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FROM Department of Water and Power
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IMMEDIATE RELEASE

Department of Water and Power engineers today announced the receipt of two government reports whose conclusions are favorable to the proposed nuclear power generating station site near Malibu.

Geological features of the site for the $92,000,000 improvement are covered in a report from the U.S. Geological Survey (USGS), while earthquake conditions are covered in a report of the U.S. Coast and Geodetic Survey (USC&GS).

The two Federal agencies were requested to make detailed studies by the Atomic Energy Commission, which plans to hold a public hearing soon on the DWP application for a construction permit for the nuclear station.

Any concern over landslide possibilities should be removed, according to DWP engineers, by the USGS conclusion that "the bedrock geology of the general site area and the offshore topography as presently known preclude the possibility of a large new slide moving part or all of the plant site seaward."

The USGS report also rates as "negligible" the probabilities of ground surface movement in Corral Canyon, due to faulting, for as long as the plant is expected to be in existence there.

In its report on earthquake conditions, the USC&GS said possible shocks associated with local minor tremors do not require any serious consideration in the design of the nuclear facility.

On the other hand, in the event of a large earthquake on the San Andreas fault, 40 miles away, special design provisions are necessary, the report said. The DWP has already incorporated such special features in its design of the project, it was stated.

Further indicating the high degree of safety provided for in the design of the nuclear power station, DWP engineers said that it will be protected from tidal waves 50 feet high.

Samuel B. Nelson, DWP general manager and chief engineer, expressed gratification that the USC&GS report gave recognition to the thoroughness of preliminary site studies made by staff engineers and consultants. The report credited the DWP with submitting "a comprehensive and accurate description of the Malibu geology, fault systems in the immediate vicinity, seismic history, and ground motions".

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Knuth

DRAFT: 6/5/64

Engineering Geology Summary of the Proposed Nuclear Power Plant Malibu Site, Los Angeles County, California

This summary statement was prepared in response to the following questions raised by the Atomic Energy Commission's Division of Regulation concerning the geologic and hydrologic conditions at the proposed nuclear power reactor site at the mouth of Corral Canyon, Malibu Beach, Los Angeles County, California. The questions are:

1. The nature and extent of landslides and the likelihood of landslides at the site which might endanger the plant.
2. The relation of the "Malibu Coast fault" to the site and the likelihood of differential ground motion at the site due to earthquakes. In this connection, how recently has movement on the "Malibu Coast fault" occurred and how recently has differential movement, if any, at the site itself occurred?
3. The possibility of flooding at the site and the retention or ion exchange characteristics of the soil.

The Malibu site is in the east-trending Malibu Coast fault zone, a major structure that at the site is 500 to 1,500 feet wide and consists of two large faults, the Malibu Coast fault on the north and the Escondido North fault on the south. Sedimentary and volcanic rocks of Middle Miocene age underlie the site and are characteristically tightly folded and intensely deformed due to tectonic activity. Near the Malibu Coast

fault, the rocks are highly sheared and offset by smaller faults paralleling the major faults. The Miocene rocks are unconformably overlain by unconsolidated stream, terrace, landslide, beach, and flood plain deposits. These deposits range in age from Recent to Late Pleistocene (not more than 400,000 years old) and in the vicinity of the site have been displaced vertically by faults paralleling the Malibu Coast fault. Detailed information on the geology of the site is presented in "Preliminary Geologic Report on the Proposed Corral Canyon Nuclear Power Plant Site, Los Angeles County, California", by R. F. Yerkes, Reuben Kachadoorian, and C. M. Wentworth.

To determine the nature and extent of the existing landslides and to evaluate the possibility of future landslides endangering the facilities at the site is dependent on quantitative knowledge of the physiographic setting, the lithologic features of the failed materials, the physical characteristics of known slides, a thorough understanding of the types of failure, and the environmental agencies that contributed to the faulure.

Physiographic setting.--Corral Canyon contains an intermittent creek that actively erodes alluvium and bedrock during flood in the rainy season. The walls of the canyon are in large part quite steep, rising 100 to 600 feet at 20° to 30° on the east wall, and a similar distance at 15° to 30° on the west wall. The south-facing coast rises at a slope angle of 12° to 30° from the actively eroding shoreline to an altitude of about 140 feet at the seaward edge of the coastal terrace.

These relatively steep slopes within the site are quite susceptible to slope failure. Some slopes originally as low as 25° have failed, whereas other 200-foot-long slopes on less deformed bedrock stand at 40°.

