3. TOPOGRAPHY, CLIMATE AND DESIGN AVALANCHES

3.1 General

A wide variety of topography and climate is found within the study area. This variation strongly affects the types of snow found in avalanche paths during the design avalanche and helps control its velocity, density, impact potential, travel distance, and other characteristics.

Dry-snow avalanches can achieve the largest sizes and highest velocities of all avalanches within the study area. The largest avalanches descend 2000 to 4000 ft (600 to 1200 m), involve more than 200,000 yd^3 (150,000 m^3) of snow and entrained material, and may approach a terminal velocity of 150 mph (70 m/s). The Girdwood/ Crow Creek area has the potential for the largest avalanches in the study area. A strong powder or wind blast accompanies some of the very high velocity avalanches and can extend the destructive range 500 to 1000 ft (150 to 300 m) beyond the distal margin of debris. Because of their high velocity and great flow depth major dry snow avalanches are not deflected by small-scale terrain irregularities or man-made defense structures.

Wet-snow avalanches are also widespread throughout the study area and occur in the same locations as the dry avalanches. These events may also descend long distances and involve very large snow masses, however velocities will rarely exceed 60 mph (25 m/s), and as a general rule will not extend for long distances into the lower part of the avalanche path (the runout zone). The relatively high densities of wet-snow avalanches cause them to be very destructive upon impact.

At low elevations dry avalanches can entrain wet snow and quickly decelerate at low elevations. Excellent examples of this occurred along the Seward Highway between Bird Creek and Girdwood in March, 1979 as large dry avalanches released at elevations of 3000 to 4000 ft (900 to 1200 m), encountered wet snow below the 1000 ft (300 m) level, and reached the road as major wet slides. In some cases, however, dry snow avalanches extended 1500 ft (450 m) into Turnagain Arm.

Because avalanches may differ considerably from one location to another, several representative areas are discussed separately in this section. We feel these areas differ from one another significantly enough to merit individual treatment although substantial variation in snow and avalanche type also occurs within each area due to elevation and exposure differences.

3.2 Girdwood, Crow Creek

The Girdwood and Crow Creek areas are located at the southeastern portion of the study area and are exposed to frequent heavy and wet storms accompanied by southeast winds from the Gulf of Alaska. Very wet snow and rain are common below 1000 feet (300 m) elevation throughout the entire snow season, a period extending from November through April. At elevations above 2000 feet (600 m), rain is much less common. Snowfall records from the Alyeska ski area (Dave Hamre, pers.

comm.), indicate that rain at the valley is often accompanied by heavy snow near the top of Alyeska (elevation 2700 feet; 800 m). Strong southeasterly winds usually accompany heavy snows, consequently the high-elevation snowpack is typically of high density (>400 kg/m^3), and strongly bonded while the low-elevation snows are typically wet and heavy.

Many of the avalanche paths that can affect valley-bottom locations begin in the high elevation snow at or above treeline and descend into wet or damp snow at lower elevations. Design avalanches may involve large masses of dry snow, as evidenced by a very large avalanche accidentally triggered and carefully observed by Dave Hamre and Peter Zug on the northwest face of Alyeska in March, 1981 (Figure 5-1). Nevertheless, this avalanche stopped in a relatively short distance considering the very large mass of snow involved and the high velocities observed. This tendency for large, dry avalanches to stop quickly in the lower reach of the avalanche path was also noted during most of the major March, 1979 avalanches along the Seward Highway between Bird Creek and Girdwood. Analysis of lower boundary timber destruction in many large Girdwood area avalanche paths suggest that even 100- or 200-year avalanches tend to stop quickly in the forest after traveling a relatively short distance. Despite the short travel distances and steep mean slopes, these avalanches may attain high velocities and will be very destructive nearly to the outer limits of their paths.

Occasionally, cold, dry snow will accumulate throughout the entire elevation range of the avalanche paths. Nevertheless we have not found evidence that avalanches have traveled very long distances on gentle gradients in the Girdwood area despite these favorable conditions. We speculate that the dense, damp underlying snow and heavy vegetation serve to rapidly reduce the speed of even the dry-snow avalanches. Major wet-snow avalanches have also reached the base area at the Alyeska ski area, however dry-snow avalanches will travel longer distances into developed areas. Toward the northern end of Crow Creek the valley bottom rises to more than 1000 feet (300 m), thus high-velocity dry-snow avalanches will be more common than at Girdwood. The runout distances of the Crow Creek avalanches are restricted as they impact the opposite valley walls.

3.3 Bird Creek, Indian, Rainbow

These areas are 10 to 18 miles (16 to 30 km) west of Girdwood on the north side of Turnagain Arm. Although they are relatively close to Girdwood, the amount of snowfall received decreases rapidly in a westerly direction. During design avalanche conditions the snowpack here will be similar to that discussed for Girdwood: dry, high-density, strongly-bonded snow will be deposited at high elevations and damp snow will persist at the valleys. The travel distances of major avalanches in Bird and Indian Creek areas are also strongly controlled by topography. The eastern sides of these valleys contain large avalanche paths that collect wind-transported snow as storms move westerly up Turnagain Arm. Thus potential for long-running avalanches is greater on the east sides of the valleys than on the west sides where slopes are steep, broken by rock outcroppings, and are often scoured by winds. When large avalanches do occur they may attain high velocities and produce extensive destruction to the forest, but will stop after traveling a relatively short distance. An example of such an avalanche is the "Van Slide" in Bird Creek Regional Park. The Van Slide was a very high energy and destructive avalanche even toward the distal margin of the path as evidenced by damage to a van that was wrapped around a tree in the runout zone. The avalanche also caused extensive damage to trees. In terms of destruction near the end of the path, the Van Slide is similar to the Zug Slide on the north face of Mr. Alyeska.

