Land and people : Finding a Balance

Los Angeles

U.S. Department of the Interior
U.S. Geological Survey

Finding a Balance **is an environmental study project that allows you and a group of your classmates to consider real environmental dilemmas concerning geologic and hydrologic hazards and to provide solutions to these dilemmas. The student packet gives you most of the information you'll need to answer the Focus Question, information like maps, data, background, a reading about the region, and a description of the "Interested Parties," or the various interest groups that have a stake in the outcome of the Focus Question. While you are working on this project, each member of your group will take a role, or become one of the interested parties. Your teacher will guide you through a series of discussions, activities, calculations, and labs. At the end of this project, your group will be asked to present and justify a solution to the environmental dilemma.**

Reading

From *The Control of Nature* by John McPhee.

"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 christiania turns for half a mile above a three-hundred-foot straight-away 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 not 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 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 paneled 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, 16 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, 20 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 that 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."

Over the last 30 years, writer John McPhee has written 22 books on the world around us. His latest, *Assembling California,* is about the geologic and human history of California.

Focus Question

You and your classmates are members of a La Crescenta civic group that has been formed to evaluate the safety of your community's school children in the event of the following geologic and hydrologic hazards: earthquakes and landslides (including mud and debris flows). Using the maps, tables, and other information in this packet, your job is to present the study of the geologic and hydrologic hazards to children that attend the following schools: Monte Vista School, Valley View School, and Rosemont Junior High School. Once your group has discovered what the hazards are, you will decide whether school children are safe attending the three schools in their present locations, or new sites for the schools must be found. Your group will make a presentation at a La Crescenta "community meeting" in which you will describe your analysis about how the community can guarantee children's safety during school.

Note: The information in this packet focuses on the community of La Crescenta, about 15 miles north of Los Angeles. The environmental and geological issues raised in this discussion of La Crescenta are the same ones facing most southern Californians.

The Interested Parties

Many groups and individuals have a stake in the La Crescenta area in southern California and in the answer to the Focus Question. As your group works to answer the Focus Question, each person will play one of the following roles:

Parent

Parents want assurances that their children are safe when they attend school. They hold local officials legally responsible for their children's safety in this geologically dynamic area; however, parents are also unwilling to send their children to far-away schools.

Geologist

Geologists realize that unwise land-use choices increase safety risks. This member of the civic group will explain what the geologic and hydrologic hazards are and how they might affect the safety of children at school.

Developers

Developers want to continue developing the land at the foot of the San

Gabriel Mountains. They hope residents will be assured that children are safe at school and that the area is, or can be made, geologically stable enough to live in.

SUPERINTENDENT OF SCHOOLS

The school superintendent wants to assure parents that children are safe and wants State and Federal support to make children safe. This person will try to protect the school board's funds from being used for school rebuilding or remodeling.

The Los Angeles Area — What You Need to Know

Los Angeles County is a beautiful, crowded, complicated place to live, and lots of people want to live there. Southern California has grown tremendously over the last century and in recent years. From 1980 to 1992, Los Angeles County had the largest population growth in the nation. Los Angeles County may be attractive, but it is not a peaceful place to live, in geologic terms. Many population centers are in areas of natural hazards, including earthquakes, floods, landslides, and mudflows.

The effects of urban growth are heightened in a region with such dynamic geology. Increased population puts great pressure on the environment. For example, increased recreation in the mountains increases the number of fires. Fires lead to erosion and erosion can lead to landslides.

The San Gabriel Mountains have always experienced fires, floods, and landslides. But, because more people live in the foothills of the San Gabriel Mountains, in communities like La Crescenta and Montrose, normal geological processes have become hazards. To build these communities, people have altered hillsides and drainage systems, have replaced absorbent top soils with runoff-causing asphalt. As the area has become more crowded, it has become necessary and desirable to build homes into the hillsides. To build safely on steep slopes, people have had to alter the slopes, thus decreasing the slopes' stability.

Climate — Warm, Dry Summers and Cool, Wet Winters

The topography of Los Angeles is diverse. The landscape ranges from beach to mountain, from desert to woodland. The Los Angeles area divides distinctly into the Los Angeles basin, which includes most of the city, the surrounding San Gabriel and San Fernando valleys, and the backdrop of high mountain ranges.

