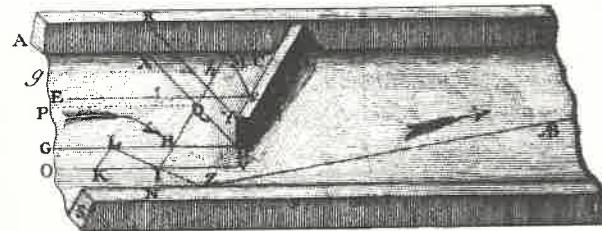


T H E
C O N T R O L
O F N A T U R E



J O H N M c P H E E

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For Vanessa, Katherine, Andrew, and Cole

C O N T E N T S

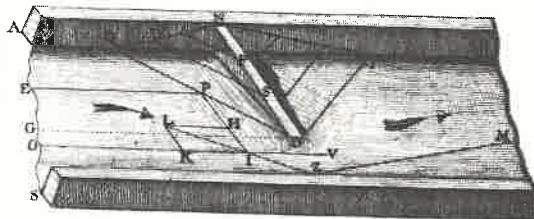
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Los Angeles

Against the Mountains



IN LOS ANGELES versus the San Gabriel Mountains, it is not always clear which side is losing. For example, the Genofiles, Bob and Jackie, can claim to have lost and won. They live on an acre of ground so high that they look across their pool and past the trunks of big pines at an aerial view over Glendale and across Los Angeles to the Pacific bays. The setting, in cool dry air, is serene and Mediterranean. It has not been everlastingly serene.

On a February night some years ago, the Genofiles were awakened by a crash of thunder—lightning striking the mountain front. Ordinarily, in their quiet neighborhood, only the creek beside them was likely to make much sound, dropping steeply out of Shields Canyon on its way to the Los Angeles River. The creek, like every component of all the river systems across the city from mountains to ocean, had not been left to nature. Its banks were concrete. Its bed was concrete. When boulders were running there, they sounded like a rolling freight. On a night like this, the boulders should have been

running. The creek should have been a torrent. Its unnatural sound was unnaturally absent. There was, and had been, a lot of rain.

The Genofiles had two teen-age children, whose rooms were on the uphill side of the one-story house. The window in Scott's room looked straight up Pine Cone Road, a cul-de-sac, which, with hundreds like it, defined the northern limit of the city, the confrontation of the urban and the wild. Los Angeles is overmatched on one side by the Pacific Ocean and on the other by very high mountains. With respect to these principal boundaries, Los Angeles is done sprawling. The San Gabriels, in their state of tectonic youth, are rising as rapidly as any range on earth. Their loose inimical slopes flout the tolerance of the angle of repose. Rising straight up out of the megalopolis, they stand ten thousand feet above the nearby sea, and they are not kidding with this city. Shedding, spalling, self-destructing, they are disintegrating at a rate that is also among the fastest in the world. The phalanxed communities of Los Angeles have pushed themselves hard against these mountains, an aggression that requires a deep defense budget to contend with the results. Kimberlee Genofile called to her mother, who joined her in Scott's room as they looked up the street. From its high turnaround, Pine Cone Road plunges downhill like a ski run, bending left and then right and then left and then right in steep christiana turns for half a mile above a three-hundred-foot straightaway that aims directly at the Genofiles' house. Not far below the turnaround, Shields Creek passes under the street, and there a kink in its concrete profile had been plugged by a six-foot boulder. Hence the silence of the creek. The water was now spreading over the street. It descended in heavy sheets. As the young Genofiles and their mother glimpsed it in the all but total darkness, the

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scene was suddenly illuminated by a blue electrical flash. In the blue light they saw a massive blackness, moving. It was not a landslide, not a mudslide, not a rock avalanche; nor by any means was it the front of a conventional flood. In Jackie's words, "It was just one big black thing coming at us, rolling, rolling with a lot of water in front of it, pushing the water, this big black thing. It was just one big black hill coming toward us."

In geology, it would be known as a debris flow. Debris flows amass in stream valleys and more or less resemble fresh concrete. They consist of water mixed with a good deal of solid material, most of which is above sand size. Some of it is Chevrolet size. Boulders bigger than cars ride long distances in debris flows. Boulders grouped like fish eggs pour downhill in debris flows. The dark material coming toward the Genofiles was not only full of boulders; it was so full of automobiles it was like bread dough mixed with raisins. On its way down Pine Cone Road, it plucked up cars from driveways and the street. When it crashed into the Genofiles' house, the shattering of safety glass made terrific explosive sounds. A door burst open. Mud and boulders poured into the hall. We're going to go, Jackie thought. Oh, my God, what a hell of a way for the four of us to die together.

The parents' bedroom was on the far side of the house. Bob Genofile was in there kicking through white satin draperies at the panelled glass, smashing it to provide an outlet for water, when the three others ran in to join him. The walls of the house neither moved nor shook. As a general contractor, Bob had built dams, department stores, hospitals, six schools, seven churches, and this house. It was made of concrete block with steel reinforcement, sixteen inches on center. His wife had said it was stronger than any dam in California. His crew had

called it "the fort." In those days, twenty years before, the Genofiles' acre was close by the edge of the mountain brush, but a developer had come along since then and knocked down thousands of trees and put Pine Cone Road up the slope. Now Bob Genofile was thinking, I hope the roof holds. I hope the roof is strong enough to hold. Debris was flowing over it. He told Scott to shut the bedroom door. No sooner was the door closed than it was battered down and fell into the room. Mud, rock, water poured in. It pushed everybody against the far wall. "Jump on the bed," Bob said. The bed began to rise. Kneeling on it—on a gold velvet spread—they could soon press their palms against the ceiling. The bed also moved toward the glass wall. The two teen-agers got off, to try to control the motion, and were pinned between the bed's brass railing and the wall. Boulders went up against the railing, pressed it into their legs, and held them fast. Bob dived into the muck to try to move the boulders, but he failed. The debris flow, entering through windows as well as doors, continued to rise. Escape was still possible for the parents but not for the children. The parents looked at each other and did not stir. Each reached for and held one of the children. Their mother felt suddenly resigned, sure that her son and daughter would die and she and her husband would quickly follow. The house became buried to the eaves. Boulders sat on the roof. Thirteen automobiles were packed around the building, including five in the pool. A din of rocks kept banging against them. The stuck horn of a buried car was blaring. The family in the darkness in their fixed tableau watched one another by the light of a directional signal, endlessly blinking. The house had filled up in six minutes, and the mud stopped rising near the children's chins.

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STORIES LIKE THAT do not always have such happy endings. A man went outside to pick up his newspaper one morning, heard a sound, turned, and died of a heart attack as he saw his house crushed to pieces with his wife and two children inside. People have been buried alive in their beds. But such cases are infrequent. Debris flows generally are much less destructive of life than of property. People get out of the way.

If they try to escape by automobile, they have made an obvious but imperfect choice. Norman Reid backed his Pontiac into the street one January morning and was caught from behind by rock porridge. It embedded the car to the chrome strips. Fifty years of archival news photographs show cars of every vintage standing like hippos in chunky muck. The upper halves of their headlights peep above the surface. The late Roland Case Ross, an emeritus professor at California State University, told me of a day in the early thirties when he watched a couple rushing to escape by car. She got in first. While her husband was going around to get in his side, she got out and ran into the house for more silverware. When the car at last putt-putted downhill, a wall of debris was nudging the bumper. The debris stayed on the vehicle's heels all the way to Foothill Boulevard, where the car turned left.

Foothill Boulevard was U.S. Route 66—the western end of the rainbow. Through Glendora, Azusa, Pasadena, it paralleled the mountain front. It strung the metropolitan border towns. And it brought in emigrants to fill them up. The real-estate line of maximum advance now averages more than a mile above Foothill, but Foothill receives its share of rocks. A debris flow that passed through the Monrovia Nursery went on to Foothill and beyond. With its twenty million plants in

twelve hundred varieties, Monrovia was the foremost container nursery in the world, and in its recovery has remained so. The debris flow went through the place picking up pots and cans. It got into a greenhouse two hundred feet long and smashed out the southern wall, taking bougainvillea and hibiscus with it. Arby's, below Foothill, blamed the nursery for damages, citing the hibiscus that had come with the rocks. Arby's sought compensation, but no one was buying beef that thin.

In the same storm, large tree trunks rode in the debris like javelins and broke through the sides of houses. Automobiles went in through picture windows. A debris flow hit the gym at Azusa Pacific College and knocked a large hole in the upslope wall. In the words of Cliff Hamlow, the basketball coach, "If we'd had students in there, it would have killed them. Someone said it sounded like the roar of a jet engine. It filled the gym up with mud, and with boulders two and three feet in diameter. It went out through the south doors and spread all over the football field and track. Chain-link fencing was sheared off—like it had been cut with a welder. The place looked like a war zone." Azusa Pacific College wins national championships in track, but Coach Hamlow's basketball team (12-18) can't get the boulders out of its game.

When a debris flow went through the Verdugo Hills Cemetery, which is up a couple of switchbacks on the mountain front, two of the central figures there, resting under impressive stones, were "Hiram F. Hatch, 1st Lieut. 6th Mich. Inf., December 24, 1843—October 12, 1922," and "Henry J. Hatch, Brigadier General, United States Army, April 28, 1869—December 31, 1931." The two Hatches held the hill while many of their comrades slid below. In all, thirty-five coffins came out of the cemetery and took off for lower ground. They went down Hillrose Street and were scattered over half a mile. One

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came to rest in the parking lot of a supermarket. Many were reburied by debris and, in various people's yards, were not immediately found. Three turned up in one yard. Don Sulots, who had moved into the fallout path two months before, said, "It sounded like thunder. By the time I made it to the front door and got it open, the muck was already three feet high. It's quite a way to start off life in a new home—mud, rocks, and bodies all around."

Most people along the mountain front are about as mindful of debris flows as those corpses were. Here today, gone tomorrow. Those who worry build barricades. They build things called deflection walls—a practice that raises legal antennae and, when the caroming debris breaks into the home of a neighbor, probes the wisdom of Robert Frost. At least one family has experienced so many debris flows coming through their back yard that they long ago installed overhead doors in the rear end of their built-in garage. To guide the flows, they put deflection walls in their back yard. Now when the boulders come they open both ends of their garage, and the debris goes through to the street.

Between Harrow Canyon and Englewild Canyon, a private street called Glencoe Heights teased the mountain front. Came a time of unprecedented rain, and the neighborhood grew ever more fearful—became in fact so infused with catastrophic anticipation that it sought the drastic sort of action that only a bulldozer could provide. A fire had swept the mountainsides, leaving them vulnerable, dark, and bare. Expecting floods of mud and rock, people had piled sandbags and built heavy wooden walls. Their anxiety was continuous for many months. "This threat is on your mind all the time," Gary Lukehart said. "Every time you leave the house, you stop and put up another sandbag, and you just hope everything

will be all right when you get back." Lukehart was accustomed to losing in Los Angeles. In the 1957 Rose Bowl, he was Oregon State's quarterback. A private street could not call upon city or county for the use of heavy equipment, so in the dead of night, as steady rain was falling, a call was put in to John McCafferty—bulldozer for hire. McCafferty had a closeup knowledge of the dynamics of debris flows: he had worked the mountain front from San Dimas to Sierra Madre, which to him is Sarah Modri. ("In those canyons at night, you could hear them big boulders comin'. They sounded like thunder.") He arrived at Glencoe Heights within the hour and set about turning the middle of the street into the Grand Canal of Venice. His Cat was actually not a simple dozer but a 955 loader on tracks, with a two-and-a-quarter-yard bucket seven feet wide. Cutting water mains, gas mains, and sewers, he made a ditch that eventually extended five hundred feet and was deep enough to take in three thousand tons of debris. After working for five hours, he happened to be by John Caufield's place ("It had quit rainin', it looked like the worst was over") when Caufield came out and said, "Mac, you sure have saved my bacon."

McCafferty continues, "All of a sudden, we looked up at the mountains—it's not too far from his house to the mountains, maybe a hundred and fifty feet—and we could just see it all comin'. It seemed the whole mountain had come loose. It flowed like cement." In the ditch, he put the Cat in reverse and backed away from the oncoming debris. He backed three hundred feet. He went up one side of the ditch and was about halfway out of it when the mud and boulders caught the Cat and covered it over the hood. In the cab, the mud pushed against McCafferty's legs. At the same time, debris broke into

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Caufield's house through the front door and the dining-room window, and in five minutes filled it to the eaves.

Other houses were destroyed as well. A garage left the neighborhood with a car in it. One house was buried twice. (After McCafferty dug it out, it was covered again.) His ditch, however, was effective, and saved many places on slightly higher ground, among them Gary Lukehart's and the home of John Marcellino, the chief executive officer of Mackinac Island Fudge. McCafferty was promised a lifetime supply of fudge. He was on the scene for several days, and in one span worked twenty-four hours without a break. The people of the street brought him chocolate milkshakes. He had left his lowbed parked around the corner. When at last he returned to it and prepared to go home, he discovered that a cop had given him a ticket.

A METROPOLIS that exists in a semidesert, imports water three hundred miles, has inveterate flash floods, is at the grinding edges of two tectonic plates, and has a microclimate tenacious of noxious oxides will have its priorities among the aspects of its environment that it attempts to control. For example, Los Angeles makes money catching water. In a few days in 1983, it caught twenty-eight million dollars' worth of water. In one period of twenty-four hours, however, the ocean hit the city with twenty-foot waves, a tornado made its own freeway, debris flows poured from the San Gabriel front, and an earthquake shook the region. Nature's invoice was forty million dollars. Later, twenty million more was spent dealing with the mountain debris.

There were those who would be quick—and correct—in

saying that were it not for the alert unflinching manner and imaginative strategies by which Los Angeles outwits the mountains, nature's invoices at such times would run into the billions. The rear-guard defenses are spread throughout the city and include more than two thousand miles of underground conduits and concrete-lined open stream channels—a web of engineering that does not so much reinforce as replace the natural river systems. The front line of battle is where the people meet the mountains—up the steep slopes where the subdivisions stop and the brush begins.

Strung out along the San Gabriel front are at least a hundred and twenty bowl-shaped excavations that resemble football stadiums and are often as large. Years ago, when a big storm left back yards and boulevards five feet deep in scree, one neighborhood came through amazingly unscathed, because it happened to surround a gravel pit that had filled up instead. A tungsten filament went on somewhere above Los Angeles. The county began digging pits to catch debris. They were quarries, in a sense, but exceedingly bizarre quarries, in that the rock was meant to come to them. They are known as debris basins. Blocked at their downstream ends with earthfill or concrete constructions, they are also known as debris dams. With clean spillways and empty reservoirs, they stand ready to capture rivers of boulders—these deep dry craters, lying close above the properties they protect. In the overflowing abundance of urban nomenclature, the individual names of such basins are obscure, until a day when they appear in a headline in the *Los Angeles Times*: Harrow, Englewild, Zachau, Duns-muir, Shields, Big Dalton, Hog, Hook East, Hook West, Limekiln, Starfall, Sawpit, Santa Anita. For fifty miles, they mark the wild boundary like bulbs beside a mirror. Behind chain links, their idle ovate forms more than suggest defense.

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They are separated, on the average, by seven hundred yards. In aggregate, they are worth hundreds of millions of dollars. All this to keep the mountains from falling on Johnny Carson.

The principal agency that developed the debris basins was the hopefully named Los Angeles County Flood Control District, known familiarly through the region as Flood Control, and even more intimately as Flood. ("When I was at Flood, one of our dams filled with debris overnight," a former employee remarked to me. "If any more rain came, we were going to have to evacuate the whole of Pasadena.") There has been a semantic readjustment, obviously intended to acknowledge that when a flood pours out of the mountains it might be half rock. The debris basins are now in the charge of the newly titled Sedimentation Section of the Hydraulic Division of the Los Angeles County Department of Public Works. People still call it Flood. By whatever name the agency is called, its essential tactic remains unaltered. This was summarized for me in a few words by an engineer named Donald Nichols, who pointed out that eight million people live below the mountains on the urban coastal plain, within an area large enough to accommodate Philadelphia, Detroit, Chicago, St. Louis, Boston, and New York. He said, "To make the area inhabitable, you had to put in lined channels on the plain and halt the debris at the front. If you don't take it out at the front, it will come out in the plain, filling up channels. A filled channel won't carry diddly-boo."