Landslide characteristics.--Landslides cover about one-third of the site area. Each of the three largest slides cover an area of about 1,000,000 square feet; several others are 100,000 to 300,000 square feet in area, and smaller slides are abundant. They have formed chiefly in bedrock though the larger slides locally involve surficial deposits; only minor slides have developed entirely within surficial deposits. Generally landslides are not correlative with specific types of bedrock, however, the rocks of Unit B are expecially susceptible to failure along the coastline. The surface traces of the mapped faults are preferred locations for landslides; the traces of the Malibu Coast and Escondido North faults are in part concealed by landslides on the walls of Corral Canyon.

Some of the slides have relatively fresh scarps or cracks at the head, or are crossed by pavement that has been disrupted by ground movement; these are classified as active. Little is known concerning rates of movement of these slides. Those known to be active are moving intermittently and slowly. This is well shown in the case of the 8-inch concrete divider of Pacific Coast Highway where it crosses the large slide east of the canyon mouth.

None of the slides is so old or so situated as to be deeply dissected by erosion, with the exception of the large slump on the east wall of Corral Canyon north of the Malibu Coast fault. If this is a landslide and not an erosion feature, it probably dammed Corral Canyon when it moved. This dam was probably about 100 feet above present creek level and has since been removed by erosion.

Lithologic features.--Bedrock in the site area consists chiefly of interbedded sandstone, siltstone, and mudstone. These rocks have been tightly folded and moderately to intensely and pervasively sheared. The interbedded mudstones contain montmorillonitic (swelling) clays.

Types of rock failure.--Two types of rock failure are recognized, slumps or multiple slumps, and debris slides. Slumps consist of one or several "slices" of bedrock that have not been internally deformed to any great degree by sliding. Debris slides may form in part by flowage; the material in such slides consists of relatively small semi-independent rock fragments.

The soles of some of the smaller slumps were observed; these consist of one or more closely-spaced surfaces of rupture with undeformed material both above and below. The large slide west of the mouth of Corral Canyon has been bored near the shoreline to an altitude of minus 49 feet. The borings bottomed in probable bedrock, but no obvious surfaces of rupture were detected by in-hole inspection of the borings.

Environmental agencies.--During the rainy season the Corral Canyon area is subject to short, intense rainstorms that are capable of completely saturating the ground. In 1952, six inches of rain fell on already saturated ground during a four day rainstorm in the Santa Monica Mountains. Such saturation of the ground is a major immediate cause of slope failure in this general area, as it results in a vast increase in the weight of potentially unstable ground, as well as a decrease in rock strength.

Corral Canyon is in an area of known seismic activity and will be subject to seismic shock in the future. Ground vibration, especially if it occurs when the rocks are saturated, can cause initiation or rejuvenation of landslides in the site area.

The potential danger from the landslides at the site during the 50 year estimated lifetime of the plant is contingent on the condition of the rocks, i.e., the degree to which they are water saturated, the attitude of bedding planes, the amount and locale of erosion, and the occurrence of seismic events in the vicinity of Corral Canyon.

At the site the two large, active landslides that flank the mouth of Corral Canyon are moving seaward, due largely to removal of support at the toe by coastal erosion of Unit B rocks. Continued activity of these slides can be expected. A combination of saturated ground and severe seismic shock could be expected to accelerate movement of the slides. Headward migration would be possible under these circumstances; lateral migration would be less likely. Under the most severe conceivable circumstances, it is probable that the shoulders of the canyon mouth within 500 feet of the shoreline could be included in the landslides by headward and lateral migration of their boundaries.

The toes of these two landslides are at or seaward of the shoreline, but it is unlikely that they extend very far seaward. The [illegible] bottom slopes very gently and water depth 3 miles offshore of Cor[illegible] Canyon is about 300 feet. In addition, the sole of the landslide west of the canyon mouth has been interpreted from borings to lie at minus 4 feet at a distance of about 100 feet north of the shoreline.

There is little potential danger from large scale natural landsliding on the east wall of Corral Canyon in the proposed construction site. The west wall near the canyon mouth rises more steeply to a greater height and thus has slightly greater potential for natural failure. Failure of improperly constructed cuts would probably constitute as great a hazard as additional landsliding of natural slopes in the construction area.

The bedrock geology of the general site area and the offshore topography as presently known preclude the possibility of a large slide moving part or all of the plant site seaward relative to the shoreline.