Los Angeles' weather is greatly affected by topography. The climate within the city varies widely. Summer temperatures can range from a cool 68 degrees Fahrenheit on the coast to 80 degrees or 90 degrees Fahrenheit only 20 miles inland. During the winter, heavy rains are common and a single storm may drop as much as 3 inches of rain in an hour.

The San Gabriel Mountains in the Los Angeles area cause special weather conditions. Here, moist air masses move inland from the Pacific and are cooled as they meet and rise over the mountains. This cooling produces heavy rainfalls on the windward slopes. This is called the orographic effect. The eastward mountain slopes are in a rain shadow, hence rainfall is much less.

The Geologic Hazards of La Crescenta

A HISTORY OF FLOODS

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. Much of the damage related to natural disasters (excluding droughts) is caused by floods and associated mud and debris flows.

Los Angeles Civic Center

	NORMAL MONTHLY PRECIPITATION (IN INCHES)	AVERAGE DAYS OF PRECIPITATION (.01 INCHES OR MORE)
January	2.92	6
February	3.07	6
March	2.61	4
April	1.03	1
May	0.19	1
June	0.03	≤1
July	0.01	1
August	0.14	5
September	0.45	1
October	0.31	2
November	1.98	3
December	2.03	5

Which county gained the most people between 1980 and 1990? Which county gained the largest percentage of growth during that period?

About how much rainfall does each storm bring? Answer this question by dividing the monthly precipitation amount by the number of days per month with measurable rain. Which month has the heaviest storms?

■

Floods can be categorized by what caused them. Dam failure can cause catastrophic flooding. If a dam fails as a result of neglect, poor design, or structural damage caused by an event such as an earthquake, a gigantic quantity of water is let loose downstream, destroying anything in its path. Intense or prolonged storms that drop large amounts of rain within a brief period can cause flash floods. Flash floods occur with little or no warning and can reach full peak in a few minutes.

Southern California's climate makes floods more likely. The area has a distinct wet season. Floods are more frequent during this season. When a very wet winter follows several dry ones severe flooding can occur.

In *The Control of Nature,* John McPhee writes about the dramatic floods of 1978. But dramatic floods occur regularly in the San Gabriel foothills. La Crescenta, Shields Canyon, La Canada, and Pickens Canyon have experienced several profound and damaging floods during the 20th century.

The year 1934 came in with a bang in Los Angeles County. The "New Year's Day Flood" in the La Canada Valley killed more than 40 people, destroyed about 400 houses, and damaged streets, bridges, and highways. A deadly debris flow killed 12 people who had gone to seek shelter in the Montrose Legion Hall. The debris simply crashed through the middle of the building, leaving holes in the uphill and downhill walls.

Why was the 1934 debris flow so damaging? Two reasons — fire and lack of heavy rainstorms in the years before the flood. First, fire increases the likelihood of landslides after a heavy storm. Fire destroys the vegetation that anchors top soil, and makes it more likely that the soil will slide when saturated. A report on the 1934 storm notes, "About 7.5 square miles of mountain area tributary to La Canada Valley was burned over by a fire in November, 1933, and from this burned-over area came practically all of the run-off that produced the debris movement in the La Crescenta-Montrose district." Second, the 1934 storms produced the heaviest rainfall in years. Sediments of all sizes — including boulders weighing tons — had been building up in the canyons for a long time. The heavy rains and the burned hills caused the debris to flow, and destroy all in its path.

Living in Earthquake Country

Southern California is home to more than 20 million people and is vital to the Nation's economy. Unfortunately, the region is also laced with many active faults that can produce strong earthquakes. The San Andreas Fault is the best known. It runs almost the entire length of California and generates shocks as large as magnitude 8. In Southern California the last magnitude 8 earthquake was in 1857. But smaller temblors, like the 1971 San Fernando and 1994 Northridge earthquakes, occur more frequently. Both of these magnitude 6.7 quakes were very damaging.

An earthquake is a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. This shaking can cause buildings and bridges to collapse; disrupt gas, electric, and phone service; and sometimes trigger landslides, avalanches, flash floods, fires, and huge, destructive ocean waves (tsunamis).

More Earthquakes to Come

Southern California has a problem with earthquakes — it hasn't been having enough of them. After the 1994 magnitude 6.7 earthquake in Northridge (northwest of La Crescenta), scientists used new techniques to study seismic activity. They have discovered that Southern California has not had enough large earthquakes to release all the pressure building up underground.

