2 HISTORY AND DEVELOPMENT OF GRADING CODES

Records dating back as far as 2000 B.C. about the Babylonian Empire of Hammurabi substantiate that developing and enforcing building codes are among the oldest and most enduring of all governmental functions.

Hammurabi's law was simple and straightforward; his enforcement was devastatingly harsh. An example is his translated law Number 229 (in Ref. 1, Chapter 1):

> *If a builder has built a house for a man, and his work is not strong, and if the house he has built falls in and kills the householder, that builder shall be slain.*

Fortunately, enforcement of building codes today is not nearly as "final" in its application!

Although substantially improved from these early times, complex modern codes and enforcement procedures still must undergo continual appraisal and updating. As new earth-moving equipment and techniques evolve, and as pressures to build upon previously "unbuildable" or undesirable sites increase, existing building codes will have to be strengthened to insure safe, economical development of especially steep hillside sites. In establishing criteria for safe grading and hillside development, drainage, erosion control, stability, and settlement are primary geologic considerations.

Ground conditions such as the movement of surface and subsurface water, weathering, wind, and seismic activity are the geologic processes constantly operating on and within the earth. Individually, these processes are significant. Often they are interrelated. Hence, ground features may be the result of a composite of processes. The intensity and importance of these many geologic processes in any specific area are dependent upon several factors: geographic location, climate, elevation, earth material and composition, and time. Varying combinations of these factors can create totally different land forms. Where the land forms contain potential geologic hazard conditions, responsible governmental officials have been forced to establish grading-code requirements that demand high-quality performance from specialists in the fields of civil engineering, soil mechanics, and engineering geology.

2-1 HISTORY OF GRADING CODES

Immediately after World War II, a spiraling demand for building sites in California intensified the development of foothill and mountain slopes for low-cost residential living. Vastly improved earth-moving technology made recontouring mountains more economical than paying increasing costs for flatland areas. The rapidly increasing population and the high market potential for homes with views further accelerated early hillside development. During this same time, "borrow site" operations (where earth materials were graded and removed for construction materials) were expanded to create access roads and to obtain base and embankment materials for public improvements. The "borrow sites" created oversteepened cut slopes; and often loose fills were pushed over slopes and into canyons with little thought given to potential consequences.

Because damaging rainstorms are infrequent in California, and because the proportion of hillside to flatland homes was still rather small in the late 1940s and early 1950s, normal precipitation damaged relatively few sites, and the general population developed a false sense of safety about hillside developments. During the winter rainy season of 1951-52, California residents were shocked with reality, as described by Richard H. Jahns [1] in a statement prepared for the Office of Emergency Preparedness Geologic Hazards and Public Problems Conference Proceedings:

> *The immediately preceding years had been relatively dry ones, but during the winter season of 1951-52 the heavens seemed to open up. One severe storm during the period of January 13-18 yielded 7.5 inches of precipitation in downtown Los Angeles and substantially greater quantities in some of the adjacent hills, with results that were locally devastating. Fresh cuts and fills were scoured and deeply gulleyed; enormous volumes of rock, mud, and coarse debris were mobilized and various mixtures of water and solid matter invaded lower areas where they clogged existing drainage facilities and occupied much settled land. An estimated quarter of a million cubic yards of debris were subsequently removed from the city streets alone, and property damage amounted to approximately $7.5 million.*

The aftermath of this disastrous rainfall taught the city the price it must pay if hillside development continued under antiquated building and grading conditions. The exploding population had collided with nature. As a consequence, in 1952, the City of Los Angeles adopted the first grading ordinance in the United States, thereby assuming a pioneering role in the control of man's modification of natural urban terrain. Both the original ordinance and its modifications have formed the foundation of all subsequent grading codes adopted by cities and counties throughout the United States. Many city and county agencies followed Los Angeles in adopting grading codes. Some of the municipalities that have utilized the original Los Angeles code include:

Cities	*Dates*	*Counties*	*Dates*
Beverly Hills	1952	Los Angeles	1957
Pasadena	1953	Santa Barbara	1959
Glendale	1954	San Mateo	1960
Burbank	1954	Orange	1962
San Francisco	1956	Riverside	1963
Ventura	1958	Sonoma	1964
San Diego	1962		
Riverside	1963		
Orange	1964		
Laguna Beach	1965		

Although patterned after the original Los Angeles code, many of these subsequent codes were so modified prior to adoption that they were barely enforceable, and some were codified without proper staffing or implementation. With the tremendous growth pressures created by the influx of population and industry, many city and county agencies found that they lacked necessary controls to ensure safe development of their hillside urban areas. Too often, the agencies did not realize what problems are involved with such development until they experienced serious damage to life and property. Sometimes, rather than try to resolve these problems by following the advice of experienced professional engineers, geologists, contractors, and/or building officials, the agencies adopted the most readily available established ordinance without fully understanding its contents or control procedures. This often resulted in further unforeseen problems and failures.

Acknowledging the close relationship between the engineering of building construction and the engineering of safe soil foundations, the City of Los Angeles Charter charged its Department of Building and Safety with the responsibility of regulating both construction and grading. Accordingly, in 1952, regulation of all new grading in certain designated hillside areas was placed under the jurisdiction of a newly created Grading Section within the City of Los Angeles Department of Building and Safety. A system of mandatory permits, inspections, and certifications was tested and put into practice; as a result, earthwork and slope failures were reduced. However, slopes, bedrock, and geologic structures were adjudged to be engineering problems; therefore, the determination of whether or not a geologic appraisal was needed was left to the discretion of the field grading inspector or the department engineer. If there was doubt about the stability of the soil, the builder was required to obtain a report from an approved soil-testing laboratory. An "approved soil-testing" laboratory was one that was inspected by the Building Department and determined to contain the necessary testing equipment to perform the soil testing required by the code. A "Certificate of Approval" was given to the soil-testing company and a list of approved laboratories was made available to the public.

During January of 1956, a violent two-day rainstorm created extensive damage, some of which was attributable to oversight and not considering geologic factors during site development. This damage prompted the establishment in May 1956 of an ad hoc geologic hazards committee. This committee was comprised of geologic and engineering specialists: structural, civil, and soil engineers; engineering and mining geologists; and professors of geology from two local universities. The purpose of this committee was to advise the city on all problems of engineering geology and geologic hazards.

Committee members, recognizing the common basis of their specialized areas of concern, worked together to develop channels through which they could fulfill their purpose. First, they recognized the need for having detailed topographic and geologic maps of the city to be used as base maps for further investigations. Further, they realized that in spite of capable soil mechanic supervision, compacted fills are only as stable as the underlying bedrock on which they are constructed. Therefore, an expert geological opinion would be required to accompany the findings of the soil engineer. This change relieved the grading inspectors of the responsibility to make decisions regarding geological and soil engineering conditions.

As a consequence of recommendations from this committee, from 1956 through early 1960, the City of Los Angeles and some of the adjacent cities required geological reports prior to issuing grading permits. However, these reports were superficial and proved to be of little value to grading plan checkers, field inspectors, civil engineers, or soil engineers for the following reasons:

1. The planning commissions and the engineering and building departments had not defined clearly for subdividers the types of investigation needed to provide the information desired.
2. Few building department staff members had developed skills needed to interpret geological reports.
3. Subdividers would not pay for any investigations they were not required to provide.
4. The geological consultants only performed the limited investigations that they were authorized or paid to accomplish.

During the period from 1956 through 1961, geologic reports were required for hillside sites, but geologists were seldom retained during construction; therefore, they did not inspect during construction to see that their recommendations had been complied with, nor did they investigate potential hazards that might have been uncovered by the grading. Soil engineers were called out only when notified by grading contractors or at times when field technicians happened to notice potential problems. As recently as 1959, there were some grading operations supervised by grading foremen who lacked soil engineering skills and who, in turn, told field technicians where to take their tests. Prior to the application of "Supervised Grading" during 1962 and 1963, design civil engineers did not supervise construction (or any phase of construction). Their main function was to get plans approved through the government agencies and stake sites for construction grading.

