic terms, federally owned forest resources yielded approximately \$500 million from timber sales, royalties, and grazing forest lands in 1970. Additionally, the value at stump (standing timber that was subsequently cut) of State and private forest interests was in excess of \$1¼ billion in 1970. When these yields are considered along with the incalculable ecological benefits of the forests, it is apparent that a viable fire preparedness program is essential for the protection of these valuable resources.

Although wildland (including brush and tundra) fires are an ever-present threat to life, the fact that loss of life has been relatively low can be attributed to improved local preparedness and emergency actions, which are becoming increasingly important as residential development increases in urban and rural areas.

Protection includes those programs, procedures, and techniques that are required in the prevention, prediction and warning, and suppression of wildland fires. The protection programs are a combined team effort of Federal, State, local, and privately operated fire protection agencies. The ultimate goal is the systematic reduction of the amount of wildland acreage burned each year.

Organization and Facilities

Federal and State. The organizations of the Federal and State wildfire control agencies are designed to meet the peculiar conditions in their specific areas of responsibility and thus vary widely. Agencies of the Departments of the Interior, Agriculture, Defense, and Commerce are participants in Federal interagency fire control agreements.¹ Additionally, the U.S. Forest Service, in the Department of Agriculture, has cooperative agreements with 50 States, and the Bureau of Land Management, in the Department of the Interior, with 13 States. Federal support to the States includes financial assistance, training, inspection, implementation of research knowledge and technology, and development and procurement of fire equipment. Additionally, Federal and State agencies have joint procurement contracts with private operators for use of aircraft in fire suppression activities.

National Forest System. The U.S. Forest Service, Department of Agriculture, provides protection for

183.2 million acres in 154 National Forests and 3.8 million acres in 19 National Grasslands under the National Forests Organic Administration Act of June 4, 1897, as amended² (Figure 1). National Forest resources—timber, water, forage, wildlife, and recreation—are managed in combination to meet present and future public needs. The program of managing several forest resources for the benefit of the greatest number of people is known as “multiple use.” This is a cardinal principle of National Forest management as emphasized by Congress in the Multiple Use - Sustained Yield Act of June 12, 1960.³

Public Lands and National Parks. The Bureau of Land Management (BLM), U.S. Department of the Interior, is responsible for the multiple-use management and protection from wildfire of 450 million acres of public lands, of which 277 million acres are in Alaska.⁴ Public lands are those federally owned lands which have not been set aside for uses such as national forests and parks (Figure 2). Through cooperative agreements with other agencies, both Federal and non-Federal, the Bureau also has an important role in the protection of about 50 million acres of private and State-owned lands, including approximately 16 million acres in Alaska. Also, the Interior Department's National Park Service administers 29 million acres, of which 14 million require fire protection.

State and Private Lands. State and privately owned forest and nonforested watershed lands receive Federal funding through the Cooperative Forest Fire Control Program, which originated with the Weeks Law of March 1, 1911, as amended.⁵ The Law authorized the Secretary of Agriculture to enter into agreements with the States “to cooperate in the organization and maintenance of a system of fire protection on any private or State forest lands . . . upon the watershed of a navigable river.” Cooperating States had to provide for a fire-protection system, to which the Federal Government could contribute up to one-half of the cost.

The Clarke-McNary Act of 1924 and subsequent amendments⁶ broadened and strengthened the provisions of the Weeks Law. State and privately owned forest and nonforested watershed lands receive fire protection under authority granted by Section 2 of the 1924 Act. Fire protection capability has shown steady growth as a result of the assistance provided by the

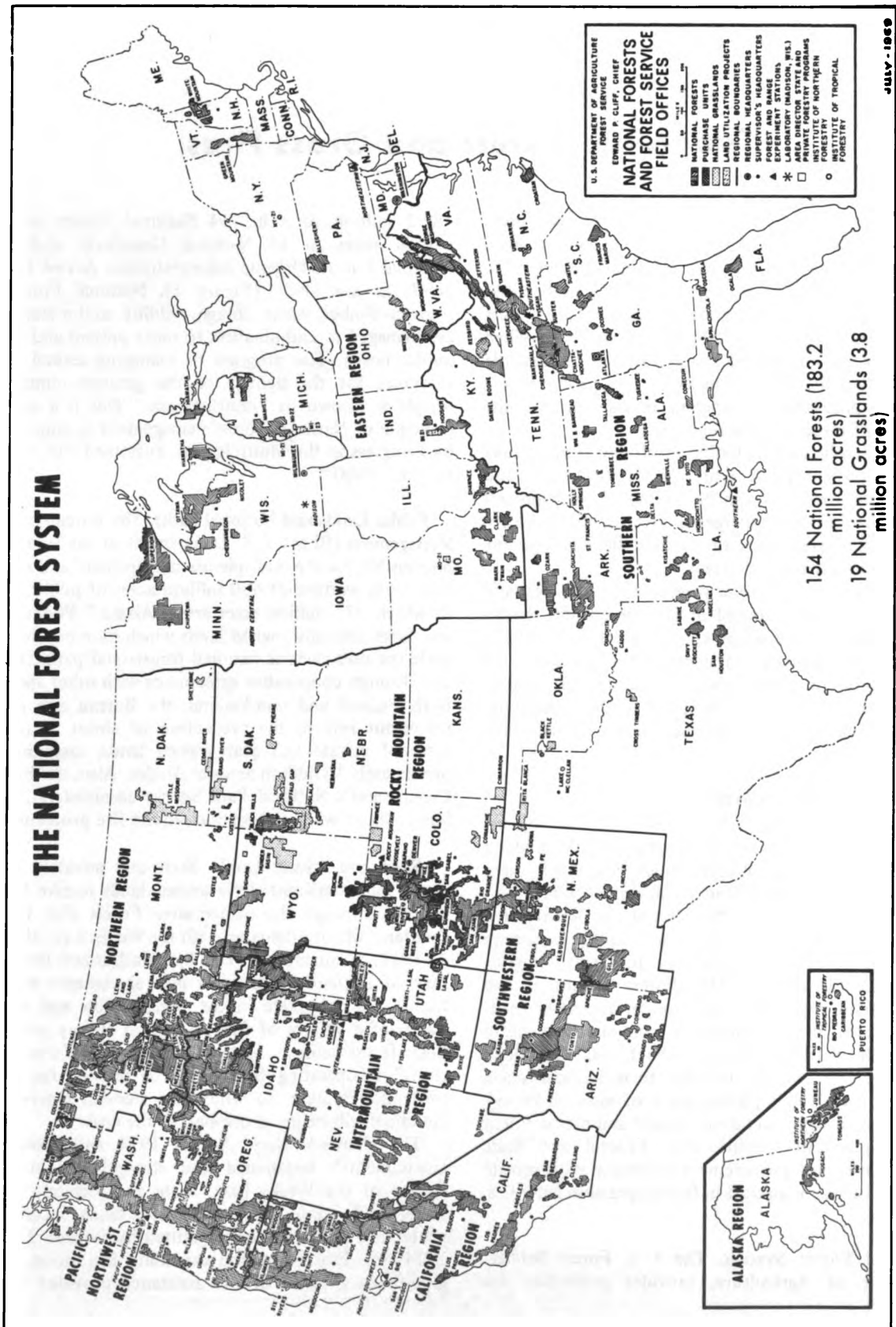


Figure 1.—The National Forest System—U.S. Forest Service.

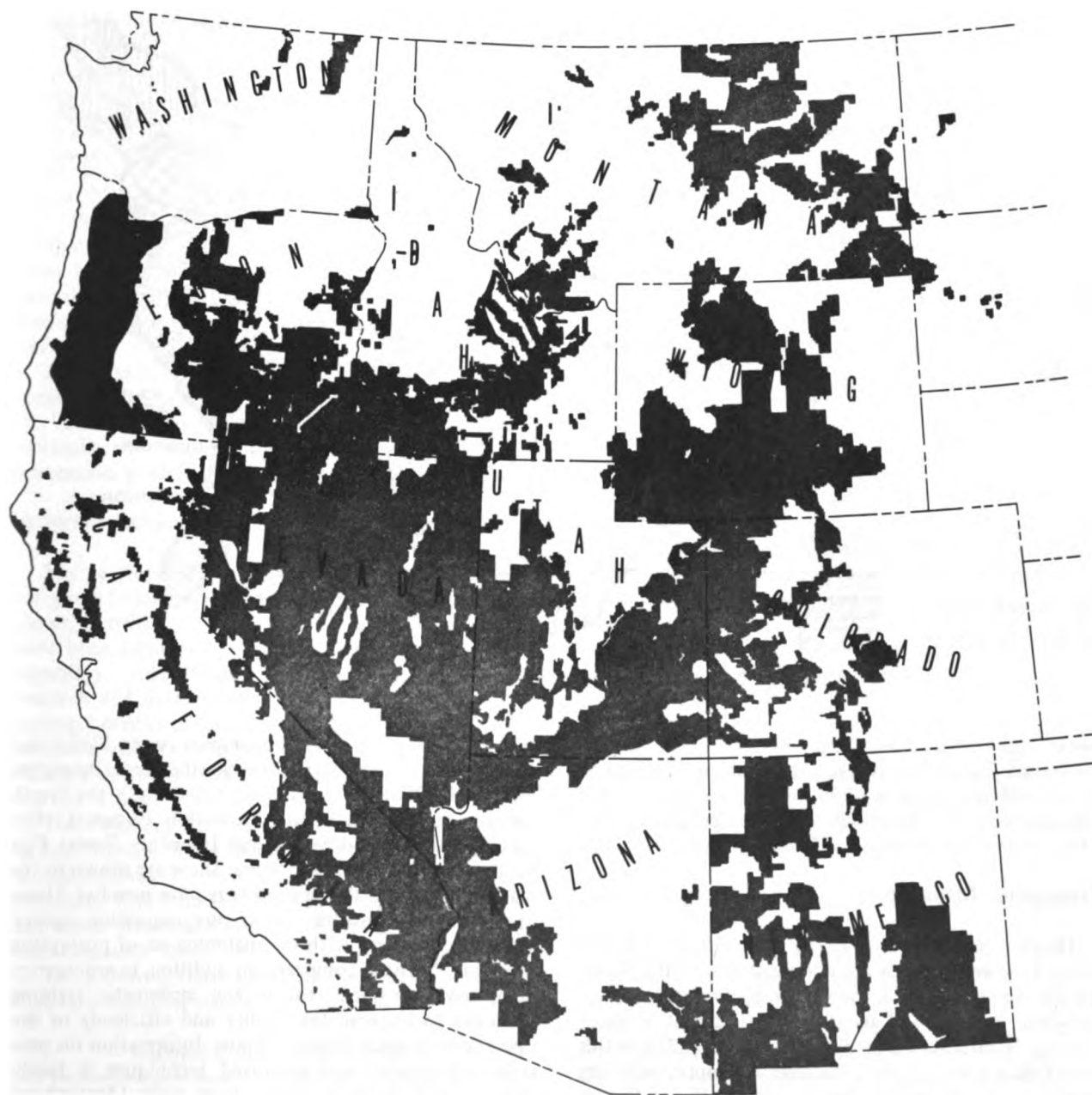


Figure 2.—Public Lands in the Western United States. Shaded areas are public lands managed by the Department of the Interior, Bureau of Land Management, which also administers approximately 277 million acres of public-domain land in Alaska—BLM map.

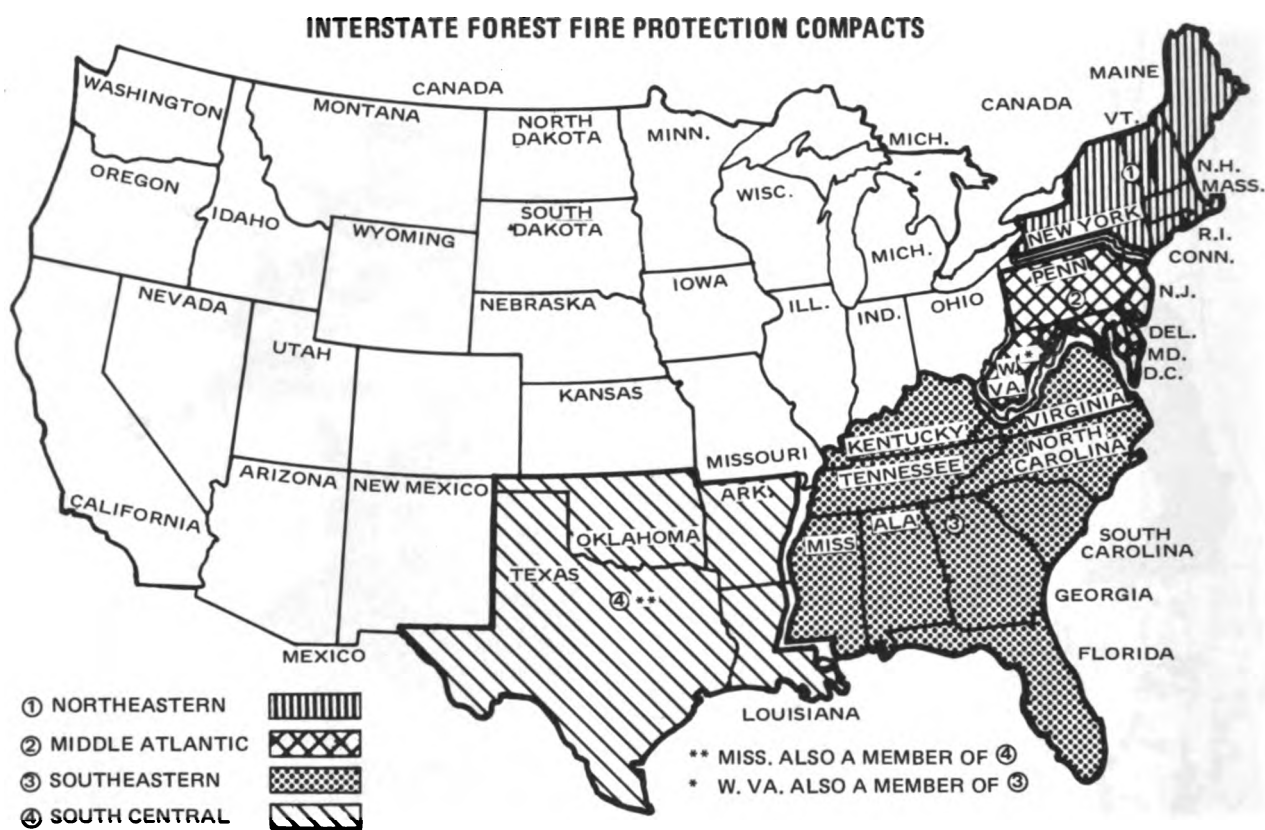


Figure 3.—Interstate Forest Fire Protection Compacts.

Weeks and Clarke-McNary legislation. In 1912, only 11 States had joined the program; this number increased to 29 in 1925 and to 50 in 1966. In 1912, only 61 million acres were protected; by 1925 the acreage increased to 178 million and by 1970 to 520 million acres.

Emergency Measures

Disaster Relief Act of 1970.⁷ The Office of Emergency Preparedness can provide assistance to the States for the suppression of a fire if it is determined to be of sufficient severity and magnitude to warrant a major disaster declaration by the President. Section 225 of this Act (Public Law 91-606) authorizes assistance, including grants, to any State "for the suppression of any fire on publicly or privately owned forest or grassland which threatens such destruction as would constitute a major disaster." The Governor of the State must certify to the need for Federal disaster assistance. Assistance provided under PL 91-606 is supplemental to State and local efforts.

Interstate Compacts. In recognition of the need for manpower, equipment, and supplies to meet fire emergencies, several mutual-aid groups have been formed among the States. Examples are the Northeastern Inter-

state Forest Fire Protection Compact (seven States and two Canadian Provinces), the Southeastern Interstate Forest Fire Protection Compact (10 States), the South Central States Forest Fire Protection Compact (five States), and the Middle Atlantic Interstate Forest Fire Protection Compact (five States). These are shown in the map in Figure 3. The compacts require member States "to render all possible aid to the requesting agency which is consonant with the maintenance of protection at home."⁸ These compacts, in addition to emergency help, have provided regular and systematic training programs to improve the quality and efficiency of the operations of each member State. Information on new tools, equipment, and improved techniques is freely exchanged. In addition to the above, several States have initiated informal agreements for mutual assistance in fire protection emergencies.

Emergency Recovery from Fire. Section 216 of the Flood Control Act of 1950 authorizes the Secretary of Agriculture to use funds appropriated for flood prevention purposes to do emergency work following fires, floods, or other disasters. This authority may be used only when an emergency exists, when regular programs and funds are inadequate, and when there is a reasonable possibility that watershed conditions can be improved

sufficiently by emergency measures to protect life or public health or minimize the hazard of damaging floods and debris flows. Since Federal funds are limited to \$300,000 under the Act, cost sharing by State and local governments is encouraged.

Special Studies

As part of the continuing effort to improve fire preparedness capability, the National Commission on Fire Prevention and Control has been directed to conduct a broad study on "Reducing Destructive Loss from Fire in Both Life and Property in the U.S.," in accordance with Title 2 of the Fire Research and Safety Act of 1968. The study is to be completed by June 30, 1973.

The Stanford Research Institute (SRI) has been commissioned by the Forest Service to conduct a study of "Fire Control." Operations research and analysis methods will be applied to the problems of fire prevention, prediction and warning, and fire suppression.

Program Achievements

The development of extensive road and trail systems for ground tankers and pumpers and the use of tractors, plows, trenchers, aircraft, and infrared air mapping units have been combined to form an efficient preparedness capability. Additionally, the continuous progress in research and development programs, fire weather forecasting, prediction and warning systems, prevention methods, and communications procedures has served to enhance this overall fire preparedness capability throughout the Nation.

The "Smokey Bear" program, which has been popularized through movie theaters, news media, and posters, is undoubtedly the best known of the fire prevention programs. It is estimated that the Smokey Bear program has saved America more than \$10 billion in potential forest resource losses.⁹

The following statistics reflect the effectiveness of the Federal protection program:

National Forest Protected Areas

<i>Period</i>	<i>Man-Caused Fires Average per Year</i>	<i>Forest Visitors¹⁰ Average per Year</i>
1940-1949	6,003	15,770,000
1960-1969	5,106	134,818,000

This progress in the reduction of man-caused fires is commendable; however, continued efforts are needed.

The following figures pertaining to lands under the control of the major Federal protection agencies, and those covered by cooperative agreements, also reflect a

downward trend in total acreage burned, by fires from all causes:

Forest Service

<i>Period</i>	<i>Area</i>	<i>Average Acres Burned per Year</i>
1950-1959	National Forests	261,264
1960-1969	National Forests	196,000
1950-1959	State and private	8,074,797
1960-1969	State and private	3,704,871

Bureau of Land Management

1950-1959	Public and other lands	1,235,796
1960-1969	Public and other lands	874,342

Notwithstanding the downward trend, BLM reports that the 1968 and 1969 fire seasons were especially severe. The 1969 season was one of the worst in many years because of the many acres burned in Alaska, with attendant losses of valuable resources.

Following is an assessment of capabilities and limitations of the various Federal, State, and privately operated programs for fire prevention, for prediction and warning, and for fire suppression.

Fire Prevention

An effective fire prevention program includes comprehensive educational and legislative enactment and enforcement procedures, and fire risk reduction by weather modification.

Public Education. The public-education campaign conducted by Federal and State fire protection agencies is designed to reduce the number of man-caused fires. In addition to the "Smokey Bear" program, "Keep Green" associations actively publicize the fire prevention theme, fire prevention and forest conservation practices are taught to school students, messages are disseminated to the public through the news media, and the Federal and State forestry officials establish personal contacts in the forests and parks.

Despite these measures, most fires (65 percent) are still caused by man. In an effort towards further reduction of man-caused fires, the Forest Service analyzes predominant causative groups by areas to determine project emphasis needs. Two such projects have been initiated. One involves special contacts in the Southern States to reduce the high number of incendiary fires. The second concerns reduction of man-caused fires by specific age groups, principally in the Western United States.

Law Enforcement. The steady population movement into areas of critical fire hazard has placed tremendous burdens on fire protection agencies. The effectiveness of fire prevention on non-Federal lands is largely dependent on the adequacy and enforcement of State fire laws. Some States have enacted excellent fire prevention laws and have taken the necessary enforcement action; however, there are inadequate fire laws and enforcement procedures in many of the Nation's high-hazard areas. Laws should require as a minimum: permits for debris burning, the use of fire safety devices for mechanical equipment operating in the woodlands, strict zoning and building regulations, the construction and maintenance of fire breaks, and the establishment of access and escape routes.

Lightning Modification. During the period 1966 to 1970, 50,670 lightning fires burned 5,777,630 acres of forest resources, at an annual cost of \$100 million for firefighting.¹¹ Experiments during the period 1965-1967 indicated a possible 60 percent reduction in cloud-to-ground lightning strikes by massively seeding clouds with silver iodide nuclei. In July 1971, the Federal Council for Science and Technology approved a national program for weather modification, which included a National Lightning Suppression Program, *Project Skyfire*. The objective of Skyfire is to develop a seeding technology to reduce the frequency of forest fire-starting lightning strikes from cumulonimbus clouds. The Forest Service estimates that current research and development efforts could lead to an operational light-suppression capability within the next 6 years.

Prediction and Warning

Lookout towers and aircraft are the key elements in the fire detection and warning system. Fixed observation posts, manned for continuous surveillance during the fire seasons, are supplemented by reports from local citizens. Commercial and private pilots file reports to Federal Aviation Administration stations, which relay them to the nearest fire control agency. Federal and State agencies are increasing the use of government-owned and privately contracted aircraft in fire detection and warning programs. The use of airborne infrared and electronic systems has provided the capability of detecting fires at night and through dense smoke. Weather forecasts and predictions of fire danger conditions are essential in the planning of prevention and suppression measures, the prediction of fire behavior, and the implementation of effective fire suppression tactics.

National Fire Danger Rating System. The National Fire Danger Rating System (NFDR) provides information on variations in fire danger, which information is used in planning for the most efficient allocation of firefighting resources. Fire danger ratings are computed from all

available information on weather conditions, plus type, composition, and moisture content of burnable vegetative fuels. These ratings provide information on the basic aspects of fire behavior.

Predictions of severe fire danger may require restrictions on the use of commercial and recreational wooded areas, shutdown of logging operations, and rescheduling of hunting seasons.

The need for wildfire danger rating, on a national basis, was recognized as early as 1940; however, a partially developed National Fire Danger Rating system was not introduced until 1964. By 1965, most fire control organizations were using modified versions of the NFDR system. In recognition of the need for an even more comprehensive national system, a National Fire Danger Rating Research Work Unit was established at Fort Collins, Colorado. As a result of current research, a new NFDR system is expected to be operational in 1972.

This system will initially include a subjective risk factor (the degree to which an area will be exposed to ignition). However, the ultimate goal of an objective risk factor may not be attained for several years.

A determination must also be made as to the number and location of fire danger stations. (See Part VIII, Chapter D, for further details.)

Fire Weather Service. The National Oceanic and Atmospheric Administration's Federal Plan for a National Fire Weather Service is designed to provide improved and expanded fire weather service for all fire control agencies. The forecast and advisory field services portion of the program is now approximately two-thirds complete; the next portion to get underway is a research and development program to apply improvements in weather technology to fire weather forecasting.

The goal is to improve the fire weather forecasts by keeping the operating staff abreast of advances in meteorology and equipping it to meet the requirements of increasingly dynamic fire control organizations. Development of forecast techniques will concentrate on finding ways of combining the products of the National Meteorological Center at Suitland, Maryland, with local weather observations, to prepare forecasts for areas as large as a national forest and as small as the area of a going fire. (See Part VIII, Chapter D for further details.)

Public Fire Detection and Reporting. Although the pilot reports mentioned previously have been a valuable part of the detection and warning system, standardization of reporting procedures would improve the accuracy of determining fire locations.

The Utah Cooperative Fire Fighters, a group composed of representatives from wildland fire control agencies, has devised an improved system of fire location and reporting.¹² When the Federal Aviation Administration receives a pilot fire report, the location is determined by magnetic heading and distance from one or more VOR (very high frequency omni-range) stations. This system eliminates the confusion in attempting to convert magnetic headings to true north and in locating by township, range, and section in FAA offices. FAA reporting to the proper fire control agency is facilitated by color-coding on the map, with a current list of fire agency contacts attached to the map.

Fire Suppression

A vital ingredient in an effective fire suppression program is early detection, followed by swift initial attack with sufficient firefighting forces. (Figure 4 depicts the firefighting team.) The requirement calls for a presuppression capability in being—an organized, trained, and supplied “ready alert” force, which can rapidly and effectively attack fires when they are small. *Presuppression* is defined as activities in advance of fire occurrence to ensure effective suppression action. It includes recruitment and training of ground and aerial forces, maintenance of fire equipment, improvement of fire control procedures, procurement of equipment and supplies, reduction of high-hazard fuels at strategic locations, and prerecording of information to facilitate suppression action.

Presuppression Effort. Emergency financing, to combat large fires, is and will continue to be an essential part of the fire protection program. However, investment in presuppression efforts could cut not only the costs of suppressing a fire but also the resource losses resulting from it. The Forest Service budget presentation to Congress—Explanatory Notes for the Protection and Maintenance Appropriation, Fiscal Year 1970—states:

If fiscal year 1970 turns out to be a year of average fire weather severity, the National Forest protection forces finances under this budget would be expected to spare over one million acres from fire and avert damages to resources in excess of \$100 million. Each dollar invested would return, based on long-term averages, approximately \$3.85 in resources spared from damages and emergency suppression costs averted.

Depending on the severity of the fire season, emergency suppression costs exceed presuppression costs by ratios ranging from 2:1 to 6:1, as shown in the following figures. (In reference to the third table, it should be noted that fire severity in the National Forests in FY 1969 and 1970 was not so critical as in FY 1971.)

Public Lands¹³—Bureau of Land Management

<i>Calendar Year</i>	<i>Presuppression Costs</i>	<i>Emergency Suppression Costs</i>
1968	\$ 4,742,000	\$13,190,000
1969	4,856,000	28,579,000
1970	5,961,000	24,225,000
<i>Calendar Year</i>	<i>Presuppression Manpower (Man-Months)</i>	<i>Emergency Manpower (Man-Months)</i>
1968	1,921	5,431
1969	1,836	9,880
1970	1,638	10,308

National Forests¹⁴—Forest Service

<i>Fiscal Year</i>	<i>Presuppression Costs</i>	<i>Emergency Suppression Costs</i>
1968	\$26,200,000	\$48,800,000
1969	27,500,000	24,700,000
1970	28,000,000	26,400,000
1971	29,200,000	85,300,000

Several problems have been identified in the presuppression program, primarily these:

- Permanent protection forces are severely strained by extended fire seasons.
- Poorly trained men are constantly faced with a tough firefighting job that better-trained forces could handle more efficiently and safely; adequate prefire training is required for emergency firefighting personnel.
- Contracting for helicopters, other aircraft, bulldozers, trucks, and other special equipment during and under the stress of emergency conditions may result in higher costs.
- There is a need to consider further all elements of a total presuppression effort, ranging from firemen stations to fire control headquarters.
- There is a need for reexamination of all elements of construction programs for fuel breaks and fire breaks.

An excellent Department of Agriculture report¹⁵ provides the best current illustration of the effectiveness of sound presuppression preparedness. As a result of the extreme drought conditions in the Forest Service Southwestern Region 3 in 1971, the fire danger situation was the worst in over 35 years.¹⁶ In addition to such prevention measures as closing the National Forests to the

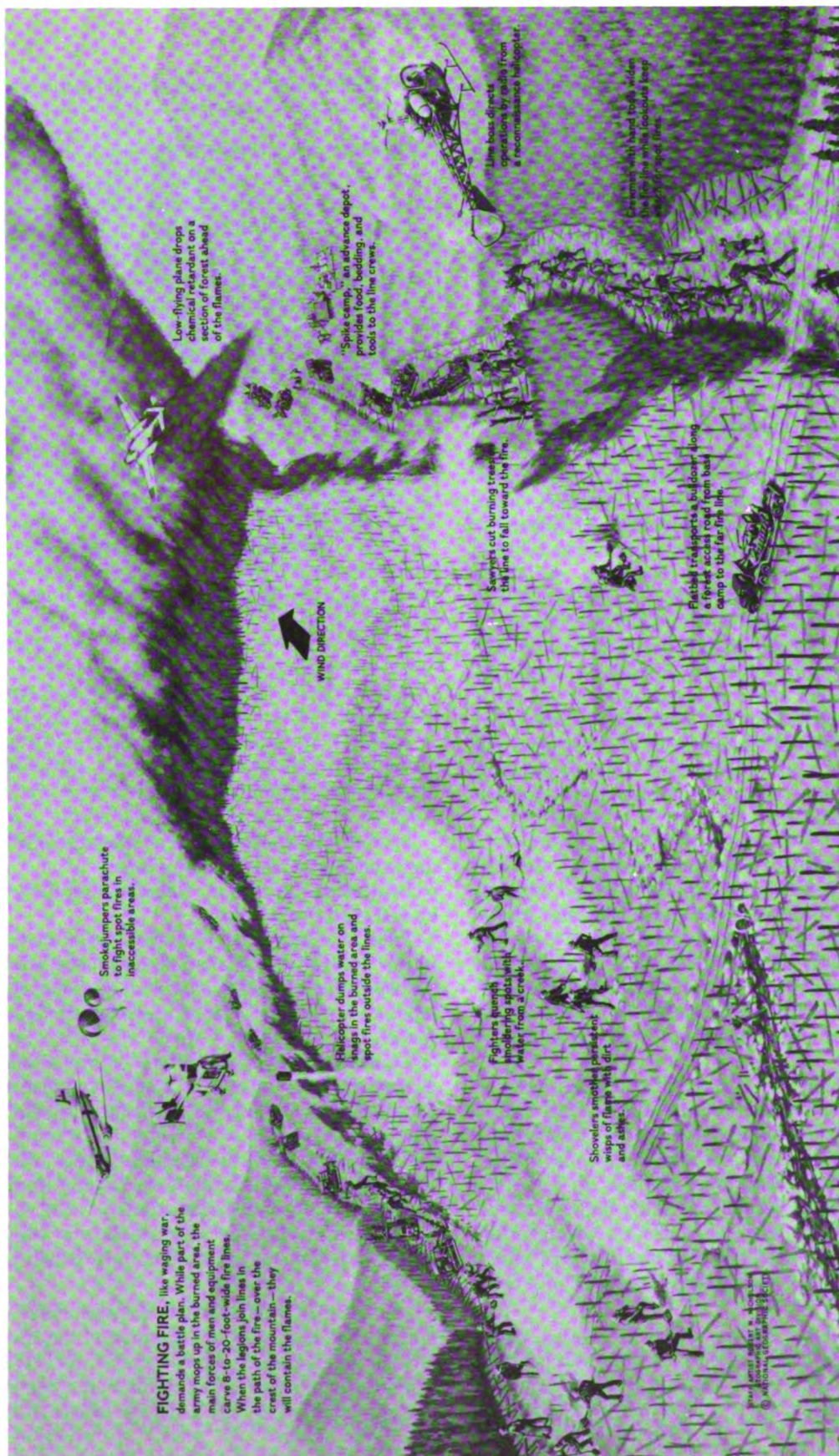


Figure 4.—The Firefighting Team in Action—from *National Geographic*, July 1968 (pp. 108-9), Staff Artist Robert W. Nicholson, (c) 1968 National Geographic Society, reprinted with permission.

public, Region 3 took the following presuppression action:

- Contract air tankers and helicopters were placed on base prior to contract dates.
- The Santa Fe satellite air tanker base was activated.
- Four air tankers, three lead planes, and three helicopters were added to the regular initial attack air organization.
- The normal complement of 12 smokejumpers was increased to 28.
- Twenty-five large models of ground tankers were brought in from another Region.
- Eleven organized crews were activated and placed throughout the Region to supplement the one inter-regional crew.
- STOL (short takeoff and landing) aircraft (Twin Otter and Caribou) and a DC-6 were placed on duty.

Results of the increased presuppression effort were compared to the critical fire years of 1951 and 1956:

	January 1-July 31		
	1951	1956	1971
Number of fires	1,263	1,765	2,319
Area burned (NF Acres)	94,011	77,679	36,266
Average acreage per fire	74	44	16

If 1971 fires had burned at 1951 average acreage per fire rate, 172,000 acres would have been lost, instead of the 36,266 acres actually burned over; at 1956 average acreage per fire, 102,000 acres would have been lost.

A direct comparison of area burned for the critical years shows strong initial attack through successful manning resulted in a minimum acreage loss reduction of 66,000 acres and a possible maximum acreage loss reduction of 136,000 acres.¹⁷

This represents savings of \$5.9 million to \$12.2 million in wildfire suppression costs (based on today's large fire suppression costs of \$90 per acre). Savings in potential resource damage totaled \$66 million to \$136 million.

Although the success of this presuppression program can be partially attributed to excellent planning in allocation of available resources, these procedures are not always possible because of the risk involved in reducing the initial attack capability in the neighboring forest areas.

BLM believes that it also demonstrated the value of extra presuppression effort in Alaska in 1970. Because of an extremely dry period for the previous 1½ years, BLM received an emergency fund of \$500,000 for advance preparedness. Emergency fire-fighting crews were recruited and trained, helicopter attack teams were supplemented, and extra air tanker

crews were placed on standby. The Bureau responded to and controlled a record 301 fires during the first 75 days of the 1970 fire season. In 1969 during this same time period, 289 fires burned 500,000 acres, as compared to 9,700 acres burned in 1970. (It should be recognized, however, that there are many factors involved in comparing fire years.)

Vegetative fuels management, the treatment of the flammable materials of the wildlands, is a major presuppression program that enables reduction of resource losses and fire suppression costs. Vegetative fuels management includes disposal procedures to prevent dangerous accumulation of burnable debris, the modification or conversion of highly flammable fuels to less flammable species, and the construction of fuel and fire breaks.

• *Fuel Disposal.* In some forest areas, vegetative matter accumulates at twice the rate of decomposition. The two principal methods of disposal are piling-and-burning and prescribed burning, which require the skillful application of fire under rigidly controlled conditions. Although the Forest Service employs smoke management procedures to limit burning to times at which atmospheric conditions are favorable to smoke convection and dispersion, ecological considerations may require that this procedure be restricted in the near future. Efforts are extensive in Forest Service research to find economic uses for residues. Machines such as chippers and choppers are being used and further developed (Figure 5). Increased use of forest vegetation and mechanical rearrangement to hasten decomposition are inroads to reducing accumulation but cannot be expected to offset this vast natural storage of energy for many years.

• *Fuel Type Conversion.* The conversion of vegetative cover of highly flammable plants to a cover of low-flammability plants is an effective method in preventing the rapid spread of fires. Such conversions improve soil stability, increase water yield, improve wildlife habitat, and increase forage production in addition to reducing fire hazards. In fiscal year 1970, the Forest Service converted 34,941 acres of highly flammable brush to perennial grasses. (Figure 6 shows brush vegetation.)

The Laguna brush fires of 1970, in San Diego County, California, provide a dramatic example of the need for vegetative type conversion programs. The bushy chaparral type fuel erupted with such explosive force that it raged out of control for 9 days and caused damage and destruction estimated at \$100 million.¹⁹ (See Part VIII, Chapter D for further details.) In addition to the direct dollar losses, virtually all normal activities were disrupted in 13 cities of the County as citizens responded to the disaster. Other population centers elsewhere in the country are exposed to this type disaster because of their proximity to highly volatile fuel areas.



Figure 5.—Mechanical Chipper Disposing of Fuel Debris in the Ocheco National Forest, Oregon, 1961—U.S. Forest Service photo.



Figure 6.—Brush in the Laguna Area Before the Fires in San Diego County, California, in 1970—photo courtesy of the County of San Diego, Department of Agriculture.

- **Firebreaks.** These are natural or constructed barriers where fires can be checked. Constructed firebreaks are usually strips where vegetative material has been totally removed. Such breaks may also improve access by firefighters and often accommodate firefighting equipment such as tankers and tractors.

- **Fuel Breaks.** These are strategically located strips through hazardous fuel areas where vegetation has been modified in order to reduce the fire hazard (see Figure 7). By FY 1970, there were 2,084 miles of fuel breaks and 1,798 miles of firebreaks in the National Forests. The Federal agencies estimate that up to an additional 22,000 miles of fuel breaks are needed.

Research and Development Programs. Ongoing fire research is now on the threshold of important new methods to prevent fires, reduce fire hazards, provide accurate fire weather forecasts, and detect and provide other essential intelligence about fires. These capabilities, if combined with scientific and technical resources such as are available in the aerospace industry, can provide an essential capability for reduction of fire control costs and resource losses and for the prevention of forest fire disasters.

Project AERO-FIRE. In recognition of the need to increase fire suppression capabilities, Congress has included \$1 million in the FY 1972 appropriation for the Forest Service to *begin* an accelerated research and development program in aerial fire suppression techniques. Project AERO-FIRE²⁰ will include four major phases:

- **Research and Development,** to include operations research and cost-benefit analyses of fire control alternatives for application of new technology; development of forest fire command and control systems; formulation of fire attack methods.

- **Design, Develop, and Test Fire Control Systems,** to include designs for automatic fire weather stations; telemetry and display units for aerial fire detection and mapping; testing of high-altitude fire retardant delivery from fixed wing aircraft; terrain avoidance systems for helicopters.

- **Demonstrate, Evaluate, and Train,** to include demonstration and evaluation of new technology under actual forest fire conditions and development of the necessary timing programs to insure effective application of research and development results.



Figure 7.—Fuel Break That Helped Stop the 1971 Fire in Los Padres National Forest, California—U.S. Forest Service photo.

Table 1.—Cooperative Forest Fire Expenditures, FY 1970, under Section 2, Clarke-McNary Act.

State	State and Private Funds	+	Federal Funds*	=	Total Expenditures	Federal allotments to States— FY 1971
Alabama	\$ 1,921,434		\$ 491,693		\$ 2,413,127	\$ 473,336
Alaska	2,157,109		168,331		2,325,440	163,399
Arizona	56,119		54,740		110,859	44,470
Arkansas	1,493,947		491,173		1,985,120	470,660
California	28,249,420		1,153,860		29,403,280	1,118,648
Colorado	702,247		132,152		834,399	142,929
Connecticut	303,825		125,868		429,693	123,030
Delaware	16,181		14,370		30,551	27,730
Florida	6,362,131		649,258		7,011,389	625,568
Georgia	6,219,258		682,862		6,902,120	662,026
Hawaii	161,272		62,493		223,765	56,712
Idaho	1,141,160		260,375		1,401,535	312,718
Illinois	391,572		110,700		502,272	108,952
Indiana	213,580		88,680		302,260	85,972
Iowa	70,477		64,474		134,951	62,021
Kansas	551,647		178,689		730,336	188,559
Kentucky	1,327,729		336,751		1,664,480	344,012
Louisiana	2,814,718		544,186		3,358,904	544,372
Maine	1,633,719		455,224		2,088,943	441,332
Maryland	956,891		193,619		1,150,510	216,895
Massachusetts	463,819		225,129		688,948	218,259
Michigan	2,625,374		575,703		3,201,077	556,696
Minnesota	615,484		368,172		983,656	356,938
Mississippi	2,320,469		545,309		2,865,778	528,667
Missouri	1,620,016		414,283		2,034,299	422,211
Montana	555,998		191,076		747,074	181,758
Nebraska	512,073		136,706		648,779	146,980
Nevada	510,241		146,310		656,551	169,930
New Hampshire	265,944		121,524		387,468	117,817
New Jersey	816,347		209,691		1,026,038	230,285
New Mexico	120,740		82,415		203,155	82,462
New York	1,815,455		438,656		2,254,111	442,061
North Carolina	3,536,113		575,121		4,112,234	564,763
North Dakota	13,964		14,000		27,964	16,180
Ohio	735,553		172,823		908,376	185,291
Oklahoma	451,032		207,768		658,800	213,518
Oregon	3,434,769		590,955		4,025,724	581,458
Pennsylvania	2,298,939		421,848		2,720,787	408,974
Rhode Island	183,003		59,803		242,806	67,090
South Carolina	2,675,645		482,662		3,158,307	498,143
South Dakota	123,634		60,648		184,282	70,842
Tennessee	2,981,861		511,313		3,493,174	511,472
Texas	1,428,453		395,168		1,823,621	383,112
Utah	356,000		107,229		463,229	122,373
Vermont	76,832		70,853		147,685	68,694
Virginia	1,871,690		475,453		2,347,143	474,669
Washington	4,454,317		606,705		5,061,022	587,785
West Virginia	664,150		216,701		880,851	212,086
Wisconsin	2,649,179		502,146		3,151,325	506,829
Wyoming	186,969		78,104		265,073	97,503
TOTALS	\$97,108,499		\$15,264,772		\$112,373,271	\$15,238,187

*Excludes funds for administration, inspection, and similar expenses.

• **Operational Program**, to include lease or purchase of aircraft and helicopters, modification of aircraft and helicopters; manufacture and maintenance of new equipment for use in fire command and control systems, fire attack, and fire hazard reduction.

Modular Retardant Tanks. The modular system consists of a series of fire retardant tanks which are capable of rapid installation in military cargo aircraft, without modification of the aircraft. Successful testing of the modular equipment was conducted on a military cargo-type aircraft at Edwards Air Force Base, California, in August 1971. Further development of this concept may prove its adaptability for use in other than military aircraft.

A California National Guard C-130 aircraft, equipped with modular retardant tanks, was tested in the October 1971 Santa Barbara fire. Preliminary results indicate that, with additional evaluation, military aircraft could provide a valuable backup force to the initial attack capability.

Federal-State Cooperative Forest Fire Control Program. Section 2 of the Clarke-McNary Act authorizes a Federal financial share of no more than 50 percent of each State's total program expenditures for the year. The Federal contribution amounted to 14.5 percent (\$15,238,187) of the total program expenditures (over \$113.5 million) for FY 1970.²¹ The current authorization of \$20 million was approved by Congress on October 26, 1949. Federal, State, and private forest fire control expenditures for FY 1970 and Federal allotments to the States for 1971 are shown in Table 1.

Rural Fire Protection. Within the United States, there are approximately 420 million acres of rural lands that are either unprotected or inadequately protected against fire.²² These areas include cropland, pastureland, farmsteads and other farmland, nonmountainous range areas, and lands with structures in rural communities. Approximately one-fourth of the Nation's total population resides within these areas. Protection from fire is generally poor due to lack of equipment, facilities, and trained personnel.

With the increasing number of people and structures exposed to the hazards of fires in these areas, it is incumbent upon State and local governments to initiate preparedness programs to mitigate against this hazard and improve firefighting capability. Federal revenue-sharing proposals offer one solution for financial and other assistance to the States and to local governments in organizing, training, and equipping fire forces in rural areas and communities.

Status of the Air Tanker Force. Although the air tanker has demonstrated its importance as an integral part of the initial attack team,²³ the air tanker fleet is rapidly approaching obsolescence, and the high cost of

parts and components presents a serious operational problem. Relatively few aircraft are owned and operated by the Federal and State protection agencies. During the late 1950's and 1960's, excess military aircraft, from single engine to four engine, with load capacities of from 600 to 2,000 gallons, were converted to airtankers.²⁴ These aircraft were obtained from the surplus fleet by either competitive bid or outright sale by the General Services Administration and were modified and tested by the private contractors, who subsequently provided the air tanker capability to Federal and State agencies during the past 15 years.

The present air tanker fleet of approximately 125 aircraft is composed of TBM, B-17, B-26, PB4Y, F7F, AF, S2, PV2, DC-6, and C-119-type aircraft. The most probable source of additional aircraft for tankers would be certain piston-engine models that may become available as surplus from the military services. Current possibilities, many now in storage, are: P2V, C-119, S2F2, SA16 Albatross, C-123 Small Hercules, C-130. The DC-6 is available on the civilian market.

Most aircraft that are specifically designed for or adaptable to air tanker operations by the aerospace industry are currently too expensive for purchase by private operators. For example, the Canadian CL-125, designed for aerial fire suppression and scheduled for evaluation under Project AERO-FIRE, will cost \$1.4 million per aircraft. This is prohibitive for purchase by private operators, requiring an outlay of \$40 million to \$50 million.

Cost and efficiency of operations become the prime considerations in selection of replacement aircraft. For the near-term period (at least the next 10 years), current military surplus aircraft can efficiently perform the fire suppression mission, with considerably reduced total outlay of expenditures. (See Table 2 for characteristics and performance comparisons.)

Acquisition of Air Tankers. The problem of lease vs. sale agreements is deserving of special attention when considering the vital role of air tankers. A typical lease agreement requires the operators to make arrangements to reactivate the aircraft from storage, place the aircraft in good airworthy condition (including tank installation for FAA Certification), and bear the cost of the reactivation, tank installation, and certification. There are also restrictions on modification of the aircraft because of possible recall by the military service. Any undue hardships placed on operators because of unsatisfactory lease agreements could have an adverse effect on the efficiency of the initial attack technique in fighting wildfires.

The outright sale of aircraft and helicopters excess to military needs is complicated by existing Department of Defense directives that require the demilitarization of certain aircraft, a stripping process that may leave the aircraft unsuitable for air tanker use.

Table 2.—Available Tanker Aircraft Characteristics and Performance Chart—from
Aircraft Flight Handbook and other aircraft reference materials.

Criteria	CL-215	PBY ^a	C-119	DC6 ^b	P2V
Cost	\$1,400,000	\$120,000	\$100,000 ^c	\$100,000 ^c	\$100,000 ^c
Gross Weight	43,000	40,000	72,000	90,000	74,000
Retardant Capacity	1,400	1,400	2,400	3,000	2,400
Engines	R-2800 (2)	R-2600 (2)	J-34 (1) R-4360 (2)	R-2800 (4)	J-34 (2) R-3350 (2)
Engine H/P	2100	1860	3200 lbs. ^d 3500	2400	3200 lbs. ^d 3500
Rate of Climb, at gross	1000 ft/min.	1200 ft/min.	1500 ft/min.	1070 ft/min.	2700 ft/min.
Takeoff run, at gross	1950 ft.	1800 ft.	1750 ft.	2700 ft.	2850 ft.
Power Off Stall (Landing weight)	72 mph	70 mph	74 mph	84 mph	80 mph
Cruise Speed	180 mph	180 mph	200 mph	230 mph	220 mph
Number Aircraft Available	In prod'n	50-100	35+ ^e	50-200	26+ ^e

^aThis aircraft can be modified to scoop water (a CL-215 capability) at a cost of \$40 to \$50 thousand.

^bAvailable on the civilian market.

^cEstimated only.

^dJet thrust stated in pounds.

^eMilitary has in storage and active inventory.

A waiver or amendment of current policies, to permit sale of certain excess military aircraft to private operators, would allow continuation of the present aerial tanker mode of operation, which has proven satisfactory to the Federal agencies. A determination would be required that the mission of aerial suppression is critical in fire disaster control, and that the sale of suitable aircraft to specific reliable private operators is in the public interest.

Canada, in realization of the importance of aerial suppression, has recently sold three U.S. P2V aircraft to a private operator in British Columbia. Twenty-six P2V's, currently in storage at Davis Monthan Air Force Base, Arizona, are being considered by the Forest Service as replacement aircraft in the air tanker force.

Additionally, some assurance would be required that the aircraft would be used for the purpose intended. The Secretaries of Agriculture and Defense are reviewing the subjects as a matter of urgency in an effort to resolve the problem of availability of suitable aerial tanker aircraft.

There is currently no long-range plan to resolve the problem of the approaching obsolescence of the air tanker force.²⁵ Future plans should consider that suitable surplus military aircraft may not be available after the next 10 years.

Emergency Measures

Under PL 91-606, emergency funds can be made available whenever a fire on publicly or privately owned forest or grassland threatens such destruction as would

constitute a major disaster and a State Governor has requested disaster relief. This means, however, that there must be a *going* fire before emergency funds can be made available. Emergency aid cannot now be made available simply because conditions threaten an imminent "blow-up" or because State fire facilities are completely committed in fighting several small fires.

The importance of preplanning for the efficient allocation of available resources cannot be over-emphasized. For example, prearrangement for the transportation and housing of personnel and equipment, plus procedures for remuneration for their use, will avoid legal and technical roadblocks to effective response in emergencies.

The States could also provide contingency funds for use in fire protection when hazardous conditions exhaust or threaten to exhaust available resources. Such contingency funding might be feasible under Federal revenue sharing.

Findings

1. *The losses from fires can be reduced below the current annual average by emphasizing the existing prevention and presuppression programs by the Forest Service and the Bureau of Land Management.*

The following programs are in being and should receive continued emphasis:

- Construction of additional fuel breaks;
- Conversion of highly flammable woodland fuels to less volatile vegetation;

- Public education programs intended to reduce man-made fires;
- Early-season recruitment, training, and equipping of fire suppression forces;
- A developmental program for vegetative fuels disposal, other than prescribed burning.

2. *A major element of the fire suppression program is the air tanker fleet, which is fast approaching obsolescence. Losses from forest and grassland fires can only increase if deterioration of the tanker fleet is allowed to continue.* Potential solutions to correct this situation include:

- In the near-term period (10 years), the use of current military surplus aircraft—thus requiring smaller total expenditures, by the Federal Government as well as private operators, in maintaining an efficient aerial fire suppression capability.
- Waiver or amendment of present Defense Department policies to permit sale of the most suitable surplus military aircraft to private operators.
- Development by the Forest Service of a long-range plan to resolve the problem of future tanker obsolescence.

3. *The use of military aircraft equipped with a modular tanking capability would provide a valuable emergency backup force to the existing air tanker fleet.*

4. *Reduction of fire-igniting lightning, which causes 35 percent of forest and grass fires, is feasible.* A research program, Project Skyfire, has been initiated by the Forest Service.

5. *Aerial fire suppression is a key element of the initial attack team in accomplishing the ultimate goal of containing fires when they are small; however, additional operational evaluation is necessary to determine the most effective aerial suppression techniques.* Project AERO-FIRE, a program of the Forest Service designed to develop these techniques, is now being funded.

6. *Strengthening of fire prevention and suppression capabilities by State, local, and private interests will reduce loss of life and property.* Options for improvement in these capabilities include these measures:

- Close coordination by the Council of State Governments with State legislative bodies in the enactment and enforcement of improved fire laws.
- Provision, through preparedness planning, for the efficient use of available State resources in meeting fire emergency conditions. Plans should include specifics to resolve legal, technical, and fiscal problems relevant to the movement of personnel and equipment.
- Extension of rural fire control capability to cover rural lands now either unprotected or inadequately protected against fire.
- Provision of State contingency funds to permit the augmentation of established resources when extraordinary fire hazard conditions develop. Federal revenue sharing could be a source for such funds.

7. *The number of fires, from all causes, can be reduced or contained by an improvement in the present prediction and warning procedures.* Programs which offer a potential for improvement are:

- Completion by the Forest Service of the new National Fire Danger Rating System, with the dissemination and use of standardized procedures by all field agencies. Development of an "objective risk" rating system which would provide more accurate information of fire conditions in selected fire danger rating areas.
- Completion of the NOAA "Federal Plan for a National Fire Weather Service" to provide improved and expanded fire weather service for all fire control agencies.
- Standardization of procedures for fire reporting by pilots to FAA. A system similar to that of the Utah Cooperative Fire Fighters organization should be considered by the Forest Service, BLM, and FAA for use on a national basis.

Notes

¹The Boise Interagency Fire Center (BIFC), Boise, Idaho, is an example of a cooperative Federal operation. Jointly operated by the Forest Service, the Bureau of Land Management, and the National Oceanic and Atmospheric Administration, the Center supports fire protection efforts in the Western States and Alaska.

²76 Stat. 1157; 16 USC 473-478, 479-482, 551.

³Public Law 86-517, 74 Stat. 215, 16 USC 528-531.

⁴Statutory authorities are:

- The Protection Act of 1922, Section 2 of the Act of September 20, 1922 (42 Stat. 857, 16 USC 594);
- The Taylor Grazing Act of 1934, Section 2 of the Act of June 28, 1934 (48 Stat. 1269, 43 USC 315);

- The Act of 1937, Section 5 of the Act of August 28, 1937 (50 Stat. 874, 43 USC 1181a);

- The Act of 1955 for Reciprocal Fire Protection Agreements, Section 1856 of the Act of May 27, 1955 (69 Stat. 66, 42 USC 1856a-d);

- Section 601 of the Act of June 30, 1932 (47 Stat. 417, 31 USC 686);

- The Public Land Administration Act of 1960, Title 1 of the Act of July 14, 1960 (74 Stat. 506, 43 USC 1361).

⁵64 Stat. 872; 16 USC 480, 500, 513-519, 521, 552, 563.

⁶43 Stat. 653, 16 USC 471, 505, 515, 564-570.

⁷84 Stat. 1744, 26 USC 4071.

⁸ Article VIII, *The Northeastern Interstate Forest Fire Protection Compact*, approved June 25, 1949.

⁹ "Smokey's Record," pamphlet, State Foresters in cooperation with the U.S. Department of Agriculture, Forest Service, revised, January 1970.

¹⁰ U.S. Department of Agriculture, Memorandum to Chief, OEP PL 91-606 Disaster Study Group, August 5, 1971.

¹¹ Forest Service, Fire Control Division.

¹² U.S. Department of Agriculture, Forest Service, *Fire Control Notes*, Vol. 32, No. 2, Spring 1971.

¹³ U.S. Department of the Interior, memorandum to Chief, OEP PL 91-606 Disaster Study Group, August 5, 1971.

¹⁴ USDA, August 5, 1971, memorandum (updated).

¹⁵ U.S. Department of Agriculture, Forest Service, Southwestern Region, *Manning 1971, a Region 3 Report*, Fall 1971.

¹⁶ Ray Bell, State Forester, New Mexico Forestry Commission.

¹⁷ *Manning*, pp. 29-30.

¹⁸ U.S. Forest Service, Division of Fire Control.

¹⁹ San Diego County, Office of Civil Defense.

²⁰ Aerospace Engineering, Research and Operations for forest fire prevention and control.

²¹ USDA, August 5, 1971, memorandum (updated).

²² U.S. Department of Agriculture, memorandum to Chief, OEP PL 91-606 Disaster Study Group, September 7, 1971.

²³ Forest Service *Annual Summary Reports* (Air Operations), 1969 and 1970, credit fast initial attack of helicopters and air tankers in holding down total burned acreage, by dropping more than 18½ million gallons of chemical fire retardants.

²⁴ W. T. Larkins, "Forest Fire Air Attack Systems," *American Aviation Historical Society Journal*, Vol. 9, No. 3 (Fall 1964).

²⁵ Office of Emergency Planning, *Report to the Congress on Investigative Study of Forest and Grass Fires*, Senate Document 30, 90th Cong., 1st Sess., May 5, 1967, p. 13. Finding confirmed as still current.

Chapter F. Earthquakes

(Earthquakes, of all the natural disasters in this country, can inflict the greatest loss of life and property. Studies have concluded that a repetition of the 1906 San Francisco earthquake would cause billions of dollars of damage, with the potential loss of thousands of lives.)

(Earthquakes are the most difficult disaster phenomenon to prepare for. Earthquakes may occur without warning at any time of day, during any day of the year.) In addition to the dangers of ground shaking and surface faulting, earthquakes often trigger the disastrous secondary effects of fire, floods caused by dam failure, landslide, and tsunami. For many years, the 1906 earthquake in San Francisco was referred to as the "San Francisco Fire." In the aftermath of the San Fernando, California, earthquake on February 9, 1971, some 80,000 residents were evacuated because of danger of collapse of the Van Norman Dam.

When lack of warning is coupled with multiple hazards, preparedness measures must take into account the particular vulnerability of the community at risk—population, buildings, roads, utility networks, and emergency services. (See Part VIII, Chapter E, in Volume III of this report for further elaboration of the earthquake phenomenon.)

Risks and Consequences

(Thousands of small earthquakes occur in the United States every year.) Moderate or severe earthquakes are relatively infrequent, but they pose a significant threat for which special hazard reduction and preparedness measures are needed. The seismic risk map of the United States (Figure 1), depicts the relative damage expectancy from earthquakes, and shows that several population centers are located in high-risk areas. The record of major earthquakes occurring in the United States since 1865 is shown in Table 1.

In the past 8 years, the United States has experienced one severe and one moderate earthquake. The severe earthquake in Alaska in 1964 (between 8.3 and 8.7 on the Richter scale) released energy equivalent to 100 underground 100-megaton nuclear explosions on one line.¹ (The Alaska earthquake caused \$500 million in property damage, 131 deaths, and hundreds of injuries.) The moderate earthquake at San Fernando (6.6 on the Richter scale) released only about 1/1000 as much energy as the Alaska earthquake, yet it caused about the

same amount of property damage and half as many deaths.

The San Fernando earthquake is especially noteworthy because of what *might* have happened—if it had occurred at the center instead of the edge of the metropolitan area, if at a later hour of the day, if at a greater intensity, if the Van Norman dam had collapsed completely.²

It is clear that there is a continuing risk and an increasing vulnerability to earthquakes in the United States: . . . the pressures of population growth are causing expansion into areas that are more difficult to develop safely than those of past decades—often into mountainous areas, active fault zones, or areas of artificial fill that necessarily have earthquake-related problems associated with them.

Society is rapidly becoming more complex and interdependent; so that we are becoming increasingly reliant on critical facilities whose loss can create major disasters.

* * * * *

The increasing population density in some of our cities creates problems such as a very localized earthquake causing a major catastrophe, such as was not possible some years ago.

And, rightly or wrongly, I think people increasingly look to their governmental agencies to help them or protect them from natural disasters such as earthquakes, even when they individually have demonstrated little foresight—or even negligence—in preparing for such events.³

The following discussion examines the current status of earthquake hazard reduction, prediction, warning, and preparedness and the prospects for the near-term future.

Hazard Reduction Considerations

The most effective hazard reduction program would be to avoid building in the areas of high seismic risk. However, this is not entirely practical or feasible. Therefore, public officials have to devise programs to reduce earthquake hazards without impairing economic activities and growth while evolving improved protection. This is not an easy task, as witnessed by the

controversies in Los Angeles and San Francisco as to whether "skyscrapers" should be allowed in those cities.

Table 1.—Property Damage in Major U.S. Earthquakes, in millions of dollars (actual)—from *Earthquake Investigation in the United States* (Rev. 1969), U.S. Department of Commerce; OEP data used for 1971 earthquake.

Year	Locality	Damage
1865	San Francisco, Calif.	.5
1868	San Francisco, Calif.	.4
1872	Owens Valley, Calif.	.3
1886	Charleston, S.C.	23.0
1892	Vacaville, Calif.	.2
1898	Mare Island, Calif.	1.4
1906	San Francisco, Calif.	24.0
	Fire loss	500.0
1915	Imperial Valley, Calif.	.9
1918	Puerto Rico (tsunami damage from earthquake in Mona Passage)	4.0
1918	San Jacinto and Hemet, Calif.	.2
1925	Santa Barbara, Calif.	8.0
1933	Long Beach, Calif.	40.0
1935	Helena, Mont.	4.0
1940	Imperial Valley, Calif.	6.0
1941	Santa Barbara, Calif.	.1
1941	Torrance-Gardena, Calif.	1.0
1944	Cornwall, Canada-Massena, N.Y.	2.0
1946	Hawaii (tsunami damage from earthquake in Aleutians)	25.0
1949	Puget Sound, Wash.	25.0
1949	Terminal Island, Calif. (oil wells only)	9.0
1951	Terminal Island, Calif. (oil wells only)	3.0
1952	Kern County, Calif.	60.0
1954	Eureka-Arcata, Calif.	2.1
1954	Wilkes-Barre, Pa.	1.0
1955	Terminal Island, Calif. (oil wells only)	3.0
1955	Oakland-Walnut Creek, Calif.	1.0
1957	Hawaii (tsunami damage from earthquake in Aleutians)	3.0
1957	San Francisco, Calif.	1.0
1959	Hebgen Lake, Mont. (damage to timber and roads)	11.0
1960	Hawaii and U.S. West Coast (tsunami damage from earthquake off Chile)	25.5
1961	Terminal Island, Calif. (oil wells only)	4.5
1964	Alaska and U.S. West Coast (tsunami damage from earthquake near Anchorage—includes earthquake damage in Alaska)	500.0
1965	Puget Sound, Wash.	12.5
1966	Dulce, N. Mex.	.2
1969	Santa Rosa, Calif.	6.3
1971	San Fernando, Calif.	553.0
Total		1,862.1

Most deaths caused directly by an earthquake are the result of structural collapse, although there are engineering techniques to make new structures reasonably earthquake resistant at a small additional cost. A more serious and costly problem is to make older existing buildings safe.

It should be more generally understood that earthquake losses are largely unnecessary and preventable. In the whole of past history, something like 90 percent of the loss of life in earthquakes, and a major fraction of the destruction and economic loss, has been due to the failure of weak structures, such as would never be erected under any modern system of building regulation and inspection. This is particularly evident in the Mediterranean region and in the Near East; but the condition exists in many countries, even to a considerable extent right here in California.⁴

Control over building codes, construction permits, zoning, and land use are almost entirely in the jurisdiction of State and local governments. The Federal Government currently can exercise direct control only over its own construction, although it has the potential for indirect control through its loan and grant programs. Also, it can provide information regarding seismic safety to interested officials and encourage safety standards by example and influence. (See Part IV, Chapter A, Land Use and Construction.)

The formulation of building codes and zoning ordinances to reduce the hazard from earthquakes depends upon more than a knowledge of the seismic, geologic, and engineering principles involved. Legal, social, and economic factors must be considered in conjunction with the scientific and engineering factors to determine what constitutes "acceptable risk."

The most graphic manifestation of State interest in earthquake hazard reduction is the California Legislature's Joint Committee on Seismic Safety, organized to develop a seismic safety plan for the State. The 4-year planning effort also includes private and Federal earthquake experts. In September 1971, the Committee sponsored an Earthquake Risk Conference "to examine intensively the concept of 'risk' and approaches to its evaluation with the purpose of defining 'acceptable earthquake risk' as a basis for public policy for the State of California."⁵ The participants at the 3-day meeting examined the problem from several standpoints and concluded not with an explicit statement of "acceptable risk" but with a sentiment that the risk should not be greater than that of death by disease. It was concluded further that, on the basis of potential fatalities, the present risk to life from earthquakes in California is at an unacceptable level.⁶

The design of structures to withstand an earthquake must consider not only the expected magnitude of the seismic shock but also the stability of the ground upon which the structure is to be placed. Earthquake effects

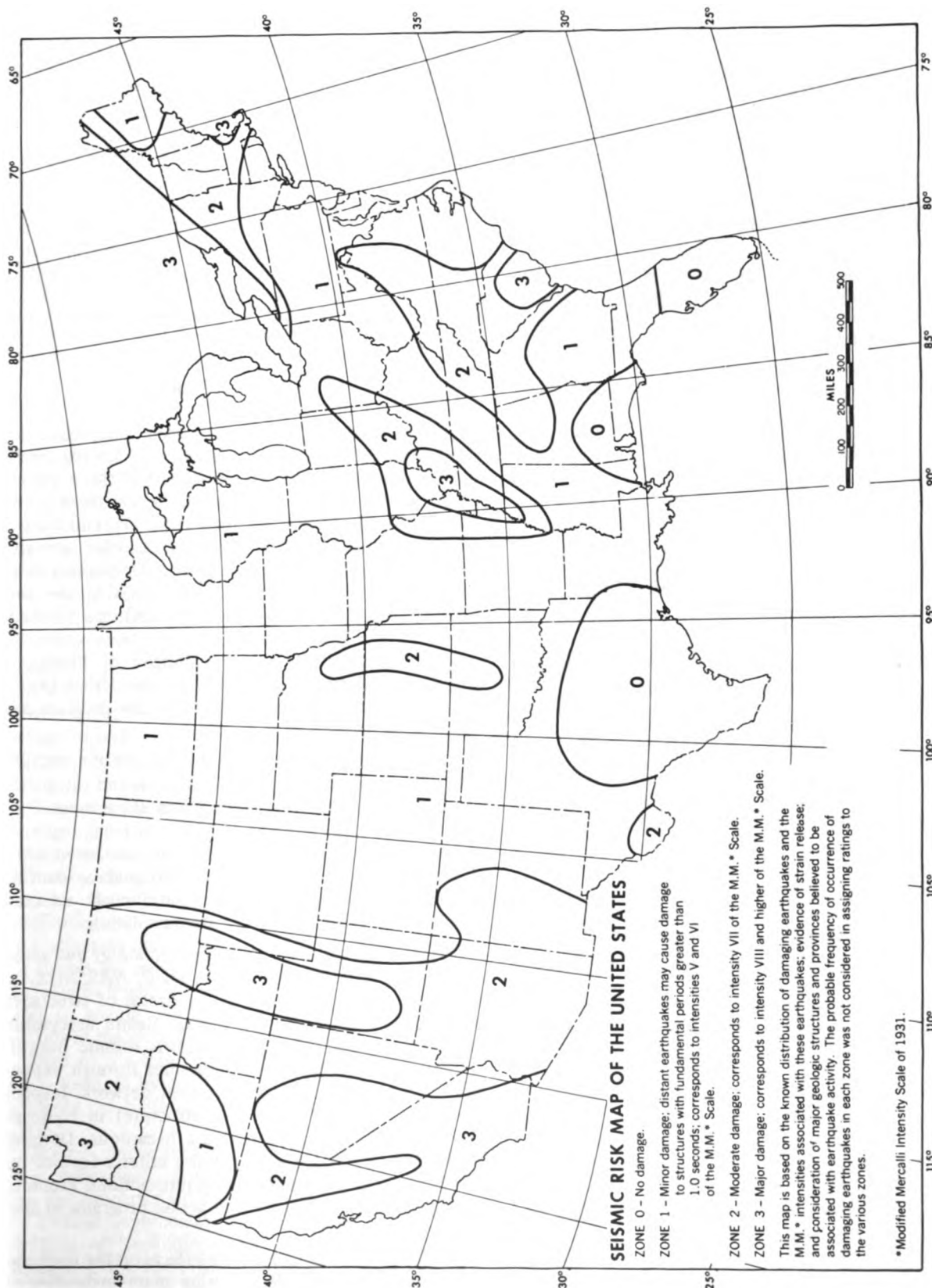


Figure 1.—Seismic Risk Map of the Conterminous United States—after S. T. Algermissen, "Seismic Risk Studies in the United States," *Proceedings of the Fourth World Conference on Earthquake Engineering* (Vol. 1, pp. 19-27), Santiago, Chile, 1969.

on structures built on soft soil are magnified, in some instances, as compared to those built on firm soils or on bedrock. The vibrations last longer and are of greater amplitude and lesser frequency. As a result, proximity to a fault is not the only important factor in determining hazard vulnerability. For this reason, it is not uncommon to have areas farther away from the epicenter sustain more damage than areas closer to the earthquake's center. Other factors, such as the impact of vertical in addition to horizontal motions, also contribute to the effect an earthquake has on a structure.

