BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION FOR LICENSE FOR MAJOR PROJECT

SUSITNA HYDROELECTRIC PROJECT
DRAFT LICENSE APPLICATION

VOLUME 10

EXHIBIT E
CHAPTER 3 - FISH, WILDLIFE AND BOTANICAL RESOURCES
SECTION 3

November 1985

NOTICE

A NOTATIONAL SYSTEM HAS BEEN USED
TO DENOTE DIFFERENCES BETWEEN THIS AMENDED LICENSE APPLICATION
AND
THE LICENSE APPLICATION AS ACCEPTED FOR FILING BY FERC
ON JULY 29, 1983

This system consists of placing one of the following notations beside each text heading:

(o) No change was made in this section, it remains the same as was presented in the July 29, 1983 License Application

(*) Only minor changes, largely of an editorial nature, have been made

(**) Major changes have been made in this section

(***) This is an entirely new section which did not appear in the July 29, 1983 License Application

VOLUME COMPARISON

VOLUME NUMBER COMPARISON

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CHAPTER 3

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3 - BOTANICAL RESOURCES (**)

3.1 - Introduction (*)

The object of this report is to describe the existing botanical resources of the Susitna Basin; the impacts which the Susitna Hydroelectric Project will produce on those resources; and mitigative measures incorporated by the project to avoid, minimize, rectify, reduce, or compensate for the predicted adverse impacts. As stated in Section 1.2, the primary importance of botanical resources within the project area is their key role as components of wildlife habitat. The following discussions have been coordinated closely with baseline descriptions, impact assessments, and mitigative measures presented in Section 4 (Wildlife), and form an important basis for that section.

A diversity of plant communities occurs within the study area designated for botanical resources and wildlife of the Susitna Hydroelectric Project. The study area (Figures E.3.3.1 and E.3.3.2) includes the watershed of the Susitna River upstream from Gold Creek; a corridor extending approximately 1 mile to each side of the downstream floodplain between Gold Creek and Cook Inlet; corridors approximately 5 miles in width encompassing the transmission routes from Healy to Fairbanks and Willow to Anchorage; and the intertie transmission corridor from Willow to Healy, with a study area varying from approximately 4 to 18 miles in width (Commonwealth Assoc. 1982).

In this report, the entire Susitna Basin has been subdivided into three component drainage basins: the upper, middle, and lower basins. These areas are delineated in Figure E.3.2.1, and the designations are used consistently throughout the discussions of botanical resources and wildlife (Exhibit E, Chapter 3, Sections 3 and 4, respectively). However, because the watershed of the Susitna River upstream from Gold Creek, at River Milepost (RM) 137 (Figure E.3.3.3), was distinguished for study purposes from the downstream floodplain study corridor, data were evaluated separately for these two areas in certain cases. In these cases, the entire basin area upstream from Gold Creek is defined as the Watana and Gold Creek Watersheds, as shown in Figure E.3.3.5. Data presented collectively for the WGC watersheds therefore include all of the upper basin and all of the middle basin except that portion downstream from Gold Creek. The latter area is represented in the downstream floodplain study corridor.

Unless cited otherwise, the descriptions that follow are from McKendrick et al. (1982). Vegetation types are characterized in accordance with the terminology of Viereck and Dyrness (1980). Common names of plant species appear in the text; their scientific names are shown in Appendix E3.3. Species and varieties under review by the USFWS for official designation as endangered or threatened are referred to by scientific nomenclature in the text.

3.1.1 - Regional Botanical Setting (o)

The Susitna River system drains parts of the Alaska Range to the north and parts of the Talkeetna Mountains to the south. The vegetation communities of the region are typical of those covering vast areas of Alaska and northern Canada. They include forest and shrub communities on stream floodplains; coniferous and deciduous forests on canyon slopes adjacent to the floodplains; shrub communities, conifer stands, and tundra on benches above the canyon slopes; and tundra at higher elevations (Figure E.3.3.6). River action and fires contribute greatly to the ever-changing mosaic of plant communities and successional stages within the region.

Predominant vegetation of the lower mountains and lower slopes of the higher mountains in the project area is alpine tundra. Some areas mapped as rock have pioneering species growing in crevices, but the plants provide negligible ground cover. These habitats are common in mountainous areas throughout Alaska. Permanent snowfields and glaciers are found at higher elevations of the Susitna watershed in the Alaska Range.

The benches bordering the middle basin portion of the Susitna River and the area around the Maclaren River are moist tundra. This type includes herbaceous meadows as well as shrub-dominated sites, both of which are widespread in Alaska, especially in the Brooks Range, on the Seward Peninsula, and near the Killuck Mountains.

Along east-west reaches of the Susitna River in the middle basin, steep canyon slopes and some adjacent areas are covered with closed spruce-hardwood forest. This type of vegetation is most common along rivers in the south-central and interior regions of Alaska.

Vegetation north of the Susitna River to the Denali Highway along portions of the Seattle, Brushkana, and Deadman Creek drainages is variously composed of mat and cushion tundra, sedge-grass tundra, low shrub types with birch and willow predominant, and alder-dominated tall shrub.

The southeast portion of the middle basin has extensive flat areas covered by low shrubland and woodland conifer communities. The flats in the lower Oshetna River and Lake Louise area are spruce woodland.

Each of the transmission corridors crosses several vegetation types. The Healy-to-Fairbanks transmission corridor includes ridges, wet flatland, and rolling hills with areas of open spruce, open deciduous, and mixed forest; shrublands; and wet tundra. The Willow-to-Anchorage transmission corridor passes through closed birch forest, mixed conifer-deciduous forest, wet sedge-grass marshes, and open and closed spruce stands. The Willow-to-Healy intertie corridor traverses a variety of vegetation types, from closed spruce-hardwood forests in the south to tundra and shrubland in the north.

3.1.2 - Floristics (*)

Floristics surveys were made in the Susitna Basin and intertie corridor by McKendrick et al. (1982) and Commonwealth Assoc. (1982), respectively. These provided information on the numbers and distribution of plant species which occur within portions of the project area.

The following floristics data are summarized from McKendrick et al. (1982) and Commonwealth Assoc. (1982) where further details may be found.

(a) General (*)

In the region including the Watana and Gold Creek watersheds, the downstream floodplain, and the intertie corridor, 295 vascular plant species belonging to 151 genera and 57 families were identified (McKendrick et al. 1982) (Appendix E3.3). Two hundred fifty-five species were identified in the Watana and Gold Creek watersheds, and 76 species downstream from Gold Creek.

Plant families in the Watana and Gold Creek watersheds having the most represented species were the Compositae (Asteraceae), Salicaceae, Rosaceae, Gramineae (Poaceae), Cyperaceae, and Ericaceae. Within the non-vascular flora, 11 genera of lichens (including at least 12 species) and 7 taxa of mosses were identified in these areas.

The downstream floodplain flora was predominantly a subset of the Watana and Gold Creek watersheds flora. Of the 76 plant species found downstream from Gold Creek, 54 also occurred in upstream areas. Downstream sites were confined to the floodplain, which reduced the number of habitats represented and floristic variability relative to the upstream area. Also, the larger study area and greater time spent in sampling the Watana and Gold Creek watersheds may in part account for the larger number of species found there.

In the intertie corridor from Willow to Healy, Commonwealth Assoc. (1982) identified 128 species of vascular plants. All but 18 of these species were also found in the Watana and Gold Creek watersheds by McKendrick et al. (1982) (Appendix E3.3).

(b) Range Extensions (*)

McKendrick et al. (1982) found 22 vascular plant species in the Watana and Gold Creek watersheds and 9 in the downstream floodplain corridor which were outside their reported ranges (see Hulten 1968) (Table E.3.3.1). However, the Susitna River drainage upstream from Gold Creek is not well represented in existing plant collections, and range extensions may be expected from any additional botanical surveys in the area.

Two species found in the Watana and Gold Creek watersheds- (Sheldon groundsel and timber oatgrass) represent appreciable range extensions. Sheldon groundsel had not been officially reported in Alaska previously, except as possibly present in the Skagway area. Timber oatgrass had been reported only in locations near upper Cook Inlet and near Skagway (Hulten 1968).

In August, McKendrick et al. (1982) found a single specimen of Sheldon groundsel in a mesic (moderately wet) midgrass community near upper Portage Creek. Timber oatgrass was identified in the grass portion of a mosaic of low birch and grass communities between the Maclaren River and the Denali Highway.

Two other plant occurrences of note were reported by McKendrick et al. (1982). Robbins pondweed, a submerged rooted aquatic, was found in Watana Lake (Figure E.3.3.5). There has been limited collection of this species in Alaska. Hulten (1968) reported it from Summit village south of Healy, and Welsh (1974) indicated that it is known from southcentral Alaska, but is evidently rare. Black spruce, one of the most common trees found by McKendrick et al. (1982) in the middle Susitna Basin, had been reported by Hulten (1968) to be in areas north and south of the middle Susitna River drainage, but not in the drainage. Viereck and Little (1972), however, did include the Susitna drainage in their distribution map of this species.

Most other range extensions reported by McKendrick et al. (1982) in the Watana and Gold Creek watersheds were less noteworthy. Most were extensions to the north (more inland) from their previous observations. For example, white bog-orchids had previously been found only near the coast in Alaska. Northern bog-orchids and sweet gale extensions involved sites between areas that were previously included in their ranges. Two-flower cinquefoil and Kane lousewort extensions were south of their previously reported ranges.