During 1958, the Geologic Hazards Committee established the Board of Qualifications of Engineering Geologists to formulate a list of qualified professional geologists to parallel the roster of qualified soils-testing laboratories. These lists were to assist the developers and the general public in choosing qualified geologists and soil-testing firms. The County of Los Angeles established such a board in 1960, the County of Orange in 1962, and the County of Ventura in 1967. These qualification boards were the predecessors of the State Board of Registration for Geologists and Geophysicists (1968) who now license engineering geologists in California. The boards also acted as geotechnical advisors to local building and safety departments.

On March 6, 1960, Dr. Richard H. Jahns, then the Chairman of Earth Sciences at the California Institute of Technology and President of the City of Los Angeles Geologic Qualifications Board, submitted the board's guide for geologic investigations to the City of Los Angeles. This outline was accepted by the cities of Los Angeles and Glendale during May 1960, and has been the basis of subsequent preliminary investigations requirements. Unfortunately, adequate supervision by qualified professionals was not begun until after the heavy rains of 1961–62.

Charles A. Yelverton [2] affirms that although the great majority of private builders and subdividers recognized the importance of geologic conditions in determining site stability, many public officials and land planners failed to take geology into account. The combination of termination of "landslide" insurance by the insurance industry and instances of landslides, slumps, and settlements in 1958 caused many hillside residents to become nearly hysterical. The Los Angeles City Council responded to ensuing pressures by amending the 1952 grading ordinance in April 1963. One of the more stringent requirements of the revision requires a 2:1 ratio of horizontal to vertical slope angle rather than the previous 1:1 ratio. The council further required: (1) that both geologic and engineering reports be submitted before building permits are issued, and (2) that all grading operations be supervised by engineering geologists and soil engineers during grading construction.

In the spring of 1962, the City of Glendale initiated the combined soil engineering and engineering geological investigations that required full-time inspection by the site soil engineer, weekly inspections by the site geological consultant, and final certification by the site design civil engineer. The County of Los Angeles effected in October 1962 even more sophisticated requirements of supervised civil engineering including monthly reports from the site supervising civil engineer as well as monthly progress reports from the site soil engineer and engineering geologist.

The County of Los Angeles also initiated holding up building permits until after rough-grade approval. In turn, rough-grade approval was granted only after receipt of the "final" soil and geological reports attesting to the stability of the lots and rough-grade certification by the supervising civil engineer. Prior to final approval, the county received from the supervising engineer a final certification that all lot drainage, approved drains, plan elevations, erosion prevention methods, and stabilization methods were completed according to the approved plan and were functioning for their intended purposes. The County of Orange initiated similar requirements in February 1963, and on April 25 of that year, the City of Los Angeles enacted their very stringent grading code. In the interim, Los Angeles has continued to amend its grading code in response to recognized needs and new technology. Thus, it is not surprising that in 1980, the City of Los Angeles

Grading Code remained the most detailed prescriptive grading code and the most vigorously enforced of all the grading ordinances in the United States studied by this author.

2-2 DEVELOPMENT OF CHAPTER 70 OF THE UNIFORM BUILDING CODE

The multitudinous problems, procedures, trials, and errors suffered by governmental agencies and hillside-development industries of Southern California during the period from 1956 through 1961 inadvertently became the basis of Chapter 70 of the *Uniform Building Code* (UBC) published by the International Conference of Building Officials (ICBO) [3]. A regrettable lack of uniformity had persisted in the existing grading codes. The codes had lacked integrity because they had been pieced together as particular problems arose rather than developed comprehensively. The only valuable geotechnical field supervision of grading during that period was by soil-testing companies and governmental grading inspectors. The lack of uniform code requirements and the limited grading-code enforcement personnel understandably failed to require a quality of performance that insured safe construction.

In 1959, the Building Codes Committee of the Association of Engineering Geologists (AEG) started collecting and reviewing existing grading codes in an attempt to establish uniformity. During 1960 to 1962, this committee wrote the preliminary text for a brochure, "Hillside Grading and Development," which later resulted in a 1965 publication by the AEG entitled *Geology and Urban Development.* Within the appendix of the preliminary brochure is a composite code intended for use as a guide for building officials everywhere who either plan to write a new code or to amend an existing code. Various sections of the composite code detailed many facets of grading-code enforcement that should be considered. The appendix was not written to be used as a finalized document; it was written in the grading-code terminology then in use. Prior to the appearance of that appendix, no code had mentioned soil engineers or soil engineering, geology or engineering geology. No codes had previously required site supervision by civil engineers. The primary requirements of former codes involved approved slope gradients, drainage provisions and compaction tests to be approved by an approved soil-testing laboratory. The pre-1962 soil reports provided "fill control" test results and design bearing values only and infrequent structural setback recommendations.

The composite code was primarily intended to establish adequate field supervision requirements, to define the types of professionals needed for supervision, to outline their responsibilities, and to institute soil engineering reports that considered many phases of applied soil mechanics including "fill-control." By delegating various requirements to proper professionals, the composite code prompted good engineering performance, which is protective of public health, safety, and welfare.

The final rough draft of the composite code was completed in October 1962. About the same time, the Los Angeles Foothill and Basin Chapters of ICBO were in the process of modifying the County of Los Angeles Grading Code for use as a chapter on excavation and grading for the UBC. Gerald Wilson, then Director of Building and Safety, City of Glendale, was one of the seven-member Code-Changes Committee of ICBO who had been impressed with the work that had gone into writing the composite code previously described. He asked the Building Codes Committee to assist ICBO in drafting their document. During weekly meetings that followed, Chapter 70 was developed for presentation to the ICBO Code Changes Committee in January 1963. The Chapter 70, UBC, committee comprised three licensed civil engineers, two of whom were experienced in soil mechanics; an engineering geologist working with a foundation engineering firm; an engineering geologist from a governmental agency; one consulting engineering geologist; and four building department officials. This effort resulted in the adoption of Chapter 70, Excavation and Grading, as an appendix to the 1964 edition of the UBC, published by ICBO. Figure 2-1 is of Dr. James E. Slosson and Douglas E. Moran, who were on the original and subsequent committees that developed Chapter 70, UBC.