To stabilize mountain streambeds and stop descending rocks even before they reach the debris basins, numerous crib structures (barriers made of concrete slats) have been emplaced in high canyons—the idea being to convert plunging streams into boulder staircases, and hypothetically cause erosion to work against itself. Farther into the mountains, a dozen dams

of some magnitude were built in the nineteen-twenties and thirties to control floods and conserve water. Because they are in the San Gabriels, they inadvertently trap large volumes of debris. One of them—the San Gabriel Dam, in the San Gabriel River—was actually built as a debris-control structure. Its reservoir, which is regularly cleaned out, contained, just then, twenty million tons of mountain.

The San Gabriel River, the Los Angeles River, and the Big Tujunga (Bigta Hung-ga) are the principal streams that enter the urban plain, where a channel that filled with rock wouldn't carry diddly-boo. Three colossal debris basins—as different in style as in magnitude from those on the mountain front—have been constructed on the plain to greet these rivers. Where the San Gabriel goes past Azusa on its way to Alamitos Bay, the Army Corps of Engineers completed in the late nineteen-forties a dam ninety-two feet high and twenty-four thousand feet wide—this to stop a river that is often dry, and trickles most of the year. Santa Fe Dam, as it is called, gives up at a glance its own story, for it is made of boulders that are shaped like potatoes and are generally the size of watermelons. They imply a large volume of water flowing with high energy. They are stream-propelled, stream-rounded boulders, and the San Gabriel is the stream. In Santa Fe Basin, behind the dam, the dry bed of the San Gabriel is half a mile wide. The boulder-strewn basin in its entirety is four times as wide as that. It occupies eighteen hundred acres in all, nearly three square miles, of what would be prime real estate were it not for the recurrent arrival of rocks. The scene could have been radioed home from Mars, whose cobby face is in part the result of debris flows dating to a time when Mars had surface water.

The equally vast Sepulveda Basin is where Los Angeles receives and restrains the Los Angeles River. In Sepulveda

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Basin are three golf courses, which lend ample support to the widespread notion that everything in Los Angeles is disposable. Advancing this national prejudice even further, debris flows, mudslides, and related phenomena have “provided literary minds with a ready-made metaphor of the alleged moral decay of Los Angeles.” The words belong to Reyner Banham, late professor of the history of architecture at University College, London, whose passionate love of Los Angeles left him without visible peers. The decay was only “alleged,” he said. Of such nonsense he was having none. With his “Los Angeles: The Architecture of Four Ecologies,” Banham had become to this deprecated, defamed, traduced, and disparaged metropolis what Pericles was to Athens. Banham knew why the basins were there and what the people were defending. While all those neurasthenic literary minds are cowering somewhere in ethical crawl space, the quality of Los Angeles life rises up the mountain front. There is air there. Cool is the evening under the crumbling peaks. Cool descending air. Clean air. Air with a view. “The financial and topographical contours correspond almost exactly,” Banham said. Among those “narrow, tortuous residential roads serving precipitous house-plots that often back up directly on unimproved wilderness” is “the fat life of the delectable mountains.”

People of Gardena, Inglewood, and Watts no less than Azusa and Altadena pay for the defense of the mountain front, the rationale being that debris trapped near its source will not move down and choke the channels of the inner city, causing urban floods. The political City of Los Angeles—in its vague and tentacular configuration—actually abuts the San Gabriels for twenty miles or so, in much the way that it extends to touch the ocean in widely separated places like Venice, San Pedro, and Pacific Palisades. Los Angeles County reaches

across the mountains and far into the Mojave Desert. The words "Los Angeles" as generally used here refer neither to the political city nor to the county but to the multinamed urban integrity that has a street in it seventy miles long (Sepulveda Boulevard) and, from the Pacific Ocean at least to Pomona, moves north against the mountains as a comprehensive town.

The debris basins vary greatly in size—not, of course, in relation to the populations they defend but in relation to the watersheds and washes above them in the mountains. For the most part, they are associated with small catchments, and the excavated basins are commensurately modest, with capacities under a hundred thousand cubic yards. In a typical empty reservoir—whatever its over-all dimensions may be—stands a columnar tower that resembles a campanile. Full of holes, it is known as a perforated riser. As the basin fills with a thick-flowing slurry of water, mud, and rock, the water goes into the tower and is drawn off below. The county calls this water harvesting.

Like the freeways, the debris-control system ordinarily functions but occasionally jams. When the Genofiles' swimming pool filled with cars, debris flows descended into other neighborhoods along that part of the front. One hit a culvert, plugged the culvert, crossed a road in a bouldery wave, flattened fences, filled a debris basin, went over the spillway, and spread among houses lying below, shoving them off their foundations. The debris basins have caught as much as six hundred thousand cubic yards in one storm. Over time, they have trapped some twenty million tons of mud and rock. Inevitably, sometimes something gets away.

At Devil's Gate—just above the Rose Bowl, in Pasadena—a dam was built in 1920 with control of water its only objective.

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Yet its reservoir, with a surface of more than a hundred acres, has filled to the brim with four million tons of rock, gravel, and sand. A private operator has set up a sand-and-gravel quarry in the reservoir. Almost exactly, he takes out what the mountains put in. As one engineer has described it, "he pays Flood, and Flood makes out like a champ."

IT WAS ASSUMED that the Genofiles were dead. Firemen and paramedics who came into the neighborhood took one glance at the engulfed house and went elsewhere in search of people needing help. As the family remained trapped, perhaps an hour went by. They have no idea.

"We didn't know why it had come or how long it was going to last."

They lost all sense of time. The stuck horn went on blaring, the directional signal eerily blinking. They imagined that more debris was on the way.

"We didn't know if the whole mountain was coming down."

As they waited in the all but total darkness, Jackie thought of neighbors' children. "I thought, Oh, my gosh, all those little kids are dead. Actually, they were O.K. And the neighbors thought for sure we were all gone. All our neighbors thought we were gone."

At length, a neighbor approached their house and called out, "Are you alive?"

"Yes. But we need help."

As the debris flow hit the Genofiles' house, it also hit a six-ton truck from the L.A.C.F.C.D., the vigilant bureau called Flood. Vigilance was about all that the L.A.C.F.C.D. had been able to offer. The patrolling vehicle and its crew of

two were as helpless as everyone else. Each of the crewmen had lived twenty-six years, and each came close to ending it there. Minutes before the flow arrived, the truck labored up Pine Cone Road—a forty-one-per-cent grade, steep enough to stiff a Maserati. The two men meant to check on a debris basin at the top. Known as Upper Shields, it was less than two years old, and had been built in anticipation of the event that was about to occur. Oddly enough, the Genofiles and their neighbors were bracketed with debris basins—Upper Shields above them, Shields itself below them, six times as large. Shields Debris Basin, with its arterial concrete feeder channels, was prepared to catch fifty thousand tons. The Genofiles' house looked out over Shields as if it were an empty lake, its shores hedged about with oleander. When the developer extended Pine Cone Road up into the brush, the need for Upper Shields was apparent. The new basin came in the nick of time but—with a capacity under six thousand cubic yards—not in the nick of space. Just below it was a chain-link gate. As the sixteen-ton truck approached the gate, mud was oozing through. The basin above had filled in minutes, and now, suddenly, boulders shot like cannonballs over the crest of the dam, with mud, cobbles, water, and trees. Chris Terracciano, the driver, radioed to headquarters, "It's coming over." Then he whipped the truck around and fled. The debris flow came through the chain-link barrier as if the links were made of paper. Steel posts broke off. As the truck accelerated down the steep hill, the debris flow chased and caught it. Boulders bounced against it. It was hit by empty automobiles spinning and revolving in the muck. The whole descending complex gathered force with distance. Terracciano later said, "I thought I was dead the whole way." The truck finally stopped when it bashed against a tree and a cement-block wall. The rear window shattered.

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Terracciano's partner suffered a broken leg. The two men crawled out through the window and escaped over the wall.

Within a few miles, other trapped patrols were calling in to say, "It's coming over." Zachau went over—into Sunland. Haines went over—into Tujunga. Dunsmuir went over—into Highway Highlands. As bulldozers plow out the streets after events like these, the neighborhoods of northern Los Angeles assume a macabre resemblance to New England villages under deep snow: the cleared paths, the vehicular rights-of-way, the parking meters buried within the high banks, the half-covered drift-girt homes. A street that is lined with palms will have debris berms ten feet up the palms. In the Genofiles' front yard, the drift was twelve feet deep. A person, without climbing, could walk onto the roof. Scott's bedroom had a few inches of space left at the top. Kimberlee's had mud on the ceiling. On the terrace, the crushed vehicles, the detached erratic wheels suggested bomb damage, artillery hits, the track of the Fifth Army. The place looked like a destroyed pillbox. No wonder people assumed that no one had survived inside.

There was a white sedan under the house eaves crushed to half its height, with two large boulders resting on top of it. Near the pool, a Volkswagen bug lay squashed. Another car was literally wrapped around a tree, like a C-clamp, its front and rear bumpers pointing in the same direction. A crushed pickup had boulders all over it, each a good deal heavier than anything a pickup could carry. One of the cars in the swimming pool was upside down, its tires in the air. A Volkswagen was on top of it. Bob Genofile—owner, contractor, victim—walked around in rubber boots, a visored construction cap, a foul-weather jacket, studying the damage, mostly guessing at what he couldn't see. A big, strongly built, leonine man with prematurely white hair, he looked like a middle linebacker

near the end of a heavy day. He wondered if the house was still on its foundation, but there was no telling in this profound chaos, now hardening and cracking like bad concrete. In time, as his house was excavated from the inside, he would find that it had not budged. Not one wall had so much as cracked. He was uninsured, but down in the rubble was a compensation of greater value than insurance. Forever, he could say, as he quietly does when he tells the story, "I built it, man."

Kimberlee's birthday came two days after the debris. She was a college student, turning nineteen, and her father had had a gift for her that he was keeping in his wallet. "I had nineteen fifty-dollar bills to give her for her birthday, but my pants and everything was gone."

Young Scott, walking around in the wreckage, saw a belt sticking out of the muck like a night crawler after rain. He pulled at it, and the buried pants came with it. The wallet was still in the pants. The wallet still contained what every daughter wants for her birthday: an album of portraits of U.S. Grant, no matter if Ulysses is wet or dry.

The living room had just been decorated, and in six minutes the job had been destroyed—"the pale tangerines and greens, Italian-style furniture with marble, and all that." Jackie Genofile continues the story: "We had been out that night, and, you know, you wear your better jewelry. I came home like an idiot and put mine on the dresser. Bob put his on the dresser. Three weeks later, when some workers were cleaning debris out of the bedroom, they found his rings on the floor. They did not find mine. But—can you believe it?—a year and a half later Scott was down in the debris basin with one of his friends, and the Flood Control had these trucks there cleaning it out, and Scott saw this shiny thing, and he picked it up,

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and it was my ring that Bob had given me just before the storm."

Before the storm, they had not in any way felt threatened. Like their neighbors, they were confident of the debris basins, of the concrete liners of the nearby stream. After the storm, neighbors moved away. Where Pine Cone Road swung left or right, the debris had made centrifugal leaps, breaking into houses. A hydrant snapped off, and arcing water shot through an upstairs window. A child nearly drowned inside his own house. The family moved. "Another family that moved owned one of the cars that ended up in our pool," Jackie told me. "The husband said he'd never want to live here again, you know. And she was in real estate."

After the storm, the Genofiles tended to wake in the night, startled and anxious. They still do. "I wake up once in a while really uptight," Bob said. "I can just feel it—go through the whole thing, you know."

Jackie said that when rain pounds on a roof, anywhere she happens to be, she will become tense. Once, she took her dog and her pillow and went to sleep in Bob's office—which was then in Montrose, down beyond Foothill Boulevard.

Soon after the storm, she said, "Scotty woke up one night, and he had a real high temperature. You see, he was sixteen, and he kept hearing the mud and rock hitting the window. He kept thinking it was going to come again. Kim used to go four-wheeling, and cross streams, and she had to get out once, because they got stuck, and when she felt the flow of water and sand on her legs, she said, she could have panicked."

Soon after the storm, the family gathered to make a decision. Were they going to move or were they going to dig out their house and rebuild it? Each of them knew what might

have happened. Bob said, "If it had been a frame house, we would be dead down in the basin below."

But it was not a frame house. It was the fort. "The kids said rebuild. So we rebuilt."

As he sat in his new living room telling the story, Bob was dressed in a Pierre Cardin jumper and pants, and Jackie was beside him in a pale-pink jumpsuit by Saint Germain. The house had a designer look as well, with its railings and balconies and Italianate marbles under the tall dry trees. It appeared to be worth a good deal more than the half-million dollars Bob said it might bring. He had added a second story and put all bedrooms there. The original roof spreads around them like a flaring skirt. He changed a floor-length window in the front hall, filling the lower half of it with cement block.

I asked what other structural changes he had made.

He said, "None."

The Genofiles sued Los Angeles County. They claimed that Upper Shields Debris Basin had not been cleaned out and that the channel below was improperly designed. Los Angeles settled for three hundred and thirty-seven thousand five hundred dollars.

From the local chamber of commerce the family later received the Beautification Award for Best Home. Two of the criteria by which houses are selected for this honor are "good maintenance" and "a sense of drama."

I HAVE NOT BEEN specific about the dates of the stories so far recounted. This was to create the impression that debris pours forth from the mountains continually, perennially, perpetually—which it does and does not, there being a great temporal disparity between the pace at which the mountains

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behave and the way people think. Debris flows do not occur in every possible season. When they do happen, they don't just spew from any canyon but come in certain places on the mountain front. The places change. Volumes differ. There are vintage years. The four most prominent in this century have been 1934, 1938, 1969, and 1978. Exceptional flows have occurred at least once a decade, and lesser ones in greater numbers. Exceptional flows are frequent, in other words, but not frequent enough to deter people from building pantiled mansions in the war zone, dingbats in the line of fire.

Why the debris moves when it does or where it does is not attributable to a single agent. The parent rock has been extensively broken up by earthquakes, but that alone will not make it flow. Heavy rainfall, the obvious factor, is not as obvious as it may seem. In 1980, some of the most intense storms ever measured in Los Angeles failed to produce debris flows of more than minimal size. The setting up of a debris flow is a little like the charging of an eighteenth-century muzzle-loader: the ramrod, the powder, the wadding, the shot. Nothing much would happen in the absence of any one component. In sequence and proportion each had to be correct.

On the geologic time scale, debris flows in the San Gabriel Mountains can be looked upon as constant. With all due respect, though, the geologic time scale doesn't mean a whole lot in a place like Los Angeles. In Los Angeles, even the Los Angeles time scale does not arouse general interest. A super-event in 1934? In 1938? In 1969? In 1978? Who is going to remember that? A relatively major outpouring—somewhere in fifty miles—about once every decade? Mountain time and city time appear to be bifocal. Even with a geology functioning at such remarkably short intervals, the people have ample time to forget it.

In February of 1978, while debris was still hardening in the home of the Genofiles, Wade Wells, of the United States Forest Service, went up and down Pine Cone Road knocking on doors, asking how long the people had lived there. He wondered who remembered, nine years back, the debris-flow inundations of Glendora and Azusa, scarcely twenty miles away. Only two did. Everyone else had arrived since 1969.

Wells is a hydrologist who works in the mountains, principally in San Dimas Experimental Forest, where he does research on erosion and sedimentation—the story of assembling debris. With a specialist's eye, he notes the mountain front, and in its passivity can see the tension: "These guys here, they should be nervous when it rains. Their houses are living on borrowed time. See that dry ledge? It's a waterfall. I've seen hundreds of tons of rock falling over it." More often, though, he is thousands of feet above the nearest house, on slopes so steep he sometimes tumbles and rolls. With his colleagues, he performs experiments with plants, rock, water, fire. When I first became interested in Los Angeles' battle with debris flows, I went up there with them a number of times. The mountains, after all, are where the rocks come from. The mountains shape the charge that will advance upon the city. People come from odder places than the East Coast to see this situation. One day, a couple of scientists arrived from the Cordillera Cantábrica, in northwestern Spain. When they saw how rapidly the San Gabriels were disintegrating, one of them said he felt sorry for Wells, who would soon be out of work. When Wells told him that the mountains were rising even faster than they were coming down, the man said, "*Muy interesante. Sí, señor.*"

From below, one look at the San Gabriels will suggest their advantage. The look is sometimes hard to come by. You

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might be driving up the San Gabriel River Freeway in the morning, heading straight at the mountains at point-blank range, and not be able to see them. A voice on KNX tells you that the day is clear. There's not a cloud in the sky, as the blue straight up confirms. A long incline rises into mist, not all of which is smog. From time immemorial, this pocket of the coast has been full of sea fog and persistent vapors. The early Spaniards called it the Bay of Smokes. Smog, the action of sunlight on nitrogen oxides, has only contributed to a preexisting veil. Sometimes you don't see the San Gabriels until the streets stop and the mountains start. The veil suddenly thins, and there they are, in height and magnitude overwhelming. You plunge into a canyon flanked with soaring slopes before you realize you are out of town. The San Gabriel Mountains are as rugged as any terrain in America, and their extraordinary proximity to the city, the abruptness of the transition from the one milieu to the other, cannot be exaggerated. A lone hiker in the San Gabriels one winter—exhausted, snowblinded, hypothermic—staggered down a ridgeline out of the snow and directly into the parking lot of a shopping center, where he crawled to a phone booth, called 911, and slumped against the glass until an ambulance came to save him.