In the downstream floodplain corridor, McKendrick et al. (1982) found nine species outside their ranges as reported by Hulten (1968) (Table E.3.3.1). One of these, raspberry, though not reported to extend into the region by Hulten (1968), was reported by Viereck and Little (1972) to occur there. Devil's club showed a slight range extension upriver. Small-fruit bullrush had previously been found only in four areas outside southeast Alaska. An unverified specimen which appeared to be Chamisso's arnica represented a large extension from the Alaska Peninsula and southeast Alaska. The presence of enchanter's nightshade was an extension inland from coastal regions. Sweet-scented bedstraw and thinleaf alder were minor extensions, and baneberry and northern black currant were extensions from the surrounding areas into the basin.

It is again emphasized that many of the range extensions reported above were merely the result of more intensive botanical collections by McKendrick et al. (1982) than had been made previously and did not represent plants growing in unexpected environments.

3.1.3 - Contribution to Wildlife, Recreation, Subsistence, and Commerce (*)

In the Susitna watershed as elsewhere, botanical resources make essential contributions to human activities and land uses. Vegetation is necessary for the regional maintenance of surface water and ground water quality through water retention, determination of physical and chemical soil properties, and erosion control. Botanical resources are also essential as fish and wildlife habitat components, as discussed further in Section 2 (Fish) and Section 4 (Wildlife). Wood is used by local residents for building and heating homes (Laroe 1981); however, total consumption for these uses is insignificant on a basin-wide basis. In addition, the mosaic of plant communities and successional stages provides an important aesthetic contribution (Exhibit E, Chapter 8). Thus, botanical resources directly support all of the limited human activities and land uses of the project area (Exhibit E, Chapters 5, 7, and 9).

Commercial use of plant resources within the project area has been limited to small logging operations along the Susitna River floodplain in the lower basin (ADNR 1982b). Vegetation of the upper and middle basins is almost entirely undisturbed. Timber sales are planned for portions of public lands within management units of the Matanuska-Susitna-Beluga Cooperative Planning

Program (ADNR 1982b). Lands with highest forestry potential within the project area are located along nearly the entire length of the Susitna River floodplain downstream from the confluence with Portage Creek. Eleven timber sales totaling approximately 325,100 acres within the lower basin are planned by the Alaska Department of Natural Resources and Matanuska-Susitna Borough; most are scheduled to begin no earlier than 1992 (ADNR 1982b).

3.2 - Baseline Description (**)

3.2.1 - Threatened or Endangered Plants (*)

At present, no endangered or threatened plant taxa are officially listed for Alaska by federal or state authorities; however, 33 plant taxa are currently under review by the U.S. Fish and Wildlife Service (1980a) for possible protection under the Endangered Species Act of 1973. Murray (1980) discusses the habitats, distributions, and key traits of most of the Alaskan candidate taxa. Searches for these plants were made in two areas: the Watana and Gold Creek watersheds (Figure E.3.3.5) (McKendrick et al. 1982) and the intertie transmission corridor between Willow and Healy (Commonwealth Assoc. 1982) (Figures E.3.3.1 and E.3.3.7). No surveys of candidate taxa were conducted in the downstream floodplain corridor, because none of them (Table E.3.3.2) are normally found in association with river floodplains.

(a) Watana and Gold Creek Watersheds (*)

Table E.3.3.2 shows the plant taxa on Murray's (1980) list believed most likely to occur in the Susitna River drainage and in the habitats to be affected by construction of the proposed dams and associated facilities. McKendrick et al. (1982) conducted ground searches for these candidate taxa in the following areas of the Watana and Gold Creek watersheds: (1) alpine areas near the Susitna and West Fork Glaciers; (2) lowlands of the upper and middle basins, including those of the Maclaren and Tyone Rivers and their associated ridges, terraces, and periglacial features; (3) calcareous outcrops and promontories along the Susitna River near Watana and Kosina Creeks; (4) potential alternative access routes in the middle basin; and (5) borrow sites planned for dam construction. These areas were selected after reviewing the literature pertaining to the likely habitats of endangered plant taxa, conferring with specialists in Alaska plants, and conducting discussions with project geologists to identify calcareous soils.

Several of the taxa listed by Murray (1980) were known calciphiles (plants that normally grow on calcareous soils). Three locations with calcareous soils were found in the project area. One was on the northwest flank of Mt. Watana at about 3,700 ft (1,128 m) elevation, another on the south side of the Susitna River immediately east of its confluence with Kosina Creek, and the third was on the north side of the Susitna River about 4.5 miles (7 km) west of Watana Creek. Calciphilic plants were found on two of these sites, but none of those found was listed by Murray (1980).

Well-drained rocky or scree slopes were searched in alpine areas of the upper drainage basin in the steep valleys adjacent to the Susitna and West Fork Glaciers. None of the taxa under federal review were found.

Well-drained, sandy or gravelly ridges and terraces in lowlands of the upper and middle drainage basins were searched. Shores of lakes and ox-bow ponds, and peri-glacial features were emphasized. A trip was made downstream as far as Devil Canyon, and two large gravel bars within the riverbed were surveyed. None of the taxa under federal review were found in these lowland surveys.

Three sites judged by substrate characteristics potentially to support rare plants were searched along the proposed access route section from the Denali Highway to Watana (Figure E.3.3.7). One site was a sandy blowout area on the northwest side of Deadman Mountain; one was a series of dry ridges (probably glacial moraines or terraces) on the south side of Deadman Mountain; and one was an area of windblown ridges on the east side of Deadman Mountain. No candidate threatened or endangered taxa were found at any of these sites, nor along any of the other proposed access corridors.

Vegetation in the vicinity of borrow sites proposed for dam construction (Figure E.3.3.7) was surveyed in July 1981. No candidate threatened or endangered taxa were found.

(b) Willow-to-Healy Intertie (o)

The Willow-to-Healy intertie corridor (Figures E.3.3.2 and E.3.3.7) was surveyed for the presence of Smelowskia borealis var. villosa, Taraxacum carneocoloratum, and Montia bostockii, all of which appear on Murray's (1980) list (Table E.3.3.2). Geologic and topographic maps were used to identify potential habitat areas for these taxa within the intertie corridor. None of the candidate taxa were found in the locations surveyed (Commonwealth Assoc. 1982).

(c) Summary (*)

In summary, the Susitna River watershed upstream from Gold Creek was surveyed at selected habitat sites for plant taxa under consideration for threatened or endangered status. Access routes, borrow areas, and the intertie corridor were also surveyed for the presence of these taxa. No candidate threatened or endangered plants were found.

3.2.2 - Plant Communities (**)

(a) Methods (**)

Vegetation of the project area was mapped at three different scales by McKendrick et al. (1982), using photo-interpretation of high-altitude (U-2) color infrared photographs at a scale of 1:120,000 and LANDSAT imagery, followed by confirmation of vegetation types in the field. Plant communities were classified in accordance with Viereck and Dyrness (1980). The WGC Watersheds (Figure E.3.3.5) were mapped at a scale of 1:250,000 (Figure E.3.3.6). The Healy-to-Fairbanks and Willow-to-Anchorage transmission corridors were mapped at a scale of 1:63,360 (Figures E.3.3.8 through E.3.3.12). Vegetation maps of the intertie corridor, presented at a scale of 1:250,000 in Commonwealth Assoc. (1982), were adapted from a map previously prepared by the Joint Federal-State Land Use Planning Commission for Alaska (1973) and adapted subsequently by the U.S. National Park Service (1976).

Whereas the vegetation maps show definite boundaries between vegetation types, such lines of demarcation do not exist in the field and are imposed by the judgment of the cartographer. Another consideration is that the smallest feasible units mappable at the 1:250,000, 1:63,360, and 1:24,000 scales are about 642 acres, about 40 acres, and about 7 acres, respectively. Therefore, vegetation types shown on the larger scale maps and tables derived from them are sometimes absent from the smaller scale mapping and tables (McKendrick et al. 1982).

In order to develop more detailed vegetation maps of a larger area with emphasis on mapping browse vegetation to support habitat-based impact assessment and mitigation plan refinement (particularly the estimation of moose carrying capacity), additional mapping of the project area was done by R.A. Kreig and Associates, Inc. (RAK) in 1985. Digitizing of the entire mapped data base has been completed and the production of a photobase map is nearing completion (available in winter 1985). The RAK mapping was done at a scale of 1:63,360 using available 1:24,000 true color and 1:60,000 color infrared aerial photography and encompasses an area of about 1.6 million acres. The mapping area surrounds project impact areas from the vicinity of Gold Creek and Hurricane on the west to the big bend of the Susitna River on the east and beyond (Figure E.3.3.3). The RAK mapping employed the classification system of Viereck et al. (1982) with modifications made as a result of the Alaska Vegetation Classification Workshop (1984) and fieldwork done by RAK. All vegetation types were mapped to at least Classification Level III. Forest, tall shrub, and low shrub communities were mapped to Classification Level IV. In addition, the percent canopy cover of willow, shrub birch, and alder was indicated on each polygon. Ground-truthing was conducted to the extent that categorical detail was added to the mapping beyond the limitations of the aerial photography.