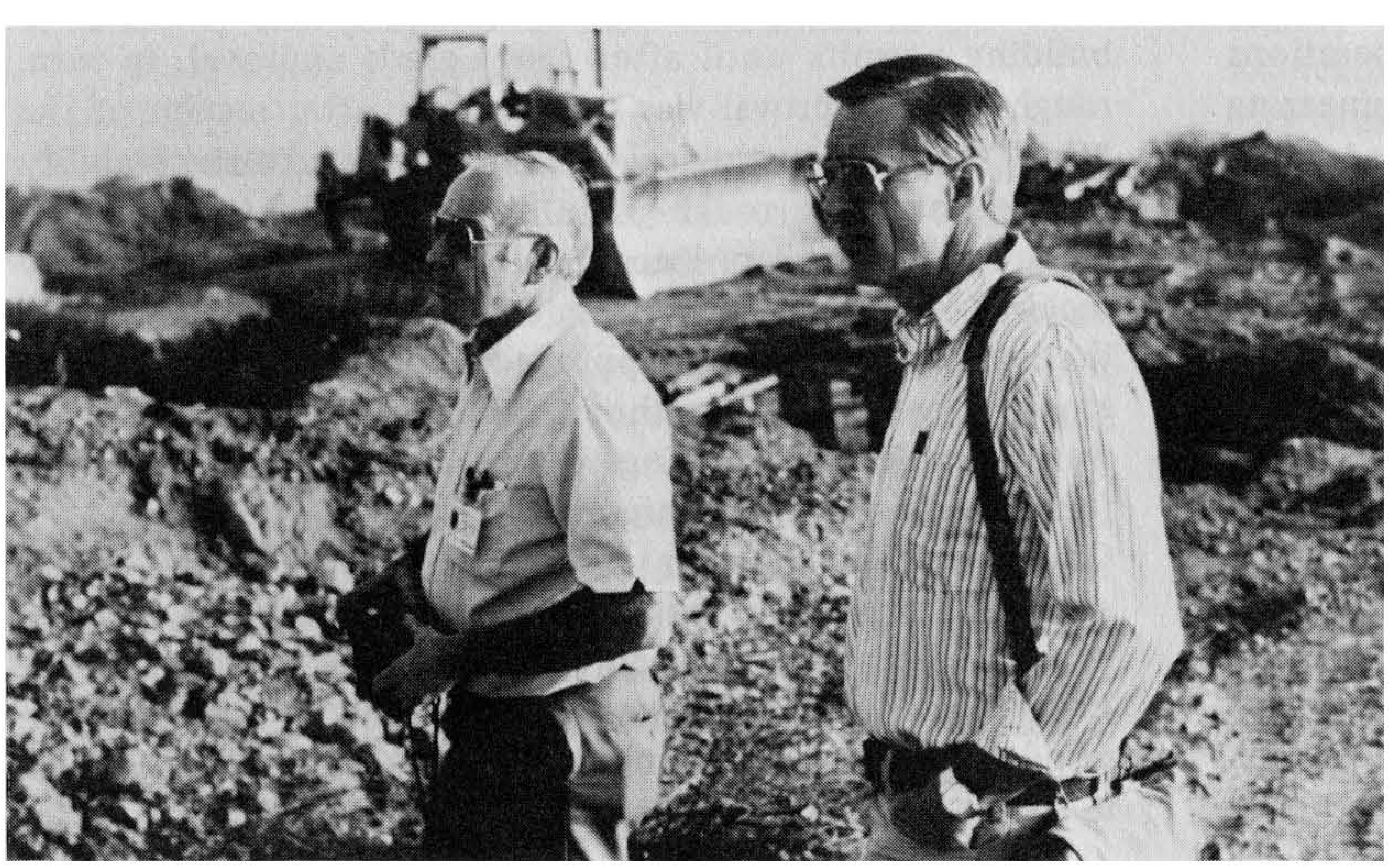


Figure 2.1 Dr. James E. Slosson (left) and Douglas E. Moran (right) inspecting the upper portion of the "Big Rock landslide," Malibu, CA in 1980 for the State of California, Dept. of Emergency Preparedness. Slosson and Moran contributed to the development of Chapter 70, UBC, from its initial concept through to completion. Dr. Slosson is past State Geologist of California; Moran, a licensed civil engineer and engineering geologist, manages his own firm. Voluntary efforts by such experts have helped to raise the standards of performance in the construction industry. Photo by C. Michael Scullin.

There was some disagreement about the contents of Chapter 70, UBC, by some professional organizations due to their limited or complete lack of participation in drafting the document. Numerous recommended changes were submitted between July 1964 and March 1967. An ad hoc committee was initiated in May 1967 to thoroughly review, revise, or rewrite the grading code chapter. Meetings were held through October 1968 and the final draft was submitted to ICBO in January 1969, and published in the 1970 edition of the UBC. This ad hoc "Chapter 70" committee included twenty members and six alternate members representing the following organizations:

Members	*Alternates*
International Conference of Building Officials (ICBO)–4	3
Civil Engineers and Land Surveyors (CCE & LS)–2	0
Structural Engineers of Northern California (SEAONC)–1	1
Structural Engineers of Southern California (SEAOSC)–1	0
American Society of Civil Engineers (ASCE)–2	1
Consulting Engineers Association of California (CEAC)–2	0
Association of Engineering Geologists (AEG)–2	1
Consulting Engineering Geologists (CEG)–2	0
Engineering Grading Contractors Assoc. (EGCA)–1	0
Building Industries Association (BIA)–1	0
Associated Home Builders (AHB)–1	0
Associated General Contractors (AGC)–1	0

A good grading code should provide for the use of acceptable standards to ensure the health and safety of individuals and the community. The desirability of efforts directed toward this goal and the activities leading to improvements have long been recognized by many who participate in formulating grading codes and standards of engineering practice. Many of those involved in developing the previously discussed County of Orange, California Grading Code during 1963–64 were also effective participants of the 1967–69 ad hoc "Chapter 70" committee that formulated the 1970 edition of Chapter 70, UBC. Much of the progress in developing the uniform grading code is attributable to these voluntary efforts.

Figures 2-2 through 2-5 illustrate accelerated growth in the rolling hillsides of Mission Viejo and Laguna Niguel areas of Orange County, California. The Mission Viejo Company, developers of the community of Mission Viejo, California, represents one of the few or the only planned community developers in the United States that maintains an Earthwork Department staffed with personnel experienced in grading inspection and grading operations. The Mission Viejo Company has extended a considerable effort of applied research in geotechnical control, landscaping, erosion control, and slope maintenance throughout their site development history and has achieved an enviable record of slope performance.

Figure 2.2 The partial development of the Crown Valley Parkway and Niguel Road area of Laguna Niguel, Orange County, California during 1964. The undeveloped Mission Viejo area is in the background. Photograph by and courtesy of Robert W. Ross.

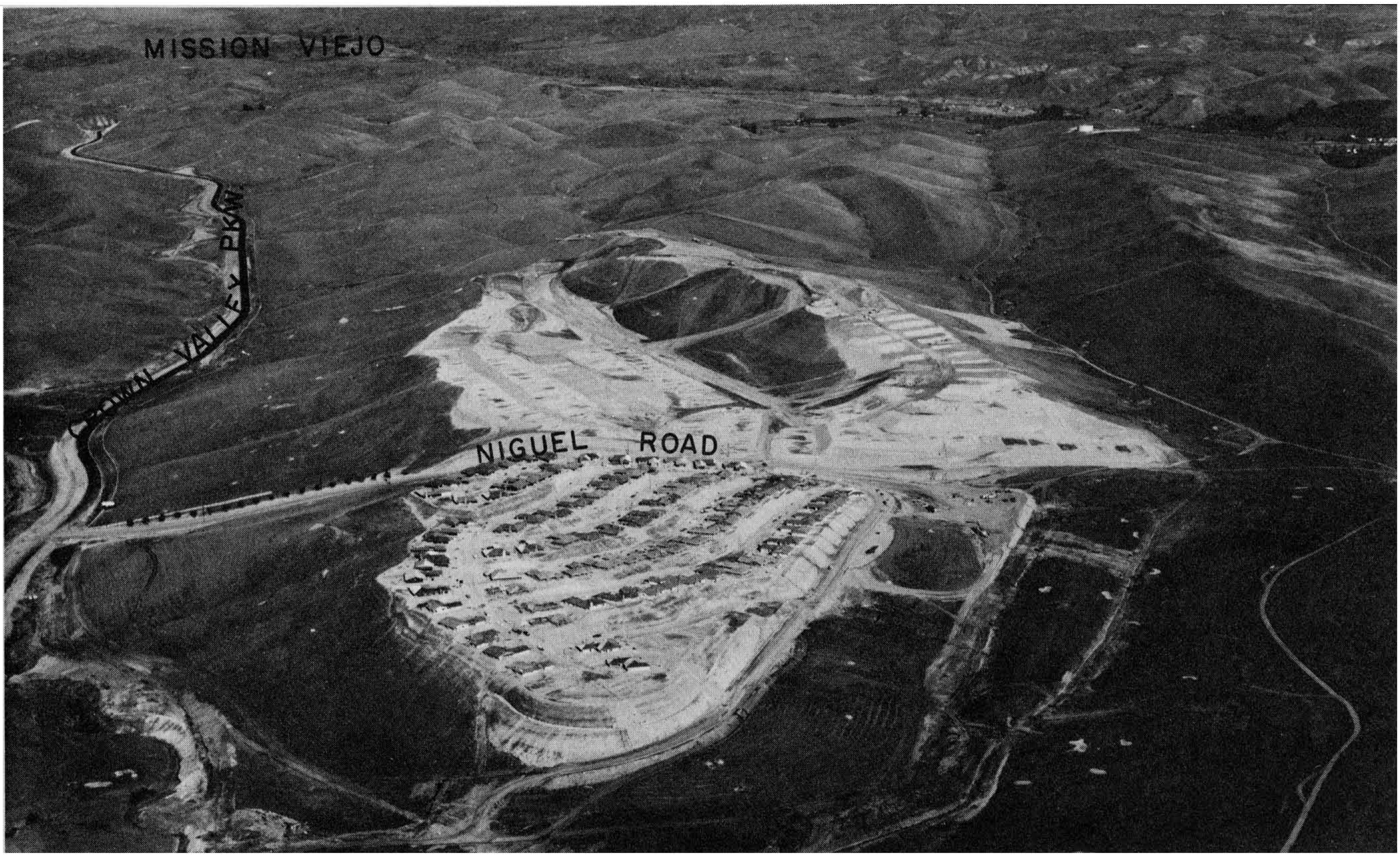


Figure 2.3 Crown Valley Parkway and Niguel Road area of Laguna Niguel developed in August 1979, 15 years later. Mission Viejo area is well developed as shown in background. Photograph by and courtesy of Ace Aerial Photography.