Hang-glider pilots go up the San Gabriels, step off crags, and, after a period of time proportional to their skills, land somewhere in the city. The San Gabriels are nearly twice as high as Mt. Katahdin or Mt. Washington, and are much closer to the sea. From base platform to summit, the San Gabriels are three thousand feet higher than the Rockies. To be up in the San Gabriels is to be both above and beside urban Los Angeles, only minutes from the streets, and to look north from ridge to dry ridge above deeply cut valleys filled with gulfs of clear air. Beyond the interior valleys—some fifty thousand feet

away and a vertical mile above you—are the summits of Mt. Baldy, Mt. Hawkins, Mt. Baden-Powell. They are so clearly visible in the dry blue sky that just below their ridgelines you can almost count the boulders that are bunched there like grapes.

If you turn and face south, you look out over something like soft slate that reaches fifty miles to an imprecise horizon. The whole of Los Angeles is spread below you, and none of it is visible. It is lost absolutely in the slate-gray sea, grayer than a minesweeper, this climatic wonder, this megalopolitan featherbed a thousand feet thick, known as "the marine layer." Early in the day, it is for the most part the natural sea fog. As you watch it from above through the morning and into the afternoon, it turns yellow, and then ochre, and then brown, and sometimes nearly black—like butter darkening in a skillet.

Glancing down at it one day while working on an experiment, Wade Wells said it seemed to have reached the hue of a first-stage smog alert. Wells was helping Edwin Harp, a debris-flow specialist from the United States Geological Survey, collect "undisturbed" samples by hammering plastic tubes into the mountain soil.

"If the soil were nice and compliant, this would be nice and scientific," Harp said, smacking the plastic with a wooden-handled shovel. After a while, he extracted a tube full of uncompliant material, and said, "This isn't soil; it's regolith." Regolith is a stony blanket that lies under soil and over bedrock. It crumbled and was pebbly in the hand.

As they prepared to sink another tube, I said, "What's a first-stage smog alert?"

"Avoid driving, avoid strenuous activity," Wells answered.

Harp said, "Avoid breathing."

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The slope they were sampling had an incline of eighty-five per cent. They were standing, and walking around, but I preferred—just there—to sit. Needle grass went through my trousers. The heads of needle grass detach from the stalks and have the barbed design of arrows. They were going by the quiver into my butt but I still preferred to sit. It was the better posture for writing notes. The San Gabriels are so steep and so extensively dissected by streams that some watersheds are smaller than a hundred acres. The slopes average sixty-five to seventy per cent. In numerous places, they are vertical. The angle of repose—the steepest angle that loose rocks can abide before they start to move, the steepest angle the soil can maintain before it starts to fail—will vary locally according to the mechanics of shape and strength. Many San Gabriel slopes are at the angle of repose or beyond it. The term "oversteepened" is often used to describe them. At the giddy extreme of oversteepening is the angle of maximum slope. Very large sections of the San Gabriels closely approach that angle. In such terrain, there is not much to hold the loose material except the plants that grow there.

Evergreen oaks were fingering up the creases in the mountainsides, pointing toward the ridgeline forests of big-cone Douglas fir, of knobcone and Coulter pine. The forests had an odd sort of timberline. They went down to it rather than up. Down from the ridges the conifers descended through nine thousand, seven thousand, six thousand feet, stopping roughly at five. The forests abruptly ended—the country below being too dry in summer to sustain tall trees. On down the slopes and all the way to the canyons was a thicket of varied shrubs that changed in character as altitude fell but was everywhere dense enough to stop an army. On its lower levels, it was all green, white, and yellow with buckwheat, burroweed, lotus

and sage, deerweed, bindweed, yerba santa. There were wild morning glories, Canterbury bells, tree tobacco, miner's lettuce. The thicket's resistance to trespass, while everywhere formidable, stiffened considerably as it evolved upward. There were intertwining mixtures of manzanita, California lilac, scrub oak, chamise. There was buckthorn. There was mountain mahogany. Generally evergreen, the dark slopes were splashed here and there with dodder, its mustard color deepening to rust. Blossoms of the Spanish bayonet stood up like yellow flames. There were lemonade berries (relatives of poison ivy and poison oak). In canyons, there were alders, big-leaf maple bushes, pug sycamores, and California bay. Whatever and wherever they were, these plants were prickly, thick, and dry, and a good deal tougher than tundra. Those evergreen oaks fingering up the creases in the mountains were known to the Spaniards as chaparros. Riders who worked in the related landscape wore leather overalls open at the back, and called them chaparajos. By extension, this all but impenetrable brush was known as chaparral.

The low stuff, at the buckwheat level, is often called soft chaparral. Up in the tough chamise, closer to the lofty timber, is high chaparral, which is also called hard chaparral. High or low—hard, soft, or mixed—all chaparral has in common an always developing, relentlessly intensifying, vital necessity to burst into flame. In a sense, chaparral consumes fire no less than fire consumes chaparral. Fire nourishes and rejuvenates the plants. There are seeds that fall into the soil, stay there indefinitely, and will not germinate except in the aftermath of fire. There are basal buds that sprout only after fire. Droughts are so long, rains so brief, that dead bits of wood and leaves scarcely decay. Instead, they accumulate, thicken, until the plant community is all but strangling in its own duff.

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The nutrients in the dead material are being withheld from the soil. When fire comes, it puts the nutrients back in the ground. It clears the terrain for fresh growth. When chaparral has not been burned for thirty years, about half the thicket will be dry dead stuff—twenty-five thousand tons of it in one square mile. The living plants are no less flammable. The chamise, the manzanita—in fact, most chaparral plants—are full of solvent extractives that burn intensely and ignite easily. Their leaves are glossy with oils and resins that seal in moisture during hot dry periods and serve the dual purpose of responding explosively to flame. In the long dry season, and particularly in the fall, air flows southwest toward Los Angeles from the Colorado Plateau and the Basin and Range. Extremely low in moisture, it comes out of the canyon lands and crosses the Mojave Desert. As it drops in altitude, it compresses, becoming even dryer and hotter. It advances in gusts. This is the wind that is sometimes called the foehn. The fire wind. The devil wind. In Los Angeles, it is known as Santa Ana. When chamise and other chaparral plants sense the presence of Santa Ana winds, their level of moisture drops, and they become even more flammable than they were before. The Santa Anas bring what has been described as "instant critical fire weather." Temperatures rise above a hundred degrees. Humidity drops very close to zero. According to Charles Colver, of the United States Forest Service, "moisture evaporates off your eyeballs so fast you have to keep blinking."

Ignitions are for the most part caused by people—through accident or arson. Ten per cent are lightning. Where the Santa Anas collide with local mountain winds, they become so erratic that they can scatter a fire in big flying brands for a long distance in any direction. The frequency and the intensity of the forest fires in the Southern California chaparral are the greatest in

the United States, with the possible exception of the wildfires of the New Jersey Pine Barrens. The chaparral fires are considerably more potent than the forest fires Wade Wells saw when he was an undergraduate at the University of Idaho or when he worked as a firefighter in the Pacific Northwest. "Fires in the Pacific Northwest are nothing compared with these chaparral fires," he remarked. "Chaparral fires are almost vicious by comparison. They're so intense. Chaparral is one of the most flammable vegetation complexes there are."

It burns as if it were soaked with gasoline. Chaparral plants typically have multiple stems emerging from a single root crown, and this contributes not only to the density of the thickets but, ultimately, to the surface area of combustible material that stands prepared for flame. Hundreds of acres can be burned clean in minutes. In thick black smoke there is wild orange flame, rising through the canyons like explosion crowns. The canyons serve as chimneys, and in minutes whole mountains are aflame, resembling volcanoes, emitting high columns of fire and smoke. The smoke can rise twenty thousand feet. A force of two thousand people may fight the fire, plus dozens of machines, including squadrons in the air. But Santa Ana firestorms are so violent that they are really beyond all effort at control. From the edge of the city upward, sixteen miles of mountain front have burned to the ridgeline in a single day.

So momentous are these conflagrations that they are long remembered by name: the Canyon Inn Fire, August, 1968, nineteen thousand acres above Arby's by Foothill Boulevard, above the world's foremost container nursery, above the chief executive officer of Mackinac Island Fudge; the Village Fire and the Mill Fire, November, 1975, sixty-five thousand acres above Sunland, Tujunga, La Crescenta, La Cañada. The Mill

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Fire, in the words of a foreman at Flood, "burnt the whole front face off."

It is not a great rarity to pick up the *Los Angeles Times* and see a headline like this one, from September 27, 1970:

14 MAJOR FIRES RAGE OUT OF CONTROL
256 HOMES DESTROYED AS
FLAMES BURN 180,000 ACRES

In millennia before Los Angeles settled its plain, the chaparral burned every thirty years or so, as the chaparral does now. The burns of prehistory, in their natural mosaic, were smaller than the ones today. With cleared fire lanes, chemical retardants, and other means of suppressing what is not beyond control, people have conserved fuel in large acreages. When the inevitable fires come, they burn hotter, higher, faster than they ever did in a state of unhindered nature. When the fires end, there is nothing much left on the mountainsides but a thin blanket of ash. The burns are vast and bare. On the sheer declivities where the surface soils were held by chaparral, there is no chaparral.

Fine material tumbles downslope and collects in the waterless beds of streams. It forms large and bulky cones there, to some extent filling the canyons. Under green chaparral, the gravitational movement of bits of soil, particles of sand, and other loose debris goes on month after month, year after year, especially in oversteepened environments, where it can represent more than half of all erosion. After a burn, though, it increases exponentially. It may increase twentyfold, fortyfold, even sixtyfold. This steady tumbling descent of unconsolidated mountain crumbs is known as dry ravel. After a burn, so much dry ravel and other debris becomes piled up and ready to go

that to live under one of those canyons is (as many have said) to look up the barrel of a gun.

One would imagine that the first rain would set the whole thing off, but it doesn't. The early-winter rains—and sometimes the rains of a whole season—are not enough to make the great bulk move. Actually, they add to it.

If you walk in a rainstorm on a freshly burned chaparral slope, you notice as you step on the wet ground that the tracks you are making are prints of dry dust. In the course of a conflagration, chaparral soil, which is not much for soaking up water in the first place, experiences a chemical change and, a little below its surface, becomes waterproof. In a Forest Service building at the foot of the mountains Wade Wells keeps some petri dishes and soil samples in order to demonstrate this phenomenon to passing unbelievers. In one dish he puts unburned chaparral soil. It is golden brown. He drips water on it from an eyecup. The water beads up, stands there for a while, then collapses and spreads into the soil. Why the water hesitates is not well understood but is a great deal more credible than what happens next. Wells fills a dish with a dark soil from burned chaparral. He fills the eyecup and empties it onto the soil. The water stands up in one large dome. Five minutes later, the dome is still there. Ten minutes later, the dome is still there. Sparkling, tumescent, myco-phane, the big bead of water just stands there indefinitely, on top of the impermeable soil. Further demonstrating how waterproof this burned soil really is, Wells pours half a pound of it, like loose brown sugar, into a beaker of water. The soil instantly forms a homuncular blob—integral, immiscible—suspended in the water.

In the slow progression of normal decay, chaparral litter seems to give up to the soil what have been vaguely described

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as "waxlike complexes of long-chain aliphatic hydrocarbons." These waxy substances are what make unburned chaparral soil somewhat resistant to water, or "slightly nonwettable," as Wells and his colleagues are wont to describe it. When the wildfires burn, and temperatures at the surface of the ground are six or seven hundred centigrade degrees, the soil is so effective as an insulator that the temperature one centimetre below the surface may not be hot enough to boil water. The heavy waxlike substances vaporize at the surface and recondense in the cooler temperatures below. Acting like oil, they coat soil particles and establish the hydrophobic layer—one to six centimetres down. Above that layer, where the waxlike substances are gone, the veneer of burned soil is "wettable." When Wells drips water on a dishful of that, the water soaks in as if the dish were full of Kleenex. When rain falls on burned and denuded ground, it soaks the very thin upper layer but can penetrate no farther. Hiking boots strike hard enough to break through into the dust, but the rain is repelled and goes down the slope. Of all the assembling factors that eventually send debris flows rumbling down the canyons, none is more detonative than the waterproof soil.

In the first rains after a fire, water quickly saturates the thin permeable layer, and liquefied soil drips downhill like runs of excess paint. These miniature debris flows stripe the mountainsides with miniature streambeds—countless scarlike rills that are soon the predominant characteristic of the burned terrain. As more rain comes, each rill is going to deliver a little more debris to the accumulating load in the canyon below. But, more to the point, each rill—its natural levees framing its impermeable bed—will increase the speed of the surface water. As rain sheds off a mountainside like water off a tin roof, the rill network, as it is called, may actually triple

the speed, and therefore greatly enhance the power of the runoff. The transport capacity of the watershed—how much bulk it can move—may increase a thousandfold. The rill network is prepared to deliver water with enough force and volume to mobilize the deposits lying in the canyons below. With the appearance of the rills, almost all prerequisites have now sequentially occurred. The muzzle-loader is charged. For a full-scale flat-out debris flow to burst forth from the mountains, the final requirement is a special-intensity storm.

Some of the most concentrated rainfall in the history of the United States has occurred in the San Gabriel Mountains. The oddity of this is about as intense as the rain. Months—seasons—go by in Los Angeles without a fallen drop. Los Angeles is one of the least-rained-upon places in the Western Hemisphere. The mountains are so dry they hum. Erosion by dry ravel greatly exceeds erosion by water. The celebrated Mediterranean climate of Los Angeles owes itself to aridity. While Seattle is receiving its average rainfall of thirty-nine inches a year, Chicago thirty-three, the District of Columbia thirty-nine, and New York City forty-four, Los Angeles is doing well if it gets fifteen. In one year out of every four over the past century, rainfall in Los Angeles has been under ten inches, and once or twice it was around five. That is pure Gobi. When certain storm systems approach Los Angeles, though—storms that come in on a very long reach from far out in the Pacific—they will pick up huge quantities of water from the ocean and just pump it into the mountains. These are by no means annual events, but when they occur they will stir even hydrologists to bandy the name of Noah. In January, 1969, for example, more rain than New York City sees in a year fell in the San Gabriels in nine days. In January, 1943, twenty-six inches fell in twenty-four hours. In February, 1978, just before

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the Genofiles' house filled with debris, nearly an inch and a half of rain fell in twenty-five minutes. On April 5, 1926, a rain gauge in the San Gabriels collected one inch in one minute.

The really big events result from two, three, four, five storms in a row coming in off the Pacific. In 1980, there were six storms in nine days. Mystically, unnervingly, the heaviest downpours always occur on the watersheds most recently burned. Why this is so is a question that has not been answered. Meteorologists and hydrologists speculate about ash-particle nuclei and heat reflection, but they don't know. The storm cells are extremely compact, deluging typically about ten miles by ten. One inch of rain on a patch that size is seven million two hundred and thirty-two thousand tons of water. In most years, in most places, a winter rain will actually stabilize a mountainside. The water's surface tension helps to hold the slope together. Where there is antecedent fire, water that would otherwise become a binding force hits the rill network, caroms off the soil's waterproof layer, and rides the steep slopes in cataracts into the nearest canyon. It is now a lubricant, its binding properties repelled, its volume concentrating into great hydraulic power. The vintage years present themselves when at least five days of rain put seven inches on the country and immediately thereafter comes the heaviest rainfall of the series. That is when the flint hits the steel, when the sparks fly into the flashpan. On that day, the debris mobilizes.