Therefore, to establish appropriate design criteria and to formulate meaningful zoning regulations, it is necessary to have accurate descriptions of all pertinent geologic considerations in the area of concern. Correlation of these descriptions with the types of seismic activity to be anticipated in the area yields a geologic hazard map useful to planners and engineers.

Local Hazard Reduction Programs

The City of Long Beach, California, provides an excellent example of local effort to reduce the hazards of earthquakes. In an examination of the earthquake hazard provisions of its building code, Long Beach adopted a concept called "Balanced Risk." Risk maps for the city were developed. Design and construction standards were rated in terms of hazard and risks. After assessment of the seismic and geologic hazards and the required resistance capacity of a structure, and after considering the number of occupants and its intended life, there evolved a balanced risk formula for both new construction and existing buildings. This interesting approach by a municipality could prove useful in dealing with a serious, complex problem. Similar efforts, but using different approaches, have been conducted in Las Vegas, Nevada, and in Santa Rosa, California.

California's Field Act is an example of statewide legislation that has been demonstrably effective. The Field Act was passed by the Legislature in 1933 after the Long Beach earthquake. It requires earthquake resistant design of public school buildings. The 1971 earthquake in the San Fernando area tested about 200 pre- and post-Field Act school buildings. Of the former, 85 were found to be potentially dangerous in the event of a similar earthquake, and 13 buildings on 10 school sites had to be demolished. Most of the post-Field Act schools were undamaged, although some of them suffered minor damage (to ceilings and light fixtures, for example).⁷ Because of the time of the earthquake (6:01 a.m.), the buildings were not occupied, hence there are no comparative data on personal injury.

Among structures other than school buildings, those designed for earthquake resistance generally sustained far less damage than those that were not so designed, except in some cases in which ground motion far exceeded design expectations.

The San Fernando earthquake demonstrated that proper engineering and site selection can reduce damage. It also demonstrated that scientific knowledge is not yet sufficient, particularly with respect to ground motions close to epicentral regions and to the effects of energy transmission through different geologic structures.⁸

Overall, the application of hazard reduction measures is quite variable. Some localities have enacted land-use planning ordinances and building codes directed toward reducing earthquake hazards. But local ordinances are not uniform, nor are they always enforced. Standards for safe design and construction tend to be relaxed after disastrous earthquakes because of pressures to reestablish local economies and to limit dollar costs to the communities.

National Hazard Reduction Program

Three successive government panels have made detailed recommendations for programs to achieve earthquake hazard reduction.⁹ Many aspects of those recommendations are now reflected in a proposed joint program designed for both long- and short-term hazard reduction goals. The participating agencies are the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the Advanced Research Projects Agency (ARPA), the National Science Foundation (NSF), the U.S. Army Corps of Engineers (COE), the National Bureau of Standards (NBS), and the Department of Housing and Urban Development (HUD). Relevant portions of the program are summarized below:

- *Locate geologically hazardous areas (NOAA, USGS, NSF).* Locate geologically hazardous areas and categorize detailed risk posed by earthquakes in these areas. Prepare detailed maps at scales useful for national, regional, and local planning, detailing the risk associated with sites because of past or potential earthquakes. Identify active and inactive faults and continuously monitor seismic activity and crustal strain accumulation.
- *Develop damage resistant design technology and assist community planning (NSF, COE, HUD, NBS, NOAA).* Develop methods to improve the design of structures to resist damage from earthquakes. Relate acceptable risk of structural damage to known seismic hazard. Quantify seismic hazards to structures through expansion of the strong-motion instrument network. Inspect Federal properties (by class of structure) in high-risk areas and identify those that are hazardous. Develop model building codes and land-use criteria for use by the Federal Government and local jurisdictions. Promote the development of community action programs to alleviate known hazards.
- *Predict earthquakes and their effects on the works of man (USGS, NOAA, NSF).* Develop an understanding of earthquake mechanisms by studies of measurable geo-

physical phenomena. Correlate changes in these phenomena with earthquake occurrences to identify precursor events, which will make possible predicting earthquakes on a regular basis. Improve existing prediction or warning services for secondary earthquake effects such as tsunamis and landslides.

- *Demonstrate the feasibility of controlling the maximum size of future earthquakes (USGS, ARPA, NOAA, NSF).* Demonstrate through long-term field experiments (10 years) in an unpopulated area that fluid injection and withdrawal can be used to manipulate the strain accumulation and release rates along active faults. The goal is to release strain through a large number of small events over a period of time rather than allowing the strain to accumulate to the point where there is a major earthquake. Upon scientific evaluation of the results of this experiment, the techniques, if successful, can be applied to more populated high-risk areas.

In addition to this program, an environment and resources study of the San Francisco Bay area by the Department of Housing and Urban Development and the Department of the Interior has been in progress since January 1970. This 4-year study will provide, among other things, information on potential earthquake hazards and the effect of earthquake shock on adjoining lands. It is anticipated the data collected will be used for planning and developing urban facilities.

HUD is also financing a study by NOAA, in cooperation with USGS, the Earthquake Engineering Research Institute, and Professor Karl Steinbrugge, in earthquake damage estimates, seismic risk mapping, and earthquake resistant construction practices.

Earthquake Research

Comprehensive analytical seismology studies are carried on by universities. This work is primarily theoretical research that, in the longer term, might lead to prediction and prevention or modification. However, very effective programs in engineering seismology are conducted by many universities and institutions. The Earthquake Engineering Research Institute has acted as a catalyst among universities, governments, and consultants in theoretical and applied research.

Most of the seismic research conducted by universities is financed by grants from the Federal Government, primarily the National Science Foundation, NOAA, and USGS.

Several universities throughout the country have long maintained programs of earthquake investigation and cooperate with the seismic research programs of the Federal Government. Among these are the California Institute of Technology, the University of California (Berkeley), the University of Southern California, Stanford University, the Massachusetts Institute of Technol-

ogy, the University of Michigan, the University of Illinois, Pennsylvania State University, and the Colorado School of Mines. Most of these programs are concerned with the physical properties of earthquakes, using sensitive measuring devices and conducting extensive postearthquake analysis. Also, there are many other schools with extensive programs in seismology, including Lamont-Doherty Geological Observatory, Columbia University, and Saint Louis University.

Federal research is carried out by NOAA at its Environmental Research Laboratory at Boulder, Colorado, where seismology and geomagnetism functions were recently consolidated. The close association of these functions will enhance the timely application of research findings.

USGS, through its National Center for Earthquake Research, conducts a comprehensive program of earthquake investigations. Included in the program are field studies and theoretical analysis of earthquake ground motion, with particular emphasis on geologic effects. Federal research on design criteria, land use, and construction are discussed in Part IV, Chapter A.

Monitoring. The fundamental input of all dynamic research in earthquake engineering is the ground motion to which the structure is subjected in a major earthquake. For several decades, NOAA's strong ground motion seismological network has provided data on ground motion (acceleration, displacement, velocity) near earthquake sources, in representative geologic environments, and in a wide range of structures. Other important information is derived from postcard canvasses after earthquakes and through actual field investigation in earthquake damage areas.

The design of structures to withstand earthquakes requires knowledge of ground motion and the interaction between structure and ground, as well as the responses of structures to earthquake motions. During the past few years, acceleration recording instruments have been installed in buildings in order to obtain data from future earthquakes. An important contribution to monitoring, usually carried on jointly by USGS, NOAA, and local universities under Federal grants, is the field study of earthquake aftershocks.

Scientists are concerned that man, through the development and modification of his environment, may have actually caused some earthquakes and increased the potential for others. The effect of water loading on the stresses contained in basin rocks and along faults in the rift valley behind major dams has long been a concern of seismologists and engineers. Many of the largest dams, such as Hoover, Shasta, Hungry Horse, Flaming Gorge, and Glen Canyon, have been monitored for seismic activity for many years. It is evident that during the water-filling process definite seismic readjustment took place. There have been small but no major earthquakes connected with the development of these reservoirs in

the 30 years this monitoring has been carried out in the United States.¹⁰

The advent of underground nuclear testing brought with it concern about the possibility of triggering earthquakes. As a result, underground tests are intensely monitored for seismic effects. While each blast produces a swarm of small-readjustment microearthquakes, no event to date, including the recent explosion on Amchitka Island in Alaska, has been followed by an earthquake such as would occur through natural processes in the surrounding tectonic structure.¹¹

Mapping. Analyses of the data provided by the monitoring programs can be expressed on maps which depict seismicity, seismic risk, faults, and geologic hazards.

Through its program of earthquake location and field investigation, NOAA provides extensive seismicity maps depicting the locations of all earthquakes of interest. These are then used as a basis for seismic risk maps, which attempt to assign maximum values of earthquake disturbances.

Among the more productive efforts of USGS in earthquake investigation has been the mapping of active faults. The active strands of the entire San Andreas fault are being identified and mapped in detail for the first time.

A series of strip maps has been published covering more than half of the San Andreas fault, showing recently active breaks. These maps are important in indicating lines of future activity and contribute to the calculation of risk estimates and the formulation of zoning regulations.

Prediction. There is some confusion on the subject of earthquake prediction. Often the layman thinks of earthquake prediction in the same terms as he has become accustomed to think of weather forecasting and storm warnings, that is, a highly probable occurrence at particular locations in a matter of hours. On the other hand, when the scientist thinks and talks about earthquake prediction, he has quite a different perspective in mind. The following extracts from the Senate hearings on the San Fernando Earthquake illustrate this situation:¹²

• Asked by Senator John Tunney if earthquake prediction was a national goal, Dr. Clarence Allen of the California Institute of Technology responded:

Oh, yes. . . . I think it is a reasonable goal to work for. Although, I should point out that what the engineer really needs is not so much an earthquake prediction; what he needs to know is what are the statistics, what is the probability of an earthquake in a given location at a given time. This is what he needs and what he wants. And, really, the problem of earthquake probability is a more

realizable goal and is fundamental to the engineers being able to design safe and economic buildings.

• In a later statement, Dr. Jerry Eaton of the USGS National Center for Earthquake Research also commented on achieving the prediction goal:

Our goal in all of this work is to develop a thorough and precise understanding of the physical processes and materials involved in earthquake generation, so that we might develop a technique for the prediction of future earthquakes.

We feel that the goal is a realistic one. The problem is well defined, many of the tools that are required are available, and we are rapidly developing concepts, which lead us to believe that we may be able to predict some earthquakes in the next 10 years.

• On short-term prediction of an earthquake, this exchange took place:

Senator Tunney: In retrospect, what would have been necessary to predict the February quake 24 hours in advance as to occurrence of earth shock, as to location, measuring instruments, and so on?

Dr. Allen: I think this is still a long-range goal, if you're talking about a 24-hour warning system for earthquakes. I think at the moment it is completely unrealistic.

• Senator Birch Bayh asked if accurate earthquake predictions could be made and what Congress could do. After Dr. Robert Wallace, also of the USGS research center, described the elements of prediction as "where things will happen, what will happen, and when they can happen," Dr. Eaton commented:

(The prediction of the time of an earthquake is still some distance away from us. At the present time, it would be unrealistic to sit here and say we can set up a warning system and predict the time of an impending earthquake.)

The easiest prediction would be . . . to predict where the earthquakes will probably occur.

Dr. Charles Richter, the inventor of the Richter Scale, expresses what is perhaps the most pessimistic view on the subject:

Public obsession with prediction diverts attention away from the actually possible measures to diminish the damaging effects of future earthquakes. Conversely, the impossibility of exact prediction is used as an argument against any and all precautionary measures, ignoring the obvious fact that where earthquakes have occurred in the past they may be expected in the future.¹³

What Dr. Richter appears to be urging is that the primary commitment of resources should be in hazard reduction measures with a calculable payoff—for example, demolishing or reinforcing unsafe buildings—rather than research and experimentation to develop a

prediction capability that will undoubtedly take years, if it is possible to develop at all.

The National Center for Earthquake Research and NOAA have a long-range experimental research program with the objective of developing a technique for the prediction of future earthquakes. Other nations with high seismic risk, notably Japan and Russia, are pursuing similar experiments, and the Japanese have achieved some degree of success in the city of Matsushio under special circumstances.

Instrumentation. The major components needed for developing an earthquake prediction capability, as well as for other applications, are highly sensitive instruments that monitor precursors such as microearthquakes and fault movements as well as the day-to-day activity on the major faults. In the first instance, efforts are made to find a correlation between the thousands of tiny quakes and the development of a big one. In the second instance, attempts are made to identify those areas where no slippage is occurring between the two sides of the fault and where the tension is not being released. Although there are opposing views, some scientists believe that these areas are most prone to severe earthquakes, since massive amounts of energy are released quickly when the fault does rupture. The San Andreas Fault system, the earthquake zone presenting the greatest economic and life hazard to California urban areas, is a case in point:

The segments of the fault [San Andreas] nearest San Francisco (from San Juan Batista, about 75 miles southeast of San Francisco, northwestward to Pt. Arena) and Los Angeles (Cajon Pass northwest to Cholame, about 175 miles southeast of San Francisco) are segments that appear to remain "locked" for periods of time, long enough for large strain to build up and be released in strong earthquakes. The last significant slippage on the northern segment was in 1906 and on the southern segment in 1857. . . .

Therefore, our two main urban areas in California are along segments of the San Andreas fault where we can expect the largest shocks.¹⁴

The present instrumentation networks in the United States are concentrated in the western part of the country.

The USGS National Center for Earthquake Research, located at Menlo Park, California, undertakes intensive studies of the San Andreas Fault system. Special emphasis is placed on the development of the seismic instrumentation and the data reduction and analysis procedures required for detailed studies of microearthquakes and aftershocks. High priority is also placed on the development of improved instruments and experiments for measuring crustal strain, including creep, across and near the fault.

The NOAA Earthquake Mechanism Laboratory, located at San Francisco, measures the gradual deformation of rocks accompanying the accumulation of strain at sites along the San Andreas Fault. Continuous strain measurement offers a potential observational approach to the prediction of earthquakes. These strain measurements are only one part of NOAA's program, which includes seismic monitoring and monitoring changes in the magnetic field and telluric currents. These are the main observational data for determining the mechanism and the state of strain along strike-slip faults, such as the San Andreas Fault system.

The NOAA Environmental Research Laboratories record data from seismographs located in remote areas in several western States. This activity provides rapid computer location of epicenters. NOAA's National Earthquake Information Center, now at Rockville, Maryland, is scheduled for consolidation with the other activities at Boulder.

The California Institute of Technology, supported by NSF, operates a network of 20 monitoring stations in northern California. Some 49 other stations are operated by universities in connection with their geological and geophysical stations. The primary instrumentation networks in the Western States are depicted in Figure 2. Only those seismograph stations that telemeter their signals directly to a central point are shown. Each network contains other stations from which data are collected in other ways. In addition, accelerographs are placed in many buildings throughout the area covered by the seismograph networks.

Most scientists are in general agreement that an increase in the amount of instrumentation in high seismic areas is essential to progress in the ability to predict, prevent, or mitigate earthquake occurrences. More knowledge is needed regarding the relationship between faults and earthquake occurrence, as well as the properties of earthquakes and the behavior of structures during such occurrences. Recent in-depth analysis of the subject, such as the OST report *Earthquake Hazard Reduction* (August 1970), recommends increased instrumentation as a prerequisite to progress in all applications.

Experimentation. Several experimental activities have excited some scientists with the potential of finding the key to developing an earthquake prediction capability, perhaps even a control capability.

For example, an apparent correlation has been discovered between the injection of fluid into subterranean rock and the occurrence of low-intensity earthquakes. This occurred unexpectedly at Denver when the local area began experiencing small earthquakes soon after the nearby Rocky Mountain Arsenal commenced pumping fluid wastes into the ground. When the injection was discontinued, the level of earthquake occurrence decreased sharply.

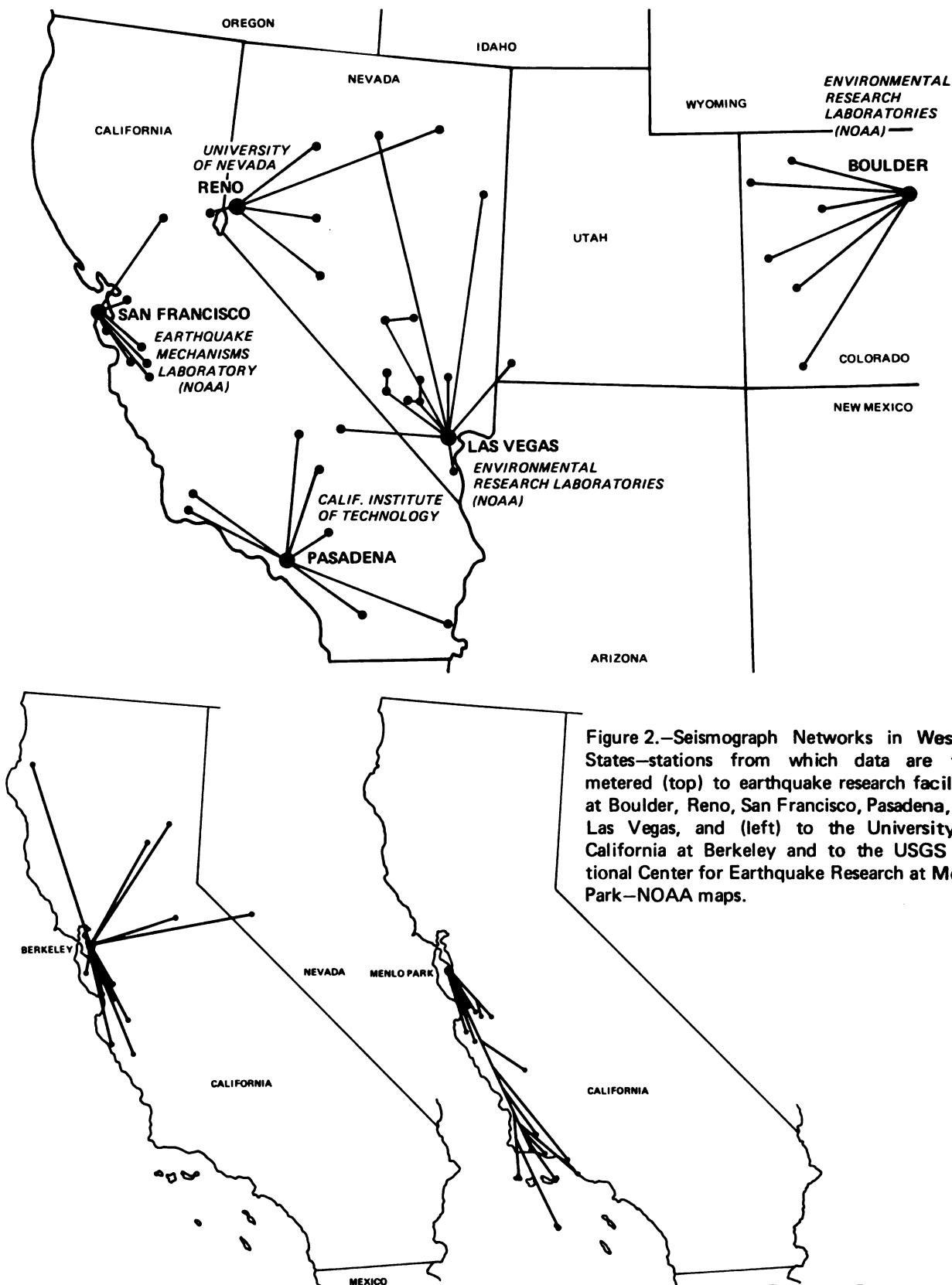


Figure 2.—Seismograph Networks in Western States—stations from which data are telemetered (top) to earthquake research facilities at Boulder, Reno, San Francisco, Pasadena, and Las Vegas, and (left) to the University of California at Berkeley and to the USGS National Center for Earthquake Research at Menlo Park—NOAA maps.

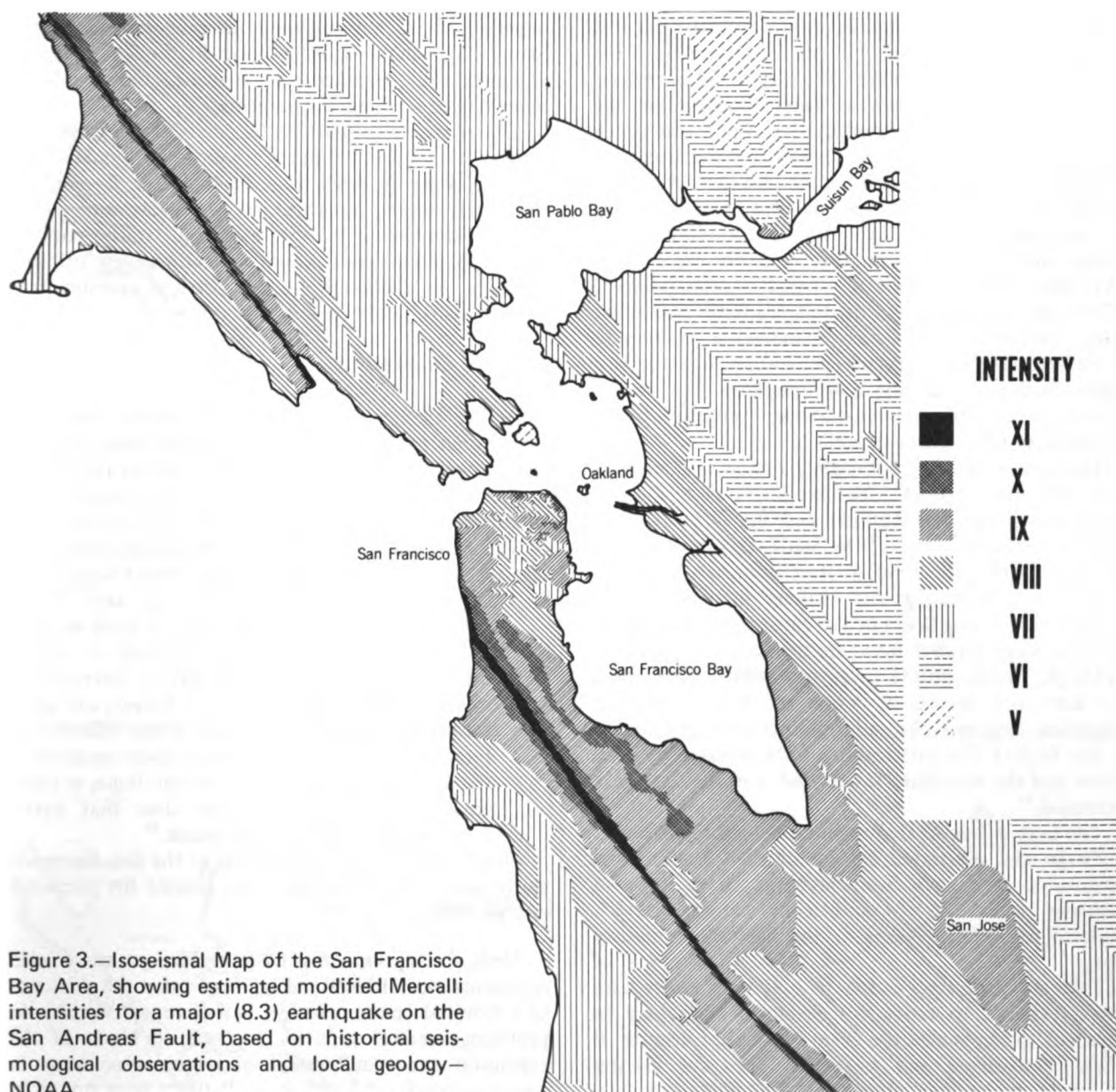


Figure 3.—Isoseismal Map of the San Francisco Bay Area, showing estimated modified Mercalli intensities for a major (8.3) earthquake on the San Andreas Fault, based on historical seismological observations and local geology—NOAA.

Such temblors were then recorded in the vicinity of Rangely, Colorado, after construction of the Unita Basin Seismological Observatory in 1962 with its network of 14 stations. Here, the occurrences of earthquakes above magnitude 0.5 varies from one to 70 per day. The two largest, both on April 21, 1970, had magnitudes of 3.7 to 4.0 on the Richter scale. Testing is continuing to verify the theory that increased pressure caused the quakes by releasing the strain between the two sides of a fault.

Disaster Preparedness

The San Fernando earthquake demonstrated the importance of disaster preparedness and emergency

operations. The closely coordinated and cooperative arrangements of the hospitals in Los Angeles County proved invaluable in that disaster. (Their experience has been presented in a new film, "Date With Disaster," being used by OEP to foster improved emergency medical preparedness throughout the United States as part of the disaster preparedness program.) The police departments and volunteer agencies executed a remarkably successful evacuation of some 80,000 residents below the Van Norman dam. Yet all of the evaluation reports make the point that the next time "we may not be so lucky." All of the things that might have happened in this event emphasize that much needs to be done to develop preparedness for a major earthquake.

Earthquake Study. Preparedness for earthquakes, and disasters in general, begins with an understanding of the threat and how to respond. The first involves vulnerability analysis and potential damage assessment; the second involves plans, including the use of emergency procedures and resources, to cope with the situation. Response to localized and minor disasters does not require elaborate analysis and planning; but this is not the case with a major earthquake in a modern metropolitan area. This consideration underlies the actions taken this year by the Director of OEP in commissioning NOAA to conduct an earthquake damage assessment study. Concurrently, OEP issued planning assignments to all Federal agencies concerning emergency response to a major earthquake in the San Francisco Bay area—a prototype of the research-planning program to be expanded to other high-risk areas.

The earthquake study considers a range of intensities (6.0, 7.0, and 8.3 on the Richter scale) along the two major faults—the San Andreas and the Hayward—and covers the nine counties of the San Francisco Bay area. For each earthquake event, an isoseismal map (Figure 3) is prepared, reflecting the various intensity ranges (similar to contour lines) of the earthquake. Correlated with the maps for each event are the surface structures—buildings, roads, utility networks—which have been evaluated and scored in terms of their earthquake resistance. (Figure 4 shows hospital facilities in relation to the faults.) The interaction of the released physical forces and the structures is analysed, and the damage is estimated.¹⁵

The high degree of thoroughness being applied in this study is well illustrated by the detailed key-facilities inventories that have been prepared. Each type of structure or facility is described and evaluated and is depicted on detailed maps of the San Francisco Bay area.

This study represents the first comprehensive analytical attempt to estimate beforehand what may be expected to happen in the event of a major disaster. It offers a reasoned and calculated basis for disaster preparedness planning, which heretofore has been largely based on relatively gross estimates and characterized by generalities.

Plan for Response. While the earthquake study proceeds to develop the basis, an Outline Plan for Federal Response has been issued for detailed planning by Federal, State, and local governments. It includes planning assignments for 28 Federal agencies and covers 32 emergency functions.

The objective of the plan is to ensure a comprehensive preparedness and rapid response at the disaster area in order to minimize loss of life and initiate prompt recovery efforts. The planning assumes that (1) the earthquake would occur without warning, (2) the extent of casualties and damage would be greater than that

experienced in any previous disaster in the United States, (3) a major disaster under PL 91-606 would be declared, and (4) massive Federal assistance would be required and forthcoming immediately.

(The planning responsibilities include all conceivable activity involved in preparing for emergency operations: search and rescue, evacuation, mass shelter, feeding and food distribution, damage and safety assessment and posting, emergency transportation and traffic control, fire suppression and prevention, emergency utilities, scientific evaluation, volunteer services coordination, disaster loans, public facility restoration.)

Disaster Evaluation

Actual earthquakes are the real, albeit unwanted, laboratories for developing new and improved preparedness procedures. The lessons learned from past earthquakes have the advantage of realism that hypothetical situations do not. A joint panel of the National Academy of Sciences-National Academy of Engineering in its post-disaster analyses of the San Fernando event found that:

(Some of the earthquake losses can and will be restored in the near future; others, such as transportation disruption, severe damage to public utilities and facilities, and serious lowering of water-storage capacity, will take longer; and some losses can never be regained. These effects will force stricter earthquake preparedness measures in the Los Angeles area—and, we may hope, in other areas as well—as it is now clear that better preparation could have been made.¹⁶

Other analyses and evaluations of the San Fernando earthquake established important lessons for preparedness planning.

Medical Aspects. An OEP evaluation team with representatives of HEW and VA found that the existence of a hospital communication net was most valuable in providing medical care to the victims. Much of the confusion and misallocation of resources common in past emergencies did not occur. Patients were smoothly transferred from damaged hospitals to undamaged ones. Hospitals closest to the disaster area were not saturated with victims, as a central command post directed ambulance drivers where to take individuals, depending on the types of injuries. However, it was also found that:

Had the lack of (1) emergency medical communications in the public sector, (2) predisaster planning, (3) organizations, and (4) definition of lines of medical authority and responsibility, which prevailed in this quake, been coupled with the circumstances of a similar quake occurring at a more vulnerable hour and with an epicenter closer to the densely developed center of Los Angeles, utter disaster would have very probably been the result.¹⁷

III. DISASTER PROTECTION—F. EARTHQUAKES

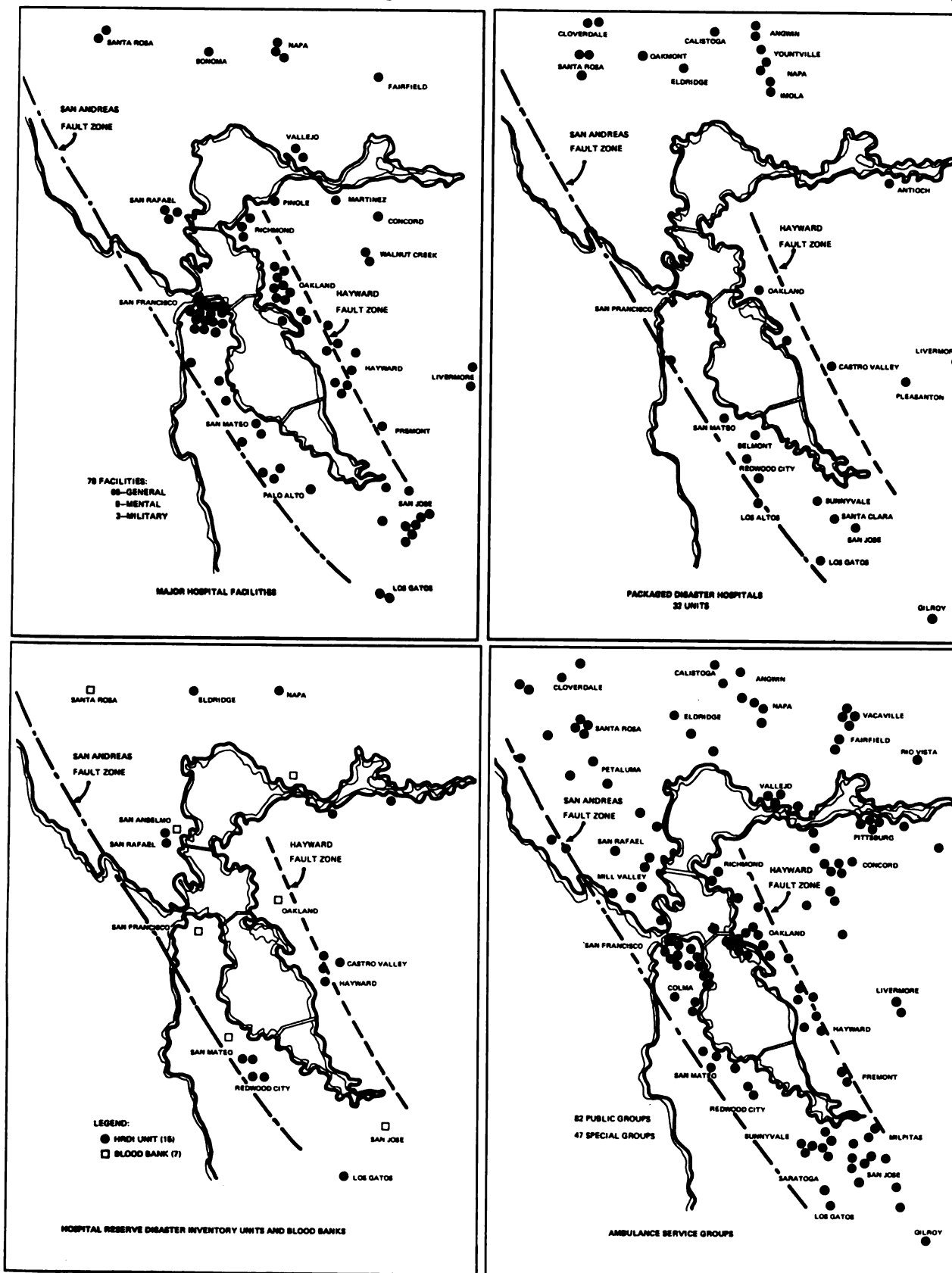


Figure 4.—Hospital Facilities, San Andreas and Hayward Fault Zones.

Evacuation. An OEP evaluation team with representatives of NOAA found that the evacuation of approximately 80,000 people living below the Van Norman Dam was executed in a timely and efficient manner. Some delay was experienced in ordering the evacuation; however, once the order was given, the movement out of the area was accomplished efficiently. In particular, it was found that the obligatory evacuation authority in Section 409.5 of the California Penal Code "is a beacon for all those States which do not have such authority to clear disaster areas. Such legislation should be enacted by any State that may ever face an evacuation situation; it is a must for any jurisdiction whose disaster planning is anything more than a pretense."¹⁸ The *Example State Disaster Act of 1972* contains such a provision.

Search and Rescue. Other evaluation reports of the San Fernando disaster, including one by the Los Angeles County Commission, found that search and rescue operations for disaster victims could be improved. The rescue activity, particularly searching the rubble for buried bodies, could have been more efficient.

A similar situation was noted after the 1964 Alaska earthquake. The recent International Meeting on Earthquakes in San Francisco recommended that nations with seismic problems develop and test new search and rescue techniques, since one of the most crucial determinants in saving lives after an earthquake is the speed with which the people trapped in the debris are provided medical assistance. U.S. cities in the highest seismic risk zones should be better prepared to implement extensive search and rescue operations.

Essential Facilities. This earthquake again illustrated the importance of the existence of emergency facilities and "backup" systems to provide services in the immediate aftermath of the disaster. Fortunately, most facilities and systems continued to function or were soon restored. Command and control of emergency operations were effected without too much difficulty. However, the collapse of several highway overpasses had a limited effect on transportation. The damage to the Sylmar Converter Station did result in the loss of electric power in some areas, and the subsequent fires in Newhall did strain the capabilities of the local firefighting agencies. It is clear that a more severe earthquake would have resulted in more loss of life and property, because sufficient emergency facilities and systems did not exist.

Intergovernmental Coordination. The San Fernando earthquake illustrated the importance of intergovernmental planning. The problem of coordination will be solved only by better cooperative planning, training, and public education on the part of all governments. The OEP earthquake planning for the San Francisco Bay area is a major step forward in this regard. The maps being developed illustrate the interdependency of the nine Bay

counties with respect to water, power, gas, transportation, medical, and other services. For the area to provide emergency services in the event of a serious disaster, comprehensive metropolitan planning for these and other factors will be needed.

This multijurisdictional cooperation in planning for and responding to disaster is highlighted in the Council of State Governments' recommendations on this subject (see Part VII of this report, in Volume Two). Also, Part V, Chapter B has a further discussion of the value of prompt on-the-scene evaluation and postdisaster critiques to improve disaster preparedness.

In its detailed evaluation, the Los Angeles County Earthquake Commission found that "the local, State and Federal agencies that were involved conducted their emergency activities independently of each other at a time when team effort or coordination would have been mutually helpful. This was evidenced by the almost total lack of communication among the agencies."¹⁹ As a result of its investigation, the Commission made several recommendations, including:

- Local governments should establish emergency operating centers in the event of a serious disaster.
- Local governments should ensure the existence of emergency communication for any foreseeable contingency.
- Local governments should evaluate and update plans, procedures, and preparedness measures.
- Provisions should be made to improve interjurisdictional coordination in future disasters.
- Officials should develop a countywide emergency transportation plan.
- A study should be undertaken to ascertain the best disaster communications systems.

In addition to these pertinent recommendations, the report provides a clear description of what problems a metropolitan area could experience as a result of a severe earthquake.

Findings

1. *The greatest potential for reducing the loss of life and property from earthquakes lies in restricting the use of land in high-risk areas and in imposing appropriate structural-engineering and materials standards upon both new and existing buildings.* The San Fernando earthquake demonstrated the value of the Field Act, since little damage, overall, was sustained by school buildings built to its specifications. However, it was also demonstrated that emergency and other essential facilities, such as hospitals, fire stations, police stations, and power plants, must be built to special safety standards in order to survive seismic disasters.

While primary action in these matters is required of State and local governments, the Federal Government can set an example through its own construction projects and

can make its financial assistance contingent upon State and local action. Also needed is a program to translate seismic risk factors into design standards to make new structures in high-risk areas earthquake resistant and to remove or improve structurally unsafe buildings. The approaches to this problem by the State of California and in the City of Long Beach are examples of a beginning to the solution to this problem.

2. *The greater use of instruments is essential to increasing knowledge, to providing risk maps, and to developing a theory of prediction—and perhaps control—of earthquakes.* In this connection, much can be learned in a general way from the atmospheric sciences, where extensive instrumentation has contributed to our knowledge and ability to predict, and in some instances modify, the weather.

3. *The development of seismic risk maps is an essential first step in hazard reduction and preparedness planning.* In all high-seismic zones, risk mapping of the faults near populated areas is needed in order to develop specific preparedness programs. It is most important that the results of risk mapping be produced in a simplified form for use by local government officials, planners, and engineers.

4. *At this time, the capability does not exist to predict the timing of earthquakes with any significant degree of certainty.* Indeed, the question of whether an earthquake prediction and warning capability can be developed is a point of contention among the experts. Nevertheless, there are some possibilities that deserve further close attention and concerted research and experimentation.

5. *There is a possibility that earthquakes can be controlled.* For example, experiments have shown that it is possible to induce the occurrence of small earthquakes, through the injection of fluids into faults, and thereby release the strain along a fault gradually, rather than letting it build up so that a massive earthquake results when the fault ruptures.

6. *The level of earthquake disaster planning in most areas of high seismic risk is not satisfactory.* A significant exception is in the San Francisco Bay area, where both the California Legislature and the Federal Government are taking important steps. The California Joint Committee on Seismic Safety is expected to produce a seismic safety plan in 4 years. At the Federal level, OEP's Outline Plan for Federal response to a possible earthquake in the San Francisco area and the OEP-NOAA study of what might happen in the event of an earthquake in that area will be prototypes for similar steps toward improving disaster preparedness. This combined vulnerability analysis and comprehensive planning by the Federal Government could also be a forerunner to State disaster planning envisioned in Section 206 of PL 91-606.

7. *The potential catastrophe of a major earthquake in a metropolitan area poses unique protection requirements.* In order to ensure the continued availability of vital utilities and services for recovery from the effects of an earthquake, several options should be analyzed: (1) feasibility of better protection for such services and facilities and their locations, (2) to the degree possible, relocation to less-vulnerable perimeter areas, and (3) development of backup systems. The studies mentioned above should be useful in this regard.

8. *Public awareness of the threat posed by earthquakes is essential to success in preparing for them and moderating their destructive effects.* Every possible means should be used to create and maintain this awareness: including coverage by the news media; the distribution in simple, convenient form of facts about earthquake hazards and emergency response check lists; and orientation and training sessions.

9. *The capability to mount effective search and rescue operations in an earthquake disaster is marginal.* As evident from the San Fernando case, there is a need for readily available special equipment and special procedures to locate and extricate buried persons.

Notes

¹Committee on the Alaska Earthquake of the Division of Earth Sciences, National Research Council, *The Great Alaska Earthquake of 1964, Human Ecology* (Washington, D.C.: National Academy of Sciences, 1970), p. 17.

²*Report of the Los Angeles County Earthquake Commission, San Fernando Earthquake, February 9, 1971* (Los Angeles, November 1971).

³Testimony of Dr. Clarence R. Allen, Professor of Geology and Geophysics, Seismological Laboratory, California Institute of Technology, in U.S. Senate, *Governmental Response to the California Earthquake Disaster of February 1971*, Hearings

before the Committee on Public Works, San Fernando, Calif., 92d Cong., 1st Sess., 1971, pp. 562-563.

⁴C. F. Richter, "Earthquake Disasters—An International Problem," paper presented at the International Meeting on Earthquakes, San Francisco, May 1971; contained in the *Conference Report* (Tab F), NATO Committee on the Challenges of Modern Society.

⁵Proceedings of this conference will be published.

⁶Robert E. Schnabel, "Earthquake Risk Conference," memorandum to the Assistant Director for Disaster Programs, Office of Emergency Preparedness, September 26, 1971.

⁷H. S. Lew, E. V. Leyendecker, and R. D. Dikkers, *Engineering Aspects of the 1971 San Fernando Earthquake*, U.S. Department of Commerce, National Bureau of Standards, Building Science Series 40 (Washington, D.C.: U.S. Government Printing Office, December 1971), p. 311.

⁸See *Report of the Los Angeles County Earthquake Commission, San Fernando Earthquake, February 9, 1971; Governmental Response to the California Earthquake Disaster of February 1971*; and U.S. Department of the Interior and U.S. Department of Commerce, *The San Fernando, California, Earthquake of February 9, 1971*, Geological Survey Professional Paper 733 (Washington, D.C.: U.S. Government Printing Office, 1971).

⁹See: 1) *Earthquake Hazard Reduction*, Report of the Task Force on Earthquake Hazard Reduction, Office of Science and Technology (Washington, D.C.: U.S. Government Printing Office, September 1970); 2) *Proposal for a Ten-Year National Earthquake Hazards Program: A Partnership of Science and the Community*, Ad Hoc Interagency Working Group for Earthquake Research, Federal Council for Science and Technology (Washington, D.C., December 1968); and 3) Ad Hoc Panel on Earthquake Prediction, *Earthquake Prediction: A Proposal for a 10 Year Program of Research*, prepared for the Office of Science and Technology, May 1965.

¹⁰L. C. Pakiser et al., "Earthquake Prediction and Control," *Science*, Vol. 166 (December 1969), p. 1470. Also, "Report on Reservoir Loading," National Science Foundation, Committee on Seismology (in preparation).

¹¹This recent underground explosion, Cannikin, was detonated on November 6, 1971, in an enclosure one mile beneath the surface and had a magnitude of 7.0 on the Richter Scale.

¹²*Governmental Response to the California Earthquake Disaster of February 1971*, pp. 566, 640, 643-644.

¹³Richter, *op. cit.*, p. F.3.

¹⁴George O. Gates, "Earthquake Hazards," *Geologic Hazards and Public Problems*, Conference Proceedings, May 27-28, 1969, Office of Emergency Preparedness, Region 7, Santa Rosa, California, p. 25.

¹⁵This is a simplified description of the methodology used by Karl Steinbrugge and S. T. Algermissen, who are conducting the investigations leading to the preparation of a study report.

¹⁶The Joint Panel on the San Fernando Earthquake, *The San Fernando Earthquake of February 9, 1971: Lessons from a Moderate Earthquake on the Fringe of a Densely Populated Region* (Washington, D.C.: National Academy of Sciences-National Academy of Engineering, 1971), pp. 1, 3.

¹⁷August H. Groeschel, "Study of the Medical Aspects of the Los Angeles Earthquake," memorandum to the Director, Office of Emergency Preparedness, February 22, 1971.

¹⁸Timothy A. Vanderver, Jr., Jack A. Riley, and Charles Conway, "The Van Norman Dam Evacuation," report to the Office of Emergency Preparedness, Washington, D.C., March 1971, p. 16.

¹⁹*Report of the Los Angeles County Earthquake Commission, San Fernando Earthquake, February 9, 1971*, p. 21.

Chapter G. Landslides

Introduction

Landslides are a perennial problem for mountainous areas, especially in seismic regions. (As mountainous areas in the United States become more populated and are used more for highways and other structures, the danger from landslides will increase.) Landslides triggered by earthquakes have the potential for serious and extensive destruction. This was shown in the Madison Canyon, Montana, slide of 1959, a secondary effect of the Hebgen Lake earthquake, and in the Turnagain Arm area of Anchorage during the 1964 Alaska earthquake. In the latter instance, the largest of five major slides resulting from the Alaska quake, a complete subdivision was seriously damaged when the ground gave way in a concave pattern along 4,300 feet of the choicest property.¹ Other metropolitan areas are increasingly vulnerable to landslide activity where buildings are erected on water-soaked landfill or unstable slopes.

(It is estimated that the direct and indirect costs of landslides to the United States run to the hundreds of millions of dollars each year in damage to highways, railroads, industrial installations, public works, and personal property.²)

Landslides can be categorized in several ways, the most basic distinction being falls, slides (including avalanches and slumps), and flows. Landslides may be initiated by erosion, heavy rain or snow accumulation, or a combination of these factors. As indicated above, they also may be triggered by an earthquake.

Falls consist of loosened material breaking clear and moving to a lower level without seriously disturbing the surface between. Slides involve a downward movement of an entire section of a slope due to subsurface shearing; material may move as a unit—slumping—or may break up into small units—avalanching. Flows may be dry or wet, but their movement is characterized by plasticity, which permits them to spread outward over wider areas and to move greater distances than other types of landslides. They often involve greater masses of material and continue downhill far beyond the base of the slope from which they originated. Many of history's most destructive landslides have been flows.

Landslides in mountainous areas usually take the form of falls and avalanches. In areas of gentle slopes, where water content is high, the slump is more prevalent. This type is usually more destructive of property because of

the greater degree of urbanization in these areas. Flows are frequently secondary effects of an earthquake. In these instances water-soaked soils, consisting predominantly of fine particles, become unstable and flow downslope or lose their bearing capacity, allowing structures built on them to sink with minimum lateral movement. (Refer to Part VIII, Chapter G, in Volume Three, for further discussion and illustrations.)

Detection, prevention, and control of landslides begin with delineation of the geologic factors that influence them. These are generally well known. Next is the application of these factors to the terrain and rock formations of a given area, from which conclusions can be drawn regarding landslide potential. This process involves detailed mapping and field and laboratory investigation. When potentially hazardous conditions (e.g., ground water erosion and slope instability) are identified, preventive measures can be taken. These involve proper site preparation—through drainage, removal of overburdened material, and safe grading of slopes—and, where possible, limitations on construction, especially of homes and other habitable buildings.

These control measures are becoming more common and are effective in reducing the incidence of landslides. However, more field and laboratory work is needed on the causes and mechanics of landslides and on soil and rock slope stability before it will be possible to predict with more precision the time, place, and extent of landslide activity.

Since the prediction of landslides resulting from earthquakes is particularly difficult and preparedness measures are therefore less meaningful, most of the effort to prevent and control landslides in the United States is in areas where the natural stability of the earth has been altered by excavation, or by the loss of natural holding forces such as grass and brush, or where the instability of the natural terrain poses a threat to engineered construction such as highways, railroads, and viaducts.

Federal and State Programs

The Federal program of mapping landslide risk areas is accomplished by the U.S. Geological Survey. Information recorded on these risk maps ranges from a general identification of features and degree of activity to detailed analysis of the geologic factors affecting the

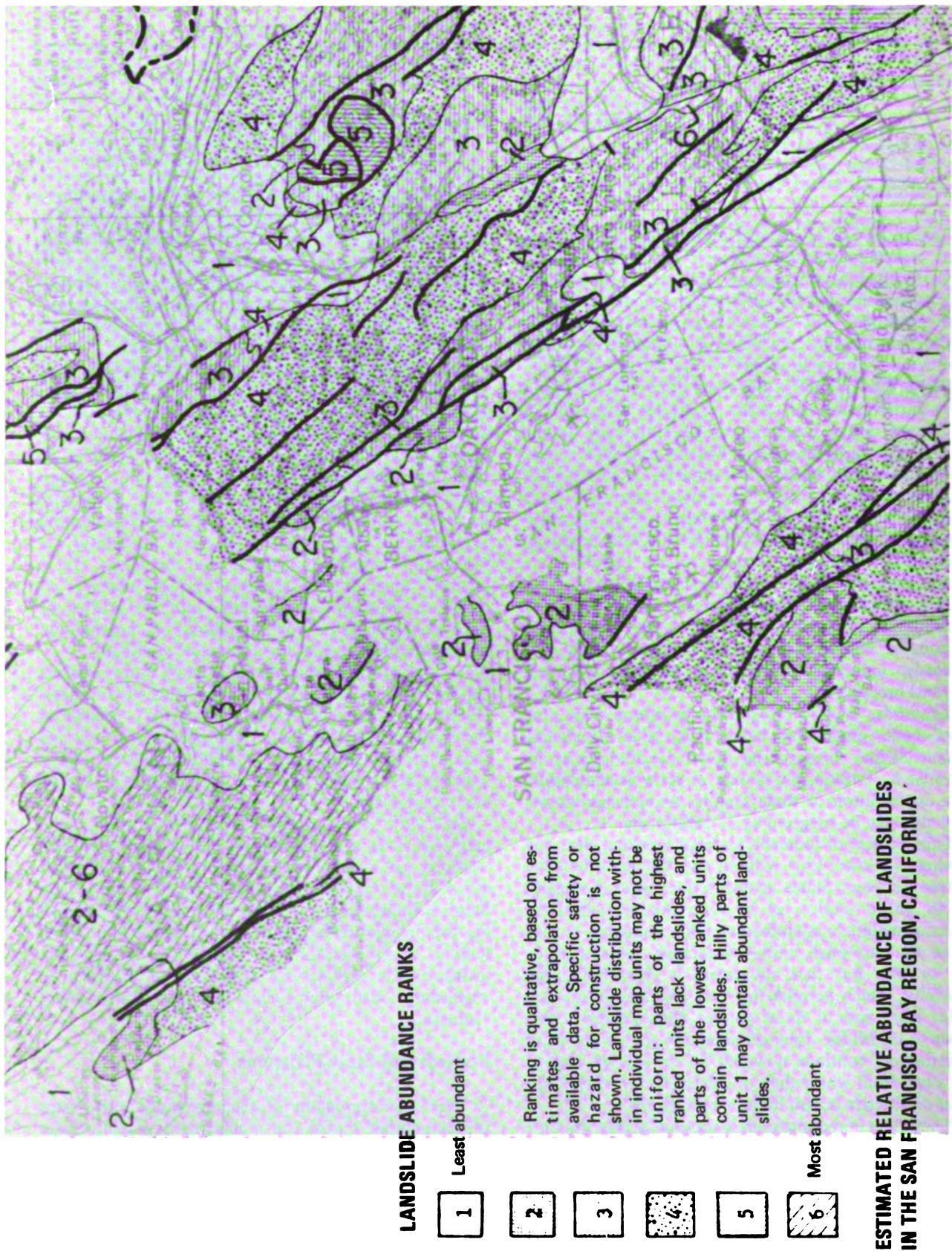


Figure 1.—Section of Landslide Risk Map of California—U.S. Geological Survey.

mass movements of soil and rock. Although the sum total of the acquired data is very large, there has been no systematic analysis of landslide phenomena on a national scale. However, for many local areas throughout the country where particularly hazardous slide conditions exist, concerted efforts have been made to study the problem in detail and give attention to minimizing the effects. (The map of San Francisco Bay Area in Figure 1 is an example of such analysis.)

Direct engineering applications to the landslide problem are made frequently by the Federal Highway Administration in the Department of Transportation. However, there are no standard design criteria for the prevention of damage to highway facilities from earthslides. Highway slopes in indigenous soils are designed for stability on the basis of past experience or, in critical locations, on the results of engineering analyses. A minimum safety factor (available resisting forces divided by driving forces) has been adopted. The majority of highway slopes have a factor of safety much greater than the prescribed minimum. Highways in high seismicity areas are an exception. In these instances, the usual procedure is to analyze the slope and include an estimate of the expected maximum driving force to be exerted on the slope by an earthquake.

The USDA Soil Conservation Service, through the National Cooperative Soil Survey program, includes in the soil surveys the names, locations, and past evidences of soils having a high susceptibility to landslides. USDA also furnishes technical assistance to landowners and local governments, advising on land use and soil and water management so as to minimize landslides where susceptibility to such hazards exists. Use of USDA soil surveys by city and county planners, zoning officials, architects, and engineers is expanding rapidly over the one-third of the privately owned land for which the soil surveys are now complete.

California leads in State activities to protect against landslides. Through its Division of Mines and Geology, California has a program consisting of five projects funded by State and county agencies and two projects funded wholly by the State. The objective of these projects is the delineation of slide-prone areas.

Additionally, the Division of Mines and Geology is doing a long-term study of landsliding in coastal regions of California to identify slide mechanisms as well as slide-prone areas. During 1970-71, 23 counties were surveyed for this type of hazard. A special project for 1971 involved the mapping by aerial photography of the extensive landslides caused by the San Fernando earthquake of February 9, 1971. These maps are being used for determining postquake ground stabilities in that area.

No other States have instituted separate programs dealing with landslide hazards. In most cases they are relying on cooperation in the programs of Federal agencies to meet their needs.

Landslide Monitoring

Visual surveillance by highway maintenance crews and by forest rangers is the present method of monitoring potential slide areas. Unfavorable soil conditions and preliminary bulging and spalling are indicators of the need for warning and remedial action.

Although there are no systematic programs, instrumental surveillance is feasible and is used in areas with structures such as reservoirs, viaducts, highways, railroads and hydroelectric plants. In these instances, seismic tiltmeters and creep meters are employed to monitor slow deformation. Rainfall, temperature, and the soil moisture content are also monitored.

A program for predicting snowslides has been successful in the Wasatch Range in Utah. Instruments are used for measuring factors that are likely to produce snowslide conditions, such as wind, temperature, precipitation, snow stability, and slope stability. When the combination of these factors indicates an avalanche is imminent, artillery is used to dislodge small slides and thus reduce the danger of a large destructive slide.

Except for these situations, and in cases of long-term slumping where the onset can be recognized and proper warning and preventive measures instituted, current technology can provide only an alert to landslide dangers. It can provide little information as to the time a landslide will occur. Early warning of the majority of landslides is, therefore, not feasible.

Landslide Avoidance and Mitigation

Several actions may be taken to avert landslides or to mitigate the damage in the event a slide does occur.

The susceptibility to slides of any parcel of land on which a facility is to be located must be determined accurately. On highly susceptible land, appropriate zoning laws and other building limitations can be used to control the location and type of construction. The laying of rights-of-way for dams, bridge abutments, and watersheds can be done with special consideration of the landslide characteristics of the area.

If unavoidable landslide risks must be taken, good engineering and construction practices can do much to reduce danger. These include removal of unstable materials; selection of a safe slope factor in excavation; provision for both surface drainage and subdrainage between the overburdened material and bedrock; installation of retaining walls, bulkheads, pilings, and tie rods; and proper final grading and landscaping for soil retention.

Many of these methods are used in combination. Before a road embankment is constructed, for example, the unstable material should be removed and firm material shaped for drainage and restraining contours. Cut slopes constructed with benches or berms are preferable to a uniform slope. If studies confirm

sufficient stability, a horizontal surface drain can be placed at the foot of each embankment in the terraced series, as further insurance against possible slides.

In addition, known slide hazards can be mitigated through such actions as leaving probable slide paths as open parkland, thereby reducing the danger to structures. Also, if highways, railways, or aqueducts must traverse unstable areas where control of earth slumps is not possible, such areas can be bridged, so that any movement can continue without disturbing the artery. Such bridging, however, would probably add substantially to cost.

Emergency Measures

The usual emergency measures necessary for evacuating endangered people and caring for the evacuees apply to landslide preparedness in the relatively rare instances when warning is possible. Especially necessary is equipment for earthmoving and for clearing and repairing highways and railroad rights-of-way

Findings

1. *Landslides do not represent a major danger to life or loss of property in the United States, except when they occur as secondary effects of earthquakes.* Landslide-vulnerable areas are being identified through various Federal and State programs, with more concentrated effort going into areas where highways, railroads, reservoirs, and other extensive structures are located. In these cases, measures can be taken to mitigate the effects of landslides or even to avoid them, but predicting the

precise timing of occurrence is not feasible. *Additional basic information is needed from field and laboratory research on the causes and mechanics of landslides. This, in turn, could assist in predicting the time of their occurrence.*

2. *The existing landslide data have not been systematically analyzed to provide a national picture.* However, in areas such as parts of California, where particularly hazardous slide conditions exist, the problem has been studied in detail and steps have been taken to minimize the effects. *Land-use and construction regulations are potential means to further moderate the adverse effects of landslides.*

3. *Consideration should be given to expanding the landslide program of the U.S. Geological Survey, in conjunction with other Federal and State agencies, to encompass:*

- Increased effort to identify and classify existing and potential landslide areas throughout the United States;
- Expansion of soil- and rock-mechanics research to develop information on the various basic types of landslides;
- Studies of elements which trigger landslides, such as earthquakes, blasting, change in hydrologic conditions, and heavy storms;
- Development of criteria for proper design methods and construction techniques to cope with landslide problems;
- Establishment of a central source of landslide information nationally.

Notes

¹Committee on the Alaska Earthquake of the Division of Earth Sciences, National Research Council, *The Great Alaska Earthquake of 1964, Human Ecology* (Washington, D.C.: National Academy of Sciences, 1970), p. 253.

²Department of Commerce, National Oceanic and Atmospheric Administration.

Chapter H. Tsunamis

Introduction

Tsunamis are great sea waves caused by submarine earth movement (earthquake or volcanic eruption). They are unique phenomena that pose difficult preparedness problems. Tsunamis travel great distances and at speeds in excess of 600 miles per hour in the open sea, but are virtually undetectable in deep water, where they may have amplitudes of only a foot. When the waves enter shallow water near the coastlines, they are slowed to less than 40 miles per hour. There, much of their energy is converted to building walls of water that can reach heights of 100 feet or greater before they strike the coast with devastating force.

While extremely destructive, tsunamis are relatively rare phenomena and are generally confined to the Pacific Ocean basin. Only one out of 15 earthquakes with the potential for tsunami generation actually produces the great waves. Since 1900, 181 tsunamis have been recorded in the Pacific; 34 caused damage near the epicenter source, and nine were destructive both locally and distantly. Since 1946, the United States and its possessions have experienced a major tsunami only every 7 to 8 years. Because tsunamis are infrequent and random, it is difficult to keep all potentially vulnerable areas alert to the dangers. Meanwhile, it is necessary to keep detection and warning systems functioning at an optimum level.

Tsunami warning and preparedness require: (1) an instrumented network to monitor seismic activity and to detect tsunamis, (2) a complex procedure of calculating the arrival times of the great waves, (3) a smoothly functioning communication system for gathering information and disseminating watches and warnings, (4) local centers from which the warning can be relayed to the public, and (5) detailed emergency plans for the protection of property and the evacuation of endangered areas.

The basis for determining a tsunami warning is the difference between the speed of seismic waves (vibration within the earth) and the speed of tsunamis in deep water. Seismic waves traverse the entire globe in 20 minutes, while tsunamis, even at 600 miles per hour, require 23-24 hours to traverse the Pacific.

The time span between warning and arrival of the great waves falls into three general categories.

- Points on the periphery of the Pacific Ocean basin can expect 12 to 20 hours of warning when the waves originate on the opposite side of the Pacific.
- Central Pacific locations, such as the Hawaiian Islands, usually can count on 2 to 12 hours between warning and impact, depending on the origin of the waves.
- Communities in the epicentral area where the tsunami is generated, however, must consider the earthquake itself as a warning.

In addition to their rarity, and the prediction and warning problems that this poses, there is another characteristic of tsunamis that makes warning even more difficult: once they are detected, it is impossible to predict wave heights for any point along the shores.

To compensate partially for this uncertainty, an internationally accepted standard has been developed that defines endangered areas on the Pacific Shores as those with elevations less than 50 feet above mean sea level for distantly generated tsunamis and less than 100 feet for those generated locally. This approach is much too broad but must be used in the absence of more definitive knowledge.

Historically, variations in wave height have been remarkable, even at points relatively close to each other. In addition, spectacular waves have occurred which exceeded 100 feet. In Lituya Bay, Alaska, in 1958 an earthquake caused an extensive landslide that in turn caused a local wave that attained a height of more than 1,700 feet but dissipated quickly when it entered the open ocean.¹ (This extraordinary event was thus only indirectly earthquake generated.) A wave at Scotch Cap, over 200 miles from the epicenter of a 1946 Aleutian Islands earthquake, reached at least 110 feet.² These are extreme cases. More often, the arriving waves have less amplitude than expected, and precautionary measures, if taken, are viewed as unnecessary effort and expense. This is because accurate wave height information and the exact delineation of threatened areas cannot be provided.

Existing Programs

Organizational Arrangements. The National Oceanic and Atmospheric Administration and its predecessors have operated the Tsunami Warning System (TWS) as a national system since 1948 (under authority of Public

Law 80-373, August 1947). The service began to take form after the 1946 earthquake in the Aleutian Islands, when seismologists of the Coast and Geodetic Survey (now the National Ocean Survey) recognized that the seismograph stations and tide stations of the Pacific area could be improved and augmented to provide a tsunami warning system. A Tsunami Communication Plan was developed as a necessary extension of the detection and warning aspects of the system.³ This plan designated primary and secondary communications channels to each local center in the system, set standard message formats, and designated the responsible officials and an alternate for each area.

The Alaskan Regional Tsunami System, directed from the Palmer, Alaska, Observatory, was established in 1967. Its function is to detect and locate major earthquakes in the Aleutian-Alaskan region and provide resulting tsunami information and warnings to people in that region.

For accurate location of earthquakes and rapid detection of tsunamis, an extensive network of stations throughout the Pacific is required. Therefore, international cooperation has been vital to the successful operation of the warning system. This cooperation has been furthered by UNESCO's Intergovernmental Oceanographic Commission (IOC), which brought together earth and oceanographic scientists of 11 countries to give international status to the Tsunami Warning System and to establish an International Tsunami Information Center (ITIC) at Honolulu. This center ensures dissemination of tsunami warnings, collects tsunami data on a real-time basis, encourages tsunami research, and promotes the exchange of scientific and technical personnel and information among the participating nations.

Procedures. The detection network of the present Tsunami Warning System is composed of 22 seismograph stations and 47 tide stations in 16 countries on the shores and islands of the Pacific Ocean (Figure 1). Sensors at these stations continuously monitor the seismic activity and sea level.

The publication *Communication Plan for the Tsunami Warning System*⁴ outlines procedures and designates primary and alternate communication channels between the Tsunami Warning Center (TWC) at the Honolulu Observatory and each sensing station and dissemination agency in the system.

Within a few minutes after an earthquake occurs, seismologists analyze seismograms and report information to the TWC, where the location and magnitude of the earthquake are determined. If a possible tsunami is indicated, a "tsunami watch" is established and tide stations, outward from the epicenter, are queried for confirming water-wave recordings. When positive wave action is reported by a tide station, the Honolulu center issues a "tsunami warning," which includes any reported

wave heights and the expected times of arrival for threatened areas.

While it is difficult to evaluate the warning program in terms of lives and dollars saved, it is a fact that since the program's inception no tsunami has struck a distant coastline that did not receive a warning. The accuracy of wave prediction, the timelines of the warning, and the reaction of the populace have varied widely. Since the program began in 1948, there have been 21 warnings; 17 were followed by heavy waves striking some portion of the warned area. Four of these tsunamis were destructive over wide areas: in the Kuriles and Kamchatka area in 1952; in Alaska and the Aleutian Islands in 1957; in South America (particularly Chile), Hawaii, and Japan in 1960; in Alaska, California, Oregon, and Washington in 1964.

Facilities. The present geographic coverage provided by the basic components of the tsunami detection network (seismographs, tsunami sensors, and communications) is inadequate in some areas.

Seismographs. Seismographic coverage for South America, the Kuriles-Kamchatka area, the Southwest Pacific, and Mexico is insufficient to ensure receipt of data from sites distributed optimally around points of earthquake origin, where tsunamis are likely to be generated.

Tide Stations. The network of tsunami sensors (tide stations) in Central and South America is only marginally adequate for Pacific-wide warnings and is totally inadequate to provide local warnings in those areas. There are only 11 tide stations along the 6,000 miles of coastline between southern Chile and San Diego, California. There are no participating tide stations in the Kuriles-Kamchatka area, and only in recent years has modest progress been made in attempts to gain sensor data from the U.S.S.R.

Communications. Tsunami Warning System traffic is sent through the facilities of the Federal Aviation Administration, the Defense Communications Agency, the National Aeronautics and Space Administration (NASA), the National Weather Service, and other government agencies, both domestic and foreign. Figures 2 and 3 illustrate the communications circuits used to transmit tsunami information. These circuits are tested each month through the use of "dummy" messages, and a comprehensive evaluation based on these tests is conducted every 3 months by the National Communications System (NCS). Steps are then taken to improve the weak links and the level of reliability. In the evaluation for the period January-June 1971, NCS reported that 83 percent of the tsunami test messages were delivered to addressees in 30 minutes or less (the NOAA objective).