Methods used for the quantitative characterization of vegetation types are described in detail by McKendrick et al. (1982). The 64 locations and associated vegetation types surveyed in the Watana and Gold Creek watersheds during the summer of 1980 are indicated in Table E.3.3.3 and Figure E.3.3.13. At these locations, plant species composition and community structure determinations were made; and data on elevation, slope, aspect, and landform also were gathered to relate to plant species composition. The cover contributed by each plant species was measured within a series of vertical layers as percent area of each layer. The ground layer was defined to be all herbaceous and woody species less than 1.6 feet (0.5 m) tall. The shrub layer included woody species taller than 1.6 feet (0.5 m) with a diameter at breast height (dbh) less than 1 inch (2.5 cm). The understory layer consisted of woody species between 1 inch (2.5 cm) and 4 inches (10.0 cm) dbh. Overstory vegetation contained species larger than 4 inches (10.0 cm) dbh. This classification approach is used here to describe the vertical layering within plant communities of the project area.

The sites sampled in 1981 were revisited to the extent possible in 1984 in order to measure changes which might have occurred and to enhance understanding of successional sequences and time frames (Helm et al. 1985). In addition to those measurements taken in 1981, increased attention was given to aging of older individual plants and to low shrub densities.

Aquatic vegetation within the Watana and Gold Creek watersheds was examined during August 1980. In order to obtain site-specific information on aquatic plant species, 24 selected ponds and lakes and their adjacent uplands were surveyed on foot from Devil Canyon (RM 152) to the confluence of the Susitna and Oshetna Rivers (RM 233) (Figure E.3.3.14). During the surveys, species composition, dominance, and total cover (relative to the amount of water) were estimated. Elevation, estimated rooting depth, and width of surrounding wetland area were recorded. Surrounding wetland was limited by definition to the Lacustrine-Limnetic-Emergent Wetland-Vascular Wetland class of Cowardin et al. (1979). Many remaining ponds and lakes were examined by helicopter overflights.

Quantitative descriptions of downstream floodplain plant communities were made during the summer of 1981 at the 29 locations shown in Figure E.3.3.4. Vegetation cover by species was measured along transects. Density of woody species was determined by counting individual stems of plants within specific height ranges growing inside designated measurement plots. Age, height, and diameter at breast height (dbh) of low shrubs, tall shrubs, and trees were measured for randomly selected plants along the transects, and the age of each measured tree or shrub was determined by counting growth rings taken from cross-sectional cuttings or cores. Crown dominance, a measure of which species within a stand were capturing the canopy sunlight, was evaluated as follows: (1) open growth (not encountered), (2) dominant (received sunlight from above and the sides), (3) codominant (received sunlight from above, but not from the sides), (4) intermediate (plant barely reached main canopy), (5) overtopped (plant was below general level of canopy), (6) subordinate (below the overtopped category), and (7) ground (the lowest level). The ground elevation of each floodplain stand relative to river surface elevation was measured by rod-and-level technique at two or three different times during the summer of 1981. Time of day for each measurement was recorded for later reference to rate of river flow.

(b) <u>Watana and Gold Creek Watersheds</u> (**)

Figure E.3.3.6 shows the general distribution of vegetation in the Watana and Gold Creek watersheds as mapped by McKendrick et al. (1982). Table E.3.3.3 and Figure E.3.3.12 indicate field sampling locations and associated vegetation types characterized for ground-truth and floristics during June, July, and August 1980 (McKendrick et al. 1982). Acres and percentages of total area covered by vegetation types in the RAK vegetation mapping area (Figure E.3.3.3) are shown in Table E.3.3.4, based on mapping at a scale of 1:63,360 by

R.A. Kreig and Associates (1985). Tables E.3.3.5 and E.3.3.6 compare equlvalent mapping units used.

The structure and distribution of vegetation types at elevations below tundra in this area are strongly influenced by past fires, evidenced by fire scars on the trees. Post-fire succession for black spruce stands typically proceeds from the initial herbaceous and shrubby stages to young black spruce stands to dense and finally decadent black spruce/moss communities (Van Cleve and Viereck 1981). Post-fire succession in white spruce stands includes the initial herb and tree seedling stage; the shrub-tree sapling stage; and the dense hardwood stage of aspen, birch, or a mixture of aspen and birch. From this point the stand proceeds through a mature hardwood-spruce seedling stage, a mixed white spruce-hardwood stage, and finally a mature white spruce stage (Van Cleve and Viereck 1981). Most of the herbaceous, shrubby, deciduous, and mixed forest communities identified and described below may be successional stages in the process of transition to black or white spruce forest.

(i) Forests (**)

All forest types are composed of at least 10 percent canopy of trees over five meters in height at maturity. The forest types are classified according to the species contributing at least 75 percent of the canopy cover percentage and further classified by the total canopy cover value.

Forest vegetation types are located at lower elevations and cover approximately 25 percent total area of the RAK vegetation mapping area (Figure E.3.3.3). The mean elevation of forest areas sampled was 1,716 feet (range 1,100 to 2,600 feet).

The average elevational limit for trees in the project area (i.e., black and white spruce, paper birch, trembling aspen, and balsam poplar) is 3,200 ft (McKendrick et al. 1982), ranging from about 2,800 to 3,500 ft. Black and white spruce are the most frequent species at or near treeline. The deciduous trees, paper birch and trembling aspen, generally occur below 2,300 feet and balsam poplar stands are found only on the floodplain.

Forested communities in this area were similar to those described by Viereck (1975). Black spruce generally occurred on wetter sites than white spruce, and both spruce species occurred on colder sites than those of deciduous or mixed forests. Closed forests occur on sites warmer than those of open forests. Deciduous and mixed forest stands in the project area were considered earlier successional stages of the conifer stands (Viereck 1970, 1975; Hettinger and Janz 1974).

- Coniferous Forest (**)

  Conifer forest types have at least 75 percent of the total forest canopy cover value composed of conifer species. These forests covered approximately 17 percent of the RAK mapping area and consisted of spruce stands with a majority of either white or black spruce. These forests contained a well-developed ground layer with a high percent cover (94 percent) (Tables E.3.3.7 through E.3.3.10). The layering structures of white and black spruce stands were similar, except that white spruce stands usually had a greater overstory cover (35 percent compared to 14 percent), a reflection of the generally larger cover area of individual mature white spruce trees (Tables E.3.3.8 and E.3.3.9).

  Core sampling indicated that large white spruce ranged from 34 to 78 years in age and large black spruce from 77 to 171 years. Several white spruce stands examined appeared to be recovering from past disturbance, perhaps fire; black spruce stands showed less signs of disturbance.

  - White Spruce (***)

    This type consists of forest with 75 percent of the total canopy cover composed of white spruce. About 83 percent of the white spruce in the mapping area is classified as open and 17 percent is classified as closed. Open white spruce commonly occurs on well-drained convex sites, along drainages and near treeline, while closed white spruce generally occurs along drainages or well-drained slopes of north, northeast or northwest aspects. The understory is composed of willow (*Salix planifolia*), dwarf birch and alder with more shrub cover in the open stands because of the more open tree canopy. The wetter sites generally support a greater percentage of willow and the dryer sites support more dwarf birch. Typical groundcover species in the open forests are crowberry, northern Laborador tea, bog blueberry, mountain cranberry, woodland horsetail, bluejoint, feather moss, and lichens. Closed white spruce ground cover includes cloudberry, nagoonberry, woodland horsetail, twinflower, and feather moss.

. Black Spruce (***)

This type consists of forest with 75 percent of the total canopy cover composed of black spruce. About 81 percent of this type in the RAK mapping area is classified as open forest, while the remaining 19 percent is closed forest. This type typically occurs on poorly drained organic permafrost soils. Willow, dwarf birch and alder occur in the shrub layer. Ground cover species include Labrador teas, bog blueberry, beauverd spirea, crowberry, sedges, woodland horsetail, nagoonberry, and peat mosses.

. Black and White Spruce (***)

This type consists of forests wherein neither black spruce nor white spruce dominate the canopy cover with 75 percent cover value. About 85 percent of this type in the mapping area is open forest, while 15 percent is closed forest. Open black and white spruce type occurs near treeline, on moist slopes and in ecotonal areas of black and white spruce. Closed black and white spruce type occurs on terraces, at the base of south-facing slopes, and on poorly drained north-facing slopes. The shrub layer is composed of willow, dwarf birch and occasionally alder. The major species of the understory are bog blueberry, beauverd spirea, prickly rose, bluejoint, woodland equisetum, sedges, Labrador tea, nagoonberry, cloudberry, crowberry, mountain cranberry, feather mosses and peat mosses.

. White Spruce Woodland (***)

This is a woodland community (canopy cover values of 10 to 25 percent) with 75 percent of the total canopy cover value composed of white spruce. This type generally occurs on well-drained sites at elevational treelines, in areas of regenerating vegetative growth, or successional or ecotonal sites between white spruce and low shrub. This type is similar to the open white spruce type, but with even more shrub cover because of the more open tree canopy. Willow, dwarf birch and occasionally alder compose the shrub layer. Important ground cover species are northern Labrador tea, bog blueberry, mountain cranberry, woodland horsetail, polargrass, fireweed and feather mosses.

. <u>Black Spruce Woodland</u> (***)

This is a community with 75 percent of the total canopy cover value composed of black spruce. This type occurs on wet poorly drained cold sites and it often grades into a peat bog. The shrub layer is composed of willow and dwarf birch. Ground cover species are Alaska bog willow, swamp cranberry, Labrador tea, bog blueberry, cottongrass, sedges, and peat mosses.