Figure 2.4 The Crown Valley Parkway terminating at the San Diego Freeway (I-405). The undeveloped Mission Viejo, Oso Creek (1964) is shown upper center, and Plano Trabuco is shown upper right. Santiago Peak and the Santa Ana mountains are shown in the background. Photograph by and courtesy of the Mission Viejo Company.

Figure 2.5 The community of Mission Viejo in August 1976, 12 years later. The San Diego Freeway and Mission Viejo High School are shown in lower left foreground. Oso Creek is shown at right, Plano Trabuco upper right, Santiago Peak and the Santa Ana mountains appear in the background. Photograph by Ace Aerial Photography, and courtesy of the Mission Viejo Company.

Figures 2-6 through 2-10 are illustrations of the grading of Lake Mission Viejo from 1975 through 1977. The photographs show the extensive canyon bottom cleanouts and the development of the community adjacent to and simultaneously with the lake construction during a 2-year period.

Figure 2.6 The Oso Creek Valley in Mission Viejo, California, showing the area of the proposed Lake Mission Viejo in early 1975. Photograph by and courtesy of the Mission Viejo Company.

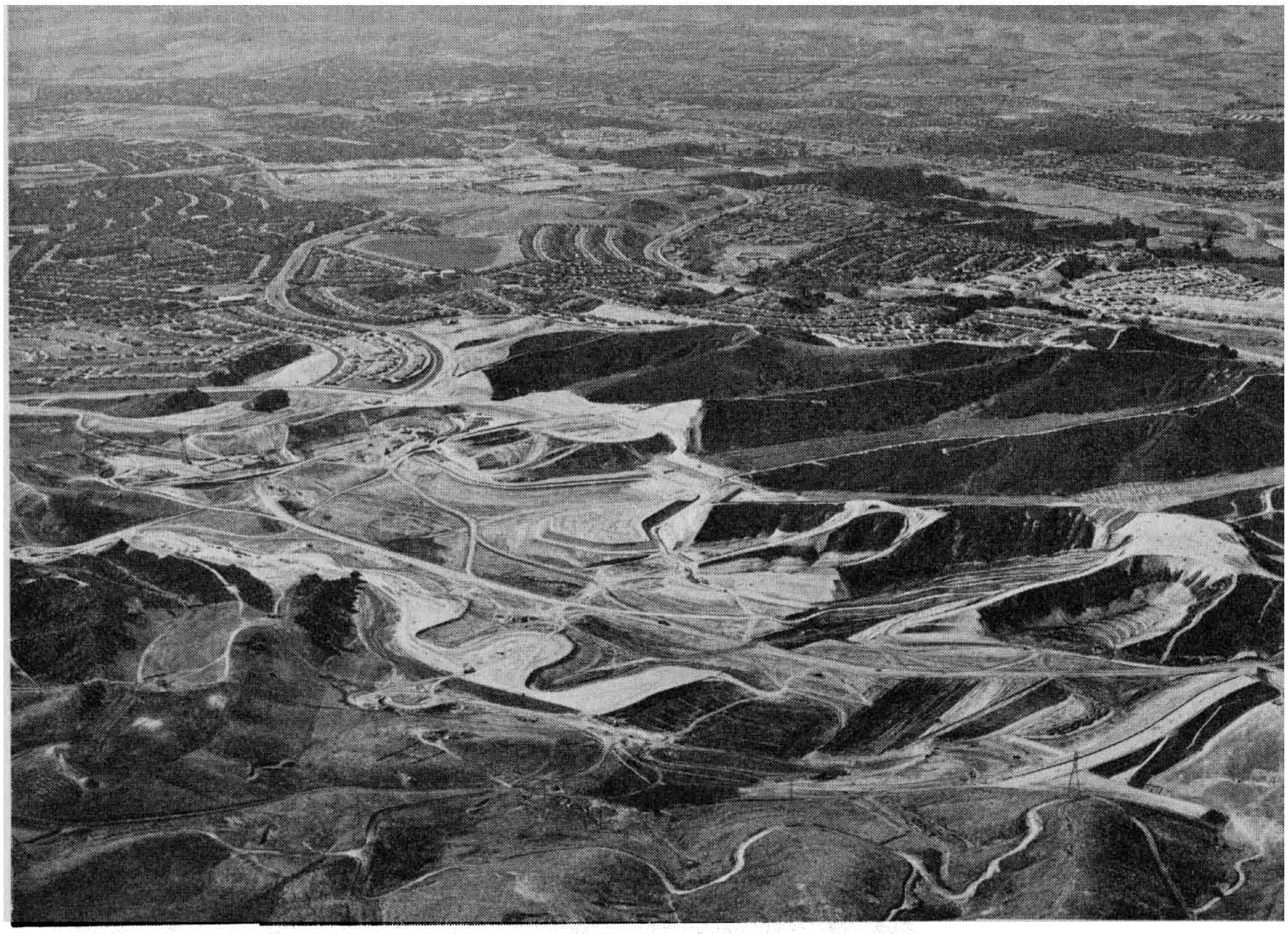


Figure 2.7 Lake Mission Viejo grading construction in progress on November 12, 1975. Note the extensive canyon clean-out and compressible soil removal. The slurry trench is being excavated in the left center. Photograph by and courtesy of the Mission Viejo Company.

Figure 2.8 The Lake Mission Viejo grading completed as shown on September 1, 1976. The future Mallorca condominium site, in center with equipment, has been graded. Photograph by Aerial Eye Inc., courtesy of the Mission Viejo Company.