FIVE MILES INTO the mountains from the edge of the city is a small, obscure, steep-sided watershed of twenty-five hundred acres which is drained by the Middle Fork of Mill Creek, a tributary of the Big Tujunga. The place is so still you

can hear the dry ravel. From time to time, you hear the dry cough of semi-automatic weapons. It is the sound of city folk pursuing a hobby. Recreational marksmanship is permitted on the Middle Fork. There are eight million people just down the wash, and they shoot some interesting guns. Amos Lewis, who covered the region as a deputy sheriff for twenty-five years, once found beside the Angeles Crest Highway "a gun you could hide behind your tie—you'd think it was a tie clip." He has also seen enough muzzle-loaders to have made a difference in the Battle of Long Island. In an imaginative, life-loving city, there will always be people with a need to fire antique weapons. On July 24, 1977, a marksman on the Middle Fork rammed Kleenex down his barrel instead of cloth wadding. Under the Kleenex was black powder. In black powder there is more of an incendiary risk than there is in the smokeless kind. When the rifle fired, flaming Kleenex shot out the muzzle and burned down three thousand eight hundred and sixty acres, including the entire watershed of the Middle Fork.

It was a textbook situation—a bowl in the mountains filled with hard chaparral that had not been touched by fire in ninety-nine years. The older chaparral becomes, the hotter it burns. In its first ten years of new growth, it is all but incombustible. After twenty years, its renewed flammability curves sharply upward. It burns, usually, before it is forty years old. The hotter the fire, the more likely a debris flow—and the greater the volume when it comes. The century-old fuel of the Middle Fork was so combustible that afterward there were not even stumps. The slopes looked sandpapered. The streambed, already loaded, piled even higher with dry ravel. The Middle Fire, as the burn was known, was cause for particular alarm, because a small settlement was a mile downstream. Its name—Hidden Springs—contained more prophecy than its residents

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seemed prepared to imagine. Three hundred and ninety thousand cubic yards of loose debris was gathered just above them, awaiting mobilization.

Dan Davis and Hadi Norouzi, L.A.C.F.C.D. engineers, went up there after the burn to tell the people what they might expect. In midsummer, it is not a simple matter to envision a winter flood if you are leaning on a boulder by a desiccated creek. "We spent a lot of time trying to prevent a disaster from occurring," Davis said recently. "The fact that people would not believe what *could* happen was disappointing, actually. We held meetings. We said, 'There's nothing we can do for you. Telephones are going to go out. Mud will close the road. You're abandoned. If you're here, get to high ground.' " There was no debris basin, of course. This was a hamlet in the mountains, not a subdivision at the front. Conditions were elemental and pristine. "We walked people through escape routes," he went on. "We told them the story of fire and rain. We said, 'If heavy rain starts, you've got fifteen to thirty minutes to get out.' "

Norouzi told them they were so heavily threatened that no amount of sandbags, barricades, or deflection walls was ever going to help them. "There is nothing you can build that will protect you."

Half a year went by, and nothing stirred. Cal Drake went on making jewelry in his streamside apartment. He and his wife, Mary, shared a one-story triplex with two other couples. The Drakes, from the city, had moved to Hidden Springs two years before, in quest of a "quiet life." Elva Lewis, wife of Amos the sheriff, went on running her roadside café. Gabe Hinterberg stayed open for business at the Hidden Springs Lodge. In December and January, there was an unusual amount of rain, but no flood. By the end of the first week of

February, there had been eighteen inches in all. Then, in the next three days, came enough additional rain to make this the winter of the greatest rainfall of the twentieth century, exceeded only by 1884 and 1890 in the records of Los Angeles County. The National Oceanic and Atmospheric Administration selected the word "monstrous" to befit the culminating February storm, in which almost a foot of rain fell in twenty-four hours, and, in the greatest all-out burst, an inch and a half in five minutes. This was the storm that sent the debris down Pine Cone Road, overtopped the Zachau Basin, mobilized the corpses in the Verdugo Hills. In the small valley of the Middle Fork, upon the scorched impenetrable ground, three million tons of water fell in one day.

Toward midnight February 9, an accidental fire broke out in a small building of Gabe Hinterberg's. A fire truck eventually came. Half a dozen people fought the fire, assisted by the heavy rain. One of them was George Scribner. The five-minute spike of greatest downpour occurred at about one-thirty. Half an hour later, George said, "Hey, we got the fire put out."

Gabe said, "Good deal."

And then Gabe and George were dead.

Amos Lewis, nearby, was holding a fire hose in his hand and was attempting to prevent it from kinking. In his concentration, he did not see danger coming. He heard nothing ominous. He only felt the hose draw taut. Through his peripheral vision he became aware that the fire truck—with the hose connected to it—was somehow moving sideways. Seconds later, Amos Lewis, too, was swept away.

The snout of the debris flow was twenty feet high, tapering behind. Debris flows sometimes ooze along, and sometimes move as fast as the fastest river rapids. The huge dark snout

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was moving nearly five hundred feet a minute and the rest of the flow behind was coming twice as fast, making roll waves as it piled forward against itself—this great slug, as geologists would describe it, this discrete slug, this heaving violence of wet cement. Already included in the debris were propane tanks, outbuildings, picnic tables, canyon live oaks, alders, sycamores, cottonwoods, a Lincoln Continental, an Oldsmobile, and countless boulders five feet thick. All this was spread wide a couple of hundred feet, and as the debris flow went through Hidden Springs it tore out more trees, picked up house trailers and more cars and more boulders, and knocked Gabe Hinterberg's lodge completely off its foundation. Mary and Cal Drake were standing in their living room when a wall came off. "We got outside somehow," he said later. "I just got away. She was trying to follow me. Evidently, her feet slipped out from under her. She slid right down into the main channel." The family next door were picked up and pushed against their own ceiling. Two were carried away. Whole houses were torn loose with people inside them. A house was ripped in half. A bridge was obliterated. A large part of town was carried a mile downstream and buried in the reservoir behind Big Tujunga Dam. Thirteen people were part of the debris. Most of the bodies were never found.

As Amos Lewis suddenly found himself struggling in the viscous flow, he more or less bumped into a whirling pickup coming down in the debris from who knows where upstream. One of the roll waves picked him up and threw him into the back of the truck. As the vehicle spun around and around, it neared one bank. Lewis saw an overhanging limb. He reached for it, caught it, and pulled himself above the rocky flow. Years later, just about where this had happened, he told Wade Wells and me the story. "I got pushed to one side," he said as he

finished. "I lucked out." Lewis is a prematurely white-haired man with a white beard and dark-brown eyes. On this day in late spring, his muscular build and deeply tanned skin were amply displayed by a general absence of clothing. He wore bluejean shorts, white socks, mountain boots, and nothing else. When people began to discover human remains in the reservoir, he had gone in his patrol car to investigate the fate of his neighbors. "I had to go roll on them calls," he said. "A deputy sheriff has to roll on any type of body being found. I carried out at least four, maybe five, skulls."

The thirteen people who died in Hidden Springs were roughly a third of the year-round community; there was a much larger summer population. The main house of Lutherglen, a resort-retreat of the First English Evangelical Lutheran Church, remained standing but in ruins. Houses that stayed put were gouged out like peppers and stuffed with rocks. Lewis gestured across the canyon—across foundations with no houses on them, bolts sticking up out of cinder blocks where sills had been ripped away—toward some skeletal frames made of two-by-fours. "They used to be trailer stalls," he said. "The people left their cars by the river and walked up the bank to the trailers. The cars ended up in the dam." The First English Evangelical Lutherans sued the Los Angeles County Flood Control District for twenty million dollars. The judge threw the case out of court—followed, moments later, by the collection plate. Since the act in question was God's, the defendant might as well have been the plaintiff, and the Plaintiff the target of the suit.

I remarked to Lewis, who is now retired as sheriff, that I thought I'd heard a machine gun earlier in the day. "I worked the canyon car here for twenty-five years," he said. "I probably rolled on a minimum of a hundred and fifty calls where people

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said they heard machine guns. I never saw a machine gun."

Wells was attentive to this remark, raising his eyes with interest. Behind his mild ecological look—his tortoise-shell glasses, his amiable scientific manner—lay a colonel's affection for ordnance. At the time, in the Reserve, he was a lieutenant colonel and rising. He'd been on active duty seven years, two in Vietnam. He told me one day that if California were to secede from the United States it would be one of the richest countries in the world and, with its present units of the National Guard, be among the best defended. "You can take a file and in fifteen minutes make an automatic weapon out of an M1," he said to Amos Lewis. "It can sound like a machine gun."

This set off a long and highly technical discussion between the scholarly hydrologist and the shirtless mountaineer, each slipping into a second self against a backdrop of huge boulders that had been somewhere else a short time before and had been delivered by a force that was high in the kiloton range. Most of the mud, sand, and rock had gone into the Big Tujunga, behind the dam, and the county had spent more than two million dollars taking it out. The debris that had stayed in the valley closely resembled glacial debris—chaotic, unsorted till, a round-rock mélange. Far up the hillsides framing the valley, some of it clung like bits of plaster stuck to an old wall, thus recording the high edges of the discrete slug, where six hundred thousand tons went by.

WHEN YOU WALK in the stream valleys of the San Gabriels, you will see rocks the size of heads wedged among the branches of trees. In a small tight valley called Trail Canyon, I saw two boulders that were a good deal wider than the bed of the brook

that had carried and rounded them. They were bigger than school buses. Surrounded by lesser debris, they had moved a long distance in its company. At a guess—from their dimensions and specific gravity—the aggregate weight of the two rocks was a hundred and sixty tons.

In February, 1978, a boulder weighing three hundred and fifteen tons ended up on a residential street about a third of a mile inside the Los Angeles city limits. Through some neighborhoods, boulders in great numbers advance like Chinese checkers. People pile them up against fences, use them in retaining walls. When Dan Davis was working for Flood, he found debris—on an urban thoroughfare after a storm—a mile and a half from the nearest debris basin. ("When I saw that, I knew we had a real problem.") In 1938, a restaurant on the main street of Sierra Madre was destroyed by invading boulders. Two-foot boulders rumbled through Claremont, coming to a stop three miles from the mountain front. Five miles from the front you can see boulders a foot in diameter. If you ask people how the rocks got there, they assume it was by a process that is no longer functioning. If you suggest that the rocks may have come from the mountains, people say, "No way." Off the eastern end of the San Gabriels, rocks the size of soccer balls are eight miles south of the front.

Building stones in places like Glendora and Covina were delivered by streams from high in the mountains. The stream-rounded rock is more vulnerable to earthquake than bricks would be, but bricks are not shipped F.O.B. by God, and in a land of kaleidoscopic risks what is one more if the rocks are free? Mike Rubel's castle, in Glendora, is made of stream-rounded debris in sizes approximating cannonballs. Dunsinane was not much larger than this suburban home. The ground level of Rubel's castle is twenty-two thousand square

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feet. From its battlements rise towers sixty-seven feet high and seventy-four feet high, built with San Gabriel boulders and store-bought cement. There are six towers, four set in the walls and two in the courtyard freestanding. Bees live in the Bee Tower, and emerge through archery slits. All around the walls, muzzles of cannons protrude from crenels that are lined with shark-fin glass.

The intensity of the electronic surveillance is high, but the owner is not unfriendly. He likes to sit on a balcony above the courtyard, looking out over his walls and through the crowns of palms at the ridgeline of the mountains. He is a large man to the point of private tailoring. He began his castle in 1959 and completed it in 1985. When he had been working on the project ten years, he took an unexpected delivery of building materials in the form of a debris slug that breached his defenses, untimbered his portcullises, and got into the inner bailey.

"The ground was shaking just like an earthquake. In the washes, the water was going three billion miles an hour. You could hear the boulders rumbling. It was marvellous."

As a result, there is now a twelve-foot curtain wall on the periphery of the castle. Rubel calls his domain, which is surrounded by commoner houses on a most conventional street, the Kingdom of Rubelia. Numerous crafts are practiced there, and he has a hand-set-printing operation called the Pharm Press. In the Kingdom of Rubelia, F is Ph and Ph is F. There are hand-cranked phorges in the blacksmith phoundry. There are potters' wheels, looms, and lathes.

Sitting beside him on his balcony and dreamily looking at the mountain peaks, I said, "The castle is obviously the result of something."

Rubel said, "Yes. A genetic defect."

Rubel explained that he had built the castle with the help of numerous friends—friends from his days in Citrus High School, friends from his briefer days at Cal Poly. “We were twenty-year-old kids,” he said. “And we were flunking out of school. We said, ‘If we can’t amount to anything, we might as well build a castle.’”

Prince Philip of Great Britain, who is not a Rubelian and gets no F, has made two visits to Rubel’s castle.

Cal Poly—the California State Polytechnic University—is not to be confused with Caltech. I bring this up because I went to Caltech one day and, in a very impromptu manner, asked to see a geologist. Any geologist. It had not been my purpose, in pursuing the present theme, to get into the deep geology. I meant to roam the mountains and the mountain front with foresters and engineers, to talk to people living on the urban edge, to interview people who sell the edge—a foreign correspondent covering the battle from behind both lines. But not beneath them. This was a planned vacation from projects in geology—the continuation of a holiday that had begun with stream capture in the lower Mississippi and had spread forth into such innocent milieus as eruptions in Iceland and flowing red lava in Hawaii. Now, in Los Angeles, I had been avoiding geologists in the way that one tries to avoid visits to medical doctors. All had gone well for a matter of weeks, but then, one morning, I just happened to be in Pasadena looking up into the veiled chimeric mountains, and severe symptoms began to develop. Right off the street—in much the way that a needful patient would seek out a Doc-in-the-Box—I walked into the geology department of the California Institute of Technology, found the departmental office, and asked for professional help.

After a short wait, spent leafing through a magazine, I

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was shown into the office of Leon Silver, whom I knew only by reputation—an isotope geologist whose exacting contributions to geochronology have not repressed his interest in crustal settings, global tectonics, the Big Picture. An ebullient man, husky, in his sixties, he spread out the local sheets from the geologic map of California for a brief rehearsal of the rocks and faults before leading me to the roof of the building, where he continued his diagnosis in the panoramic presence of the rock itself. The roof was flat, a deck. Funnel vents and other apparatus gave the impression that the Caltech geology department was a cruise ship in the lee of seventy miles of mountains.

The institution as a whole, in its remarkable beauty and surprisingly compact size, is sort of a bonsai university—with pools, rialtos, inclined gardens—above which the mountains seem all the more immense. Silver said that if I was looking for first causes in the matter that concerned me I had come to the right place. “The geology provides the debris,” he went on. “The San Gabes are a climber’s nightmare. Several people a year die on the incompetent rock.”

“Yes,” I said. “The rock up there is really rotten.”

Silver seemed offended. Drawing himself up, he said, “I beg your pardon, sir. It is not rotten. It is shattered.” The region was a tracery of faults, like cracks in ancient paint. The mountains were divided by faults, defined by faults, and framed by them as well: on the near side, the Raymond Fault, the Sierra Madre Fault, the Cucamonga Fault; on the far side, the San Andreas Fault. The rock of the San Gabriels had been battered and broken by the earthquakes on these and related faults. In 1971, Silver had flown over the San Gabes immediately after an earthquake that reached 6.2 on the Richter scale. Like artillery shells randomly exploding, the aftershocks

were sending up dust in puffs all over the landscape. Something like that would add quite a bit, he said, "to the debris potential." Some of the rock up there had become so unstable that whole hunks of the terrain were moving like glaciers. One mountaintop was heading south like a cap tipping down on a forehead. Things like that had been going on for so long that the mountains were in many places loaded with debris from ancient landslides—prime material, prepared to flow. "The ultimate origin of the debris flows," he said, "is the continuous tectonic front that has made this one of the steepest mountain fronts in North America and produced a wilderness situation not a hundred metres from people's houses."

The continuous tectonic front is where the North American and Pacific Plates are sliding past each other—where Bakersfield moves toward Mexico City while Burbank heads for Alaska. Between Bakersfield and Burbank lie the San Gabriel Mountains. With the San Bernardino Mountains east of them, they trend east-west, forming a kink in the coastal ranges that come down from San Francisco and go on to Baja California. The kink conforms to a bend in the San Andreas Fault, which runs along the inland base of the mountains. The kink looks like this:



It could be a tiptoeing h. It resembles a prize-winning chair. Los Angeles is like a wad of gum stuck to the bottom of the chair. The mountains are one continuous system, but its segments are variously named. The upper stretch is called the Coast Ranges. The lower leg is called the Peninsular Ranges. The kink is called the Transverse Ranges.