. <u>Black and White Spruce Woodland</u> (***)

This is a community with neither black spruce nor white spruce dominating the tree canopy cover value with 75 percent. This type occurs near altitudinal limits of trees, on moist sites, and as successional or ecotonal types between black and white spruce. Willow, dwarf birch and occasionally alder occur in the shrub layer. Understory species are commonly netleaf willow, shrubby cinquefoil, bog blueberry, mountain cranberry, woodland horsetail, sedges, feather mosses, Labrador teas, and crowberry.

- <u>Broadleaf Forest</u> (***)

Broadleaf forest types have at least 75 percent of the tree cover percentage composed of broadleaf species, and occupy about one percent of the total mapped area. Data from sampled stands are presented in Tables E.3.3.11 to E.3.3.13.

. <u>Paper Birch</u> (***)

This type is a community with 75 percent of the total canopy cover composed of paper birch. Paper birch forests comprise about 44 percent of this type, and are found on well-drained slopes, along floodplains, and in drainage ravines. Open paper birch (about 56 percent of this type) is usually found on well-drained slopes and drainages. Closed stands and drier open stands have low cover value willow and alder shrub understories, while these species along with dwarf birch form a better developed shrub layer in moist sites. Ground cover species include bluejoint, Labrador tea, crowberry, bog blueberry, mountain cranberry, bunchberry, oak fern, and Polytrichum moss.

. Birch-Aspen (***)

Paper birch and aspen is a community with neither paper birch nor aspen dominating the canopy cover with 75 percent cover values. This type is found on well-drained slopes with southern aspects. Willow and alder occasionally occur in the understory with low percentage cover values. Understory species are prickly rose and bearberry.

. Other Broadleaf (***)

These types include various forest types: open and closed balsam poplar (80 percent), open and closed aspen (2 percent), and open and closed birch-poplar (18 percent). A heterogenous mix of types, they are lumped here because of the low areal extent of project impacts upon them. Willow and alder are frequently in the shrub layer, and some typical understory species include bunchberry, mountain cranberry, twinflower, and highlands cranberry.

. Broadleaf Woodland (***)

These types have canopy cover values of 10 to 25 percent. The woodland deciduous types are analagous in species composition to the open broadleaf types. The shrubs and understory species have higher percentage cover values than in the open deciduous types.

- Mixed Forest (**)

Mixed conifer-broadleaf types have neither conifer species nor broadleaf species dominating 75 percent of the tree canopy cover value and cover approximately 7 percent of the total mapping area. Most of the larger stands were found on slopes downstream from Tsusena Creek (Figure E.3.3.5). These were successional stands which developed as spruce replaced deciduous trees. See Tables E.3.3.14 and E.3.3.15.

. Spruce-birch (***)

This mixture most frequently occurs on well-drained south facing slopes and along drainages when white spruce is present in the mixture. When black spruce is present in the mixture, the site is usually a poorly drained north facing slope. About 49 percent of this type in the mapping area is closed forest, and 51 percent is open. Sparse willow and alder are present in the shrub layer of closed spruce-birch forests, while denser willow, alder and dwarf birch are present in open forests. Typical understory species in closed forests are bog blueberry, mountain cranberry, bluejoint, bunchberry, Labrador teas, and Polytrichum moss. Typical open forest understory species include beauverd spirea, fireweed, bluejoint, oak fern, and feather moss.

. Spruce-birch-poplar (***)

This mixture occurs along floodplains. About 63 percent of this type in the mapping area is closed forest, while the remaining 37 percent is open forest. Willow and alder are present in the shrub layer. Beauverd spirea, bunchberry, northern Labrador tea, crowberry, bog blueberry, and mountain cranberry are species common to the understory.

. Spruce-birch-aspen (***)

This mixture occurs on well drained south-facing slopes. About 88 percent of this type in the mapping area is closed forest, with the remaining 12 percent open forest. Willow, dwarf birch and occasionally alder are present in the shrub layer. Understory species include bunchberry, twinflower, mountain cranberry, northern Labrador tea, feather moss and bog blueberry.

. Spruce-poplar (***)

This mixture occurs on floodplains. About 63 percent of this type in the mapping area is closed forest, with the remaining 37 percent being open forest. Willow and alder occur in the shrub layer. Woodland horsetail, fireweed, bunchberry, beauverd spirea and Polytrichium moss are common to the understory.

. Mixed Woodland (***)

This category is composed of three types each dominated by white spruce: woodland spruce-birch (97 percent), woodland spruce-poplar (1 percent) and woodland spruce-birch-aspen (2 percent). These mixtures are analogous in species composition to the open mixed conifer-broadleaf. The shrubs and understory species have higher percentage cover values than in the open conifer-broadleaf types.

(ii) Scrub (***)

Under the most recent vegetation classification scheme for Alaska (Viereck et al. 1982), the item "scrub" applies to types including dwarf trees, tall shrubs, low shrubs, and dwarf shrubs. All scrub types have less than 10 percent forest canopy cover (i.e. trees over 16 feet in height at maturity) and shrubs comprise 25 percent or more of the absolute cover.

Scrub types occupy about 65 percent of the total area mapped, and so are dominant features of the landscape. Of these types, low shrub is the most dominant (65 percent of total scrub), followed by dwarf shrub (23 percent of total), tall shrub (8 percent), and dwarf tree (4 percent).

- Dwarf Tree Scrub (***)

Dwarf tree scrub types have dwarf trees under 16 feet in height at maturity and they comprise at least 10 percent dwarf forest canopy cover values.

. Conifer Dwarf Tree Scrub (***)

This type has 75 percent of the total dwarf tree canopy cover value composed of conifer species.

The closed conifer (about 11 percent of this in the mapping area) dwarf trees are most frequently black spruce and inhabit north-facing permafrost slopes or wet poorly drained concave sites. Ground cover species include sedges, bluejoint, bog blueberry, Labrador tea, crowberry, cloudberry, woodland horestail, and peat mosses. The open conifer (about 69 percent of this type in the mapping area) dwarf trees are usually black spruce and occur on flat poorly drained permafrost sites or on north-facing permanent slopes. The shrub layer species are willow, dwarf birch and occasionally alder. Ground cover species include sedges, bluejoint, bog blueberry, Labrador teas, crowberry, Alaska bog willow, swamp cranberry, coltsfoot, cloudberry, cotton grasses, horsetails, and peat mosses. The woodland (about 20 percent of this type in the mapping area) dwarf trees are usually black spruce occurring on wet poorly drained permafrost sites which grade into sphagnum bog areas. The shrub layer is composed of willow and dwarf birch. The understory species include bog rosemary, Labrador tea, cotton grasses, horsetails, Alaska bog willow, buckbean, narrow-leaved burreed, marsh cinquefoil, and peat mosses. The woodland conifer scrub may also occur as dwarf white spruce and/or black spruce trees at elevational treeline.

. Other Tree Scrub (***)

This category includes several types, each of which is fairly restricted in its distribution in the mapping area. The broadleaf closed, open and dwarf shrub types have 75 percent of the total dwarf tree canopy cover value composed of broadleaf species. The mixed broadleaf-conifer closed, open and woodland dwarf scrub types have neither broadleaf nor conifer trees occupying at least 75 percent of the total dwarf tree canopy cover value.

- Tall Shrub Types (**)

The tall shrub types are scrublands in which at least 25 percent of the overstory is of a height greater than 5 feet. Tall shrub communities covered approximately 6 percent of the total area and were dominated by Sitka alder and were found mostly on steep slopes above the Susitna River or sometimes above flat benches at a mean elevation of 1,880 feet (range 1,600 to 2,550 feet (Figure E.3.3.6). Many of these stands were 7 to 13 feet tall. Approximately 25 species were identified in the alder stands (Table E.3.3.16).

Alder stands frequently occurred as narrow strips through other vegetation types on the slopes adjacent to the Susitna River. Alder would also be present in rings at a particular elevation around mountains or in strips along tributary streams, such as Portage Creek. Closed stands had almost complete vegetation cover, contributed primarily by the ground layer and understory (Table E.3.3.16). One open alder stand surveyed had less vegetation cover than the closed stands (85 percent and 96 percent cover, respectively), with greatest percent cover in the understory layer (Table E.3.3.17).

. Alder Tall Shrub (***)

In this type, alder occupies at least 75 percent of the total shrub cover value. Closed tall alder shrub communities (about 51 percent of the total for this type in the mapping area) are usually found on steep slopes above treeline, along drainages and as pioneer communities on river floodplains. Alder has almost complete canopy cover in these shrub overstories. Willow occasionally occurs in the shrub understory. Other understory species include bluejoint, woodland horsetail, and twinflower. Open tall alder scrub communities (about 49 percent of the total for this type in the mapping area) are found along rivers or on steep slopes above treeline. Willow usually occurs in the low shrub understory.

. Other Tall Shrub (***)

This type is composed of a variety of communities: willow tall shrub (15 percent of this type in the mapping area), alder-willow shrub (82 percent), shrub birch (1 percent), shrub birch-willow (1 percent), and shrub birch-ericaceous shrub (1 percent). Tall shrub willow communities (78 percent closed, 22 percent closed) occur as riparian communities along drainages, as pioneer communities along floodplains, and on slopes above treeline. The shrub layer is composed of feltleaf willow, grayleaf willow, and diamondleaf willow. Understory species include sedges, polargrass, arctic dock, woodland horsetail, fireweed, and bluejoint. Tall alder-willow shrub communities (28 percent closed, 72 percent open) are usually found on steep slopes above treeline, as a riparian community along drainages and on floodplains. Understory species include polargrass and Bigelow sedge.