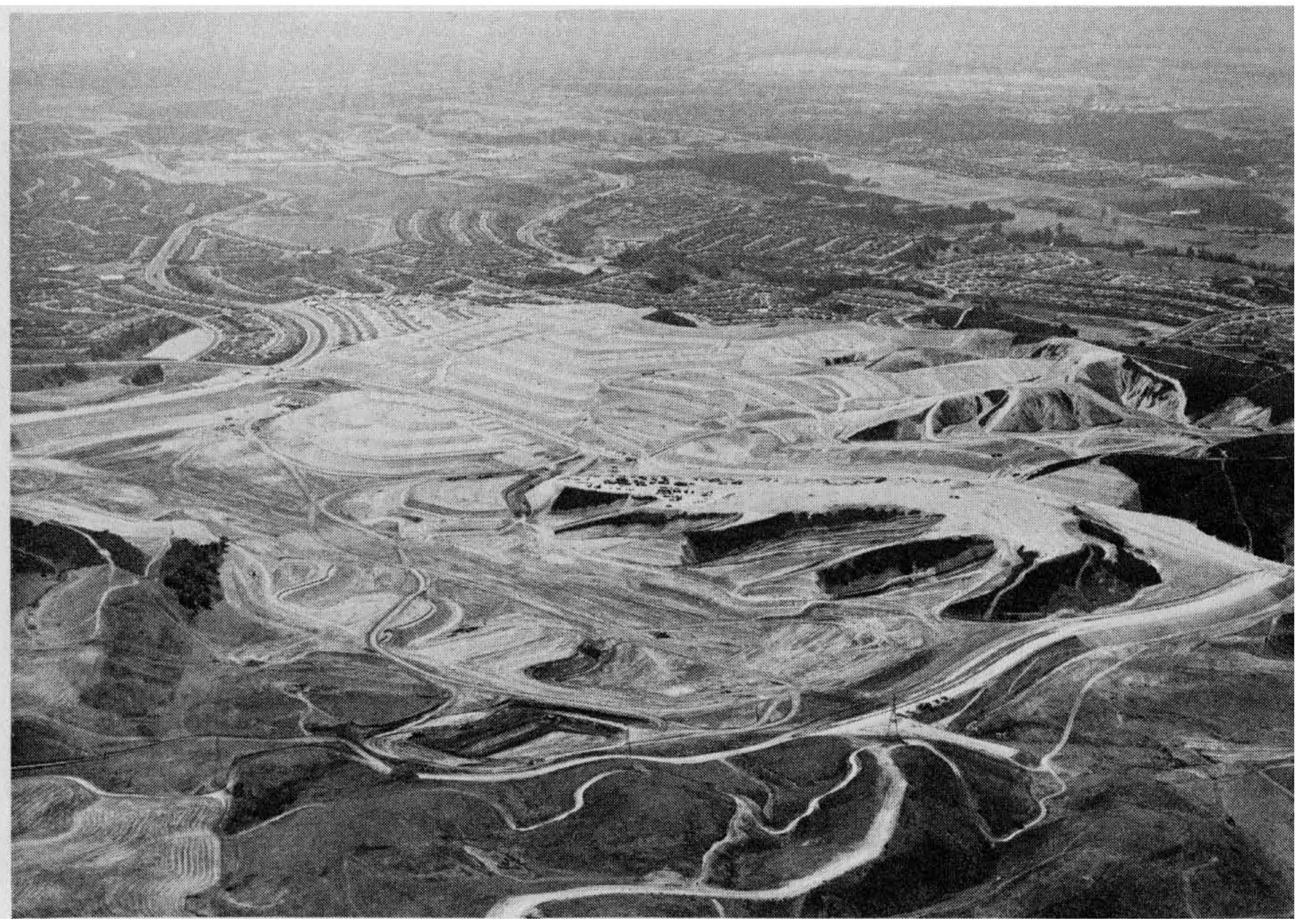


Figure 2.9 Lake Mission Viejo grading construction nearing completion, October 1976. Water is from rain runoff. The retention basin spillway is shown under construction in the center foreground. Rough graded residential sites are shown at right center. Photograph by Aerial Eye, Inc., courtesy of the Mission Viejo Company.

Figure 2.10 Lake Mission Viejo during drought moratorium of lake filling, August 1977. The soil cement and bulkhead edge have been completed, and sand for the main beach is in place. (Lower right). Residential construction is shown in progress at upper right. Photograph by Aerial Eye, Inc., courtesy of the Mission Viejo Company.

2-3 PHILOSOPHY OF CHAPTER 70 OF THE UNIFORM BUILDING CODE

A major objective in preparing Chapter 70 was to provide the most flexible, broadly applicable code possible—one that would require minimum modification when adopted by local communities. Chapter 70 establishes a framework for utilizing the same engineering consultants for all earthwork performed at given sites by providing the authority for building officials to require preliminary investigations by qualified soil engineers and engineering geologists, and then to require the developers to retain these same two professionals during construction to certify the stability of the building sites at rough grade prior to issuing building permits. Chapter 70 also authorizes building officials to require supervision by a civil engineer during construction. He coordinates his findings with those of soil and geology experts, keeping such supervision in the hands of qualified professionals.

Chapter 70 clearly defines the responsibility of these professional consultants and supports them with the authority of the law.

While it is important for building officials to work under codes that allow them to require investigations and control by all three of the aforementioned professionals, it is equally important that these three professionals have the freedom to perform top-quality work and to assume full responsibility for their individual decisions. In Southern California, this need is most important in controlling hillside urban development.

Present requirements of Chapter 70 for both grading and supervision are basic. Therefore, although local agencies may have to make minor modifications in adapting the code to fit local conditions, care should be taken to retain the basic provisions of this document. Modification should neither relieve the professional consultants from their responsibilities nor pass these responsibilities onto building officials who are generally untrained in engineering and who rarely have such professionals on their staffs.

Each provision of Chapter 70 was tested for conformity with the following five basic principles before being included:

1. Does it establish safe minimum standards for the protection of public health, safety, and welfare without either imposing excessive control or causing hardship where either limited or no control is necessary?
2. Does it apply uniformly anywhere that excavation and grading need to be controlled?
3. Does it conform to the pattern and intent of the Uniform Building Code without duplicating or conflicting with existing code provisions?
4. Does it require use of qualified experts to investigate and evaluate sites prior to recommending safe minimum standards for avoiding or overcoming existing unfavorable and hazardous conditions, or those that may be created by construction?
5. Is it easy to apply and enforce uniformly?

To maintain the integrity of the code, future changes should be limited to the following areas:

1. Clarification of provisions.
2. Modification of specifications to match or include changing standards of practice.
3. Modification of organizational or departmental procedures to fit local implementation and enforcement.

The principal reason for control of construction standards and procedures by governmental agencies is to safeguard public health, safety, and welfare. Without regulation, some construction would be substandard and therefore hazardous. In general, codes and ordinances have been adopted that establish minimum standards, and building officials have been given the authority to inspect construction for adherence to these codes. The Uniform Building Code (UBC) has the added purpose of providing uniformly and universally applicable minimum standards. Such model codes suggest appropriate legislation by the states to permit the adoption of such codes and standards by reference. This allows the adoption of Chapter 70, UBC, without stating all of its sections in their entirety. Chapter 70 includes minimum grading standards that have been determined from experience to allow safe hillside development. It defines desired performance rather than detailing standards and specifications that could, in effect, become substitutes for correct engineering solutions or designs. Its procedures provide full opportunity for open expressions of view by those having substantial knowledge in the subject, and for voluntary adoption anywhere in the nation. As an appendix chapter, it may or may not be adopted alone or with the building code.

The administrative and legal portions of Chapter 70, which add legal power to code enforcement, are important tools for building officials. Elimination or weakening of these sections would invite future embarrassment and possible legal action resulting from structural failures. Recognizing the importance of these code sections, several agencies, including the Counties of Orange and Los Angeles, California, have strengthened their local requirements. They have particularly detailed called inspections by the grading division. Called inspections are those that are called in or requested by the developer's superintendent (or permittee) at various stages of grading construction. No further work is allowed until that stage is inspected and approved. Further discussion of this method is found in Section 5-2 of this text.

They are requiring certification of completion according to the approved permit specifications by grading contractors as part of Sections 7014(c) Engineered Grading Requirements, 7014(d) Regular Grading Requirements, and Section 7015(a), Final Reports. (See Chapter 70 in the appendix.)

Successful administration of grading codes requires specialized, well-trained personnel from administrators down through inspectors. While they work with a wide variety of technical problems, grading inspectors spend the major portion of their time dealing with practitioners of fundamentally inexact sciences facing variables of weather conditions, soil properties, and geologic hazards as well as local performance requirements. Therefore, "standard" designs can rarely be applied safely to hillside grading sites without the knowledgeable approval by professional soil engineers and engineering geologists. Standards of engineering practice covering the demands made upon the various parts of engineered embankments, hillside building foundations and building pads, as well as the details of the expected performance in service of each of these, are subjects for which additional research is needed and technical evolvement is anticipated.

2-4 NATIONWIDE GRADING CODES

There are four model building codes recognized nationally as being suitable for broad adoption. One of these is sponsored by the American Insurance Association, and the other three by organizations of local building officials: the International Conference of Building Officials (ICBO), which publishes the Uniform Building Code (UBC) [3], the Southern Building Code Congress International, Inc, (SBCC), which publishes the *Standard Building Code* [4], and the Building Officials and Code Administrators International, Inc., which publishes the (BOCA) *Basic Building Code* [5]. Of these model code organizations, ICBO and SBCC publish a Chapter 70 UBC-type grading code for voluntary adoption within their regions of influence. When authorized by a suitable enabling act of state law, these model codes may be adopted by reference, thereby greatly simplifying the preparation of a local code and assuring the reasonableness of its technical provisions.

The adoption of such codes often seems to follow a local community emergency or disaster.