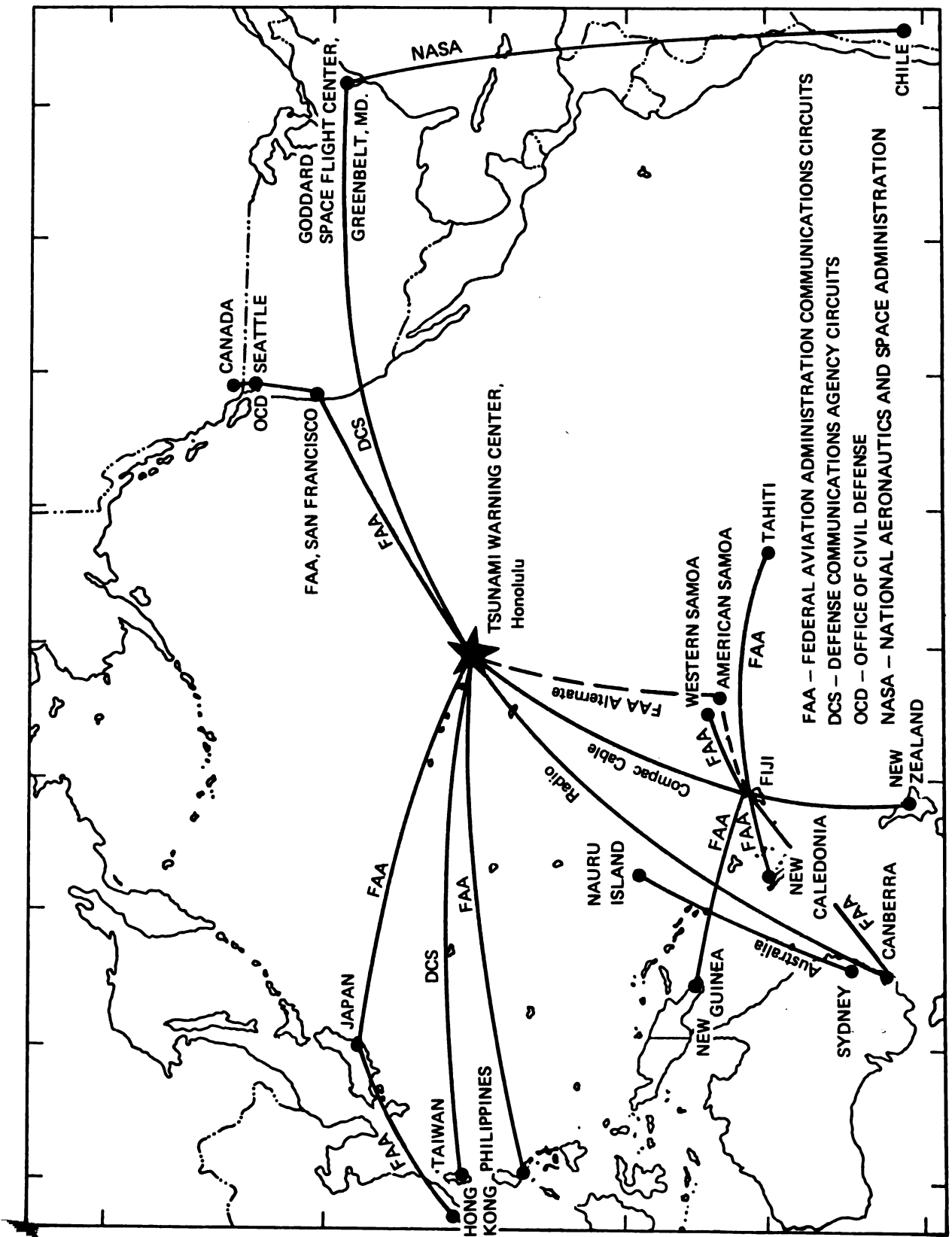


Figure 2.—Communications Circuits Serving Foreign Participants in the Tsunami Warning System—NOAA.

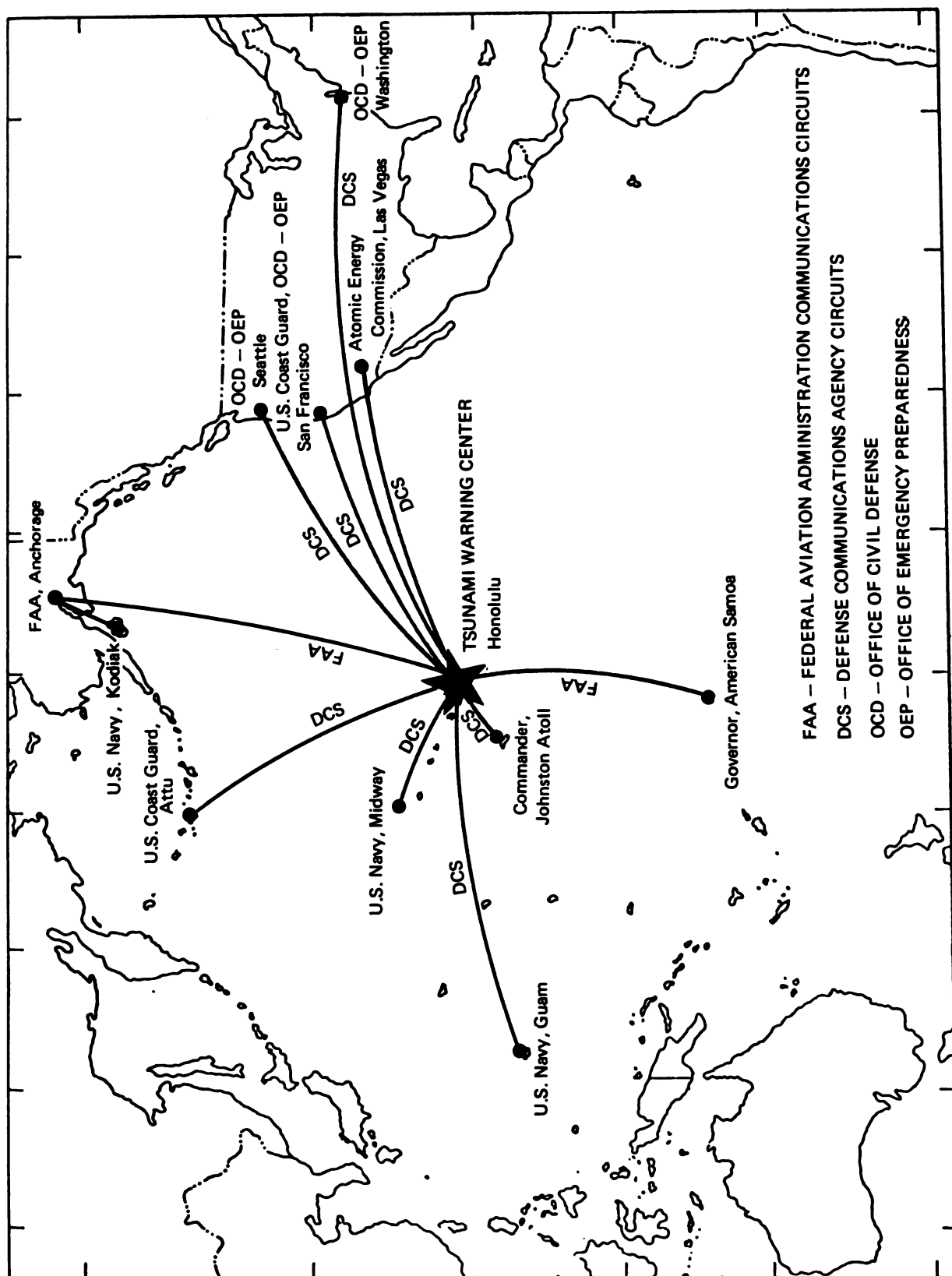


Figure 3.—Communications Circuits Serving United States Participants (excluding NOAA) in the Tsunami Warning System—NOAA.

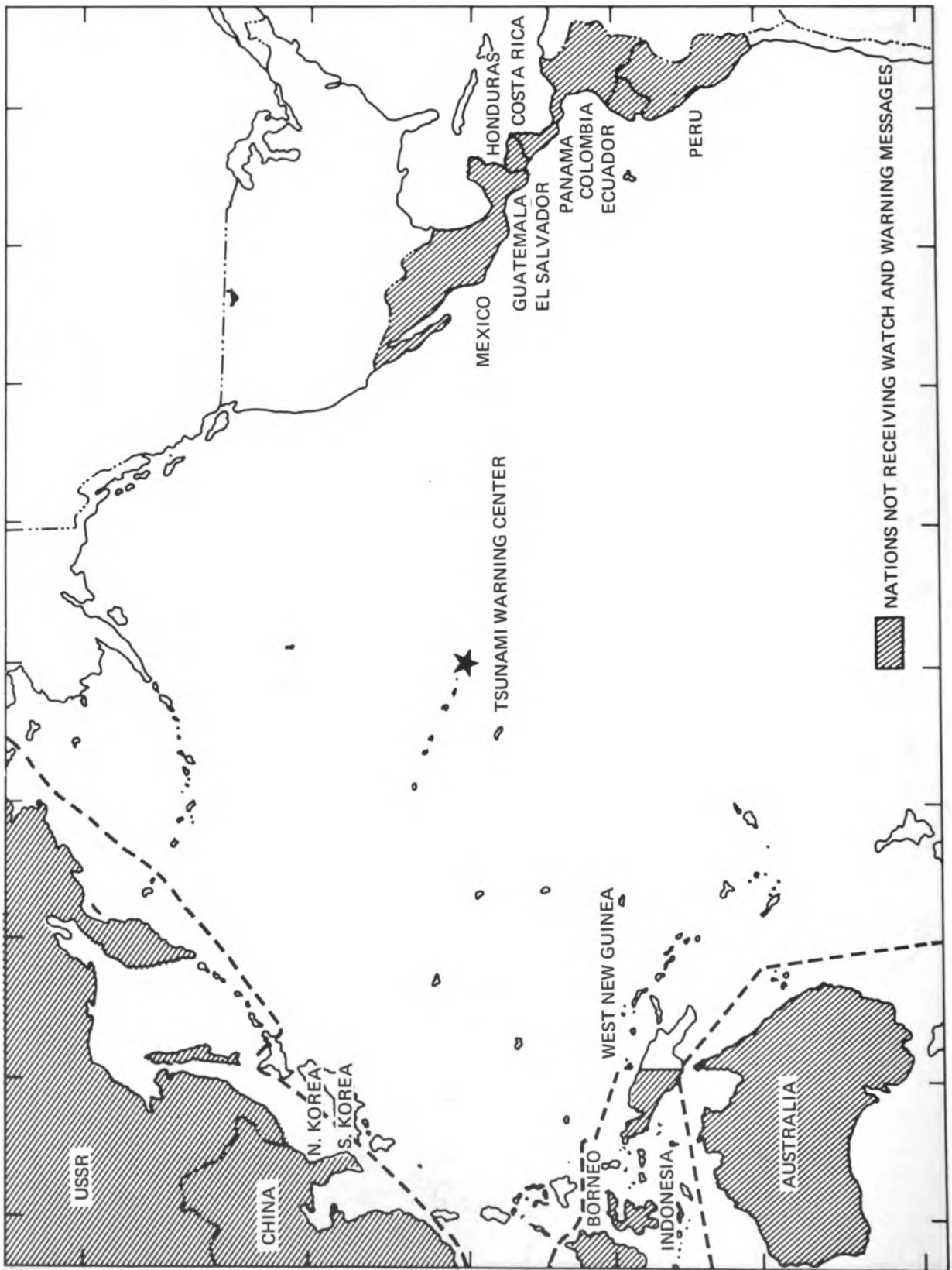


Figure 4.—Nations Bordering on the Pacific Ocean but Not Receiving Tsunami Watch and Warning Messages—NOAA.

This improved upon the 74 percent received within 30 minutes during the period July-December 1970.⁵

There are still 17 nations with shorelines on the Pacific Ocean which do not receive tsunami watch and warning messages (see Figure 4).

Planned Improvements

Detection Network Expansion. NOAA's short-range plans call for the installation of new visual recording seismographs at Port Moresby, Papua; Antofagasta, Chile, and possibly Tacubaya, Mexico. Longer-range plans include a station in southern Chile, possibly at Sombrero, which would provide considerable help in locating earthquakes south of Santiago, and one in the Galapagos Islands, to fill a gap of 4,400 kilometers between Tacubaya, Mexico, and Hauncayo, Peru, and to aid in locating and evaluating South and Central America earthquakes.

Additional tsunami sensing stations are planned for Talara, Peru; Salina Cruz, Mexico; Newport, Oregon; Neah Bay, Washington; Amchitka; the Ryukyu Islands; Davao, Philippines; and Nukualofa, Tonga Islands.

These planned stations would increase the detection network to 28 seismograph stations and 84 tide stations. This would assure warnings, in most instances, of 2-2½ hours following tsunami generation. During this period, the tsunami would have progressed as far as 1,000 miles, so that any Pacific area more distant from the tsunami source could receive timely warning. Data telemetered from the network sensors via satellite, which is also planned and is discussed below, would improve the timeliness of warning up to 90 minutes. The radius of the area which could not be given timely warning would be reduced to approximately 400 miles.

In addition to the geographic expansion of the network, there are plans to modernize or replace many of the instruments now in use. Examples are a specially designed pressure gauge, to be located at sites on the open coast to minimize the effects of local topography, and a deep ocean sensor, which would provide data for evaluating the destructive potential of a tsunami.

Satellite Telemetry. NOAA has plans for the use of the Geostationary Operational Environmental Satellite (GOES) as a data collector and communication relay in

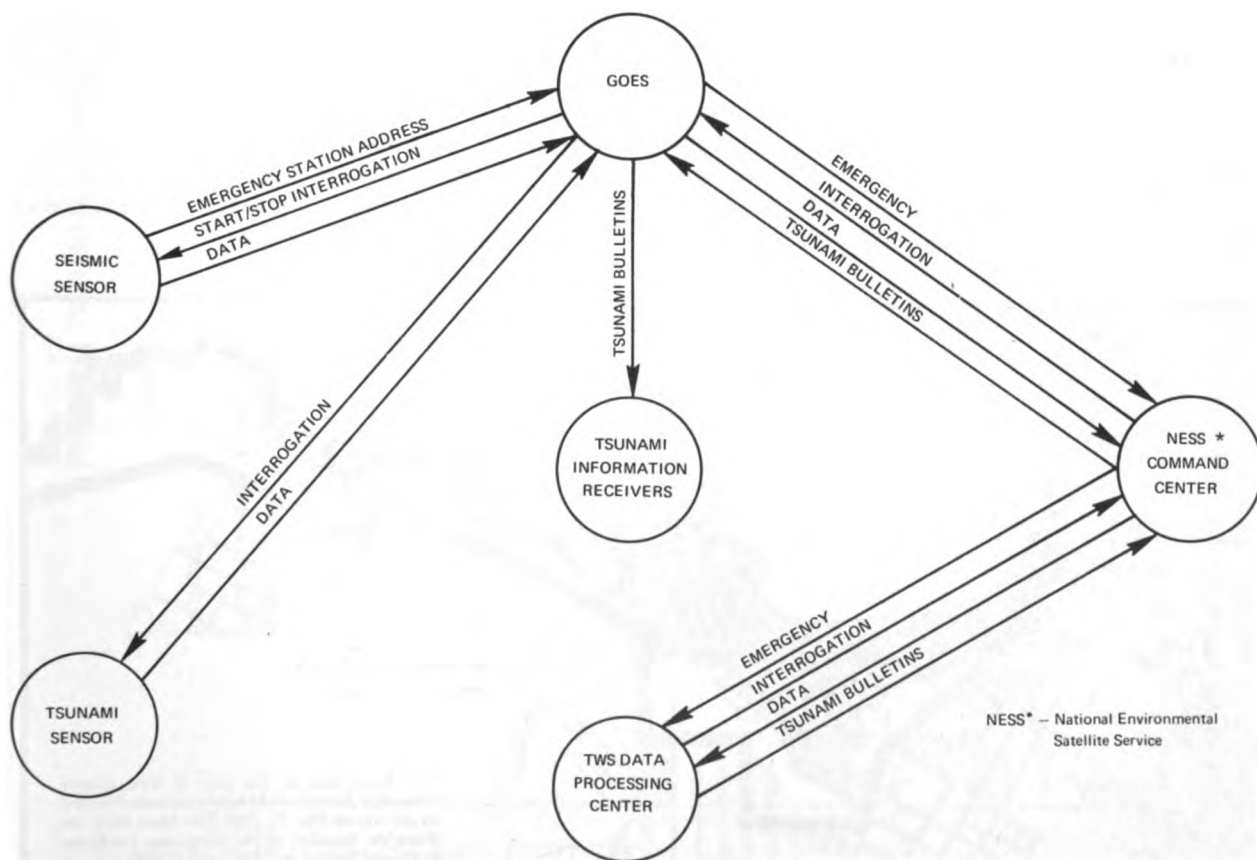


Figure 5.—GOES Operational Schematic, showing how the planned Geostationary Operational Environmental Satellite would serve as the communications and telemetry link in the Tsunami Warning System—NOAA.

the Tsunami Warning System. The first launch of GOES is scheduled for about mid-1972. Its use in the TWS will provide a safe, reliable, low-power vehicle for obtaining seismic and wave-action data, and transmitting these data and warning messages to users and disseminators (Figure 5). As mentioned above, its use will improve the warning time as much as 60 percent.

Other Improvements. Although the West Coast of the United States has experienced only one locally generated tsunami, the seismic history of this area and its tsunami potential should not be ignored. Dense populated areas there cannot be assured of adequate warning from the TWC at Honolulu in the event of a locally generated tsunami. A West Coast Regional Warning System, planned by NOAA and similar to the one at Palmer, Alaska, would fill this void. The warning center would have full responsibility for public releases of tsunami warning information in California, Oregon, and Washington. The system would consist of a network of approximately eight tide stations operating in California, Oregon, and Washington and approximately 12 seismic stations in these States plus Nevada and Arizona. The basic observatories and telemetry for this system are already in existence in the Western States.

Preparedness

Hawaii, California, and Alaska have tsunami communications plans or procedures which are based on the Federal plan⁶ but are extended to include responsible agents in each locality. Message formats are indicated, and State officials are instructed on procedure and told

whom to contact.⁷ These documents do not include items related to evacuation, traffic control, assembly points, mass care, and other emergency operations—matters left to local governments.

Local-level plans have not been developed in many tsunami-vulnerable communities. Two excellent California plans can be cited, however: for Ventura County⁸ and for the unincorporated coastal areas of Orange County.⁹ These plans designate types of action to be carried out by police and fire departments and other organizations. Chains of command, duty stations, available facilities and equipment, and instructions for proper procedures are outlined.

The first step in developing more effective local plans is defining local danger areas. Detailed studies of the shoreline, harbor areas, and bottom configurations in each locality are necessary for accurate determination of areas subject to inundation. Some localities, having experienced tsunamis, have defined vulnerable areas and established safety zones. For example, Figure 6 depicts a safety zone at Hilo Bay, Hawaii, based on a tsunami experience of 1960. In other localities, theoretical calculations have been combined with experience factors to develop criteria for inundation limits. The inundation areas shown in Figures 6 and 7 were developed by using these two sources. Figure 8, which is printed in the Oahu telephone book, serves as a ready reference in the event evacuation of that area is required.

When the danger areas have been determined, methods for protecting lives and property can be instituted. Evacuation routes, emergency access routes, and shelter and relief centers can be established.

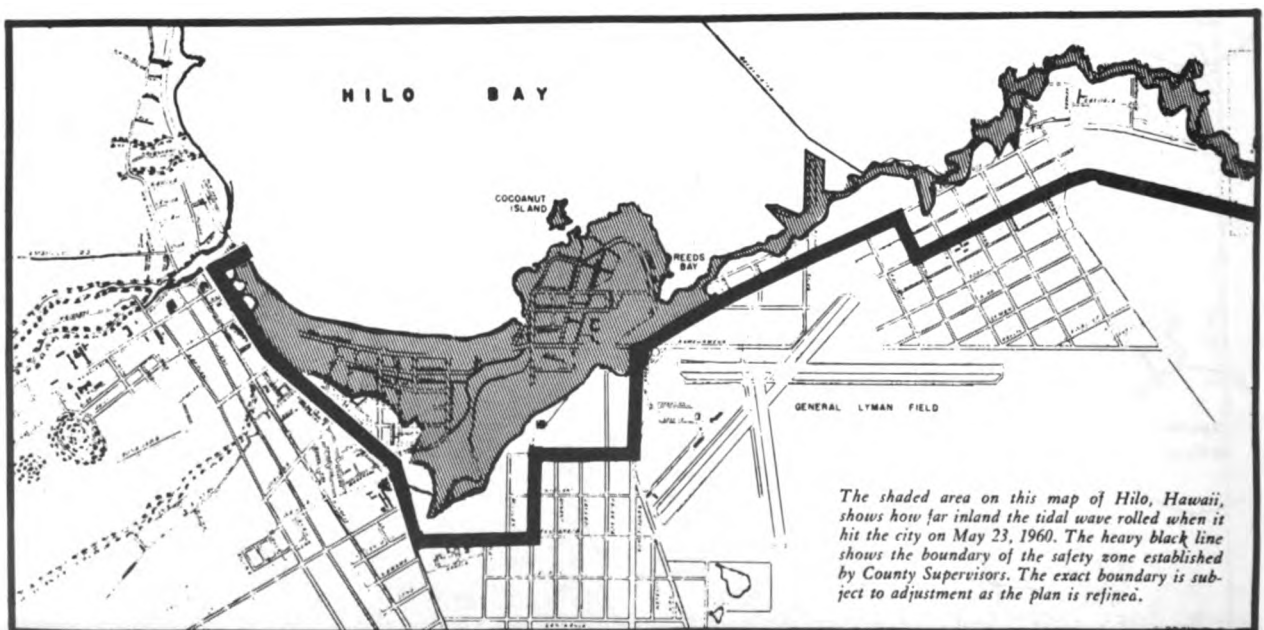


Figure 6.—Hilo, Hawaii, Tsunami of May 23, 1960—Hilo Tribune.

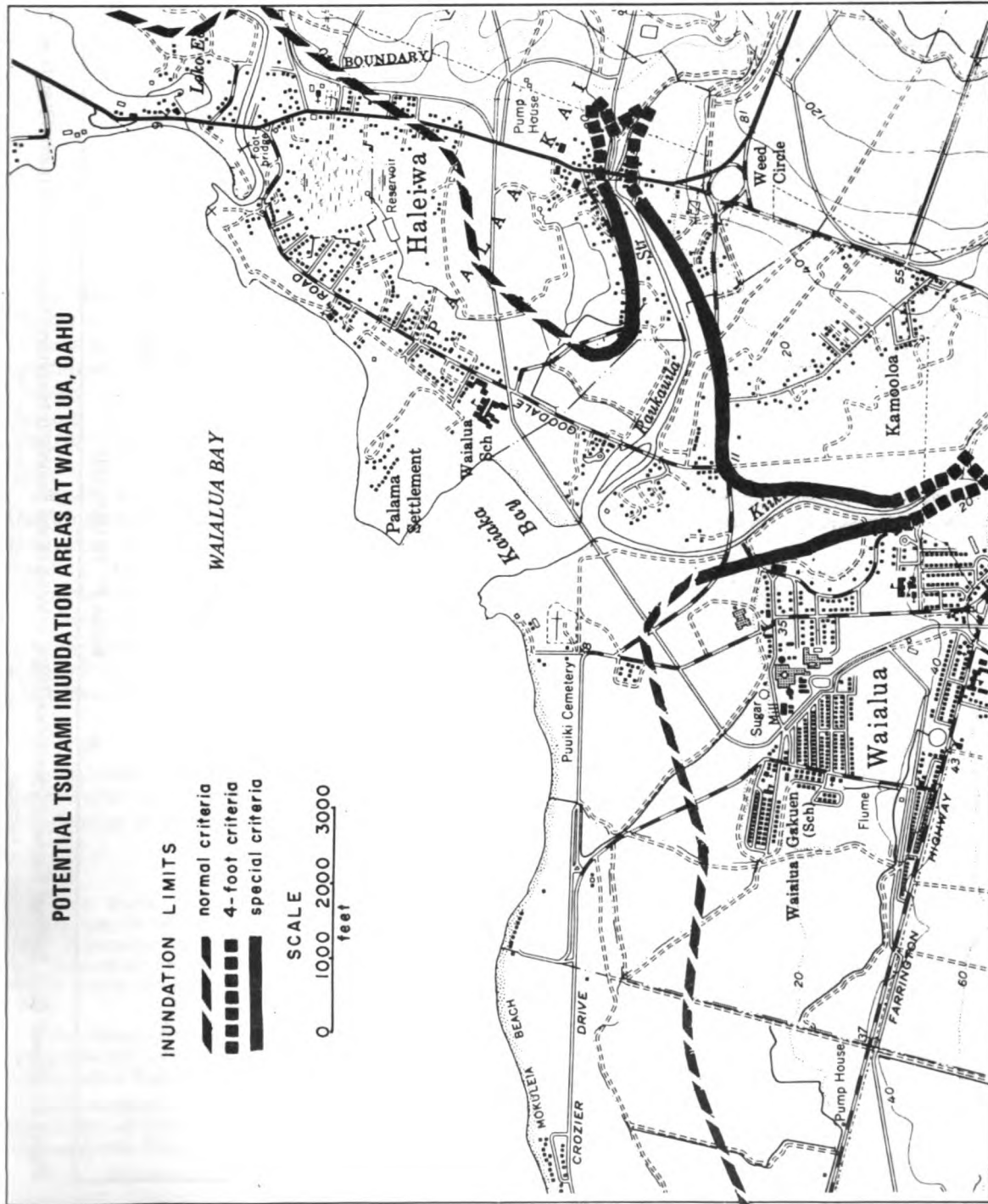


Figure 7.—Potential Tsunami Inundation Areas at Waialua, Oahu. "Normal criteria" establish the runup possible by a 50-foot wave modified by the shore contours. "Four-foot criteria" define inland areas that would be vulnerable to rising waters even though beyond the calculated runup line. "Special criteria" are based on limits of previous tsunami inundations—NOAA.

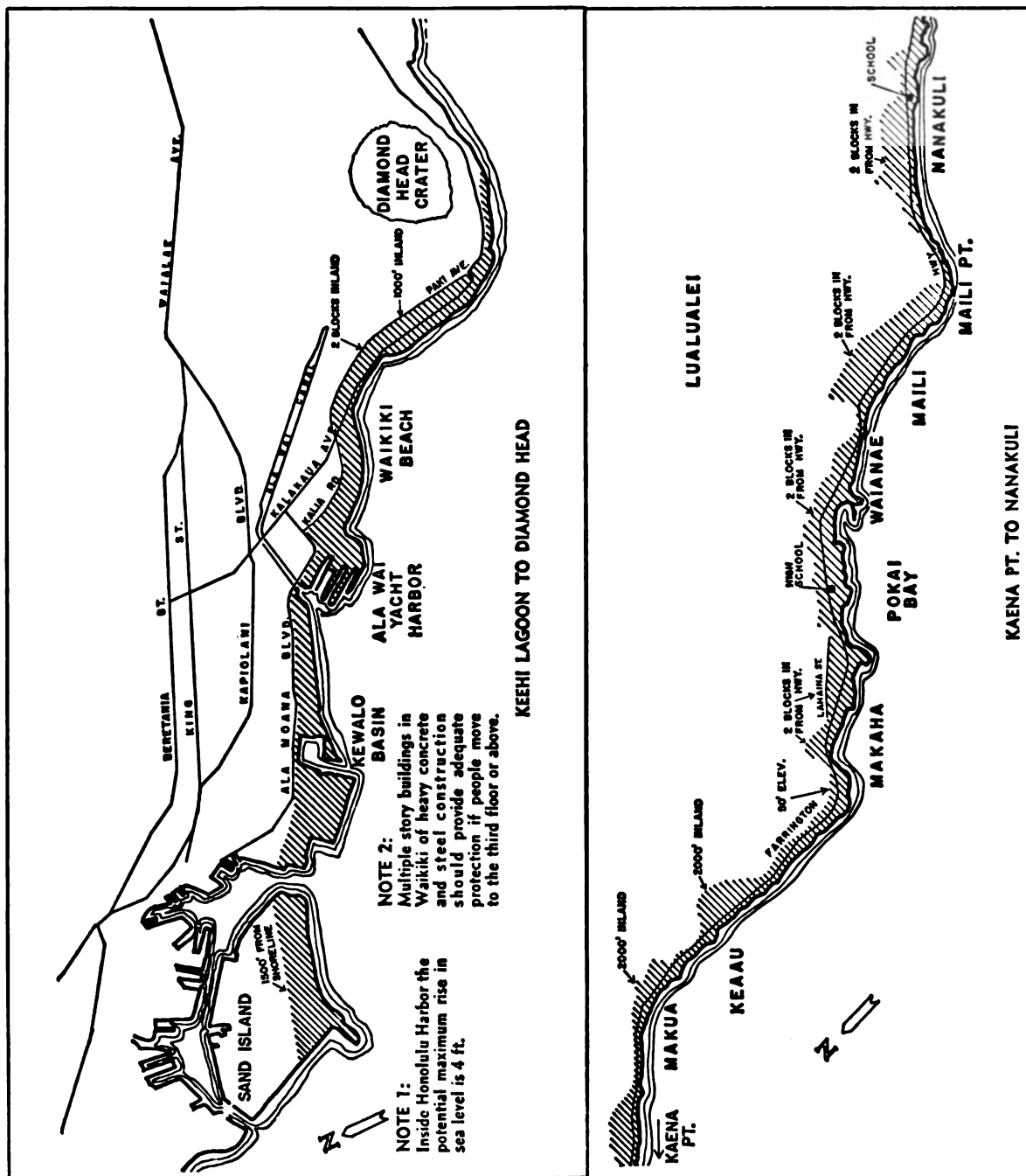


Figure 8.—Hawaii Civil Defense Tsunami Inundation Maps, printed in the Honolulu telephone book, serve as ready references if evacuation is necessary—*Oahu Telephone Directory, November 30, 1970, pp. 14, 17.*

Regional and Local Warning. The United States (NOAA) has assumed the responsibility of providing tsunami warnings to foreign and domestic regional centers, which in turn alert local agencies and the public. In the United States, the States concerned have designated an agency as a regional center, which has primary responsibility for receipt and further dissemination of warnings to local areas.

There is some question concerning the effectiveness of the various warning methods. Experience has shown that radio and TV broadcasting and other forms of communication are only partially effective and that warning devices tend to be ignored or, if heeded, that action is seldom taken until after follow-up information has been obtained.¹⁰ Radio and TV are effective in giving detailed information and instructions, but are unsuitable as a primary warning system, because all stations do not provide 24-hour coverage, nor are sets in continuous use by the public. Various national warning systems are under study, such as the Office of Civil Defense Decision Information Distribution System ("DIDS"), which might be adapted for dissemination of tsunami information to the public.

Studies assessing the adequacy of public response to the Tsunami Warning System have indicated that the most serious breakdown is at the local level.¹¹ Misunderstanding, distrust, apathy, curiosity, and the lack of mechanisms for ensuring proper response all work against the effectiveness of the warning. The processes of disseminating local warnings, establishing emergency preparedness, and informing the public as to proper procedures vary widely in effectiveness.

Findings

1. *Accurate prediction of tsunami arrival time and wave height at any given point in the Pacific Ocean is not feasible at present. There is a need to reduce the*

time between detection of tsunami waves and the warning of vulnerable areas. Programs for improving prediction and warning, some already underway, include:

- The expansion and modernization of 28 seismographs and 84 tsunami sensors equipped with standardized instruments designed specifically for the detection of tsunamis to provide more complete and reliable information on the generation of tsunamis and on their amplitude and speed (NOAA plan).
- The use of NOAA's Geostationary Operational Environmental Satellite as a communication relay. This would reduce the elapsed time for warning to regional disseminating agencies from an average of 2-2½ hours to about 1 hour. This time saving would reduce the radius of the unwarned area from 1,000 to 400 miles.
- The establishment of a West Coast Regional Tsunami Warning Center, headquartered in San Francisco or Sacramento, to provide more timely warning service for nearly seven million people living in cities susceptible to tsunamis. Adequate warning of locally generated tsunamis cannot be assured from the centers in Honolulu or Palmer, Alaska.
- The initiation of a comprehensive research program to investigate (1) the geologic processes that deform the ocean floor and produce earthquakes, (2) the actual mechanism of tsunami generation, (3) the relationship between earthquake magnitude and tsunami height, (4) methods of tsunami recognition, and (5) methods for predicting wave heights and probable tsunami landfall.

2. *The inclusion of tsunami emergency procedures in telephone directories, as done in Oahu, Hawaii, would improve the public response to tsunami warning.* These procedures could include information on warning devices and emergency procedures, zones of possible inundation, evacuation routes, and the location of relief centers.

Notes

¹R. J. Brazee and James Jordan, "Preliminary Notes on Southeastern Alaska Earthquake," *Earthquake Notes*, Vol. XXIX (September 1958); Don J. Miller, *Great Waves in Lituya Bay*, Geological Survey Paper 354-C, U.S. Department of the Interior (Washington, D.C.: U.S. Government Printing Office, 1960).

²*Preliminary Report on Seismic Sea Waves from Aleutian Earthquake of April 1946*, (Berkeley: University of California Department of Engineering, 1946).

³*Communication Plan for Tsunami Warning System*, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 7th ed. (Washington, D.C., 1971).

⁴U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Rockville, Md., January 1971.

⁵E. W. Daniel, Jr., *Report of the Tsunami Communications Tests for the Third and Fourth Quarters of FY 71* (Washington, D.C.: National Communications System, November 9, 1971).

⁶*Communication Plan for Tsunami Warning System*.

⁷*Standard Operating Plan for Tsunami Regional Evaluation*, State Civil Defense, Joint Tsunami Research Effort and Tsunami Advisor, Honolulu, January 1967; *Standard Operating Procedures, Seismic Sea Wave*, State of California, California Disaster Office, April 1969; *Alaska Seismic Sea Wave Warning Plan*, Department of Public Safety, Alaska Disaster Office, revised October 1969.

⁸*Basic Plan, Tidal Wave, Warning, Evacuation*; prepared by Sheriff's Department, County of Ventura, and OCD.

⁹*Emergency Operations Plan, Seismic Sea Wave Threat to the Unincorporated Coastal Areas of Orange County*, Sheriff's Department, Orange County, and OCD.

¹⁰J. Eugene Haas, "Final Report on the Effectiveness of Tsunami Warning System in Selected Coastal Towns in Alaska," Environmental Science Services Administration Contract No. E-230-69(N), (unpublished, Boulder, Colo., May 1971), pp. 7-8, 13-14.

¹¹James Havighurst, *Perception of Tsunami Hazard* (Honolulu: Hawaii Institute of Geophysics, 1967). See also Haas, *op. cit.*, pp. 2-3.

Chapter I. Volcanoes

General

While some 79 percent of all volcanoes are contained in the "ring of fire" which circumscribes the Pacific Ocean, their distribution is irregular, with 45 percent in the Western Pacific islands and only 17 percent in the Pacific coastal region of North and South America (see Figure 1). In the United States, only two volcanoes in Hawaii and 27 in Alaska are active. The latter are primarily in the Aleutian chain. In the conterminous United States most of the volcanoes lie along the Cascade Range of Washington, Oregon, and California (Figure 2). At present, these volcanoes are inactive and are not an immediate threat; however, they must be considered as only dormant, and thus pose some potential danger to the urban and agricultural centers of the Pacific Northwest.

Volcanic eruptions cannot be prevented; therefore, programs for protection necessarily involve procedures which are feasible in prediction and warning, as well as preparedness to take the necessary action to prevent loss of life and mitigate damage.

Existing Programs

Statutory Authority. Present programs in volcanology are carried out entirely by the U.S. Geological Survey (USGS).¹

Organization, Facilities, and Procedures. During the first years of its existence, USGS efforts in volcanology consisted of field investigations conducted mostly by outside consultants. They covered the most significant eruptions that occurred and performed basic research and studies at the Hawaiian Volcano Observatory (HVO). The USGS volcano program now consists of three main elements, in the Hawaiian Islands, in the Pacific Northwest, and in New Mexico.

Hawaiian Islands. The prediction and warning of volcanic hazards in the Hawaiian Islands is performed by the HVO, located on the rim of the Kilauea Crater. USGS assumed responsibility for operations of the HVO in 1924, 12 years after its founding by the Massachusetts Institute of Technology.² HVO monitors the volcanically generated microearthquake activity, measures long-term tilt and bulging (deformation), makes regular

temperature measurements and chemical analyses of the gases and lava of the volcanoes, and assesses the level and trend of the activity. On this basis, normal cyclical patterns are confirmed, or signs of unusual activity identified, and predictions and warnings are prepared.

The monitoring net consists of more than 20 seismographs and associated telemetry equipment which are located on the slopes of Kilauea and transmit data to a network center at the HVO. A larger net, the local tsunami warning network for Hawaii, with a center on Oahu, receives seismic data recorded on neighboring Hawaiian Islands and supplies them to the HVO to augment the Kilauea recordings. The observatory also conducts a continuing development and testing program on instruments, techniques, and hypotheses required to refine predictions of volcanic activity.

Pacific Northwest. Study of the volcanoes in the Cascade Range of the Pacific Northwest is currently concentrated on Mt. Rainier, Washington; Lassen Peak, California; and Mt. St. Helens, Washington. Not covered by the present program are the nine remaining inactive but potentially dangerous volcanoes. This effort began in the mid-1950's as an outgrowth of engineering geology studies in the Puget Sound lowland. In the past 15 years, it has consisted essentially of geologic mapping and evaluation of existing hazards, although the level of microearthquake activity has been monitored for brief periods at Mt. Rainier, Mt. Saint Helens, and Lassen Peak.

New Mexico. Basic volcanic research of the Jemez Mountains, a large, inactive volcano complex in New Mexico, began in 1946. Detailed evaluations of structure and volcanic products have resulted in important advances in volcanology that have had far-reaching influence in the understanding of large-scale eruptions. (For additional information on volcanoes, see Part VIII, Chapter H.)

Volcanic Hazards

Lava flows, pyroclastic ejecta (which include flows and airborne volcanic debris), and volcanic mudflows are the volcanic hazards that must be considered in the protection program.

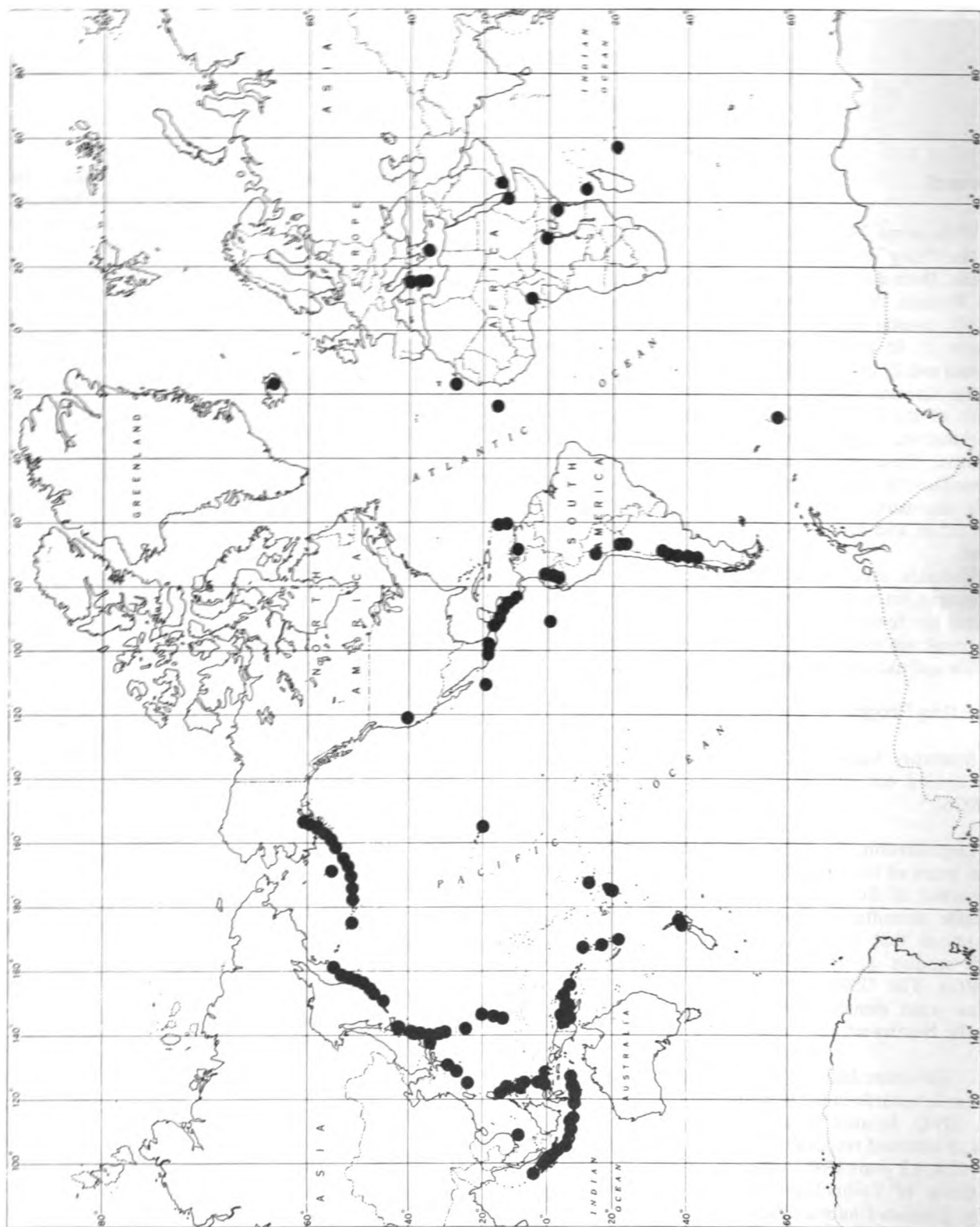


Figure 1.—Location of Volcanoes Which Have Erupted Since 1900.

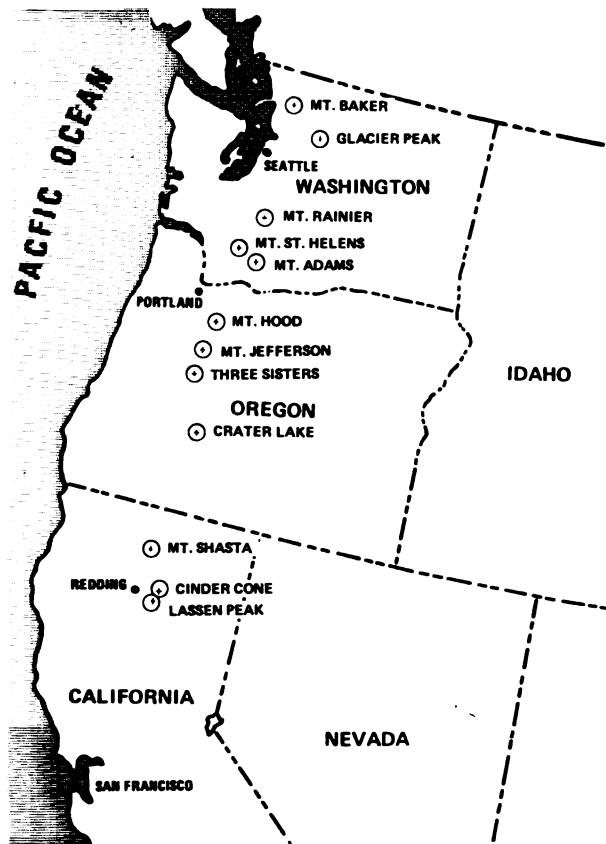


Figure 2.—Dormant Volcanoes of the Pacific Northwest—
U.S. Geological Survey.

Lava Flows. These flows are completely destructive but confined to restricted areas in the immediate vicinity of the generating volcano. They may be effusive, represented by a slow outpouring from a crater or a fissure, or result from an explosive eruption which may generate a river of molten materials tens of yards wide, with rates of flow up to 30 miles per hour.

Volcanic soils are very productive, and the slopes of relatively quiescent volcanoes are often farmed extensively. Residences are sometimes situated on the slopes and in adjoining valleys in well-populated areas. This is prevalent in Mexico, Italy, Hawaii, and Japan. The property in the path of a lava flow cannot be saved, and any economic use of the slopes of a volcano involves a calculated risk.

Pyroclastic Ejecta. These are rock particles formed by the explosive fracture of liquid and solid material by rapidly expanding gases. When the particles are fine, they are combined with other debris and blown aloft in enormous quantities, where they remain suspended for long periods. Settling in a stifling blanket over wide areas, they cause respiratory problems, kill crops, and

reduce the productivity of the land for many years until they assimilate into the soil.

Pyroclastic flows are the most dangerous and difficult volcanic phenomena to guard against. If people are not well clear of the danger area before the eruption, there is little hope of escape. These flows arise when airborne pyroclastic rocks are too heavy to remain aloft and flow downslope like a hot liquid. They attain speeds of more than 60 miles per hour, behaving much like an avalanche and causing plants and buildings to burst into flame.

Volcanic Mudflows. The threat posed by active volcanoes is not restricted to eruptions. The large amounts of loose ejecta scattered on slopes near active volcanoes, as well as parts of the volcanoes themselves, are highly susceptible to sudden downslope movement in the form of volcanic mudflows. The volcanoes of the Cascade Range are particularly susceptible to mudflow hazards because of the high rainfall along the crest of the Cascade Range and the large volume of water that is temporarily stored as snow and glacier ice at higher altitudes on the volcanoes.

During heavy rains, large volumes of unconsolidated debris can be stripped from steep volcanic slopes and carried quickly downslope by mudflows. A subtle increase in thermal emission can cause release of melt-water, saturating large quantities of debris and making it highly susceptible to mudflow transport. More than 55 mudflows have originated on the slopes of Mt. Rainier in the past 10,000 years. The largest of these, 4,800 years ago, traveled 45 miles down the valley of the White River before spreading out on the Puget Sound lowland as a lobe 20 miles long and 3 to 10 miles wide.

Capabilities and Limitations.

Mitigation. Because of the devastating force of volcanic eruptions, mitigation of damage has proved to be difficult. Some success has been attained in slowing or diverting lava flows by strategically locating stone barricades. Danger zones on slopes can be mapped and controlled to prohibit entry by humans and domestic animals. During periods of danger, animals and some items of property can be moved out of the paths of lava flows to safer locations.

Prediction and Warning. The capability to predict volcanic activity and give proper warning varies from acceptable to clearly inadequate, depending on the geographic areas involved.

Hawaii. HVO, through its seismic and deformation monitoring, has given accurate warning of eruptions of Kilauea, most notably in 1955 and 1960,³ and again in August and September 1971. The extensive and accurate Kilauea data do not afford a basis for prediction of eruption of other volcanoes, although some techniques

are transferable. Methods which have been used for making predictions include temperature of hot springs, composition of water and gas, and infrared photography of the area. But none has been found as effective as seismic and tilt measurements.

● *Pacific Northwest.* The prediction and warning capability in this area is limited to preliminary efforts at only four of the 12 major volcanoes in the Cascade Range. The lack of widespread concern about these volcanoes may be attributed to their long-dormant status. Instrumentation and monitoring of active volcanoes are practical and easily justified, but the problem is more complicated when dormant volcanoes are considered. Long-quiet areas can come to life after hundreds of years. Although activity would be heralded by precursor disturbances, it is not practical to make continuous instrumental surveillance of such volcanoes to discover such premonitory activities. Therefore, intermittent instrumented surveillance and long-term geological analysis must be the basis for any protection program involving these volcanoes.

Preparedness. Effective actions include establishing evacuation routes and procedures, setting up collection points and relief centers, and stocking and staffing hospitals to handle the special problems of burns, heat exhaustion, and respiratory difficulties. Evacuation is practical even in most instances of violent eruption, because it is generally possible to recognize an impending eruption by monitoring the seismic occurrences, temperature regime, and characteristic cycles of activity.

Consideration must be given to each type of hazard in the designation of evacuation routes. Lava flows will follow easily discernible paths at velocities slow enough to permit evacuation. Pyroclastic flows travel so rapidly and range so far that the slopes of the volcano and its adjoining valleys must be evacuated as rapidly as possible. In planning evacuation or relief from airborne debris, long-term weather forecasts and prevailing winds must be considered.

An example of preparedness and response, based on a hard lesson from the past, was recently provided by the volcanic activity of Mt. Soufrière on St. Vincent Island in the Caribbean. In 1902, the eruption of Mt. Soufrière killed 1,565 persons, and the eruption of Mt. Pelée on the following day killed 30,000. In November 1971, Mt. Soufrière began to show signs of activity, which increased to such a high level that 2,000 people were evacuated on December 8.

In this latest instance, the response by scientists and emergency assistance organizations provides an example of feasible preparedness procedures, in addition to the immediately executed evacuation. Scientists were in the field to monitor the activity shortly after the first reported signs of life. Representatives of the Smithsonian Institution Center for Short-Lived Phenomena and USGS volcanologists joined scientists of the University of the West Indies on St. Vincent Island to observe and record the emergence of the new lava in the center of the crater lake, the lake water level and temperature, and the seismic activity. Additionally, observations were continued at Mt. Pelée to ensure immediate detection of unusual activity.

Findings

With the exception of those on the Hawaiian Islands, most volcanoes in the United States are inactive, and thus pose only a relatively latent threat to the Pacific Northwest.

Since the volcanoes in the Pacific Northwest are considered to be only dormant, the capability to provide intermittent instrumental monitoring should be extended to the existing 12 volcanoes. At the first signs of activity, complete monitoring procedures comparable to those in Hawaii can be undertaken.

Prediction and warning of volcanic activity in Hawaii is considered satisfactory; however, research and development should be continued in an effort to improve monitoring devices, such as seismic event counters and borehole tiltmeters.

Notes

¹USGS derives its authority from its enabling act (43 USC 31), dated March 3, 1879.

²T. A. Jagger, *My Experiments with Volcanoes* (Honolulu: Hawaiian Volcano Research Association, 1956), pp. 80, 114.

³Cliff Ollier, *Volcanoes* (Cambridge, Mass.: The MIT Press, 1969), p. 155.

Chapter J. Frosts and Freezes

Many factors affect the success or failure of agriculture, but none plays a more decisive role than weather. Annual losses attributed to weather are estimated at \$11 billion. Based on 30 years' experience, frosts and freezes have accounted for 10 percent of these losses.¹ Frosts and freezes constitute a milder form of catastrophe than other types of disasters; however, the economic impact on agricultural industries and communities can be severe. For example, a bad freeze in the citrus-producing areas of California and Arizona, representing an investment in

excess of \$1.3 billion, can reduce the annual sales value of \$135 million by \$75 million.²

In extreme instances, certain plants can be completely destroyed, or injured to the extent that recovery may take months or years. Economic losses are borne by the agribusiness community and the consumer, as well as by the producer.

Since frosts and freezes cannot be prevented, protection lies in prediction, warning, and preparedness procedures. The Federal Government provides frost and freeze

PRESENT AGRICULTURAL WEATHER SERVICE PROGRAM

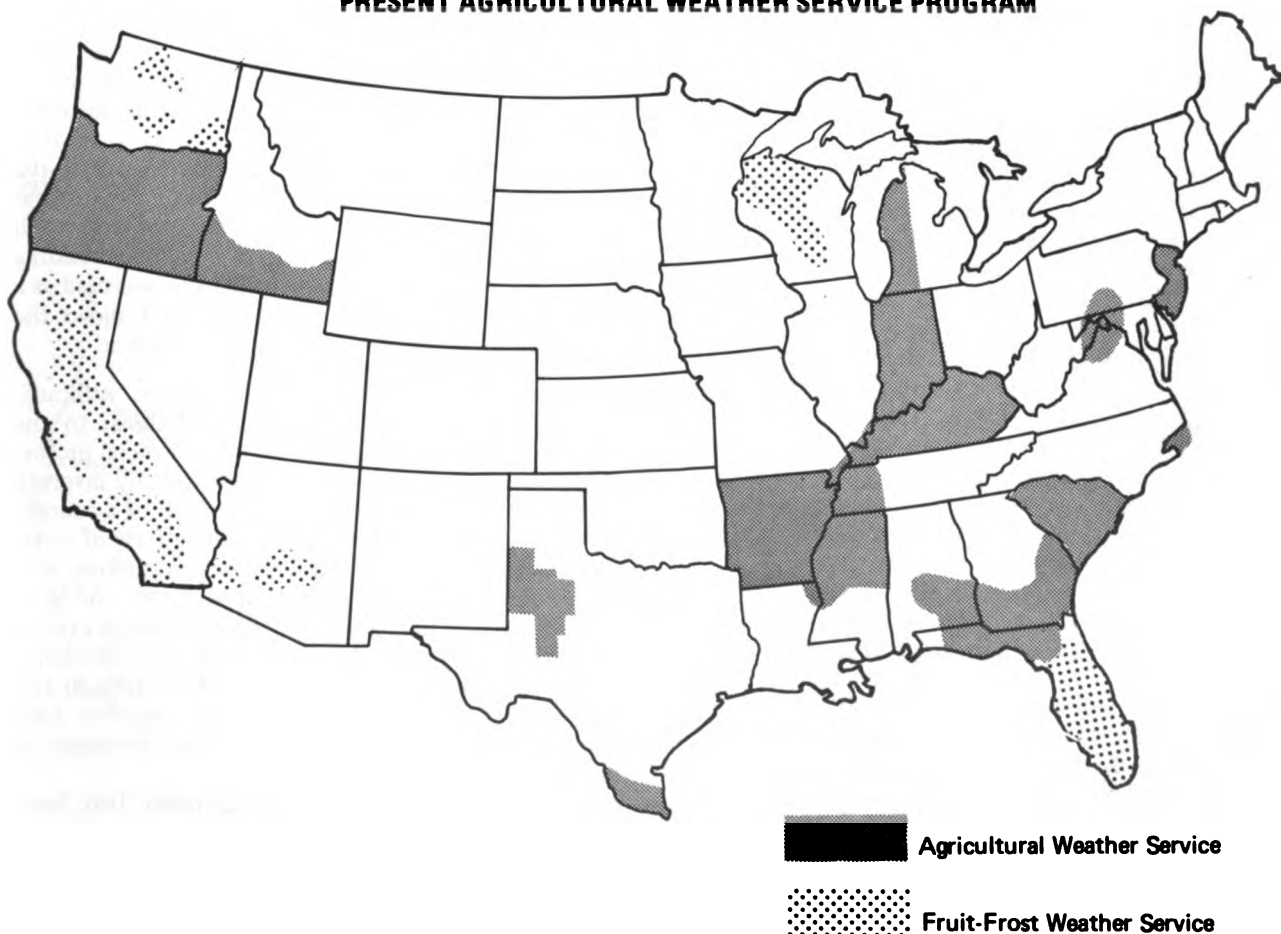


Figure 1.—Present Agricultural Weather Service Program—NOAA Plan for a National Agricultural Weather Service (p. 21).

predictions and warnings; however, protection measures for crops are primarily the concern of the producer.

Prediction and Warning

Frost warnings were first issued in 1880 to Louisiana sugar growers. Some 2 years later, an attempt was made to provide fruitgrowing areas with frost warnings for temperatures below 40°F. As this service became generally accepted, especially by Pacific Coast fruitgrowers, the U.S. Department of Agriculture was given the responsibility to "display frost and cold wave signals" under the Organic Act of 1890.³ The special need to provide frost warnings led to the establishment of the Fruit-Frost Weather Service. By the early 1920's the Weather Bureau was providing frost-warning services to Pacific Coast fruitgrowers and by the 1930's to other parts of the Nation.⁴ In 1926 it was reported that \$14 million worth of California citrus fruit was saved as a result of warnings the Bureau issued during a single cold wave.⁵ Recognizing the need for specialized forecasts and advisories to all areas of agriculture, the Agricultural Weather Service program was established for 12 areas of the United States with concentrations of weather sensitive crops (Figure 1).

National Weather Service. It is estimated that at least \$1 billion in crop losses could be saved by better weather forecasts.⁶ In an evaluation of user requirements, it has been determined that the Agricultural Weather Service and Fruit-Frost Weather Service effectively (within existing technical capabilities) meet the needs of agricultural interests in selected areas of the United States. In those States which have no specialized agricultural weather programs, National Weather Service headquarters arranges for service to agriculture as a part of the general forecast service. This arrangement does not meet the full requirement for agricultural weather services for the following reasons:⁷

- Public service forecasts and advisories, while frequently of general interest to agriculturists, do not cover all parameters of importance.
- No advisories are available that interpret the forecast meteorological parameters in terms of probable effects on agricultural operations and environmental quality.
- Special agricultural observations essential to the production of adequate forecasts are not available.

No area in the United States is completely free from the effects of frosts and freezes. Because valuable and highly weather-sensitive agricultural products are cultivated throughout the country, an expansion of the Agricultural Weather Service would provide more and better information to the remaining areas of the country (refer to Figure 1).

Plan for an Improved Agricultural Weather Service. In response to a directive by Congress,⁸ the Department

of Agriculture and the Weather Bureau formulated a plan to expand the current service into unserved areas. The program would consist of advanced and effective integration of available meteorological talent with that of Federal and State specialists at colleges of agriculture and agriculture experiment stations, to provide users with both short- and long-range planning information and certain specialized services. Advisory services will also be provided to the Department of Agriculture. As the program is implemented, the specialized efforts of the Fruit-Frost Weather Service will receive continued emphasis to assure that critical seasonal requirements for frost and freeze warnings are met.

*Implementation of the Plan.*⁹ Phase 1 of the plan is complete. Funds for program expansion into some unserved areas are included in the President's FY 1973 budget. In considering priorities by States, it was determined that the most profitable application of agricultural weather forecasts can be realized in those regions where the number of weather-related options or alternative operational decisions is greatest, that is, where weather-sensitive agriculture (high cash receipts per acre) is concentrated. Furthermore, those States with a higher proportion of farm population would potentially profit most from valid, timely, and pertinent weather information.

Based on these points, an order implementing the Agricultural Weather Service in the remaining States was developed by multiplying each State's per-acre cash receipts by the percent of total U.S. population residing on farms in the State. (See Figure 2.) This was used as a rating factor to rank the States.¹⁰ Table 1 shows the order of proposed implementation of the Service.

Frost and Freeze Alleviation Programs. Although frosts and freezes constitute an annual threat to the agricultural industry, there are no major Federal protection programs nor any Federal agency directly involved in the overall coordination and supervision of a concentrated national program to alleviate the effects of frosts and freezes. There are many private institutions, universities, industrial firms, and Federal, State, and local agencies engaged in research and development of protection devices and procedures; however, the cumulative results of these diverse efforts are not available in any one Federal agency, and thus many growers have incomplete information on which to base decisions on methods of protection.

Protection methods are grouped under two basic classifications: *Active* methods, which must be carried out immediately before and during a period of actual frost or freeze occurrence, and *passive* methods, which must be used well in advance of the immediate threat and are designed to avoid rather than prevent danger.

*Active Methods.*¹¹ The most widely used methods are heaters, wind machines, and overhead irrigation.

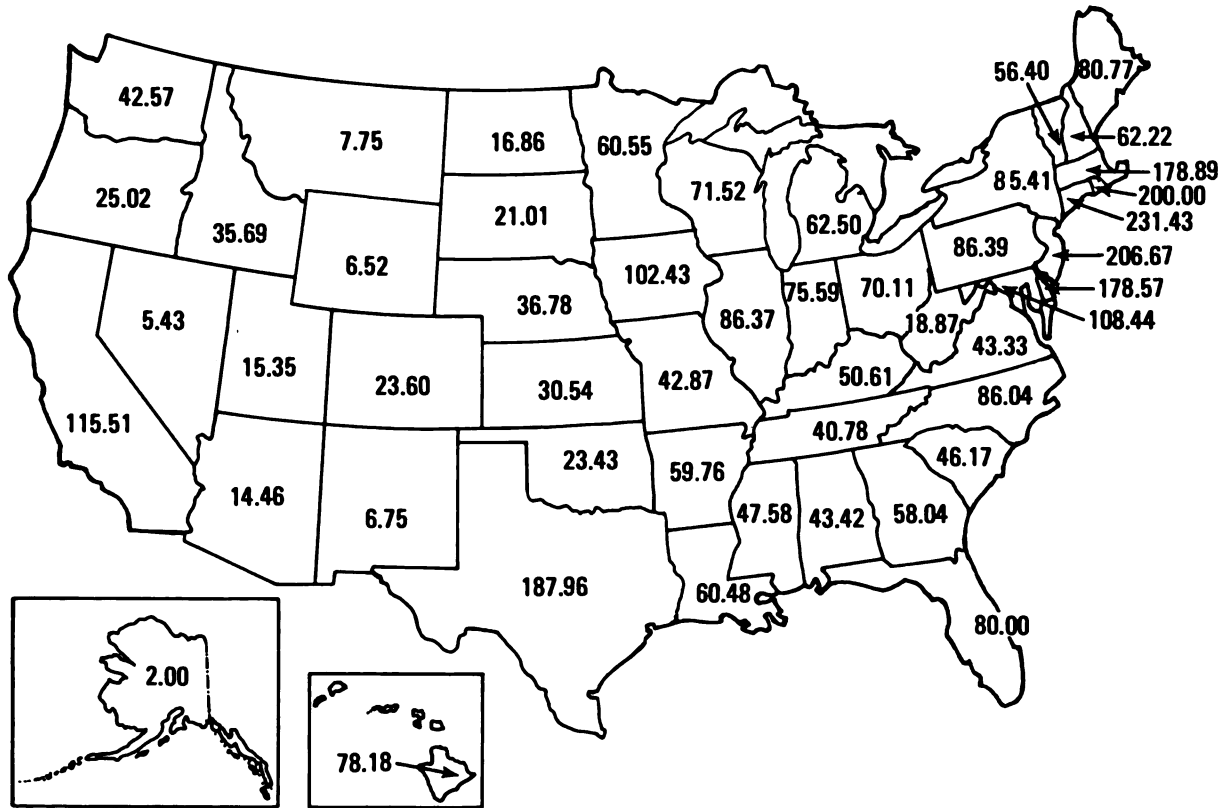


Figure 2.—Cash Receipts in Dollars per Acre of Farmland, 1968 (above) and State Farm Population as a Percentage of the Total U.S. Population, 1960 (below)—NOAA Plan . . . (p. 33).

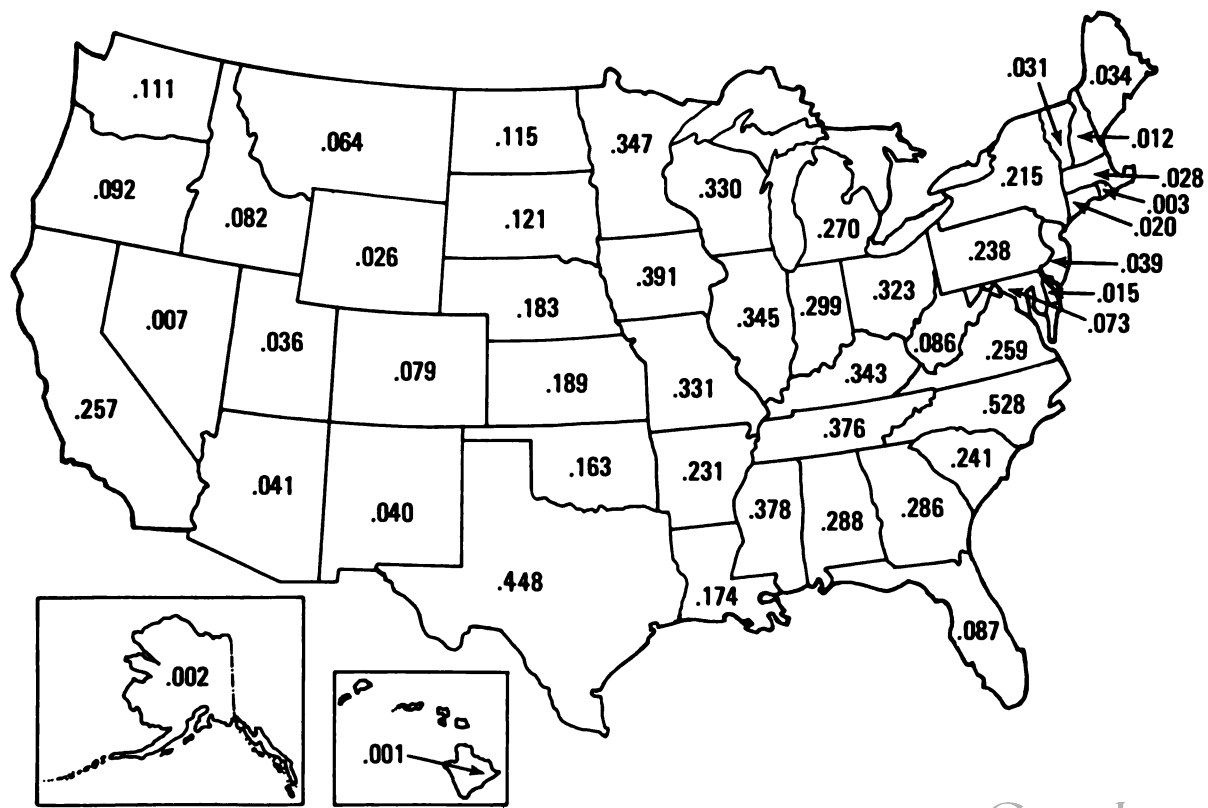


Table 1.—Agricultural Weather Service Implementation Plan—adapted from NOAA Plan for a National Agricultural Weather Service (p. 34).