- Low Shrub Types (**)

Low shrub scrub types are shrublands with 25 percent or more overstory cover which is between 8 inches and 5 feet in height. If tall shrubs are present, they have less than 25 percent cover. Low shrub vegetation types were found to be common in the mapping area where they covered 43 percent of the total area. Low shrub communities were widespread on the extensive, relatively flat river benches (mean el. 2,562 feet) (range 2,100 to 3,200 feet), where soils were frequently wet and gleyed, but usually without standing water. Birch and willow, generally 3 to 5 feet tall, were predominant in both separate and mixed stands. The cover percentages of ten closed and two open low shrub stands sampled are shown in Tables E.3.3.18 and E.3.3.19, respectively.

. Dwarf Birch Low Shrub (***)

This type typically occurs on convex well-drained sites. About 59 percent of this type in the mapping area is a closed community, while the remaining 4 percent is open. Other important associated species are willows, Labrador tea, crowberry, bog blueberry, mountain cranberry, beauverd spirea, sedge, bearberry, cloudberry, nagoonberry, fescue grass, *Stereocaulon* lichens, reindeer moss, *Nephroma* lichens and feather moss.

. Low Willow Shrub (***)

Willow occupies at least 75 percent of the total shrub overstory cover. About 36 percent of this type is a closed community in the mapped area, while the other 64 percent are open communities. Low willow shrub communities occur along drainages, wet concavities, wet flat benches, and slopes and streams at higher elevations. Understory species in closed communities include sedges, Arctic dock, polargrass, shrubby cinquefoil, horsetails, hairy butterwort, saussurea and meadow bistort. Species associated with open communities include vanilla holygrass, fescue grass, netleaf willow, burnet, northern anemone, ragwort, gentian, Arctic dock, cloudberry, shrubby cinquefoil, bog blueberry, and Stereocaulon lichens.

- Ericaceous Shrub (***)

  The ericaceous shrubs Labrador tea and bog blueberry compose at least 75 percent of the shrub overstory. About 14 percent of the communities of this type in the mapping area are closed, while the other 86 percent are open. Both communities occur on steep dry slopes above treeline. Species in the understory include Arctic willow, netleaf willow, diamondleaf willow, dwarf birch, crowberry, mountain cranberry, sedges, fescue grass, four-angle mountain heather, bearberry, white mountain-avens, wormwood, polargrass, feather moss, club moss, and Polytrichum moss.

- Dwarf Birch - Low Willow (***)

  Both birch and willow have greater than 25 percent cover value in the low shrub overstory. About 42 percent of the communities of this type in the mapping area are closed, with the other 58 percent open. The communities occur on moist slopes. Species occurring in the understory include bog blueberry, woodland horsetail, sedge, mountain cranberry, Labrador tea, coltsfoot, crowberry, fescue grass, polargrass, bearberry, fireweed, netleaf willow, feather moss, wormwood, and bluegrass.

- Dwarf Birch - Ericaceous Shrub (***)

  Neither dwarf birch nor ericaceous shrubs have cover values of at least 75 percent of the total shrub cover value. About 14 percent of the communities of this type are closed, while 86 percent are open. This type occurs on well-drained convex slopes. The species of this type are dwarf birch, Labrador tea, bog blueberry, mountain cranberry, crowberry, polargrass, Arctic bluegrass, fescue grass, bearberry, wormwood, sedges, netleaf willow, Arctic willow, and feather moss.

. Other Low Shrub (***)

This type consists of two related types: low alder (54 percent of type; 21 percent closed, 79 percent open) and low alder-low willow (46 percent of type; 18 percent closed, 82 percent open).

The low alder communities contain alder which has a cover value of at least 75 percent of the total shrub cover. The low alder-low willow communities have at least 25 percent cover by each component.

- Dwarf Shrub (***)

The dwarf shrub scrub are communities with 25 percent or more cover in dwarf shrub less than 8 inches tall. If tall and low shrubs are present, their combined cover should be less than 25 percent. The closed dwarf shrub communities (about 13 percent of the communities of this type in the mapping area) are found on dry slopes and ridges at higher elevations. Typical species include four-angle mountain heather, sedges, netleaf willow, Arctic willow, bog blueberry, mountain cranberry, diapensia, crowberry, alpine azalea, purple reedgrass, red fescue, and white mountain-avens (Table E.3.3.20). The open dwarf shrub communities (about 87 percent of the communities) are found on dry windy ridges and rocky areas usually above treeline. Typical species associated with these communities include roundleaf willow, Arctic willow, polar willow, netleaf willow, diapensia, bog blueberry, mountain cranberry, crowberry, red fescue, Labrador tea, and alpine azalea.

(iii) Herbaceous Communities (***)

The herbaceous communities have less than 25 percent cover of woody plants, but 2 percent or more cover values for vascular and nonvascular flora. Altogether, they occur on about 1 percent of the total vegetation mapping area in a wide variety of habitats.

- Graminoid Herbaceous (***)

  These types make up about 99 percent of the herbaceous communities found in the mapping area and are herbaceous communities with the greatest percentage of cover in grasses or sedges.

  . Wet Graminoid Herbaceous (***)

    These communities occur on wet concave sites, typically with standing water, usually underlain by permafrost. Typical species include cotton grasses, sedges, buckbean, marsh cinquefoil, and swamp horsetail (see also Table E.3.3.21).

  . Mesic Graminoid Herbaceous (***)

    These communities occur on moist flat areas typically without standing water. Associated Bigelow sedge, tussock cottongrass, diamond leaf willow, dwarf birch, Labrador tea, bog blueberry, mountain cranberry and Arctic bluegrass (see also Table E.3.3.22).

  . Dry Graminoid Herbaceous (***)

    These grasslands occur on well-drained, dry, rocky slopes and steep, south-facing slopes. Typical species of this type are fescue grass, red fescue, purple reedgrass, shortstalk sedge, tufted hairgrass, timothy, wormwood, netleaf willow, white mountain-avens and mountain cranberry.

- Other Herbaceous (***)

  These communities have their greatest percentage of cover composed of forbs, mosses, or lichens, and occur sporadically from streambeds to rocky ridges.

(iv) Aquatic Vegetation (*)

Lakes and ponds surveyed for aquatic vegetation are shown in Figure E.3.3.14. Aquatic species identified during these surveys are listed by site in Table E.3.3.23. A summary of the dominant aquatic species and factors which may influence their locations in and around many of the water bodies in the Watana and Gold Creek watersheds is presented in Figure E.3.3.15. Burreed and yellow pond lily probably contributed more to total cover than all other aquatic species combined. Yellow pond lily, a submerged species with large floating leaves, was particularly prominent and formed large beds in several water bodies. It was absent along the edges of ponds and appeared to grow best at depths ranging from 2 to 7 feet, frequently forming a band around ponds and lakes between the shallows and deep water. Burreed, in contrast, frequently dominated the shallows of the ponds from 0.5 to 2 feet in depth. Horsetail, mare's tail, and bladderwort were also common in these shallows. Horsetail was common on rocky bottoms where little other vegetation was present. Bladderwort was prominent in shallows having a mud bottom or a bottom of organic matter.

Along the edges of water bodies, sedges appeared to contribute more to total cover than all other edge species combined. They were the prevalent species of the pond shallows, along the pond periphery, and also on floating mats when they are present.

Lakes and ponds with gently sloping substrates had more aquatic plants, both submerged and emergent, than did water bodies with steeply sloping substrates; but above 3,100 feet in elevation, there was usually sparse aquatic vegetation cover regardless of substrate morphology. Rocky bottoms supported less aquatic vegetation than did mud or sand bottoms. Floating mats of vegetation were sometimes a part of the associated emergent wetland. These mats were dominated by sedges, sphagnum moss, and other common bank species.

Watana Lake was unique in that it was dominated by Robbins pondweed, a submerged rooted aquatic species that grows in water from about 4 to 8 feet in depth. The reason for the lack of other vascular plants in Watana Lake and the presence of Robbins pondweed is not understood.

(v) Sparse Vegetation (***)

Sparsely vegetated types occurred in about 2 percent of the total mapped area. Communities were typed sparse when 5 to 10 percent of a barren area was vegetated with forest, scrub, or herbaceous communities.

(vi) Barren Areas (**)

Unvegetated areas were found to cover about 5 percent of the total area of the RAK mapping area. An area is classified barren or barren bedrock if less than 5 percent of the area is vegetated.

(c) Devil Canyon to Talkeetna (**)

The Susitna River from Devil Canyon (RM 155) to Talkeetna (RM 103) flows through a canyon that opens out near Talkeetna. Vegetation is established slowly in the floodplain until sufficient silts and sands are deposited by wind and water to provide a parent material for soil development. Scouring by ice and water during spring breakup, and fall freezeup, and by high water during summer floods accounts for much of the vegetation dynamics in the floodplain.

Willow and balsam poplar are common early successional (pioneer) species on the Susitna River floodplain. They become established on the most recently deposited river bars. As the pioneer communities mature, balsam poplar becomes dominant. The oldest, most stable areas are usually covered with mixed conifer-deciduous (birch-spruce) forest.