The possibility of landslides in Corral Canyon north of the Malibu Coast fault poses an indirect hazard to the plant site in the form of a landslide-induced flood. Rainstorm-saturated ground, especially if combined with seismic shock, could produce a landslide large enough to dam the creek and pond flood waters. If the dam were then topped and quickly eroded, a major flood could result near the canyon mouth.

Tectonic setting and fault movement.--The relation of the Malibu Coast fault to the site and the recency of movement on this and related faults was determined from detailed geologic study of the site and adjacent areas. The Malibu Coast fault is a surface trace of a crustal boundary fault of regional significance. It is one of two large faults that form a wide structural zone that trends east-west for at least 20 miles from the site. The proposed construction area is in bedrock of this zone that has been cut by several faults subparallel to the Malibu Coast fault. The rocks are intensely folded and pervasively sheared. The tectonic deformation which produced the faults has resulted in many thousands of feet of movement since the end of middle Miocene time(about 15 million years ago) and has continued through upper Pleistocene time (not more than 400,000 years ago) as indicated by vertical displacements of more than 8 feet and as much as 120 feet in rocks of this age at several localities east and west of Corral Canyon.

All of the known movement, herein meaning surface ground displacement, on the Malibu Coast fault zone is prehistoric--that is, more than 200 years old. If the band of deformed rocks just south of the Malibu Coast fault trace is considered to be part of this fault zone, the most recent ground displacement occurred sometime between about 200 and 400,000 years ago. However, if the 17 seismic shocks of magnitude 3 to 4 and the 3 shocks of magnitude 4 to 5 that occurred along the general trend of the Malibu Coast fault zone in the last 30 years can be attributed to rock deformation, subsurface movements may have occurred since 1930.

The likelihood of differential ground movement, limited in this discussion to the displacement at the ground surface, at the site due to earthquakes is dependent on the frequency and severity of earthquakes along the Malibu Coast and related faults. All well-documented large earthquakes have centered in the western Los Angeles basin, 23 to 52 miles (37 to 84 km) southeast of Corral Canyon. These include two shocks of magnitude 6 or greater and three of magnitude 5 to 6 within the last 44 years. These shocks caused considerable damage and destruction due to shaking, but none is known to have caused displacement at the ground surface. These relatively large shocks are associated with active right-lateral strike-slip (San Andreas-type) subsurface movement on the Newport-Inglewood fault zone. This zone intersects or merges with the Malibu Coast fault zone about 25 km east of the site.

The Malibu Coast fault is evidently a reverse or thrust fault, along which the rocks south of the fault are being thrust northward relative to those of the Santa Monica Mountains north of the fault. The Malibu Coast fault is considered to be part of an active system that includes the Newport-Inglewood zone. Only small-magnitude shocks have been associated with the Malibu Coast fault; none of these has resulted in known displacement at the ground surface in historic time. However, in prehistoric time faulting at eight known localities along the general trend of the Malibu Coast fault has displaced rocks no older than 400,000 years. It can be inferred from these data that similar faulting may have occurred within the site but the localities

cannot be located because of generally poor exposures. On the basis of this record the probability of ground displacement at Corral Canyon in the next 50 years is very low.

Floods.--The Corral Canyon area is subject to short intense rainstorms which result in floods. The occurrence and magnitude of these floods is affected by disastrous brush-fires and by landslides which can occur in the area.

A flood magnitude-frequency relationship has been developed for the Corral Canyon area by analyses of records for 24 streamgaging stations in the Los Angeles area. Corral Canyon itself is ungaged; however, on the basis of the regional flood frequency relationship, the magnitude of the 50 year flood at the site is estimated to be 1,500 cfs (cubic feet per second) when average vegetal cover conditions prevail (see fig.). Immediately after a brushfire has destroyed vegetal cover, peak discharges resulting from comparable rainfall events can be expected to be higher by as much as 100 percent.

Potentially, the highest flood could result from washout of a landslide damming Corral Canyon during a period of high runoff. During high runoff, the accumulation of water upstream from and landslide could develop major flood potential in a matter of hours, leaving little if any time for remedial action. Floods on the order of 10,000 cfs could occur when such a landslide dam is washed out. The probability of occurrence of such a sequence of events is very low.

Floods in Corral Canyon can be expected to be very rich in debris, particularly after vegetal cover has been destroyed by fire. Channel aggradations as high as 10 feet have been observed in nearby canyons following floods that were preceded by brushfire.