My hieroglyph represents, of course, not only the moun-

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tains but the flanking San Andreas Fault, which comes up from the Gulf of California, bends left around Los Angeles, then goes on to San Francisco and north below the sea. As if this regional context were not large enough, Silver now placed it in a larger one. The East Pacific Rise, the ocean-basin spreading center away from which the Pacific Plate and other plates are moving, sinuously makes its way from the latitude of Tierra del Fuego all the way north to Mexico, where it enters the Gulf of California. The East Pacific Rise has splintered Mexico and carried Baja California away from the mainland—much as the Carlsberg Ridge has cracked open the deserts of Afro-Arabia and made the Red Sea. Baja is not moving due west, as one might guess from a glance at a map, but north by northwest, with the rest of the Pacific Plate. The cumulative power of this northward motion presses on the kink in the San Andreas, helping the mountains rise.

That much has long seemed obvious: as the two sides of the San Andreas slide by each other, they compress the landscape at the kink. It has been considerably less obvious that a compressional force accompanies the great fault wherever it goes. In the past, the building of the Coast Ranges and the Peninsular Ranges was in no way attributed to the San Andreas Fault. A paper published in *Science* in November, 1987—and signed by enough geologists to make a quorum at the Rose Bowl—offers evidence that the San Andreas has folded its flanking country, much as a moving boat crossing calm waters will send off lateral waves. The great compression at the kink is withal the most intense. The Coast Ranges and the Peninsular Ranges are generally smaller than the Transverse Ranges. The San Gabriels are being compressed about a tenth of an inch a year.

Why the kink is there in the first place is "not well under-

stood." Just to the northeast, though, in the Great Basin of Utah and Nevada, the earth's mantle is close, the earth's crust is thin and stretching. In the past few million years, the geographic coordinates of Reno and Salt Lake—at the western and eastern extremes of the Great Basin—have moved apart sixty miles. This large new subdivision of the regional tectonics is in every way as entrancing as it is enigmatic. Almost all of California may be headed out to sea. Already, the east-west stretching of the Great Basin has put Reno west of Los Angeles, and it may be what has bent the San Andreas Fault.

Some of the rock of the San Gabriels is two hundred times as old as the San Andreas Fault, which has been in existence for less than a five-hundredth of the history of the world. Plates come and go—splitting, welding, changing through time, travelling long distances. Before the present North American and Pacific Plates began to work on this particular rock, Silver said, it may have been "bashed around in Mexico twice and perhaps across the Pacific before that." He continued, "It's a bedrock ridge up there. It's a weirdo wonderful block of rocks, the most complicated mountain range in North America. It includes the oldest rocks on the West Coast. The San Gabes look like a flake kicked around on plate boundaries for hundreds of millions of years."

The Santa Monica Mountains, a sort of footnote to the big contiguous ranges, stood off to the southwest of us, discrete and small. Like any number of lesser hills freestanding in the region, they were flexures of the San Andreas system. Oil people had found pay in the traps formed by such flexures. The Santa Monica Mountains were as shattered as the San Gabes. The several debris basins in the Santa Monicas had worked with varying success. People had died in their beds there, buried alive by debris.

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The San Gabriels were rising faster than they were disintegrating, Silver said. The debris basins had given geomorphologists an unparalleled opportunity to calculate erosion rates. They could even determine how much mountain is removed by a single storm. On the average, about seven tons disappear from each acre each year—coming off the mountains and heading for town.

Between the geology-department roof and the San Gabriels, the city gradually rose. A very long, ramplike, and remarkably consistent incline ended in the sheerness of the mountain wall. This broad uniform slope is where the seven tons an acre had emerged from the mountains, year upon year for a number of millions of years—accumulating as detrital cones, also known as fans. Broad at the bottom, narrow at the top, the fans were like spilled grain piling up at the edge of a bin. There were so many of them, coming down from stream after stream, that they had long since coalesced, forming a tilted platform, which the Spaniards had called the bajada.

"I used to live on the mountain front," Silver said. "By Devils Gate, at the mouth of Arroyo Seco. We could hear the big knockers go by—the three-metre boulders. The whole front face of the San Gabes is processed."

"Processed?"

"Shattered and broken. It is therefore vulnerable to landsliding, to undercutting by the streams, to acceleration by local earthquakes, to debris flows."

"Why does anybody live there?"

"They're not well informed. Most folks don't know the story of the fire-flood sequence. When it happens in the next canyon, they say, 'Thank God it didn't happen here.' "

"Why would a geologist live there?"

"It's a calculated risk. The higher you build, the cooler

it is. There are great views. And at night, up there, the cool air off the mountains flows down and pushes the dirty air masses back. The head of our seismological laboratory lives on the mountain front. In fact, most of the Caltech geology department lives on the mountain front."

"Where do you live?"

"Way out on the fan."

Silver passed me along to his colleague Barclay Kamb—the tectonophysicist, X-ray crystallographer, and glaciologist, who discovered, among other things, the structures of the high-pressure forms of ice: ice II through ice IX. Kamb once studied the Sierra Madre Fault Zone on the San Gabriel mountain front, and walked the relevant canyons. Recently, he has been using a surging glacier near Yakutat as a laboratory for the study of how rocks move, since ice deforms in much the way that rock does. He was about to leave for Alaska when I dropped in on him in his office. His mother was there, his father, and his son Linus, who was named for Kamb's father-in-law, Linus Pauling. In a swirl of ropes, ice axes, grad students, and relatives, Kamb, who has been described by another colleague as "the smartest man in the world," tracked six conversations simultaneously, one of which summarized concisely his sense of flowing debris. "There's a street in Altadena called Boulder," he began. "It is called Boulder for a very good reason. It is subject to severe threat. Boulder Road, below the Rubio Debris Basin, is the former course of Rubio Creek. You see encroachment of human habitation in many areas like that, which are most at risk. Above the debris basins, there are crib structures in the canyons. The theory is to prevent sediment from coming out of the mouths of the canyons. I think most geologists would say that is ridiculous. You're not changing the source of the sediment. You are just storing sediment.

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Those cribworks are less strong than nature's own constructs. The idea that you can prevent the sediment from coming out is meddling with the works of nature. Sooner or later, a flood will wipe out those small dams and scatter the debris. Everything you store might come out in one event. We're talking human time—not geologic time." Kamb lives in Pasadena, close by the mountain front.

Just upstairs was Andrew Ingersoll, the planetary scientist. In the San Gabriels, he had lived behind the lines. In the nineteen-sixties, he moved his family into a cabin that was so far up Big Santa Anita Canyon that they had to hike a mile and a quarter just to get to their car. They leased the place from the Forest Service. When they moved in, the children were three and four. Ingersoll was an assistant professor. "My colleagues in the geology department thought I was becoming a permanent hippie," he said. "But in those days everybody was some sort of hippie." The canyon was full of crib structures, arresting debris. Ingersoll did not know how to make sense of them unless they were "an example of bureaucracy doing something for its own sake." (In any case, the small wash above the Ingersolls' cabin was unprotected.) In January of 1969, during a nine-day series of storms, twelve inches of rain fell in one night. A debris flow hit the cabin, broke through a wall, and delivered three feet of mud, innumerable rocks, and one oak to the Ingersolls. The family regarded this as "just a lot of fun," he said, and continued, "Those little dams must have been nearly insignificant. They were based on the experience of Swiss farmers, and this may have been a totally different situation. It might have been a very poor concept to try to control the San Gabriels."

I also met Vito Vanoni, who is now a professor emeritus. A formal, small, wiry man with a husky voice and a sweet

smile, he is a civil engineer, and a founding and still central figure in Caltech's Environmental Quality Laboratory. "That's an awful pile of rock and dirt up there, and we're proposing to hold it back," he said. "To do something like that is extremely expensive, but there are so many of us here to pay the bill, to protect those who insist on living up there. Our zoning is not strong enough to prevent this. The forces of development are hard to oppose. Most people who buy property in those areas never see the map and wouldn't know what they were looking at if they saw one. Very few are aware. When they see the concrete stream channels, I don't know what they think. How many people really realize why the channels are there and why they are as big as they are? You can't build a channel without a debris basin, or the debris will fill up the channel and then start sashaying back and forth. Debris basins have been built in response to the need of the community—after people have had sediment in their living rooms."

I asked Vanoni where he lived.

"Up there," he said. "Below Eaton Basin—since 1949. Like my neighbors, I figure that I'm protected. I haven't seen anything across my yard yet." After a pause, he added, "If they should have a failure up there, I'm afraid I'd get wet." There was a longer pause, then another sweet smile, and he said, "I live a hundred yards from the Raymond Fault."

IN GLEN DORA, I once came upon a solid block of citrus trees surrounded by residential streets. In all directions from this dark-green stamp sprawled the megalopolitan sprawl—the vast groves of houses, many of them with the pantiled roofs, the pocket arcades, the open-trussed porches, the adobe walls

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that Reyner Banham called Neo-Churrigueresque and much admired for making "both ancestral and environmental sense." From the block of citrus the houses continued west unremittingly, east and south indefinitely, and north about eight hundred yards, where they were stopped by the mountain front. The land under the houses was almost all under citrus just a few decades ago—from the orchards of Glendora and Covina east to the orchards of Pomona and west to Pasadena. Glendora's memorial citrus was surrounded by a low stone wall of stream-rounded granodiorite, the principal rock of San Gabriel Mountain debris. As if the dark trees were not beauty enough, the largest bougainvillea in the United States adorned an edge of this vestigial scene. The bougainvillea was planted in 1901, and now, in urban isolation in the Neo-Churrigueresque, was commemorated by a plaque as California Registered Historical Landmark No. 912:

The parent stock was brought to California by a whaling ship about 1870, and the vines survive as one of the best examples remaining of the early 20th Century promotional image of California as a paradise.

"The block of citrus has since been destroyed to make space for condominiums.

Just down the street was the office of Charles Colver, who grew up in a family of orange growers and was now manager of the experimental forest in the mountains above. He lived in his family's original ranch house, its land reduced to a third of an acre. He had learned in his sixty-odd years that the "C" of the vitamin stands for "Chekhov." A tall sandy-haired man with a long face and an attractively slow cadence of speech, he had seen many slurries of flowing debris, in each a story

to tell: "After midnight, the water was rising, still clear, when, with no warning, a big bulk load came through there—a huge wall of mud with a lot of trees in it. It overtopped the flume. The debris was eight feet high."

When the big bulk loads came out of the canyons and went into the orchards of citrus, they knocked over some trees. The debris stayed where it was, and the growers planted new trees. This was the process that had built the fans, and was still building the fans. In a way that housing never could, the citrus accommodated, even when the debris was sixteen feet deep. "We have encroached on nature," Colver remarked to me one day. "When we diddle with Mother Nature, we mess up things. We're living on a floodplain. To look at it, you'd think it was flat, but there's nine hundred feet of difference from Glendora to the ocean. The alluvial fans are that deep. The types of flows that built them go on trying to build them, where we are trying to live."

Before the citrus, there were ranches; before the ranches, Indians; before the Indians, the primeval scene: huge unencumbered alluvial fans leaning into the fast-rising mountains beside the hazy plain—the broadest coastal lowland in all of California. Despite the sea fog and the general lack of more concentrated water, the climate was so congenial that when people discovered it they were willing to struggle to live in it. The people of Asuksangna were among the first. Their village has become Azusa. For agricultural purposes, they burned grasslands in spring. Inadvertently, they torched untold acreages of chaparral and set up innumerable debris flows. Lightning ignited what the Indians missed. Easily, they adapted to the consequent flows. Ranchers, when they came, settled by the canyons to guard the trickling water, and shot one another over rights to the water, which occasionally carried

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loads big enough to kill them all. Huge contiguous ranches lined the San Gabriel front—Rancho San José, Rancho Azusa de Duarte, Rancho Santa Anita, Rancho La Cañada, Rancho Tujunga, Rancho Ex-Mission de San Fernando. During the long drought of the eighteen-sixties, horses and mules went into the mountains to bring out water in tanks. The effort notwithstanding, the bones of parched cattle were scattered about the plain. The message was clear: this environment was no less hostile than it was appealing. When the railroads arrived (1876, 1885), they set off a population splurge that has since become known as California's second gold rush. The people rushing in were farmers, and the gold was oranges. From Kansas City, the fare to Los Angeles was for a brief time a dollar. The citrus orchards were established in small units, Colver said, "ten to fifteen acres each—all that one man could tend to." There were soon a hundred thousand acres of citrus. Ditches from the mountains irrigated the trees. Once in a while, the ditches filled with debris. In 1884, in the aftermath of a fire in Soledad Canyon, debris tore away the tracks of the Southern Pacific. (In 1978, in the aftermath of fire, debris wrecked the tracks in the same place.)

In the eighteen-seventies, to connect agricultural towns, local railways had begun to climb the bajada. Long straight avenues are there now, steadily rising three and four miles. At least one railway was mule-drawn. When the mules made it to the top of the fan, they went around to the back of the train and got onto a special flatcar, on which they rode downhill. In the eighteen-nineties, electricity replaced the mules, and the street railways began to assume almost the exact pattern of the freeways that have replaced them. Under the influence of the Pacific Electric Railway, communities began to coalesce, like the alluvial fans.

For many decades, there was a moat of oranges between the built-up metropolis and the mountain front. After the wildfires of 1913 resulted in the flows of 1914, inspiring, in 1915, the creation of the Los Angeles County Flood Control District, debris was not thought of as the essence of the threat. The operating word was "Flood."

Just after the beginnings of Flood Control, the naturalist John Burroughs lived for a time in Pasadena Glen. The house had broad window seats, wooden casements, a big fireplace made of stream-rounded boulders. Cabinlike in atmosphere, it suggested something a good deal more remote than a suburb, as well it might, for in its steep and shaded canyon it was truly in the wild and beyond the march of towns. This one-street neighborhood, fingering into the mountains under evergreen oaks, still has an escapist look, although it has all but been caught by the city. Taking in the whole neighborhood in a single remark, Chuck Colver will tell you, "Those people are crazy." He means that Pasadena Glen has the compact dimensions of a bobsled run, and the disassembling mountains hover above it. He means that from time to time all hell will break forth from the mountains. To the question "Why, then, do people live there?" the answer seems to be that they are like John Burroughs: they would rather defy nature than live without it. The glen is so narrow that its houses are perched between streambanks and canyon walls. The nearest debris basin is below them, and therefore not meant to help them. The narrow roadway—crossing, recrossing—laces the stream. In contexts in which most people would say "my driveway," people in the glen often say "my bridge." To get to John Burroughs' place you go over a short private ford. That is the entire driveway. A family named Horton lives where John Burroughs lived. The Hortons have watched flowing debris

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demolish their neighbors' houses. "People come in and live—as we do—where we really shouldn't live," Mel Horton remarked to me, tendering the explanation that periods between serious floods are often long.

"It's a fantastic place to be in a storm," his wife, Barbara, said. "You hear a sound like giant castanets—boulders clicking together. They're not pebbles. And there is a scent, which is absolutely heavenly, of the crushed chaparral plants. It's so fragrant and beautiful it's eerie to have it associated with something so terrifying. And, God knows, it is terrifying."

"So why do you live here?"

"Freedom," Mel said. "You go to the city for a living. For provisions. Here at home, you don't have a sense of the city. You feel renewed. There is no sense of encroachment. Although there are fifty-five homes in this canyon, the open mountains begin at this point. You're in the sycamores, the oaks. You feel removed from a sense of being surrounded."

Barbara said, "City people have trouble with the stillness here in this canyon. But something is always going on here, among the ground squirrels, the wrens, the wood pewees. There was a butterfly that chased off a bird." A rooster crowed. Barbara continued, "One needs some sense of perspective if you live in a place that has built-in hazards. But, then, what place doesn't? You can have an earthquake anywhere."

Their daughter, Alison, who lives in Alaska and was about to return there, said, "In Anchorage, I'm in a more urban environment than I ever lived in in Los Angeles. When I was in junior high school and went to friends' houses outside the glen, I felt hemmed in. Home was the escape for me here. In Alaska, I escape from home."

The Hortons' friend Roland Case Ross, emeritus professor of biology at California State University, happened to be there

as well, and he spoke up to say that the Hortons and everyone else in Pasadena Glen were "recluses—seekers of solace, nature contact, and purism." As if Ross were not. Ross remembered the mountains when the state animal was not yet extinct in the state. The state animal is the grizzly bear. Ross followed bear trails through "fog-drip country" in "chaparral litter to your knees." He knew the wild mountainsides, and how to get back to "Loss Anglus." One rainy day, he was invited to a restaurant in Altadena, and he firmly declined. "Only a damned fool would put a restaurant in a floodplain," he said. The restaurant was destroyed that evening by a debris flow.