(i) Early Successional Stands (*)

Early successional communities accounted for 5 to 10 percent of vegetated land on the floodplain and generally occurred 5 to 25 years after island or bar stabilization. They were usually dominated by horsetail and/or Drummond mountain-avens in the ground layer and balsam poplar and/or willow in the shrub layer. Characteristically, these communities had little total vegetation cover and greater than 50 percent bare ground (Table E.3.3.24). Plant species in these types generally had rhizomes, or horizontal underground stems, which could extend for many meters and were effective in binding loose sand and silt. Avens was important in stabilizing gravelly sites. Early successional stands may be correlated with low willow or mixed shrub and tall shrub vegetation types.

In most stands, balsam poplar and willow occurred at greater densities than other woody species, but alder had a relatively rapid growth rate and began to overtop willow and balsam poplar within two or three years after its establishment.

Young balsam poplar and willow stands may last up to 25 years or more from the time of the last major disturbance. Aging of these stands is difficult because floods frequently bury several years' plant growth in silt, and new growth is present above the silt. This cycle may be repeated a number of times before vegetation succession advances to a later stage.

(ii) Mid-Successional Stands (*)

Deposition of sands and silts that raise the elevation of sites above the level of frequent flooding is necessary for transition of early successional vegetation to mid-successional stages. Mid-successional types accounted for about one-fifth of vegetated land surveyed in the Susitna floodplain. Thinleaf alder, or balsam poplar that had developed into tall shrubs or immature trees, dominated these stands. Mid-successional stands include the open and closed tall shrub and balsam poplar forests of Viereck and Dyrness (1980). The alder type was the first phase and appeared to dominate from 25 to 50 years after stabilization. Balsam poplar appeared to dominate from 50 to 90 years after stabilization, but stands of this type were much less common than the younger alder-dominated stands. As noted earlier, alder overtops balsam poplar during the transition from early- to mid-successional stages. However, after about 20 years, the balsam poplar that remains rapidly increases in height, thereby overshadowing the alder and developing into the immature balsam poplar phase of the mid-successional stage.

In both alder and balsam poplar stands, there was essentially no bare ground. As balsam poplar assumes greater dominance, its density and that of thinleaf alder and feltleaf willow decline from that found in the earlier alder stands, since the balsam poplar trees become larger; but Sitka alder, prickly rose, and highbush cranberry increase in density (Table E.3.3.25 and E.3.3.26).

(iii) Late Successional Stands (**)

As the balsam poplar stands of mid-succession mature, white spruce may appear in the canopy. Mature and decadent balsam poplar stands dominate from 90 to 170 years after stabilization. Eventually, the large balsam poplars die, leaving space for development of more balsam poplar or spruce and birch, if no disturbances interrupt the process. Paper birch-white spruce types probably dominate from 170 to 300 or more years after stabilization. The corresponding vegetation types of the late successional stands are balsam poplar forest and mixed conifer-deciduous forest.

Mature and decadent (gradually dying) balsam poplar stands were found on 25 to 40 percent of the vegetated floodplain; mixed stands of birch and spruce occupied 23 to 32 percent of the area. Mature and decadent balsam poplar stands collectively averaged 90 percent total vegetation cover. Birch-spruce communities contained 12 percent cover of white spruce in the overstory (Table E.3.3.27).

Birch-spruce forest types had the greatest variation in stand structure of the vegetation types found on the floodplain. There is some evidence that these stands are self-perpetuating. Upon overmaturity, the birch overstory tends to fall, making the spruce more susceptible to wind-throw and thereby allowing a shrubby paper birch-alder-highbush cranberry-prickly rose community to develop. The shrub community then progresses to the birch-spruce forest stage.

(d) Talkeetna to Cook Inlet (**)

Vegetation in the floodplain downstream from Talkeetna had a similar successional sequence to that upstream from Talkeetna. The islands and river bars were somewhat less stable than those upstream from Talkeetna because the channel is less incised and had a more braided morphology than that upstream of Talkeetna. As a result, the effects of ice were less and the effects of flooding were greater than upstream of Talkeetna.

Separate mapping of this area was not undertaken.

(e) Transmission Corridors (**)

(i) Healy to Fairbanks (*)

The classification system used to map the Healy-to-Fairbanks transmission study corridor (Figures E.3.3.8 through E.3.3.10) was the same as that of Viereck and Dyrness (1980). The corridor crosses three distinct physiographically and phytosociologically distinct sections: Healy to Nenana River, Tanana Flats (Nenana River to Tanana River), and Tanana River to Fairbanks. Forest types accounted for almost 78 percent of the 274,000 acres of the corridor, with open forest types being dominant (Table E.3.3.28). Open spruce covered 28 percent of the area, open deciduous 11 percent, and open mixed conifer-deciduous 11 percent.

The Healy-to-Nenana River section includes a dissected plateau on the west side, a relatively flat area in the middle, and the Parks Highway and Nenana River to the east. Vegetation along the ridges leading from the plateau is predominantly open conifer (spruce), open mixed conifer-deciduous, and open deciduous forest. The flat area is predominantly low shrub with sedge-grass and open and closed conifer types. Most of the spruce trees are relatively short, except along the streams.

The Tanana Flats area extends from just beyond the Nenana River crossing to the Tanana River. This section has a mosaic of wet vegetation types which include open spruce stands with larch, low shrub, and wet sedge-grass. The distribution of many vegetation types appears to be a consequence of old stream meanders and drainage patterns. Some patches of deciduous forest occur. Dry streambeds have stringers of other vegetation, such as low shrub, along them.

The section from the Tanana River to Fairbanks passes through rolling hills covered predominantly with open deciduous forest. Small areas of spruce are less common than in the Tanana Flats section. The mixed woodland patches in this section are generally cutover areas. Many of the closed spruce areas produce very short shrub-like trees.

Most coniferous forest between the Tanana River and Fairbanks contain only spruce; few have larch. About half the areas in the Tanana Flats section contain larch as well. Spruce (presumably black spruce) occurs in low, poorly drained areas. Spruce in better-drained locations may be either black or white spruce. The black spruce-larch type, confined in Alaska to the interior, is generally found only on wet lowland sites with shallow permafrost (Viereck and Dyrness 1980).

(ii) Willow to Cook Inlet (*)

The Willow-Cook Inlet transmission study corridor passes through three principal kinds of plant communities: (1) closed birch and mixed conifer-deciduous forests, (2) wet sedge-grass marshes, and (3) open and closed spruce stands (Table E.3.3.29 and Figures E.3.3.11 and E.3.3.12).

The Willow-Cook Inlet corridor includes approximately 95,000 acres (Table E.3.3.29). It passes through relatively flat terrain that is 67 percent forested, predominantly with conifer-deciduous forests. Approximately 24 percent of the area is wet sedge-grass marsh.

Closed conifer-deciduous forest is the predominant vegetation type, covering 29 percent of the total area. These forests contain birch, white spruce, and balsam poplar trees. Birch is the predominant deciduous species. Many sites have developed either a woodland/shrubland or woodland/grassland aspect. In the vicinity of Willow, localized stands of balsam poplar are associated with the active river floodplain.

Wet sedge-grass marsh is the second most common vegetation type in this area (24 percent cover). This type has an extensive distribution and is associated with diverse networks of ponds, lakes, and meandering streams. These areas support little other vegetation except for scattered islands of black spruce and low shrubs on drier sites.

White spruce, common in most of interior Alaska, is less common in this part of the Susitna Valley. However, most closed and open spruce stands (8 and 9 percent cover, respectively) in areas dominated by mixed conifer-deciduous forest are probably white spruce. Spruce stands skirting wet sedge-grass or low shrub areas may be white or black spruce or mixtures of the two. Most woodland spruce stands are black spruce.

(iii) Willow to Healy (*)

The Willow-to-Healy intertie study corridor is covered by interior forests, muskeg, shrub communities, and tundra. White spruce and paper birch dominate the drier forested landscapes; black spruce is primarily located on poorly-drained sites. Additionally, balsam poplar and white spruce develop on the floodplains. Within or adjacent to these areas, about thirty species of willow and several species of alder occur in the understory or in thickets with little or no overstory.

The southern two-thirds of this corridor contain forested areas; the northern portion consists mainly of open woodland, shrubland, and tundra. The corridor contains fewer glaciers and ice fields than is common in similar sized areas in the region (Commonwealth Assoc. 1982). Upland and lowland spruce-hardwood forest together cover nearly three quarters (71 percent) of the total area within the Willow-to-Healy transmission corridor. Upland spruce-hardwood forest stands cover 2,888 acres and lowland spruce-hardwood forest stands cover 1,503 acres. Shrublands are the third most predominant cover type (nearly 12 percent) and occupy 713 acres. Vegetation types within the intertie right-of-way, their areal extent, and percent total area covered are presented in Table E.3.3.31.

(iv) Dams to Intertie (**)

Nearly one-half (48 percent) of the total area within the Watana-to-Gold Creek transmission right-of-way is shrub. Predominant low shrub types include dwarf birch-low willow (20 percent), and dwarf birch-ericaceous shrub (15 percent). Over a third of the right-of-way is forested, with white spruce, white spruce woodland, and black and white spruce types about equally represented. The Watana-to-Devil Canyon section contains all of the tall shrub, dwarf shrub, and low shrub acreages, and a vast majority of the coniferous forest type. The Devil Canyon-to-Gold Creek section contains most of the mixed forest and wet graminoid herbaceous types.

3.2.3 - Wetlands (**)

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. These areas are characterized by soil or substrate that is at least periodically saturated with or covered by water (Cowardin et al. 1979). Because wetlands are recognized to have important resource values, they are protected by state and federal regulations (Alaska Office of Coastal Management 1982). Examination of potential project impacts to wetlands, and how such impacts can be avoided, is mandated by Executive Orders 11988, 11990, and 11991, and by Section 404 of the Clean Water Act as amended (86 Stat. 884, USC 1344).