PHASE 1 (complete)	PHASE 5 (continued)
Arkansas	*Virginia
Indiana	*Louisiana
Kentucky	*Maryland
New Jersey	*Florida
Oregon	
South Carolina	
PHASE 2	PHASE 6
Arizona	Kansas
Ohio	Massachusetts
New York	Washington
Nebraska	Connecticut
Montana	Oklahoma
Wyoming	*Idaho
PHASE 3	PHASE 7
*Texas	Maine
North Carolina	Delaware
Iowa	South Dakota
Illinois	North Dakota
California	Colorado
	Vermont
PHASE 4	PHASE 8
Wisconsin	*West Virginia
Minnesota	New Hampshire
*Pennsylvania	Hawaii
*Mississippi	Utah
*Michigan	New Mexico
*Georgia	
*Tennessee	
PHASE 5	PHASE 9
*Missouri	Nevada
*Alabama	Rhode Island
	Alaska

*Service partially implemented.

Experimentation has also been undertaken in the use of artificially produced clouds or fogs and in the use of foam materials as an insulating base.

● **Heaters.**¹² Heating is one of the oldest and best means of cold protection. During the 1930's, widespread use of heating devices began in Southern California. As the citrus acreage expanded, pollution became severe because of the smoke and soot produced by burning oil in open containers. As a result of antipollution regulations and controls, return-stack and jumbo cone-type

heaters were developed (Figure 3). These heaters burned with higher efficiency and drastically reduced the emission of pollutants. The relatively high capital cost (\$350 to \$400 per acre) plus additional storage, refueling equipment, and labor costs (\$100 per acre) have prevented wider acceptance of this type heater.

Solid fuel petroleum coke and petroleum wax heaters, which have been developed by several petroleum companies, require no capital investment and produce only small amounts of air pollutants. The petroleum coke heaters, small coke blocks in the shape of building bricks, are more effective in terms of units of heat produced, but the cost of the fuel is higher than oil. In addition, rate of burning cannot be controlled, nor can they be extinguished after lighting. Although no capital investment is required, they do involve a substantial amount of labor, plus storage and refueling problems. The petroleum wax heaters produce more smoke and air pollution than the coke heaters and present problems in design of adequate containers. Wax spillage is a nuisance factor and may also damage individual plants.

Within the past 10 years, heaters have been introduced that burn oil and gas supplied from a central pipeline. These heaters have a high combustion efficiency and produce very little air pollution. The capital cost will probably be greater than for the conventional return-stack and jumbo-cone heaters, but reduced labor costs may promote good acceptance by growers. As with all new systems, there are deficiencies which must be eliminated.

The general use of efficient, economical, and pollutant-free heaters is an important goal for many agricultural communities. As a result of high capital and labor costs, many growers are using open oil fires in buckets, barrels, and pails, plus other materials (such as rubber tires and railroad ties) which are difficult to manage and cause smoke and air pollution.

● **Wind machines** (Figure 4). The first wide-scale use of wind machines occurred in Southern California. Wind machines produce little or no heat but depend on the presence of a temperature inversion—a layer of warm air above the surface. They provide cold protection by mixing warmer air above the plants with the colder air among the plants, a process which replaces part of the heat lost by radiation cooling of the surface.

The amount of cold protection that can be expected from a wind machine depends on the strength of the inversion, the power of the machine, the wind speed, and the distance from the machine. Results obtained with a wind machine used in a research program at the University of Florida showed that under clear, calm conditions at least 2 degrees of cold protection was obtained on an area of 8-10 acres. Winds in excess of 5 miles per hour preclude any beneficial effects from wind machines.

Wind machines offer some excellent advantages in cold protection because they minimize labor require-

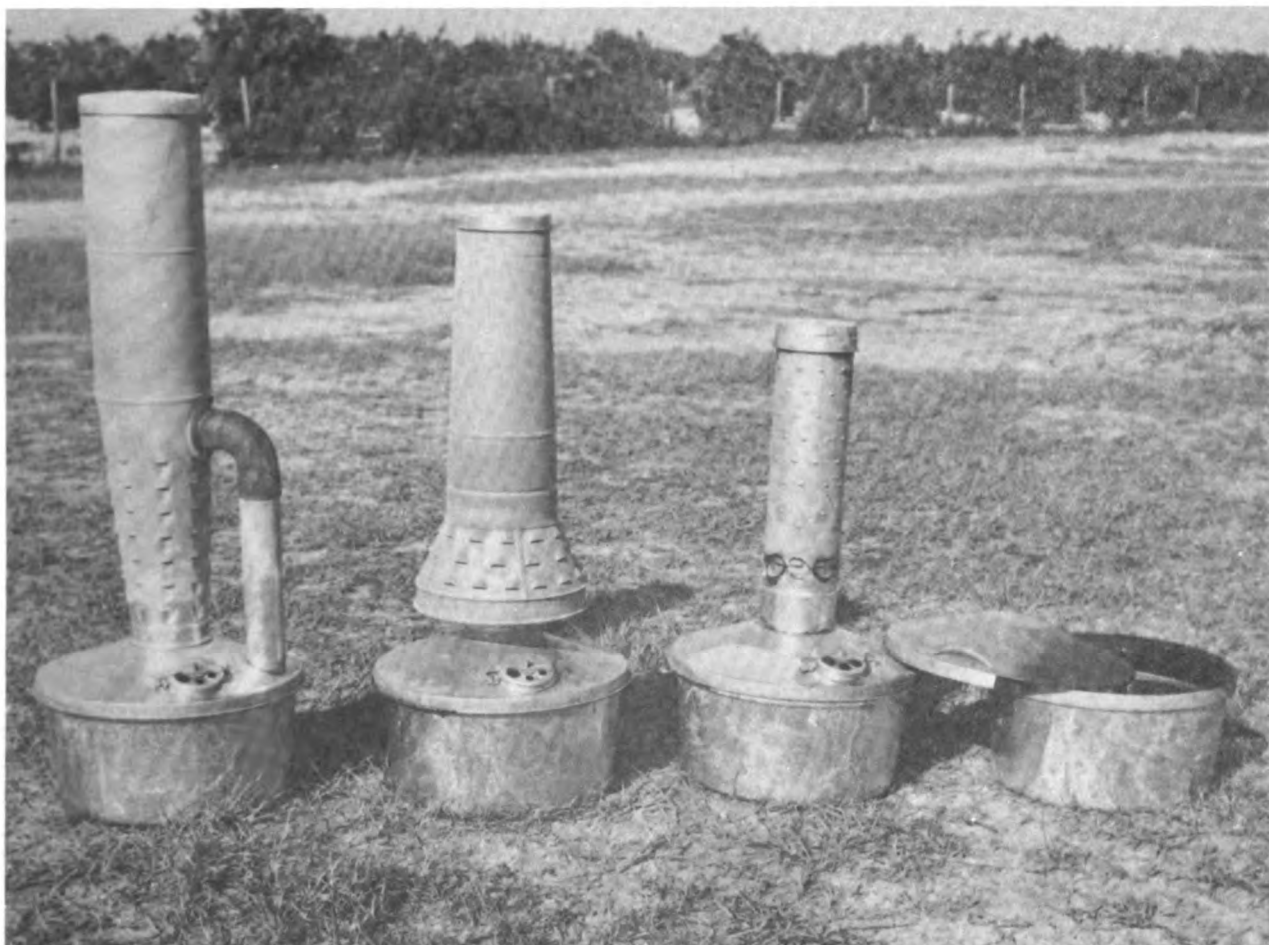


Figure 3.—Types of Heaters: (left to right) Return Stack, Jumbo Cone, Short Stack, Open Pot—University of Florida, Institute of Food and Agricultural Services.

ments, demand less refueling and less storage than heaters, are permanently located, have a low operational cost per acre, and do not produce smoke and air pollution. Conversely, they require rather high capital costs and provide cold protection only when temperature inversions and light winds exist.

● *Wind machines used in combination with heaters.* Research at the Universities of California and Arizona has shown that heaters of the conventional type and wind machines may be combined to produce a complementary effect. Part of the benefit is derived from the efficient mixing of the atmosphere in the lower layers that contain heat and by efficient distribution of the heat produced by the heaters. On windy nights, however, this combination-type procedure will not provide additional protection.

Attempts to combine heat production and wind machines into a single device have thus far not been successful. Several manufacturers have attempted to use the tremendous thrust developed by ramjet engines to

power the propellers used in wind machines; however, field trials in California, Michigan, and Florida have shown that the buoyancy imparted from the exhaust of the ramjets spoils the effect of the mixing.

● *Overhead sprinklers* (Figure 5). Primary research work in overhead sprinkler irrigation for cold protection of fruit and vegetable crops has been conducted in Michigan, Florida, and the Rio Grande Valley of Texas. Irrigation provides cold protection by the release of the latent heat of fusion when water turns from liquid to ice. If a mixture of ice and water can be kept on a plant at all times, the temperature will remain close to the freezing point of 32°F.

Sprinkling differs from other cold-protection systems in that improper use can result in more damage than if the plants were left unprotected. If not enough water is used, the temperature of the plant may drop several degrees below air temperature, thus increasing the damage. An additional hazard to large citrus trees and grapevines is that accumulation of heavy ice loads



Figure 4.—Wind Machine in a California Orange Grove—U.S. Department of Agriculture photo.

may cause breakage. Sprinkler irrigation has proved to be most effective for low-growing crops, such as nursery stock, strawberries, and ferns.

Permanent overhead irrigation systems offer the advantages of low operational costs, no air pollution, plus the possibility of their use for regular irrigation. Cost of the equipment is high (\$300 to \$500 per acre), however, and the system must be skillfully designed, located, and operated in order to insure adequate protection.

- *Artificial clouds or fogs.* The use of clouds or fogs produced artificially for protection of plants from cold

damage is based upon the assumption that the cooling effect from nocturnal radiation can be favorably modified. After World War II, surplus steam oil generators were used to produce clouds similar to those used for camouflage purposes. The amount of oil required to produce the desired effect was prohibitively expensive and also produced materials poisonous to the plants. Further experiments designed to produce the proper size and stability of water droplets for fogs have resulted in the commercial marketing of the technique. Results have been generally disappointing, although some slight modification in the loss of energy from the surface by radiation has been attained.

- *Foams* (Figure 6). The production of firefighting foams has led to cold-protection experiments that may become important for low-growing crops, as well as for other crops under special conditions. The technique has been investigated by industry and by research workers in the Rio Grande Valley of Texas, Louisiana State University, and the University of Georgia, and research is programmed at the University of Florida. Basically, the application of such foams to plants provides them with protection by making an effective heat-insulating layer, which retards the loss of heat until the danger of low temperatures has passed.

The critical factor in the development of suitable foams is that the stability of the material must be such that it remains intact for only the desired length of time. If the foam does not dissipate at the proper time, plants can be damaged by excessively high temperatures as the short-wave radiation from the sun penetrates the material.

Passive Methods. These include protective measures that can be taken before the advent of cold weather or even before the crop is planted. Farmers have always attempted to find the most favorable environment for their crops and, in particular, the least frosty areas. In this selection, close attention is paid to the national and local climatological data that have been collected over the years.

The choice of growing season, when it can be made, will offer protection against cold weather. Field crops planted early in the season offer the advantage of earlier marketing but also are subject to increasing frost risks. The availability of suitable and economical cold protection devices is often the influencing factor in decisions on when to plant.

Research has been conducted in the use of growth hormones to delay flowering of tree-fruit crops to avoid frost danger. Unfavorable side effects, such as tree damage or crop reduction, indicate that further research is necessary.

In many areas, cultivation practices have successfully reduced frost hazard. For instance, soils that are weed free, moist, and packed radiate less heat than plant-covered, freshly worked, or dry soils. In some



Figure 5.—Frost Protection Irrigation System (Avon Park, Florida, December 1962)—USDA photo.



Figure 6.—Scientists with New Insulating Foam (Weslaco, Texas, test field)—USDA photo.

localities, irrigation is curtailed during the frost season, because a tree not irrigated tends to sustain less cold damage. With some crops, special pruning practices can, delay blooming dates and lessen damage from cold weather.

Findings

1. *The Fruit-Frost Weather Service and the Agricultural Weather Service have provided satisfactory cold weather prediction and warning information to selected areas of the agricultural community; however, this service is not provided countrywide.* Completion of the "Plan for an Improved Agricultural Weather Service" will provide more effective frost and freeze protection information to all areas of the United States, but will require additional funding for completion.

2. *Many private institutions, industrial concerns, and Federal, State, and local government agencies are involved in research, development, and operational employment of various cold-protection devices; however, because of the diversity of effort and the lack of a central clearinghouse or repository of information, a continuing evaluation of progress and problems on a national scale is most difficult.*

A potential solution would be the designation of one Federal department or agency as the local coordinating point for all activities in frosts and freezes being conducted by Federal, State, local, and private organizations. This should assist immeasurably in keeping all interested organizations and industries abreast of the progress in research and development in protection devices and practices.

Notes

¹U.S. Department of Agriculture, Federal Crop Insurance Corp., *Federal All-Risk Crop Insurance: A 21 Question and Answer Explanation for Agricultural Bankers*, August 1969.

²Dale Harris, "Beat the Big Freeze," *ESSA World*, U.S. Department of Commerce, Vol. 4, No. 2 (April 1969), pp. 32-35.

³15 USC 313.

⁴Patrick Hughes, *A Century of Weather Service* (New York: Gordon and Breach, Science Publishers, Inc., 1970), p. 192.

⁵*Ibid.*

⁶"Even Computers, It Seems, Find Weather is Fickle," *New York Times*, December 29, 1966.

⁷U.S. Department of Commerce, *Federal Plan for a National Agricultural Weather Service* (Washington, D.C.: U.S. Government Printing Office, January 1971).

⁸Authorized by the Appropriations Committee of the 87th Congress, 1st Session, Report No. 497 (General Bill, 1962) Accompanying H.R. 7577 and Report No. 448 Accompanying H.R. 7444.

⁹*Ibid.*

¹⁰A final factor concerns local requirements. Those States with a sufficiently strong local interest will be given a higher priority for implementation, thereby responding to the demands arising from the fluctuating agricultural situation.

¹¹Major portions of this topic were contributed by Dr. John F. Gerber, Assistant Dean for Research, Institute of Food and Agricultural Services, University of Florida.

¹²J. F. Gerber, Warren Johnson, and J. G. Georg, "Anti-Cold Devices Help Reduce Pollution," *Citrus World* (February 1970), pp. 9, 14, 19. This article was the principal basis for this discussion of heaters.

Chapter K. Droughts

Drought has been recognized as a prime cause of human misery since the beginning of recorded history. While generally associated with semiarid and arid climates, drought can occur in areas that normally enjoy adequate rainfalls and moisture levels. Regardless of its locus, prolonged and intense drought produces the same results: extensive crop failure, premature sales of livestock resulting in losses to stockmen, shortage or disappearance of potable and industrial waters, and increases in the debt burdens of individual victims and governments in the affected areas.

Fortunately, the United States has never suffered a drought of national scope and has been able to sustain the areas of the country that do have recurring drought. Nevertheless, drought is a serious hazard, particularly in the West and Midwest. The expectation of dry conditions has become part of the way of life of farmers and ranchers in some of these areas. To a large degree, these adverse conditions have been met successfully because of improved dry farming techniques, water conservation practices, and extensive irrigation of pasture and croplands. Despite the measures taken to adapt agriculture to dry conditions, a prolonged and intense drought presents severe socio-economic problems.

The term "drought" has been commonly applied, rather inconsistently, to three major forms of dryness: (1) a natural condition caused by less-than-average precipitation over a certain period of time, (2) a natural condition under which the average precipitation is low, and (3) nature's failure to fulfill the wants or meet the requirements of man. *The definition used in this report is that drought is a meteorological phenomenon and occurs during a period when precipitation is significantly less than the long-term average and when this deficiency is great enough and continues long enough to affect mankind.* Drought is thus measured in terms of the duration and magnitude of the departure from the average climate in the area under consideration. The effects of drought are measured in the various sources of water—soils, lakes, streams, and surface and underground reservoirs—upon which man depends for his supplies. Depending upon the extent to which a drought reduces these supplies with respect to the developed demand, the effects of droughts may be mild, moderate, or severe.¹

Disaster protection, as it relates to drought, cannot be discussed in the same manner as can protection from the more abruptly occurring, violently destructive types of

disaster. The state of the art relative to prediction and warning of drought conditions is not such that it can be considered part of a viable protection program. Occurrence of drought does not require that evacuation be undertaken or first aid be provided. People are not suddenly rendered homeless or without food and clothing. The effect of drought is basically economic, and this effect develops over a prolonged period. Drought does resemble other types of disaster in that victims can be deprived of their livelihoods and communities can suffer economic decline.

Drought-protection methods fall into three categories: (1) those *passive* procedures that are taken well in advance of drought danger and that are designed to avoid losses; (2) those Federal, State, and local *alleviation programs* that shield an area from the effects of drought by early preparation (storage, conservation, and reuse of water; improvement of water supplies; weather modification to induce increased precipitation; and avoidance of high water-use activities in particularly hazardous areas); and (3) those *emergency measures* that provide relief after drought conditions become severe (economic and material assistance to sustain the inhabitants and emergency measures to supply water by piping or hauling or by weather modification to end the drought).

Passive Measures

Although drought periods cannot be accurately predicted, in certain parts of the country there are definite historic cycles of wet and abnormally dry periods that should be considered by individuals and political entities in the long-range planning of the most suitable agricultural practices.

Drought is a short-term recurring problem in the subhumid and humid zones, where there is a normal excess of moisture; it is a recurring but not a major problem along the extreme western edge of the semiarid zone, because the economy is geared to desert-type development. The major problem areas are the semiarid and dry zones where climate periodically shifts to subhumid or humid conditions. In spite of the known cyclical recurrence of abnormally dry conditions, this climate shift is often followed by unwise agricultural and livestock-raising practices which are made attractive by the relatively wet period. Farmers and ranchers should

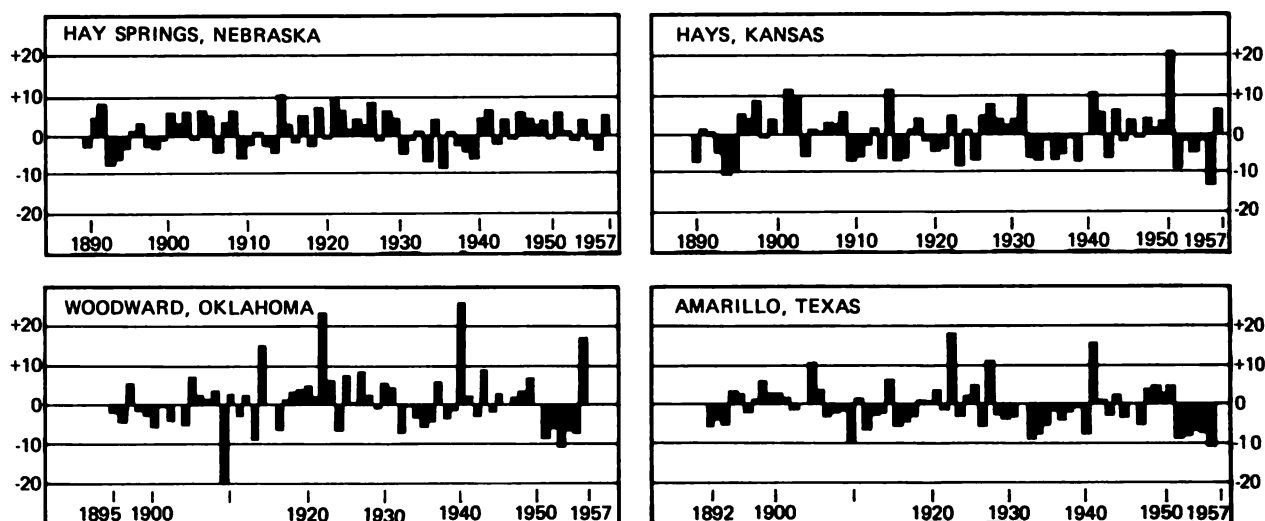


Figure 1.—Irregularity of Drought Periods: Four Localities, showing inches of precipitation above or below normal (zero on scale)—from *A Report on Drouth in the Great Plains and Southwest* (p. 13).

be cautioned against overplanting, experimenting with crops which are less hardy to drought resistance, overstocking and overgrazing livestock ranges, and laying out larger than normal capital investments.

Records of precipitation in the past century show eight severe droughts in the five southerly Great Plains States (1865-75, 1890-95, 1901-04, 1910-14, 1920-25, 1933-40, 1952-56, and 1970-71). An extract from a 534-year tree-ring growth record shows an apparently random pattern in the lengths of wet and dry periods. They vary from annual fluctuation to periods as long as 16 wet years and 15 dry years.² Although the patterns are random, the history of the cycles is sufficient for intelligent agriculture and range land management. Periods of above and below normal precipitation for four representative localities over a 70-year period in the Great Plains region are shown in Figure 1.

Drought Alleviation Programs

Federal agencies with primary responsibility in the solution of water problems are the Departments of Agriculture, Commerce, the Interior, and Defense. Although it is not possible to alter the general circulations of the atmosphere that cause drought, there are many means of advance preparation for withstanding or alleviating drought.

Water Supply Systems. The Bureau of Reclamation in the Department of the Interior has primary responsibility for all multipurpose functions related to storage, diversion, and development of waters for reclamation of arid and semiarid land in the drought-prone western States, under authority of the Reclamation Act of 1902.³

A primary method for reducing the effects of drought is to plan and build better water supply facilities to meet long- and short-range multipurpose requirements. Known fresh water reserves such as rivers, streams, lakes, and underground supplies (aquifers) can be utilized to the extent of their potential yield and the needs to be served. A limitation on this type of development is that projections of future requirements often exceed known water resources.

Public water supply projects include a range of facilities necessary for storing water and conveying it from source points to areas of need. Facilities may include pumps, wells, pumping plants, diversion dams, storage dams and reservoirs, pipe and canal distribution systems, and related structures.

Figure 2 shows the San Luis Canal and Dos Amigos Pumping Plant, San Luis Unit, Central Valley Project in California. This canal provides adequate and dependable water supplies for irrigation and for domestic, municipal, industrial, and recreational uses, thereby stabilizing the recipient service area against drought effects. The photos in Figure 3 illustrate water supply projects in Utah and Wyoming.

The U.S. Army Corps of Engineers' large reservoir projects provide primary storage for flood control on a national scale and also provide multipurpose storage for power production, municipal and industrial water supplies, irrigation, recreation, and fish and wildlife enhancement. Discussions of these projects and of the role of the Corps of Engineers appear in Part III, Chapter B, River Floods, and in the physical study on River Floods (Part VIII, Chapter A).

Weather Modification. Cloudseeding is an evolving science for control of precipitation. Serious research and



Figure 2.—Dos Amigos Pumping Plant, San Luis Canal, California—Bureau of Reclamation photo.

experimentation in precipitation augmentation date from the middle 1940s. The Federal agencies conducting the most active programs in weather modification are the National Oceanic and Atmospheric Administration (NOAA), in the Department of Commerce, and the Bureau of Reclamation. Based on experiments at Climax, Colorado, the Bureau of Reclamation is conducting an extensive pilot project in the San Juan mountains of Southwestern Colorado, to test the operational feasibility of increasing winter snowpack in order to augment the runoff into the upper Colorado river. NOAA's program is directed primarily to mitigation of hazardous weather and to a lesser extent to rainfall augmentation.

Two general types of cloud conditions are currently being used in seeding operations. In the Rocky Mountain region, winter orographic clouds (formed by the upward thrust as air masses cross mountains) are seeded to produce increased snowfall and provide deeper snowpacks above storage reservoirs. Ground-based silver iodide generators are generally used in this area, because

it is more economical and flying conditions are hazardous. In the Central and Eastern United States, summer cumulus clouds are seeded to release precipitation directly upon drought-ridden areas. Aircraft are generally preferred for this type of seeding, but ground-based generators may also be effective. For some newer seeding techniques, larger and more expensive aircraft would be required. (See Figure 4.)

"Project Skywater," a Bureau of Reclamation program, indicates that about 2 million acre-feet per year of low-cost water could be added to runoff within the Colorado River Basin as a result of an active winter-season cloud-seeding operation.⁴ This additional supply would be significant in controlling or mitigating the effects of drought in the Southwest. It has been estimated that two inches of additional rainfall in the Northern Plains area (a seasonal increase of approximately 16 percent) would increase crop yields by 10 percent.⁵

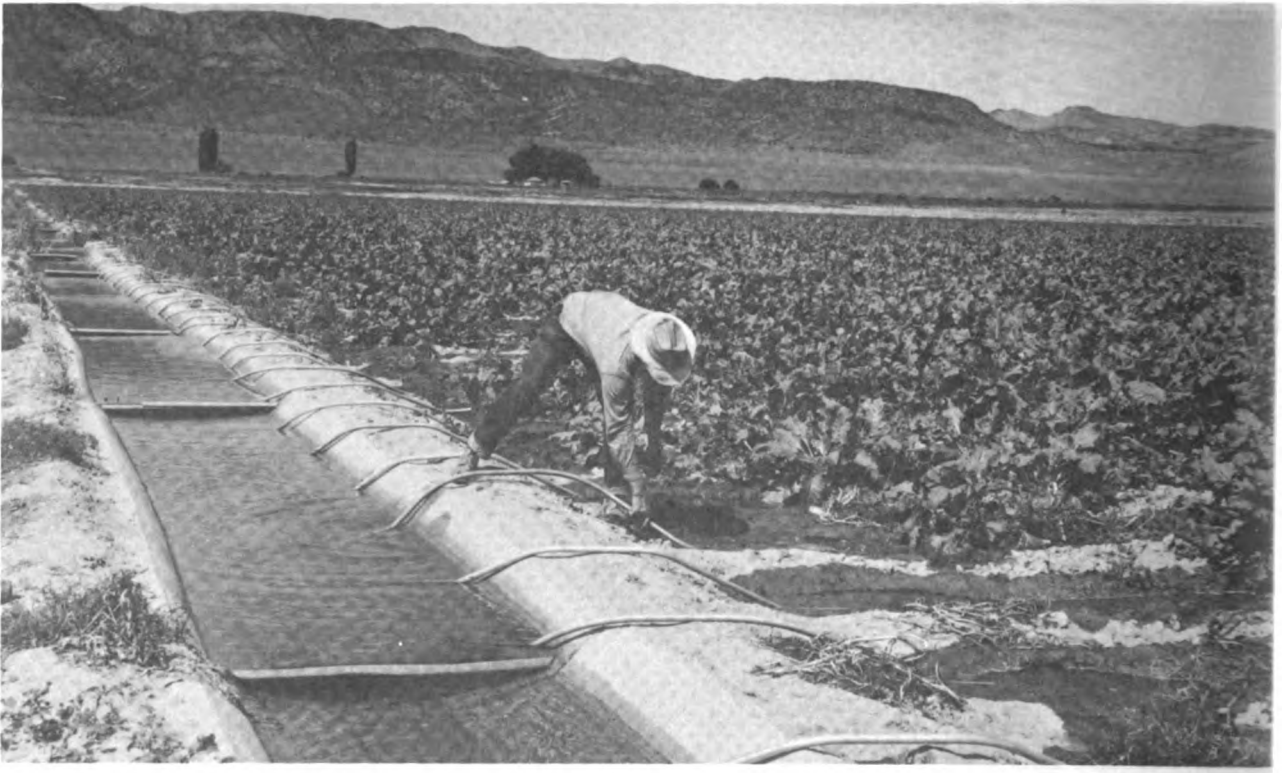


Figure 3.—Water Supply Efforts: (above) use of concrete ditches and siphons to water sugar beets (near Elberta, Utah); (below) a portion of a 1300-foot pivoting sprinkler system covering 147 acres (Seedskadee Project, Wyoming)—Bureau of Reclamation photos.



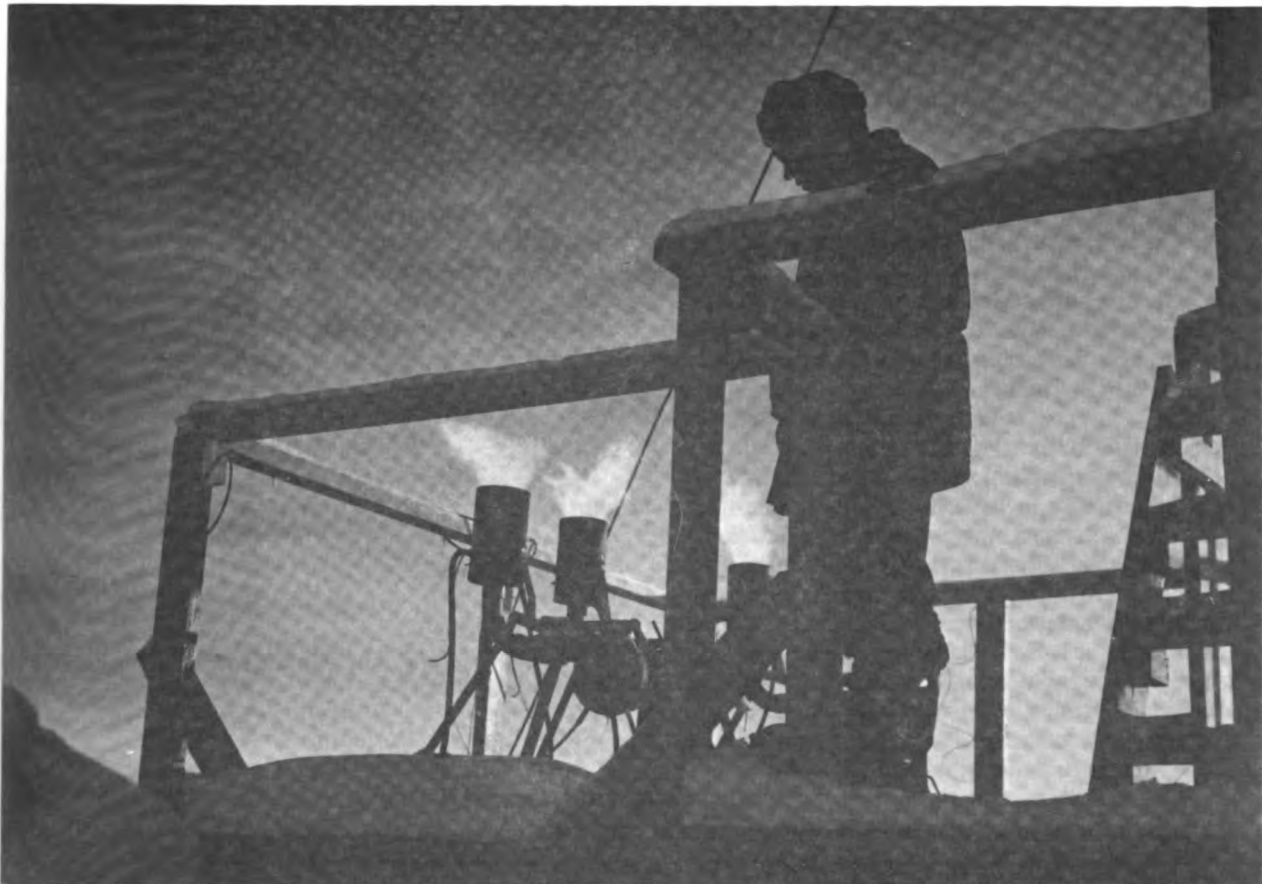


Figure 4.—Cloudseeding Methods: (above) silver iodide generators on Emerald Mountain, Colorado; (below) a T-6 aircraft tests experimental pyrotechnic cloudseeding devices near China Lake, California—Bureau of Reclamation photos.



Although current and proposed Federal weather modification programs show promise in helping to alleviate dry conditions, these programs cannot possibly accommodate all affected areas. Commercial cloud-seeding operations, however, are available to governmental and private agencies and have been operating in a majority of the drought-prone western States. Financing has been provided by State governments, counties (by local tax assessments), cities and townships, associations, private industry, and individual farmers and ranchers.

A discussion of some of the considerations involved in establishing a national weather modification program appears in Part IV, Chapter C.

Desalination. Under the Saline Water Act of 1952⁶ and the Saline Water Demonstration Act,⁷ the Office of Saline Water (OSW) in the Department of the Interior has made considerable progress in the development of desalting processes. Because seawater and brackish feed-water sources are available in many drought-prone areas, desalting offers a capability to supplement normal water supplies. There are some 712 desalting plants in operation in the world, with a total installed capacity of 245 million gallons per day.

The feasibility of using desalting plants in an emergency was demonstrated during the Cuban crisis in 1964. Three desalting units, eventually installed at Guantanamo, provided 2½ million gallons of water per day at the U.S. naval installation.

During the unusually dry weather in the northeastern United States from 1961 to 1966, water shortages developed in many areas. In New York City, supplies dropped to approximately 30 percent of capacity in October 1963.⁸

Desalting as a droughtproofing measure was assessed in 1966 by a joint technical team of Federal, State, city, and utility representatives to determine the "potentialities and possibilities of desalting for Northern New Jersey and New York City."⁹ Their study indicated that desalting could alleviate drought effects by providing supplemental water, and that desalting plants could provide this service most economically when operated in conjunction with the existing water system. The study also showed that the desalting plant could be operated either intermittently or at base load for extended periods of time and could be kept in standby condition during periods of ample natural water supply.

In a follow-on effort with OSW, New York City conducted a study concerning emergency water supply to the individual boroughs.¹⁰ This study indicated that desalting plants could supply the boroughs through modular unit increases in plant capacity.

Water Conservation. The U.S. Department of Agriculture is heavily engaged in water conservation programs. Its Soil Conservation Service provides technical assistance to landowners and operators in planning, ap-

plying, and maintaining soil and water conservation measures, under the Great Plains Conservation Program (Act of 1956, as amended November 1969),¹¹ and the Resource Conservation and Development Projects (Food and Agriculture Act of 1962).¹² The Agricultural Stabilization and Conservation Service administers the Rural Environmental Assistance Program (REAP), which provides cost-sharing assistance to farmers and ranchers for carrying out water conservation measures.

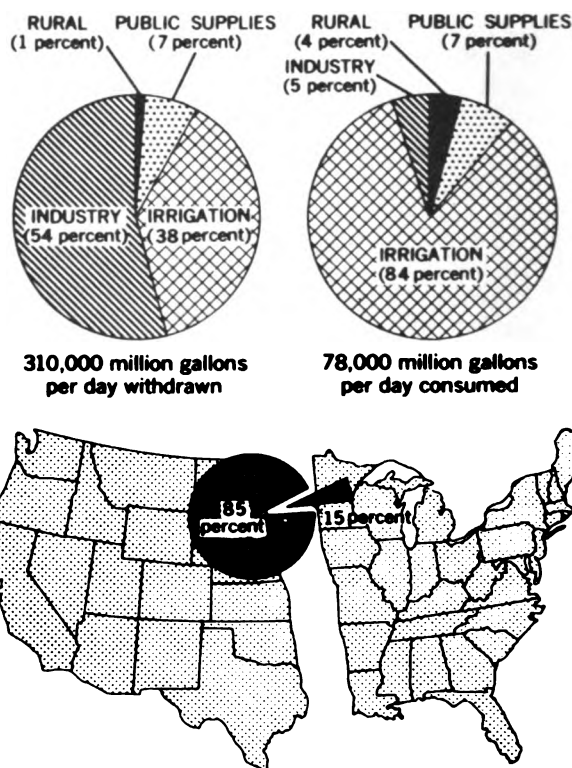


Figure 5.—Water Consumption, 1965: (above) withdrawal and consumption, by category; (below) consumption in the 17 western States and the 31 eastern States—from *Estimated Use of Water in the United States, 1965* (p. 8).

Efficient methods of handling and using water can permit a given water resource to survive longer periods of dryness. Figure 5 shows the distribution of water withdrawn and consumed in the United States in 1965. The right-hand pie chart shows that irrigation accounted for about 84 percent of the estimated 78,000 million gallons per day of fresh water consumed. Thus, efficient irrigation can have major impact on water conservation.

Research and development to improve irrigation efficiency has been an ongoing program of the Bureau of Reclamation. During the past few years, pilot projects involving computerized water scheduling, based on actual soil moisture measurements, have shown that farmers are often poor judges of when to irrigate. The

projects produced higher yields at lower rates of water usage than traditional methods.¹³

The manner of conveyance of water is highly significant. Federal Government planning criteria for irrigation projects now require that economic justification be shown for building other than lined canals. The use of pipes is encouraged, which is a marked departure from the past, when unlined canals were used except through sandy soil or other areas conducive to extreme leakage. Automation of water conveyance system operation is being developed. Some systems are being planned to include complete computer scheduling of conveyance system flows and storage through automatic control of outlet and canal gate structures.¹⁴

Reclamation of Effluents. The Environmental Protection Agency, under authority of the Water Pollution Control Act,¹⁵ conducts research and development projects and demonstrates feasible techniques for reclamation of waste waters for reuse.

It is conservatively estimated that 60 to 70 percent of the total public water supply requirements in highly developed and sewered urban and industrial areas is eventually returned to streams, lakes, or the sea via sewage systems.¹⁶ Reclamation of this effluent for recycling could increase usable water supplies significantly. During 1965, an estimated 23.6 billion gallons of water per day were withdrawn from various sources for use in public water supply systems in the continental United States.¹⁷ Public acceptance of reclaimed sewage as a source of potable water has been slow to evolve; however, pilot sewage reclamation projects, such as the locally sponsored West Santee Project near San Diego, California, have been accepted for fishing and other recreational purposes, including swimming.¹⁸

Coordinated Use of Water Resources. The U.S. Geological Survey, in the Department of the Interior, in 1894 was given the responsibility of gauging streams and determining water supplies.¹⁹ The programs conducted by the Geological Survey include determination of the source, quantity, quality, availability, distribution, and management of both surface and ground waters.

The total national water resource can be more effectively utilized if water sources can be completely identified. Historically, there has been a tendency not to recognize the association between surface-water and ground-water resources in the same hydrologic basin. In order that water withdrawals can be coordinated, and because of the importance of adjudication of water rights, these relationships need to be as clear as possible.

Drought Emergency Measures

During agricultural drought, serious problems arise in determining the nature and extent of Federal assistance warranted. During the early stages of the drought,

strong pressures may be exerted to obtain substantial Federal assistance. If the drought terminates quickly, such Federal assistance is not necessary; if prolonged, the early commitments may prove prohibitively expensive to maintain. Federal emergency assistance provided to farmers and ranchers in drought-stricken areas includes:

- Sale of feed grain at reduced prices,
- Freight cost sharing on hay,
- Grazing and haying on "diverted acres,"
- Cost sharing on water conservation measures,
- Emergency and other Farmers Home Administration loans,
- Small Business Administration loans,
- Weather modification programs,
- Office of Civil Defense loans of emergency water supply equipment.

On the basis of the experiences with the southwestern drought in 1971, consideration should be given to amending applicable legislation to provide Federal assistance more directly responsive to individual and public requirements. Unlike other disasters, droughts primarily affect agriculture, domestic and industrial water supply, water-based recreation, and fish and wildlife resources, all of which may require some Federal assistance for long periods. Nonagricultural segments of the population within a drought area may be adversely impacted only if the drought is unusually severe or prolonged.

The U.S. Department of Agriculture now has some latitude for its own programs and can extend repayment periods on loans, modify conditions and prices for feed, and suspend assistance when determined to be no longer needed. However, present legislative authorities and funding available to the Secretary are insufficient to preclude reliance by the States on a major disaster declaration to trigger desirable Federal assistance.

Prolonged droughts may adversely affect the water supply of municipalities, thereby generating a need for emergency measures. In addition to the previously cited Federal programs to augment water supplies, there are actions that can be taken in advance by State and local agencies. The need for emergency measures such as installation of pipe lines and, for small entities, the hauling and storage of water can be foreseen prior to an actual disaster condition; thus, the necessary actions can be preplanned to insure that emergency measures can be implemented in the most timely and efficient manner.

Findings

1. In certain parts of the country, there is a definite cyclical recurrence of abnormally dry conditions. Although the timing and intensity of these cycles cannot be accurately predicted, historical evidence on the probabilities of recurring dryness is well known. These factors should be considered by individuals and political entities in planning for the use of emergency measures to

increase water supplies and for the most efficient use of farm, forest, and range lands and water resources.

2. *Droughts do not pose an immediate danger to life and property, because they are slow in reaching disaster status; however, there can be a serious economic impact which develops over a prolonged period in the drought-stricken area.*

A comprehensive prevention program requires:

- Construction and improvement of modern, multi-purpose water supply facilities to ensure that fresh water reserves can be fully and effectively utilized.
- Continued emphasis and support of Bureau of Reclamation programs to maintain water reserves by encouraging efficiency in storing, transporting, and using water, especially for irrigation.
- Education of the public to accept the use of reclaimed effluent water, a feasible program which could provide a significant water supply while reducing water withdrawal requirements.
- Expanded use of desalting procedures, where economically feasible, to provide reliable supplies of fresh water from brackish water or seawater, including consideration of the droughtproofing role of desalting plants in addition to their function of supplementing other water supplies.

- Acceleration of land treatment and management programs that emphasize moisture conservation, including use of crops and grasses best suited for the limited moisture available in a drought.

3. *Weather modification holds promise of increasing precipitation during dry seasons and reducing the effects of cyclic droughts.* This potential capability can be improved by:

- Completion of ongoing weather modification pilot projects by the Bureau of Reclamation and by NOAA to refine techniques and gain operational information.
- Continued use of commercial cloud seeding operations by State, county, and local governments and by private organizations and individuals to supplement water supplies.

4. *Disaster assistance under Public Law 91-606 is not designed to cope with agricultural droughts. The central role of the Department of Agriculture in providing Federal assistance should receive continued emphasis. This should preclude reliance on a major disaster declaration in meeting the demands of agricultural droughts.*

Notes

¹H. E. Thomas et al., *General Summary of Effects of the Drought in the Southwest*, Geological Survey Professional Paper 372-H, U.S. Department of the Interior (Washington, D.C.: U.S. Government Printing Office, 1963).

²*A Report on Drouth in the Great Plains and Southwest*, prepared under direction of the Special Assistant to the President for Public Works Planning, Washington, D.C., October 1958.

³43 USC 391 et seq.

⁴See *Project Skywater, Atmospheric Water Resources Program* (pamphlet), U.S. Department of the Interior, Bureau of Reclamation (Washington, D.C.: U.S. Government Printing Office, 1971).

⁵See *Project Skywater—1970 Annual Report*, Bureau of Reclamation (Denver: U.S. Department of the Interior, 1970).

⁶66 Stat. 328, as amended; 42 USC 1951 et seq.

⁷72 Stat. 1706, 42 USC 1958a-1958g.

⁸Wayne C. Palmer, *The Abnormally Dry Weather of 1961-1966 in the Northeastern United States*, New York University Sterling Forest Conference on Drought, May 16, 1967.

⁹Northeast Desalting Team, *Potentialities and Possibilities of Desalting for Northern New Jersey and New York City* (Washington, D.C.: U.S. Department of the Interior, 1966); also, Ralph M. Parsons Co., *Engineering Study of the Potentialities and Possibilities of Desalting for Northern New Jersey and New York City*, Office of Saline Water R&D Progress Report No. 207

(Washington, D.C.: U.S. Department of the Interior, 1966), p. 2-1.

¹⁰Parsons-Jorden Corporation, *Study of Seawater Desalting as Emergency Supply for New York City*, Office of Saline Water R&D Progress Report No. 553 (Washington, D.C.: U.S. Department of the Interior, 1970).

¹¹70 Stat. 1115, as amended by 83 Stat. 194; 16 USC 590.

¹²76 Stat. 608, 16 USC 1001 et seq.

¹³Maurice N. Langley, "Automation of Irrigation," paper presented at the National Irrigation and Drainage Specialty Conference, American Society of Civil Engineers (Phoenix, Ariz., November 13-15, 1968), p. 5.

¹⁴*Ibid.*, pp. 11-14.

¹⁵70 Stat. 448, 33 USC 466.

¹⁶Harold E. Babbitt and Robert E. Baumann, *Sewerage and Sewage Treatment*, 8th ed. (New York: John Wiley & Sons, 1958); also, *Feasibility of Reclamation of Water from Wastes in the Los Angeles Metropolitan Area*, Bulletin No. 80 (Sacramento: California Department of Water Resources, 1962), p. 42.

¹⁷C. Richard Murray, *Estimated Use of Water in the United States, 1965*, Geological Survey Circular 556 (Washington, D.C.: U.S. Department of the Interior, 1968), p. 3.

¹⁸*Santee Filtration Study*, State of California, Department of Public Health, Bureau of Sanitary Engineering (Sacramento: 1965), pp. 8-10.

¹⁹28 Stat. 398.

PART IV.

DISASTER MITIGATION

Part III analyzes the measures that can be taken to cope with current vulnerability to natural disasters. Part IV is devoted to examining means to reduce that vulnerability. In most instances, this raises complex issues of public policy, and success may not be realized for many months, even years.

The chapters that follow present an outline of a national program to foster enactment and enforcement

of land-use and construction regulations by local jurisdictions to protect life and property more fully. An examination is made of initiatives to lessen the financial vulnerability associated with natural disasters through insurance. And the role of the Federal Government in weather modification activities aimed at lessening the intensity of natural phenomena is discussed.

Chapter A. Land Use and Construction

Introduction

Averting or lessening the potential effects of natural disasters can be achieved by regulating the use to which land is put and the materials and methods employed in the design and construction of physical facilities. For example:

Much of the debris in [the Lubbock tornado] originated from buildings. This debris consisted of broken glass, masonry veneer, wood cladding, copings, clay roofing tiles, and metal roof and wall panels. This in turn caused damage and generated additional debris as it struck buildings in its path. Obviously one way to reduce the loss of life, limb and property is to pay more attention to the design of these elements.¹

Similar examples could be cited in reference to other natural disasters, such as siting housing developments and utility structures on identified geological faults, on potential slide areas or unstable fills, or on flood plains.

Except on Federal lands or, in certain instances, where Federal funds are involved, the regulation of land use and of construction materials has traditionally resided in the States, with frequent delegation to counties, municipalities, or other local government units through general enabling legislation. The resulting restrictions on property rights have been sanctioned by the Supreme Court in at least two landmark decisions rendered in the 1920's.² Federal Government concern with safe land use and adequate construction practices is based on both humanitarian and economic considerations. With the continuing concentration of a large percentage of the Nation's population in urbanized areas susceptible to natural disasters, great numbers of people are in jeopardy. There is also need to protect public funds expended in recovery and rehabilitation efforts after disasters, in the form of loans and grants for construction of educational, health, and transportation facilities and for other purposes, and in guaranteeing loans made by private institutions for a variety of reasons.

With the focus on disaster mitigation, this chapter examines the feasible means to bring about a more purposeful and effective cooperative venture in this field between the Federal Government and State and local jurisdictions.

Land Use

As in other areas covered by this study, an understanding of the vulnerability to disaster of a geographic location is prerequisite to effective action directed toward achieving safer land use.

Risk Mapping. The results of vulnerability analyses are generally presented in the form of "risk maps," which portray the type and degree of hazard represented by a particular natural phenomenon in a given geographic location. Earthquake risk mapping, for example, identifies faults and the underlying geological conditions of the locality, flood plain mapping indicates the areas likely to be covered by water during floods of given magnitudes, tsunami risk maps delineate the areas that would be inundated as a result of waves of varying heights, and forest-cover mapping estimates the vulnerability of woodlands to fire.

The Federal Government is now engaged in risk mapping. The National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, and the U.S. Geological Survey (USGS), Department of the Interior, have ongoing programs to identify hazards and earth conditions in areas susceptible to earthquakes, tsunamis, landslides, and volcano activities, mostly in the Pacific States and in Hawaii. The work of the U.S. Army Corps of Engineers and the Soil Conservation Service (SCS) in mapping flood hazards is extensive. NOAA also is conducting a program to identify and map coastal areas likely to be flooded as a result of hurricanes and storm surges. The Department of Housing and Urban Development (HUD), jointly with the Department of the Interior, is sponsoring a 4-year, \$6.6 million study of the San Francisco Bay area. This effort is developing information on earthquake and landslide hazards, on the effects of earthquake shocks on different types of soil, and on the identification of the degree to which various localities in the Bay area are flood-prone.³ (For more details on these programs, see the relevant chapters of Part III.)

Private organizations, such as the American National Standards Institute (ANSI) and the several model code organizations, also engage in work leading to the publication of risk maps. Notable among these are the ANSI Standard A58.1-1955, which provides a wind map (based on work of the American Society of Civil

Engineers and others) and snow load map, and the International Conference of Building Officials model code treating seismic designs.

Land-Use Ordinances. The data developed by these risk-mapping activities can be used by local authorities to regulate future land use to mitigate the effects of disasters. Areas of extreme risk, for example, can be left undeveloped; or areas of medium hazard can be devoted to low-density occupancy, while prohibiting the location of emergency service facilities in such areas.

Enactment and Enforcement of Land-Use Ordinances. State enabling legislation, granting local autonomy in the regulation of land use, generally goes back to the 1920's.⁴ Especially during the past 5 years, States have begun to place restrictions on such autonomy to reflect disaster mitigation and environmental protection considerations.⁵ Local land-use regulation generally includes subdivision regulation, zoning ordinances, and zoning maps.

There are no model land-use codes as widely used as the model codes available for use in the preparation of building code regulations. The American Law Institute is preparing a Model Land Development Code,⁶ but it will not be completed soon. In the interim, local officials must rely on less structured sources to guide their regulatory efforts, such as the *Model Zoning Ordinance with Commentary*, American Society of Planning Officials.

Not all local jurisdictions have enacted land-use regulations. Of the almost 18,000 communities surveyed in 1968 by the National Commission on Urban Problems, 53 percent had zoning ordinances and 45 percent had subdivision regulations. Within Standard Metropolitan Statistical Areas (SMSA's), 68 percent had zoning ordinances and 59 percent had subdivision regulations.

While planning for safe use of land can often be accomplished most effectively on an area basis (by several States, counties, or municipalities), the efforts to date remain largely local in character. This is especially so in metropolitan areas. As of 1968 in Philadelphia, for example, 200 out of 238 local jurisdictions had zoning authority; in Cook County, Illinois (including Chicago), 112 out of 129.⁷ Regional or county planning bodies are mostly advisory in nature and therefore cannot overcome the adverse effects of this fragmentation.

Land-use regulations are usually enforced by officials who often must divide their time among several functions. According to the National Commission, 60 percent of local jurisdictions located in SMSA's had no fulltime staff assigned to land-use regulation in 1968.⁸

The Federal Role. The Federal Government has several procedures and programs for exercising influence in land use throughout the country.

One very effective way is to set an example by selecting proper sites for buildings constructed or leased for Federal use and for buildings financed, guaranteed, or insured by Federal agencies. Executive Order 11296⁹

forbids Federal building agencies to use the Nation's flood plains in an "uneconomic" and "unnecessary" manner and orders Federal agencies to withhold loans and grants which are inconsistent with this objective. Although limited to river floods, this Executive order establishes a legal precedent applicable to other natural disasters. Moreover, it permits the accumulation of data and administrative experience that would prove useful in any further initiative by the Federal Government to help other governmental jurisdictions prescribe safer use of land. The 1967 USDA *National Inventory of Soil and Water Conservation Needs* tabulated for each significant land use the land capability class and subclass, the treatment needs, and the change in land use needed. These statistics cover the entire country and are widely used in land-use planning.

Among other ongoing Federal programs supporting local efforts are grants made under the authority of Section 701 of the Housing Act of 1954, as amended, which includes land development. Many communities have used funds under this program to establish or improve comprehensive local land-use planning programs. (For summary information on the total grant program, see Table 1.) Included among these communities are several from Mississippi and California

Table 1.—Comprehensive Planning Assistance Grant Program: Net Approvals by Type of Area Assisted 1954-1969 (dollars in thousands)—HUD.

Type and calendar year	Program status at end of year		Net activity during year	
	Projects	Amount	Projects	Amount
Total*				
1954	1	16	1	16
1955	15	475	14	459
1956	49	1,710	34	1,235
1957	116	4,403	67	2,693
1958	192	6,606	76	2,203
1959	292	8,662	100	2,056
1960	493	13,400	201	4,738
1961	710	22,285	217	8,885
1962	1,092	42,040	382	19,755
1963	1,462	59,747	370	17,707
1964	1,841	79,178	379	19,431
1965	2,286	99,973	445	20,795
1966	2,743	122,910	457	22,937
1967	3,347	148,326	604	25,416
1968	4,634	191,271	1,287	42,945
1969	5,177	230,085	543	38,814
Small areas				
1955	7	220	7	220
1956	27	890	20	670
1957	67	2,598	40	1,708
1958	122	4,295	55	1,697
1959	170	5,090	48	795
1960	312	8,193	142	3,103
1961	482	13,716	170	5,523
1962	803	24,117	321	10,401
1963	1,105	32,932	302	8,815
1964	1,388	42,725	283	9,793
1965	1,718	52,079	330	9,264
1966	2,074	62,844	356	10,765
1967	2,512	71,498	438	8,654
1968	3,456	87,708	943	16,208
1969	3,663	96,613	207	8,908

Type and calendar year	Program status at end of year		Net activity during year	
	Projects	Amount	Projects	Amount
Metropolitan regional and other areas				
1964	1	16	1	16
1965	8	255	7	239
1966	22	820	14	565
1967	49	1,805	27	985
1968	70	2,311	506	56
1969	122	3,573	52	1,262
1960	169	4,943	47	1,370
1961	203	7,199	34	2,256
1962	247	13,840	44	6,641
1963	303	19,962	56	6,122
1964	366	26,017	63	6,055
1965	454	34,985	88	8,968
1966	526	43,026	72	8,041
1967	663	55,704	137	12,678
1968	924	71,582	262	18,910
1969	1,157	93,929	233	22,342
Statewide				
1960	12	265	12	265
1961	25	1,370	13	1,105
1962	42	4,083	17	2,713
1963	53	6,848	11	2,765
1964	70	10,210	17	3,362
1965	88	12,371	18	2,161
1966	110	16,410	22	4,040
1967	130	20,086	20	3,676
1968	196	29,999	66	6,881
1969	263	34,466	67	4,468
Advisory services to small communities				
1963	1	5	1	5
1964	17	226	16	221
1965	26	538	9	321
1966	33	629	7	91
1967	46	1,038	13	409
1968	58	1,982	16	945
1969	80	4,210	22	2,228
District				
1969	14	867	14	867

*Excludes grants for studies, research, and demonstration projects under Section 701 b.

that received Federal grants after Hurricane Camille¹⁰ and the San Fernando earthquake.¹¹ Consideration of disaster mitigation measures is not an explicit requirement for obtaining these grants, or HUD grants for other purposes, but "communities are encouraged to adopt land use and code requirements which will prevent or minimize damage that can be caused by disasters."¹²

In 1971, the President proposed a National Land Use Policy Act¹³ to provide \$100 million in Federal funding over 5 years to help States prepare land-use planning and regulatory programs. One provision of the bill encourages States to identify and control development in "areas of critical environmental concern," including hazardous areas. States that fail to develop adequate programs by 1975 would lose an annually increasing portion of Federal funds for airports, highways, and park acquisition.

The program would be administered by Interior with review of developmental matters by HUD. State laws pertaining to the development of wetland, flood plains, areas of seismic subsidence, and erosion- and mudslide-

prone areas might be reviewed annually for adequacy by the Federal Government pursuant to this Act. A regional approach to these issues could alleviate problems of local inexperience, staff limitations, and particularly the tendency of some local governments to acquiesce in unwise new development because of a desire to increase property tax revenues. The legislation should also assist State and local governments in giving recognition to environmental as well as public health and safety matters.

Construction

Even after knowledge of the hazards associated with a given locality have been identified and incorporated into land-use regulations, additional hazard mitigation measures can be taken by specifying that structures be adequately designed, constructed, operated, maintained, and—eventually—retired. For example, the roof of a light-weight structure near a coastline susceptible to hurricane-force winds can be fastened more securely to the rest of the structure and the structure itself fastened to its foundations, so that the roof will resist uplifting forces and the structure will resist overturning forces. Or bridge superstructures can be more securely braced and anchored to enable the bridge to withstand the dynamic loads created by earth tremors. This level of hazard reduction can be achieved through the enforcement of properly conceived local building ordinances. These ordinances usually consist of a regulation compendium that:

... establishes requirements for the construction and occupancy of buildings. It contains standards of performance and specifications for materials, methods and planning criteria which affect structural strength, fire resistance, adequate light and ventilation, and other considerations determined by the design, construction, alteration and demolition of buildings.¹⁴

Such ordinances generally are enacted and updated through a process that has its genesis in a vast array of public and private entities producing materials, design, and construction-method criteria and standards. These criteria and standards are used to delineate, support, or give specificity to public health-and-safety and property-protection requirements set forth in the ordinance (or code). The code itself usually reflects local conditions and, not infrequently, local socio-economic factors as well. Most local code-enforcing bodies participate in one or another of the major national model code organizations (discussed below), which provides a mechanism for relating to the criteria- and standards-issuing organizations.

Construction Standards. There are three basic types of construction standard: engineering practice, material, and test standards.¹⁵ They are used to minimize the extremely large number of variables in types, qualities,

and physical dimensions of construction products and practices.¹⁶

Because of the diversity of the construction industry, standards are developed by a large number of trade associations, private research organizations, and government agencies. A recent incomplete compilation lists over 200 such groups. Among the most significant private standards-issuing organizations are the American Society for Testing and Materials and the American National Standards Institute. Inputs to these organizations are made by such well-established groups as the American Institute of Steel Construction, the American Concrete Institute, the National Forest Products Association, the Structural Clay Products Association, the Underwriters' Laboratories, and the National Board of Fire Underwriters.

Federal agencies that have a significant role in this field are the National Bureau of Standards (NBS) and the Office of Product Standards of the Department of Commerce, the General Services Administration (GSA), the Federal Housing Administration (FHA) of HUD, and the Military Services of the Department of Defense. From the disaster mitigation viewpoint, NBS has one of the most active research programs; its activities include improving the performance of buildings, studying and understanding the response of buildings and materials to forces experienced in natural disasters, generating technical data and measurement techniques for evaluating building responses and performances, and encouraging the adoption of recommendations in applicable codes and criteria.¹⁷ The Bureau also has extensive contacts with State officials as a result of its work with the National Conference of States on Building Codes and Standards, for which it provides a secretariat.

Over a number of years, several well-known organizations have attempted a systematic compilation of construction criteria and standards. In addition to the model building-code organizations discussed below, the most significant of these groups are the American Society for Testing and Materials; the American National Standards Institute; the American Society of Mechanical Engineers; the American Society of Heating, Refrigeration, and Airconditioning Engineers; the Institute of Electrical and Electronic Engineers; and the National Fire Protection Association.¹⁸ To these, two more should be added: FHA, which publishes the *FHA Minimum Property Standards* as a basis for mortgage loan guarantees, and the American Savings and Loan Institute, which publishes the *Construction Lending Guide*.

Model Building Codes. Model building codes are suggested requirements for the regulation of building to protect the safety, health, and welfare of the public. Model codes integrate the construction standards with legal and administrative procedures and present them in a systematic and codified manner for the use of State, ~~city~~, or local jurisdictions. There are two general

approaches found in model codes: the specification-type code, which establishes building construction requirements by reference to particular materials and methods, and the performance-type, which establishes design and engineering criteria without reference to specific methods in construction. Because specific detailed information is not yet available, many model codes have features of both types. Performance codes are easier to keep current and facilitate the introduction of new materials and methods. How model codes are used by local jurisdictions is discussed later.

Model codes are prepared by private groups for voluntary adoption by local jurisdictions and are subject to continuing review and updating. The oldest model code in this country, the National Building Code, was first published in 1905 by what is now the American Insurance Association. Several other model codes prepared by other associations have come into existence since then, some of them for special purposes. Codes cover such items as structural design, fabrication, and erection; electrical wiring; heating, cooling, and air conditioning; boilers; and fire safety. The most prominent of these groups, with the location and specialty of each, are shown in Table 2.

Because of the regional and other origins of the major model codes, each tends to give special emphasis to a particular peril: the National Building Code, fire; the Uniform Building Code, earthquakes; the Basic Building Code and the Southern Standard Building Code, strong winds and heavy precipitation. With the passage of time, they have come to reflect the climatic and economic conditions of large regions of the United States, and as such have become regional in their orientation.

A few States have developed building codes, some of which take precedence over local codes and some of which are operative in areas where no local code exists. Of these, the State of New York code is the best known. It is a performance-type code that includes a program for continuing review of construction methods and materials and assistance to users in code interpretation and application.¹⁹

The Federal Government does not promulgate a model building code. The closest to such a code are the *FAA Minimum Property Standards for Single and Multifamily Housing* and the Water Resources Council-Corps of Engineers-HUD Study of Flood Plains.

Building Ordinances. These laws, specifying how buildings shall be constructed in each locality to protect health, safety, and property, represent the decisive step in construction regulation. They are also most difficult for the Federal Government to influence, because they cover an activity solely within the purview of State, county, and local jurisdictions and responsive to local economic, social, and political concerns and interests. Yet these local regulations are the most significant

Table 2.—Model Building Codes—updated from *Construction: Principles, Materials, and Methods* (p. Codes 602-5).

CODES	SPONSORING ORGANIZATION
Basic Building Code	Building Officials Conference of America, Inc. 1313 East 60th Street Chicago, Illinois 60637
Southern Standard Building Code	Southern Building Code Congress Brown-Marx Building Birmingham, Alabama 35203
Uniform Building Code	International Conference of Building Officials 50 Los Robles Avenue Pasadena, California 91101
National Building Code	American Insurance Association 85 John Street New York, New York 10038
National Plumbing Code	American National Standards Institute 1430 Broadway New York, New York 10018
Uniform Plumbing Code Uniform Heating & Comfort Cooling Code	International Association of Plumbing and Mechanical Officials 5032 Alhambra Avenue Los Angeles, California 91032
National Electric Code	National Fire Protection Association 60 Batterymarch Street Boston, Massachusetts 02110

means to effect hazard reduction measures in construction activities.

The Federal Role. The Federal Government has no direct role in the formulation, enactment, and enforcement of building ordinances. Federal agencies heavily involved in construction activities (GSA and DOD especially) and in insuring loans (HUD, Veterans Administration, Department of Agriculture) prescribe adherence to nationally known model codes or establish minimum standards. There is not enough emphasis, however, on including hazard mitigation measures not already contained in such codes or in the ordinances of

the localities in which federally financed or insured structures are to be located.

There are several programs administered by HUD that offer opportunities to support local jurisdictions in their efforts at formulating building ordinances. The three most significant grant programs are those under Section 701 of the Housing Act of 1954 (mentioned earlier), Section 105(a) of the Housing Act of 1965, and Section 101(c) of the Housing Act of 1949, as amended in 1954. The first-mentioned program encourages the development of local building ordinances (as well as land-use regulations) that conform to the minimum standards contained in nationally known codes. The second program funds efforts to improve building code enforcement activities of local jurisdictions as a prerequisite to receiving funding for urban renewal projects. To qualify for certain Federal aids under the third, the Workable Program for Community Improvement, a community must be carrying out an official plan of action (certified by HUD as a Workable Program) involving concentrated code enforcement, demolition of unsound structures, urban renewal, or similar programs of significance to disaster mitigation.

Many ongoing Federal grant and loan programs designed to improve the social, economic, health, educational, safety, and transportation conditions of the country do not now establish any hazard reduction measure as a prerequisite for financial aid. This study has not surveyed such programs completely. However, the funds involved are known to be very large, and the impact reaches virtually every local jurisdiction in the Nation. These programs could provide an incentive now lacking for these jurisdictions to incorporate safe land-use and construction regulations into State and local laws. A legal precedent for the use of this mechanism has been established by the National Flood Insurance Act of 1968, Public Law 90-448 (See Chapter B of this Part), and the experience gained in administering this law could provide useful guidance in the preparation of regulations aimed at mitigating disasters other than river floods.

Various Federal agencies make grants or loans to repair, restore, or reconstruct disaster-damaged residential structures and to do postdisaster planning. Also, Federal contributions are made to local jurisdictions for similar purposes in connection with specified public facilities. (At present, this restoration or rebuilding can be undertaken as long as it conforms with applicable building codes, specifications, and standards—Sections 243 and 252 of PL 91-606.)

Enactment and Enforcement of Building Ordinances. Because regulation of most construction is delegated by the States to county and municipal governments, few States have mandatory minimum statewide building laws. Some, however, do have laws applicable to certain types of construction—for example,

facilities used for emergency purposes (such as hospitals), public utility structures, places of public gatherings, industrial establishments,²⁰ and, more recently, industrialized housing.

In preparing building laws, most local authorities rely on model codes, especially on the first four listed in Table 2 and on the State of New York Model Code. In a 1964 survey of 1,013 cities by the International City Managers' Association (ICMA), the one most frequently adopted was the Uniform Building Code. Standards drafted to meet local conditions were the second most frequent source of codes. The National Building Code was third, the Southern Standard Building Code fourth, and the Basic Building Code fifth. Nearly a hundred more cities modified one or more of the codes for their own use. The others adopted or modified State codes, such as New York's. The data also show that the Uniform Building Code is used largely on the West Coast, the Basic Building Code in the northern Middle West, the National Building Code along the East Coast, and the Southern Standard Building Code in the South.

The importance of sound model codes with strong hazard reduction features is therefore readily apparent. There are also several other disaster mitigation factors bearing on the enactment of building ordinances:

- *Lack of Building Ordinances.* An adequate medium for the implementation of a hazard reduction program does not exist in many communities throughout the United States. In a 1968 sample survey by the National Commission on Urban Problems, almost 20 percent of the townships and municipalities with a population of 5,000 or more did not have building ordinances.²¹ Nor, generally, do rural communities.