Mel Horton said that Pasadena Glen, like so many other canyons where houses penetrate the mountain front, maintains its serenity for years on end until "four inches of rain falls in one hour."

Barbara said, "It catches your attention."

In 1969, after less than two inches of rain fell in one hour the Hortons' house was shaking, debris gouged the streambed and quadrupled its width, neighbors' houses were undermined to the point of destruction, telephone poles danced about like sticks, a big tree trunk heaved into the air and shorted the power line, and debris that missed the Hortons' house went through the house below them. Recalling that night, Barbara Horton said, "Those boulders that came down were like pianos. They formed a dam fifty feet above our bridge. Then the water broke around the sides. The larger part went across the road, toward the Childresses'. Childress wanted to run out his back door with his children. He couldn't. The flow went around his house and destroyed the Hemmings' place. Hemminger was on the roof rescuing his cat. The Hemmings eventually moved to another house in the glen."

After the 1969 event, the Forest Service, with "the bless-

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ing of the Flood Control people," lined the stream with Gunite in Pasadena Glen. I walked upstream with the Hortons, to the head of the populated canyon, to see what the Forest Service people had done. They had changed a natural stream into a concrete trough. Barbara Horton said, "It's something everybody tries to forget." The Gunite banks were topped on both sides with hundreds of large granitic boulders. Protecting the uppermost property in the glen was a twelve-foot stone barricade. In the stillness, a sound came from the head of the canyon and amplified as we drew near. It was the sound of falling water—falling off a ledge and three stories down, between narrow chasm walls. There were trees rooted in the chasm walls, and brown grass on a slope above the falls. There had been no rain in four months. The sound of the water was as unexpected as the sound of falling water on the moon.

BY THE NINETEEN-THIRTIES, the Thoreauvian recluses were well established in the mouths of canyons, and the city had not yet approached them. Looking down the fan across the orange orchards, they could call themselves remote. It is coolness that makes an orange orange. The air that fell in the evening off the San Gabriel front touched the dark trees with color, and the towns among the foothills were still discrete.

In November, 1933, the chaparral burned in numerous watersheds above Pasadena, La Cañada, La Crescenta, and Montrose, and slopes were left black and bare. Rainfall in amounts that the Flood Control District called a "Noah-type storm" followed in the last days of the year, mobilizing, on January 1, 1934, a number of almost simultaneous debris flows that came out of the mountains, went through the orchards

and into the towns, killed dozens of people, destroyed hundreds of houses, and left boulders the size of icebergs far down the fans. (In the middle of all this chaos, the football team of Columbia University went into the Arroyo Seco and defeated Stanford in the Rose Bowl.) Out of Pickens Canyon came a debris slug of such magnitude that it travelled all the way to Foothill Boulevard, crossed it, and passed through the business district of Montrose. A boulder eight feet in diameter came to rest on the main street of town, three miles south of the mountain front. This was the same Montrose to which Jackie Gentofle would one day retreat in order to feel safe. The New Year's Day Flood, as people still refer to it, killed thirty-four in Montrose and neighboring towns, and ruined nearly five hundred houses. All over the bajada, Model A's were so deeply buried that their square roofs stuck out of the mud like rafts. Streets of La Crescenta, a mile downhill from where the Gentofles live now, were like the braided rivers of Alaska, with channels of water looping past islands of debris.

The working gravel pit that filled up and fortuitously became the prototype debris basin was in Haines Canyon, just above the village of Tujunga, whose civic infrastructure it happily preserved from otherwise certain annihilation. While the mud, sand, and boulders that were deeply spread on the alluvial fans were demonstrating that a flood of rock was a far greater menace than a flood of water, this inspirational gravel pit was showing what to do about it. With enough money—enough steam shovels, enough dump trucks, enough basins cupped beneath the falling hills—Los Angeles could defy the mountains, and append to an already impressive list one more flout in the face of nature.

After Pearl Harbor, rapidly expanding war industries drew people to Los Angeles from all over the United States. They

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worked mainly in the oil, steel, and aircraft industries and in plastics factories that made butadiene as a substitute for rubber. The ascending effluents of the smelters, refineries, mills, and factories added a great burden to the marine fog layer—made heavier still as the work force moved about in cars. To describe this ochre cumulus, the world's shortest portmanteau word, which had been coined around 1905, was borrowed from London.

Housing developments had to be created. The land under the orchards was an obvious choice, and a lot of citrus fell in the war. Like a spider plant or a wandering Jew, an orange tree is psychologically sensitive. Not surprisingly, a virus broke out in the orchards—a strain known to pomologists as “the quick decline.”

When the war ended, the quick decline did not. As Chuck Colver well remembers, “This was a mortal blow. If a grower didn't suffer from it, he thought he would, so he sold to a developer as an easy way out. After the war, the new people stayed on, and it was readily apparent that agriculture and urbanization were not compatible. Citrus relied on smudge pots to protect the trees against freezes. It used fertilizer that was smelly. It created dust in the tilling. It bred flies. Big slow trucks went around full of oranges. Everybody had tolerated all this when oranges were the sole economy, but it was a nuisance to the newcomers. They threw garbage in the orchards. They stole oranges. And, above all, they complained. They passed laws against smelly fertilizer, against smudge smoke, against pesticides. Citrus could not compete. Water became too high-priced. Smog began to affect the trees. The size and quality of fruit deteriorated. A superior product became an inferior product.”

Fifty miles of citrus disappeared as the communities co-

alesced and the megalopolitan census passed eight million. Los Angeles did not spread out like a blooming flower, or grow from a center, like continental ice. It grew all at once all over the plain. It filled in the mountain front. In the late winter of 1938, thirty inches of rain had fallen in six days. Publications of the United States Forest Service later described the event as "the greatest rainstorm in the recorded history of the San Gabriel Mountains." Early debris basins did not pass this test. They filled up and overflowed. They were not designed to separate rock from water. With the rise of population, and the postwar proliferation of development along the mountain front, successive debris dams and accompanying basins—each unique, fitting the conditions of its canyon—became ever more proficient, designed to function like giant colanders. The most recent is Buena Vista Debris Basin, which was built in 1981 at the head of Norumbega Drive, in Monrovia. With its Yale bowlishness, its columnar steel trash racks, its perforated outlet tower, and its two-hundred-foot-wide rock-filled concrete dam, it represents the state of the art. The confident owner of a house just below it has landscaped his place with sandbags.

Generally, the debris basins work. People can lie peacefully in their beds and listen to the thunk of boulders heading into traps. Carter Canyon Debris Basin, in Sierra Madre, is in an extremely steep gorge under high-rising mountainsides. Carter Canyon is where Wade Wells, one arid afternoon, pointed out to me a number of rock outcroppings about thirty feet above the dry streambed and said they were the lips of falls. The debris basin was built in 1954. In the autumn of 1978, eight different fires denuded the mountains above. The Mountain Trail Fire—the one most closely related to Carter

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Canyon Debris Basin—consumed fifteen hundred acres. During a storm a few weeks later, Wells went to Carter Canyon and watched hundreds of tons of mud and boulders coming over one of the falls. The basin caught it all effectively. The basin was cleaned out, and trucks took away the debris. In 1980, when Carter Canyon Basin filled again, water alone went over the top.

There cannot be a debris basin under every rock and rill. Dennis and Susan McNamara live at 3529 El Lado Drive in Glendale, below the mouth of a minicanyon that drains about twenty-five very steep acres covered with chaparral. They had lived there for five quiet years when the watershed blazed like a ceremonial torch, September 22, 1975. Came the winter rains of 1976, and a debris slug appeared in their back yard. It filled their swimming pool. It continued across the patio and broke through glass panels into their house, where it eventually found the kitchen door and proceeded into the street. In 1977, another debris flow appeared in the McNamaras' back yard, filled the swimming pool, advanced into the house, found the kitchen door, and went out to the street. In 1978, when still another debris flow appeared in their back yard and filled their swimming pool, the McNamaras were nothing if not experienced. They slid open their glass doors and stood aside from the entering rocks. "Just the one fire started all this," Susan told me not long ago, as she showed me around. The by now revegetated slope was a steep handsome backdrop to the house. The pool was sparkling—a little debris basin in itself, all cleaned out and ready for what might come. "When it comes, it sounds like an avalanche," she said. "You can hear it start to rumble. The rocks crash against the house. Afterward, we thought of leaving, but you can't sell a house

in this situation. You'd have to tell the buyers the endangerment of it. If it rains, we get very apprehensive. We still call each other and say, 'Are you all right?'

The City of Glendale responded to the McNamaras' situation by giving them free grass seed. "That's all," Susan confirmed. "I can't say enough about the City of Glendale. In Palos Verdes—for the rich people—they *move hills*."

A debris basin that serves well in one year may not be adequate in another. It may be able to handle a fire-flood sequence of the magnitude for which it was designed, but a debris basin is not a strip mine. After a truly exceptional fire followed by a most exceptional flood, something like a strip mine is required. Designs are focussed on the "ten-year flood," the "twenty-five-year flood," the "fifty-year flood," and maps depict the "once-in-a-hundred-years flood," but these terms rest on data of only a century and a half and represent educated guesses. Rain, moreover, is merely one factor. No wonder there are times when the basins fail. When the debris hit Glendora in 1969, it scarcely slowed up as it filled two debris basins with an aggregate of a hundred and fifty thousand tons and flowed on into town. If you go up Country Club Drive, in Sunset Canyon, Burbank, you note a thick rind of defenses. With shored timbers, with six-foot walls of reinforced concrete or piled stone, properties are presented to the narrow street like medieval façades to an open sewer. There are three debris basins along Country Club Drive. There were two in 1964. The upper one failed. The slug that came down the street and invaded houses killed Aimee Miller, the wife of Frank Sinatra's piano accompanist. Her home was knocked off its foundation. Her husband was swept downhill and into a debris basin. He survived by hanging on to a Volkswagen that was part of the debris. One of their neighbors said, "When you live in a

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drainage ditch, you come to expect these things." Another said, "People often ask why we continue to live here. We have a fire nearly every year, and the floods follow. There isn't a prettier, more secluded canyon in Southern California—when it isn't on fire or being washed away. Each time we have a disaster, only one or two families move out, but there are hundreds standing in line waiting to move in. People live here, come hell or high water. Both come, and we still stay."

In the same era, a debris barrier failed above the ranch of G. Henry Stetson, the hatmaker, who had established his spread at the west end of the San Gabriels, in—of all places—the mouth of Sombrero Canyon. Below the pantiled roof, the balconies of the hacienda dripped with bougainvillea over mud deeply entering the doorways below. The floors were covered three feet deep. The furniture was destroyed. Lawns and gardens were buried under boulders and mud, which filled the Stetsons' million-gallon swimming pool and spread through their orchards, too. Sixteen feet above the streambed, a reinforced-concrete crib member that weighed two hundred and eighty pounds smashed against a tree, and the four reinforcing rods were bent around the trunk. In all, twenty-five thousand tons were added to the Stetson Ranch. The freshly burned watershed yielded altogether at least four times as much. The Stetson Ranch exists no longer. A new debris basin was built above the site. Its name is Sombrero.

Despite the recurrence of events in which the debris-basin system fails in its struggle to contain the falling mountains, people who live on the front line are for the most part calm and complacent. It appears that no amount of front-page or prime-time attention will ever prevent such people from masking out the problem.

Woman at her mailbox on a street called Bubbling Well.

In 1969, under six feet of debris, Bubbling Well stopped bubbling. "They've built more dams up there in the mountains," she says. "It will never happen again."

There are lots of mailboxes along the mountain front.
"There is no problem now."

"Our property is not affected."

"I think we're all pretty well covered. I'm hoping so. The water rushes down quite nicely in the wash."

"The fire was three years ago. It's not supposed to flood. I cancelled my flood insurance last year."

"No, we're not concerned. We lived through the San Fernando earthquake."

Many people regard the debris basins less as defenses than as assaults on nature. They are aesthetic disasters. To impose them on residential neighborhoods has been tantamount to creating a Greenwich full of gravel pits, rock quarries at either end of Sutton Place. The residents below Hook East were bitter when the basin was put in. Months later, the bulldozer tracks were still visible, they said, meaning that nothing had happened—no debris had come, and not even enough rain to obliterate the tracks. So why had the county used taxpayers' money to build something so obviously unnecessary? A form of answer came when the basin overfilled in one night. Afterward, people criticized the county for not building basins of adequate size.

When I talked to Peter Fay, who lives just below Sierra Madre Dam, he said there was a fire in his area every six or seven years. He found that "very exciting, almost fun," he said. "I have no intention of leaving the foothills. The views are so marvellous. The level of concern is quite low. If you live up in the hills, you have less smog, better views, more interesting contours—a sort of bosky sort of place. Part of my

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house was destroyed in 1969, but I am confident it won't happen again." Fay is a professor of history at Caltech.

In 1977, when Dan Davis was an engineer at Flood, he approached another homeowner below Sierra Madre Dam to warn him of the almost certain consequences of a recently extinguished fire. The man said he had lived through the 1938 flood, he had lived through the 1969 flood, and he was not concerned now. He must have had hide on his teeth. When the 1978 debris flow came, his place was buried deep in debris, but he survived.

People of the mountain front make remarkably hardy clients for consulting geologists and engineers:

"If you point out a potential geologic hazard, they say, 'I'm ready to live with that.' People really don't believe what it's like until they go through it."

"Most people don't give it a thought. Or they minimize the importance of it."

"People forget so soon. In a couple of years, they build again."

"They are playing ostrich."

As the larger rivers come into the Los Angeles plain, they sometimes thrash so violently that they pick up fresh debris from under people's houses. In 1969, when Marilyn Skates was twenty-six years old, she watched the houses of six neighbors go into Tujunga Wash. Her own house, swaying, hung on the brink. "What good does it do hanging there like that?" she cried. "Why doesn't it fall in like the rest? Go. Go. Go. Fall over. How can a house just stand there like that?"

It couldn't. The house slid into the Big Tujunga and was ground up so violently that pieces of it flew into the air. Her neighbor James Dubuque, out on the street and concerned about the fate of his own house, was about to go back inside

when a police sergeant said through a bullhorn, "If you go back into that house, prepare to take your last step. That house is going into the wash—now!"

DAN DAVIS SHOWED ME some pictures of houses wrecked by a debris flow in Ebey Canyon that same year. I asked him, "What do people think when they buy such places?"

He said, "They never see the previous event. They move up there five, six, seven and more years, and nothing happens. They don't realize the tremendous change taking place in the watershed as it gets ready for another fire. Eventually, fire threatens them. Then flood. And they are on the Santa Anita Fault. Everywhere on the mountain front, people say, 'I've lived here x years. I've never seen any flow.' They won't, until there's a fire."

When I talked with Richard Crook, a consulting geologist, he said, "Most people are not conscious of the problem. Developers will buy a piece of property without thinking, for example, that it's at the mouth of a drainage. The engineers should be cognizant of it, but they're not. There are ordinances now, but in the past there were not. Every bad year, the agencies stiffen their rules. All this assumes that we know what the maximum situation is. Maybe we have not yet seen the hundred-year flood, or even the fifty-year flood. There are a lot of disasters up there waiting to happen. The people want to live in these areas. When they buy houses, they don't know what they are getting into. The entire county ends up paying for these people's problems. The people should be assessed for these things. They are localized problems. The whole county is subsidizing people on the front line."

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Not to mention the federal government. Los Angeles is obviously rich (an indigent, threadbare city could never put up the defenses that Los Angeles has rigged against the attacking mountains), but no city is rich enough to pay off the family of every soldier who dies at the walls, or underwrite every house that fills up with boulders. Enter the generous people of the whole United States, whose revenues will help to cover the loss of a house constructed in the barrel of a canyon. The federal insurance is expensive. Its varying rates are based on zones of relative danger and on the quality of local flood-protection programs. On the average, a yearly premium of just under a thousand dollars will buy the maximum: two hundred and forty-four thousand dollars' worth of coverage. One does not have to be an actuary to see the general odds. Of, say, ten thousand houses along the mountain front, three to four hundred will be zapped per decade. A few private companies write such insurance as well. You can get lower rates if you have a "floodproofed house," which means that you are armed with deflection walls and other defenses to repel debris and send it elsewhere. In which case you also need a lawyer. Against debris flows and all other kinds of flood eighty per cent of the mountain-front people have no insurance at all.