The classification system of Cowardin et al. (1979) defines wetlands as having one or more of the following characteristics: (1) at least periodically, the land supports predominately hydrophytes; (2) the substrate is predominately undrained hydric soil; or (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Section 404 of the Clean Water Act extends permit authority to the U.S. Army Corps of Engineers (COE) for all waters of the United States, including wetlands. The COE's regulations (33 CFR 323) defines "wetlands" to mean "those areas that are inundated or saturated by surface or ground water at a frequency and duration to support, and that, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

With one exception, the term "wetlands" in this chapter corresponds with the Cowardin et al. (1979) definition as lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Under this definition, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year. The exception concerns the Healy-to-Fairbanks and Willow-to-Anchorage transmission corridors. In these areas, two vegetation types characteristic of wet or poorly drained areas--wet sedge-grass and black spruce forest--were mapped as wetlands by Acres American Incorporated (1982c), as modified from McKendrick et al. (1982).

(a) Methods (**)

Project area wetlands were mapped as part of the National Wetlands Inventory in a cooperative effort between the U.S. Fish and Wildlife service and the Applicant. Data were collected and 13 wetland maps on 15-minute USGS quad maps at a scale of 1:63,360 were produced. Mapped quads included Healy A-3, B-3, B-4, D-4, and D-5, and Talkeetna Mountains C-1, C-2, C-4, D-2, D-3, D-4, D-5, and D-6. National Wetlands Inventory Mapping is completed for all areas potentially covered by or adjacent to the impoundment, dams, camps, villages, borrow pits, access roads, railroad, and the transmission line between the dams and the Intertie.

Mapping was performed through stereoscopic interpretation of high altitude color infrared aerial photographs with detailed ground sampling. Wetlands were classified according to the U.S. Fish and Wildlife Service's "Classification of Wetlands and Deepwater Habitats of the U.S." (Cowardin et al. 1979). A minimum mapping polygon size of 2 to 4 acres for wetlands was utilized.

Acreage of wetlands affected by the three-staged project were calculated for each stage. Wetland types were grouped at the "class" level used by Cowardin et al. (1979).

Aquatic vegetation of the Watana and Gold Creek watersheds was examined during August 1982. In order to obtain site-specific information on aquatic plant species, 24 selected ponds and lakes and their adjacent uplands were surveyed on foot, from Devil Canyon (RM 152) to the confluence of the Susitna and Oshetna Rivers (RM 233) (Figure E.3.3.14). During the surveys, species composition, dominance, and total cover (relative to the amount of water) were estimated. Elevation, estimated rooting depth, and width of surrounding wetland area were recorded. Surrounding wetland was limited by definition to the Lacustrine-Limnetic-Emergent Wetland-Vascular wetland class of Cowardin et al. (1979). Many remaining ponds and lakes were examined by helicopter overflights.

(b) General Description (**)

Wetlands within the Susitna project area include riverine (rivers, creeks, and gravel bars), lacustrine (lakes), and palustrine (ponds, bogs, marshes, wet forests, shrublands and meadows). (Table E.3.3.34). These wetlands support low densities of waterfowl in the summer (9.63 adults/100 ac censused in July 1981), and are also used by migratory birds in spring and fall. Although the density and diversity of bird species are lower for the Susitna project area than for many other areas of Alaska (Kessel et al. 1982a), scoters, terns, scaup, mallards, American widgeons, swans, and other waterfowl were found during wetland surveys (Section 4.2.3[6]).

Since over one-half of the land area of the State of Alaska is mapped as wetlands by the USFWS, the wetlands lost to the project cannot be viewed as particularly unique. Emergent wetland types along with ponds and lakes are the most valuable to waterfowl providing food, cover and nesting areas. Since only 10 percent of the project affected wetlands fall into these wetland categories, it is safe to assume that the majority of the wetland acreage to be affected by the project is not utilized to any great extent by waterfowl.

The areal extents of different wetland vegetation types which will be affected by the Watana and Devil Canyon three-stage development are indicated in Tables E.3.3.35 through E.3.3.37. Wetlands occurring in the project vicinity consist mainly of riverine and palustrine systems (Tables E.3.3.35 through 3.3.37. Palustrine habitat consisting of forest, scrub-shrub, or a combination of forest with scrub-shrub account for 44 percent (7,144 acres) of the wetlands that would be affected by the three-stage development. Riverine habitat accounts for an additional 42 percent (6,844 acres) of the wetlands in the project area. Commonly occurring vegetation in forest, scrub-shrub, and emergent wetland types are listed on Table E.3.3.33.

Much of the palustrine wetlands that would be affected by the three-stage development occur on the northern side of the Susitna River. The slope to the river edge is generally not as steep on the northern side, particularly in the Watana impoundment zone, accounting for the greater proportion of palustrine wetlands on the northern side of the river.

Wet sedge-grass and potential wet spruce areas occur within the Healy-to-Fairbanks and Willow-to-Anchorage transmission corridor study areas. As discussed further in Section 3.4.2(c) the centerlines will be further evaluated in the field and adjusted to avoid wetland areas as determined by the analysis of vegetation, soils, and water data.

Aquatic species identified in the Watana and Gold Creek watersheds, percent cover of aquatic vegetation, and surrounding wetland width are listed by site in Table E.3.3.23. Wetland sites sampled ranged in elevation from

1,700 feet to 3,000 feet. A summary of the dominant aquatic species and factors which may influence their location in and around many of the waterbodies in the Watana and Gold Creek watersheds is presented in Figure E.3.3.15 (see Section 3.2.2.b.v. Aquatic Vegetation for further discussion).

3.3 - Impacts (**)

Impacts of the Susitna Hydroelectric Project on vegetation are of two general kinds: (1) loss ot all vegetative cover; and (2) change in the nature of vegetatative cover (i.e., alterations in plant community types). The first kind of impact is considered adverse while tne second kind may be considered adverse or beneficial depending upon its effect on wildlife. The following discussions treat both kinds of impact.

3.3.1 - Watana Stage I Development (**)

The Watana Stage I development includes areas affected by the impoundment zone, borrow sites, dam and spillway, construction camp, airport, and permanent village. Impacts of access roads and transmission corridors are discussed separately.

(a) Construction (**)

(i) Vegetation Removal (**)

Construction of the Watana Stage I development will result in the direct removal or inundation of vegetation within an area of approximately 21,440 acres. This acreage includes the impoundment and dam, Denali Highway to Watana access road, camp and village, quarry and borrow sites, airport, transmission line switchyards and construction roads (Tables E.3.3.40). Included in this acreage are 1,459 acres which will be rehabilitated, leaving a total of 19,981 acres which will be permanently lost as result of the construction of Watana Stage I facility (Table E.3.3.43). Of the acreage considered permanently lost 4,150 acres are water and 69 acres are barren and therefore will represent no vegetation loss. Thus, the total permanent vegetation loss due to the Watana Stage I project amounts to 15,762 acres.

Forests make up the majority of the vegetation (84 percent of Stage I loss) which will be permanently lost as a result of this project. Conifer forest, primarily open and closed black and white spruce, accounts for 40 percent of the forest types permanently lost (6,675 acres, Table E.3.3.43). Over two percent of the conifer forest in the RAK vegetation mapping area will be lost due to the Stage I project (Figure E.3.3.3, Table E.3.3.4). Mixed forest, mainly spruce-birch and spruce-birch-aspen mixes, are also a significant amount of the forested area permanently lost (5,771 acres, Table E.3.3.43). About five percent of the mixed forest in the RAK vegetation mapping area will be lost to the Project. Vegetation permanently lost during the construction of the Watana Stage I dam, reservoir, and ancillary support facilities will represent about one percent of the total vegetation found in the mapping area.

(ii) Vegetation Loss by Erosion (*)

Erosion is a persistent problem at dam construction sites in northern latitudes (Baxter 1977, Baxter and Glaude 1980). Erosion following the clearing of vegetation may be promoted by the following:

- Destabilization of till;
- Blowdown of trees near cleared areas;
- Thawing of permafrost;
- Desiccation of exposed soils; and
- Changes in drainage patterns.

Slope stability studies by Acres American (1982f) indicate that areas particularly vulnerable to vegetation loss through erosional effects include side slopes of the canyons from the south abutment of the Watana damsite (RM 184) to Vee Canyon (RM 225), along Watana Creek (RM 194), and from the Watana reservoir headwaters to the Oshetna-Goose Creek area (RM 243 to 233).

(iii) Vegetation Damage by Wind and Dust (**)

Blowdown of trees is a recognized problem in cleared areas (Todd 1982). Near reservoirs, it is promoted by increased winds due to a greater fetch as areas are cleared (Baxter and Glaude 1980, Brown 1972). Since northeasterly winds predominate in the project area most of the year, the greatest blowdown potential is in the black spruce stands on the south side of the Watana damsite. The shallow rooting depth typical of black spruce (12 inches) predisposes this vegetation type to blowdown.

Wind-generated dust is expected to occur during construction activities, particularly during and following clearing of the impoundment and borrow areas. Increased wind fetch is expected to result from clearing. Accumulations of thick dust on vegetation can potentially retard snowmelt (Drake 1981). The vegetation types which will be affected by dust in the Watana area include woodland and open black and white spruce, mixed forest types and shrubland. The direct effect of dust on plants varies with plant species and the chemical composition of dust. For example, densities of cottongrass are likely to increase, but stiff clubmoss, sphagnum moss, and some fructicose lichens may decrease in abundance when exposed to dust (CRREL 1980).