- *Lack of Uniformity.* Model codes as a vehicle for ensuring uniformity among local building ordinances are only moderately effective. Local jurisdictions often prepare their own codes or adopt only portions of the model codes used as a basis for their ordinances. Only 53 percent of those surveyed by the National Commission "substantially incorporated" (by Commission standards) model code provisions.²² Changes made to adapt model codes to local conditions at times "come from local codes prepared 20 or more years ago," according to the National Association of Home Builders.²³

- *Delay in Updating.* Advances in technology often find their way into codes only after considerable delay. Once adopted by local governments, ordinances are not easily changed. According to the National Commission survey, only 58 percent of the jurisdictions using model codes had established procedures for the annual consideration of changes recommended by the model code groups. Only 28 percent had adopted as much as 90 percent of the changes recommended by such groups during the previous 3 years. Of all jurisdictions having a building code of any kind, 45 percent either had not adopted new codes or had not comprehensively revised them in the previous 4 years.²⁴ In all fairness, however, it should

be pointed out that the process of assessing what constitutes a true technological advance is very difficult, principally because of current inability to predict accurately the applications and performance of new technology products.

Like any other law, building ordinances require competent enforcement personnel and adequate procedures and funds to ensure their effective application and expeditious compliance. The local building official entrusted with enforcement of construction ordinances is often short of the required documents. Inspectors are too few in number for the volume of construction taking place and for the existing inventory and are not always fully trained. In some localities, inspection is only one of their many functions. (The 1964 ICMA data, for example, showed that, of the 1,013 cities surveyed, only 215 employed fulltime engineers for building plans examination and 28 others used architects.)

Also, use of fines, in lieu of correcting the problem, and delays caused by large backlogs of cases often detract from effectiveness in ordinance enforcement.

Although awareness of the dangers posed by natural disasters and of resultant damage is not as widespread as it should be, several local jurisdictions have taken steps to improve ordinances to cope more adequately with the adverse effects of natural phenomena. For example:

- *Earthquake Hazard Reduction.* The Legislature of the State of California has a Joint Committee on Seismic Safety, which sponsored a conference in the autumn of 1971 to define "acceptable earthquake risk" as a basis for public policy for the State. The City of Long Beach, California, has engaged the services of J. H. Wiggins, Inc., of Palos Verdes Estates, California, to translate the risk of loss from earthquakes into engineering design criteria that can be used in evaluating existing and new structures. Both of these efforts are directed at tightening applicable building ordinances and land-use regulations. (For additional details, see Part III, Chapter F.)

- *Hurricane Hazard Reduction.* Dade County and other Florida jurisdictions have included extensive wind load requirements in their building ordinances to protect structures from the effects of hurricanes. The Emergency Council of the Governor of the State of Mississippi has formulated "critical exposure zone requirements" to improve building ordinances for Gulf Coast areas highly susceptible to hurricane damage. The Coast Code Administration of Gulfport, Mississippi, and the University of Texas are attempting to stimulate regional action to improve building codes and land uses along the Gulf Coast and thus minimize losses from hurricanes. With this objective in mind, they sponsored a hurricane conference in Gulfport in October 1971.²⁵

Safety Surveys and On-the-Scene Evaluations

The last step in the formulation of construction regulations consists of continuing survey of existing buildings and structures. These surveys are ordinarily

made to ensure continued adequacy of the structures to withstand structural and natural hazards and to enforce a variety of regulations dealing with the health, safety, and welfare of the occupants. There continues to be difficulty, however, in making retroactive new code provisions by upgrading or retiring facilities that do not satisfy new or more stringent provisions. On-the-scene evaluations discussed in other portions of this study (see especially Part VI) are similar in nature to safety surveys but are performed on an *ad hoc* basis as a result of a natural or manmade disaster.

Surveys and evaluations are the most effective means to extend regulation to existing construction and land uses. All the other efforts discussed so far in this chapter have an impact essentially on new activities, because building codes and land-use regulations are not usually enforced retroactively and therefore apply only to new projects or to those undergoing very substantial modifications. Safety surveys and evaluations, instead, deal with what already exists and can provide the information required to determine shortcomings in existing ordinances and to formulate improvements.

Surveys are performed for the most part by local officials, often examining the same building for different reasons and from different points of view. The methods and procedures used differ widely, and the results are generally kept in separate offices. Ordinarily, there is no consideration of disaster vulnerability and no set of disaster criteria to guide these efforts. Federal agencies also perform surveys of the buildings they own and lease to gather information on performance and maintenance needs, but the effort is neither comprehensive nor continuous. Such an activity is quite expensive, although no specific data are available.

In this country, there are only limited inventories of existing buildings classified as to their response to the effects of natural phenomena.²⁶ Prior to undertaking any such survey—whether on a sample or comprehensive basis—clear criteria by which to judge disaster resistance characteristics of the buildings, and standard procedures for the conduct of the survey, should be established. In view of the costs involved in an effort of this magnitude, a selective approach appears necessary. A first step could include only emergency service, health care, educational, and very-high-occupancy structures located on identified high-risk land in the largest metropolitan areas most vulnerable to natural disasters.

The Outline of a National Program

The introduction of effective hazard reduction features in land-use and construction regulations would involve the efforts of a large number of individuals and organizations in the public and private sectors. It would also eventually affect long-established socio-economic patterns in local communities. Because of the complexity of the problem, several initiatives are required.

Risk Mapping. The techniques and procedures for conducting this vital step of the process are generally known except in the case of earthquakes, where additional research is required. Instrumentation to gather more data, notably for earthquakes and volcanoes, is also needed. Furthermore, the activities to date have left untouched some geographic areas known to be susceptible to certain disasters (e.g., earthquake-prone areas not on the West Coast). The rate of progress has also been slow, as in the mapping of East Coast areas susceptible to storm surges. The risk maps prepared, moreover, often have not been of a sufficiently small geographic area or have not included adequate details to be useful as a basis for promulgating local regulations that contain strong hazard reduction features.

The results of risk mapping, often couched in scientific terms, need to be translated into terms more readily useful to local planners, engineers, architects, and builders. Seismicity data on earthquake-prone areas, for example, should be reduced to extreme dynamic load factors and disaster mitigation criteria and construction procedures for use by all participants in the land-use and construction activities. A wider dissemination of easily understood risk-mapping data is required to facilitate the efforts of local planners.

Disaster Mitigation Criteria. The individuals and organizations preparing land-use plans, construction standards, model codes, and actual regulations have relied on their own judgment as to the degree of severity of the disaster to be considered in any given locality. In the case of hurricanes, for example, they must decide whether structures in potential landfall areas should withstand loads generated by winds of 75 miles per hour or some other higher velocity. Because of the many people involved and their varied background and experience, different assumptions are made and different conclusions reached. Accordingly there is a need for a nationally recognized set of disaster mitigation criteria dealing with each major disaster, tailored to the climatological and geological characteristics of different regions of the United States, and applicable to both governmental and private construction.

Federal agencies that have large construction programs or that contribute to the development of construction or building standards could participate in the preparation of such criteria: for example, HUD, DOD, HEW, GSA, VA, NBS, and the National Science Foundation. In order to give direction and consistency to such an effort, consideration should be given to designating a lead agency.

National Focal Point. There are literally several hundred organizations and agencies and many thousands of individuals active in preparing land-use planning data, establishing building standards, compiling model codes, and enacting and enforcing local ordinances. Fragment-

tation of effort is a fact of life. Moreover, the process is very time consuming for a number of reasons, most significant of which are the large number and administratively cumbersome nature of organizations involved, the need to maintain high technical excellence, and the need to satisfy the many and varied local interests. New technology is therefore seldom reflected in the end results in timely fashion. Uniformity in regulating the same problem in different locations is also very difficult to achieve. Even after nationally recognized criteria come into existence, effective leadership will be essential to bring about hazard-reducing land-use and construction regulations at the local level. The need to establish a national focal point to provide this leadership is evident. Such a focal point could:

- Coordinate land-use and construction research activities in the private and public sectors.
- Evaluate new land-use and construction technology and foster the use of new products and practices by the industry and by government units at all levels.
- Formulate uniform nationally accepted land-use planning and construction standards that take account of regional differences resulting from vulnerability to different disasters.
- Act as a clearinghouse of information on land use and construction.

One way to establish this focal point would be by charging an existing Federal department with the functions enumerated above. The department so charged should possess a broad technical expertise in land use and construction and have established contacts with State and local jurisdictions and with private organizations active in these fields.²⁷

Use of Federal Loans and Grants. The potentiality for effecting hazard reduction at the local level through the use of Federal loan, grant, and lending insurance programs could be realized through two mechanisms. Strong hazard reduction measures could be taken into account in the administration of Federal loan and grant programs. Until national criteria for disaster mitigation are formulated and a nationally accepted set of standards and codes is adopted, each Federal agency responsible for a financial assistance program could develop applicable implementing regulations. It would be advisable to have a lead agency to ensure uniformity of interpretation and application.

A second condition could be the requirement, especially in high-risk areas, for disaster insurance coverage, wherever such coverage is available at reasonable cost. Thus, hazard reduction and disaster insurance would be coupled, as discussed in the next chapter of this Part. If a comprehensive disaster insurance program were to be established in the future, strong hazard reduction measures at the local level would already be in existence as a result of the use of Federal financial assistance programs.²⁸

Federal Construction Activities. The position of leadership by the Federal Government in disaster mitigation through safer land use and construction would be enhanced by improvements in site selection and construction standards for the structures it builds or leases.

Summary. A national program along the lines suggested in this chapter represents a feasible combination of means to improve land use and construction within the spheres of Federal, State, and local government responsibility. The land-use and construction regulation cycle is measured in years, however, and a substantial commitment of government resources will be required. Improvement started now would bear fruit only slowly. Such regulation is not retroactive in nature. Only new structures or those undergoing extensive modifications are likely to be affected. Nonetheless, disaster mitigation through safer land-use and construction regulations is feasible and can be undertaken now.

Findings

1. Land-use and construction regulations containing strong disaster mitigation features can in the long run alleviate losses caused by natural disasters. Areas identified as highly susceptible to natural hazards would be left open; no emergency facilities would be located in areas of serious natural hazards. If a new location were not feasible, design and engineering standards reflecting the high risks would be incorporated in new structures or employed to strengthen existing ones. Ordinary building regulations would apply to other areas less prone to natural disasters.

This type of regulation is constitutionally within the powers of the States and of counties and municipalities as delegated to them by the States. The Federal Government, however, has a legitimate role to play by providing information for local ordinances, stimulating disaster awareness, and encouraging the appropriate authorities to adopt strong, enforceable hazard reduction measures.

2. A national program that would involve the Federal Government to a greater degree in land-use and construction regulation is needed. It should include the following components:

- *The continuation of risk mapping now being conducted by several Federal agencies, notably NOAA, USGS, SCS, and the Corps of Engineers. The results should be translated into terms useful to local authorities and industry personnel and should be widely disseminated as a basis for determining local vulnerability to disaster and for taking appropriate action.*
- *A generally accepted set of disaster mitigation criteria dealing with each major natural phenomenon, to provide purpose and direction for the efforts of all private and public organizations now active in regulating land use and construction. Consideration should be given to the*

designation of an appropriate Federal agency to assume leadership and provide coordination of this effort.

● *The creation of a focal point in the Federal Government for activities related to land-use planning and building standards.* Such a focal point could provide technical assistance and guidelines to the several hundred educational, research, and industrial organizations as well as Federal, State, county, and municipal agencies now active in these fields.

● *The use by the Federal Government of the many existing programs that provide financial assistance and insure loans, for a variety of purposes, to further disaster mitigation. Administration of Federal grant and loan programs could take into account local enactment and enforcement of strong hazard reduction measures.* The precedent established by the National Flood Insurance Act of 1968 and the experience in administering it could prove very useful in land use and construction.

Notes

¹ *Lubbock Tornado: A Survey of Building Damage in an Urban Area*, National Bureau of Standards Technical Note 588 (Washington D.C.: U.S. Government Printing Office, 1971), p. 32.

² *Nectow v. City of Cambridge, et al.*, 277 U.S. 183 (1928), and *Village of Euclid v. Ambler Realty Company*, 272 U.S. 365 (1926).

³ Enclosure to letter from J. M. Gibson, Office of Housing Management, HUD, to Chief, OEP PL 91-606 Disaster Study Group, September 27, 1971. Waste disposal sites and water and mineral resources will also be identified by the study.

⁴ *Building the American City*, Report of the National Commission on Urban Problems to the Congress and to the President of the United States, 91st Cong., 1st Sess., House Document No. 91-34 (1968), p. 201.

⁵ *Ibid.*, pp. 208, 210, contains a discussion of State activities in this field through 1968.

⁶ *A Model Land Development Code*, Tentative Drafts Nos. 1, 2, and 3, American Law Institute, Philadelphia, 1969-1970-1971.

⁷ *Building the American City*, pp. 208, 210.

⁸ *Ibid.*, p. 210.

⁹ "Evaluation of Flood Hazard in Locating Federally Owned or Financed Buildings, Roads and Other Facilities and in Disposing of Federal Land and Properties, August 10, 1966," *Federal Register*, Vol. 31, No. 155, August 11, 1966.

¹⁰ Statement of Kenneth C. Cavanaugh, Acting Director, Office of Housing Management, HUD, in U.S. Senate, *Federal Response to Hurricane Camille (Part 4)*, Hearings before the Special Subcommittee on Disaster Relief of the Committee on Public Works, 91st Cong., 2d Sess., 1970, pp. 1817-1818.

¹¹ Statement of Raymond Carrasco, Director, Los Angeles Area Office, HUD, in U.S. Senate, *Governmental Response to the California Earthquake Disaster of February 1971*, Hearings before the Committee on Public Works, San Fernando, Calif., 92d Cong., 1st Sess., 1971, p. 533.

¹² Statement of John M. Gibson, Housing Management Officer, HUD, in U.S. Senate, *Governmental Response to the California Earthquake*, p. 548.

¹³ S. 992 and H.R. 4332, 92d Cong., 1st Sess.

¹⁴ John L. Schmidt, Walter H. Lewis, and Harold Bennett Olin, *Construction: Principles, Materials and Methods*, Vol. 3 of *Construction Lending Guide* (Chicago: American Savings and Loan Institute Press, and Danville, Ill.: Interstate Printers and Publishers, Inc., 1970), p. Codes 602-3.

¹⁵ *Building Codes: A Program for Intergovernmental Reform*, Advisory Commission on Intergovernmental Relations, A-28 (Washington, D.C.: U.S. Government Printing Office, 1966), p. 56.

¹⁶ Schmidt, Lewis, and Olin, *op. cit.*, p. Construction Standards 101-2.

¹⁷ Enclosure to letter from R. Sorey, NOAA, to Chief, OEP PL 91-606 Disaster Study Group, April 8, 1971.

¹⁸ *Building Codes*, pp. 56-57.

¹⁹ Schmidt, Lewis, and Olin, *op. cit.*, p. Codes 602-6.

²⁰ *Building the American City*, pp. 254-255.

²¹ *Ibid.*, p. 256.

²² *Ibid.*, p. 257.

²³ As quoted in Schmidt, Lewis, and Olin, *op. cit.*, p. Codes 602-4.

²⁴ *Building the American City*, p. 257.

²⁵ "Report of Hurricane Conference," Coast Code Administration, Gulfport, Mississippi, 1971 (preliminary conference proceeding—mimeographed).

²⁶ In this regard, see Section 261 of S.2358, A Bill to Amend the Disaster Relief Act of 1970, 92d Cong., 1st Sess.

²⁷ See *Building the American City*, pp. 266, 268, and S. 1859 in the U.S. Senate, 1971 *Housing and Urban Development Legislation*, Hearings before the Subcommittee on Housing and Urban Affairs of the Committee on Banking, Housing and Urban Affairs, 92d Cong., 1st Sess., 1971, Part I, pp. 657, 670, and Part II, pp. 955, 981.

²⁸ The use of Federal assistance programs to effect hazard reduction and encourage or require the use of disaster insurance is contained in a recent draft bill. See Legislative Referral Memorandum, subject: *A Draft Bill, the "Natural Disaster Mitigation Act of 1972,"* Office of Management and Budget, December 29, 1971.

Chapter B. Disaster Insurance

Introduction

The primary emphasis of this analysis of disaster insurance is on the role, both actual and potential, that it can play in disaster mitigation. In a comprehensive hazard-reduction program designed to minimize the human and economic losses resulting from natural disasters, disaster insurance offers an additional course of action complementing other possible actions discussed in preceding chapters of this report.

There are two reasons that make a consideration of disaster insurance in the context of disaster assistance an urgent matter. One deals with the continuing need for action in this area and the other with aspects of equity.

In his April 22, 1970, Message to Congress on disaster relief, the President stated: "Our experience with disasters in 1969 clearly demonstrated the need for expanded insurance coverage for property owners."

The tornado at Lubbock, Hurricane Celia, and the earthquake at San Fernando—to mention only the most serious disasters since the spring of 1970—have reinforced the realization of a need for disaster insurance.

Two aspects of equity should be noted, one from the point of view of the general taxpayer and the other from the point of view of those affected by disasters. The Federal Government is now expending public funds to assist disaster victims, and, after a disaster, many citizens have come to expect Federal assistance in one form or another. While a good case could be made for Federal assistance to a number of disaster victims on compassionate grounds, persons able to buy and capable of paying for disaster insurance should do so to lessen the burden on the general taxpayer.

From the individual's viewpoint, insurance offers a means to obtain contributory protection. Compensation in such circumstances is no longer subject to favorable action by the President or a Governor's request for disaster declaration—but becomes something due to the policyholder because he has paid an insurance premium to cover his losses in case of a disaster.

Primary attention in the following discussion is given to coverage for residential and small business properties and to those natural disaster effects that historically have been the most costly in terms of human and economic losses: floods, earthquakes, windstorms, and

wind-driven water. Coverage against man-made perils and crop insurance are not discussed. Nor are the compensatory features of insurance stressed; while their importance is fully recognized, they do not need to be restated here in any detail.

Two basic criteria have been used to analyze existing disaster insurance coverage: a determination of the extent to which existing coverage has been related to hazard-reduction and avoidance measures, and the level of public participation in purchasing disaster coverage. These are necessary ingredients in realizing an effective disaster mitigation program.

A recurring theme in the following analysis is that of insurance availability. In this context, availability includes an awareness on the part of citizens that insurance can be purchased, that protection is desirable and affordable, and that there is a real need for disaster coverage.

Throughout the analysis run two fundamental thoughts: (1) the insurance industry must continue to operate on an actuarially sound basis and (2) it must operate, over a given period of time, at a profit. These are in keeping with policies of the State Insurance Commissioners and the Federal Government.

The research conducted for this study revealed an interest within Congress, the States, and the insurance industry in providing more comprehensive disaster insurance. Such interest is illustrated by the number of bills, introduced in Congress during 1971, proposing expanded disaster coverage. Some of the bills are directed toward all disasters; others are aimed at a specific peril.¹ Additionally, the California Legislature, as might be expected in view of the San Fernando earthquake, has shown a marked interest in earthquake insurance.²

Within the insurance industry, several groups and organizations are examining the problems and availability of natural disaster insurance. This activity indicates that there are some groups in the industry concerned about existing natural disaster coverage which are seeking an industry consensus on the nature of the problem and a possible response. In addition to the industry activities, a committee of the National Association of Insurance Commissioners (NAIC) is attempting to cope with the problems of disaster coverage.

These several jurisdictions and the variety of interests they represent must be taken into account in any analysis of disaster insurance as a means to mitigate disaster hazards, and in seeking solutions to the complex problems involved.

There is, first of all, the insurance industry itself. It is large,³ it provides an essential service to the people, and it is legitimately concerned about its many billions of dollars of investments. It is not, however, as homogeneous as it might appear at first glance. It is composed of at least three large segments: the primary insuring companies, the agents, and the reinsuring companies. Each segment has a different attitude toward a comprehensive disaster insurance program. The primary insurers in turn can be categorized in several groups with differing characteristics.

Secondly, there are the States and Territories, represented by the Insurance Commissioners, who are mostly appointive officials. They are very watchful of their regulatory obligations and properly responsive to strong local interests and needs.

Thirdly, there is the Federal Government striving to achieve a more equitable solution to the disaster assistance problem.

The attitudes and goals of these segments differ, and at times, conflict. This must be recognized in any attempts to solve the disaster insurance problem—a problem of large economic, social, and legal dimensions.

Government-Sponsored Programs

This section covers two Government-sponsored insurance programs with applicability to natural disasters. The first, the Flood Insurance Program, is of particular note because it is the only natural disaster insurance program, either in government or private industry, with strong and positive hazard reduction features. The second program, the FAIR Plan, is limited in its disaster coverage but does have potential for expansion.

Flood Insurance. The increasing cost of flood losses and the unavailability of flood insurance from private companies at affordable rates provided the primary impetus for enactment of the National Flood Insurance Act of 1968 (PL 90-448). Administered by the Federal Insurance Administration (FIA) of the Department of Housing and Urban Development (HUD), the Act specifies conditions under which flood insurance may be made available. Through this program, flood insurance has been available only for residential and small-business properties, but extension of coverage to other properties is scheduled for March 1972.

From the standpoint of hazard reduction and avoidance, however, the critical feature of the Flood Insurance Program is that it is specifically designed to reduce the economic and human losses caused by floods and mudslides. Flood insurance can be made available only

in communities which have taken positive steps toward minimizing flood or mudslide losses by implementing and enforcing adequate land-use measures and by discouraging development in high-risk areas. The initiative rests with the local communities; the emphasis is on mitigating future flood and mudslide losses.

Administration. The Flood Insurance Program is administered through a cooperative arrangement between a pool of participating private insurance companies and FIA. The latter has the primary responsibility for furnishing policy guidance, enforcing the provisions of the Act, and setting the actuarial rates. The actual sale and servicing of the policies is handled through the National Flood Insurers Association (NFIA), a voluntary pool of private insurance companies. However, the arrangements are such that all fire and casualty insurance agents licensed to sell in a State may sell flood insurance even though they may not be specifically associated with an NFIA member. This permits an individual to obtain flood insurance from his local agent and avoids unnecessary hardship or inconvenience.

The risk-sharing members of the NFIA are committed to contribute to a reserve fund used to pay claims. Reimbursement of claims is made from a fund composed of Treasury funds, for the Federal Government's share (now 90 percent) of the risk, and of the remaining collected premiums after administrative expenses have been deducted. When this fund is depleted, payments are made up to a stop-loss point from a pool set up by the risk-sharing members of the NFIA. After the stop-loss point has been exceeded, Federal reinsurance is used to pay the claims.

Eligibility. The initiative to establish eligibility for flood insurance must come from the local municipality or governing unit with control over building codes and zoning. The community must first supply FIA with evidence of a need for flood and mudslide insurance and certify its desire for coverage. The application to FIA must include documentation of the community's legal authority to control land use, a statement of measures already taken to reduce mudslide and flood hazards, maps delineating the flood and mudslide-prone areas, and a history of the flood and mudslide experience in the community. By a prescribed deadline, the community must enact land-use measures, consistent with criteria established by HUD, for reduction of flood and mudslide damage.⁴ These measures must limit or otherwise control the use of land in flood-prone areas and require the adoption of zoning regulations and building codes designed to minimize flood damage. Eligibility for flood insurance is maintained only if the community continues to enforce its protective land-use measures. Under the regular Flood Insurance Program, establishment of the actuarial premium rates for flood insurance

is a requirement before a community's eligibility can be certified.

Notwithstanding this requirement, the emergency program established by a 1969 amendment to the Flood Insurance Act and in effect until December 31, 1973, provides that insurance may be made available to eligible communities before the actuarial premium rates in the community have been determined. This program was enacted to speed the implementation of the Flood Insurance Act during its initial years.

When a community becomes eligible for flood insurance, the initiative shifts to its citizens. Individual property owners and qualified small businessmen who desire this protection must purchase policies from licensed insurance agents. According to the Act, failure to purchase available coverage against flood and mudslide damage within one year from the date on which it is made available will result in the denial of specified forms of Federal disaster assistance, such as SBA loans, to nonpolicyholders in an eligible community.⁵ However, enforcement of this provision has been suspended until December 31, 1973 by a recent amendment to the Flood Insurance Act.

Coverage. The classes of property eligible for flood insurance are currently limited to dwellings housing one to four families, properties occupied by small businesses, and the contents of these properties. The Secretary of HUD has extended this coverage to other types of properties as of March 1, 1972.

Upper limits have been placed by statute on the coverage available for each policy. Insurance at subsidized rates is made available to eligible applicants in amounts up to \$17,500 for a single-family dwelling, \$30,000 for small businesses and two-to-four family units, and \$5,000 for the contents of each unit. The subsidized rates are related in part to the estimated cash value of the structure.⁶

Additional coverage up to \$17,500 for a single-family unit, \$30,000 for two-to-four family units and small businesses, and \$5,000 for contents may be purchased at the actuarial premium rate once the rates have been determined for an area.

Actuarial rates for flood insurance as established by FIA are based upon an evaluation of risk. They depend upon the degree of risk or exposure to floods and mudslides, as measured in one-foot increments, and upon the land-use and other hazard-reduction measures adopted by the community to mitigate losses. Actuarial rates, therefore, may differ greatly within a given eligible area and among eligible communities. Thus, the maximum coverage purchasable (half at the subsidized rate, half at the actuarial rate) is \$35,000 for single-family units, \$60,000 for small businesses and two- to four-family units,⁷ and \$10,000 for contents. The subsidized rates do not apply for construction after FIA has identified the flood or mudslide hazard in a community.

The rates for this additional coverage may actually be reduced if the owner makes his property more hazard resistant. This provides an incentive for property owners, who are not ordinarily required to meet new building standards or land-use measures implemented under the Flood Insurance Program, to "floodproof" their existing structures.

Coverage at subsidized rates is prohibited for new construction or substantial improvements on existing properties begun after an area has been designated as a special hazard (flood or mudslide) area. Floodproofing and use of other hazard resistant measures should, however, result in a lower actuarial premium rate.

Flood insurance covers only those losses caused by floods or mudslides as defined in the HUD regulations. Water damage losses are not covered if they resulted from causes on the owner's property or within his control or from causes which did not create general flooding in the area.

Enforcement. There are two major enforcement provisions in the Flood Insurance Program. The first is the responsibility of FIA to ensure that participating communities maintain their eligibility by implementing appropriate land-use and hazard reduction measures. The second is a prohibition, contained in Section 1314 of the Flood Insurance Act and Section 208 of PL 91-606, against duplication of benefits. The Office of Emergency Preparedness has the basic enforcement responsibility for Section 208.

If it is found that a community has not adopted or maintained adequate land-use measures, the Flood Insurance Act directs that no new policies may be sold in that area and that existing policies shall not be renewed. In addition, Section 1314 prohibits extending Federal disaster assistance compensating for losses for real or personal property to the extent that these losses could have been covered under the Flood Insurance Program.

As noted earlier, enforcement of the provision has been suspended until December 31, 1973 because it had become apparent that many persons in eligible communities were not aware of the availability of flood insurance or the penalty feature of the program. This delay is designed to give all citizens in eligible communities sufficient time to become aware of the Flood Insurance Program and take advantage of it.

Assessment. Since the Flood Insurance Program is relatively new and has not been fully implemented in most areas, it would be premature to evaluate its success and effectiveness in accomplishing its goals. Nevertheless, it may be instructive to discuss some of its more obvious problem areas and limitations.

Perhaps the most significant drawback of the program is the low level of public participation. As of December 31, 1971, only 918 communities in 47 States plus Puerto Rico out of the 5,000 to 6,000 potentially

eligible had established their eligibility either under the regular or emergency provisions of the program. Within these communities, approximately 87,000 policies for about \$1.4 billion of property insurance had been sold.⁸ Although the number of communities participating in the program more than doubled from 1970 to 1971, and approximately 10,000 new policies were sold between June and November 1971, many communities and individuals still have not taken advantage of the program's protection.

The Flood Insurance Program has not yet achieved its full potential for several reasons. First, the program is still new and information about it has not reached a large segment of the public, although HUD has publicized it extensively; accordingly, many people and communities are unaware of its existence, its benefits, or the steps required to establish their eligibility for flood insurance. Another reason is that the initiative to join must come from the communities. Membership is not automatic, nor is the program without cost to the community and the people. Communities must meet the eligibility requirements, and citizens must purchase and pay for their insurance policies.

This is not to say that these features are not positive aspects of the program, but rather that they may have deterred some communities and individuals from participation.

In addition, the mere availability of flood insurance at subsidized rates may not be sufficient incentive to encourage a community to adopt the required hazard-reduction measures. Certainly, the overall objectives of the program—minimization of losses and hazard mitigation—are worthwhile. Yet in order to get communities to meet the requirements, they must feel sufficiently threatened by floods and mudslides or by the consequences of their failure to participate in the program. As it stands now, communities in flood-prone areas are not penalized for nonparticipation. Thus, in the event of a "major disaster" (flood or mudslide), the nonparticipating community still qualifies for all of the benefits of Federal assistance.

On the other hand, if the Act is enforced as written, after December 31, 1973, nonpolicyholders in a participating community will be denied Federal disaster assistance up to the amount of coverage they could have purchased under the program. Thus, the availability of the full range of Federal disaster assistance to nonparticipating communities may detract from the desirability of joining a program which, in effect, compels citizens to either buy insurance or risk the denial of disaster assistance. It would be possible, therefore, for a nonparticipating community to fare better, in the economic recovery and relief operations following a "major disaster" declaration for a flood, than a participating community having only a small number of policyholders.

Finally, the Flood Insurance Program has not yet received strong support from those Federal agencies which guarantee loans and mortgages for home purchase and building or from savings and loan associations whose funds are insured by the Federal Government. Flood insurance is not required, for example, by the savings and loan associations, the Federal Housing Administration, the Veterans Administration, or the Small Business Administration as a prerequisite for loans or mortgages. Yet, such a requirement by major Federal agencies would undoubtedly create considerable incentive for communities to implement the necessary hazard-reduction measures and participate in the flood program.

FAIR Plans

Description of Program. The Urban Property Protection and Reinsurance Act of 1968⁹ authorized the establishment of the FAIR Plan Program under the auspices of HUD. A FAIR Plan is basically a State plan to ensure "fair access to insurance requirements." This concept was designed essentially to provide fire and extended-coverage insurance, as well as vandalism and malicious-mischief insurance, to urban property owners who have been unable to purchase insurance from private companies. Although not conceived with natural disaster insurance in mind, the FAIR Plans do, in fact, provide coverage for such perils as windstorms and brushfires. Windstorm coverage includes damage from tornadoes and hurricane-associated winds.

The initiative to participate in the program ordinarily comes from the State, with the Federal role largely limited to financial backing in the form of riot reinsurance. To qualify for Federal support, the State must design and implement a FAIR Plan which complies with the criteria set forth in the Urban Property Protection and Reinsurance Act of 1968 and in the current FIA regulations. Among other things, the Plan must provide the standard fire, extended-coverage, vandalism, and malicious-mischief insurance as a minimum coverage. Each plan also must designate the areas within the State where FAIR Plan coverage is to be made available. An inspection capability must be established to determine the insurability of property and to provide written reports specifying the condition of the property and any needed improvements. If the property is uninsurable or surcharged, the reports must clearly delineate the reasons for its uninsurability or high rating classification. In addition, the Act requires the creation of an industry placement facility through which a property owner who fulfills the FAIR Plan requirements and whose property has been inspected may obtain insurance.

Although there are variations among the States, normally a State FAIR Plan requires the participation of the property insurers doing business in that State and is operated through a pooling arrangement under the

supervision of the State insurance authorities. The participating companies share risks insured through the placement facility and are responsible for payment of claims within the limits defined by the Act.¹⁰ These companies may enter into reinsurance contracts with FIA for indemnification of an agreed-upon share of their riot losses. Only those companies that participate in the FAIR Plan on a risk-sharing basis can qualify for Federal reinsurance.

Any property owner unable to obtain insurance in the private market and whose property is in an area eligible for FAIR Plan coverage may apply to the placement facility or through an agent. Applications must be considered without regard to the specific location and condition of the property or adjacent hazards. If the placement facility or participating insurer is unwilling to insure an eligible risk at the regular rates, an inspection of the property must be made (without cost to the owner). If warranted by the inspection, improvements to the property may be required as a condition for eligibility, or "condition charges" may be assessed to reflect a particular hazard on the property. Moreover, the property may prove to be uninsurable (although only about 1 percent of the applicants have been denied FAIR Plan insurance).¹¹

The rates charged in most of the FAIR Plan jurisdictions are generally the same as in the private market. The "condition charges" (surcharge) may, however, have the effect of increasing the cost of a FAIR Plan policy above that which would have been charged if the owner had been able to buy in the private market. The surcharge is normally justified on the basis that it encourages property improvements and hazard reduction measures. The FIA is currently examining the surcharges assessed under the various FAIR Plans to determine whether the rates are actually justified by experience.

Assessment. Few States have taken advantage of the natural disaster insurance potential of the FAIR Plans. As of December 1971, only 26 States, the District of Columbia, and Puerto Rico had operative FAIR Plans.¹² In only 13 of these jurisdictions, moreover, has the FAIR-Plan insurance been made available throughout the entire area. In the others, the coverage has been confined primarily to major urban areas.

The value of the natural disaster coverage available under FAIR Plans was demonstrated following the severe brush fires in the Malibu and Newhall areas of California in September 1970. Almost all of the affected area, designated as a brush area by the Pacific Fire Rating Bureau, was covered by the California FAIR Plan. In all, 126 claims, amounting to approximately \$1,804,318, were made under the FAIR Plan for direct losses incurred as a result of the fires. Of the 70,000 structures which the Pacific Fire Rating Bureau estimates are in designated brush areas, approximately 11,000 risks are covered by the California FAIR Plan.¹³

Of those States which ordinarily experience severe windstorms, only a few participate in the FAIR-Plan Program. Texas, Florida, and South Carolina, for example, are among those which either failed to enact the appropriate implementing legislation or where the FAIR Plan was never made operative. These States have chosen to establish a separate windstorm insurance pool in hazardous areas, although the FAIR Plans provide an alternative source of windstorm and brushfire insurance to these States. Either through a geographical extension of an existing FAIR Plan or adoption of a new one, any State can make coverage available.

In the case of disasters, the value of FAIR Plans is their postdisaster aid rather than predisaster mitigation. They might be used, for example, to provide windstorm and brushfire insurance where coverage may not be available, thus allowing property owners to protect themselves against these hazards. The FAIR Plans do not, however, have strong natural hazard reduction features. Thus, while the FAIR Plans fill an important gap in providing basic property insurance, any attempts to expand the coverage to include additional natural perils, in the absence of comprehensive hazard reduction features, would not achieve the objective of hazard mitigation through disaster insurance.

Voluntary (Private) Sector Programs

General Observations. No compilation—supported by empirical evidence—of the major disaster coverage offered in the entire private market exists today. The examination of various perils and the response of the private market has been hindered by this gap. Nonetheless, two major generalizations can be made about natural disaster coverage provided by the private insurance industry.

- *The coverage is fragmented*; full coverage against major natural perils is rarely included in a standard homeowner's policy. Property owners desiring complete coverage usually must purchase separate policies to cover additional perils or specifically request an endorsement on their standard policy. In some areas, the structure of the market is such that no insurance against a specific peril (e.g., windstorm, flood) is available. *As the result of this fragmented market, unless the property owner is well-informed about existing perils and about the availability of insurance, he probably will be uninsured or underinsured.*

- *The existing coverage lacks any strong inducement to avoid hazardous areas or to take positive hazard reduction measures.* With the exception of the Flood Insurance Program, the degree of exposure to various perils is not well defined. Even though rates reflect the risk to some degree and insurance may be unavailable in high hazard areas, there is no built-in mechanism requiring avoidance of risk or implementation of hazard reduction measures, such as a requirement that com-

munities implement land-use measures and building codes designed to reduce the hazards to which they are exposed.

Following is a discussion of single-peril coverage of earthquakes, windstorms, and land subsidence.

Earthquake Insurance. Of the various forms of disaster insurance, earthquake insurance currently seems to generate the most interest and controversy. The major problems in the availability of existing earthquake coverage and the actual and potential hazard mitigation impact of earthquake insurance are treated below.

Availability. Earthquake insurance generally may be purchased throughout most of the United States from private companies.¹⁴ However, few policies have been purchased covering commercial and private properties exposed to the earthquake hazard. It has been estimated that in the United States "the aggregate value of property exposed to earthquake damage is probably in the tens of hundreds of billions of dollars,"¹⁵ yet only about \$3 billion in property is covered by earthquake insurance.¹⁶

Additional support for the fact that only a small proportion of property is covered by earthquake insurance may be found by comparing earthquake insurance premiums with those for fire and extended coverage. In the case of California, for example, which is a particularly high earthquake risk area, figures for 1965 show that earthquake insurance amounting to \$4.1 million in premiums was written. In contrast, \$123.6 million in fire insurance and \$34.8 million in extended coverage were written during that same year.¹⁷ Put another way, earthquake premiums constituted only about 3.5 percent of the fire insurance premiums and 12 percent of the extended coverage premiums during 1965.

The obvious question suggested by the foregoing statistics is why so little property, particularly in high risk areas, has been insured against earthquake damage. In fact, insurance is available and can be purchased from private companies, and current demand for residential and commercial properties apparently is being met. The low level of public participation, however, suggests that there are other factors which need to be taken into account when attempting to evaluate the actual availability of earthquake insurance.

- First, there is *ignorance about the need* for earthquake coverage in the more earthquake-prone areas. From the standpoint of disaster preparedness, widespread earthquake coverage is desirable insofar as it contributes to hazard reduction and avoidance, and provides a more equitable arrangement for disaster relief. Many citizens in high-risk areas, however, are apparently unaware of or unconcerned about their exposure to risk. Public officials have contributed to this problem insofar as they have not made sufficient efforts to inform the

public of the hazards and have allowed unsafe and unwise building practices to take place.

- In addition to lack of information concerning earthquake hazard, *complacency*—particularly in California—about the threat of a serious earthquake is probably due to the infrequency of high-intensity earthquakes that have affected major population centers. In the last 50 years, only three earthquakes with intensities greater than VIII on the Modified Mercalli scale¹⁸ have occurred in heavily populated areas of the United States, all in California—Long Beach in 1933, Bakersfield-Kern in 1952, and San Fernando in February 1971.¹⁹ It is probable, therefore, that many property owners have been lulled into a false sense of security. Furthermore, there is no evidence indicating a substantial increase in the purchase of earthquake insurance in the affected area following the San Fernando quake.

- The *inability to purchase earthquake insurance conveniently* also has an impact on availability. For example, earthquake insurance in California is normally written as an endorsement to the homeowner's policy for fire and extended coverage. Since not all property insurers write earthquake insurance, or some restrict the areas or the types of dwellings which are eligible for coverage, the property owner must find a company willing to sell him a policy. Although most leading insurers issuing homeowner's policies in California will write earthquake insurance,²⁰ the property owner is nevertheless placed in a position of "shopping around" for a company willing to insure him.

- Availability of earthquake insurance also is affected by the *reluctance of the companies to write this coverage in large amounts*. Accordingly, they do not sell it aggressively.²¹ As a result, property owners may simply be unaware that it can be purchased. To a large extent, the reluctance is due to the unpredictable, singular nature of the earthquake itself. Risk cannot be spread easily, and companies fear they will not be able to build and maintain reserves adequate to meet the claims resulting from a single, sizable earthquake in a populated area. Concomitantly, the growing commercial concentration in high-risk areas adds to the financial burden the companies would have to assume if they agreed to provide full earthquake coverage for commercial as well as residential structures. It is noted that the "growing values of commercial and industrial properties have been concentrated in certain high-risk areas and have increased to the extent that the potential liability on a single building may exceed the area-underwriting limits of a reasonably large insurance company."²² Related to this is the question of whether adequate reinsurance—or some form of financial backup—would be available to the primary insurer if earthquake underwriting were greatly expanded.

- Finally, *little positive institutional action* has been taken to encourage property owners to insure against the earthquake hazard. Lending institutions in the private

sector, as well as such Federal agencies as VA and FHA, do not require earthquake insurance as a prerequisite for home loans. Several bills which would encourage public purchasing of earthquake coverage, however, have been introduced in Congress and in the California Legislature.

Rates. Rates vary considerably with the location, coverage, and nature of the property to be insured. Two basic systems, the Eastern Method and the Western Method, are used for writing earthquake insurance in the United States. Each system is subject to the rules of the rating bureau in the individual State.

A major difference between the two systems is that the Western Method includes a mandatory deductible of 5 percent to 15 percent and the Eastern Method does not, although a credit of 25 percent is given if the holder elects a 2-percent deductible clause. The basic rates under the Western Method are considerably higher, largely reflecting the risk of exposure: the States using the Western Method (Alaska, California, Washington, Oregon, Utah, Montana, Nevada, Hawaii, Idaho, and Arizona) are considered earthquake-prone, whereas the hazard is less where the Eastern Method is used.

Within each system, rates vary according to the risk zone in which the property is located and the classification of the property to be insured.²³ In California, for example, assuming a frame or frame-stucco dwelling and a 5-percent mandatory deductible, the rates would be 11, 15, and 23 cents per \$100 of coverage, depending on location of the structure in the low-, medium-, or high-risk zones, respectively. The major population centers, San Francisco and Los Angeles, are in a zone of medium hazard.²⁴ The Pacific Fire Rating Bureau has a special rate category for buildings conforming to an earthquake-resistant design. The applicable rates are determined by the Bureau after examination of the plans and specifications of the buildings and the hazard-resistant measures employed.

In areas where the Eastern Method is employed, rates are much lower. For example, rates for wood frame dwellings vary from 4.5 cents to 15 cents per \$100 coverage with a 2-percent deductible, depending on risk zone.

A second factor restricting demand is related to the cost and terms of the policy. Although the actual rates, even in a hazardous area such as California, are not high, the mandatory deductibles attached to most policies significantly detract from the attractiveness of earthquake coverage. In California, for example, a homeowner could add earthquake insurance to his homeowner's policy (if his insurer writes earthquake insurance) for about \$45 a year for \$30,000 of coverage. The 5-percent mandatory deductible, however, amounts to \$1,500. The owner may conclude that it is unlikely his property will sustain over \$1,500 in damages and, accordingly, that the protection is not worth the extra \$45.

Assessment. Earthquake insurance in its current form is not an effective disaster preparedness mechanism for two primary reasons: it is tied only to a minimum degree to specific hazard- or loss-reduction measures, and it covers only a small percentage of the property exposed to major earthquake hazards.

With regard to the hazard reduction aspects of earthquake insurance, there is certainly value in basing the rates upon the risk zone and the building classification. However, the risk zones in particular are extremely broad and only generally reflect the exposure. For example, the Pacific Fire Rating Bureau lists Alaska, part of California, Montana, and part of Nevada in Risk Zone 1; 25 counties in California, five in Nevada, and all of Utah are in Zone 2; Imperial County of California constitutes Zone 3; four counties in Arizona comprise Zone 4; and the remainder of Arizona is Zone 5.

The current earthquake insurance rate structure using these broad zones does not adequately reflect risk variations. It is determined largely by how much insurance the companies want to sell and the property owners want to buy. Such a rate structure can have little influence on hazard reduction.

From the standpoint of hazard reduction and avoidance, the high-risk areas should be more clearly delineated. Further, in the absence of any other regulatory tool, the rates in areas of extreme risk should closely reflect the various degrees of exposure, thus providing an incentive not to build there.²⁵

It is hoped that rates which closely reflect the exposure to earthquake hazard will publicize the risk in a community and thus increase awareness of the problem. A more effective solution would be to consider the purchase of earthquake insurance as one criterion of any federally financed or insured project. Through the insurance mechanism, the community might be made acutely aware of the earthquake hazard and thus support effective community-sponsored earthquake hazard mitigation measures, such as wise land-use planning and stringent building codes.

An earthquake insurance requirement also would increase the level of public participation. Obviously, any viable program of earthquake hazard reduction must encompass a sizable segment of the community and offer economic incentives or impose sanctions to ensure community participation. Such a program also will make a contribution to the economic recovery of a disaster-stricken community. Even though insurance could never compensate totally for the human, social, and economic costs of a major earthquake, a broad-based program of insurance would greatly aid community rehabilitation.

Insurance Pools

Description. An insurance pool is an organization of insurance companies which share the premiums and losses for one or more specific types of coverage. It is

either a voluntary association or one established by State authorities requiring the participation of all insurers writing a certain line of insurance or operating in a designated area. It is usually formed to provide a market for insurance which individual companies might be unwilling or unable to underwrite on their own.

Seven States, prompted by the unavailability of windstorm and land-subsidence insurance in the voluntary market, have used the pool mechanism to ensure that property owners are able to obtain protection against these hazards. Windstorm pools have been set up in Alabama, Louisiana, Texas, Mississippi, South Carolina, and North Carolina. Florida has a windstorm and a land-subsidence pool. Pennsylvania is a separate case; insurance against the peril of land subsidence (created by deep mining there) was unavailable in the private market, so the State chose to write and sell land-subsidence insurance through a State agency rather than establish a pool.

Most of the existing windstorm and land-subsidence pools require the participation of the property insurers licensed to write fire and extended-coverage insurance in a given State. In the case of the windstorm pools, participating insurers agree to sell standard fire and extended-coverage, which includes windstorm, insurance in areas designated by the State or by the agreement (or statute) establishing the pool. To obtain windstorm coverage, therefore, eligible property owners must purchase a basic fire and extended-coverage policy from a participating member of the windstorm pool. On the other hand, land-subsidence insurance can be purchased in the Florida pool as a separate policy, or added as an endorsement to a fire and extended-coverage policy.

In addition to the windstorm and land-subsidence coverage provided through the pools, most of the States encourage companies to write this coverage outside the pool by allowing them to deduct the amount of the insurance written voluntarily from the percentage of losses developed as a result of their association with the pool.²⁶

In most pools, an inspection is made of the property to determine its insurability and, in some cases, to decide if surcharges should be added to the rates to reflect a particular hazard. As a rule, the basic rates charged through the pools are the same as similar coverage in the voluntary market. Where "condition charges" are added, the total premium for a given property may well exceed that which would have been charged if insurance had been available outside the pool. In some cases, where hazard reduction measures have been implemented or specified hazards eliminated, the premiums may be lowered to reflect the reduced risk.

Assessment. In contrast with the Flood Insurance Program, in which the hazard reduction and land-use measures actually determine the availability of flood insurance, the coverage provided through the windstorm

and land-subsidence pools is only tangentially tied to reducing the losses stemming from those two perils.

The difference in emphasis between the insurance pools and the Flood Insurance Program is a direct reflection of their different basic objectives. The Program, while also responding to insurance unavailability, has a basic objective of reducing losses. The pools instead were established primarily as a response to insurance unavailability in hazardous areas. The pools do not forcefully and directly tie insurance availability to the mitigation of the peril; most of them merely require that eligible structures built or substantially improved after a specified date be constructed in conformity with the building codes and standards used in that area.

One additional limitation of a pool is that it constitutes a response to only a single peril. For example, the needs of a property owner in areas where wind-driven water is a significant problem are not being adequately met. Even if both windstorm insurance and the Flood Insurance Program are available, the property owner must still purchase two policies for adequate protection against hurricanes, for example, in which damage is likely to occur from both wind and water. If either windstorm or flood insurance is unavailable, the property owner can only partially protect himself.

Hazard Reduction Requirements

Hazard reduction features, or their absence, have been commented upon in the assessment of the available Government and private disaster-insurance programs. Furthermore, the preceding chapter identifies feasible measures to encourage improved land-use planning and control, and more up-to-date materials and building standards have been examined. What remains to be done here is identify the mechanisms to reduce hazards through a disaster insurance program.

Eligibility Requirements. Following the example of the Flood Insurance Program, communities might be required to satisfy hazard mitigation criteria as a precondition to obtaining disaster insurance. Similar requirements also might be established for individual property owners. The process of establishing, certifying, and enforcing eligibility requirements, as well as identifying the hazards, probably will have to be assumed by the Federal Government.

Enforcement of eligibility requirements might be accomplished in several ways:

- Federal disaster assistance might be denied to communities located in an identified high-hazard area which fail to establish their eligibility for insurance.
- In identified hazardous areas, disaster insurance might not be made available for new construction, for major improvements to existing structures, or for structures rebuilt following a disaster. To strengthen this restriction, Federal disaster assistance might be denied for

losses on new construction or structures rebuilt or improved after the designation of an area as extremely hazardous.

- The Federal Government might refuse to lease buildings in hazardous areas.
- The Government might deny funds for construction and development in areas designated as extremely hazardous. Federally financed construction in moderately hazardous areas might be prohibited unless prescribed land-use measures and building standards have been met.
- Disaster insurance might be a prerequisite for receipt of certain Federal funds. Without such a requirement, there would be little pressure on a community to establish its eligibility for a disaster insurance program.

Establishment and Enforcement of Criteria. Criteria for land-use planning and building codes as a precondition for disaster insurance could follow the precedent established by the Flood Insurance Act. General provisions could be included in a basic act, implemented through a set of regulations. Communities could then be required to demonstrate local implementation and enforcement.

This procedure would accomplish a number of corollary objectives. The citizen would be alerted to the disasters to which each locality is most prone. They might thus be more likely to participate in the disaster program and adopt hazard reduction measures.

Standard minimum criteria would be formulated by the Federal Government for at least those funds and projects within Federal jurisdiction. Thus, policyholders could come to expect uniformity in such related matters as determination of community or individual exposure to risk, application of rates, surcharges, and required property improvements. Such criteria may vary somewhat from location to location to reflect different perils and degrees of risk, but they should be as consistent as feasible to ensure equal treatment of property owners. Additionally, where appropriate, criteria should take into account the exposure to all perils, and not be oriented toward a single peril.

Unquestionably, the Federal Government's sphere of activities in disaster mitigation and avoidance would be greatly extended. The leadership and some of the expertise for precisely identifying hazardous conditions of terrain and structures in small tracts would probably come from Federal sources, as would any necessary compliance and certification procedures. The Federal Government also would be required to establish standards and specifications for its own construction and leasing activities and possibly to provide relocation assistance for moving of activities from extremely hazardous areas.

Rate Structure. Within reasonable limits, rates for disaster insurance (at least for new construction) might

reflect the "on-site risk" and thus provide property owners with an incentive to take appropriate hazard-reduction and land-use measures. Surcharges or deductible clauses might prove to be flexible tools in this respect. Additional adjustments might be made to reflect disasterproofing of structures.

If rates are to be closely tied to exposure, inspection procedures may be needed initially to determine the applicable charges or other conditions of the policy. It might be beneficial to limit policies to 1-3 years, based upon the condition or exposure of property. Renewal of the policy might be made conditional upon the satisfactory implementation of stipulated hazard reduction measures. Follow-up inspections might be necessary to reevaluate rates, to verify changes in the property's exposure to hazard, or to renew a policy.

If it is not feasible to base rates on specific site conditions, small risk zones for extremely high hazard areas would serve the purpose of making the community aware of the need for hazard reduction measures.

Findings

1. Disaster insurance has the potential for creating an effective high level of disaster mitigation if it is tied to strong and enforceable hazard reduction features by establishing: (1) rate structures that reflect local hazards or (2) stringent eligibility requirements. Individuals and communities would thus become more aware of the hazards to which they are exposed and make more judicious decisions about use of their property. Communities would be effectively encouraged to enact and enforce hazard reduction land-use and construction ordinances.

2. The Flood Insurance Program, the only existing disaster insurance program with definite hazard-reduction requirements, needs to be strengthened to ensure that all communities in designated flood hazard areas participate in the program.

- Flood insurance should be required whenever Federal agencies provide financial assistance for planning, acquisition, development, reconstruction, or improvement of land, buildings, machinery, equipment, or other public or private facilities as a condition for receipt of this assistance.

- Similar consideration should be given to Federal instrumentalities which regulate, supervise, or insure lending institutions.

3. Existing insurance programs dealing with disasters other than floods have aroused little public interest and received little support; they are deficient in present coverage due to unavailability, fragmentation, or high cost; and they lack direct ties with hazard reduction measures. Improved hazard reduction requires a long-range program. Other improvements can be partially

achieved by piecemeal changes in the disaster coverage of several existing insurance programs:

- The Internal Revenue Service and the States should examine their regulations on losses and maintenance of reserves by insurance companies with a view toward modification of any clause unduly restricting the ability of such companies to write disaster insurance and thus toward providing an inducement to expand this market.
- Insurance companies, rating bureaus, and States should utilize the available hazard reduction information developed by Federal agencies in setting disaster insurance rates which better reflect exposure and in establishing requirements for disaster insurance (other than flood insurance).
- States should expand or establish insurance pools and FAIR Plans to provide more adequate disaster insurance coverage.

4. *There is a need to develop ultimately a comprehensive disaster insurance program directly tied to hazard reduction measures.*

Further experience, however, is required to determine the feasibility of such a program, because of its

many complex economic and public policy implications. There is a need to determine detailed actuarial and financial data; the respective roles of the Federal Government (if any), of the States, and of the insurance industry; the definition of perils and coverage; and the mechanisms to effect hazard reduction measures.

5. *Local public officials and private citizens often are not aware of the natural disaster hazards existing in the area in which they live, the likelihood of their occurrence, and the measures that property owners can take to avoid or mitigate them.* In the case of flood insurance, Congress recently recognized that the absence of information can be a serious problem, so it extended enforcement of specified provisions of the Flood Insurance Act for 2 years.

Responsible Federal and State agencies should develop and disseminate information concerning natural perils and hazard reduction measures to the public, lending institutions, State and local officials, builders, and other interested parties. The OEP disaster research clearinghouse can contribute to this information program.

Notes

¹See, for example, S.871 and H.R.6267, which provide for a national program of earthquake insurance; H.R.5515 authorizes HUD to establish a national earthquake program; H.R.4084, H.R.5437, H.R.5438 amend the Flood Insurance Act to include protection against earthquakes; S.903 and H.R.6266 provide for a national program of disaster insurance.

²Samples of the California Legislature activity include such bills as A.B.1327, which includes earthquake coverage in the California FAIR (Fair Access to Insurance Requirements) Plan; A.B.2499 includes earthquake coverage as a basic peril under the California Standard Form Fire Insurance Policy and California Standard Form of County Fire Insurance Policy; A.B.2534 requires that homeowner's policies include catastrophe coverage.

³It employs about 1.4 million people and is responsible for assets of about \$250 billion—*Insurance Facts-1970*, Insurance Information Institute (New York; 1970).

⁴36 FR 18175, September 10, 1971.

⁵PL 90-448, Section 1314, 82 Stat. 579, 42 USC 4021.

⁶The lowest rate is \$0.40 per \$100 for single-family structures and two-to-four family structures valued under \$17,501 and \$30,001 respectively. The highest rate is \$0.70 per \$100 and is charged for small business properties valued over \$60,000. Rates for coverage on contents range from \$0.50 per \$100 to \$1.00 per \$100. (See 35 FR 4200-4209.)

⁷The property owner may only insure the actual structure of his dwelling or small business. Up to 10 percent of the face value of the policy may be applied to units attached to the principal structure, such as an attached garage. Separate buildings, fences, wharves, boathouses, motor vehicles, animals, and the like cannot be insured under the Flood Insurance Program.

⁸Data received from the Federal Insurance Administration, Department of Housing and Urban Development.

⁹Title XI of PL 90-448, 82 Stat. 476, as amended by 83 Stat. 379, 12 USC 1749 bbb.

¹⁰24 CFR 1905-1906.

¹¹Testimony of George K. Bernstein, Federal Insurance Administrator, in U.S. House of Representatives, *HUD-Space-Science Appropriations for 1972 (Part 2)*, Hearings before a Subcommittee of the Committee on Appropriations, 92d Cong., 1st Sess., 1971, p. 826.

¹²Nevertheless, the FAIR Plans have been quite successful in making insurance available in urban areas. As of June 30, 1971, 1.2 million policies had been sold, with \$21 billion of insurance in force.

¹³"Financial Report to Members for the Period From Inception, August 15, 1968 to November 30, 1970," California FAIR Plan Association. Also, see News Release, dated January 15, 1971, from Insurance Commissioner Richards D. Barger, California Department of Insurance, and attachment.

¹⁴U.S. Department of Commerce, ESSA, Coast and Geodetic Survey, *Studies in Seismicity and Earthquake Damage Statistics*, a report prepared for the Department of Housing and Urban Development, Office of Economic and Market Analysis, March 1969, Appendix A, p. 74.

¹⁵U.S. Department of Housing and Urban Development, "Summary and Recommendations of Studies in Seismicity and Earthquake Damage Statistics by ESSA," 1969, unpublished, p. 53b.

¹⁶*Ibid.*

¹⁷*Studies in Seismicity and Earthquake Damage Statistics*, pp. 75-76.

¹⁸VIII is defined as slight damage in specially designed structures, considerable in substantial buildings, great in poorly built structures. Panel walls are thrown out of frame structures.

Chimneys, factory stacks, column monuments, and walls fall to the ground. Heavy furniture is overturned. Sand and mud are ejected in small amounts. Changes occur in well water. Persons driving automobiles are disturbed.

¹⁹"Summary and Recommendations," p. 63 (updated).

²⁰Letter from M. Kai-Kee, Chief, Rate Regulation Division, California Department of Insurance, to Mr. Philip T. Cummings, General Counsel, U.S. Senate Committee on Public Works, June 17, 1971.

²¹The Insurance Company of North America has recently attempted to increase earthquake insurance sales through a new "Quake Guard" program in California. The coverage is offered at a single Statewide rate for each type of residential structure and, in general, is less expensive than that heretofore available. Under this program, the whole State is considered as a single risk zone. The hazard reduction incentive is therefore practically nonexistent.

²²*Studies in Seismicity*, p. 75.

²³The risk zones in California have been set up for insurance-rating purposes and are delineated by county in the Tariff Rules of the Pacific Fire Rating Bureau, p. 23k. These zones should not be confused with the Algermissen seismic risk zones based upon earthquake intensity. For further information,

see S. T. Algermissen, "Seismic Risk Studies in the United States," *Proceedings of the Fourth World Conference on Earthquake Engineering*, Vol. I (Santiago, Chile, January 13-18, 1969).

²⁴"Earthquake Classification," Pacific Fire Rating Bureau. The rates prescribed for most classes of commercial structures are quite high; e.g., \$2.50 for \$100 coverage with 15 percent deductible in San Francisco and Los Angeles.

²⁵Work has been done in the area of risk mapping with particular reference to earthquakes. See, for example, *Report of the Task Force on Earthquake Hazard Reduction*, Office of Science and Technology, September 1970, and *The San Fernando Earthquake of February 9, 1971; Lessons from a Moderate Earthquake on the Fringe of a Densely Populated Region*, National Academy of Sciences—National Academy of Engineering, (Washington, D.C., 1971).

²⁶For details on the limitation placed on the insurance available through these pools in various States, see responses from the Office of the Insurance Commissioner, State of Florida (July 22, 1971), from the Office of the Commissioner of Insurance, State of Louisiana (July 20, 1971), and from the Department of Insurance, State of Alabama (July 1971), to inquiries from the OEP PL 91-606 Disaster Study Group (July 8, 1971).

Chapter C. Weather Modification

Introduction and General Considerations

Changing the weather, in a deliberate manner and with predictable results, is one means potentially within reach for averting or reducing the effects of disasters. The objective of weather modification projects is to prevent, mitigate, or expedite recovery from the deleterious effects of meteorological phenomena.

Historically, man's role relative to the weather has been a passive one. Beginning in the middle 1940's, though, scientists with the General Electric Company demonstrated in field experiments that deliberate modification of clouds and precipitation was possible. Since that time, laboratory and field investigations have expanded scientific understanding of the physics of clouds and precipitation. At present, projects sponsored by various Federal agencies involve basic and applied research, pilot demonstrations, and application programs in precipitation, fog, hail, lightning, and hurricane-severe storm modification.

Federal funding of weather modification grew slowly during the early and middle 1960's and more rapidly during the later years of the decade. Between FY 1971 and FY 1973, funding increased from \$14.2 million to \$18.4 million (see Table 1).

Table 1.—Federal Weather Modification Program, Allocation of Funding (Budget authority—not including capital outlay), in millions of dollars—Office of Management and Budget.

Agency	FY '71	FY '72	FY '73
Department of Agriculture	0.3	0.3	0.3
Department of Commerce (NOAA)	2.1	3.0	4.5
Department of the Interior (Bureau of Reclamation)	6.7	6.7	6.2
National Science Foundation	3.4	4.5	5.7
Department of Defense	1.5	1.5	1.1
Department of Transportation (FAA)	0.2	0.2	0.6
	14.2	16.2	18.4

Major current weather modification programs and interested agencies are as follows:

- *Precipitation Modification*—National Oceanic and Atmospheric Administration (Department of Commerce), National Science Foundation, Bureau of Reclamation (Department of the Interior);
- *Fog and Cloud Modification*—NOAA, Federal Aviation Administration (Department of Transportation), NSF, Department of Defense;
- *Hail Suppression*—NOAA, NSF;
- *Lightning Modification*—Department of Agriculture, NOAA, NSF, DOD;
- *Hurricane and Severe Storm Modification*—NOAA, DOD;
- *Mathematical Modeling*—BuRec., NSF;
- *Social, Economic, Legal, and Ecological Studies*—BuRec., FAA, NSF, NOAA.

With increasing Federal support and expansion of field experimentation, problems of public policy are becoming more acute. Determination of the public interest relative to weather modification demands that economic, legal, political, administrative, and environmental factors be considered with those of science and technology. Among the issues to be settled are:

- Definition of roles and responsibilities of government and private industry.
- Means of coping with international ramifications.
- Determination of public liability for damages from weather modification endeavors.
- Resolution of conflicting interests and requirements.
- Means of ensuring that ecologic and climatic effects are fully considered.

This chapter is directed at the discussion of public policy issues, principally those concerning the problem of management of weather modification activities. The various uses of weather modification to alleviate specific natural disasters are discussed in Part III.

Management of Existing Programs

(This portion of the chapter is drawn mostly from the National Academy of Sciences publication *The Atmospheric Sciences and Man's Needs: Priorities for the Future*, pages 49 and 51.)

In 1958, the National Science Foundation (NSF) was charged in Public Law 85-510 with the responsibility to "initiate and support a program of study, research, and evaluation in the field of weather modification" and "to report annually to the President and the Congress

thereon." Thus, NSF became the lead Federal agency charged with support and review responsibilities for scientific endeavors in weather modification. Provision for coordination was made by Executive Order 10807 of March 13, 1959, which assigned this responsibility to the Federal Council for Science and Technology (FCST). Coordination of weather modification research was specifically given to the Council's Interdepartmental Committee for Atmospheric Sciences (ICAS).

With the increase in funding that occurred in the 1960's, more Federal agencies, notably the Departments of Commerce, the Interior, Defense, and Agriculture, accelerated their efforts in this field. Diversity ensued to satisfy their diverse missions. This was made possible by Public Law 90-407, which modified the position of NSF and resulted in the absence of a lead agency in this field. The agencies thus became free to pursue weather modification activities consistent with their respective missions, within a broadly coordinated Federal program integrated by ICAS.

ICAS uses a variety of means to effect this coordination; it holds monthly meetings, issues annual reports which include summaries of agency programs, and sponsors annual interagency conferences. Thus, it provides a forum for exchange of information and ensures integration of agency programs. Further, FCST has reviewed program budgets prior to their submission to the Office of Management and Budget.

Within the present Federal Government framework:

ICAS has no authority to consolidate or to modify agency programs; and, most important, ICAS is not able itself to mount research efforts, no matter how badly needed they may be. Agency initiatives at the scientist level, even though endorsed by ICAS, might not be approved by agency administrators; and agencies may launch major programs without ICAS endorsement. The result has been that in important respects the national effort in weather modification has been largely dissipated in submarginal projects, while crucial problems requiring large programs remain unsolved.¹

ICAS, however, has prevented duplication of efforts and has imparted a unifying thrust to the various agency projects in the weather modification field. It has prepared a number of reports on special problems in the field and, in mid 1971, proposed a program to accelerate "national progress in the management of our national resources through a structured attack on certain defined objectives of weather modification."² This program identifies seven projects in this field which have the potential for satisfying national needs in the short term ("National Projects").

Problems of Future Weather Modification Efforts

Implementation of an expanded weather modification effort will call for a considerable increase in field experimentation. Even though it may lead to unpredictable or imperfectly understood results, this experimentation could in fact cause significant weather changes. A number of public policy issues will then enter the picture, complicated by several major technical problems.

Major Technical Problems.³ The effectiveness of weather modification for disaster prevention or for other objectives is constrained by the present state of the art. Cloud systems at times behave unpredictably after seeding, some releasing more and some less precipitation. The models and measurements techniques now in use need further refinements, which in turn call for extensive field tests.

Computers of sufficient speed and capacity do not yet exist to handle data for the more sophisticated models.⁴ Some remote measurements are made by use of surplus military radars that have been adapted to the purpose and are extremely valuable, but not ideal.⁵ Airborne instruments for measurements within clouds are not yet sufficiently accurate or reliable to yield data of requisite quality.⁶

Because of these technical problems there is at present no certainty that a stimulus applied to a cloud produces the effects that are subsequently observed. There is even less possibility of predicting the down-range global effects of relatively large projects.

Legal Aspects. Uncertainty of results and other characteristics of weather modification are creating a host of novel legal problems that have proved of great interest to the legal profession. Cases have come to trial in several States involving sovereign immunity, liability, trespass, negligence, and nuisance.⁷ Who has rights to the clouds, for example, is an issue that has been discussed but not resolved.

Clouds that pass over a man's property are potential assets that he may want to put to profitable use, but he cannot own the clouds. Analogies with laws regarding water supplies provided by streams, lakes, and wells have been advanced, but these are really not very useful because of obvious differences between the two situations. . . .