Large avalanches in the upper portions of Rainbow Creek will reach the valley bottom at elevations of 500 to 1000 feet (150 to 300 m). Both wet and dry-snow avalanches have reached to the valley at this location.

3.4 South Fork of Eagle River

The South Fork of Eagle River is a high glacial valley located approximately 25 miles (40 km) north of Bird Creek. The elevation of the valley ranges from approximately 1500 to 2000 feet (450 to 600 m) within the privately-owned area. Major avalanches begin below the ridgetops on the east and west sides of this south/north trending valley at elevations of approximately 3500 to 4500 feet (1100 to 1400 m). Because the South Fork is located inland from Turnagain Arm and is sheltered by mountain barriers of the southern Chugach Mountains precipitation is reduced as storms move northwest. Storms contain considerably less precipitation than those affecting the areas previously discussed. The valley will tend to channelize major storms as they move from south to north up the valley. Therefore winds near the ridgetops will deposit most snow on the north-facing slopes although all of the slopes will be snowcovered during big storms.

The design avalanches in the South Fork will result from release of cold, dry snow of 100 to 300 kg/m^3 density. These avalanches will encounter dry snow to the valley bottom. Furthermore avalanche slopes decrease gradually in gradient and are much more sparsely timbered than in paths along Turnagain Arm. As a result, design avalanches will decelerate slowly and extend for long distances on gentle gradients. The avalanches will be much less destructive near their distal margins than those discussed for the Turnagain Arm areas, therefore a long distance will exist between the red and blue zone boundaries.

3.5 Eagle River

The valley of Eagle River is located approximately 40 miles (60 km) north of Turnagain Arm, well inland from Gulf of Alaska moisture sources. Consequently, the area receives substantially less snow than the valleys adjacent to the Turnagain Arm.

Avalanche paths begin at elevations of approximately 2000 to 4000 feet (600 to 1200 m), primarily on steeply inclined slopes oriented from the south to the west. Most of the avalanches flow in deeply-incised erosion gullies of 20° to 30° inclination that extend to lower elevations where high-density, damp or wet snow is commonly encountered. The damp snow at elevations below 1000 feet (300 m) usually inhibits the motion of large avalanches. Certain steep slides can extend to the highway.

Major avalanches that destroyed three buildings and nearly reached several others in 1979 and 1980 probably represent the "10-year" rather than the "100-year" avalanche cycle. Although these slides were only moderate in absolute size, they had energy sufficient to destroy buildings that had not been designed for avalanche impact. The 1979 and 1980 avalanches are documented more fully in section 5.3 of this report.

Occasionally major storms affecting Eagle River will approach from the west and deposit snow into starting zones differently than the more common southeast storms. Avalanches resulting from this unusual loading will follow the same paths to the lower elevations.

3.6 Peters Creek

Several avalanche paths reach private land from the southwest slopes of Mt. Eklutna and in a tributary drainage of Peters Creek known locally as "4-mile." The avalanche paths begin at elevations of 3000 to 4000 feet (900 to 1200 m) and descend 1000 to 2000 feet (300 to 600 m).

Design avalanche conditions here probably consist of fracture and release of dry, soft slabs that produce dry and powder avalanches similar to those of South Fork. Wet-snow avalanches also occur but probably do not extend as far downslope.

3.7 Mirror Lake/N.W. Spur Mt. Eklutna

The slopes above Mirror Lake include a large number of deeply channelized small-to-moderate sized avalanche paths on WNW-facing slopes. These paths are generally in excess of 30^{o} inclination throughout most of their lengths and begin at elevations ranging from 1500 feet to 3000 feet (450 to 900 m).

Design avalanches here will result from wet snow release or hard, dry-slab release. The larger paths are directly southeast of Mirror and Edmonds Lake. These larger paths have starting zones above timberline and receive large amounts of snow that is eroded from the high, flat plateau located approximately 1 mile (2 km) west of Mt. Eklutna. This wind-blown snow will accumulate as deep, dense drifts in the upper starting zones and will release as hard-slab avalanches in mid winter or as wet snow avalanches during spring thaws. The largest avalanches will be confined to deep gullies throughout most of their lengths and will discharge onto alluvial fans. Even during unusual conditions the avalanches will stop quickly on low-gradient slopes generally below 600 feet (200 m) elevation.

The weather conditions producing major avalanches in this area will be (1) snowstorms approaching from the southeast, (2) strong southeast winds following a storm that has deposited dry, low-density snow on the upper plateau, and (3) a rapid thaw taking place while deep snow deposits exist on the steep upper portions of the paths. These three conditions may occur independently or in combination with one another.