While the federal government has not generally participated directly in the formulation and enforcement of building codes, it has exerted influence on construction practices through the codes of agencies that are responsible for governmental construction, through establishing standards of practice involving government-financed programs and for building financing and home-loan programs. An example of the latter is the *HUD Training Handbook*, (*4140*) for the Housing Production and Mortgage Credit, Federal Housing Administration, as published by the U.S. Department of Housing and Urban Development (HUD) [6]. Excavation and grading requirements are considered in detail in *Land Planning Data Sheets and Bulletins*, including Data Sheet 79g–*Land Development with Controlled Earthwork*. Other HUD grading-related standards are detailed in *Site Design*, *Criteria for Compacted Fills*, (*4075.6*), *Slope Protection for Residential Developments*, (*4075.7*), and *Soil Sampling and Testing for Residential Developments*, (*4075.5*).

The federal government promulgates many standards for its own use. Some of these standards are used by the building industries since they may be the only standards available on given subjects in their region. The HUD requirements, Highway Research Board publications, Bureau of Land Management, or Soil Conservation Service requirements contain such standards.

The federal standards are for the use of the government and are rarely intended for application by others. Nevertheless, they often contribute to the welfare of both industry

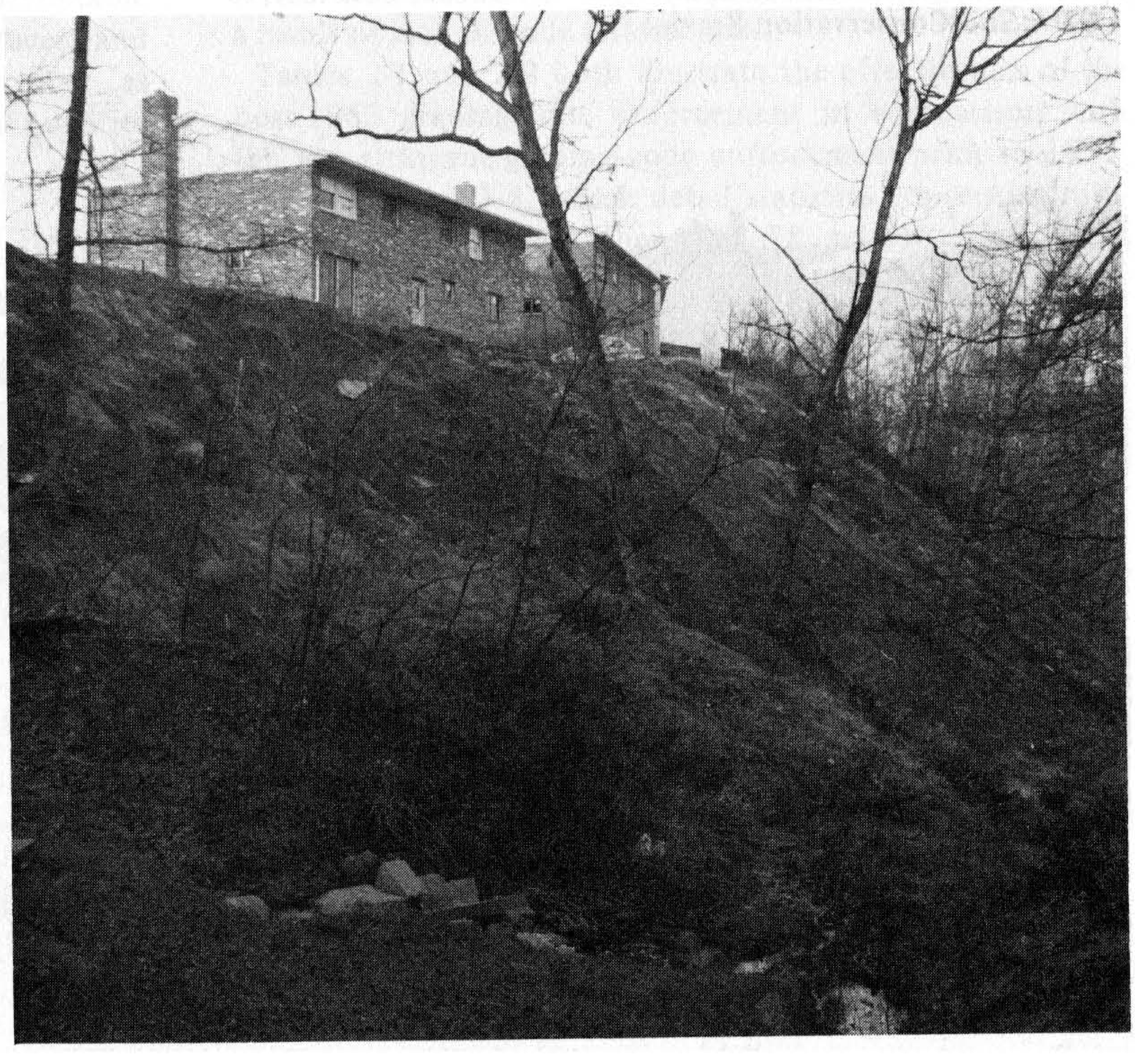


Figure 2.11 Uncompacted loose fill shown drifted over the slope at rear of residences in Silver Springs, Maryland. These houses have failed structurally due to differential settlement. Occupancy permits have been denied. (Montgomery Soil Conservation District. Photography by J. F. Hazen, courtesy of USDA-Soil Conservation Service (Montgomery Soil Conservation District.)

Figure 2.12 Erosion and siltation resulting from an intense 6-inch rainstorm in Bowie, Maryland (Prince George's County Soil Conservation District). This photograph illustrates the difficulty of completing construction if caught in a high intensity rainstorm without adequate drainage control. Desilting basins, drainage devices, and erosion control should have been completed at rough grade stage and prior to issuance of building permits, so they could function under such conditions. Photograph by R. G. Halstead, courtesy of USDA-Soil Conservation Service.

Figure 2.13 Heavy erosion from graded streets and yards at construction site in Gaithersburg, Maryland (Montgomery Soil Conservation District) resulted in extensive silting in the sediment basin shown in foreground. The basin was effective in retaining the silt, but better drainage could have been effected through in-place erosion control devices. Had such been installed earlier, siltation could have been reduced and construction work could have continued despite heavy rain. Photography by J. F. Hazen, courtesy of USDA-Soil Conservation Service.

and the general public. An example of direct influence took place in 1966, when President Johnson directed the States of Virginia and Maryland to control sedimentation that contributed to the pollution of the Potomac River. Conferences and meetings considering excavation, grading, and drainage control of residential urban development within the counties surrounding the Washington, D.C., area were held. Prince George's County, Maryland, pioneered a very detailed grading code, Article 22, Grading, Drainage and Erosion Control, adopted October 13, 1970, as an addition to the fifth edition (1970) of the BOCA Basic Building Code [7]. In 1967, Prince George's County also established a grading division within the Department of Licenses and Permits, headed by Mr. Thomas J. Rennie, Grading Control Engineer. An additional spinoff of the federal influence was publication of *Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas*, July 1975, prepared by the U.S. Department of Agriculture, Soil Conservation Service, College Park, Maryland [8].

Additional influencing contributions made by the federal government are the extensively funded research programs involving urban applications of earth sciences, such as in the areas of land use planning, soil engineering, engineering, environmental geology, and seismicity. This funded research is vitally needed to meet the demands of performance of our urban development industries. Continuing programs by groups of skilled experts in industry and government will provide the basic data for improvement of our codes and standards. Grading codes that are based upon reliable technical knowledge and are implemented through skillful administration and enforcement are of value to the community. They provide reasonable protection to the health and safety of the community and they define acceptable standards of safety for the guidance of the producers and users of the constructed sites. These standards serve as guides in reaching a common understanding of the qualities needed for acceptable performance.

2-5 EFFECTIVENESS OF GRADING-CODE ENFORCEMENT

The effectiveness of adequate grading codes as a deterrent against man-induced landslides can perhaps best be dramatized using the City of Los Angeles as a case history. From 1946 to 1962, a tremendous amount of development took place in both the City and County of Los Angeles, during which time about 37,000 residential hillside lots were developed in mountainous areas. From 1963 to 1969, 11,000 more lots were developed in increasingly complex geologic terrain. Then, during January and February of 1969, nearly 24 inches of rain fell in a five-week period—the most recorded during these weeks since 1884. In addition, most of the 48,000 hillside lots received the heaviest rainfall. According to Charles A. Yelverton [9] "On the 37,000 sites created before 1963, damage amounted to about \$6 million. In contrast, the 11,000 sites developed after passage of the 1963 ordinance sustained about \$182,000 damage." Table 2-1 details that storm damage by breaking down damage to structures and to slopes according to their time of construction: before the 1952 code enactment, during the 1952 code enforcement, and during the 1963 code enforcement.