Traditional procedures of law may not be adequate to deal with the kinds of problems that are characteristic of weather modification. Traditional requirements place on the plaintiff a burden of proof of damages, which it is inevitably difficult for him to provide. And traditional adherence to precedent provides little guidance in a field that involves new techniques and has such broad social ramifications as weather modification.⁸

Climatic Considerations.⁹ As weather modification technology expands, it will be possible to move from cloudseeding to other activities capable of changing the climate in drastic ways and over extensive areas. Regulating the rates of evaporation of large bodies of water and the rate of melting of snowpacks and glaciers are but a few of the intentional weather modification projects that might eventually become feasible. As more weather modification operations are conducted, the Nation will become increasingly aware of and sensitive to the climatic impact of such operations. This impact needs to be assessed with full consideration of the public interest and of international ramifications before specific operations are undertaken.

Economic Aspects. The determination of the cost-effectiveness of those weather modification operations which impact on a limited geographic area will be relatively easy to make. NOAA estimates, for example, that the additional 100,000 acre feet of rainfall produced over Florida in April and May 1971 was worth 68 times the cost of the weather modification operation (\$165,000).¹⁰ Even if the effects are geographically widespread, but clearly identifiable, such as the lowering of wind velocity of severe storms, the economic implications can be ascertained and decisions made accordingly. In both situations, the common good can be determined with relative ease.

As technology improves and larger programs of weather modification can be undertaken, however, the cost benefit of weather modification operations becomes very complex to ascertain.

The costs of increasing precipitation in order to increase agricultural production, for example, should be compared with the costs of alternate methods of obtaining equivalent increases. Such alternate methods would include crop diversification, selection of strains more resistant to drought, and shifting production to other locations, as well as developing other possible sources of water by means of desalting, re-use, or new dams. It is quite possible that the benefit-to-cost ratio for this example would be very different for the individual farmer, the region, the nation, and the world.¹¹

International Ramifications. The international ramifications of weather modification are an extension of the interstate problems confronting the United States. Cloud systems, river waters, and pollutants cross local as well as national boundaries. Concern for possible international implications are reflected in the stringent operational constraints imposed on hurricane seeding efforts (Project Stormfury).

As the technology advances, it may become necessary to treat large storms early in their development. The

required action would have to be taken over geographic areas far from the location where the results are desired. A new body of international, as well as national, law will be needed.

Decision Criteria for Operational Programs. The overriding criterion for the conduct of weather modification operations should be to attempt to satisfy the values and preferences of society. This process is difficult enough but is further complicated by conflicting interests within the United States and by concern over the rights of the States in this field.

Other significant criteria are: reasonable preciseness of expected results, competence and responsibility of those who implement the decisions, and legal remedies for any injured party.¹²

With respect to the disciplines necessary to the decision-making process, a paper presented before the American Sociological Association reports on studies indicating "that persons residing in and near weather modification target areas" regard decision making principally by scientists as "the least satisfactory approach."¹³ The paper urges that social scientists, too, be brought into the action in a significant way.

The public policy issues outlined here have much in common with similar issues arising out of such problems as management of the use of the electromagnetic spectrum, nuclear power generation, and the use and control of pesticides. Problems like these, in which technological and sociological aspects are intimately combined, are becoming more numerous and urgent. In these areas, wise policy clearly depends upon scientific understanding and accurate technical information. Since one cannot wait for scientific certainty, however, policy decision will have to be reached on the basis of the best possible and sometimes partial information.¹⁴ Coordination and integration of interdepartmental activities in this field are no longer adequate. Stronger management of weather modification efforts needs to be considered, as distinct from the coordinative approach, which has served the activities to date.

Management of Weather Modification

Present Status. As matters stand now in this field, public policy issues are either not being addressed at all or are being faced in an *ad hoc*, fragmented, and possibly conflicting manner. Some States, for example, require licensing of operators even though such operators may be under contract to a Federal agency. Thus, in a time-dependent situation, they are in a position to frustrate a Federal weather modification program.

"... Half the states, a few local governments, and a dozen courts have already created an embryonic legal regime," says Taubenfeld; "a more affirmatively created regime," as he describes it,¹⁵ would not in itself

guarantee that all the public issues in this field would be faced and solved in a timely or orderly fashion, or in the public interest. No legal regime in any field can accomplish such an overly ambitious objective. Lack of such a regime, however, can cause scientific progress to be impeded, public policy to be overlooked, conflicts of jurisdiction to arise, and difficult issues—often those requiring the most immediate consideration—to be ignored.

At the present, there is no Federal legislation that regulates weather modification operations. The closest approach to regulation is contained in Public Law 92-205, signed on December 18, 1971.¹⁶ This new law requires submission to the Secretary of Commerce of reports of weather modification activities (not under Federal auspices). It provides that the Secretary may specify the form and information content of the reports and may require submission both before and after modification attempts, under penalty of fines up to \$10,000. The Secretary, however, is not authorized to sanction or deny such attempts. In short, it calls for information gathering and not regulation.

The Need for a Federal Role. Opinion differs among scientists and public-administration experts as to the Federal role in "weather modification"¹⁷ activity. There are several grounds, however, on which a case for review of the Federal role can be made:

- Interested Federal agencies agree in general on it.
- The interstate nature of weather modification operations is undeniable for all but a very few cases. Weather systems respect no jurisdictional lines. Snowpack manipulation and rainmaking affect rivers that cross boundaries of many political entities. On the other hand, operations such as cold fog dissipation and heating of air over orchards to prevent freezes are local in nature.
- The international nature of certain weather modification operations is evident even in the present state of knowledge, such as in the seeding of hurricanes, and other Nations may become involved as basic underlying causes of large weather systems are more precisely identified and weather modification is attempted.
- The social, economic, and legal ramifications of weather modification operations are so substantial as to dictate that public policy in this field be made with the interests of the majority of the citizens in mind. This requires a governmental role that can prevent weather modification to avert or alleviate natural disasters. It should also ensure that separate modification activities in the same general locality are not conducted at cross purposes.

Federal Support Objectives. It appears that the Federal Government could take the lead in working with State agencies and private operations in this field. Major objectives include:

- **Information.** This requirement is partially satisfied by Section 2 of the new PL 92-205. The appropriate Federal agencies, however, could also be required to report their weather modification activities and thus ensure a centralized repository for such data.
- **Licensing.** Individuals or organizations actually performing weather modification operations could be licensed and periodically relicensed in order to ensure their professional qualification and competence to perform. Licensees would constitute a capability-in-being to allow for capitalizing on time-dependent opportunities for modifications. They would not, however, have any decision-making authority, except on matters of a tactical nature—that is, technical details created by local conditions after the decision to modify has been reached and transmitted to them.
- **Issuing of Permits.** Licensed operators also could be required to obtain a permit for the conduct of specific weather modification operations.
- **Decision Making.** Orderly implementation of weather modification activities, within the constraints established by the functions and missions assigned to Federal agencies engaged in weather modification, seems desirable.
- **Liability.** Legislation could provide for compensation for loss of life or damage to property resulting from modification operations. Licensees could be required to carry insurance to defray a portion of any claim.

In addition to the above major objectives, any weather modification regulation might include: an advisory body composed of persons, both in and out of Government service, eminent in the weather modification field, and a clearinghouse of weather modification information. Legitimate rights of the States also need to be safeguarded in those instances where interstate effects do not come into play (e.g., cold fog dissipation).

Implementation of Weather Modification Management. The only central governmental entity in this field is the Interdepartmental Committee for Atmospheric Sciences, and it is a coordinating, not a regulatory, body. Implementing the Federal role in weather modification operations could best be satisfied by placing the responsibility for such management in a single organizational body rather than in a committee. The following major management and economic considerations support the need for a single body:

- A substantial number of the operational decisions will be time dependent. In such instances, a committee could become a cumbersome mechanism. The reconciliation of conflicting departmental viewpoints might take longer than the time available for effective action.
- Weather modification operations on any large scale are expensive, and duplications should not be allowed to occur. A single body can achieve this objective more expeditiously and effectively than a committee.

• The expertise necessary to perform each of the functions of information, gathering, licensing, and issuing of permits is required to a substantial extent for the performance of all of the functions. Economical employment of resources would result from a single unit having all such responsibilities.

Ideally, the management body should be located separately from any organization conducting weather modification efforts. This consideration would indicate a new agency removed from the Federal agencies now active in this field. In the interest of not proliferating Federal agencies and of utilizing more efficiently available resources, however, a location within the existing Federal structure should be found. Several possibilities exist, with the most desirable being the Department of Commerce. It incorporates within one of its constituent administrations, the National Oceanic and Atmospheric Administration, a substantial scientific and technical capability in weather modification. NOAA operates one of the broadest programs of all the Federal agencies in this field (as indicated earlier) and has experience in the international implications of weather modification operations.

Disaster Prevention Considerations

The Director of the Office of Emergency Preparedness now has the authority to request Federal agencies to undertake weather modification actions in accordance with Section 221 of Public Law 91-606 and Executive Order 11575, when a State Governor requests assistance to avoid or lessen the effects of an imminent major disaster. The authority was used in the summer of 1971 on an experimental basis in Texas, Oklahoma, New Mexico, and Arizona. (See Part III, Chapter K.)

Findings

1. *Experiments in weather modification indicate many potential uses, including the mitigation of disasters caused by weather phenomena. There is a need for further examination of the Federal role in weather modification activities.* These activities are expanding, with some approaching an operational status, and they have the capability to create adverse as well as beneficial effects, with social, economic, legal, and international implications.

2. *Moreover, the interstate and international aspects of most such activities suggest a strong Federal role, which should include the following:*

- Licensing of operators to ensure technical qualification and scientific competence,
- Issuing of permits to licensed operators for the performance of specific operations,
- Gathering of information on each operation,
- Making operational decisions within the framework of the missions of each Federal agency participating in weather modification and of other provisions of the law,
- Establishing a policy on public liability.

3. *The Federal management of weather modification operations should be exercised by a single existing agency in order to ensure effectiveness and economy.* This agency would implement provisions related to licences, permits, information gathering, and decision making.

The Department of Commerce has extensive technical knowledge and experience in the management and operation of weather modification programs and therefore could be assigned this function.

4. There is a continuing need for coordination and integration of the activities of the Federal agencies engaged in weather modification efforts.

Notes

¹ *The Atmospheric Sciences and Man's Needs—Priorities for the Future*, National Research Council, Committee on Atmospheric Sciences (Washington, D.C.: National Academy of Sciences, 1971), pp. 50-51.

² A National Program for Accelerating Progress in Weather Modification, ICAS Report 15a (Washington: Federal Council for Science and Technology, Interdepartmental Committee for Atmospheric Sciences, 1971).

³ *The Atmospheric Sciences and Man's Needs*, pp. 48-49.

⁴ "Justification of Program Increases," enclosure with "Phase III PL 91-606 Input," Department of Commerce, National Oceanic and Atmospheric Administration, memorandum to Chief, OEP PL 91-606 Disaster Study Group, September 24, 1971.

⁵ *A National Program*, pp. 13-14.

⁶ *The Atmospheric Sciences and Man's Needs*, p. 53.

⁷ Gary Widman, Appendix E, "Sovereign Immunity for Legal Actions Involving Hurricane Modification Activities," and Appendix F, "Potential Liability for Hurricane Modification Activities," *Decision Analysis of Hurricane Modification* (Menlo Park, Calif.: Stanford Research Institute, June 1971).

⁸ *The Atmospheric Sciences and Man's Needs*, p. 54.

⁹ *Ibid.*, p. 54.

¹⁰ News Item 71-46, NOAA News Office, Rockville, Md., December 1, 1971. The worth of the rainfall compared to the weather modification cost to produce it was 32 or 68 times, depending on which of two irrigation methods—standard or overhead-sprinkler—is assumed.

¹¹*The Atmospheric Sciences and Man's Needs*, p. 53.

¹²*Ibid.*, p. 55, and H. J. Taubenfeld (ed.), *Controlling the Weather: A Study of Law and Regulatory Processes* (New York: Dunellen Publishing Co., 1970), pp. 47-113.

¹³J. E. Haas, K. S. Boggs, and E. J. Bonner, "Science, Technology, and the Public: The Case of Planned Weather Modification," Paper presented at the annual meeting of the American Sociological Association, Denver, August 30, 1971, p. 3.

¹⁴Public policy implications related to weather modification are discussed in the following publications: R. G. Fleagle (ed.), *Weather Modification: Science and Public Policy* (Seattle:

University of Washington Press, 1968); National Science Foundation, *Human Dimensions of the Atmosphere* (Washington, D.C., 1968); and Taubenfeld, *op. cit.*

¹⁵Taubenfeld, *op. cit.*, p. 18.

¹⁶The original draft was prepared by ICAS and submitted to Congress by the Department of Commerce (H.R. 6893).

¹⁷Defined in the same manner as Public Law 92-205 defines the term, namely "any activity performed with the intention of producing artificial changes, in the composition, behavior, or dynamics of the atmosphere" (85 Stat. 735).

PART V.

APPLICATION OF SCIENCE AND TECHNOLOGY

In his message to Congress on April 22, 1970, the President emphasized the need for applied science and technology in coping with natural disasters:

Improvements in disaster assistance . . . require an improved program of research and evaluation, the results of which are readily available to all who can benefit from them.

Throughout this report, scientific and technological applications have been discussed with reference to

specific measures of prevention, mitigation, and preparedness, and as applicable to the different types of natural disasters.

This part of the report is a broad examination and overall assessment of current actions and opportunities for developing a more coherent, coordinated, and comprehensive program of science and technology applied to reducing losses resulting from natural disasters. The subject is discussed from two related viewpoints in the following chapters: research and evaluation.

Chapter A. Research

Research applicable, directly and indirectly, to disaster prevention, mitigation, and preparedness encompasses a very large number and wide diversity of scientific disciplines as well as many fields of engineering and administration.

At present, there is no complete inventory of all the disaster-related research now in progress, although incomplete inventories suggest that the total effort is enormous. For example, the Smithsonian Science Information Exchange (SSIE) registry identifies over 2,400 different U.S. and foreign organizations that sponsor or conduct research. These include, within the United States alone: 86 Federal agencies; all of the States, the District of Columbia, and Puerto Rico; 129 county and city governments; 880 foundations and scientific associations; 251 universities; and 331 industrial establishments.¹ Many of these jurisdictions and institutions are involved in some aspect of emergency research. A preliminary survey conducted for the United Nations by the Smithsonian Institution Center for Short-Lived Phenomena shows that there are over 1,000 disaster research and warning centers, in about 80 different countries, devoted to natural disasters.² Within the National Academy of Sciences-National Academy of Engineering-National Research Council (NAS-NAE-NRC), there are about 40 committees and boards concerned with some type of disaster-related research.³ The National Science Foundation (NSF) is currently funding numerous disaster-related projects in such areas as:

- Earthquake engineering,
- Fire research,
- Weather modification,
- Hail suppression research,
- Techniques for counting ice nuclei in the atmosphere,
- Effects of urban centers upon local and regional weather,
- Social, economic, legal, and ecological impacts of weather modification.

The foregoing illustrates the problem of assessing the investment, and the beneficial returns from the investment, in disaster-related research. The very large number and diversity of these research activities lead many experts to different conclusions concerning the adequacy of the overall national investment, although they

may agree on specific deficiencies. However, there is a substantial consensus to the effect that there is inadequate application of research results.

While considerably more research is needed on practically all fronts, even the current body of knowledge available about disasters is not being used in the most efficient way. There is a serious gap between what is known and what is being applied. There could be considerable improvement in disaster prevention and protection and disaster response and recovery if the current scientific knowledge, physical and social, were effectively communicated to disaster planners, emergency officials and other personnel involved in coping with disasters.⁵

It should be noted that an increase in communication is not in itself sufficient. Those responsible need to act on the basis of the research conclusions; for example, by improving building codes in earthquake-prone areas.

... it is becoming increasingly evident that despite our improved knowledge and our ability to at least locate areas of potential damage and even to estimate in some instances the magnitude of prospective damages, we continue to be unable to make this knowledge available to the decision makers at the appropriate time and in the appropriate way. . . . Major emphasis at this time should be given to improving the means of communicating the available knowledge to private citizens and to public officers and to attempts at understanding the reasons, psychological and otherwise, that society either rejects such information or uses it in diverse and sometimes apparently inexplicable ways.⁶

The task of applying what is already known is complicated by the conglomerate nature of disaster-related research. Generically, the term touches on practically every field of science and technology. The distinguishing feature, however, is one of orientation or application, although the term "disaster" is often subsumed or only implied (e.g., hazard reduction or abatement, weather modification, hurricane suppression, fire prevention, flood control, safety measures or standards, building codes, zoning, storm warnings, etc.). This

complication is now recognized, and it has been suggested that a new approach—an interdisciplinary approach—be made in the field of disaster research.⁷

Interdisciplinary Approach to Disaster Research

Participating in this study, the Geophysics Research Board of the National Academy of Sciences endorsed the general view that disaster research should be supported "on a broad front" and with a systems approach to disaster preparedness. To this end the Board put forth this resolution:

In view of the continuing devastation and loss of human life resulting from natural disasters, many of which are the result of violent geophysical phenomena, the GRB stresses the potential for mitigation of such disasters through improved understanding of these phenomena. New knowledge gained through research can lead to methods of prediction, avoidance, and perhaps eventually, control and the GRB urges that such research be supported on a broad front as a national effort of high priority.

In addition to the basic geophysical research called for, the GRB strongly endorses the concept of a systems analysis approach to disaster preparedness for the protection of our increasingly complex and vulnerable technological society. In particular, the program of the Disaster Study Group of the Office of Emergency Preparedness is viewed very favorably by the GRB as an excellent start toward this goal and the support of this and related studies is urged.⁸

An interdisciplinary approach to disaster research brings to bear all of the individual disciplines that can contribute to the solution of a problem or achievement of a goal. It is goal-oriented research. For example, the problem of earthquake prediction has not been solved by separate, circumscribed disciplines; but a joint approach by geologists, seismologists, hydrologists, and possibly some borrowed techniques from the meteorologists, computer sciences, and space technology, may provide, through synthesis, a breakthrough in solving this problem. However, at this time scientists do not foresee an early solution (see Part III, Chapter F).

Another example of the need for an interdisciplinary approach can be drawn from the field of land-use and construction regulation. The national program discussed in Part IV, Chapter A, should be complemented by a program of engineering research and development directed at the analysis, design, construction, and maintenance of disaster-resistant structures, utility lines, and transportation facilities.

An extension of the interdisciplinary approach to disaster research is now being applied in formulating public policy for improved disaster protection and preparedness. This is illustrated by the approach being

made by the Joint Committee on Seismic Safety of the California Legislature. The Committee is supported by five interdisciplinary advisory groups:

- Engineering Considerations and Earthquake Sciences,
- Governmental Organization and Performance,
- Disaster Preparedness,
- Land Use Planning,
- Post Earthquake Recovery and Redevelopment.

The interdisciplinary approach in this instance is further illustrated by the recent "Earthquake Risk Conference" held by this Committee and the advisory groups at Carmel, California. The objective of the conference was: "To examine intensively the concept of 'risk' and approaches to its evaluation with the purpose of defining 'acceptable earthquake risk' as a basis for public policy for the State of California."⁹

It is interesting to note that the conference took account of measures being applied to reduce risks to other hazards, such as aircraft accidents and floods. Indeed, the broadest interdisciplinary approach provides the opportunity of transferring lessons learned in coping with one type of disaster to the solution of problems in dealing with others.

Another example of the interdisciplinary conference approach to the application of disaster research was the "International Meeting on Earthquakes" held in San Francisco May 20-25, 1971, under auspices of the NATO Committee on the Challenges of Modern Society (CCMS). About 170 seismologists, scientists, engineers, urban planners, disaster experts, and public officials, representing 17 countries, participated. In addition to plenary sessions, the conference included analyses and recommendations of four working groups covering: (1) Earthquake Disaster Prevention and Hazard Reduction, (2) Emergency Organization and Operations, (3) Rehabilitation and Recovery, and (4) Role of Governments, Universities, Industry, and Volunteer Organizations.¹⁰

Coordination of Disaster-Related Research

In the United States today, there is no one disaster research center. There are many governmental and private research centers specializing in some aspect of disaster-related research. For example, the National Oceanic and Atmospheric Administration (NOAA) has various disaster-related research centers: a Hurricane Research Center at Miami; a Severe Storm Laboratory at Norman, Oklahoma; an Earthquake Mechanism Laboratory at San Francisco; an Environmental Research Laboratory at Boulder, Colorado; a Tsunami Center in Hawaii; and an Earthquake Information Center at Rockville, Maryland. The U.S. Geological Survey has an Earthquake Research Center at Menlo Park, California. Both the Forest Service and the National Bureau of Standards are involved in fire research, and 11 Federal

agencies are concerned with research and experimentation in weather modification.

A means for coordinating the various Federal disaster-related research activities exists in the committees of the Federal Council for Science and Technology. The FCST was established by Executive Order 10807 (March 13, 1959). Its charter includes these functions:

- Provide more effective planning and administration of Federal scientific and technological programs,
- Identify research needs, including areas requiring additional emphasis,
- Achieve more effective utilization of the scientific and technological resources and facilities and prevent unnecessary duplication,
- Further international cooperation in science and technology.

The President's Science Advisor (who is also Director of the Office of Science and Technology) serves as Chairman of the Council. Eleven Federal agencies have membership and nine have observers with the Council.¹¹

The Council exercises its coordinating role through these committees: Atmospheric Sciences, Federal Laboratories, Government Patent Policy, International, Scientific and Technical Information, Water Resources Research, Intergovernmental Science Relations, Environmental Quality R&D, Excavation Technology, Automation Opportunities in the Service Areas, Energy R&D Goals, International Transfer of Technology, Marine Science and Engineering, RANN -Coordination, Ecological Research, and Environmental Health Research and Development.

As discussed in Part IV, Chapter C, the weather modification programs, involving 11 Federal agencies, are coordinated by the Interdepartmental Committee for Atmospheric Sciences (ICAS). This Committee has examined the various agency responsibilities and interests in weather modification activities with the objective of achieving a large measure of agreement on Federal regulation of such activities.

The NAS-NRC Committee on Atmospheric Sciences has expressed reservations about the use of a committee to coordinate atmospheric science programs:

But in order that the 11 separate agency programs constitute an effective national program, coordination is essential. . . .

. . . FCST and ICAS have not been able to develop an integrated national program in weather modification. Individual agency programs have been subcritical in size and research capability. ICAS has no authority to consolidate or to modify agency programs; and, most important, ICAS is not able itself to mount research efforts, no matter how badly needed they may be. . . . The result has been that in important respects the national effort in weather modification has been largely dissipated

in submarginal projects, while crucial problems requiring large programs remain unsolved.

* * * * *

A suitable administrative solution . . . would be to assign lead responsibility for research in weather modification and for coordination of major field programs to a single agency and to encourage other agencies to continue to support programs within their specific areas of responsibility.¹²

Notwithstanding these reservations, ICAS has made significant progress toward a coordinated national program in weather modification by designating specific Federal agencies responsible for subprograms or "national projects":

There is little doubt that our understanding of certain types of weather modification has reached the point where practicable application can become a reality in the very near future, provided that systematic progress is made, where possible, from research to operational status through a concerted national effort. An interdisciplinary multiagency approach will ensure that not only are the techniques perfected, but that all consequences, beneficial and detrimental, local, national and international, are fully assessed.

The suggested mechanism for accomplishing this is the establishment of National Projects.¹³

In contrast with the diversification of disaster-related research that prevails in the United States, some other countries have consolidated disaster research in one governmental agency. For example, in 1963 Japan established a National Research Center for Disaster Prevention as a part of the Science and Technology Agency under the Prime Minister's office. The Center applies science and technology to disaster prevention, mitigation of the effects of disasters, and postdisaster restoration.

The President's reorganization proposals would bring some consolidation to disaster-related research of the Federal agencies. For example, the earthquake research activities of the National Oceanic and Atmospheric Administration (Department of Commerce) and the U.S. Geological Survey (Department of the Interior) would be consolidated in a new Department of Natural Resources.

Pending action on Federal reorganization proposals, certain initiatives have been taken this year to enhance coordination of disaster-related research within the existing structure:

- The Office of Science and Technology, with NOAA serving as a lead agency under OST guidance, and in coordination with this study report, has formulated an interagency program on "Protection from Natural Disasters." The program is a result of the recent review of the administration of current technological problem areas.

- An agreement is being sought with the NAS Advisory Committee on Emergency Planning for an assessment by it of the current status of disaster-related research and to advise the Office of Emergency Preparedness on potential areas for improvement and priorities for future action.¹⁴
- The National Science Foundation has agreed in principle to consider disaster research needs identified by OEP in formulating NSF activities under its program "Research Applied to National Needs."¹⁵
- OEP has been named an observer with the ICAS.
- As directed by the President in his April 22, 1970 message, OEP is in the process of establishing a clearinghouse for all disaster-related research of the Federal Government.

Disaster Research Clearinghouse

Guidelines have been prepared for developing a disaster research clearinghouse, to be established by OEP in 1972.¹⁶

Initially, the clearinghouse will be limited to natural disaster-related research conducted or sponsored by the Federal Government. It will have the potential for expansion to include other hazards and other institutional research. Wherever possible, it will make use of other information centers, such as the National Referral Service of the Library of Congress, the Smithsonian Science Information Exchange, the Defense Documentation Center, and the Department of Commerce National Technical Information Service.

The clearinghouse will establish an inventory of disaster-related research by Federal agencies, by research centers, and by type of disaster. These data will be helpful in determining gaps and duplication and in formulating future research needs.

In this connection, the clearinghouse will work closely with the National Science Foundation, the National Academy of Sciences, the Smithsonian Institution, and the Federal Council for Science and Technology.

Disaster Research at Academic Institutions

For many years, academic institutions have engaged in disaster-related research of various kinds. The disaster research center at Ohio State University has engaged in field research concerning behavioral and sociological factors in various disaster situations. Other universities have conducted specialized research in one or more scientific and engineering fields, such as earthquake engineering.

During 1971, two initiatives were taken by academic institutions with support from NSF to develop a broad-based, interdisciplinary disaster research capability:

- The California Institute of Technology has established a Disaster Research Information Center as a focal

point of a Center for Research on Natural Disasters. This center will research both the physical and social aspects of all types of natural disasters.¹⁷

- The University of Colorado has begun a study to determine how "the research capacities of the scientific disciplines in the U.S. [can] be applied best to the systematic reduction of losses to national productivity, human suffering and social disruption resulting from natural disasters."¹⁸

Application of Disaster-Related Research

Although the San Fernando earthquake of February 1971 was moderate in intensity and the loss of life small in comparison with the exposed population, scientists and governmental officials were impressed with the fact that the limited loss involved a significant element of good fortune. Professor Clarence Allen stressed the point at the Senate Hearings in California following the earthquake:

I don't think many people realize in many ways we were exceedingly lucky in the San Fernando earthquake. It was not really a major shock. It occurred on the edge of, rather than squarely within, a major metropolitan area. It occurred in an area that could draw upon abundant emergency services. It occurred in an area with a relatively low density of older buildings. And it occurred at a time of day when the loss of life was minimized. We cannot count on being that lucky again.¹⁹

In a preliminary report to the President following this earthquake, the NAS-NAE Joint Panel on the San Fernando Earthquake recommended that:

The opportunity should be seized to make a careful evaluation of the performance of emergency services following the San Fernando Earthquake and to determine the kinds and extent of back-up required to prepare for a much larger event. Such a study, preferably involving federal, State, and other organizations, would provide guidelines for other earthquake-prone regions of high population density as well.²⁰

OEP and other Federal, as well as State, agencies did conduct immediate evaluations of the San Fernando disaster, and the lessons learned are being applied—such as the OEP program to improve the nationwide emergency medical services in all types of disasters. With regard to the potential danger of major earthquakes, the OEP Director has initiated a combined research and planning effort. NOAA has been commissioned to make a damage assessment study of a range of earthquakes in the San Francisco area. At the same time, OEP has issued an outline plan for Federal response in the event of a major earthquake in California and other high-risk locations.

The output of the damage assessment study will provide the input for detailed preparedness planning by the Federal agencies in cooperation with State and local governments. This process of applied research and planning for major earthquakes may be extended to other types of disasters in which large populations are vulnerable to catastrophic loss of life and property.

The need for such improvements in the application of disaster research is cogently expressed by the National League of Cities and the U.S. Conference of Mayors:

There appears to be no real disaster preparation or prevention programs in which local governments may participate. Too many of the available programs are post-disaster oriented. Included in such programs or assistance should be the development of information and/or information systems which would provide communities with a continuing knowledge of their vulnerability to both natural and man-caused disasters.²¹

There are Federal programs of assistance in developing local disaster preparedness, such as those of the Corps of Engineers concerning floods and NOAA concerning hurricanes and tornadoes, as described in this report. However, there is an apparent need for improvement in communication and information about the assistance now available, as well as for the development of additional programs, such as the OEP earthquake preparedness planning now in progress.

Findings

1. The most immediate need in the field of disaster research is to obtain more effective application of what is already known. This requires a better exchange of information and greater mutual understanding among the sciences, public officials, and the public itself. Improved application of research to disaster prevention, mitigation, and preparedness should result from further development of initiatives taken this past year or proposed in the President's FY 1973 budget. These are the prospects:

- Implementation of a Federal Disaster Research Clearinghouse by the Office of Emergency Preparedness should enhance the exchange of information between research activities and public officials.
- Assessment of current disaster research activities by the Advisory Committee on Emergency Planning, National Academy of Sciences, should provide a basis for future improvements.
- Incorporation of disaster research requirements in the program of "Research Applied to National Needs" by the National Science Foundation should encourage and achieve improvement in disaster research applications to existing problems.
- Establishment of a program of symposia and conferences with interdisciplinary participation, such as the State and the International Earthquake Conferences held

in California, should enhance greater mutual understanding and problem-solving in coping with disasters.

- Completion, refinement, and expanded application of the combined damage analysis-emergency planning endeavor instituted by OEP with respect to major earthquakes could serve as a model for applying disaster research to public policy and programs for protecting the lives and property of the people from natural disasters.

2. An interdisciplinary approach to disaster research is recognized as essential in developing coherent and comprehensive disaster prevention, mitigation, and preparedness programs. Among the academic institutions, the California Institute of Technology and the University of Colorado have taken the first initiatives. Also, the National Academy of Sciences, the National Science Foundation, and OEP are now actively fostering interdisciplinary disaster research.

3. There is no one place or organization in the United States that is designated and chartered to bring together the many specialized research results for an interdisciplinary approach to improving disaster prevention, mitigation and preparedness. The proposed Department of Natural Resources is an attempt to alleviate some of these problems of coordination.

Knowledge applicable to disasters is variegated and is, more often than not, also applicable to other interests and objectives of society. For example, research on insurance, communications, seismology, and weather forecasting may contribute to man's knowledge about disasters. This situation is pertinent to any consideration of giving disaster research some central focus. *Further study is required* before attempting any conclusions. *This study should address the desirability and practicability of establishing a National Center for Disaster Research*, which could have the following among its responsibilities:

- Serve as a more encompassing disaster research clearinghouse, to include private as well as governmental research activities;
- Provide an interconnection between the many specialized disaster research laboratories and centers throughout the Nation;
- Sponsor and conduct interdisciplinary disaster research;
- Coordinate on-the-scene scientific research and evaluations following major disasters;
- Formulate recommendations for improved measures of disaster prevention, mitigation, and preparedness;
- Provide a center for professional development of disaster program officials and visiting scholars;
- Publish a professional journal;
- Assist in fostering U.S. interests in international activities related to disaster research;
- Undertake special studies directed by the President and the Congress.

Notes

¹Agencies Supporting Research Registered at the Science Information Exchange, Smithsonian Science Information Exchange (Washington, D.C., April 1971).

²Natural Disaster Research Centers and Warning Systems: A Preliminary Survey, Smithsonian Institution Center for Short-Lived Phenomena (Cambridge, Mass., July 1971).

³National Research Council—National Academy of Sciences—National Academy of Engineering report to the OEP PL 91-606 Disaster Study Group, July 1971.

⁴W. D. McElroy, Director, National Science Foundation, letter with enclosures to the OEP PL 91-606 Disaster Study Group, July 16, 1971 (updated).

⁵"Work Group IV Report on the Role of Governments, Universities, Industry and Volunteer Organizations," *International Meeting on Earthquakes Conference Report*, NATO Committee on the Challenges of Modern Society, San Francisco, May 1971, p. 7.

⁶A. F. Spilhaus, Jr., Executive Director, American Geophysical Union, letter to Robert E. Schnabel, Chief of the PL 91-606 Disaster Study Group, OEP, June 23, 1971, p. 4.

⁷Dr. Harold Brown, President, California Institute of Technology, letter to the Director, Office of Emergency Preparedness, with enclosed faculty proposal by Drs. George Housner and Donald Hudson, February 16, 1971.

⁸Minutes of the Meeting on May 24, 1971 of the Geophysics Research Board of the National Academy of Sciences (Washington, D.C., October 22, 1971), pp. 7-8.

⁹Robert E. Schnabel, "Earthquake Risk Conference," Memorandum to the Assistant Director for Disaster Programs, Office of Emergency Preparedness, September 26, 1971. Presentations covered all aspects of the subject: Government's Response to Risk; Legal Provisions Relating to Seismic Safety; Congressional Directions in Risk Reductions; Risk Taking and Disaster Insurance; Availability and Desirability of Earthquake Insurance; Factors in Human Response to Earthquake Risk; Response to Emotional Problems in Earthquakes; Social Benefits Versus Earthquake Risks; Geologic Hazards: Problems for Joint Solution; Adjusting to Earthquakes: Costs and Benefits; Seismic Risk Evaluation of Nuclear Power Plants; Systematic Approach to Uncertainty and Risk; Civil Structures and Earthquake Safety; Earthquake Risks and Resulting Liability; Earthquake Safety and the Concept of Balanced Risk; Practical Safety Goals in Air Transportation; and Flood Control Program. (Publication of the Conference Proceedings is pending.)

¹⁰Conference Report, *International Meeting on Earthquakes, San Francisco, California, May 20-25, 1971*, Office of Emergency Preparedness (Washington, D.C., 1971).

¹¹Members are: the Departments of Agriculture; Commerce; Defense; Health, Education, and Welfare; Housing and Urban

Development; the Interior; State; and Transportation; the Atomic Energy Commission; the National Aeronautics and Space Administration; and the National Science Foundation. Observers are: the Arms Control and Disarmament Agency; the Council of Economic Advisers; the Council on Environmental Quality; the Department of Justice; the Environmental Protection Agency; the Office of Management and Budget; the Office of Economic Opportunity; the Smithsonian Institution; and the Veterans Administration.

¹²Committee on Atmospheric Sciences, National Research Council—National Academy of Sciences, *The Atmospheric Sciences and Man's Needs—Priorities for the Future* (Washington, D.C., 1971), pp. 50-51.

¹³Federal Council for Science and Technology, Interdepartmental Committee for Atmospheric Sciences, *A National Program for Accelerating Progress in Weather Modification*, ICAS Report 15a (Washington, D.C.: June 1971), p. 20.

¹⁴The Advisory Committee on Emergency Planning of the National Academy of Sciences was established in 1965. It has provided OEP with advice on war preparedness measures, such as resource management, industrial mobilization, and postattack recovery. The OEP Disaster Center, established and operating, was in large measure based on the recommendation of this Committee.

¹⁵See National Science Foundation brochure "Research Applied to National Needs, FY 1970-72."

¹⁶Charles E. Fritz, *Some Guidelines for Developing an Office of Emergency Preparedness Clearinghouse on Emergency Related Research*, Institute for Defense Analyses Paper P-824 (Washington, D.C., November 1971).

¹⁷Dr. Harold Brown, letter to the Director, Office of Emergency Preparedness, September 9, 1971.

¹⁸Proposal to the National Science Foundation by Drs. J. Eugene Haas and Gilbert White, University of Colorado, July 1971.

¹⁹U.S. Senate, *Governmental Response to the California Earthquake Disaster of February 1971*, Hearings before the Committee on Public Works, San Fernando, Calif., 92d Cong., 1st Sess., 1971, p. 562.

²⁰The Joint Panel on the San Fernando Earthquake, *The San Fernando Earthquake of February 9, 1971: Lessons from a Moderate Earthquake on the Fringe of a Densely Populated Region*. National Academy of Sciences—National Academy of Engineering (Washington, D.C., March 22, 1971), p. 10.

²¹Andrew B. Horgan, Director, Information and Federal Aids Services, National League of Cities—U.S. Conference of Mayors, letter with enclosures to the OEP PL 91-606 Disaster Study Group, June 15, 1971, p. 2.

Chapter B. Evaluation

Disaster evaluation is the connecting link between new knowledge, acquired through experience and research, and improved disaster preparedness. Too often evaluation is a missing link. This accounts for failures and delays in applying lessons learned by hard experience and in determining operational needs that require research.

There are several ways to accomplish disaster evaluations, and any effective evaluation system is a combination of most, if not all, of them.

On-the-Scene Evaluation

An indispensable means of achieving better understanding and improvements is by on-the-scene disaster evaluation. Although individuals caught up in a disaster learn much by their experience, what they learn may not be recorded and later may not be accurately recalled. Also, what one individual may learn is usually based on a limited view of what happened. Finally, the individual may not fully comprehend the real causes and the actual effects of his experience. All of this is to say: on-the-scene disaster evaluation requires special knowledge and techniques, and objective and timely analyses.

Objective and timely analyses of a disaster depend upon the ready availability of professional evaluators. Sometimes, the experts are ready and willing, but the funds for field evaluation are not available. This was the case with respect to the 1964 Alaska earthquake:

The greatest obstacle that the Committee encountered in trying to fill gaps in the collection of data about the Alaska earthquake was the absence of a mechanism to secure quick funding for data-collection efforts. . . . The records of the biological effects of the earthquake and the human response to it are especially incomplete, not because qualified persons who were willing to make the studies were lacking, but simply because funds were not obtainable.

* * *

Until such funding is assured, total collection and analysis of useful information from earthquakes and a coherent research program designed to reduce losses from earthquakes will not be possible.¹

A similar conclusion was reached at the International Meeting on Earthquakes at San Francisco in 1971:

Perhaps the most serious weakness in disaster research has been the consistent failure to take advantage of the immediate study that would be possible during or immediately after a large-scale disaster. . . . The lack of support for such immediate studies during the emergency period is the basic reason, because skilled personnel have always been available for this purpose.²

In the course of this study, it was found that the lack of programmed and contingency funding for immediate on-the-scene evaluation of disasters has been generally the case in the past. This situation was confirmed recently by the Director of the Environmental Research Laboratories:

The degree to which we [ERL] have reacted in the past [to major disasters] has been limited because we were not sure we could recover the costs spent during the emergency. We have made requests for supplemental budget appropriations which did not materialize.³

In contrast with the deliberate—but slow-starting, lengthy, and still incomplete—evaluation of the Alaska earthquake, and perhaps in reaction to it, there was a spontaneous response following the San Fernando earthquake. Numerous Federal, State, and local agencies, private institutions, and professional associations converged at the scene of the disaster to conduct evaluations. Within 6 weeks there were several published reports:

- The Joint Panel on the San Fernando Earthquake, National Academy of Sciences–National Academy of Engineering, submitted to the President on March 22, 1971, a preliminary report on *Lessons from a Moderate Earthquake on the Fringe of a Densely Populated Region*. Among other things, the Panel reported that:

The San Fernando Earthquake was the best monitored earthquake in United States history because of the high level of scientific preparedness in this area and the immediate response of earthquake researchers.⁴

- The U.S. Geological Survey and the National Oceanic and Atmospheric Administration issued a joint preliminary report containing 54 separate evaluations by both government scientists and professional members of

the Earthquake Engineering Research Institute. They observed:

A prompt response to the earthquake was critical for both the public officials and the private persons who had to cope with the destruction had a great and immediate need for reliable information about the earthquake and its effects. In addition, past experience had shown that (1) monitoring of after-shocks and continuing distortions of the earth's surface must begin promptly because these phenomena die out quickly, (2) the field evidence from which the nature of earthquakes and their damaging geologic effects must be deduced is rapidly destroyed by even emergency repairs or heavy precipitation, and (3) hazardous geologic and engineering situations must be quickly identified and brought to the attention of public and private officials.⁵

- The National Bureau of Standards published a preliminary report in March 1971 of its engineering survey and evaluation of damage to buildings and other structures.⁶ This evaluation was conducted for the Office of Emergency Preparedness; the report provided immediate photographic evidence and commentary on the damages sustained by various structures. A final, detailed report was submitted in December 1971.⁷

- OEP, with the cooperation of the Veterans Administration and the Department of Health, Education, and Welfare, conducted an immediate on-the-scene evaluation of the emergency medical conditions following the San Fernando earthquake. The evaluation report has resulted in a program initiated by OEP to improve emergency medical preparedness throughout the Nation.⁸ (See Part III, Chapter F, for further details.)

The foregoing represent only the early evaluation reports following the earthquake; in the succeeding months numerous additional reports have been published. These evaluations have led to (1) an increase in knowledge about the nature of earthquakes, (2) initiatives for improved disaster preparedness, and (3) identification of disaster research needs.

The early evaluations of the San Fernando earthquake not only resulted in a wealth of material but could have been responsible for the saving of many lives, particularly in the case of the evacuation of some 80,000 inhabitants below the Van Norman Dam. Scientific and engineering evaluation of the dam led public officials to order this evacuation as a precautionary measure.

The San Fernando experience also demonstrated the need for organizing and coordinating postdisaster evaluations. Many survey and evaluation teams followed one another over the same ground, so that public officials and private citizens became annoyed by recurring inquiries. It would appear that some focal point, clearinghouse, or registration center is needed to

organize and coordinate postdisaster evaluations when an event of great interest and significance occurs, not to deny but to enhance an orderly and systematic inquiry.

The many independent evaluations and resulting reports of the San Fernando earthquake also point up the need for and benefits of postdisaster critiques; that is, critiques bringing together the many evaluations of different aspects of the event.

Postdisaster Critique

In early every major disaster, something new is learned, or could be learned. It is evident that lessons learned in past disasters have led to improved prediction, warning, preparedness planning, and public response, with a consequent reduction in the loss of life. Conversely, the continued vulnerability and increasing loss of property reflects work yet to be done concerning prevention and mitigation.

An example of a prompt postdisaster critique resulting in early and effective remedial action occurred following Hurricane Camille. Within 3 days following the disaster, OEP convened an interagency task force to examine all aspects of preparedness and response. One product of this critique was the complete restructuring of the field management of Federal disaster assistance. The new structure was tested and refined in subsequent disasters at Lubbock, Texas (tornado), San Fernando, and Corpus Christi, Texas (Hurricane Celia). The lessons from Camille, of course, resulted in major improvements in disaster legislation.

Following the San Fernando earthquake, a number of postdisaster critiques were conducted to record the lessons and to recommend remedial actions.

- The "Earthquake Risk Conference," sponsored by the California Legislature's Joint Committee on Seismic Safety (see preceding chapter), represents an interdisciplinary critique of the earthquake hazards in California, and in particular the lessons learned from the San Fernando event.

- The Report of the Los Angeles County Earthquake Commission also reflects a comprehensive postdisaster critique of the San Fernando earthquake in terms of lessons learned and recommendations for public policy.⁹

These immediate appraisals contrast with the Alaska earthquake investigation, now in its seventh year. This long-term study, while important for purposes of science, does not provide the timely critique that can be effective in bringing needed changes in public policy concerning hazard reduction and improved preparedness. It may be that the moderate San Fernando earthquake will generate more official action than the "Great Alaska Earthquake" because of what might have happened and because timely evaluation, including critiques, provide an impetus for governmental action.

Predisaster Exercise and Critique

The hard lessons are learned in actual disasters, and these lessons can best be exploited by postdisaster evaluation. Other lessons may be learned more easily, at least in terms of hardship, by predisaster exercises and accompanying critiques. Not only is this method of predisaster evaluation a way of measuring emergency readiness, but it can be a useful tool in actually developing the plans and procedures that constitute disaster preparedness. This was actually the case with the county hospitals when the earthquake occurred at San Fernando, as described in Part III, Chapter F.

In some States, a day is designated annually to exercise the State Disaster Plan. In Virginia, it is December 7. In other States, it may coincide with the approach of the tornado or hurricane season and serve as a means of alerting the public as well as public officials.

The critique of an exercise is as important as the exercise itself, and it is too often omitted.

An effective critique of a disaster exercise requires observers and evaluators who are not participants in the actual exercise. They must know what to look for, record what they see, and present factual reports of their observations. In turn, these observations must be interpreted in meaningful terms for improved preparedness and emergency performance. This form of evaluation requires a professional staff, which, unfortunately, is not always available at State level and, less often, locally.

Preparedness and Performance Evaluation

In addition to evaluating the preparedness for and performance during an emergency, and the pertinent facts after a particular disaster, there is a need for an overall evaluation program—an across-the-board assessment. Such an assessment was conducted for OEP by the Council of State Governments throughout the 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, American Samoa, Guam, and the Trust Territory of the Pacific Islands. Each State and the separate jurisdictions were evaluated in terms of the legal authority to act promptly and effectively in a natural

disaster emergency; the availability of funds to actually implement the required actions; and the status of plans, organization, procedures, facilities, and training to execute emergency actions in natural disasters. As a result of this evaluation, OEP contracted further with the Council of State Governments to develop recommendations for the improvement of State legislation and plans for disaster preparedness and emergency operations. The Council's suggestions for State legislation are contained in Part VII of this report.

Findings

1. In an overall disaster program, evaluation is the link connecting research and experience with improved preparedness. An effective evaluation program will include a combination of predisaster and postdisaster observations and assessments:

- Predisaster exercises and critiques provide for improvement of plans and procedures and afford simulated training.
- On-the-scene evaluations are essential to a better understanding of the problems and to identifying and recording lessons learned.
- Postdisaster critiques provide a basis for determining remedial actions to be taken on the lessons learned, including long-range reduction of vulnerability and improvement in preparedness.

2. Prompt, thorough, and coordinated on-the-scene evaluation of major disasters is essential. In some instances it may be critically important in the immediate disaster phase, such as the evaluation of the Van Norman Dam and the decision to evacuate persons in jeopardy following the San Fernando earthquake. General requirements for such evaluations should be stated in advance, and contingency funds should be established by responsible agencies, thereby assuring quick response. Coordination of on-the-scene evaluation can best be accomplished by the Office of Emergency Preparedness, which now coordinates other aspects of Federal assistance in major disasters.

Notes

¹Committee on Alaska Earthquake, *Toward Reduction of Losses from Earthquakes: Conclusions from the Great Alaska Earthquake of 1964* (Washington, D.C.: National Academy of Sciences, Division of Earth Sciences, 1969), pp. 10-11.

²Work Group IV Report, *International Meeting on Earthquakes Conference Report*, NATO Committee on the Challenges of Modern Society, San Francisco, May 1971, pp. 5-6.

³Wilmot N. Hess, Director, Environmental Research Laboratories, NOAA, U.S. Department of Commerce, Letter to the OEP PL 91-606 Disaster Study Group, August 3, 1971.

⁴The Joint Panel on the San Fernando Earthquake, *The San Fernando Earthquake of February 9, 1971* (Washington, D.C.: National Academy of Sciences-National Academy of Engineering, 1971), p. 19.

⁵U.S. Geological Survey and National Oceanic and Atmospheric Administration, *The San Fernando, California, Earthquake of February 9, 1971*, Preliminary Report (Geological Survey Professional Paper 733), U.S. Department of the Interior and U.S. Department of Commerce (Washington, D.C.: U.S. Government Printing Office, 1971). Among the contributors to

this report were: California Division of Mines and Geology; California Division of Oil and Gas; California Institute of Technology; Lamont-Doherty Geological Observatory of Columbia University; H. J. Degenkolb and Associates, Engineers, pp. 1, 3.

⁶H. S. Lew, E. V. Leyendecker, and R. D. Dikkers, *Engineering Aspects of the 1971 San Fernando Earthquake*, U.S. Department of Commerce, National Bureau of Standards, Building Science Series 40 (Washington, D.C.: U.S. Government Printing Office, December 1971).

⁷Institute of Applied Technology, National Bureau of Standards, *The San Fernando, California, Earthquake of February 9, 1971* (Washington, D.C.: U.S. Department of Commerce, March 1971).

⁸A. H. Groeschel, *Study of the Medical Aspects of the Los Angeles Earthquake*, Staff Memorandum to the Director of OEP, February 22, 1971 (unpublished).

⁹*Report of the Los Angeles County Earthquake Commission, San Fernando Earthquake, February 9, 1971* (Los Angeles, Calif., November 1971).

PART VI.

HISTORICAL DATA

This part of the report consists of two chapters reflecting (1) the evolution of Federal disaster legislation and (2) selected statistics on major disasters and Federal assistance in the United States during the past 10 years.

It will be noted that for more than a century the Federal Government responded with special disaster relief measures after the occurrence of a particular major disaster. The relief was supplemental to the State and local communities and to contributions by private volunteer organizations. The principal motivation was humanitarian. In the 1950's Federal disaster assistance was established on a permanent basis, although limited to restoring public facilities. More recently assistance was expanded to provide substantial relief to the

individual citizen. Preparedness for disasters is the latest major addition to Federal legislation, providing for the development of disaster plans and programs and for advance emergency measures when disasters are imminent.

The chapter on selected statistics includes data on major disaster declarations and fund allocations by the Federal Government. These data cover numbers of declarations, types of disasters, and States affected during the past 10 years. During that time, almost three quarters of a billion dollars were expended from the President's disaster relief fund, and major disasters were declared for all but five States. The more significant disasters are also highlighted.

Chapter A. Disaster Legislation

This part of the study provides a brief legislative review of natural disaster assistance in the United States, with particular emphasis on the role of the Federal Government. This evolving role is exemplified in the comprehensive Disaster Relief Act of 1970, Public Law 91-606, as amended,¹ which commits the Federal Government, on a permanent basis, to major responsibilities in disaster preparedness planning and assistance. A chronological summary of Federal disaster assistance laws is included at the end of this chapter.

Early Disaster Operations

Private Relief Efforts. Prior to the 1950 enactment of Public Law 875 by the 81st Congress,² there was no permanent program of Federal disaster assistance to State and local governments in the United States. Private agencies bore the primary responsibility for disaster relief. The most effective private disaster relief organization was the American Red Cross. Governmental sanction for the activities of this quasi-public institution was set out in the Act of January 5, 1905.³ Operating within the framework of this law, the Red Cross was usually able to provide short-term assistance—food, clothing, emergency housing—and limited financial support for rehabilitation. In addition, it conducted or assisted rescue operations, evacuation, and mass care. These activities were aimed at the direct and immediate relief of the stricken population.

Private aid, with the exception of Red Cross assistance, was largely nonexistent in most sections of the country. Where other private relief organizations did exist, they were usually inadequate in the face of large-scale natural disasters. The narrow scope and focus of the Red Cross mission, the limited presence of other private assistance efforts, and the limited budgets of all disaster aid organizations inhibited disaster recovery.

Local and State Governments. In this early period (before PL 81-875), local government services, in daily life as well as in time of disaster, were narrowly focused and extremely limited. Primary emphasis centered on law enforcement. In time of disaster this included protection of people and prevention of looting. As municipalities grew in size and complexity, all public services were expanded. Local government disaster response was broadened beyond law enforcement to

include considerations of public health and safety. Later, as part of this evolutionary process, local governments attempted repair of disaster-damaged public facilities—roads, streets, bridges, and sewers. This assumption of additional responsibility was forced on the communities to insure continuation of their economic activity and social fabric. No real alternative existed. Local governments, however, were generally unable to meet these demands fully when confronted with large-scale disaster devastation. The narrow tax base of local government, plus statutory limits on municipal bonded indebtedness, severely curtailed discretionary funds available for emergency disaster relief. These constraints often forced communities to make only minimal repairs to the most important public facilities. Frequently, only partial resumption of public services was possible. In many cases, public facilities were left in a state of disrepair for long periods of time.

States also faced limitations on disaster relief funding and varied widely in the degree of disaster assistance offered to subordinate political subdivisions. This remains true today. Some States provided financial aid to disaster-stricken areas from special emergency funds or from general contingency funds authorized by State legislatures. In other cases, State legislatures authorized aid in specific disasters. In still other States, laws prohibited giving State aid to communities and individuals.

Agencies of State governments occasionally supplied manpower and equipment for projects falling within the purview of their usual areas of operation. Even with optimum use of all available State and local resources, however, disaster relief efforts were not adequate. The Federal Government moved to correct this situation.

The Federal Government. The only alternative to the limited assistance of private agencies and State and local governments lay in an appeal to Washington for special disaster aid. As early as 1803, the Federal Government recognized its responsibility for disaster assistance in cases where efforts of private agencies and State and local governments were not adequate to cope with disaster damage. Between 1803 and 1950, over 100 separate special assistance acts were passed by Congress. These laws, however, were enacted only after disasters had occurred. The after-the-fact nature of this *ad hoc* legislation resulted in a time lag between catastrophe and

Federal assistance, and hardship and suffering were long endured before assistance could be made available.

Some Federal agencies were, however, given specific authority to render assistance in particular kinds of disasters, somewhat alleviating this situation. The Corps of Engineers, for example, has had authority since 1941 to undertake emergency repair of flood control works and to conduct rescue operations.⁴ Since 1934, the Bureau of Public Roads has assisted with financing repair and reconstruction of disaster-damaged highways and bridges of the Federal-Aid Highway System.⁵ The Reconstruction Finance Corporation was given authority to make disaster loans for repair and reconstruction of certain public facilities, first in 1933 only after earthquakes,⁶ and later after other disasters.⁷

During the 1930's, a large amount of Federal disaster aid was channeled through programs of such agencies as the Federal Civil Works Administration, the Federal Emergency Relief Administration, the Works Progress Administration, the Public Works Administration, and the Civilian Conservation Corps. These programs, while not primarily geared to disaster assistance, frequently gave effective disaster aid. Federal disaster assistance was not formally coordinated, however, and there was no continuous program of Federal disaster aid.

Prompted by the need for continuing Federal disaster aid in the hurricane-plagued Gulf Coast and flood-prone areas along the Mississippi and Missouri Rivers, Congress in 1947 enacted the first general disaster relief act—Public Law 233, 80th Congress (approved July 27, 1947).⁸ The War Assets Administrator was authorized to transfer surplus Federal property to the Federal Works Administrator, who in turn was to lend or transfer this property to State and local governments to alleviate disaster impact. The Federal Works Administration could work through any Federal agency or any State or local government, and Federal agencies were directed to give this effort full cooperation. Congress made no special appropriation to carry out this Act; rather, FWA was directed to use funds available under the Surplus Property Act of 1944⁹ for the transfer of surplus or other excess property.

FWA thus assumed responsibility for administering the Disaster Surplus Property Program. When a disaster of sufficient severity occurred, FWA would recommend that the President invoke PL 80-233. Upon favorable Presidential action, the War Assets Administration (WAA) was alerted to anticipate material requests from local governments. FWA and WAA processed these requests and arranged for property delivery.

Surplus property was gradually depleted, and it became evident that a program of Federal funds for disaster relief to States and localities was urgently needed. The President began allocating money for disaster assistance from his general contingency fund. This informal grant program finally led to the establishment of a special emergency fund. This was the

forerunner of the first Federal disaster assistance authority.

Federal Disaster Act (PL 81-875) and Amendments

On September 30, 1950, the 81st Congress passed the first comprehensive Federal Disaster Act (Public Law 81-875). This law gave the President broad and continuing disaster assistance powers in those cases in which he declared the situation a "major disaster." PL 81-875 was directed principally at aiding the recovery and repair of public facilities of local governments.

Under the authority of PL 81-875, the President on March 2, 1951, issued Executive Order 10221,¹⁰ which delegated disaster relief administrative responsibility to the Housing and Home Finance Agency (HHFA).

The 82nd Congress, by Public Law 107 (August 3, 1951)¹¹ amended PL 81-875 to provide for the easing of credit restrictions under the National Housing Act and to authorize the furnishing of emergency housing for victims of disasters. The amendment was prompted by the Kansas-Missouri flood of 1951.

On January 15, 1953, the President revoked Executive Order 10221 and issued Executive Order 10427,¹² transferring PL 81-875 administration from HHFA to the Federal Civil Defense Administrator.

Under Executive Order 10427, the Federal Civil Defense Administration (FCDA) was empowered to:

- Direct and coordinate disaster relief efforts of Federal agencies,
- Draft disaster assistance regulations for the President,
- Foster development of State and local organizations and plans,
- Prepare annual and *ad hoc* reports on disaster relief and related materials for the President's consideration and possible submission to the Congress.

Executive Order 10427 emphasized the supplemental nature of Federal assistance set out in PL 81-875. The Order stated specifically that Federal aid was not a substitute for disaster assistance efforts of State and local governments and private agencies. Federal financial support for disaster assistance was made contingent upon reasonable collateral State and local expenditures.

The 83rd Congress enacted Public Law 134 (July 17, 1953),¹³ further amending PL 81-875 to permit loan and donation of Federal surplus property to State and local governments for repair of disaster-damaged public facilities and for individual rehabilitation. This law was passed in the aftermath of a 1953 tornado in Worcester, Massachusetts.

Executive Order 10737 (October 29, 1957)¹⁴ amended Executive Order 10427 and produced further alterations in Federal disaster relief administration. The new order established qualification procedures for States applying for Federal disaster assistance. It also set forth Federal administrative guidelines that would be followed

in the granting of disaster assistance. The order spelled out the kind and extent of Federal disaster relief offered under PL 81-875 and set out procedures for release of Federal disaster funds.

On July 1, 1958, by Executive Order 10773,¹⁵ the President delegated all functions previously administered by FCDA to the new Office of Defense and Civilian Mobilization—renamed by statute¹⁶ a month later as the Office of Civil and Defense Mobilization (OCDM). Three years later, Executive Order 10952 (July 20, 1961)¹⁷ transferred civil defense operational responsibility to the Department of Defense but retained in OCDM overall responsibility for directing and coordinating disaster relief efforts of Federal agencies. OCDM was thereupon renamed the Office of Emergency Planning (OEP).¹⁸

With the approval of Public Law 87-502¹⁹ on June 27, 1962, Guam, American Samoa, and the Trust Territory of the Pacific Islands were included within the definition of "State" and made eligible for Federal assistance under PL 81-875. This action made PL 81-875 applicable to all of the United States and its possessions. (Puerto Rico and the Virgin Islands were included in the original law; disaster relief is separately authorized for the Canal Zone by Title 2, Chapter 9, Section 235 of the Canal Zone Code.)

PL 87-502 also authorized emergency repair and temporary replacement of disaster-damaged facilities of State governments. PL 81-875 originally provided only for emergency repair or temporary replacement of public facilities owned by local governments.

Public Law 89-769 (November 6, 1966)²⁰ amended PL 81-875 by including rural communities, unincorporated towns, and villages as eligible entities on whose behalf a State or local government might make application for Federal disaster aid. PL 89-769 delegated additional authority and responsibility to OEP, specifically:

- Authority to share (on a 50-50 basis) costs of repair, restoration, or reconstruction of certain State, county, municipal, or other local government agency projects in the process of construction where damage was the result of a major disaster (Section 9);
- Authority to plan and coordinate all Federal disaster assistance (Section 12);
- Responsibility for disaster preparedness liaison with State and local governments (Section 12);
- Responsibility for the conduct of a study on ways to prevent or minimize loss of property, personal injury, and death from forest and grass fires (Section 13). (The OEP Investigation Study of Forest and Grass Fires was submitted to Congress on May 5, 1967.)

Special Legislation in the 1960's

In addition to the general disaster assistance provided for in PL 81-875 and amendments thereto, the Congress

enacted a limited number of laws which provided increased Federal aid in several major disasters.

1964 Amendments to the Alaska Omnibus Act (PL 88-451).²¹ This Act was passed to assist Alaska in its recovery from the March 27, 1964, earthquake. It liberalized the original Alaska Omnibus Act²² by:

- Increasing Federal contributions from 50 percent to 94.9 percent for highway construction on the Federal-Aid System,
- Authorizing the Secretary of Agriculture greater discretion in releasing indebtedness of borrowers under Farmers Home Administration programs,
- Providing additional assistance for public facilities and urban renewal projects through HHFA loans,
- Permitting the Small Business Administration (SBA) to make 30-year loans for dwelling repair and replacement.

Pacific Northwest Relief Act of 1965 (PL 89-41).²³ This Act was in response to extensive flood and high-water damage and property loss during December 1964 and early 1965 in California, Idaho, Nevada, Oregon, and Washington. The Act authorized \$70 million for repair and reconstruction of disaster-damaged highways not eligible under PL 81-875. The Act also directed a flood prevention study of the Eel River.

Southeast Hurricane Disaster Relief Act of 1965 (PL 89-339).²⁴ Heavy damage from Hurricane Betsy to Florida, Louisiana, and Mississippi prompted the passage of Public Law 89-339. The measure authorized the sale of federally provided mobile homes to the disaster victims then occupying them. It contained the first loan forgiveness provision in disaster legislation, authorizing the Small Business Administration and the Farmers Home Administration to cancel up to \$1,800 on loans over \$500 granted for repair of damage caused by a disaster. The Secretary of Housing and Urban Development was directed to do a study of alternative disaster assistance programs, including disaster insurance.

Disaster Relief Act of 1969 (PL 91-79)

Shortly after Hurricane Camille struck the Gulf Coast in August 1969, Congress passed Public Law 91-79 (October 1, 1969).²⁵ This Act permitted the Federal Government, through the Director of OEP (the agency's name was changed later that month from the Office of Emergency Planning to the Office of Emergency Preparedness²⁶) to provide additional disaster assistance, particularly to individuals affected by major disasters. Specifically, this law:

- Permitted loans by SBA and FHA with authority to cancel up to \$1800 on loans over \$500 received for damage caused by a disaster,

- Permitted the President to distribute through the Secretary of Agriculture coupon allotments and surplus food commodities to low-income households,
- Authorized unemployment payments to individuals unemployed as a result of a major disaster,
- Authorized OEP, acting for the President, to make grants to States and political subdivisions for the purpose of removing debris deposited on privately owned lands or waters as a result of a major disaster,
- Provided for financial assistance to States to develop comprehensive plans and programs for assisting individuals suffering losses as a result of major disasters.

Disaster Relief Act of 1970 (PL 91-606)

In order to modernize and consolidate legislation, the 91st Congress passed the Disaster Relief Act of 1970, Public Law 91-606, which was approved by the President on December 31, 1970. This Act repealed Public Laws 81-875, 89-769 (except Section 7, pertaining to higher-education facilities assistance in disaster areas), and 91-79, but retained and made permanent many of their provisions. It also added substantially to the increasing trend of Federal assistance for individual victims of disasters.

Passage of PL 91-606 represents the most significant landmark in the history of the Federal Disaster Assistance Program. It not only included almost all of the previous provisions for Federal disaster assistance but incorporated new features based on many years of experience by the Federal Government in responding to the human suffering and material losses caused by natural disasters. The new provisions follow:

- For Federal funding to State and local governments for disaster-damaged public facilities, the Act removed the restriction to only *emergency* repairs or *temporary* replacement and authorized up to 100 percent reimbursement of the cost of their *permanent* repair, restoration, or replacement.
- Federal grant-in-aid program administrative procedures may be waived or modified during a declared major disaster.
- The Director, OEP, is authorized to coordinate, with their consent, the relief effort of private organizations such as the Red Cross, the Salvation Army, and the Mennonite Disaster Service.
- Nondiscrimination in disaster assistance is emphasized.
- The resources of the Federal Government can be made available, on determination by the President, to avert or lessen the effects of a disaster before it occurs.
- The Director, OEP, is given special authority to set up emergency communications and to provide temporary public transportation to carry out his responsibilities in a major disaster situation.

- Age of any adult Federal loan applicant will not be considered in determining his eligibility.
- SBA and FHA are authorized to make loans to sources of major employment in a disaster area in such amounts that will permit these sources to resume operations and contribute to the restoration of the economic viability of the area.
- Legal assistance may be given to low-income individuals to meet their needs as a consequence of a major disaster, consistent with the goals of the programs of the Act.
- The President may make a grant to a local government which has experienced a substantial loss of property tax revenue as a result of a major disaster.
- Federal loans for repair, restoration, or replacement of residences are contingent upon compliance with applicable building codes and standards of safety, decency, and sanitation.

This last-mentioned provision did not, however, cover privately owned, nonprofit institutions serving the public—facilities equally at the mercy of a disaster but often with inadequate resources to enable recovery. The California earthquake in February 1971, in particular, damaged or destroyed several private medical care facilities. Consequently, Congress added a new Section 255 to PL 91-606 to authorize similar grants for tax-exempt nongovernment medical care facilities. The amendatory legislation, Public Law 92-209, was passed and approved in December 1971, but its authority was made retroactive to the beginning of the year.²⁷

In addition to these new features in Public Law 91-606 is the requirement—in Section 203(h)—that the OEP Director “make, in cooperation with the heads of other affected Federal and State agencies, a full and complete investigation and study for the purpose of determining what additional or improved plans, procedures, and facilities are necessary to provide immediate effective action to prevent or minimize” casualties and property losses from disasters—the basis for this report.

Executive Order 11575 (December 31, 1970)²⁸ provides for administration of PL 91-606. Essentially, in this Order the President reserves to himself the declaration of major disasters, determinations with respect to restoration of Federal facilities, and the prescribing of time limits for granting priorities for public-facilities and housing assistance in the disaster area. The OEP Director is delegated authority to act in all other matters for which the President is given responsibility in the Act except two: the Secretary of Defense is designated to act for the President concerning the availability and use of civil defense communications for disaster warnings; the Secretary of Agriculture acts for the President concerning the use of surplus commodities and food coupons in a major disaster situation.