It's an interesting bet. If you don't have a fire, you could go fifty years without a flood. After a fire occurs, people from the Sedimentation Section of the Hydraulic Division of the Los Angeles County Department of Public Works are swift to tell homeowners what to do when rain comes. After studying someone's property, they present a "Post-Fire Protective Advice" sheet, on which one or more of twelve printed suggestions have been checked off. One suggestion is "Construct pipe-and-timber deflector." Another is "Board windows and/or

doors with plywood." Another is "Consider evacuation during heavy storms."

Arthur Cook, the Acting City Manager of Glendora, recalls with some choler the procedures of 1968 after twenty thousand acres burned above town. When I visited his office in City Hall, he said, "The whole face of the hills burned. We started right then to prepare for the winter rains. We knew what would happen. It was evident. We went to the government agencies—county, state, and federal. We were met with total negativism. They could not help *prevent* a disaster, they said—they could only come in after the fact. We thought, If no one's going to help us, we'll try to help ourselves. We held neighborhood meetings. We recommended plywood walls, block walls. We told people they'd have to make their own preparations. People said we were alarmists. They'd lived here fifty years, and, by God, it had never happened. So the city installed batten boards along some streets. On Rainbow Drive, we erected chicken-wire fences with sheets of plywood. We deployed thousands of sandbags."

Sally Rand lived in Glendora, pretty far up on the fan. At Christmastime that year, in the Kingdom of Rubelia, she did her phan dance at Mike Rubel's castle. Four weeks later came the devastative rain. Listening to it thump his roof, Art Cook said to himself, "This is the night. I'd better get down to the Hall." He got into his car and went down Palm to Grand; as he turned onto Grand, the flow met him. It picked up his car and carried it a quarter of a mile. ("I just sat there, scared as hell.") Eventually, his slithering wheels found traction, and he drove off none the worse for having been a part of the snout of the debris. "A wave six to eight feet high came out of Rainbow Canyon," he said. "The rock, debris—every-thing was suspended in the liquid mass. Horrendous boulders,

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trees, car bodies were suspended in the mass. It sounded like a train—a runaway express train. Just a roar."

As an average populace in a shamefully litigious nation, the people of Glendora took their town to court. "After we busted our butts for months trying to help people, we ended up being sued by the people we tried to help," Cook said. "They said in court that we were cognizant there were going to be problems and we did not stop Mother Nature in her tracks. You read about flooding on the Mississippi. They don't sue the city for not keeping the Mississippi from going over its banks. Here they do sue the city for not keeping the mountains from eroding." The city lost.

I asked Cook how things appeared at the moment. After mentioning a couple of new debris basins and some crib dams, he said, "The areas are protected now. People rebuilt. People had their home and they were going to keep it. People started listening to City Hall. There's no way to guarantee that Mother Nature won't go on a rampage, but if it did we have the facilities to cope with it. Now we're in great shape, with no concern for the future."

In the fifty miles of the San Gabriel front, almost all levels of income are represented, from multifamily dingbats to pasture enclaves with moats and armed guards. Under isolated tufts of old citrus are electrically operated iron gates leading to palm-lined driveways between retaining walls of granodiorite debris. Relentlessly, builders go on finding tracts for new housing. They often borrow something from the precipitous slopes—a practice known as mountain-cropping. Whether an owner has a two-million-dollar house protected by nothing more than a trash rack in front of a culvert or a hundred-and-fifty-thousand-dollar hut with a large debris basin right beside it, debris-flow information is supposed to be a part of the

exchange when houses are sold. For example, here's a nice little bungalow for sale pretty far up the fan in the neighborhood where Art Cook and his automobile were given a quarter-mile ride by the debris flow of 1969. Three bedrooms. A quarter of an acre. How about debris flows?

"Not that I know of," the realtor says. "I've never heard of that happening up there."

House, swimming pool, Jacuzzi, forty yards from Pine Cone Road, \$274,500. Could there be a debris problem?

Crescenta Valley Realty: "No. There is not. There is not any problem."

"Why not?"

"It is well maintained."

Pasadena Glen. Two bedrooms, one bath, nine hundred and fifty-two square feet, \$129,500. Flood and mud?

Realtor: "There has been in the past—some flooding in the lower areas. But this one is up high. We have to make buyers aware that they are in a special-study zone."

A special-study zone is a place where debris is likely to interrupt the special study, where canyons aim at homes, where insurance rates are high.

New home, built by developer, on one acre, on Ben Lomond Drive, Bradbury. Four bedrooms, four baths, three thousand square feet, \$337,500. Flood and mud problems?

Coldwell Banker: "Not to my knowledge. They would have to be disclosed, too. Each listing has a seller's disclosure form, and there's nothing about mudflows on the form."

House on Bubbling Well, Glendora, \$167,000. Mud and flood?

Alosta Realty: "No, no. Oh, years and years ago we had a big flood. They built that dam, and there's no problem there at all."

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Silent Ranch Estates, shake-roofed or tile-covered castles, "individually built," in the four-hundred-thousand-to-one-million-dollar range. Possible debris-flow problems?

Realtor: "There are a couple of houses which I would not touch. The others—I don't think so. I haven't heard anything to that effect. Every house you'd see, we'd have to take that into account."

Terrace View Estates, gated community, all view lots, up to one and a half acres at roughly \$135,000 an acre. Debris flows?

"No. We went through the whole winter there. We had some very heavy rains and there were no problems."

New development in a former orange orchard—top of the fan. House for sale: four bedrooms, exercise room, sunken shower, sunken tub, elevator, \$1,100,000. Flood and mud?

Realtor: "I have watched this project for over two years. There is no evidence yet of anything. Our company bought three lots there. We would not have invested in these places if there was a problem."

The house across the street has forty-five hundred square feet of living space, not including its three-car garage; a dry gully in the back yard is spanned by a footbridge—\$695,000. Although the street is a cul-de-sac, it has evidently been designed as a conduit for more than motor vehicles. The houses beside it are high on built-up banks. Below the turnaround at the bottom is the mouth of a concrete channel, waiting to take in whatever may come. Above the tract, a developer-built debris basin and trash rack call to mind a teacup and tea strainer. The slope rises through live oaks into soft chaparral.

Three-bedroom tri-level, two and a half baths, on two-tenths of an acre in Sunland, just inside the Los Angeles city line. Den, wet bar, pantile roof. \$245,000. Mudflow problem?

"I have worked in that area since 1979, and there has not been, to my knowledge, anything large up there."

Flat roof, carport, thick-picket fence, fifth of an acre in Sunland, just inside the Los Angeles city line. Debris?

"Trust me. I have lived many years in hill communities. About ten years ago, there *was* a problem. It had to do with the way they had graded the cemetery."

Six bedrooms, septic tank, three baths, fifth of an acre in Sunland, just inside the Los Angeles city line. Mud-flow problem?

"Yes, it's always a problem. Special insurance is necessary."

Two bedrooms, one bath, \$91,000, in Sunland, just inside the Los Angeles city line. The house is on Hillrose Street directly below Verdugo Hills Cemetery. Could there possibly be a debris-flow problem?

"No. Not at all."

Four bedrooms, three baths, pool, third of an acre, \$239,900, on Hillhaven Avenue, Sunland, just inside the Los Angeles city line. Is there a debris problem?

"If you make an offer, the seller must tell you. A cemetery slid out a couple of years ago."

Other houses, other realtors, same neighborhood:

"I don't know. I don't think they have that problem there."

"There was a problem years ago. They have a channel there now."

"It's always possible, but that place is not on enough of a hill."

"Not that I know of."

"That I don't know. You have to check with the City of Los Angeles."

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CARL GUNN CAME TO Los Angeles with his parents in 1916, "when you could drill a hole ninety feet deep and the water would flow out and irrigate your eighty acres." Born in Iowa and made of baling wire, he has been in Glendora fifty years. Like Chuck Colver, he antedates the debris basins and the people they protect. He still lives beyond all defense, far up the bed of a canyon, in what is locally called the elfin forest. His house is small, one-story, with tractors, disk harrows, and other machinery around it, at the base of a slope that rises fifteen hundred feet in half a mile. Retired now, and close by a wood stove, he used to work the Blue Bird Ranch. He leased four hundred and forty acres and raised cattle and lemons. He said, "When I was farming the Blue Bird and we got forty inches, we was tickled to death—cattle running around in grass that was up to their belly. There were some beautiful silt valleys here. Now it's all houses and streets. The old ranchers and farmers are gone. Damn few know the story. They're newcomers. Ninety per cent of them never know that the water can go down there like the milltails of Hell. They have no perspective on the possibilities. The people who buy the houses don't know that sooner or later stuff is going to come down through here like shit through a tin horn." Gunn once built himself a crude two-room cabin. It recently changed hands for two hundred and fifty thousand dollars. In the canyon where he lives now, a loud sound woke him up one winter morning at six o'clock. It was the sound of errant debris breaking into his house. "Before you could say 'scat,' the water and mud were three feet deep. I didn't hardly believe it. It doesn't bother me. I know that it happened. If a fire comes, then I worry. I wouldn't trade this place for a dozen others, even though you know what can happen. It's the privacy. The

coyotes. The deer. If it gets where I can't pee off my front porch, I'll move."

Chakib Sambar, who was born in Lebanon and is now the vice-principal of Crescenta Valley High School, has lived against the mountains nearly thirty years. He has seen his share of debris—especially outside his back door, where it has built up in considerable volume in a crease called Eagle Canyon. When I called on him one day in early June, he handed me a 3-iron. As we began a short hike into the canyon, he explained that the sheriff had circulated a rattlesnake alert. "I've never been out here at this time of year," he went on. "I only come out in the spring and the fall."

I said, "You call this summer?"

He said, "When it hits a hundred, it's summer."

The canyon was loaded with debris. We walked through pale-yellow yucca. "This is California chaparral," he said. "When a fire hits this plant, it explodes. It actually explodes." Sambar's son Tod was with us. He did not carry a golf club and was apparently relying on his youthful agility to frustrate the baking serpents. Sambar carried a putter. "We have seen a lot of fires and floods," he said. "The original channel in this canyon was forty feet lower than it is now. This is the beginning of another disaster—a great mass of debris to go out in a storm."

"It seems to be aimed at your house," I said.

"Yes," he said. "It is." And he laughed as he added, "My wife is not very thrilled."

"Then why do you live here?"

"Actually, we moved up here because it was the only place we could afford. We bought our house for thirty thousand dollars. It is now worth ten times that."

When the Richter scale is busy, waves form in the Sambar

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swimming pool. When fires close in, the Sambars have stood on their roof to watch the flames.

"This canyon and this entire mountain were on fire for forty days," he said. "You learn to adapt. You live with it. Fortunately, trouble doesn't come too often. In the years we have been here, we have had only one major earthquake, two major fires, and one major flood."

In Los Angeles, a longtime resident born in Iowa or in Lebanon is something like a royal palm. Neither is native and both are common. Rare, though, is Miner Harkness. He was born in Sierra Madre, and half a century later he still lives there—right up against the hard chaparral, with a watershed behind him that has an average grade of eighty-five per cent and in many places is vertical. This is the country under Mt. Wilson, the roughest segment of the range. Harkness has an insurance brokerage, which is half a mile from his house. On a wall there is an Ansel Adams poster called "Examples." In the photograph, huge boulders lie at the foot of mountains.

Harkness likes to go up from town and into the loose rock. "My big love is backpacking and taking day shots out and doing peaks," he said. "I'm not a big-wall rock climber." The remarks were made in his Toyota 4 × 4 while he showed me around the nearby mountains. He was a small, compact man with alert blue eyes and dark brows, an intelligent and kindly face. His hair, generally thinning, was gone in the back, his beard Vandykish and in two shades of gray. We were looking north up Big Santa Anita Canyon—a lovely vista over crisscrossing spurs. On a high mountain face several miles away was a region that appeared to have been bared, and bared again, by the sort of rock avalanche that comes away like a broken tooth and exposes the interior of hundreds of acres of mountain. There were dozens such. The denudation had been caused entirely

by human beings, and was the result of the switchbacks in a complexly engineered route built to enable trucks to get around a falls. "It's still eroding," Harkness said. "It's a permanent scar. We call it the Burma Road."

The trucks hauled the concrete bars and other components of some fifty crib structures that were emplaced in tributaries of Big Santa Anita in the early nineteen-sixties. Harkness referred to them as check dams, and explained—as Barclay Kamb had—that they were meant to prevent the streams from downcutting and thus reduce the watersheds' production of debris. Harkness said, "Big Santa Anita Canyon was a wild place with a beautiful trail in it. When they bulldozed that giant road, we thought they were *creating* more debris flow than they could ever hope to stop. With the check dams, they were virtually destroying the canyons. All the natural beauty was being virtually wiped out. I felt that what they were doing was wrong. It was costly to taxpayers, too. We're talking about millions and millions of dollars, wasted. There is absolutely no good reason to put those check dams in. They were doing this in canyon after canyon after canyon."

It was an era when even the newspapers were reflecting the confidence of the county engineers—when, according to one reporter, "stabilizing the steep banks will, once and for all, put an end to erosion."

PROJECT AIMS TO HALT
EROSION OF MOUNTAINS

VALLEY AUTHORITIES VOTE
LANDSLIDES UNNECESSARY

"Flood Control and the Army Corps of Engineers have lost all perspective as to what they're all about," Harkness said.

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"The difficult thing is, they get paid, and we—who just live here—don't. If we stop them, they come back a few years later and do it again. They refer to flood control and saving human lives—they push it on that basis—and that's a lot of bullshit. They were going to do Little Santa Anita, cutting roads in six or seven miles. Can you imagine the debris flows that would be caused by *that*?"

The check-damming of Little Santa Anita was stopped by Miner Harkness, Barclay Kamb, Peter Fay, and others, whose organized efforts dissuaded the Los Angeles County Flood Control District and the Los Angeles County Board of Supervisors. While the battle was going on, a volunteer who spent his evenings knocking on doors to enlist opposition to the check dams spent his days in the mountains as a heavy-equipment operator vigorously making check dams.

"We were not just the Sierra Club raising hell," Harkness said. "I have great respect for the Sierra Club, but I think at times they oppose everything that comes along. I'm not just some nature nut. I've been in the mountains, and I know what the mountains are about."

Harkness has seen three mountain lions—creatures so elusive that a person can spend a lifetime trying to see one. As a kid, he hunted deer with arrows. When the red cars of the electric railway came up to an earlier Sierra Madre, people got off and hiked into the canyons. At night, they sometimes carried tin cans cut through on a slant to hold and reflect lighted candles. They walked up Little Santa Anita Canyon and on to the observatory on Mt. Wilson, climbing four thousand feet holding candles. In the mountains above Sierra Madre lived four Lalone brothers, who trapped coyotes and cut wood. Unsurprisingly, they were often called upon to search for and rescue people whose candles—this way or that—

went out. The efforts of the Lalone brothers evolved into a group called Sierra Madre Search & Rescue. The team is twenty-five in number now, and Miner Harkness has been a part of it for thirty-five years.

We drove downstream toward the city. Near Big Santa Anita Dam, which was built in 1927 to impound water, he said, "Kids climb the walls of this beautiful canyon. They get scared and freeze. The rock is decomposed granite, which is a climber's nightmare. In the Sierra, the granite would hold a two-ton truck; here it won't even hold my hands pulling down on it. We rappel to the kids. Tie them off. Get a rope and helmet on them, and bring them down."

These were the first people to train bloodhounds for mountain rescue. They were the first to rappel from the air. On a rescue in Bear Canyon, ten miles from home, Harkness was in a helicopter and, in his words, "there was just no place to land," so he stood on the skids and jumped to the ground. That was the impulsive preamble to a rappelling procedure now known as helitak, which is practiced by mountain-rescue teams everywhere in the world.

The members of Sierra Madre Search & Rescue are so skilled and so famous that they have been called to emergencies in, among other places, the Adirondacks, Iowa, and Mexico. Needless to say, they cover the whole of California. Their phone number is on a wall at Yosemite National Park. They conjoin sometimes with the United States Air Force—C-130s with Sierra Madre trucks inside. In the nineteen-seventies, they thought of lowering bloodhounds from choppers in slings, easing them down into the chaparral. The procedure has its limitations. A lot of San Gabriel terrain is much too rugged for dogs.