Building sites graded under the stringent 1963 grading code, which requires engineering geologic and soil engineering studies, clearly performed well during the 1969 severe (50-year) rainstorm season. A statistical analysis of storm damage data from this period cited by James E. Slosson and James P. Krohn [10] and detailed in Table 2-2, dramatically demonstrates the economic value of enforcing this code. Slosson and Krohn indicate that for an added \$50 to \$100 cost per typical tract house for soil engineering and geologic study, loss due to rainstorms can be reduced by 90%. When results of these studies are "coupled with certification of professional services . . . a percentage of safety approaching 100% (can be achieved). The slight increase in original cost is generally more than balanced by the reduction of loss during a disaster" [10]. They further indicate that structures built under strict technical codes are more economical to maintain than paying the cost of repair or replacement of structures lost during disasters as a result of lack of code enforcement.

Tables 2-1 and 2-2 both illustrate the effectiveness of the post-1963 grading-code enforcement in comparison with the less stringent grading-code enforcement prior to 1952. Tables 2-3 and 2-4, which detail statistics concerning rainstorm damage during the 1977–78 rainfall season, the heaviest of this century in the Los Angeles area, further substantiate the value of enforcing stringent grading codes. Jack Fratt, General Manager of the City of Los Angeles Department of Building and Safety, was quoted in the *Los Angeles Times* of April 20, 1978, as saying that "about three thousand of the city's 67,000 hillside homes had suffered storm damage. Of these, only 210 were erected after the 1963 grading code went into effect." Storm

TABLE 2-1 CITY OF LOS ANGELES 1969 RAINSTORM DAMAGE

Date of Development (No. of Sites Created)	*Pre-1952 (10,000)*	*1952-1962 (27,000)*	*1963-1969 (11,000)*	*Totals (48,000)*
Damage to structures	\$1,028,300	\$ 414,100	\$ 5,300	\$1,447,700
Damage due to slope failure[1]	\$2,272,700	\$2,353,600	\$177,100	\$4,803,400
Total damage	\$3,301,000	\$2,767,700	\$182,400	\$6,251,100

[1] Includes natural slopes, fill slopes, and cut slopes; no structural damage is included.

Source: Charles A. Yelverton, "The Role of Local Governments in Urban Geology," *Environmental Planning and Geology* (Washington, D.C.: Supt. of Docs., U.S. Govt. Printing Office, 1969), p. 81.

TABLE 2-2 LANDSLIDE AND FLOOD DAMAGE TO HILLSIDE HOMES DURING JANUARY AND FEBRUARY 1969 (50-YEAR STORM EVENT), COUNTY OF LOS ANGELES

Construction Dates and Legal Requirements	*Number of Hillside Homes Built*	*Damaged Homes*			*Average Cost Prorated for Total Number of Homes*
		Number	*Percent of Total*	*Total $ Damage*	
Pre-1952: No legal requirement for soils engineering or engineering geology studies	10,000	1040	10.40	$3,300,000	$330
1952–1963: Soils engineering studies required; minimum engineering geology studies	27,000	350	1.30	$2,767,000	$102
Post-1963: Extensive engineering geology and soils engineering studies required	11,000	17	0.15	$ 80,000	$ 7

Source: James E. Slosson and James P. Krohn, "Effective Building Codes," *California Geology* (Sacramento: California Division of Mines and Geology, June 1977), p. 139.

TABLE 2-3 SLOPE FAILURES IN THE CITY OF LOS ANGELES FEBRUARY-MARCH 1978 RAINSTORMS

Description	*Number of Sites Constructed*	*Number of Failures*	*Percent Failure*	*Dollar Value*
Pre-1963 (pre-modern code)	37,000	2,790	7.5	40–49 million
Post-1963 (modern code)	30,000	210	0.7	1–2 million

Source: James E. Slosson and James P. Krohn, co-chairmen, "AEG Building Code Review, Mudflow/Debris Flow Damage, February 1978 Storm—Los Angeles Area," *California Geology* (Sacramento: California Division of Mines and Geology, Jan. 1979), p. 8.

TABLE 2-4 SLOPE FAILURES IN THE COUNTY OF LOS ANGELES FEBRUARY-MARCH 1978 RAINSTORMS

Description	*Number of Slopes*	*Number Failed*	*Percent of the 1446 Total Slope*	*Percent of Slope Failure*	*Dollar Value*
Slopes graded between 1962 and 1971[1]	80,919	1,150	79.5	1.4	unknown
Slopes graded since 1971	26,310	296	20.5	1.1	>10 million

[1] L. A. County revised the grading code in 1971.

Source: James E. Slosson and James P. Krohn, co-chairmen, "AEG Building Code Review, etc.," *California Geology* (Sacramento: CDMG, Jan. 1979), p. 9.

damage up to March 9, 1978, was estimated to be at $70 million, a figure disclosed by City of Los Angeles officials. This sum included the clean-up and salvage work on public lands as well as on private property. Private property losses in the City of Los Angeles were estimated at $49–$50 million.

The Building Codes Committee of the Southern California Section, AEG, completed an investigation and analysis of the causes and effects of the 1977-78 rain damage [11] while serving as a member of a Storm Damage Task Force established the by the City of Los Angeles. The task force evaluated the city's grading ordinance and its interpretation and application during a 60-day hillside grading and building permit moratorium during the late spring of 1978. Tables 2-3 and 2-4 are taken from this AEG study.

The Department of Licenses and Permits, Prince George's County, Maryland, adopted Article 22, Grading, Drainage and Erosion Control Ordinance on October 13, 1970. During 1975, heavy, prolonged rains from tropical storm Eloise resulted in numerous slope failures. Some of the landslides affected residences in the southern part of the county. A task force on unstable soils was formed in June 1976, and submitted their very detailed report in October 1977. The effectiveness of Prince George's County grading-code enforcement was illustrated, in part, as indicated by the Task Force on Unstable Soils Report [12]: "A total of 26 known landslide incidents with 58 properties were involved. . . . These projects, with the exception of the State Highway Administration Project, were all constructed prior to 1971 when the County enacted grading regulations."

The report further stated,

> *The extent of the landslides on developed land in the County is limited. This may be because the previous availability of land made it unnecessary to develop land with steep slopes and controls of the grading ordinance and enforcement staff which began in 1971 appears* [sic] *to be effective. All known slides except one resulted from construction prior to 1971. The one exception was caused by developer violation of the regulations and permit.*

2-6 SUMMARY AND CONCLUSIONS

This chapter has reviewed the development and increasing effectiveness of modern grading codes during three decades. Statistics presented clearly indicate that the cooperative contributions of government and industry toward establishing effective grading codes have benefited public safety and welfare. While the universal enforcement of modern grading codes does not yet exist in the United States, especially rapidly growing urban areas on both the east and west coasts are gradually adopting them with encouraging results. The trend will magnify as urbanization increasingly expands to areas of potential geologic hazards.

It is an erroneous assumption that "natural slopes are safer" and that only man-made or man-affected slopes fail. Slope failures are a natural phenomenon that have taken place for millions of years, and they are an integral aspect of the many geologic processes acting within and upon our planetary surface. It really isn't surprising to note that probably 90% to 99% of all slope failures are related to natural conditions, and that the great majority of slope failures are in areas of low or no human habitation. Therefore, if we interrupt this natural process with our urban development, or continue to remove support from our land without knowledgeable replacement or with careless consideration, we will pay with our very own wealth, health, and possibly our lives, or with those of our descendants.

While there has not been a universal adoption of grading codes appropriate for safe development of all sites under construction, the technology and standards adequate for present needs are available. Therefore, the combined efforts of appropriate governmental agencies and experienced professional groups, supported by concerned citizens, can and will establish a system of reasonable standards and control procedures. Since in teaching it is far better that a textbook be ahead of rather than behind the times, this text is looking ahead to the time when grading codes will be more universally applied. Most readers of this book will have from 10 to 30 years of working life ahead of them. As improvements in technology allow improved implementation of the concepts presented in this book, more and more citizens will be protected from hazards of unsafe development.