Specific Major Disaster Assistance Programs of Federal Agencies

Several Federal agencies have specific disaster assistance programs that are activated following a major disaster declaration. After such a declaration by the President, the appropriate agency head has full statutory authority to use these programs. OEP serves as coordinator for these programs as well as those authorized under PL 91-606, as amended. The following are representative of these specific programs.

The Secretary of Agriculture is authorized to:

- Liberalize loan programs administered by the Rural Electrification Administration—42 USC 1855bb (a),
- Provide loans for waste disposal systems and other public facilities—7 USC 1926 (c),
- Divert acreage, under the price support program, to crops that will reestablish a proper farm-products balance after a disaster—7 USC 1421 (c),
- Provide free feed grains from Commodity Credit Corporation-owned stocks, for distressed livestock under certain conditions—7 USC 1427.

The Secretary of Housing and Urban Development is authorized to:

- Adjust repayment and maturity schedules on loans—42 USC 1855bb (b),
- Liberalize FHA loan insurance requirements for disaster victims—12 USC 1715 (f),
- Give priority treatment to public agencies in major disaster areas for facilities and housing programs—42 USC 1855dd.

The Secretary of Health, Education, and Welfare is authorized to:

- Provide financial assistance for the construction and operation of public elementary and secondary schools in

areas affected by a major disaster—20 USC 646, 79 Stat. 1158 (this authority was first granted in 1965 and was extended in 1967),

- Provide financial assistance, under certain conditions, to public institutions of higher education if damaged in a Presidentially declared major disaster. (Funding for this purpose, though authorized, has been appropriated only for one specific disaster, and the authority has not otherwise been used. It is due to expire June 30, 1972.)

The Administrator of the Small Business Administration is authorized to:

- Liberalize economic injury loans to small business firms—15 USC 636(b)(2),
- Liberalize loan qualification requirements for privately owned colleges and universities damaged in a Presidentially declared major disaster—15 USC 636(f).

The Administrator of the Veterans Administration (38 USC 1820(f)), *the Secretary of the Interior* (42 USC 1855gg), and *the Commissioner of Internal Revenue* (26 USC 165(h)) are authorized to liberalize certain programs and relax requirements to assist major disaster victims.

In addition to the above, there are more than 200 special statutory authorizations which can be used by about 25 executive departments and agencies to provide assistance to disaster victims. These apply to situations for which no major disaster has been declared, as well as those for which such a declaration has been made. (A comprehensive list of Federal programs which can be used in disaster situations has been prepared by OEP. This is used by the Federal Coordinating Officers at the scene of a disaster.)

Table 1. Evolution and Expansion of Federal Disaster Assistance

• 1803-1947	Special acts (128)—to provide relief for victims of specific disasters.
• 1947 PL 80-233	First general disaster relief act; surplus Federal property transferred to State and local governments.
• 1950 PL 81-875	Federal funds authorized for emergency repair and replacement of public facilities of local governments.
• 1951 PL 82-107	Authorized emergency housing.
• 1953 PL 83-134	Permitted loan or donation of Federal surplus property to State and local governments for repair of public facilities and for individual rehabilitation.
• 1962 PL 87-502	Extended coverage of PL 81-875 to include State public facilities and Guam, American Samoa, and Trust Territory of the Pacific Islands.

Table 1. Evolution and Expansion of Federal Disaster Assistance—Continued

● 1964-1965

PL 88-451

1964 Alaska earthquake assistance.

PL 89-41

1964-65 flood damage assistance to California, Idaho, Nevada, Oregon, and Washington.

PL 89-339

Hurricane Betsy (1965) assistance to Florida, Louisiana, and Mississippi.

● 1966

PL 89-769

Further expanded PL 81-875: Rural communities, unincorporated towns, and villages were made eligible for Federal disaster relief.

Permitted sharing of costs with State and local governments for repair or restoration of public facilities in process of construction but damaged by natural disaster.

Affirmed OEP authority to coordinate all Federal disaster assistance programs, and made OEP responsible for disaster preparedness liaison with State and local governments.

● 1969

PL 91-79

Comprehensive act covering most aspects of previous legislation but limited to 15 months; provisions included:

- Designation of a Federal coordinating officer during a major disaster,
- Federal agency cooperation in rendering disaster assistance,
- Federal assistance to States for development of disaster plans,
- Authority to use civil defense communications for disaster warnings,
- Debris removal from private property by Federal agencies and grants to State and local governments for this purpose,
- Forest and grassland fire suppression grants to States,
- Temporary housing for disaster victims,
- SBA, FHA, VA loans at reduced interest,
- Adjustment of Federal loans,
- Authority to distribute food and coupons to disaster victims,
- Federal unemployment compensation,
- Federal funds for purchase of timber in disaster areas,
- Restoration of U.S.-owned facilities in disaster areas,
- Federal contribution of 50 percent to State and local governments to restore public facilities public facilities under construction at time of disaster,
- Priority to applications for public-facility and housing assistance.

● 1970

PL 91-606

Comprehensive disaster assistance act with no expiration date; most provisions of PL 91-79 included and new ones added covering:

- Emergency support teams,
- Use of local firms and individuals,
- Federal grant-in-aid programs,
- Coordination of relief organizations,
- Nondiscrimination in providing disaster assistance,
- Emergency communications,
- Provision of emergency public transportation,
- Disregard of age of applicant for assistance,
- Aid to major sources of employment,
- Provision of legal services,
- Community disaster loan funds,
- Minimum standards for residential structure restoration,
- Relocation assistance.

● 1971

PL 92-209

Amended PL 91-606 to authorize Federal grants for repair, reconstruction, or replacement of medical care facilities owned by tax-exempt organizations and damaged or destroyed by a major disaster—up to 100 percent of net cost for existing facilities, up to 50 percent for those under construction.

Notes

¹84 Stat. 1744. Title II was amended by PL 92-209 (December 18, 1971), 85 Stat. 742.

²64 Stat. 1109, 42 USC 1855.

³PL 4, 58th Congress; 33 Stat. 599, 36 USC 1.

⁴PL 228, 77th Congress, Sec. 5, as amended; 55 Stat. 650, as amended; 33 USC 701n. PL 771, 81st Congress, Sec. 208; 62 Stat. 1182, 33 USC 701t.

⁵PL 393, 73rd Congress, Section 3; 48 Stat. 994, 23 USC 13a.

⁶PL 4, 73rd Congress; 48 Stat. 20, 12 USC 347d.

⁷PL 160, 73rd Congress; 48 Stat. 589, 15 USC 605k.

⁸61 Stat. 422, 42 USC 1851-1852.

⁹PL 457, 78th Congress; 58 Stat. 765, 50 USC App. 1611.

¹⁰3 CFR 1949-1953 Comp., p. 735.

¹¹65 Stat. 173, 12 USC 1706c.

¹²3 CFR 1949-1953 Comp., p. 925.

¹³67 Stat. 180, 42 USC 1855b(c).

¹⁴3 CFR 1954-1958 Comp., p. 395.

¹⁵3 CFR 1954-1958 Comp., p. 416.

¹⁶PL 85-763; 72 Stat. 861; 5 USCA 1332-15, note; 50 USCA App. 2271, note. Also see EO 10782, 3 CFR 1954-1958 Comp., p. 422.

¹⁷3 CFR 1959-1963 Comp., p. 479.

¹⁸By PL 87-296 (September 22, 1961); 75 Stat. 630; 5 USCA 1332-15, note; 50 USCA App. 2271, note; 50 USCA 404, note.

¹⁹76 Stat. 111; 42 USC 1855a, 1855b.

²⁰80 Stat. 1316, 42 USC 1855 et seq.

²¹78 Stat. 505; 48 USCA, following Section 57 and preceding notes.

²²PL 86-70, 73 Stat. 141 (codified in several USC titles).

²³79 Stat. 131.

²⁴79 Stat. 1301.

²⁵83 Stat. 125, 42 USC 1855aaa.

²⁶By a rider to a supplemental appropriation bill, PL 90-608 (October 21, 1968), 82 Stat. 1193, 50 USC App. 2271, note.

²⁷85 Stat. 742.

²⁸36 FR 37.

Chapter B. Selected Statistics

Introduction

The following selected statistics deal primarily with major disaster declarations and allocations from the President's Disaster Fund. In view of this, it is important to remember that the figures shown represent only a portion of the actual losses from natural disasters. For example, allocations to Alaska after the 1964 earthquake were \$57.6 million, while total damage has been estimated at \$500 million. A more precise picture of the actual losses from each type of disaster can be found in the various physical studies, Part VIII of this Report.

The statistical summary covers the 10-year period 1961-1970. (All figures are for calendar years.) During that time span, Connecticut, Massachusetts, New Hampshire, Rhode Island, South Carolina, Utah, and the District of Columbia received no allocations from the President's Disaster Fund. It should not be assumed that those areas were free from the effects of disaster; rather, it is likely that any loss from a natural disaster that occurred was not of sufficient magnitude to warrant a major disaster declaration.

Data for 1971 disasters have been excluded from the statistical summary, since the complete figures were not yet available. It is anticipated that the totals will be substantial, due in part to the costly San Fernando earthquake in February. Allocations made in 1971 for prior-year major disasters are included, however.

It should also be noted that the classifications of disasters that appear in this section have been derived from the wording of the Governor's request for a major disaster declaration. The category "severe storms" encompasses such phenomena as winter storms, excessive rainfall, and heavy rainfall and often includes flooding. At the same time, allocations for tornadoes include allocations for the severe storms and flooding that frequently accompany tornadoes. Thus, the total allocations for floods would be substantially greater if it had been possible statistically to separate flooding from severe storms and tornadoes.

Explanations

Table 1 and Figure 1 represent a breakdown of major disaster declarations and allocations by type of disaster. From these, it can be seen that the largest portion of both declarations and allocations was for severe storms. Hurricanes and tornadoes were declared major disasters an equal number of times, although approximately four

times as much money was allocated for hurricanes as for tornadoes. Floods received a large number of declarations, but a comparatively small amount in allocations—the opposite of earthquakes, which were few in number and high in amount allocated, due to the Alaskan earthquake.

Table 2 divides allocations from the President's Disaster Fund by calendar year and by State. The large allocations to certain States are usually the result of single particularly destructive disasters rather than several lesser ones. For example, note the very high allocations to Alaska in 1964, California in 1969, Mississippi in 1969, and Texas in 1970.

The two maps in Figure 2 together reveal the lack of any consistent correlation between the number of disaster declarations and the total amount allocated to a State. Louisiana and North Dakota each received five major disaster declarations in the 10-year period, but the former received \$58.42 million in allocations while the latter received only \$7.67 million. Again, this is often the result of one large disaster—Hurricane Betsy in the case of Louisiana.

Table 3 and the maps in Figure 3 indicate which States are especially vulnerable to each type of disaster. Even though the figures shown are not the actual losses or total number of disasters that occurred, a definite geographical pattern can be seen in most cases. Only floods and severe storms strike a wide area; the other types of disasters are more narrowly confined.

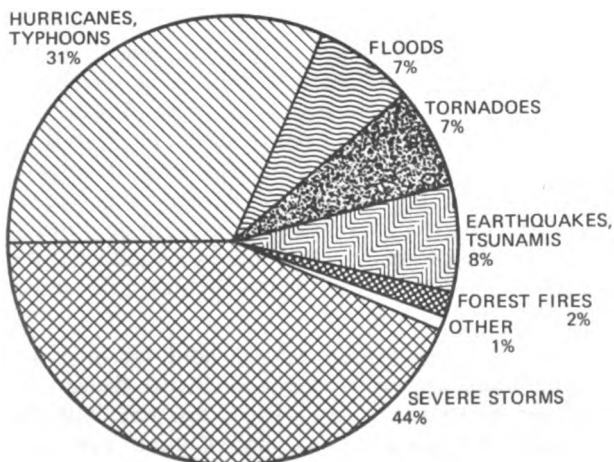
Figure 4, a graph of per capita allocations by State, can be compared with Table 2 or Table 3. In some cases, there is a definite correlation: Iowa ranks 15th in total allocations and 19th in per capita allocations; Maryland, 39th and 42nd; Nebraska, 28th and 26th; Oklahoma, 46th and 47th, and Wisconsin, 41st and 43rd, respectively. Alaska ranks high on both scales, but proportionately much higher on the per capita scale. California, the leader in total allocations, falls to 11th on a per capita basis.

Figure 5 bears witness to the need for increased disaster insurance, as it compares actual damage to estimated loss payments for selected disasters. With the exception of Hurricane Celia, insured losses were consistently less than half of the total losses and generally much less than half.

Table 1.—Number of Major Disaster Declarations (upper figure) and Allocations (\$ millions-lower figure) from the President's Disaster Fund, by Calendar Year and Type, 1961-1970.

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Totals
Severe Storms	-- --	9 36.03	10 8.67	14 69.30	5 20.04	5 2.93	4 16.25	11 6.11	16 136.90	13 42.90	87 339.13
Hurricanes, Typhoons	2 8.00	1 16.90	3 3.58	5 15.55	3 44.07	1 2.41	2 12.25	2 9.25	3 91.37	1 37.50	23 240.88
Tornadoes	2 2.55	1 0.73	-- --	-- --	7 28.18	1 3.70	2 2.25	6 2.32	2 7.00	2 6.56	23 53.29
Floods	8 6.54	9 8.45	5 1.97	2 0.26	5 9.11	4 5.30	2 1.87	-- --	8 17.32	-- --	43 50.82
Earthquakes, Tsunamis	-- --	-- --	-- --	2 58.85	1 2.00	-- --	-- --	-- --	-- --	-- --	3 60.85
Forest Fires	1 0.83	-- --	-- --	-- --	-- --	-- --	1 1.12	-- --	-- --	1 16.00	3 17.95
Droughts	-- --	-- --	1 0.13	2 0.82	-- --	-- --	-- --	-- --	-- --	-- --	3 0.95
Other	-- --	2 2.83	1 1.59	-- --	4 1.26	-- --	-- --	-- --	-- --	-- --	7 5.68
Totals	13 17.92	22 64.94	20 15.94	25 144.78	25 104.66	11 14.34	11 33.74	19 17.68	29 252.59	17 102.96	192 769.55

ALLOCATIONS FROM THE PRESIDENT'S DISASTER FUND
BY TYPE OF DISASTER, 1961-1970



NUMBER OF MAJOR DISASTER DECLARATIONS
BY TYPE OF DISASTER, 1961-1970

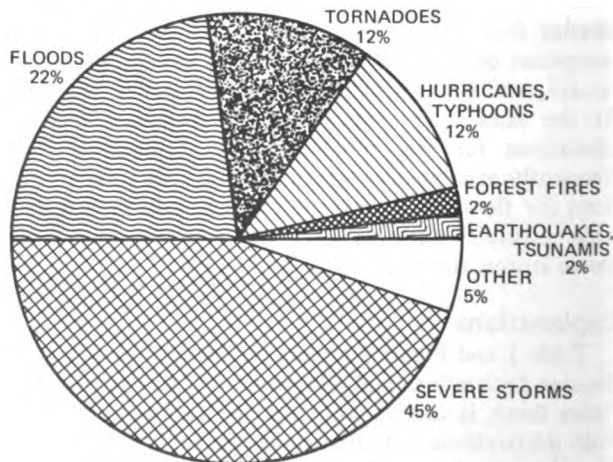


Figure 1.—Number of Major Disaster Declarations and Allocations from the President's Disaster Fund, by Type, 1961-1970.

Table 2.—Allocations from the President's Disaster Fund, by Calendar Year and State, 1961-1970.

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Totals
Alabama	0.68	--	--	--	--	--	--	--	1.22	0.40	2.30
Alaska	--	--	--	57.60	--	--	7.60	--	0.15	--	65.35
Arizona	--	--	--	--	--	2.12	--	--	--	2.10	4.22
Arkansas	0.80	--	0.15	0.25	--	--	--	0.65	0.35	--	2.20
California	0.83	4.48	2.63	38.85	2.90	1.00	7.00	--	116.90	23.21	197.80
Colorado	--	--	--	--	19.70	--	--	--	4.10	0.75	24.55
Connecticut	--	--	--	--	--	--	--	--	--	--	--
Delaware	--	4.50	--	--	--	--	--	--	--	--	4.50
Dist. of Columbia	--	--	--	--	--	--	--	--	--	--	--
Florida	--	1.71	--	10.50	2.50	--	--	0.75	--	0.85	16.31
Georgia	0.40	--	0.08	2.15	--	0.45	--	--	--	--	3.08
Hawaii	--	--	0.25	--	--	--	--	0.30	--	--	0.55
Idaho	0.26	1.25	0.25	1.20	--	--	1.12	--	--	--	4.08
Illinois	1.75	--	--	--	3.50	--	1.00	0.30	3.78	--	10.33
Indiana	0.95	--	--	0.74	1.75	--	--	0.22	--	--	3.66
Iowa	0.50	0.46	--	--	5.50	--	--	1.37	3.34	--	11.17
Kansas	--	--	--	--	2.00	3.70	1.25	--	0.90	--	7.85
Kentucky	--	0.80	3.25	0.85	--	--	0.40	0.38	0.21	1.15	7.04
Louisiana	--	0.02	--	2.65	39.75	--	--	--	16.00	--	58.42
Maine	--	--	--	--	--	--	--	--	--	3.90	3.90
Maryland	--	2.03	--	--	--	--	--	--	--	--	2.03
Massachusetts	--	--	--	--	--	--	--	--	--	--	--
Michigan	--	--	--	--	1.45	--	--	--	--	--	1.45
Minnesota	--	--	--	--	12.15	1.63	--	0.76	5.90	4.72	25.16
Mississippi	1.50	2.81	--	--	1.82	--	--	--	74.15	--	80.28
Missouri	0.50	--	--	0.65	1.96	--	--	--	--	--	3.11
Montana	--	--	--	8.00	--	--	--	--	--	--	8.00
Nebraska	--	0.74	0.40	0.78	--	0.85	1.25	--	--	--	4.02
Nevada	--	0.33	0.70	--	1.08	--	--	--	0.15	--	2.26
New Hampshire	--	--	--	--	--	--	--	--	--	--	--
New Jersey	--	17.10	--	--	1.13	--	--	2.05	--	--	20.28
New Mexico	--	--	--	--	2.40	--	--	--	--	--	2.40
New York	--	3.50	0.75	--	--	--	0.62	--	0.52	0.83	6.22
North Carolina	--	1.23	--	0.33	--	--	--	0.40	--	--	1.96
North Dakota	--	--	--	--	0.50	1.58	--	--	3.79	1.80	7.67
Ohio	--	--	--	0.90	0.45	--	--	1.27	6.10	--	8.72
Oklahoma	--	--	--	--	--	--	--	0.18	--	0.55	0.73
Oregon	--	1.70	0.21	14.00	--	--	--	--	--	--	15.91
Pennsylvania	--	--	--	--	0.13	--	--	--	1.25	--	1.38
Rhode Island	--	--	--	--	--	--	--	--	--	--	--
South Carolina	--	--	--	--	--	--	--	--	--	--	--
South Dakota	--	0.73	--	--	0.66	--	--	--	1.05	--	2.44
Tennessee	--	--	0.75	--	--	--	--	--	0.65	--	1.40
Texas	8.00	--	0.50	--	0.33	0.60	10.10	0.55	--	43.66	63.74
Utah	--	--	--	--	--	--	--	--	--	--	--
Vermont	--	--	0.13	0.11	--	--	--	--	0.40	--	0.64
Virginia	--	3.50	0.22	--	--	--	--	--	10.15	--	13.87
Washington	--	0.75	0.59	3.90	2.00	--	--	--	--	--	7.24
West Virginia	1.75	0.40	1.70	0.10	--	--	1.25	--	0.60	--	5.80
Wisconsin	--	--	--	--	1.00	--	--	--	0.93	--	1.93
Wyoming	--	--	0.30	--	--	--	--	--	--	--	0.30
American Samoa	--	--	--	--	--	2.41	--	--	--	--	2.41
Guam	--	16.90	0.72	--	--	--	--	--	--	--	17.62
Puerto Rico	--	--	--	0.74	--	--	--	--	--	17.72	18.46
Trust Territories	--	--	2.36	0.40	--	--	2.15	8.50	--	--	13.41
Virgin Islands	--	--	--	0.08	--	--	--	--	--	1.32	1.40
Totals	17.92	64.94	15.94	144.78	104.66	14.34	33.74	17.68	252.59	102.96	769.55

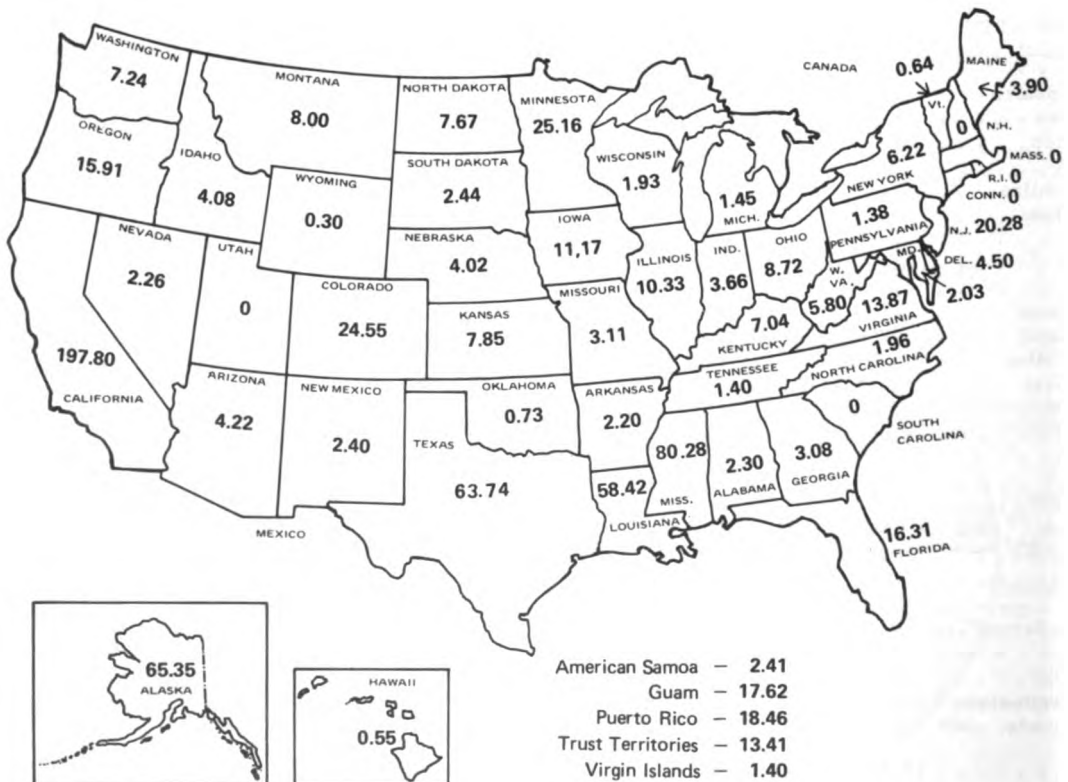
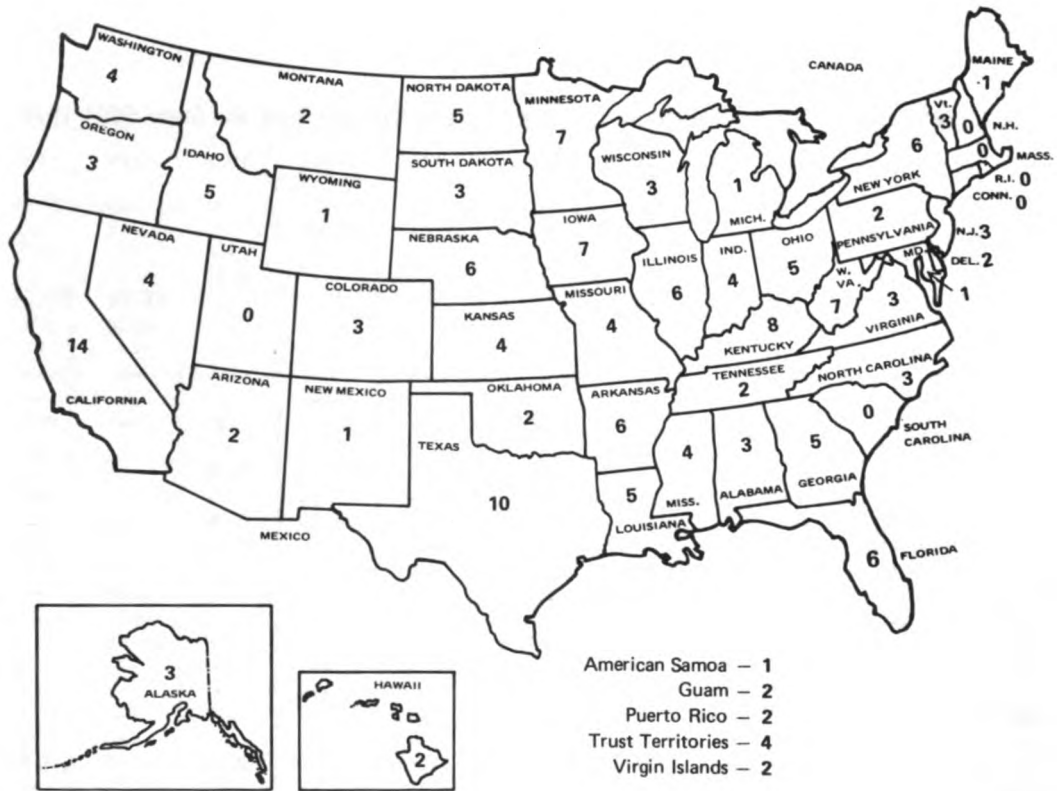


Figure 2.—Number of Major Disaster Declarations (above) and Allocations from the President's Disaster Fund, by State, 1961-1970.

Table 3.—Allocations from the President's Disaster Fund, by Type and State, 1961-1970.

	Severe Storms	Hurricanes, Typhoons	Tornadoes	Floods	Other	Totals
Alabama	--	1.22	0.40	0.68	--	2.30
Alaska	7.75	--	--	--	57.60 ^a	65.35
Arizona	2.10	--	--	2.12	--	4.22
Arkansas	0.75	--	1.45	--	--	2.20
California	171.87	--	--	6.26	19.67 ^{abc}	197.80
Colorado	4.85	--	19.70	--	--	24.55
Connecticut	--	--	--	--	--	--
Delaware	4.50	--	--	--	--	4.50
Dist. of Columbia	--	--	--	--	--	--
Florida	0.85	13.75	--	1.71	--	16.31
Georgia	0.08	2.00	--	1.00	--	3.08
Hawaii	0.55	--	--	--	--	0.55
Idaho	1.20	--	--	1.76	1.12 ^b	4.08
Illinois	2.98	--	6.55	0.80	--	10.33
Indiana	0.96	--	1.75	0.95	--	3.66
Iowa	2.16	--	0.72	8.29	--	11.17
Kansas	--	--	5.85	2.00	--	7.85
Kentucky	5.86	--	0.38	0.80	--	7.04
Louisiana	--	58.40	--	--	0.02 ^d	58.42
Maine	3.90	--	--	--	--	3.90
Maryland	2.03	--	--	--	--	2.03
Massachusetts	--	--	--	--	--	--
Michigan	--	--	1.45	--	--	1.45
Minnesota	17.83	--	--	7.33	--	25.16
Mississippi	--	75.97	--	1.50	2.81 ^d	80.28
Missouri	2.16	--	--	0.95	--	3.11
Montana	8.00	--	--	--	--	8.00
Nebraska	3.28	--	--	0.74	--	4.02
Nevada	1.08	--	--	1.18	--	2.26
New Hampshire	--	--	--	--	--	--
New Jersey	19.15	--	--	--	1.13 ^e	20.28
New Mexico	2.40	--	--	--	--	2.40
New York	5.60	--	--	0.62	--	6.22
North Carolina	1.96	--	--	--	--	1.96
North Dakota	2.28	--	--	5.39	--	7.67
Ohio	1.90	--	6.82	--	--	8.72
Oklahoma	0.73	--	--	--	--	0.73
Oregon	15.70	--	--	0.21	--	15.91
Pennsylvania	1.25	--	--	--	0.13 ^e	1.38
Rhode Island	--	--	--	--	--	--
South Carolina	--	--	--	--	--	--
South Dakota	--	--	0.73	1.71	--	2.44
Tennessee	1.40	--	--	--	--	1.40
Texas	1.15	56.10	6.49	--	--	63.74
Utah	--	--	--	--	--	--
Vermont	0.40	--	--	0.11	0.13 ^f	0.64
Virginia	13.65	--	--	0.22	--	13.87
Washington	4.65	--	--	0.59	2.00 ^a	7.24
West Virginia	2.40	--	--	3.40	--	5.80
Wisconsin	0.43	--	1.00	0.50	--	1.93
Wyoming	0.30	--	--	--	--	0.30
American Samoa	--	2.41	--	--	--	2.41
Guam	--	17.62	--	--	--	17.62
Puerto Rico	17.72	--	--	--	0.74 ^f	18.46
Trust Territories	--	13.41	--	--	--	13.41
Virgin Islands	1.32	--	--	--	0.08 ^f	1.40
Totals	339.13	240.88	53.29	50.82	85.43	769.55

^a Earthquakes, Tsunamis--California 1.25,
Total 60.85

^b Forest Fires--California 16.83, Total 17.95

^c Dam break and flood--1.59

^d Chlorine Barge--Total 2.83

^e Water Shortage--Total 1.26

^f Droughts--Total 0.95

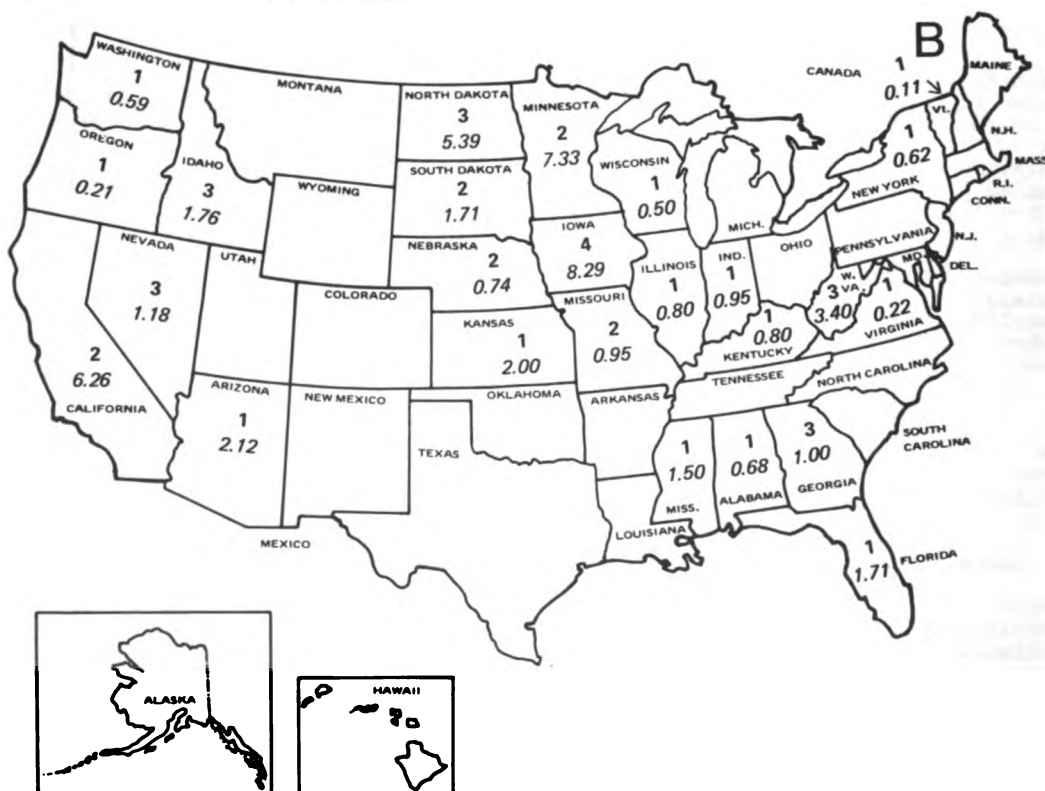
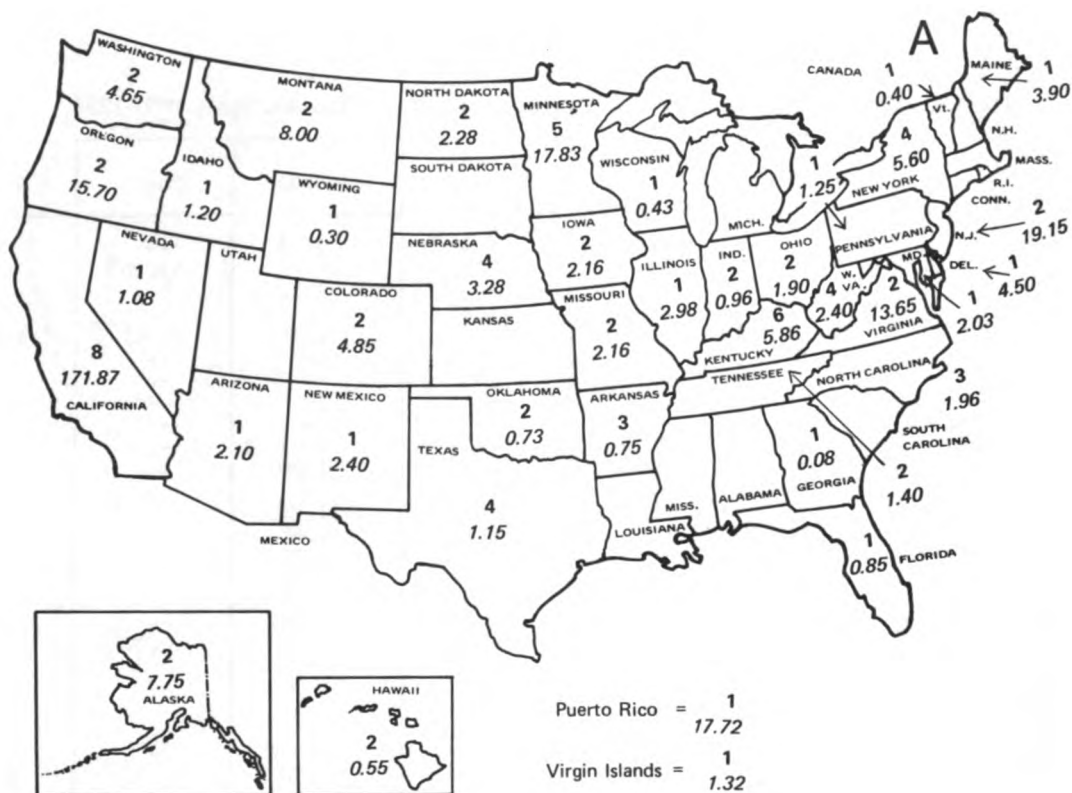
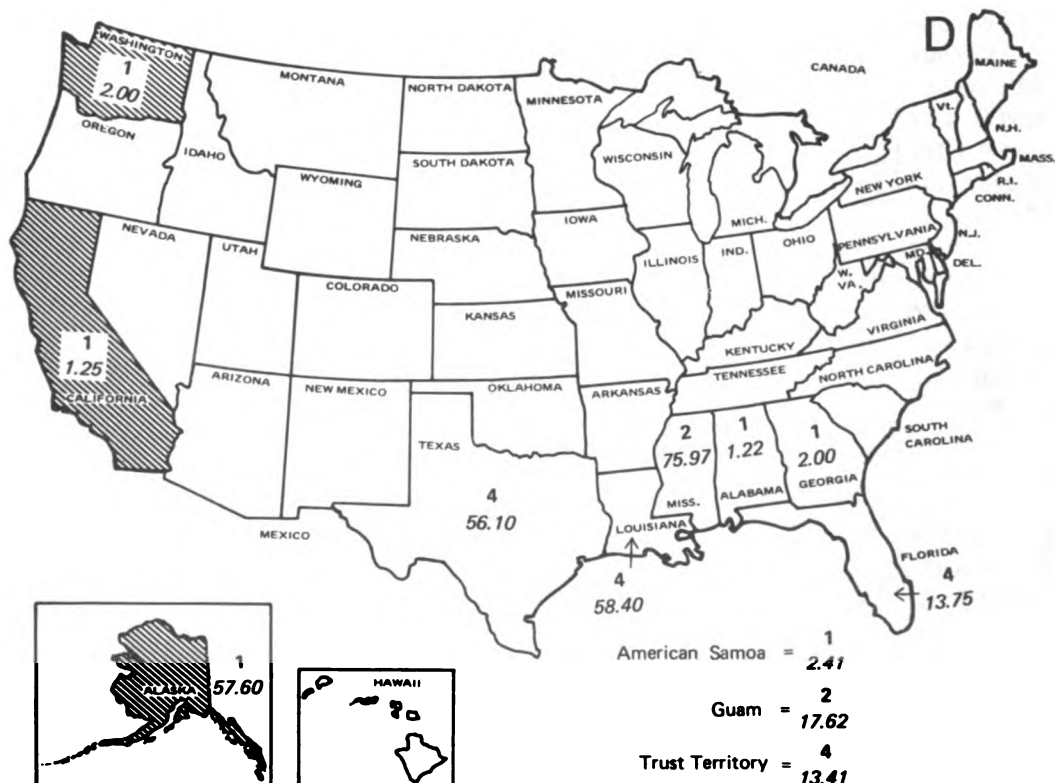


Figure 3.—Number of Declarations and Allocations, by Type and State, 1961-1970: A—Severe Storms, B—Floods,



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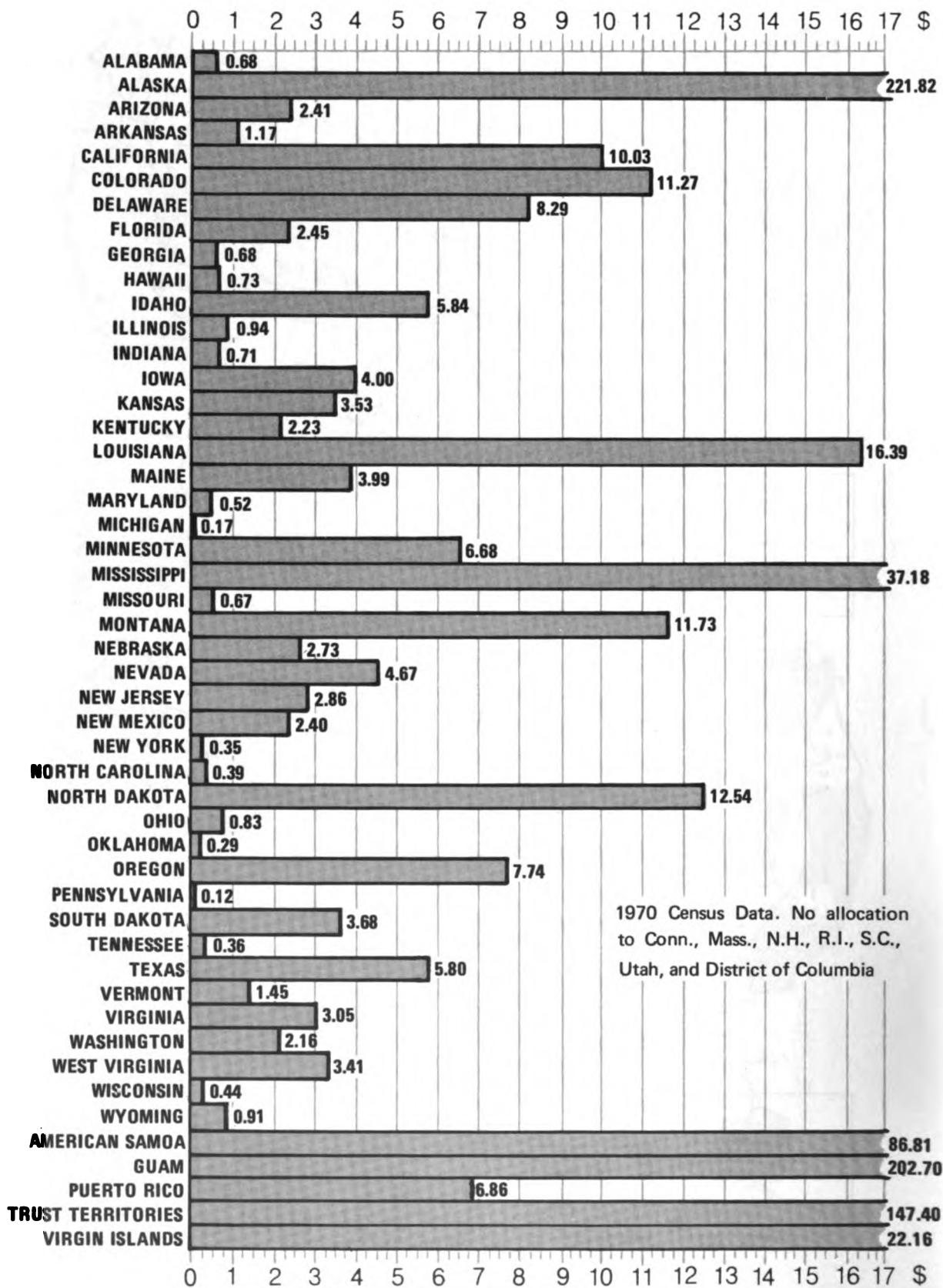
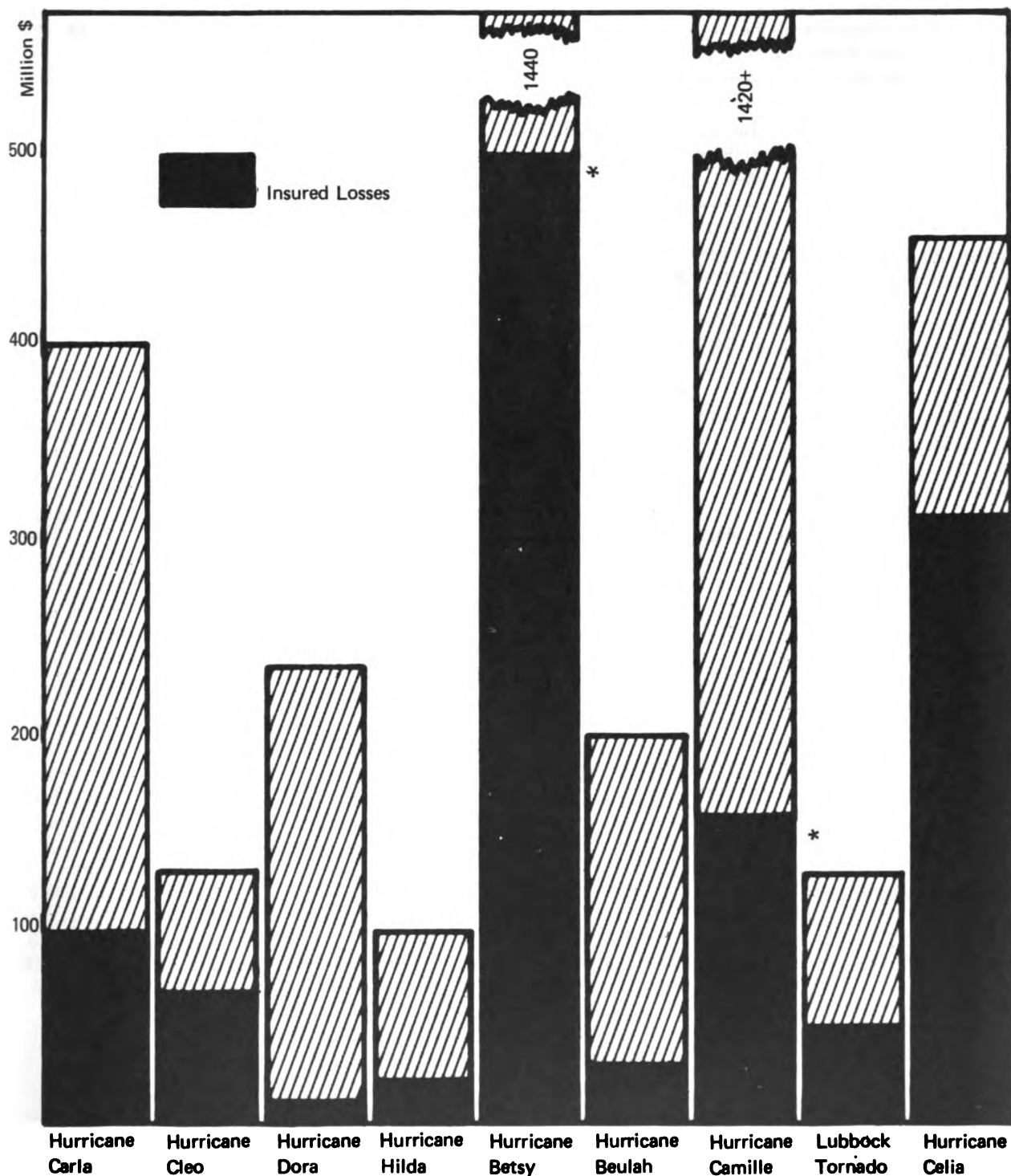


Figure 4.—Per Capita Allocations by State, 1961-1970.



*Includes fixed property losses only.

Estimated loss payments are based on data reported to the American Insurance Association and Insurance Services Offices.

Figure 5.—Actual Damage Compared to Insured Losses for Selected Disasters, 1961-1970.

Table 4 is meant to provide a quick summary of the most significant disasters of the past decade. The table illustrates the enormous destruction that can be caused by a single phenomenon. It may be worthwhile to note

that six of the 13 disasters listed were hurricanes, which were responsible for over 60 percent of the total damage.

Table 4.—Significant Disasters, 1961-1970 (at least \$100 million in damage and 10 lives lost)—NOAA and OEP data.

Month/ Year	Disaster	Estimated Damage (\$M)	Lives Lost
9/61	Hurricane Carla	408.3	46
3/64	Alaska Earthquake	500.0	131
10/64	Hurricane Hilda	100.0	38
12/64	California, Oregon Floods	415.8	40
3-5/65	Floods—Basins of the Upper Mississippi, the Missouri, and the Red River of the North	181.3	16
4/65	Palm Sunday Torna- does—Midwest	300.0	271
6/65	South Platte Basin Floods	415.1	16
9/65	Hurricane Betsy	1,440.0	75
9/67	Hurricane Beulah	200.0	15
1-2/69	California Floods	399.2	60
8/69	Hurricane Camille	1,420.8	256
5/70	Lubbock, Texas, Tornado	135.0	26
8/70	Hurricane Celia	453.8	11

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Commonwealth of Pennsylvania Insurance Department
State of South Carolina Department of Insurance
Texas State Board of Insurance
American Insurance Association
National Association of Independent Insurers
National Association of Insurance Agents
National Association of Insurance Commissioners
Reinsurance Association of America.

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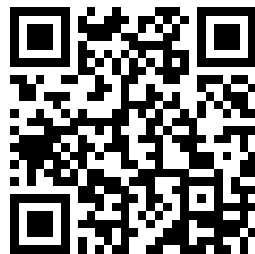
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REPORT TO THE CONGRESS

DISASTER PREPAREDNESS

EXECUTIVE OFFICE OF THE PRESIDENT

OFFICE OF EMERGENCY PREPAREDNESS



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VOLUME TWO

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Volume Two

DISASTER PREPAREDNESS

PART VII

EXAMPLE STATE DISASTER ACT OF 1972

Part VII of the PL 91-606 Disaster Study consists of the text and accompanying explanation of an Example State Disaster Act as an aid to State officials in considering possible legislative action to strengthen their disaster legislation to meet the growing vulnerability to the impact of such events. Prepared under a contract with the Office of Emergency Preparedness, Executive Office of the President, the Example Act was developed by the Disaster Project and the Committee on Suggested State Legislation of the Council of State Governments.

Under Project Director Frederick L. Zimmermann, Professor Emeritus, Hunter College, the Disaster Project of the Council drafted the Example Act, along with the commentary thereon. It was twice reviewed by a subcommittee of the Council's Committee on Suggested State Legislation.

Members of the Subcommittee were Dr. Carl Frasure (Chairman), Professor, West Virginia University; Dr. Carl Everstine, Legislative Reference Director of Maryland; Mr. Alan Norris, Member of the State Legislature of Ohio; Mr. Charles Wheeler, Director, State Commission on Higher Education Facilities of North Carolina; and Mr. Leo Kennedy, Secretary of the Committee.

Following acceptance by that subcommittee, the Act was reviewed for style by Dr. Everstine, who is a member of the Committee on Style of the Conference of State Commissioners on Uniform State Laws, and accepted by the full Committee.

In addition to inclusion as a related part of this PL 91-606 Study, the Example Act has been published by the Council of State Governments as a Special Report, part of its *1972 Suggested State Legislation*.

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Explanatory Note

When parentheses are used, the verbiage therein is part of the text of the Act. When brackets are employed, the verbiage contained is either alternative, explanatory, or directive.

Introduction

The Example State Disaster Act has been prepared for consideration by the States in any adaptation of their laws to meet the growing impact of disaster. This Report is intended to present the text of the statute with accompanying discussion. The Introduction is a brief, general explanation of the reasons for the Example Act. The text was prepared with the idea that sections, language, or purposes may prove helpful to States as they consider revision of their disaster laws.

The report embodies a Section-by-Section commentary on the Statute. Those of its provisions which are self-explanatory are not commented on. However, most of the provisions can be illuminated by background or other explanatory comments.

All of the States have statutes dealing with disasters. For the most part, they were enacted during the 1950's. At that time the primary motivation was to provide the basis for preparation and response to military attack, especially involving nuclear weapons. It was perceived that governmental action in connection with any kind of catastrophe has common elements. Accordingly, these earlier statutes were broadened in their language to make them more applicable to circumstances caused by floods, conflagrations, hurricanes, and other disruptions of a natural or manmade kind. Within limits, these statutes have proved useful in meeting such disaster situations. In fact, this report is a recognition of the value of the intergovernmental system of disaster organization for which they provide a legal base. However, it has become clear not only that provisions thought useful in a civil defense context are not always well suited to meeting all disaster problems and responsibilities but also that vulnerability to disaster is steadily increasing. Understandably, the experience of the past decade and a half has shown many inadequacies in the measures originally formulated. In order to deal more directly with the problems of nonmilitary disasters, while not excluding civil defense, and to meet the rising disaster threat, this example of a State disaster statute has been prepared.

The episodic character of disaster is the most difficult element with which to deal successfully in statutory and administrative terms. It has given rise to a number of contradictions. States have recognized the need to include all of their territory within the jurisdiction of State and local disaster agencies and to create thoroughgoing organizations prepared in advance for all contingencies. Yet, there has been some reluctance to take disaster preparedness seriously because of the tendency

to hope that a catastrophe will never come. The result has been at times to establish systems of preparedness and response that look much more complete on paper than they actually are. In addition, some basic questions such as the implementation of clear responsibility and the funding of disaster programs have not been answered or have been left indefinite.

This draft legislation is designed primarily as a compendium of provisions which can be employed or adapted separately by individual States in accordance with their particular needs but of course can be used as a complete disaster statute or model therefor by those States wishing to repeal their present laws and consolidate provisions into a new Disaster Code. The former approach would result in the inclusion of modernizing features of the Example Act into existing State law.

A notable feature of the Example Act is its handling of the jurisdictional question. As indicated earlier there is need to make sure that every part of the State is served by the State Disaster Agency and by a local disaster agency. Yet experience has shown that, for a variety of reasons, many localities are unable or unlikely to effect comprehensive disaster prevention, protection, and relief organizations. In some instances the reluctance or inability is due to a lack of trained personnel and money which can be set aside to handle situations that, however real, are only contingent. In other instances a particular area may have a history of relative freedom from disasters and may have difficulty in seeing why it should maintain an organization sufficient to afford real protection for catastrophes which rarely occur. Nevertheless, failure to make provision for such eventualities invites heavy loss of life and severe property damage when the unexpected occurs.

To strike a proper balance the Example Act provides that the State Disaster Agency has jurisdiction over and is obligated to provide services in all areas of the State. In addition, a local disaster apparatus must exist to cover every area within the State, but the nature of the necessary local provision for disaster contingencies can vary with the situation of each community. Major population centers and communities in which there is good reason to recognize a high disaster potential are required to have local disaster organizations. The statute provides that other communities may do so if they wish. Communities which do not need disaster organizations of their own are required to assign disaster responsibilities to an official of the local government. These

responsibilities would be those of a liaison officer with the appropriate State and local disaster organizations. The purpose is to have a specific individual who would know what help is available in time of disaster and how it is to be obtained.

Another feature of the disaster organization authorized by the Example Act is that disaster services could be provided on a cooperative basis. Contiguous counties, cities, towns, or other units could establish an interjurisdictional disaster agency to serve them on a joint basis or a locality could make agreements with one or more of its neighbors for the furnishing of some or all disaster services. The Governor could also make such arrangements on an interstate basis or, if his State is on an international boundary, with an adjacent foreign jurisdiction.

The Interstate Civil Defense and Disaster Compact, developed in the early 1950's, contains provisions of similar import. It has been enacted in all but three States (Hawaii, Louisiana, Wisconsin), but with considerable variation in approach as to participants. Some States enacted it with all other jurisdictions eligible to join, others only with their bordering States, and still others with only certain bordering States. Unfortunately, with the decline of the nuclear threat, there has been no real effort since the middle fifties to clear up this mixed pattern of enactment. However, it is now becoming increasingly clear that there must be more effective interjurisdictional coordination to meet the growing disaster problem. Since the Compact provides an invaluable legal basis for interstate and possible State-foreign relationships useful in the proper functioning of a comprehensive disaster preparedness and response system, Section 10 of the Example Act provides specifically for the enactment of the Compact with all bordering States previously omitted and gives the Governor authority to enter into it with other appropriate States as well. It is vital that this provision be enacted by all States.

This interstate aspect of the disaster problem is particularly important because many major population centers and other vulnerable areas cross boundaries: e.g. Greater New York, Chicago, St. Louis, and Kansas City; and some of a nonmetropolitan character such as the New Madrid earthquake region (Missouri, Illinois, Kentucky, Tennessee) and other areas particularly susceptible to floods or earthquakes.

The Governor is already considered to have responsibility for a number of disaster related functions. He generally acts in his capacity as head of the Executive

Branch of the State Government. However, in the past, much of his authority has been regarded as inherent in his office or has devolved on him because there was no one else to assume the role. As head of the State Government, it is appropriate that the Governor be specifically identified as the responsible official with paramount power to direct the overall disaster program and to assume command of disaster response and relief forces in time of emergency. The Example Act makes this specific identification and provides procedures for the orderly administration of the disaster program.

Particular attention is also called to the State-local relationships provided by the Example Act. There would be disaster plans both at the State and local levels. In general, each such plan would cover those aspects of disaster prevention, preparedness, response, and relief activities most appropriate for the governmental unit or areas covered by the plan. In addition, however, the relationship of State and local plans to each other is a matter of great importance. The State Division of Disaster Emergency Services created by the Act would be responsible not only for preparing the State Disaster Plan but also for assisting local communities and interjurisdictional areas with the preparation of their plans. Local plans would be submitted to the Governor for approval. This integration of State and local activities is necessary to promote efficient and effective action in time of emergency.

The Act deals with a number of other matters related to disasters, including the rights and obligations of private persons, emergency communications, and the making of studies relating to a number of factors important in reducing or eliminating the danger of loss of life and property from a variety of causes of disasters.

Generally speaking, the scope of the Act can be ascertained from an examination of its first three sections. It should be pointed out that the statute is not intended to apply to the normal police and other protective services, except that the recognition of the functions performed by these agencies is essential for any comprehensive disaster law. Similarly, no effort is made to substitute for the activities that would be undertaken by the Armed Forces in time of actual attack upon the United States.

A short commentary follows each section of the Example Act. The major provisions are discussed and the reasons for their inclusion presented. The failure to identify a particular provision within a Section means that no special comment on it is deemed necessary.

Example State Disaster Act of 1972

Section 1. Short Title

This Act shall be cited as the [name of the State] Disaster Act of 1972.

Commentary—Section 1

Section 1. Short Title.—This provision is intended only for purposes of easy reference and identification of the Act. Whether or not it is included is entirely a matter of the drafting style of individual States.

Section 2. Purposes

The purposes of this Act are to:

1. reduce vulnerability of people and communities of this State to damage, injury, and loss of life and property resulting from natural or manmade catastrophes, riots, or hostile military or paramilitary action;

2. prepare for prompt and efficient rescue, care, and treatment of persons victimized or threatened by disaster;

3. provide a setting conducive to the rapid and orderly start of restoration and rehabilitation of persons and property affected by disasters;

4. clarify and strengthen the roles of the Governor, State agencies, and local governments in prevention of, preparation for, and response to and recovery from disasters;

5. authorize and provide for cooperation in disaster prevention, preparedness, response, and recovery;

6. authorize and provide for coordination of activities relating to disaster prevention, preparedness, response, and recovery by agencies and officers of this State, and similar state-local, interstate, Federal-state and foreign activities in which the State and its political subdivisions may participate;

7. provide a disaster management system embodying all aspects of pre-disaster preparedness and post-disaster response; and

8. assist in prevention of disasters caused or aggravated by inadequate planning for and regulation of public and private facilities and land use.

Commentary—Section 2

Section 2. Purposes.—This Section sets forth briefly the major objectives and intent of the legislation. The eight numbered purposes need not be repeated here since they are stated in the statute. It is important to point out, however, that they emphasize the several phases of the disaster problem. Taken together they deal with all phases of the subject starting with planning, preparedness, and prevention, as well as actual operations during and after disasters. In order to minimize danger and damage associated with disasters, thorough consideration is essential. Even though disasters may occur only infrequently, failure to be ready for them results in loss of life and destruction of property—sometimes of catastrophic proportions. The legal, administrative, fiscal, training, and operational activities required to cope with disasters successfully, and to prevent them where possible, cannot be undertaken in the hours or minutes that constitute the normal maximum warning time. Accordingly, it is the intent of the statute to provide the means of doing the necessary work in timely fashion.

Section 3. Limitations

Nothing in this Act shall be construed to:

1. interfere with the course or conduct of a labor dispute, except that actions otherwise authorized by this Act or other laws may be taken when necessary to forestall or mitigate imminent or existing danger to public health or safety;
2. interfere with dissemination of news or comment on public affairs; but any communications facility or organization (including but not limited to radio and television stations, wire services, and newspapers) may be required to transmit or print public service messages furnishing information or instructions in connection with a disaster emergency;
3. affect the jurisdiction or responsibilities of police forces, fire fighting forces, units of the armed forces of the United States, or of any personnel thereof, when on active duty; but State, local, and interjurisdictional disaster emergency plans shall place reliance upon the forces available for performance of functions related to disaster emergencies; or
4. limit, modify, or abridge the authority of the Governor to proclaim martial law or exercise any other powers vested in him under the constitution, statutes, or common law of this State independent of, or in conjunction with, any provisions of this Act.

Commentary—Section 3

Section 3. Limitations.—There are a large number of normal governmental activities which have some relationship to disaster prevention, preparedness, or response or which involve resources that in time of need can be devoted to the problems of disaster. This Act does not attempt to provide for these activities or to replace them. The Act builds on and, where necessary, supplements normal governmental structure and procedures. In most instances the effect of the Act on other matters or its lack of connection with them will be clear. However, there are some respects in which a special marking out of the limits of the Act is appropriate. The Section contains four limitations of this type. Each is commented on here.

1. This provision makes it clear that the Act is not intended for emergencies that are produced by strikes. On the other hand, work stoppages when a disaster has occurred or is imminent can cause or increase danger. Accordingly, the language in this part of the Act is intended to strike a proper balance.

2. There is not intention to interfere with freedom of speech or of the press. Accordingly, the provision specifically so states.

Communications are vital in time of disaster. Thus language has been included to assure that the communications media will be available to carry information and instructions needed by the public.

3. Police, fire, and military units are organized emergency forces. Even in the absence of disaster legislation these forces plan, train, and function to meet emergencies. A purpose of this provision is to assure that these organizations and their personnel will not be interfered with in the conduct of their normal roles. Also, it is important for disaster organizations to take account of the tasks regularly performed by these emergency forces and to build upon the help available from them. For this reason the provision contains an express statement that this should be done.

4. In all jurisdictions the Governor in fact exercises authority to respond to emergencies. In large measure this authority has developed as a result of experience and exists by custom. Statutes or constitutional provisions dealing with these emergency powers tend in many cases to be fragmentary or vague. There is some virtue in keeping them so because it is desirable that the Governor be able to do whatever is reasonable in meeting unforeseen circumstances. Without a declaration that, whatever they may be, the Governor's powers to deal with emergencies remain intact, some might construe a comprehensive disaster statute as a complete law on the subject, which by its very nature could displace existing law. This provision negates any such construction.

Section 4. Definitions

As used in this Act:

1. "disaster" means occurrence or imminent threat of widespread or severe damage, injury, or loss of life or property resulting from any natural or manmade cause, including but not limited to fire, flood, earthquake, wind, storm, wave action, oil spill, or other water contamination requiring emergency action to avert danger or damage, volcanic activity, epidemic, air contamination, blight, drought, infestation, explosion, riot, or hostile military or paramilitary action;

2. "political subdivision" means any county, city, town, village, or other unit of local government; and

3. "unorganized militia" means all able-bodied male and female persons between the ages of [16] and [50] years.

Commentary—Section 4

Section 4. Definitions.—The Act contains only three definitions. All other terms used are to be considered as having their normal meanings.

The definition of "disaster" is made purposely broad in subject matter, but is confined to situations in which the effect is widespread or severe. The identification of specific kinds of disasters is illustrative and it includes virtually all of the major types that can be expected in the United States. The definition includes the imminent threat as well as the actual occurrence. This is necessary because other parts of the Act call for the taking of measures in order to prevent or reduce danger that is about to occur.

The definition of "political subdivision" is meant to embrace all units of general local government and special districts. The specific enumeration may vary from State to State because of differences in terminology.

In general the "unorganized militia" as conceived in the past has included all able-bodied males. The upper and lower age limits have either been ill-defined or have varied from State to State. The definition here employed is unusual in that it includes both men and women. This is important because the types of disaster response activities contemplated by the statute could in many cases be performed equally well by men and women. Furthermore the purpose is to make possible service by all persons who are in a position to render aid.

Section 5. The Governor and Disaster Emergencies

(a) The Governor is responsible for meeting the dangers to the State and people presented by disasters.

(b) Under this act, the Governor may issue executive orders, proclamations, and regulations and amend or rescind them. Executive orders, proclamations, and regulations have the force and effect of law.

(c) [If desired, use this subsection to authorize establishment of a Governor's Disaster Emergency Council to advise him on matters relating to disasters. If a council is established it may be particularly helpful to include representation of local governments.]

(d) A disaster emergency shall be declared by executive order or proclamation of the Governor if he finds a disaster has occurred or that this occurrence or the threat thereof is imminent. The state of disaster emergency shall continue until the Governor finds that the threat or danger has passed or the disaster has been dealt with to the extent that emergency conditions no longer exist and terminates the state of disaster emergency by executive order or proclamation, but no state of disaster emergency may continue for longer than [30 days] unless renewed by the Governor. The Legislature by concurrent resolution may terminate a state of disaster emergency at any time. Thereupon, the Governor shall issue an executive order or proclamation ending the state of disaster emergency. All executive orders or proclamations issued under this subsection shall indicate the nature of the disaster, the area or areas threatened, the conditions which have brought it about or which make possible termination of the state of disaster emergency. An executive order or proclamation shall be disseminated promptly by means calculated to bring its contents to the attention of the general public and unless the circumstances attendant upon the disaster prevent or impede, promptly filed with the State Office of Disaster Emergency Services, the [State records-keeping agency] and the [local records-keeping agency] in the area to which it applies.

(e) An executive order or proclamation of a state of disaster emergency shall activate the disaster response and recovery aspects of the State, local, and interjurisdictional disaster emergency plans applicable to the political subdivision or area in question and be authority for the deployment and use of any forces to which the plan or plans apply and for use or distribution of any supplies, equipment, and materials and facilities assembled, stockpiled, or arranged to be made available pursuant to this Act or any other provision of law relating to disaster emergencies.

(f) During the continuance of any state of disaster emergency the Governor is commander-in-chief of the organized and unorganized militia and of all other forces

Commentary—Section 5

Section 5. The Governor and Disaster Emergencies.—

The clear fixing of responsibility for disaster prevention, preparedness, response, and recovery activities is essential to an effective system. The Governor already occupies a leadership position in these matters by tradition and usage. Moreover, he is the only official in the State whose legal and political position is sufficiently broad to make it possible for him to marshal whatever personnel and resources are most appropriate in dealing with unexpected situations requiring rapid, flexible, and sometimes diverse actions.

Some of the lettered paragraphs of this Section require no special comment. Only those that would benefit from further explanation are identified and discussed below.

Paragraph (b) gives the Governor the basic authority to implement the statute in the normal way—by administrative regulations which then have the same standing as law.

Paragraph (d) provides for the method by which the Governor can bring a state of disaster emergency into being. On the whole this procedure is similar to the one now used in most States. However, several features of this Paragraph are either unusual or are worthy of special attention.

It should be noted that it is required that a proclamation or order declaring an emergency must be filed promptly with appropriate State and local records-keeping agencies. Since a state of disaster emergency has legal consequences it is important that evidentiary documents with respect to its existence, duration, and the circumstances surrounding it be made matters of public record. For this reason the minimum contents of the proclamation or order are also prescribed.

Finally, either the Governor or the Legislature can terminate a state of disaster emergency, and limitations are set on its duration. Such provisions are included because the powers to be exercised during a disaster emergency are extraordinary ones and so should be confined to the periods intended by law.