In Sierra Madre's City Hall, the team has a den they call

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the Rescue Room. Citations adorn the walls—from the American Red Cross, from El Gobierno del Estado de Baja California, from the Department of State of the United States of America. Hanging from the ceiling is a helicopter's tail rotor bent like a boomerang. A parachute is up there, too. Now that they can rappel from helicopters hovering as much as a hundred and fifty feet off the ground, they no longer have a need for parachutes. The Rescue Room is furnished with seats from a 747.

As a consequence of jumping off helicopters and carrying heavy backpacks, Miner Harkness walks with a very slight limp. On New Year's Day, he rides. When the community of Sierra Madre constructed a Rose Parade float to display the Search & Rescue team, the float was a rolling mountain.

At the upper edge of his home town, we went into Sierra Madre Canyon—a former summer colony, a narrow wash of the Little Santa Anita River. It was something like Pasadena Glen, a couple of miles away, but instead of Gunite stream-banks—not to mention the reinforced-concrete box channels prevalent elsewhere—this unaltered wash was full of stream-rounded cobbles and brought to mind villages of the Pyrenees and villages of the Massif Central. "Some houses in this canyon you walk up a trail to get to," Harkness said. Most were extremely close to the wash and to each other. There was a covered bridge over the wash. At the head of the street was Sierra Madre Dam, larger than an ordinary debris basin but modest as a dam. Harkness said he had seen logs three feet in diameter shooting over the spillway like canoes. Los Angeles County and the U.S. Army Corps of Engineers had proposed expanding the dam and building crib structures far up the canyon the better to arrest the debris. "They spoke of major fires, of the hundred-year flood. It's always the same tactics.

But the people of Sierra Madre said, 'Buzz off!' We said, 'Hey! We love our canyon as it is. We'll take the risk.' They used constant scare tactics, saying that the dam was cracked, and so forth. Then they said, 'If you people don't accept our recommendations, you people are going to be legally liable for the City of Arcadia.' " Arcadia lies below Sierra Madre, at the bottom of the fan.

"They go into some town and the people are sold this bill of goods," Miner Harkness went on. "The next thing you know, it's done, and the people say, 'Jesus Christ! What happened to our canyon?' That will not happen in Sierra Madre. The people love the canyon, and they get up in arms. In Sierra Madre when there's a fire, the whole town comes up to the mountain frontier to stand on roofs and soak them down. That is the spirit that keeps the Flood Control people and the Army Corps of Engineers from tearing this canyon to shreds."

He took me up to high ground, where we looked out into a fading haze at a large part of Los Angeles. The fan, below us, was a paisley of swimming pools. There were million-dollar houses on some truncated hills. Harkness said, "People who come up here and knock off the tops of these mountains—if they get wiped out in a debris flow or a forest fire, that is the price they pay for the view. The county or the state should not have to foot any of that. In a person's tax bill, though, a high percentage of the total is for flood control. That's wrong. Living there is a risk people should be willing to take. A major brushfire declared a national disaster! That's b.s.! I know the risk in building a house there. You build there or buy there because you want to be there. Other people shouldn't be required to pay for my risk."

One February morning years ago, Miner Harkness stopped downtown for a quick cup of coffee before flying a

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mission in a Los Angeles County helicopter. Some firemen were drinking coffee, too. A fireman's pager sounded. A debris flow had mobilized, and people were trapped.

Harkness felt "a real cold chill." Of the several dozen most vulnerable houses in Sierra Madre, his was one. He went home immediately. All around the place, red lights were flashing.

His house had been torn in two, with his wife, Sara, in it, and their infant daughter, and their five-year-old twin sons, another daughter, and Joanne Crowder, a next-door neighbor. In a small canyon above, a large amount of debris had bulked up through time. The construction of a fire road had contributed to the volume. As people so often do, Harkness compared it to a loaded gun. Sara and the baby were in the master bedroom. When the slug of mud and boulders came out of the mountain crease, Joanne Crowder, who had fled to the Harkness house, was caught by the entering debris. It broke her back and a collarbone. The Harknesses' hot-water heater was flung upon her, and the water scalded her legs to the third degree.

The Harkness house projected from the hillside and had a carport beneath the master bedroom. The debris tore off the master bedroom with Sara and the baby inside. The bedroom fell on the family station wagon. With the bedroom on top of it, the station wagon went down the driveway and on down the street. In what remained of the house, the twins and their sister Claudine were unhurt. Sara and the baby came to the end of their ride unhurt. The station wagon suffered considerably. When the bedroom was taken off it, the car was twenty-six inches high.

The living room had been knocked four feet askew but had not collapsed. A bathtub was ripped nearly in half. Almost

surely, the master bedroom would have broken into pieces if it had not fallen on the station wagon and been carried away intact. Furniture and jewelry were all over the hill—"heirlooms everywhere, but there was no looting; no one took a thing."

The baby, Andrea, slept on her father's chest for six months after the event. She still gets nervous in a lightning storm.

Naturally, I asked Miner Harkness if he had contemplated moving away.

The look that came into his face suggested that he was confronting a strange, unprecedented question. He said, "It never entered my mind." He remembered Sierra Madre when it was an isolated town. He had seen the subdivisions change the country where he hunted as a boy. He had built his house as close as he could to his predilected mountains. It was on Churchill Road off Mountain Trail, just west of Sierra Madre Canyon, on a site where there had once been a hunting lodge—for the people from Los Angeles who came up to Sierra Madre on the railway with the red cars. Miner and Sara Harkness (an intensive-care nurse) were not about to move away. Their destroyed house was uninsured. Inspection showed that not much could be kept but a small block wall. Engineers who looked over the site told the Harknesses not to rebuild. When Miner made clear to them that such advice would go unheeded, they suggested a monumental retaining wall—a sort of one-family check dam—to try to stabilize future debris.

Building a check dam was not his style. "The heavy equipment would tear up the canyon," he said. His solution was a house enlofted. It stands in the air, on sixteen concrete pylons, each fifty-seven inches around. The pylons go down into the

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earth more than ten feet. Inside them are bundles of reinforcing rods wrapped in sheaths of steel.

The house itself is sheathed in cedar, and has an outside stairway of rough-hewn planks. Its windows are large and without curtains, which are not needed among the evergreen oaks. When the city emerges from beneath its veils, nothing impedes the view. The place has the aspect of a lookout tower positioned on the front—a post of observation in the cycle of fire and rain. Seven times, Miner Harkness and his family have been ordered to evacuate their house because of the threat of fire. And after the fires the dry ravel has built new depths of debris. Harkness clearly sees himself as an indigenous part of the cycle. Sitting on one of his rough planks, he said, "When the Santa Ana winds blow, and a big fire gets under way, you're not going to be able to hold it if it ever comes through here. That is a risk you take."

I F LOS ANGELES hangs on long enough, it will cart the mountains entirely away, but already it is having difficulty figuring out where to put them. In a productive season, the debris basins will catch more than a million cubic yards. The reservoirs back in the mountains take in much more than that. Over-all cleanout costs can exceed sixty million dollars in a single year—a required expenditure if the system is to function.

The Los Angeles side of this battle is unexampled in heroic chutzpah—to a degree expressible in the volume of any fan. For a brief geologic time, debris has been pouring out of Little Santa Anita Canyon, for example, and piling up on the plain. Among the San Gabriels' alluvial fans, this is a modest one in all respects. Its toe is down at the horse track—Santa

Anita—and its slope begins to rise through the Los Angeles Arboretum and then goes on rising a couple of miles, through the center of Sierra Madre and on up Baldwin Avenue to Carter Debris Basin, at the mountain front. The fan coalesces with fans on either side, but its width can be approximated at a mile and a half. Calculation shows that this one minor fan consists of about two billion cubic yards of material that has so far come off the watersheds above. Toward the middle of the twentieth century, Los Angeles undertook to replace nature as the depositor of material. Los Angeles assumed responsibility as well for at least fifty other fans on the San Gabriel front, not to mention lesser uplifts, like the Santa Monica Mountains and the Verdugo Hills.

Against the prodigious odds, Los Angeles is much more successful than it may appear to be when neighborhoods buried to the rooflines are pictured in the *Times*. To date, the debris basins have trapped twenty million tons of mountain. A small fraction of that figure has managed to get beyond them. Since the basins can fill up in a few hours, equipment has to be marshalled very swiftly to make cleanouts—and sometimes repeated cleanouts where more debris is expected. At the height of a storm, radio patrols are all over the front feeding information into the computers of the Storm Operation Center, which deploys forces from six field yards—deploys the motor graders, the backhoes, the front-end loaders, the trailer-mounted night-construction floodlight systems, the thirty-five-ton truck-mounted clamshell cranes, the forty-five-ton draglines with six-yard buckets, the six-inch pumps that can suck in and spit out rocks, the rock grapples that can pick up fifteen-ton boulders, and, above all, the big ten-wheelers: dump trucks capable of hauling fifteen tons at a time.

Los Angeles owns some of this equipment, but Los An-

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geles is not an OPEC country. Los Angeles cannot afford to keep hundreds of dump trucks waiting for an annual or biennial storm. The debris is made attractive to private truckers. They are paid fifty dollars an hour for lugging mud, no overtime. Flood has used as many as three hundred private trucks in one storm. They come from all over Southern California—from Lone Pine in the Owens Valley, from San Diego. Forty trucks once came from Redding, nearly five hundred miles north, and found no work when they arrived. A call once came to the section from a heavy-equipment operator in the Midwest. He wanted the work for his cranes and large loaders, and was willing to send them two thousand miles.

Wherever there has been an antecedent fire, debris basins are likely to fill to the brim. In 1978, every basin filled for fifteen miles under the slopes burned by the Mill Fire—eighteen basins in all. In some of them, the rocks were so big that they had to be broken by dynamite before they could be removed. Dunsmuir was cleaned twice that winter, Mullally and Denivelle three times. They filled as they were being emptied. Zachau was cleaned out three times as well, but it still let boulders ten feet in diameter get away. People living below Zachau sued (unsuccessfully), claiming that the county had not maintained the basin. "We had records that showed if there was two ounces of dirt in it we took it out," Dan Davis says, his indignation unmitigated.

Before the creation of the debris basins, mountain sands were carried to the ocean by winter floods. Now there is a beach problem. Sand is being lost to offshore canyons and is not being naturally replenished. A place that values its beaches as much as Southern California does has no choice but to buy sand. Sand has been transported by ten-wheelers from the mountains to the beaches. When thirty thousand yards of sand

was put on Zuma Beach, people complained about the color contrast. Materials cleaned out of the Laurel Ridge Debris Basin, in the Santa Monica Mountains, used to be hauled over the mountains in a direction away from the ocean and dropped at the Calabasas dump. Subsequent Laurel cleanouts went onto the beach. The Sedimentation Section has been investigating the possibility of using pipeline slurries to transport debris to distant gravel pits; it could also go in pipelines to the beach. Vito Vanoni said, "I think the day will come when we grind it all up and send it to the beach. The question is: Where do we get the water for the slurry? We could use sewage. That's not so good. Possibly we could use salt water."

Years ago, in an act of lyric irony, Flood Control bought four cloud-seeding generators and set them up near reservoirs in the mountains and along the front. The cloud-seeding generators have been used almost exclusively during foul winter weather, since they would not be efficacious under the otherwise azure sky. The department is criticized for seeding clouds. On the other hand, letters appear in the *Times* attacking the department when it does *not* seed clouds. The generators shoot incoming weather fronts with microscopic crystals of silver iodide. This is known as "enhancing the storm." The storm is worth at least a hundred dollars an acre-foot. Los Angeles wants the water so much that it mines the storm. This requires artful judgment. The idea is to increase the volume of rain, but not to the point of mobilizing debris flows. The cloud-seeding generators were running on February 7, 1978, for example, and they ran on February 8 and February 9, but they were shut down when the proportions of the storm became apparent. The events on Pine Cone Road and at Hidden Springs and in the Verdugo Hills Cemetery, among others, occurred in the first hours of February 10. The seeding could

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not have added anything much to the total rainfall, but the fact remains that during the wettest week of the雨iest season of the twentieth century the cloud-seeding generators were enhancing the storm. Cheeky is the warrior who goes behind the lines to pick the enemy's pockets on the eve of battle.

In 1980, when John Tetterer was Acting Chief Deputy Engineer at Flood, he remarked at a symposium, "The war stories we tell each other are almost exclusively related to debris problems. . . . We are all getting blitzed after fires by small canyons. . . . Funny things are occurring in small debris basins. I cannot tell you exactly what. All I know is that during major storms debris sometimes goes over the spillway when the basin is not really full. We do not understand the dynamics, but it seems that these small basins act more like flip buckets than lakes. . . . We and the U.S. Army Corps of Engineers expected our channels to last maybe a hundred years. We have seen cases where the reinforcing steel was exposed in one storm. . . . We do not know enough. . . . We also find communities starting to wonder why their high-priced facilities fail during storms when they are needed. I do not blame them, do you? . . . We should stop building things where they do not belong, and leave some room for nature." To which his colleague Arthur Bruington added, "Through the district, the residents are battling, but sediment is still winning. . . . Managing the sediment capable of being produced by the San Gabriel Mountains is important to the safety of the residents of the district, but, frankly, it is like trying to hold back the storm tides of the ocean."

After one season, twelve million cubic yards were removed from four of the mountain reservoirs. After one season, a million two hundred thousand yards were taken out of the

debris basins. In Santa Fe Basin, the huge trap in the San Gabriel River where it meets the Los Angeles plain, the Army Corps of Engineers has fifteen million yards it wants to get rid of, but where? Disposal sites have become extremely hard to find. Every abandoned gravel pit between Tujunga and Twenty-nine Palms has already been filled with the rock of the transverse mountains, or so it seems. Chuck Colver, of Covina, who watched his orchards go down and his neighbors come up, has been around long enough to see a likely solution to the problem. "One of these days," he predicts, "they'll be buying tracts of houses to get a place to deposit the material."

Donald Nichols, of the Department of Public Works, pointed out to me one day that the word "debris" suggests sanitary landfill and odor, so debris-disposal sites are now called "sediment-placement sites" in order to get communities to accept them. "To have to stroke our folks like that kind of insults me, frankly," he said. "But disposal is a real dilemma. The Sierra Club says, 'If you put it here, you'll kill a lizard.' The Forest Service and Fish and Game also complain. Acquisition of debris-disposal areas is much slower today because of the California Environmental Quality Act. When we try to establish a new disposal area, we run into opposition from homeowners and environmentalists. The environmentalists run the gamut from the sensible ones to the crazies. They say, 'You'll kill what you put it on. You'll dislocate animals. You'll alter the land form.' That's correct. But when we're finished we'll plant vegetation. The animals will come back. The rest we have to leave to the Big Guy in the Sky, who will finally naturalize these deposits we make."

The Big Guy doesn't always do a perfect job. In Laguna

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Canyon years ago, some forty houses were built on old disposed debris. In 1978, the fill failed. The forty houses—worth two hundred and fifty to five hundred thousand dollars each—slid downhill like sleds.

Inevitably, someone was inspired to put the rock back up in the mountains. This elegant absurdity may be the *ne plus ultra* in telling the Big Guy who's in charge. San Gabriel Dam, a few miles upriver from Azusa, was built in the late nineteen-thirties to keep debris from clogging a reservoir just below it. More than twelve million tons of debris have been stopped behind San Gabriel Dam in one rainy season. San Gabriel catches so much mountain that it has to be more or less continuously cleaned out. Fifty or sixty trucks have lined up to lug the debris away. One place they have put it is in the tributary Burro Canyon, a haul of less than a mile, and—in elevation—six hundred feet up. "That way the engineers can have job security," Wade Wells once said to me. "They take the debris and carry it back into the mountains, where they create a potential debris flow."

"Burro will someday serve as a campground," Don Nichols said. "We have improved on nature by putting a mountain up there that doesn't come back down. Burro has debris basins in it. It has *its own* debris basins. We put fourteen million cubic yards in Burro Canyon."

Wells and I went up there one day to see this epic artifact—in clear dry air and vast silence—eight miles from Arby's. A California quail ran by, sporting its knightlike plume. In the V-shaped mountain valley, the deposit rested like an aircraft carrier in dry dock—a comparison that would be more apt if aircraft carriers were not so small. Debris basins were along its upper flank, there to *protect* the man-made deposit.

JOHN MCPHEE

Burro Creek passed under it, through a deep culvert a mile long. For twenty million dollars, Los Angeles had returned the rock to the mountains. For twenty million dollars, they had built in Burro Canyon an edifice ten times as large as the largest pyramid at Giza.