In order to give some feel for the actual practice of grading-code enforcement, Chapter 3 will describe patterns of organization and staffing, personnel tasks and responsibilities, budgeting, planning, and personnel utilization of a grading division. The aim of Chapter 3 is to attune the reader to basic administrative considerations in the establishment or continued development of a grading-code enforcement division of government. However, these suggestions may also be of value to those involved with management responsibilities in grading industries and professions.

References

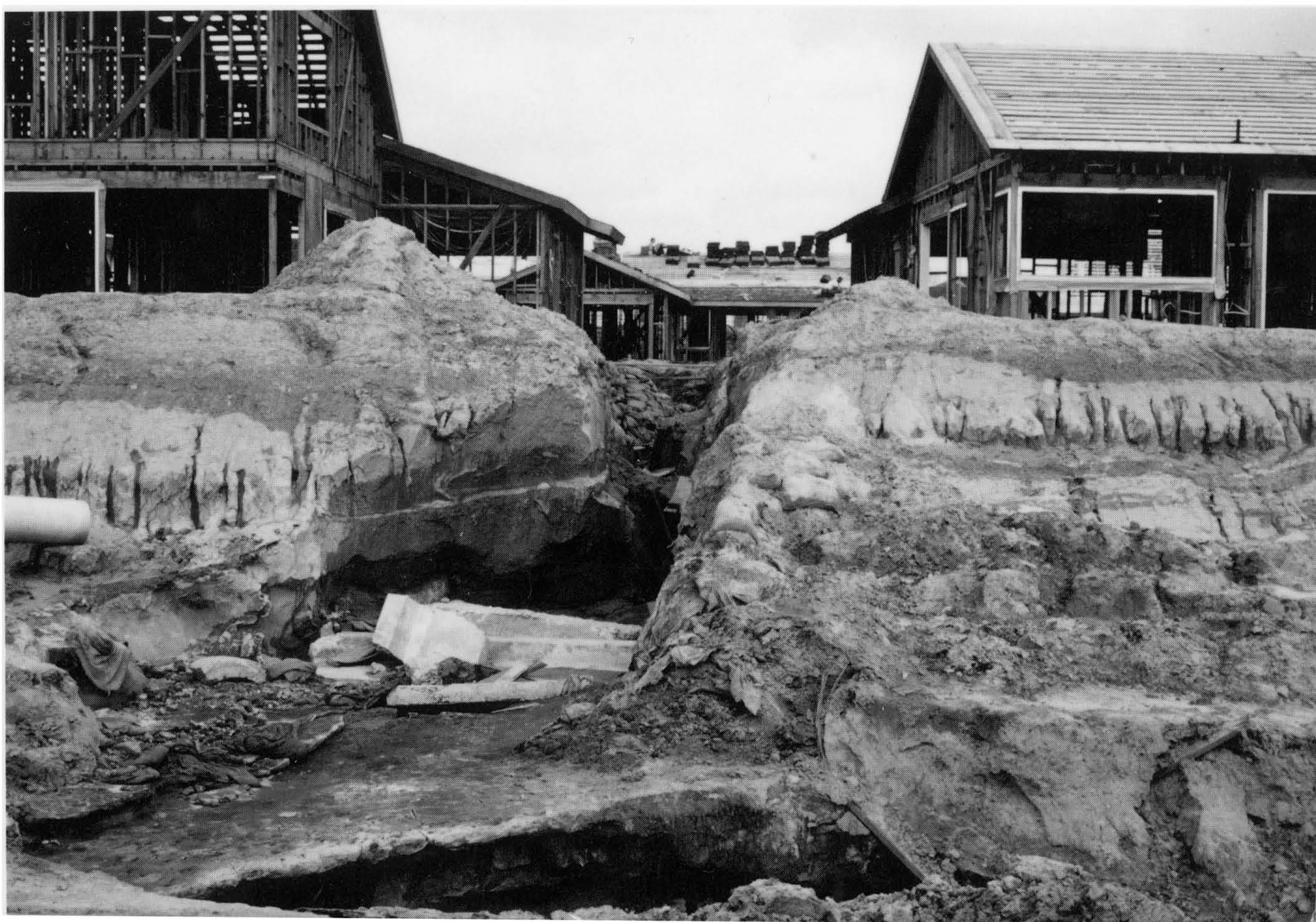
1. Richard H. Jahns, "Seventeen Years of Response by the City of Los Angeles to Geologic Hazards," in *Geologic Hazards and Public Problems*, conference proceedings, May 1969, Robert A. Olson and Mildred M. Wallace (eds.), Office of Emergency Preparedness (Washington, D.C.: U.S. Govt. Printing Office), pp. 283–296.
2. Charles A. Yelverton, "The Role of Local Governments in Urban Geology," in *Environmental Planning and Geology*, Proceedings of the Symposium, Oct. 1969, Donald R. Nichols and Catherine C. Campbell (eds.), U.S.G.S. and H.U.D. (Washington, DC.: U.S. Govt. Printing Office), pp. 76–81.
3. International Conference of Building Officials, "Chapter 70, Excavation and Grading," *Uniform Building Code* (Whittier, CA.: ICBO, 1976), pp. 677–687.
4. Southern Building Code Congress International, Inc., "Standard Excavation and Grading Code," *Standard Building Code* (Birmingham, Ala.: SBCC, 1975), pp. 1–15.
5. Building Officials & Code Administrators International, Inc., "Precautions During Building Operations, Sections 1307 and 1308," *Basic Building Code* (Chicago: BOCA, 5th ed., 1970), pp. 367–368.
6. U.S. Department of Housing and Urban Development, *HUD Handbook* (Washington, D.C.: HUD, April 1973). See the following circulars: 4140.1, Land Planning Principals for Home Mortgage; 4140.2, Land Planning Procedures and Data for Home Mortgage Insurance; 4140.3, Land Development with Controlled Earthwork; 4075.5, Soil Sampling and Testing for Residential Developments; 4075.6, Criteria for Compacted Fills; 4075.7, Slope Protection for Residential Developments.
7. Prince George's County, Maryland, "Article 22. Grading, Drainage and Erosion Control," *BOCA Basic Building Code*, 5th ed. (Hyattsville, MD: Department of Licenses and Permits, Prince George's County, 1970), pp. 52–83.
8. U.S. Department of Agriculture, Soil Conservation Service, *Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas* (College Park, MD: USDA, 1975), 281 p.
9. Charles A. Yelverton, "The Role of Local Governments in Urban Geology," in *Environmental Planning and Geology*, Proceedings of the Symposium, Oct. 1969, Donald R. Nichols and Catherine C. Campbell (eds.) (Washington, D.C.: U.S.G.S. and H.U.D., U.S. Govt. Printing Office), pp. 80–81.
10. James E. Slosson and James P. Krohn, "Effective Building Codes," *California Geology* (Sacramento: CDMG, June 1977), pp. 136–139.

11. James E. Slosson and James P. Krohn, co-chairmen, "AEG Building Code Review, Mudflow/Debris Flow Damage, February 1978 Storm–Los Angeles Area," *California Geology* (Sacramento: CDMG, Jan. 1979), pp. 8-11.

12. Department of Licenses & Permits, Prince George's County, Maryland, *Unstable Soils Task Force Report* (Hyattsville, MD.: Prince George's County, Oct. 1977), 65 p. plus Appendix.

EXCAVATION AND GRADING CODE ADMINISTRATION, INSPECTION, AND ENFORCEMENT

C. Michael Scullin



EXCAVATION AND GRADING CODE ADMINISTRATION, INSPECTION, AND ENFORCEMENT

C. MICHAEL SCULLIN

Former Grading Section Supervisor
County of Orange, California
Consulting Engineering Geologist
Thousand Oaks, California

With a foreword by

JAMES E. SLOSSON, Ph.D.

President, State of California Board of Registration
for Geologists and Geophysicists, and
Professor of Earth Sciences,
Los Angeles Valley College