Paragraph (e) indicates some of the consequences which result from a gubernatorial declaration of a state of disaster emergency. In particular it is meant to provide the basis for the use and distribution of materials, supplies, and equipment specially kept for use in connection with such emergencies. Further, this provision is the basis for calling the disaster plans previously made into operation.

Paragraph (f) is partially declaratory of the law as it is generally understood. The Governor is normally commander-in-chief of the forces referred to. In addition, the Paragraph gives direction to certain types of procedures which should be employed. Ideally, preparation

available for emergency duty.* To the greatest extent practicable, the Governor shall delegate or assign command authority by prior arrangement embodied in appropriate executive orders or regulations, but nothing herein restricts his authority to do so by orders issued at the time of the disaster emergency.

(g) In addition to any other powers conferred upon the Governor by law, he may:

(1) suspend the provisions of any regulatory statute prescribing the procedures for conduct of State business, or the orders, rules, or regulations of any State agency, if strict compliance with the provisions of any statute, order, rule, or regulation would in any way prevent, hinder, or delay necessary action in coping with the emergency;

(2) utilize all available resources of the State Government as reasonably necessary to cope with the disaster emergency and of each political subdivision of the State;

(3) transfer the direction, personnel, or functions of State departments and agencies or units thereof for the purpose of performing or facilitating emergency services;

(4) subject to any applicable requirements for compensation under Section 13, commandeer or utilize any private property if he finds this necessary to cope with the disaster emergency;

(5) direct and compel the evacuation of all or part of the population from any stricken or threatened area within the State if he deems this action necessary for the preservation of life or other disaster mitigation, response, or recovery;

(6) prescribe routes, modes of transportation, and destinations in connection with evacuation;

(7) control ingress and egress to and from a disaster area, the movement of persons within the area, and the occupancy of premises therein;

(8) suspend or limit the sale, dispensing, or transportation of alcoholic beverages, firearms, explosives, and combustibles; and

(9) make provision for the availability and use of temporary emergency housing.

to meet disasters should be thorough enough so everyone knows his responsibilities in advance. However, it is recognized that human foresight is far from perfect and that the law must allow for decisions to be made and orders issued on the basis of conditions as they actually are at any given moment. Accordingly, the provision establishes a policy of preparing and using as many orders as possible on a standby basis, but makes it clear that orders issued in time of disaster are valid.

Paragraph (g) enumerates a number of specific actions that may be taken to cope with disasters. Consequently, it constitutes the legal authority for them to be taken. They are of three basic kinds: suspension of normal routines during emergencies, operational measures, and measures for good order.

A special word may be appropriate in reference to the authority to suspend the provisions of regularly applicable laws relating to the conduct of State activities or otherwise affecting conduct in normal times. Many requirements are designed to afford procedural protections such as notice of actions about to be taken. Others are designed as good practice in most circumstances. Also, laws relating to the administrative structure and performance of the State Government usually presume that reasonable amounts of time are available and that good government requires the following prescribed routines.

In times of emergency it is often necessary to make exceptions on an ad hoc basis and to improvise in order to forestall impending catastrophe or to ameliorate serious conditions that have suddenly arisen. These considerations are important to an understanding of this Paragraph.

*If State police or highway patrols or agencies having similar functions are not otherwise available to the Governor for disaster duty, a provision should be added making them available.

Section 6. State Division of Disaster Emergency Services

(a) A Division of Disaster Emergency Services is hereby established in the Office of the Governor. The Division shall have a Director appointed by and to serve at the pleasure of the Governor. The Division shall have a planning officer and other professional, technical, secretarial, and clerical employees as necessary for the performance of its functions.

(b) The Division of Disaster Emergency Services shall prepare and maintain a State Disaster Plan and keep it current, which plan may include:

(1) prevention and minimization of injury and damage caused by disaster;

(2) prompt and effective response to disaster;

(3) emergency relief;

(4) identification of areas particularly vulnerable to disasters;

(5) recommendations for zoning, building, and other land-use controls, safety measures for securing mobile homes or other nonpermanent or semi-permanent structures, and other preventive and preparedness measures designed to eliminate or reduce disasters or their impact;

(6) assistance to local officials in designing local emergency action plans;

(7) authorization and procedures for the erection or other construction of temporary works designed to protect against or mitigate danger, damage, or loss from flood, conflagration, or other disaster;

(8) preparation and distribution to the appropriate State and local officials of State catalogs of Federal, State, and private assistance programs;

(9) organization of manpower and chains of command;

(10) coordination of Federal, State, and local disaster activities;

(11) coordination of the State Disaster Plan with the disaster plans of the Federal Government; and

(12) other necessary matters.

(c) The Division of Disaster Emergency Services shall take an integral part in the development and revision of local and interjurisdictional disaster plans prepared under Section 8. To this end it shall employ or otherwise secure the services of professional and technical personnel capable of providing expert assistance to political subdivisions, their disaster agencies, and interjurisdictional planning and disaster agencies. These personnel shall consult with subdivisions and agencies on a regularly scheduled basis and shall make field examinations of the areas, circumstances, and conditions to which particular local and interjurisdictional disaster plans are intended to apply, and may suggest or require revisions.

(d) In preparing and revising the State Disaster Plan, the Division of Disaster Emergency Services shall seek the advice and assistance of local government, business,

Commentary—Section 6

Section 6. State Division of Disaster Emergency Services.—This Section carries out the theme of gubernatorial responsibility. If the Governor is to have direct responsibility for disaster services the administrative agency in charge of this State function should be immediately under him. Accordingly, it is provided that a Division be created in the Governor's office rather than in some other agency of the State government which would be under the direction of a commissioner who might also have other duties and who, in any event, would be subordinate to the Governor.

Paragraph (a) provides authorizing detail. In a particular State it will probably be necessary to amplify this Paragraph in order to cover a variety of other administrative matters. No effort is made to include such details here because the style and practice in each State varies. It should be specially noted, however, that among the personnel of the Division express mention is made of a planning officer. This is done because having such a person with appropriate professional qualifications is of great importance.

Paragraph (b) provides for a key element. If the State is to be prepared for disasters, it must have a disaster plan well thought out in advance and available to all who are expected to make use of it. This Paragraph requires such a plan, provides that it be kept up-to-date, and indicates the items which are most appropriate for inclusion in it.

Paragraph (c) marks out a State role in assisting localities. Disaster services will be provided by a combination of State and local agencies. Accordingly, it is desirable to provide formal connections between State and local planning activities. Also, the State Disaster Agency should be well enough staffed and equipped to provide technical assistance and advice to local governments and their disaster agencies.

Finally, it should be noted that the Paragraph makes it possible for the State Division to advise a local disaster agency concerning *required* changes in the local disaster plan.

Paragraph (e) is included in order to point out to the State Disaster Agency and all other persons and agencies that it may be desirable to give certain parts of the disaster plan the standing of law. On the other hand, the provision makes it equally clear that unless further steps are taken a disaster plan is not law. By requiring the Governor to select the portions of the plan that are to be given the effect of law and include them in appropriate orders or regulations, encouragement is given for a careful analysis of the several parts of the plan and the conscious making of decisions as to the status of each.

Paragraph (f) is a listing of powers and duties of the State Disaster Agency. It should be recognized that a number of other provisions of the statute also confer authority and responsibilities on the agency and on the Governor. The 13 enumerated items in this Paragraph

labor, industry, agriculture, civic, and volunteer organizations and community leaders. In advising local and interjurisdictional agencies, the Division shall encourage them also to seek advice from these sources.

(e) The State Disaster Plan or any part thereof may be incorporated in regulations of the Division of Disaster Emergency Services or executive orders which have the force and effect of law.

(f) The Division of Disaster Emergency Services shall:

(1) determine requirements of the State and its political subdivisions for food, clothing, and other necessities in event of an emergency;

(2) procure and pre-position supplies, medicines, materials, and equipment;

(3) promulgate standards and requirements for local and interjurisdictional disaster plans;

(4) periodically review local and interjurisdictional disaster plans;

(5) provide for mobile support units;

(6) establish and operate or assist political subdivisions, their disaster agencies, and interjurisdictional disaster agencies to establish and operate training programs and programs of public information;

(7) make surveys of industries, resources, and facilities within the State, both public and private, as are necessary to carry out the purposes of this Act;

(8) plan and make arrangements for the availability and use of any private facilities, services, and property and, if necessary and if in fact used, provide for payment for use under terms and conditions agreed upon;

(9) establish a register of persons with types of training and skills important in emergency prevention, preparedness, response, and recovery;

(10) establish a register of mobile and construction equipment and temporary housing available for use in a disaster emergency;

(11) prepare, for issuance by the Governor, executive orders, proclamations, and regulations as necessary or appropriate in coping with disasters;

(12) cooperate with the Federal Government and any public or private agency or entity in achieving any purpose of this Act and in implementing programs for disaster prevention, preparation, response, and recovery; and

(13) do other things necessary, incidental, or appropriate for the implementation of this Act.

are meant to supplement and complete these other provisions to the end that the State Disaster Agency will have a comprehensive mandate to function in the fields of disaster prevention, preparedness, response, and recovery.

The enumerated items are of several different kinds. Some of them confer authority to perform specific preparedness or operational tasks. Others, such as the compiling of registers of available personnel and materials, are for planning and informational purposes. It will be helpful to consider the items in this Paragraph along with the earlier provisions relating to the preparation and contents of the State Disaster Plan.

Section 7. Financing [Alternative #1]

(a) It is the intent of the Legislature and declared to be the policy of the State that funds to meet disaster emergencies shall always be available.

(b) The [Disaster] Emergency Funding Board* is established composed of the President [Pro Tem] of the Senate, the Speaker of the House and the Chairman of the [appropriate financial] committee of each House.

(c) A [Disaster] Contingency Fund is established which shall receive monies appropriated thereto by the Legislature. [Monies in the [Disaster] Contingency Fund shall remain therein until expended.]

(d) It is the legislative intent that the first recourse shall be to funds regularly appropriated to State and local agencies. If the Governor finds that the demands placed upon these funds in coping with a particular disaster are unreasonably great, he may [with the concurrence of the [Disaster] Emergency Funding Board,] make funds available from the [Disaster] Contingency Fund. If monies available from the Fund are insufficient, and if the Governor finds that other sources of money to cope with the disaster are not available or are insufficient, the Governor, with the concurrence of the [Disaster] Emergency Funding Board, may transfer and expend monies appropriated for other purposes or borrow for a term not to exceed [2] years from the United States Government or other public or private source.

(e) Nothing contained in this Section shall be construed to limit the Governor's authority to apply for, administer, and expend grants, gifts, or payments in aid of disaster prevention, preparedness, response, or recovery.

Section 7. Financing [Alternative #2]

(a) It is the intent of the Legislature and declared to be the policy of the State that funds to meet disaster emergencies shall always be available.

(b) The [Disaster] Emergency Funding Board* is established, composed of the President [Pro Tem] of the Senate, the Speaker of the House, and the Chairman of the [appropriate financial] committee of each House.

(c) It is the legislative intent that the first recourse shall be to funds regularly appropriated to State and local agencies. If the Governor finds that the demands placed upon these funds in coping with a particular disaster are unreasonably great, [with the concurrence of the [Disaster] Emergency Funding Board,] he may make funds available by transferring and expending monies appropriated for other purposes or may borrow for a term not to exceed [2] years from the United States Government or any other public or private source.

*Another alternative as indicated by the bracketing is to leave out the term Disaster and employ a Contingency Fund and Emergency Funding Board which would cover other emergencies in addition to disasters. Some States already have this type of agency.

Commentary—Section 7

Section 7. Financing.—Financing of disaster planning and operations has until now been one of the weakest parts of the entire public disaster activity. The temptation is great to omit or skimp on the provision of money for this purpose. In the situation of chronic shortage of public funds and constant pressure to devote them to many worthy uses, it is easy to gamble on the possibility that a disaster will not occur this year. Also, it is possible to comfort oneself with the general belief that in time of need somehow a way will be found to do whatever is necessary. However, experience shows that such an approach is insufficient. While one cannot predict exactly when disasters will strike and how severe they will be, the statistical record demonstrates that one or more of them is almost certain to occur in almost every year. When the disaster actually comes, money as well as personnel and materials are needed immediately and often in substantial amounts.

This Section is presented in two alternative forms. The difference between them is that alternative 1 provides for the creation of a special contingency fund, whereas alternative 2 does not. A number of States already have such funds and have found them useful. Other jurisdictions are reluctant to create them because they do not wish to appropriate money that may or may not be used. It is desirable to provide for a contingency fund, but if such a course should prove impracticable in particular States, alternative 2 provides the maximum that can be done in the absence of a fund.

Paragraph (a) is the same in both alternatives. Its purpose is to state as a matter of law that the Legislature intends money always to be available for the meeting of disaster needs. This lays the foundation for subsequent provisions of the Section permitting emergency expenditures, transfers, and borrowing.

Paragraph (b) is particularly important in terms of the composition of the Board which it establishes. Obviously, the Legislature can vote money and take other necessary actions to meet disasters if it is in session. However, there are significant periods of time in every State when the Legislature is not in session. If a disaster occurs at such a time a problem arises in that there is no legislative authority available for immediate action. Accordingly, the Board here proposed is composed of the general and financial leadership of the Legislature. Pursuant to subsequent provisions, it is given the authority to act when the Legislature as a whole is not in session. There has been some use of similar devices in the past. The Legislature should find the arrangement satisfactory because it entrusts the power to a body drawn from its own membership.

Paragraph (c) in alternative 1 is the special fund provision which constitutes the difference between the two alternatives. The reasons for it have been set forth above. It should be noted that money appropriated to this fund should not be permitted to lapse. As a general rule,

[Action pursuant to this subsection shall be only with the concurrence of the [Disaster] Emergency Funding Board.]

(d) Nothing contained in this Section shall be construed to limit the Governor's authority to apply for, administer, and expend any grants, gifts, or payments, in aid of disaster prevention, preparedness, response, or recovery.

appropriate monies would lapse at the end of the appropriation period unless it is specifically provided otherwise.

Paragraphs (d) and (e) of alternative 1 and (d) of alternative 2 set forth the procedures and sequences to be employed in securing money for coping with disaster emergencies. If a special fund is established, the order in which resources are to be tapped begins with the use of funds normally available from the several State agencies. For example, State highway departments customarily have money for snow removal. Police agencies are expected to expend significant parts of their budgets in coping with unforeseen occurrences, including those of a disaster character. In addition, it is sometimes possible to make use of funds regularly available in State agencies without transgressing the defined purposes and functions of the particular agencies.

Where a special fund exists, it should be called into play as the next recourse. Thereafter the transfer, borrowing, and grant acceptance provisions which constitute the balance of the Section can be employed.

Section 8. Local and Interjurisdictional Disaster Agencies and Services

(a) Each political subdivision [and unincorporated place] * within this State shall be within the jurisdiction of and served by the Division of Disaster Emergency Services and by a local or interjurisdictional agency responsible for disaster preparedness and coordination of response.

(b) Each county shall maintain a disaster agency or participate in a local or interjurisdictional disaster agency which, except as otherwise provided under this Act, has jurisdiction over and serves the entire county.

(c) The Governor shall determine which municipal corporations need disaster agencies of their own and require that they be established and maintained. He shall make his determinations on the basis of the municipality's disaster vulnerability and capability of response related to population size and concentration. The disaster agency of a county shall cooperate with the disaster agencies of municipalities situated within its borders but shall not have jurisdiction within a municipality having its own disaster agency. The Division of Disaster Emergency Services shall publish and keep current a list of municipalities required to have disaster agencies under this subsection.

(d) Any provision of this Act or other law to the contrary notwithstanding, the Governor may require a political subdivision to establish and maintain a disaster agency jointly with one or more contiguous political subdivisions, if he finds that the establishment and maintenance of an agency or participation therein is made necessary by circumstances or conditions that make it unusually difficult to provide disaster prevention, preparedness, response, or recovery services under other provisions of this Act.

(e) Each political subdivision which does not have a disaster agency and has not made arrangements to secure or participate in the services of an agency shall have a liaison officer designated to facilitate the cooperation and protection of that subdivision in the work of disaster prevention, preparedness, response, and recovery.

(f) The Mayor, Chairman of the County Board of Supervisors, or other principal executive officer of each political subdivision in the State shall notify the Division of Disaster Emergency Services of the manner in which the political subdivision is providing or securing disaster planning and emergency services, identify the person who heads the agency from which the service is obtained, and furnish additional information relating thereto as the Division requires.

(g) Each local and interjurisdictional agency shall prepare and keep current a local or interjurisdictional disaster emergency plan for its area.

*A few States have areas of sparse population that are not within the territorial limits of any county or incorporated unit of local government.

Commentary—Section 8

Section 8. Local and Interjurisdictional Disaster Agencies and Services.—As already pointed out, local governments should have disaster services of their own. The State can provide a great deal and can coordinate activities, but a disaster occurs in a particular place and must be met by services promptly provided on the spot. It is the plan of this statute that every community in the State will have the services of both State and local authorities.

On the other hand, disaster response organization has at times been characterized by an over-elaboration of paper disaster agencies, particularly at the local level. Experience has shown that while all local communities require access to disaster services, not all such communities have the resources or the need to maintain comprehensive disaster agencies and plans of their own. There are several ways that local needs can be served. Which of them is most effective depends on the particular circumstances of individual communities. This Section provides standards and procedures by which the most effective choices of organizational and responsibility patterns can be made.

Paragraph (a) merely states the jurisdictional necessity for the State agency to function everywhere and for each local area to have locally based disaster services.

Paragraph (b) identifies the county as the unit of government which, in most instances, is likely to provide disaster services. Its territorial extent makes it generally suitable for this function. In rural areas it is likely to be the basic governmental unit as well. In urban and suburban areas it may be more appropriate for other units of government such as major cities to maintain their own disaster agencies. Subsequent Paragraphs of this Section mark out the circumstances under which this may be the case.

Paragraph (c) gives the Governor the responsibility of determining which municipalities require their own disaster agencies. The more customary alternative would have been to fix a population limit in the statute and to require all communities in excess of that population to maintain disaster agencies. However, such a test is too mechanical. There are many small communities which, because of their location, industrial development, or other conditions are particularly able to maintain or are in need of their own disaster services. Accordingly, the Paragraph fixes general standards for determining which communities need to maintain disaster agencies and authorizes the Governor to make the decision.

In order to make the pattern or responsibility clear, the Paragraph also provides that only one local disaster agency will have jurisdiction in a particular area. Accordingly, the county agency would cooperate with a municipal disaster agency but would not duplicate its territorial responsibilities.

Paragraph (d) recognizes that no established political boundary lines are inevitably appropriate for the provi-

(h) The local or interjurisdictional disaster agency, as the case may be, shall prepare and distribute to all appropriate officials in written form a clear and complete statement of the emergency responsibilities of all local agencies and officials and of the disaster chain of command.

sion of local disaster services. Several adjoining counties or communities may provide a more suitable basis for the function than would any one of them acting alone. Accordingly, the Governor is given authority to require that such counties or municipalities act jointly, when he finds such a course to be more suitable.

Paragraph (e) deals with communities that do not themselves require disaster agencies. Generally speaking, such communities will receive disaster services from the county in which they are located. However, any organized unit of general local government should be aware of the assistance that can be secured in time of disaster and of the means for obtaining it. The liaison officer required by this Paragraph is intended to serve this purpose.

Paragraph (h) deals with a problem that has presented an organizational weakness in the past. In some areas satisfactory plans have been made, but responsibilities and authority to carry them out are not communicated to those who should have the information. This Paragraph requires that such information be provided.

Section 9. Establishment of Interjurisdictional Disaster Planning and Service Areas

(a) If the Governor finds that two or more adjoining counties would be better served by an interjurisdictional arrangement than by maintaining separate disaster agencies and services, he may delineate by executive order or regulation an interjurisdictional area adequate to plan for, prevent, or respond to disaster in that area and direct steps to be taken as necessary, including the creation of an interjurisdictional relationship, a joint disaster emergency plan, mutual aid, or an area organization for emergency planning and services. A finding of the Governor pursuant to this subsection shall be based on one or more factors related to the difficulty of maintaining an efficient and effective disaster prevention, preparedness, response, and recovery system on an unijurisdictional basis, such as:

- (1) small or sparse population;
- (2) limitations on public financial resources severe enough to make maintenance of a separate disaster agency and services unreasonably burdensome;
- (3) unusual vulnerability to disaster as evidenced by a past history of disasters, topographical features, drainage characteristics, disaster potential, and presence of disaster-prone facilities or operations;
- (4) the interrelated character of the counties in a multicounty area;
- (5) other relevant conditions or circumstances.

(b) If the Governor finds that a vulnerable area lies only partly within this State and includes territory in another State or States or territory in a foreign jurisdiction and that it would be desirable to establish an interstate or international relationship, mutual aid, or an area organization for disaster, he shall take steps to that end as desirable. If this action is taken with jurisdictions that have enacted the Interstate Civil Defense and Disaster Compact, any resulting agreement or agreements may be considered supplemental agreements pursuant to Article VI of that compact.

(c) If the other jurisdiction or jurisdictions with which the Governor proposes to cooperate pursuant to subsection (b) hereof have not enacted that compact, he may negotiate special agreements with the jurisdiction or jurisdictions. Any agreement, if sufficient authority for the making thereof does not otherwise exist, becomes effective only after its text has been communicated to the Legislature and provided that neither House of the Legislature has disapproved it by adjournment of the next ensuing session competent to consider it or within thirty days of its submission, whichever is longer.

Commentary—Section 9

Section 9. Establishment of Interjurisdictional Disaster Planning and Service Areas.—Section 8 (d) of the Act deals with joint disaster agencies for municipalities. Its language is also broad enough to encompass joint action by counties. However, the criteria to be applied are not spelled out in detail in that provision. Section 9 (a) is intended for that purpose.

There are many areas in which the State cannot be considered a self-contained unit. Just as two or more municipalities or counties may require cooperative action, two or more States, or even a State and a foreign jurisdiction, may benefit from joint or cooperative action. Paragraphs (b) and (c) deal with such situations.

The Interstate Civil Defense and Disaster Compact mentioned in this Section has been enacted by almost all of the States. But the pattern of enactments is varied. Some States have entered into the Compact only with the States on their borders or even with only some of those States. Others have not imposed such a limitation and so are in position to cooperate with any jurisdictions as circumstances may warrant.

Although the Interstate Civil Defense and Disaster Compact was formulated in the early 1950's—very largely with the problems of possible nuclear attack in mind—its language is broad enough to permit its use in any kind of disaster situation, including those of natural or man-made origin. Article VI of the Compact authorizes its implementation by the making of supplementary agreements dealing with specific subjects.

Article VI of the Civil Defense and Disaster Compact authorizes an enacting State to make supplemental agreements with other States. The Article does not specify the official who is so authorized. Consequently, the only official who clearly has the power is the Governor. As head of the State Government, he normally is the one to make agreements on behalf of the State. If another official is to have such authority, the statute (or in this case the compact) would have to be more specific.

In those States which have enacted the Civil Defense and Disaster Compact, it is already statutory law. Accordingly, Article VI is legislative authorization for the Governor to make supplemental agreements binding on the State. No further legislative authorization is necessary. Also, it should be noted that Congress has given its consent to the compact pursuant to the procedures set forth in the Civil Defense Act of 1950. This includes consent to Article VI. Accordingly, it is not necessary to inquire whether a particular supplemental agreement would need the consent of Congress. Even if it would, Congress has already consented in advance.

As indicated earlier in this Report, our present approach to disaster prevention, preparedness, response, and recovery is more comprehensive than former legislation was. Accordingly, the question is whether the

supplemental agreements that the Governor could make under the Interstate Civil Defense and Disaster Compact are inclusive enough to serve present needs. In all probability they are.

Article I of the Compact reads in relevant part:

The purpose of this compact is to provide mutual aid among the States in meeting any emergency or disaster from enemy attack or other cause (*natural or otherwise*) including sabotage and subversive acts and direct attacks by bombs, shellfire, and atomic radiological, chemical, bacteriological means, and other weapons. The prompt, full and effective utilization of the resources as may be available from the United States Government or any other source, are essential to the safety, care, and welfare of the people thereof . . .

From this language, and from other parts of the Compact, including Article VI, it seems clear that it is addressed to the mutual aid and response elements of disaster. However, this specifically includes the making of plans to cope with disaster conditions. Accordingly, it seems clear that most of the things about which States might agree could be covered. Long-range preventive measures such as joint or cooperative construction of protective works on land-use regulation in an interstate area should probably be undertaken under special and more specific authorization than that contained either in the Compact or in the Example Act.

It should be noted that Congress has specifically consented to the Civil Defense and Disaster Compact, which in Article 10 states, "The term 'State' may also include any neighboring foreign country or province or State thereof."

Section 10. Intergovernmental Arrangements

(a) This State enacts into law and enters into the Interstate Civil Defense and Disaster Compact with all States, as defined therein, bordering this State, which States have enacted or shall hereafter enact the compact in the form substantially as follows.*

[Insert exact text of Interstate Civil Defense and Disaster Compact.]

(b) The Governor may enter into the compact with any State which does not border this State if he finds that joint action with the State is desirable in meeting common intergovernmental problems of emergency disaster planning, prevention, response, and recover.

(c) Nothing in subsections (a) and (b) shall be construed to limit previous or future entry into the Interstate Civil Defense and Disaster Compact of this State with other States.

(d) If any person holds a license, certificate, or other permit issued by any State or political subdivision thereof evidencing the meeting of qualifications for professional, mechanical, or other skills, the person may render aid involving that skill in this State to meet an emergency or disaster, and this State shall give due recognition to the license, certificate, or other permit.†

Commentary—Section 10

Section 10. Intergovernmental Arrangements.—This Section is devoted almost entirely to the enactment of the Interstate Civil Defense and Disaster Compact. In most States this will mean merely recodification of the Compact so as to combine it with the rest of the State law on disaster. In some instances it may also mean increasing the number of other States with which the State is authorized to cooperate. In those few instances where a State has not previously enacted the Compact, it is strongly recommended that this be done.

Paragraph (d) of the Section, as its accompanying note indicates, is also contained in substance in the Compact. However, it is desirable that persons with licensed skills be legally able to render aid in time of disaster even if their licenses are from jurisdictions other than those with which the State is a participant in the Compact.

*If the State has already enacted the Interstate Civil Defense and Disaster Compact, the provision should read "... in the form substantially contained in section__ of the State code." In such case the text of the compact need not be included in this Act.

†A similar clause is contained in the Interstate Civil Defense and Disaster Compact.

Clause (d) is included in the example statute because, first, it makes it unnecessary for there to be a partner to put it into effect and, secondly, it covers licenses which are issued by political subdivisions in some States (e.g., Maryland).

Section 11. Local Disaster Emergencies

(a) A local disaster emergency may be declared only by the principal executive officer of a political subdivision. It shall not be continued or renewed for a period in excess of [7] days except by or with the consent of the governing board of the political subdivision. Any order or proclamation declaring, continuing, or terminating a local disaster emergency shall be given prompt and general publicity and shall be filed promptly with the [chief local records-keeping agency].

(b) The effect of a declaration of a local disaster emergency is to activate the response and recovery aspects of any and all applicable local or interjurisdictional disaster emergency plans and to authorize the furnishing of aid and assistance thereunder.

(c) No interjurisdictional agency or official thereof may declare a local disaster emergency, unless expressly authorized by the agreement pursuant to which the agency functions. However, an interjurisdictional disaster agency shall provide aid and services in accordance with the agreement pursuant to which it functions.

Commentary—Section 11

Section 11. Local Disaster Emergencies.—This Section parallels in general the provisions of the Act dealing with the declaration and continuance of a state of disaster emergency proclaimed by the Governor. There are emergency situations meriting such proclamation at the local level but which are not intense or widespread enough to require the declaration of an emergency at the State level. For the most part, the legal framework for local disaster emergencies should be contained in local laws and ordinances. Accordingly, this Section is brief.

Particular attention should be given to Paragraph (c) of this Section. Since the law underlying an interjurisdictional agreement cannot be contained solely in the laws of any one local jurisdiction, it is necessary for State law to contain a provision such as this Paragraph. The particular language used here is also intended to make clear that even by declaring a local emergency no single participant in an interjurisdictional arrangement can commit resources or incur obligations on behalf of the other parties to the arrangement, except pursuant to the interjurisdictional agreement.

Section 12. Disaster Prevention

(a) In addition to disaster prevention measures as included in the State, local, and interjurisdictional disaster plans, the Governor shall consider on a continuing basis steps that could be taken to prevent or reduce the harmful consequences of disasters. At his direction, and pursuant to any other authority and competence they have, State agencies, including but not limited to those charged with responsibilities in connection with flood plain management, stream encroachment and flow regulation, weather modification, fire prevention and control, air quality, public works, land use and land-use planning, and construction standards, shall make studies of disaster prevention-related matters. The Governor, from time to time, shall make recommendations to the Legislature, local governments, and other appropriate public and private entities as may facilitate measures for prevention or reduction of the harmful consequences of disasters.

(b) The [appropriate State agency], in conjunction with the Division of Disaster Emergency Services, shall keep land uses and construction of structures and other facilities under continuing study and identify areas which are particularly susceptible to severe land shifting, subsidence, flood, or other catastrophic occurrence. The studies under this subsection shall concentrate on means of reducing or avoiding the dangers caused by this occurrence or the consequences thereof.

(c) If the Division of Disaster Emergency Services believes on the basis of the studies or other competent evidence that an area is susceptible to a disaster of catastrophic proportions without adequate warning, that existing building standards and land-use controls in that area are inadequate and could add substantially to the magnitude of the disaster, and that changes in zoning regulations, other land-use regulations, or building requirements are essential in order to further the purposes of this section, it shall specify the essential changes to the Governor. If the Governor upon review of the recommendation finds after public hearing that the changes are essential, he shall so recommend to the agencies or local governments with jurisdiction over the area and subject matter. If no action or insufficient action pursuant to his recommendations is taken within the time specified by the Governor, he shall so inform the Legislature and request legislative action appropriate to mitigate the impact of disaster.

(d) The Governor, at the same time that he makes his recommendations pursuant to subsection (c), may suspend the standard or control which he finds to be inadequate to protect the public safety and by regulation place a new standard or control in effect. The new standard or control shall remain in effect until rejected by concurrent resolution of both houses of the Legislature or amended by the Governor. During the time it is in effect, the standard or control contained in the Governor's regulation shall be administered and given

full effect by all relevant regulatory agencies of the State and local governments to which it applies. The Governor's action is subject to judicial review [in accordance with the State administrative procedure act] [provide appropriate review procedures] but shall not be subject to temporary stay pending litigation.

Commentary—Section 12

Section 12. Disaster Prevention.—It is axiomatic that the best way to deal with a disaster is to prevent its occurrence. In many instances this cannot be done because the phenomena which cause it are beyond Man's control. However, it is possible to create conditions which will cut susceptibility to the harmful consequences of disaster such as injury, death, and loss of property to a minimum and which will facilitate effective response to danger. These measures are of a long-range nature and most of them are not generally thought of in a disaster context at all. For example, the proper elevation of a bridge to allow for passage of flood waters is a highway construction matter. Proper reinforcement and structural design of buildings to make them as resistant as possible to fire or earthquake is generally handled as a matter of overall building regulation. In the main, these activities should be left with the agencies responsible for the individual subject matters. However, it is important that their relevance for disaster be recognized and that disaster considerations enter into the planning, regulation, and operational activities in these other fields.

Land use is probably the single most important factor bearing on the prevention of damage and loss of life from disasters. Accordingly, Paragraph (d) gives the Governor an extraordinary power in this regard. It is desirable because experience shows that local and private persons and agencies normally are not sufficiently aware of the dangers from disaster and usually are not organized or motivated to give the subject sufficient emphasis in the conduct of their regular activities. The Paragraph comes into play only after the officials and persons most directly concerned have been apprised of the facts and have failed to act. Even so, the Paragraph has safeguards written into it in that gubernatorial action can be overridden by the Legislature. However, court stays prior to final judicial determinations are not allowed because litigation is frequently protracted and during its continuance many costly or irreversible actions could be taken.

Section 13. Compensation

(a) Each person within this State shall conduct himself and keep and manage his affairs and property in ways that will reasonably assist and will not unreasonably detract from the ability of the State and the public successfully to meet disaster emergencies. This obligation includes appropriate personal service and use or restriction on the use of property in time of disaster emergency. This Act neither increases nor decreases these obligations but recognizes their existence under the constitution and statutes of this State and the common law. Compensation for services or for the taking or use of property shall be only to the extent that obligations recognized herein are exceeded in a particular case and then only to the extent that the claimant may not be deemed to have volunteered his services or property without compensation.

(b) No personal services may be compensated by the State or any subdivision or agency thereof, except pursuant to statute or local law or ordinance.

(c) Compensation for property shall be only if the property was commandeered or otherwise used in coping with a disaster emergency and its use or destruction was ordered by the Governor or a member of the disaster emergency forces of this State.

(d) Any person claiming compensation for the use, damage, loss, or destruction of property under this Act shall file a claim therefor with the [name of appropriate State agency] in the form and manner the [appropriate State agency] provides.

(e) Unless the amount of compensation on account of property damaged, lost, or destroyed is agreed between the claimant and the [appropriate State agency], the amount of compensation shall be calculated in the same manner as compensation due for a taking of property pursuant to the condemnation laws of this State. [Each State will need to determine the administrative and judicial procedures to be used and add appropriate provisions to the statute.]

[(f) Nothing in this Section applies to or authorizes compensation for the destruction or damaging of standing timber or other property in order to provide a fire break or to the release of waters or the breach of impoundments in order to reduce pressure or other danger from actual or threatened flood.]

Commentary—Section 13

Section 13. Compensation.—The main point of this Section is that private persons and entities owe and must assume the risks for certain aspects of disaster. However, beyond the point where it is reasonable for such persons and entities to bear the costs resulting from catastrophic occurrences or attendant upon coping with them, the public treasury should provide compensation. This is particularly true whenever an individual's loss was incurred in order to advance the public interest rather than to protect his own life or property. As the later comments on this Section will indicate in greater detail, it is not possible at this time to offer as much assistance in this field of law and public policy as would be desirable. Nevertheless, the subject requires attention. What is provided in this statute is presented as the best that can be done now and in the hope that it will encourage further exploration.

Paragraph (a) ideally should be a definition of the obligations of private individuals with respect to their conduct and property. The purpose is to delineate the level of burden and risk which under present law a person is bound to assume. As the Paragraph specifically states, it is only excess damage or provision of services greater than those which a citizen owes the community in time of peril that should receive compensation. Since the law on this subject has not previously been formulated with any degree of exactness, the Paragraph recites the existence of such obligations and declares that they are intended to remain as they are. In the absence of such a declaration, the Section might be construed as a broad recognition of a right to compensation for any and all help furnished by an individual in time of emergency.

Paragraph (b) is designed to assure that claims for compensation will not be construed to exist, except to the extent provided pursuant to the Act and unless the claimant follows the established procedures for making and proving his claim.

Paragraphs (c)-(e) embody two policies which are believed to be equitable and appropriate. The first is that compensation for property should be only if it was "taken" for the public benefit. If it was contributed or used and returned in reasonable condition, the assumption can be made that the individual suffered no significant loss or that he meant to donate his property.

The second point is as to the measure of damages. Every State provides for such measurement in cases of taking by condemnation. To the extent that compensation in the circumstances contemplated by this Section is appropriate, it is compensation for property taken by the public.

Paragraph (f) is likely to be controversial. Its justification is on practical grounds. Losses through forest fire and flood occur frequently and amount to millions of dollars for single instances. Until much more has been done to develop well thought-out and soundly

financed programs of compensation, a system that does not make exclusions for catastrophic losses is likely to be so unrealistic as to be beyond the capacity of most States.

Some questions of legal rights and obligations related to disasters have no answers. Until now, it has not been thought essential to obtain them, because in time of peril some people respond without considering their own personal danger, inconvenience, or risk of loss. Perhaps it will never be possible to estimate how much life and property is compromised by the lack of clarity in these matters or the extent of the inequities that result from the absence of well-defined and consciously thought-out policies in this field. Nevertheless, we are now at the point where it is necessary to define and implement personal and property rights and obligations in statutory terms. This requires both policy formulation and implementation.

If governmental entities are to think in terms of compensation for various aspects of disaster service and loss, it must be determined what private individuals owe to the community as a matter of legal and civic obligation and what is the area of personal service or dedication of property that government has a right to demand, but only with payment of compensation. Clear policies equitably implemented are particularly needed because disaster conditions require that the services or property be placed at the disposal of the public first. Only after they have been used, and sometimes damaged, destroyed, or expended, can the equities be administratively or judicially fixed.

Neither the existing situation nor the desirable content of policy is clear. Accordingly, a study would have to determine how much can be made of present law relating to the rights and obligations of private persons in disaster situations. This would involve the collection and analysis of relevant case law and of any statutory provisions that might be in point. Because the subject has not received conscious and systematic attention from either the States or the Federal Government, considerable interpretation and construction by analogy would be necessary.

The applicability of this study to response is more obvious than to preparedness. In this connection it should be pointed out that the Office of Emergency Preparedness is much concerned with zoning and other land-use controls as tools for preventing or reducing dangers from disasters. While the bases of State and local land-use controls have been extensively explored by courts and text writers over a period of more than fifty years, the specific consideration of questions relating to restrictions on private property, expressly based on the public right to regulate in the name of disaster prevention or protection, would benefit from explicit statement.

Section 14. Communications

The Division of Disaster Emergency Services shall ascertain what means exist for rapid and efficient communications in times of disaster emergencies. The Division shall consider the desirability of supplementing these communications resources or of integrating them into a comprehensive State or State-Federal telecommunications or other communications system or network. In studying the character and feasibility of any system or its several parts, the Division shall evaluate the possibility of multipurpose use thereof for general State and local governmental purposes. The Division shall make recommendations to the Governor as appropriate.

Commentary—Section 14

Section 14. Communications.—The subject of this Section is a critical one. In large measure it will have been handled by activities under other provisions of the Act—especially those dealing with the State, local, and interjurisdictional disaster plans. Clearly, the planning and arranging of communications patterns and availability of facilities should be included in planning and preparedness work.

However, one additional element of the situation should be considered, and it is the purpose of this Section to underscore it. Some State agencies have special communications systems in order to assist them in rapid and efficient contact with their many offices and facilities throughout the State. In other jurisdictions, such systems do not exist, but may be considered for either special or general governmental use. Where such systems already exist, they can form reliable mechanisms for the sending and receipt of messages in times of emergency. The need for emergency communications could contribute to the feasibility of a State, or States and the Federal Government, developing or expanding an interrelated communications networks, as exemplified by Nebraska.

Section 15. Mutual Aid

(a) Political subdivisions not participating in interjurisdictional arrangements pursuant to this Act nevertheless shall be encouraged and assisted by the Division of Disaster Emergency Services to conclude suitable arrangements for furnishing mutual aid in coping with disasters. The arrangements shall include provision of aid by persons and units in public employ.

(b) In passing upon local disaster plans, the Governor shall consider whether they contain adequate provisions for the rendering and receipt of mutual aid.

(c) It is a sufficient reason for the Governor to require an interjurisdictional agreement or arrangement pursuant to Section 9 of this Act that the area involved and political subdivisions therein have available equipment, supplies, and forces necessary to provide mutual aid on a regional basis and that the political subdivisions have not already made adequate provision for mutual aid; but in requiring the making of an interjurisdictional arrangement to accomplish the purpose of this Section, the Governor need not require establishment and maintenance of an interjurisdictional agency or arrangement for any other disaster purposes.

Commentary—Section 15

Section 15. Mutual Aid.—Proper provision for mutual aid is one of the key elements in preparedness and response. In general, the Act provides three means of securing it: State assistance to localities in time of disaster, interjurisdictional arrangements, and the provision of special services by contract.

Insufficiency of local forces is so frequent a characteristic of disaster emergency conditions as to be almost the normal expectation. Accordingly, it is essential that means be available to mobilize and employ personnel and material from areas that have not been affected by the disaster. This Section is included to make sure that the subject receives full consideration and that all of the appropriate procedures of the Act are brought to bear on the solution of the problem.

Section 16. Weather Modification

The Division of Disaster Emergency Services shall keep continuously apprised of weather conditions which present danger of precipitation or other climatic activity severe enough to constitute a disaster. If the Division determines that precipitation that may result from weather modification operations, either by itself or in conjunction with other precipitation or climatic conditions or activity, would create or contribute to the severity of a disaster, it shall direct the officer or agency empowered to issue permits for weather modification operations to suspend the issuance of the permits. Thereupon, no permits may issue until the Division informs the officer or agency that the danger has passed.

Commentary—Section 16

Section 16. Weather Modification.—Many States regulate weather modification activities. The approach generally is through licensure of operators and control of the procedures that can be lawfully used. The subject is specialized and extensive enough so that it would be inappropriate to encompass a general weather modification statute within the confines of the present legislation. Moreover, the use of weather modification in most circumstances is either unrelated to disaster emergencies or is intended to alleviate drought emergencies.

The place at which weather modification is most likely to impinge on disaster situations is the possible imprudent conduct of the activity at times when it might intensify adverse storm conditions. Accordingly, the Section authorizes the State Disaster Agency to suspend permits for weather modification operations during those limited periods when they might have such an effect.

Section 17. Effective Date

This act shall take effect [immediately].





COLORADO

Department of Public
Health & Environment

PUBLIC HEALTH ORDER 20-38 LIMITED COVID-19 RESTRICTIONS

April 15, 2021

PURPOSE OF THE ORDER

I am issuing this Public Health Order (PHO or Order) in response to the existence of thousands of confirmed and presumptive cases of Coronavirus disease 2019 (COVID-19) and related deaths across the State of Colorado. This Order supersedes PHO 20-36 COVID-19 Dial and PHO 20-29 Voluntary and Elective Surgeries and Procedures, and implements reduced restrictions for individuals, businesses and activities, as well as reporting requirements for hospitals, to prevent the spread of COVID-19 further in Colorado.

FINDINGS

1. Governor Polis issued **Executive Order D 2020 003** on March 11, 2020, declaring a disaster emergency in Colorado due to the presence of COVID-19. Since that time, the Governor has taken numerous steps to implement measures to mitigate the spread of disease within Colorado, and has further required that several public health orders be issued to implement his orders.
2. I have issued public health orders pertaining to the limitation of visitors and nonessential individuals in skilled nursing facilities, intermediate care facilities, and assisted living residences; defining the terms of the Governor's **Stay at Home**, **Safer at Home**, and **Protect our Neighbors** requirements as well as **Critical Business** designations; requiring hospitals to report information relevant to the COVID-19 response; and requiring the wearing of face coverings in the workplace and urging their use in public. These measures all act in concert to reduce the exposure of individuals to disease, and are necessary steps to protect the health and welfare of the public. Additionally, in reducing the spread of disease, these requirements help to preserve the medical resources needed for those in our communities who fall ill and require medical treatment, thus protecting both the ill patients and the healthcare workers who courageously continue to treat patients.
3. As of April 14, 2021, there have been 485,318 known cases of COVID-19 in Colorado, 26,661 Coloradans have been hospitalized and 6,319 Coloradans have died from COVID-19. Multiple sources of data show that COVID-19 transmission and the use of the hospital system due to COVID-19 have leveled off in Colorado.

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4. With the rescission of PHO 20-36 COVID-19 Dial, but the pandemic ongoing, it remains critical for individuals, communities, businesses, and governments to remain vigilant regarding the spread of COVID-19. Individuals are encouraged to remain at least 6 feet away from non-household contacts, wash their hands, and wear a face covering to reduce the likelihood of disease transmission. As we continue to combat COVID-19 in our communities, continuing some limited requirements to mitigate disease spread remain appropriate.

5. The following additional public health orders remain in effect:

- a. PHO 20-20 Requirements For Colorado Skilled Nursing Facilities, Assisted Living Residences, Intermediate Care Facilities, And Group Homes For COVID-19 Prevention And Response;
- b. PHO 20-33 Laboratory Data Reporting for COVID-19; and
- c. PHO 20-37 Vaccine Access And Data Reporting For COVID-19.

INTENT

This Order includes limited requirements for individuals and businesses to mitigate the spread of COVID-19 in Colorado. The Order incorporates the requirements of **Executive Order D 2020 138**, as amended and extended by **Executive Order D 2020 164, D 2020 190, D 2020 219, D 2020 237, D 2020 245, D 2020 276, D 2020 281, D 2021 007, D 2021 035, D 2021 056, and D 2021 079** concerning face coverings. Additionally, the Order maintains some restrictions on certain activities while we continue to take steps to limit the spread of COVID-19 in Colorado, and includes a provision that authorizes CDPHE to require a county to comply with additional restrictions should certain metrics be met. The Order also includes hospital reporting requirements regarding bed capacity to provide the State with critical information to assess the status of the COVID-19 pandemic relative to the statewide capacity to provide necessary medical care and services to Coloradans.

ORDER

This Order supersedes and replaces Public Health Orders 20-29 and 20-36, as amended, effective at 12:01 AM on Friday, April 16, 2021.

I. COVID-19 RESTRICTIONS

A. FACE COVERINGS

- 1. Face coverings are required pursuant to **Executive Order D 2020 138**, as amended and extended by **Executive Order D 2020 164, D 2020 190, D 2020**

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219, D 2020 237, D 2020 245, D 2020 276, D 2020 281, D 2021 007, D 2021 035, D 2021 056, and D 2021 079, for all individuals in the following settings:

- a. Preschool through grade 12 schools (including extracurricular activities), child care centers and services, and indoor children's camps;
 - b. Public areas of state government facilities, and areas in state government facilities where members of the public come into contact with state government employees;
 - c. Congregate care facilities, including nursing facilities, assisted living residences, intermediate care facilities, and group homes;
 - d. Prisons;
 - e. Jails;
 - f. Emergency medical and other healthcare settings (including hospitals, ambulance service centers, urgent care centers, non-ambulatory surgical structures, clinics, doctors' offices, and non-urgent care medical structures);
 - g. **Personal services;** and
 - h. **Limited healthcare settings.**
2. For counties with a one week disease incidence rate in excess of 35 per 100,000, face coverings are also required pursuant to **Executive Order D 2020 138**, as amended and extended, in a **Public Indoor Space**, as defined in **Executive Order D 2020 138**, as amended and extended, where 10 or more unvaccinated individuals or individuals of unknown vaccination status are present.
 3. Exceptions to the face covering requirements include
 - a. individuals 10 years of age or younger,
 - b. individuals who cannot medically tolerate a face covering, and
 - c. individuals participating in one of the activities described in Section II.I of **Executive Order D 2020 138**, as amended and extended.
 4. Face coverings may be removed in a school classroom setting for the limited purpose of playing an instrument that cannot otherwise be played while wearing a face covering.
 5. Nothing in this Order changes or abrogates the Centers for Disease Control and Prevention's (CDC) Order on January 29, 2021, requiring the wearing of masks by travelers to prevent the spread of COVID-19. All Coloradans must abide by the CDC's Order, which can be found at <https://www.cdc.gov/quarantine/masks/mask-travel-guidance.html>.

B. ALL BUSINESSES AND GOVERNMENT ENTITIES. All businesses and government entities shall comply with the requirements in this Section I.B.

1. Work Accommodations. Employers are strongly encouraged to provide reasonable work accommodations, including accommodations under the

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Americans with Disabilities Act (ADA) for individuals who cannot obtain access to COVID-19 vaccine or who for medical or other legal reasons cannot take a COVID-19 vaccine.

2. Face coverings. All employers must implement the face covering requirements in **Executive Order D 2020 138**, as amended and extended, as applicable.
3. Disease mitigation practices. Employers and sole proprietors are strongly encouraged to follow the best practices for disease mitigation found in [CDPHE Guidance](#).

C. MASS INDOOR GATHERINGS

1. In addition to the requirements in Section I.B of this Order, the requirements in this Section I.C apply to **Mass Indoor Gatherings**.
2. When more than 100 people are gathered in a room in a **Public Indoor Space**, the setting may operate at 100% capacity not to exceed 500 people, with 6 feet distancing required between parties of unvaccinated people or when vaccination status is unknown. Existing approved variances remain in effect, including 5 Star Program approvals granted by a county. Venues may apply to their local public health agency for a variance to exceed 500 people, to be finally approved by CDPHE. These requirements do not apply to the following sectors:
 - a. Places of worship and associated ceremonies,
 - b. Retail services,
 - c. Restaurants that have sit-down dining and do not have unseated areas where 100 or more people could gather (such as dance floors or common gathering areas), and
 - d. School proms and graduations that wish to exceed these thresholds shall be subject to review and approval by local public health agencies in accordance with CDPHE [prom](#) and [graduation](#) guidance.
3. Face coverings are required for all individuals in a **Mass Indoor Gathering**, except in the following circumstances:
 - a. individuals 10 years of age or younger,
 - b. individuals who cannot medically tolerate a face covering, and
 - c. individuals participating in one of the activities described in Section II.I of **Executive Order D 2020 138**, as amended and extended.

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D. OUTDOOR EVENTS

1. Outdoor ticketed, seated event venues in excess of 30,000 square feet require CDPHE approval, in consultation with the local public health agency. Existing approved variances, including 5 Star Program approvals granted by a county, remain in effect.

E. SCHOOLS AND CHILD CARE

1. **Schools** and child care shall work with their local public health agencies as COVID-19 cases occur, and shall follow the CDPHE guidance for [Cases and Outbreaks in Schools and Child Care](#).
2. **Schools** that are entirely remote learning due to ongoing COVID-19 cases and outbreaks shall not have in-person extracurricular activities.

E. ADDITIONAL COUNTY RESTRICTIONS

1. CDPHE may require counties whose resident hospitalizations threaten to exceed 85% of hospital or hospital system capacity to implement additional restrictions to mitigate disease transmission.

II. HOSPITAL FACILITY REPORTING

- A. COVID-19 Case Reporting. All Colorado hospitals shall report to CDPHE in a form and format determined by CDPHE, certain information for all suspected (pending laboratory test) and confirmed (positive laboratory test) cases of COVID-19, including but not limited to:

1. race and ethnicity;
2. numbers of suspected and confirmed cases who are hospitalized, who are hospitalized and using a ventilator, or who are in the emergency department waiting for an inpatient bed;
3. numbers of suspected and confirmed cases who are discharged and in recovery;
4. deaths due to COVID-19; and
5. medical equipment and supply information, including but not limited to total bed and intensive care unit (ICU) bed capacity and occupancy, ventilator availability and utilization, and availability of N95 masks.

Reporting by hospitals shall be done in CDPHE's EMResource reporting system on a daily basis or as otherwise required by this Order.

- B. Hospital Bed Capacity Reporting. All Colorado hospitals shall report to CDPHE the following in EMResource daily at 10:00 a.m.:

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1. The daily maximum number of beds that are currently or can be made available within 24 hours for patients in need of ICU level care; and
2. The daily maximum number of all staffed acute care beds, including ICU beds, available for patients in need of non-ICU hospitalization.

III. DEFINITIONS

- A. Limited Healthcare Settings** means those locations where certain healthcare services are provided, including acupuncture (not related to personal services), athletic training (not related to personal services), audiology services, services by hearing aid providers, chiropractic care, massage therapy (not related to personal services), naturopathic care, occupational therapy services, physical therapy, and speech language pathology services.
- B. Mass Indoor Gathering** is any indoor space where more than 100 unvaccinated individuals or individuals with unknown vaccination status are gathered in a room.
- C. Personal Services** means services and products that are not necessary to maintain an individual's health or safety, or the sanitation or essential operation of a business or residence. **Personal Services** include, but are not limited to, personal training, dog grooming, or body art and also applies to noncritical professionals regulated by the Division of Professions and Occupations, within the Department of Regulatory Agencies (DORA) including but not limited to services provided by personal beauty professionals such as hairstylists, barbers, cosmetologists, estheticians, nail technicians, as well as massage therapists, whose work requires these professionals to be less than six feet from the person for whom the services are being provided.
- D. Public Indoor Space** means any enclosed indoor area that is publicly or privately owned, managed, or operated to which individuals have access by right or by invitation, expressed or implied, and that is accessible to the public, serves as a place of employment, or is an entity providing services. **Public Indoor Space** does not mean a person's residence, including a room in a motel or hotel or a residential room for students at an educational facility.
- E. School** means pre-kindergarten through 12th grade. A school includes all grade levels contained in a building or multiple buildings on a campus.

IV. ENFORCEMENT

This Order will be enforced by all appropriate legal means. Local authorities are encouraged to determine the best course of action to encourage maximum compliance. Failure to comply with

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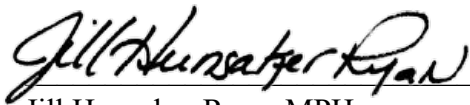
this order could result in penalties, including jail time, and fines, and may also be subject to discipline on a professional license based upon the applicable practice act.

V. SEVERABILITY

If any provision of this Order or the application thereof to any person or circumstance is held to be invalid, the remainder of the Order, including the application of such part or provision to other persons or circumstances, shall not be affected and shall continue in full force and effect. To this end, the provisions of this Order are severable.

VI. DURATION

This Order shall become effective at 12:01 AM on Friday, April 16, 2021 and will expire in 30 days unless extended, rescinded, superseded, or amended in writing.



Jill Hunsaker Ryan, MPH
Executive Director

April 15, 2021

Date



AMENDED PUBLIC HEALTH ORDER 20-38
LIMITED COVID-19 RESTRICTIONS
May2, 2021

PURPOSE OF THE ORDER

I am issuing this Public Health Order (PHO or Order) in response to the existence of thousands of confirmed and presumptive cases of Coronavirus disease 2019 (COVID-19) and related deaths across the State of Colorado. This Order supersedes PHO 20-36 COVID-19 Dial and PHO 20-29 Voluntary and Elective Surgeries and Procedures, and implements reduced restrictions for individuals, businesses and activities, as well as reporting requirements for hospitals, to prevent the spread of COVID-19 further in Colorado.

FINDINGS

1. Governor Polis issued **Executive Order D 2020 003** on March 11, 2020, declaring a disaster emergency in Colorado due to the presence of COVID-19. Since that time, the Governor has taken numerous steps to implement measures to mitigate the spread of disease within Colorado, and has further required that several public health orders be issued to implement his orders.
2. I have issued public health orders pertaining to the limitation of visitors and nonessential individuals in skilled nursing facilities, intermediate care facilities, and assisted living residences; defining the terms of the Governor's **Stay at Home**, **Safer at Home**, and **Protect our Neighbors** requirements as well as **Critical Business** designations; requiring hospitals to report information relevant to the COVID-19 response; and requiring the wearing of face coverings in the workplace and urging their use in public. These measures all act in concert to reduce the exposure of individuals to disease, and are necessary steps to protect the health and welfare of the public. Additionally, in reducing the spread of disease, these requirements help to preserve the medical resources needed for those in our communities who fall ill and require medical treatment, thus protecting both the ill patients and the healthcare workers who courageously continue to treat patients.
3. As of May 1, 2021, there have been 512,804 known cases of COVID-19 in Colorado, 28,870 Coloradans have been hospitalized and 6,449 Coloradans have died from COVID-19. Multiple sources of data show that COVID-19 transmission and the use of the hospital system due to COVID-19 have leveled off in Colorado.

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4. With the rescission of PHO 20-36 COVID-19 Dial, but the pandemic ongoing, it remains critical for individuals, communities, businesses, and governments to remain vigilant regarding the spread of COVID-19. Individuals are encouraged to remain at least 6 feet away from non-household contacts, wash their hands, and wear a face covering to reduce the likelihood of disease transmission. As we continue to combat COVID-19 in our communities, continuing some limited requirements to mitigate disease spread remain appropriate.

5. The following additional public health orders remain in effect:

- a. PHO 20-20 Requirements For Colorado Skilled Nursing Facilities, Assisted Living Residences, Intermediate Care Facilities, And Group Homes For COVID-19 Prevention And Response;
- b. PHO 20-33 Laboratory Data Reporting for COVID-19; and
- c. PHO 20-37 Vaccine Access And Data Reporting For COVID-19.

INTENT

This Order includes limited requirements for individuals and businesses to mitigate the spread of COVID-19 in Colorado. The Order incorporates the requirements of **Executive Order D 2020 138**, as amended and extended by **Executive Order D 2020 164, D 2020 190, D 2020 219, D 2020 237, D 2020 245, D 2020 276, D 2020 281, D 2021 007, D 2021 035, D 2021 056, and D 2021 079** concerning face coverings. Additionally, the Order maintains some restrictions on certain activities while we continue to take steps to limit the spread of COVID-19 in Colorado, and includes a provision that authorizes CDPHE to require a county to comply with additional restrictions should certain metrics be met. The Order also includes hospital reporting requirements regarding bed capacity to provide the State with critical information to assess the status of the COVID-19 pandemic relative to the statewide capacity to provide necessary medical care and services to Coloradans.

ORDER

This Order supersedes and replaces Public Health Orders 20-29 and 20-36, as amended, effective at 12:01 AM on Friday, April 16, 2021.

I. COVID-19 RESTRICTIONS

A. FACE COVERINGS

- 1. Face coverings are required pursuant to **Executive Order D 2020 138**, as amended and extended by **Executive Order D 2020 164, D 2020 190, D 2020**

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219, D 2020 237, D 2020 245, D 2020 276, D 2020 281, D 2021 007, D 2021 035, D 2021 056, D 2021 079, and D 2021 095 for all individuals in the following settings:

- a. Preschool through grade 12 schools (including extracurricular activities), child care centers and services, and indoor children's camps;
 - b. Public areas of state government facilities, and areas in state government facilities where members of the public come into contact with state government employees;
 - c. Congregate care facilities, including nursing facilities, assisted living residences, intermediate care facilities, and group homes;
 - d. Prisons;
 - e. Jails;
 - f. Emergency medical and other healthcare settings (including hospitals, ambulance service centers, urgent care centers, non-ambulatory surgical structures, clinics, doctors' offices, and non-urgent care medical structures);
 - g. **Personal services;** and
 - h. **Limited healthcare settings.**
2. For counties with a one week disease incidence rate in excess of 35 per 100,000, face coverings are also required pursuant to **Executive Order D 2020 138**, as amended and extended, in a **Public Indoor Space**, as defined in **Executive Order D 2020 138**, as amended and extended, where 10 or more unvaccinated individuals or individuals of unknown vaccination status are present.
- a. Individuals are permitted to remove their medical or non-medical cloth face coverings in **Public Indoor Spaces** if 80% of the individuals in the **Public Indoor Space** have shown proof of vaccination.
3. Exceptions to the face covering requirements include
- a. individuals 10 years of age or younger,
 - b. individuals who cannot medically tolerate a face covering, and
 - c. individuals participating in one of the activities described in Section II.I of **Executive Order D 2020 138**, as amended and extended.
4. Face coverings may be removed in a school classroom setting for the limited purpose of playing an instrument that cannot otherwise be played while wearing a face covering.
5. Nothing in this Order changes or abrogates the Centers for Disease Control and Prevention's (CDC) Order on January 29, 2021, requiring the wearing of masks by travelers to prevent the spread of COVID-19. All Coloradans must abide by the CDC's Order, which can be found at <https://www.cdc.gov/quarantine/masks/mask-travel-guidance.html>.
6. For **Restaurants**, once 85% of the **Restaurant** employees have been fully

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vaccinated, the **Restaurant** employees are no longer required to wear face coverings.

B. ALL BUSINESSES AND GOVERNMENT ENTITIES. All businesses and government entities shall comply with the requirements in this Section I.B.

1. Work Accommodations. Employers are strongly encouraged to provide reasonable work accommodations, including accommodations under the Americans with Disabilities Act (ADA) for individuals who cannot obtain access to COVID-19 vaccine or who for medical or other legal reasons cannot take a COVID-19 vaccine.
2. Face coverings. All employers must implement the face covering requirements in **Executive Order D 2020 138**, as amended and extended, as applicable.
3. Disease mitigation practices. Employers and sole proprietors are strongly encouraged to follow the best practices for disease mitigation found in [CDPHE Guidance](#).

C. MASS INDOOR GATHERINGS

1. In addition to the requirements in Section I.B of this Order, the requirements in this Section I.C apply to **Mass Indoor Gatherings**.
2. When more than 100 people are gathered in a room in a **Public Indoor Space**, the setting may operate at 100% capacity not to exceed 500 people, with 6 feet distancing required between parties of unvaccinated people or when vaccination status is unknown. Existing approved variances remain in effect, including 5 Star Program approvals granted by a county. Venues may apply to their local public health agency for a variance to exceed 500 people, to be finally approved by CDPHE. These requirements do not apply to the following sectors:
 - a. Places of worship and associated ceremonies,
 - b. Retail services,
 - c. Restaurants that have sit-down dining and do not have unseated areas where 100 or more people could gather (such as dance floors or common gathering areas), and
 - d. School proms and graduations that wish to exceed these thresholds shall be subject to review and approval by local public health agencies in accordance with CDPHE [prom](#) and [graduation](#) guidance.
3. Face coverings are required for all individuals in a **Mass Indoor Gathering**, except in the following circumstances:

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- a. individuals 10 years of age or younger,
- b. individuals who cannot medically tolerate a face covering, and
- c. individuals participating in one of the activities described in Section II.I of **Executive Order D 2020 138**, as amended and extended.

D. OUTDOOR EVENTS

1. Outdoor ticketed, seated event venues in excess of 30,000 square feet require CDPHE approval, in consultation with the local public health agency. Existing approved variances, including 5 Star Program approvals granted by a county, remain in effect.

E. SCHOOLS AND CHILD CARE

1. **Schools** and child care shall work with their local public health agencies as COVID-19 cases occur, and shall follow the CDPHE guidance for [Cases and Outbreaks in Schools and Child Care](#).
2. **Schools** that are entirely remote learning due to ongoing COVID-19 cases and outbreaks shall not have in-person extracurricular activities.

F. ADDITIONAL COUNTY RESTRICTIONS

1. CDPHE may require counties whose resident hospitalizations threaten to exceed 85% of hospital or hospital system capacity to implement additional restrictions to mitigate disease transmission.

G. NON-CONGREGATE SHELTERING

1. Governmental and other entities are strongly urged to make shelter available to people experiencing homelessness whenever possible and to the maximum extent practicable, and are authorized to take all reasonable steps necessary to provide non-congregate sheltering along with necessary support services to members of the public in their jurisdiction as necessary to protect all members of the community.

II. HOSPITAL FACILITY REPORTING

- A. COVID-19 Case Reporting. All Colorado hospitals shall report to CDPHE in a form and format determined by CDPHE, certain information for all suspected (pending laboratory test) and confirmed (positive laboratory test) cases of COVID-19, including but not limited to:

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May 2, 2021

1. race and ethnicity;
2. numbers of suspected and confirmed cases who are hospitalized, who are hospitalized and using a ventilator, or who are in the emergency department waiting for an inpatient bed;
3. numbers of suspected and confirmed cases who are discharged and in recovery;
4. deaths due to COVID-19; and
5. medical equipment and supply information, including but not limited to total bed and intensive care unit (ICU) bed capacity and occupancy, ventilator availability and utilization, and availability of N95 masks.

Reporting by hospitals shall be done in CDPHE's EMResource reporting system on a daily basis or as otherwise required by this Order.

B. Hospital Bed Capacity Reporting. All Colorado hospitals shall report to CDPHE the following in EMResource daily at 10:00 a.m.:

1. The daily maximum number of beds that are currently or can be made available within 24 hours for patients in need of ICU level care; and
2. The daily maximum number of all staffed acute care beds, including ICU beds, available for patients in need of non-ICU hospitalization.

III. DEFINITIONS

- A. **Limited Healthcare Settings** means those locations where certain healthcare services are provided, including acupuncture (not related to personal services), athletic training (not related to personal services), audiology services, services by hearing aid providers, chiropractic care, massage therapy (not related to personal services), naturopathic care, occupational therapy services, physical therapy, and speech language pathology services.
- B. **Mass Indoor Gathering** is any indoor space where more than 100 unvaccinated individuals or individuals with unknown vaccination status are gathered in a room.
- C. **Personal Services** means services and products that are not necessary to maintain an individual's health or safety, or the sanitation or essential operation of a business or residence. **Personal Services** include, but are not limited to, personal training, dog grooming, or body art and also applies to noncritical professionals regulated by the Division of Professions and Occupations, within the Department of Regulatory Agencies (DORA) including but not limited to services provided by personal beauty professionals such as hairstylists, barbers, cosmetologists, estheticians, nail technicians, as well as massage therapists, whose work requires these professionals to be less than six feet from the person for whom the services are being provided.

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- D. Public Indoor Space** means any enclosed indoor area that is publicly or privately owned, managed, or operated to which individuals have access by right or by invitation, expressed or implied, and that is accessible to the public, serves as a place of employment, or is an entity providing services. **Public Indoor Space** does not mean a person's residence, including a room in a motel or hotel or a residential room for students at an educational facility.
- E. School** means pre-kindergarten through 12th grade. A school includes all grade levels contained in a building or multiple buildings on a campus.

IV. ENFORCEMENT

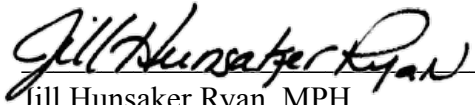
This Order will be enforced by all appropriate legal means. Local authorities are encouraged to determine the best course of action to encourage maximum compliance. Failure to comply with this order could result in penalties, including jail time, and fines, and may also be subject to discipline on a professional license based upon the applicable practice act.

V. SEVERABILITY

If any provision of this Order or the application thereof to any person or circumstance is held to be invalid, the remainder of the Order, including the application of such part or provision to other persons or circumstances, shall not be affected and shall continue in full force and effect. To this end, the provisions of this Order are severable.

VI. DURATION

This Order shall become effective on Sunday, May 2, 2021 and will expire on May 15, 2021 unless extended, rescinded, superseded, or amended in writing.


Jill Hunsaker Ryan, MPH
Executive Director

May 2, 2021

Date