When the tectonic plates under the Earth's crust grind against each other, energy builds. In Southern California, the stresses are distributed along the San Andreas Fault and other smaller faults. When too much stress builds up along a fault, the earth's crust cracks and earthquakes occur. Quakes must occur to relieve the pressure along the faults.

But a look back at the earthquake history of the last two centuries suggests that Southern California should have had seven times as many Northridge-sized earthquakes as it has had. The scientists' conclusion: in Southern California, the probability of a magnitude 7 or greater earthquake by the year 2024 is as high as 80 to 90 percent.

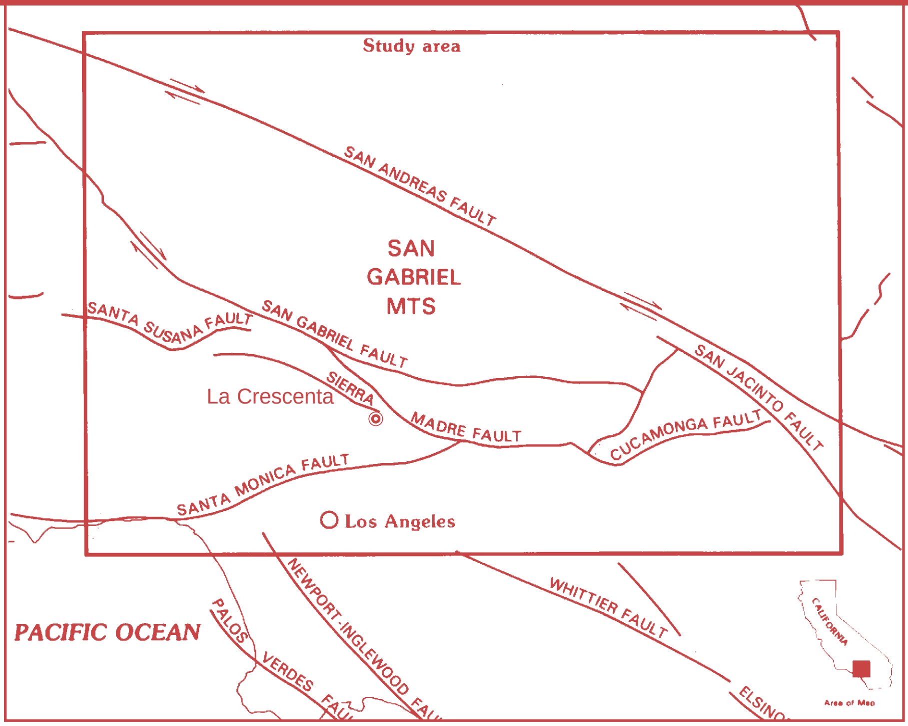
Landslides Too?

Landslides occur when masses of rock, earth, or debris move down a slope. Landslides may be small or large and can move at slow to high speeds. They are activated by storms and fires and by human modification of the land. New landslides occur as a result of rainstorms, earthquakes, volcanic eruptions, and various human activities.

Mudflows (or debris flows) are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as during heavy rainfall. Mud and debris flows can move rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds. These flows can travel several miles from their source, growing in size as they pick up trees, cars, and other materials along the way.

Landslides are classified in several ways. One way to describe a landslide is by sediment size. Debris flows contain a wide assortment of sediments — boulders, sand, and mud — but generally less than 10 percent silt and clay. Earthflows contain few boulders and contain mostly fine sand, silt, and clay. Debris flows move faster, farther, but earthflows can move over lower slopes. In the mountains, debris flows and mudflows fill up channels and reservoirs. Landslides are also classified by material type and how it moves. Geologists also describe landslides by the percentage of saturation (with water) and the slope inclination necessary for the slide to occur. (See the table "Geologic environments likely to produce earthquake-induced landslides in the Los Angeles region.")

Landslides and mudflows are common events in Los Angeles County because of active mountain-building processes, rock characteristics, intense storms, and earthquakes. In fact, the 1994 Northridge



This figure shows that faults run under the Earth's crust in southern California like veins run under your skin. Remember that an earthquake is a release of stored energy that causes the sudden movement of rock on opposite sides of a fault.

earthquake triggered more than 10,000 landslides. Many landslides have been occurring over the same terrain since prehistoric times. Although they may be stable right now, these landslides can be activated by storms, fires, or inappropriate human modification of the land.

Debris Basins — Catch It If We Can

Since the 1930's, debris basins have been used to catch sediments that otherwise could damage land downstream. The huge basins are designed to catch large amounts of sediment. When they become about 25 percent full, debris basins are cleaned out. Removing the debris is expensive. Each basin holds about 78,480 cubic yards of debris! One reason debris removal is so expensive is that Southern California is running out of places to put the debris. The sediments have to be taken further away for disposal, increasing the cost. Another problem is that some basins have filled up during storms. Generally, however, when debris basins are in the right place, they do a good job of protecting developments downstream from debris flows.

NEWSFLASH!

The Population's Growing
Just Ask the Mountain Lions

To learn more about what's happening in the Los Angeles area, read the following newspaper articles.
"Big Southland Population Jump Expected"
by Jesus Sanchez
Los Angeles Times July 13, 1995.

"Bolstered by an anticipated economic revival, the Los Angeles area will grow by 2.3 million residents over the next decade, the largest numerical gain of any metropolitan area in the Nation, according to the study scheduled to be released today by the Palo Alto-based Center for Continuing Study of the California Economy....

In the Los Angeles area, the center's estimated regional population growth rate will exceed the pace of the past five years, when the area was hit by severe economic slump. The study's authors said the newcomers will be drawn to the area by the job growth in such industries as high-technology manufacturing, foreign trade, tourism, and entertainment....

The report had good news for the Los Angeles area's long-suffering residential real estate market, which will benefit from the anticipated addition of between 750,000 and a million new households by 2005.

Among the study's other major findings and projections for the region:

- The size of the school-age population — ages 5 to 17 — will rise by a million in the next 10 years...
- The share of households with incomes above $75,000 will grow from 22.5 percent this year to nearly 32 percent by 2005."

"Officials Hunt for Menacing Mountain Lion"
by Nicholas Riccardi
Los Angeles Times, March 14, 1995.

"Sheriff's deputies and state officials hunted big game in the foothills near La Crescenta on Monday — a mountain lion that they say has killed two dogs and come within 10 feet of humans over the past week.

The most recent encounter was at 1 a.m. Monday, when Chul Yoon was awakened by the barking of his Akita dog....When Yoon looked out his window, he saw a mountain lion clamp its jaws around the 80-pound dog's neck and drag it over the 4-foot stone wall that separates Yoon's back yard from the surrounding woods....

Several residents have also reported seeing a big cat in the La Crescenta Valley over the last week, officials said.

Sightings are not that unusual anymore, said Patrick Moore, a Fish and Game spokesman. But the incidents indicate that there is a mountain lion up there that's found an easy way to find a meal. It's easier to snatch a dog than spend all that time fighting over deer.

In the last few years, numerous residents have seen mountain lions in the foothills, as the cats overrun their habitat and suburban developments encroach...

...It's just coming too close to human beings for comfort, [Moore] said. The fear is that it's only a matter of time before a human being is involved."

For Your Information: We Have a Plan

Unlike earthquakes, debris flows can be predicted and avoided to some extent. Earthquakes occur without warning and create most of their destruction within minutes. But rainfall-induced debris flows develop over several hours, leaving some time for forecasting, warning, and emergency response. The USGS and the National Weather Service operated a real-time warning system for rainfall-induced debris flows in the San Francisco Bay region for a decade (1986-1995), and were usually able to provide a general advisory (a watch) early in the storm. When necessary, they provided a warning at the beginning of significant debris flow activity.

Even if a school is in the path of a potential debris flow, there should be time for an orderly evacuation, that is **if** an advisory is issued, and **if** an evacuation plan exists. The plan must include enough school buses, drivers, and a system for deciding who goes in which bus. Most important, the plan must include a safe place to take kids until the storm passes and their parents can pick them up.

Glossary

Use these definitions of important terms as you answer the Focus Question.

CLINOMETER- An instrument used to measure angles.

DEBRIS FLOW- A moving mass of water-saturated near-surface materials.

EARTHFLOW- A flowing mass of fine-grained soil particles mixed with water.

SEDIMENT- Solid rock or mineral fragments transported and deposited by wind, water, gravity, or ice. Sediment accumulates loosely in layers.

EROSION- The removal of weathered rocks by the action of water, wind, ice, or gravity.

LANDSLIDE TYPE	TYPE OF MATERIAL	MINIMUM SLOPE INCLINATION	REMARKS
Rock falls	Rocks weakly cemented, intensely fractured or weakened	40	Common near ridge crests and on spurs, ledges, artificially cut slopes, and slopes undercut by active erosion
Rock avalanches	Rocks intensely fractured and exhibiting significant weathering, planes of weakness dipping out of slope, weak cementation, or evidence of previous landsliding	25	Restricted to slopes of >153 yards relief that are undercut by active erosion
Rock slumps	Intensely fractured rocks, preexisting rock slump deposits, shale and other rocks containing layers of weakly cemented or intensely weathered material	15	
Disrupted soil slides	Loose, unsaturated sands	15	
Soil slumps	Loose, partly to completely saturated sand or silt; poorly compacted manmade fill composed of sand, silt, or clay; preexisting soil slump deposits	10	Common on embankments built on soft, saturated foundation materials, in hillside cut-and-fill areas, and on river and coastal flood plains
Soil block slides	Loose, partly to completely saturated sand or silt; poorly compacted manmade fill composed of sand or silt	5	Common in areas of preexisting landslides along river and coastal flood plains, and on embankments built on soft, saturated foundation materials
Soil earth flows	Stiff, partly to completely saturated clay and preexisting earth-flow deposits	10	
Soil lateral spreads	Loose, partly or completely saturated silt or sand; slightly compacted manmade fill composed of sand	0.3	Common on river and coastal flood plains, embankments built on soft, saturated foundation materials, delta margins, sand dunes, sand spits, alluvial fans, lake shores, and beaches
Rapid soil flows	Saturated, slightly compacted manmade fill composed of sand or sandy silt; loose, saturated granular soils	2.3	
Subaqueous landslides	Loose, saturated granular soils	0.5	Common on delta margins (subaqueous part)

Table: Geologic environment likely to produce earthquake-induced landslides in the Los Angeles region.

Topographic map (Activity 3). Study this topographic map of the La Crescenta area. Find the schools mentioned in the focus question, the debris basins, and the foothills of the San Gabriel Mountains. Note every feature, natural or manmade, that would affect childrens' safety in the event of a geologic hazard.

Geologic map of the Sierra Madre Fault Zone (Activity 3). This geologic map provides important information: the age, type, and distribution of sediments in the Sierra Madre Fault Zone. Use this map to consider the effects of earthquake-induced landslide in the La Crescenta area.

Description of Map Units

af — **ARTIFICIAL FILL** includes housing development, flood-control dams, flood-debris storage, and road fill.

Qc — **COLLUVIUM** (Holocene) talus and slopewash, generally brown to red-dish-brown poorly sorted heterogeneous deposits of locally derived debris. These deposits are more abundant than indicated on the map but are generally too small to show.

Qal — **ALLUVIUM** (Holocene and Pleistocene).

Qal$_1$ — **UNIT 1** (Holocene) white to light-gray unconsolidated fine to coarse sand and gravel containing abundant cobbles and boulders; includes deposits of present stream channels, flood plains, and alluvial fans (now mostly controlled by flood-control channels and dams). Qal$_1$f, alluvial-fan surface.

Qal$_2$ — **UNIT 2** (Holocene) gray to pale-brown unconsolidated fine to coarse sand and gravel containing abundant cobbles and boulders; includes deposits of stream terraces, recently abandoned flood plains, and alluvial fans with incipient soil. Qal$_2$f, alluvial-fan surface.

Qal$_3$ — **UNIT 3** (Pleistocene) yellow to yellowish-pale-brown unconsolidated fine to medium sand and gravel containing abundant cobbles and boulders and highly weathered diorite clasts; includes stream terraces and moderately dissected alluvial fans with poorly to moderately developed soils. Qal$_3$f, alluvial-fan surface.

		DIAMETER OF PARTICLE
Boulders	Gravel	1 meter
Cobbles	Gravel	decameter
Pebbles	Gravel	centimeter
Sand		millimeter
Sand		1/10 of millimeter
Silt	Mud	1/100 of millimeter
Clay	Mud	

Table: Standard size classes of sediments. What's the difference between silt and sand? Size. This table shows how geologists classify sediments by size.