(iv) Effects of Altered Drainage (o)

Local alteration of drainage patterns and surface water regimes may result from clearing, ditching, and other construction activities. Blocking drainage patterns may cause waterlogging of soils, thermal and hydraulic erosion, and shifts of surface flow to adjacent drainages (CRREL 1980). Resulting changes in surface water regimes will cause plant communities to shift accordingly. The time required for these changes to occur, and the extent of the change, will depend on the extent of hydrologic alterations and on plant successional dynamics (Neiland and Viereck 1977).

(v) Effects of Change in Albedo (o)

Cleared soils usually absorb more solar radiation than do vegetated soils and consequently thaw sooner in spring and deeper over the summer. Conversely, with less insulation soils freeze earlier and deeper in the winter. Resulting changes in surface hydrology will cause plant communities to change.

(vi) Indirect Consequences of Vegetation Removal (o)

Methods of vegetation removal may have indirect impacts on other vegetation. Spruce budworm disease, which occurs in areas adjacent to the Susitna watershed (Hegg 1970), may be more likely to invade the area if spruce trees are cut but not removed or burned. Clearing may also enable other insects and decay organisms to increase in abundance (Kimmey and Stevenson 1957).

(vii) Effects of Increased Fires (o)

The increased numbers of people in the area during the construction period may cause increased incidences of fires. Fire has been a natural factor shaping plant communities in the area, so increased fires would cause changes in plant communities similar to those that can already be observed there.

Because successional patterns following project-related fires would be more likely to manifest themselves during the operations phase, they are discussed in Section 3.3.1(b).

(b) Filling and Operation (**)

Some construction-related impacts such as fugitive dust will diminish after the project is built, but other problems such as erosion will continue. The most conspicuous filling and operation-related changes in vegetation will be those caused downstream as a result of streamflow regulation, but less drastic changes may be caused by micro- and mesoclimatic changes, increased fire incidence, and increased off-road vehicle (ORV) use. In many instances, vegetation will respond to these disturbances through characteristic successional recovery patterns. The following subsections describe filling- and operation-related changes and the successional patterns of plant communities as they recover from development-induced change.

(i) Vegetation Succession Following Removal (**)

On sites where vegetation has been removed, natural plant succession will occur unless prevented by inundation, extremely adverse seedbed conditions, or facility maintenance. Successional patterns expected in forests, shrublands, and tundra are discussed below.

- Forest Areas and Shrubland (*)

Within forest and shrubland areas, newly cleared sites with largely intact mineral and organic soils will rapidly revegetate with plants native to the original community. Herbs, shrubs, and deciduous trees will resprout, and some herbs and shrubs will regenerate from buried seed (Neiland

and Viereck 1977, VanCleve and Viereck 1981, Conn and DeLapp 1982a, b).

In interior Alaska, characteristic early successional herbs and shrubs are bluejoint, meadow horsetail, prickly rose, tall bluebell, bunchberry, northern bedstraw, Labrador tea, twin-flower, goosefoot, pale corydalis, dragonhead, fireweed, crazyweed, and rough cinquefoil. Early successional trees are willow, aspen, and poplar.

From 6 to 25 years after clearing, willow and/or alder will typically dominate areas that were originally black spruce forest or shrubland (see reviews of forest succession by Neiland and Viereck 1977, VanCleve and Viereck 1981). McKendrick et al. (1982) found that typical heights for willow and alder between 3 to 6 years old were 15 inches (60 cm) and 68 inches (170 cm), respectively. Soon thereafter a tree canopy of young black spruce, willow, and alder will develop. Dense stands of spruce with well-developed moss and lichen components will not develop for 50 to 100 years. Mature black spruce trees in typical 100 year old stands usually do not exceed 45 feet in height.

Succession after clearing of areas that were originally white spruce follow similar initial stages as those for black spruce. Paper birch and/or aspen are frequently present in the mixed tree canopy stage. As this canopy matures, white spruce predominates, sometimes with paper birch interspersed. Understory cover beneath the mature canopy is usually dominated by grasses, ericaceous shrubs, and feather mosses.

- Tundra (*)

Clearing of tundra and concurrent removal of topsoil will, except in certain rocky alpine sites, typically result in higher soil temperatures and, if permafrost is present, a deeper thaw (Bliss and Wein 1972, Hernandez 1973, Gersper and Challinor 1975, Chapin and Shaver 1981). Either of these conditions may lead to the development of a different plant community from that originally present and possibly a very long restoration period. One to several centuries may be required for recovery from disturbance where the topsoil is lost (Brown et al. 1978a,b). But if topsoil is retained, recovery to the same community type is frequently rapid if permafrost is not present. The topsoils contain most of the available nutrients, rhizomes, and seeds required for rapid recolonization (see discussion by Chapin and VanCleve 1978).

Although natural successional trends of tundra are far less predictable than for forested areas, the following sequence is likely to occur. The first vegetation types to reestablish in moist or wet tundra (with the organic layer retained) are likely to be cottongrass species and, if buried seed is present, sedges on wet sites. Grasses may predominate on drier sites (see Chapin and Chapin 1980, Chapin and Shaver 1981, Gartner 1982). Within 5 to 10 years after normal revegetation begins, at least a 50 percent and often a 100 percent vegetation cover recurs on sites on which the original organic layer was retained. Native woody and herbaceous species characteristic of adjacent areas will also begin to invade within 10 years; likely species in the project area include willows, bog blueberry, mountain cranberry, northern Labrador tea, shrubby cinquefoil, prickly rose, field oxytrope, lupine, green alder, and dwarf and resin birch. Reestablishment of normal densities, however, may require several decades.

(ii) Effects of Erosion and Deposition (**)

If the drawdown zone of the Watana impoundment is typical of that of other northern reservoirs, it will remain partially or totally unstable until bedrock or gravel/cobble/boulder substrates are exposed. The drawdown zone will remain essentially unvegetated, resulting in a barren area between the maximum and minimum pool elevations. Shoreline recession is likely, with consequent loss of vegetation (Baxter and Glaude 1980). Except during a series of drought years, vegetation is not expected to invade the drawdown zone, and no effects on vegetation from ice shelving are anticipated. Although some of the evolving shoreline above the drawdown zone will be readily colonized by early seral stages such as grasses and herbaceous species, stabilization of this upper shoreline may require 30 years or more (Newbury and Malaher 1972).

Three factors are primarily responsible for slope instabilities: changes in the groundwater regime, the magnitude of reservoir level fluctuations, and thawing of permafrost (ADF&G 1982f). Further explanation of these factors may be found in Chapter E.6, Section 3.3.

The Watana Stage I Reservoir will generally occupy the steeply sloping sidewalks of the river canyon. As such, these areas contain generally bedrock-controlled slopes with little or no overburden which are quite stable. The major areas of instability during Stage I area are expected along Watana Creek, where lacustrine slopes overlay frozen tills. These areas are currently unstable, and will likely remain so or become more unstable after reservoir filling.

(iii) Effects of Regulated Flows (**)

A mosaic of plant communities in various stages of floodplain succession is found in the floodplain of the Susitna River. This diversity is the result of processes of vegetative recession; the replacement of an established plant community with a younger community. Vegetative recession results from changes in river morphology, which is controlled in the Susitna River floodplain by ice processes, flooding events, bank erosion and deposition of bed material throughout the open water period. Figure E.3.3.16 illustrates patterns of vegetation succession along the downstream floodplain.

The effects of regulated flows on vegetation at a particular location will vary considerably with channel morphology and the distance downstream from the Watana dam. Potential impacts on floodplain vegetation will be discussed separately for the river reaches between Watana and Devil Canyon, Devil Canyon to Talkeetna, Talkeetna to the Yentna River, and from there to Cook Inlet. Detailed information on channel morphology and changes in the hydrologic regime can be found in Chapter 2, Sections 2.1 and 3.2.3.

- Watana to Devil Canyon (RM 184 to RM 152) (**)

  This reach of the river is mostly a single channel with steep armored banks and bedrock outcroppings. The two dominant processes presently controlling vegetative recession are ice scouring at river freezeup and at breakup.

During river freezeup, the steep gradient of the river stretch restricts ice formation to the borders of the river channel in most areas (see Chapter 2). Growth of border ice and ice in the center of the channel of slower reaches results in increased stage. Buoyant forces on the border ice resulting from increased staging cause scouring of attached vegetation as the ice fractures, rises, and disintegrates. In addition, ice blockage in the channel can result in ice scouring of vegetation higher on the banks and islands and can also cause the river to overflow into side channels where additional scouring of bed materials and vegetation occurs.

The effects of river breakup on vegetation are greatest when breakup occurs rapidly before extensive in-place melting and deterioration (rotting) occurs and in association with high spring flows. Ice jamming in spring at constricted points can have dramatic local effects due to the typically higher discharges which occur during breakup. Floods which occur at breakup can also have major effects due to the force of water and ice released when a jam is breached.

The increased temperatures of the water released from Watana in winter will preclude the formation of an ice cover in this reach. In addition, the mean annual flood (with a 2-year return period) will be reduced by 37 percent to 27,200. These changes will likely result in vegetation encroachment toward the main channel, the establishment of vegetation in overflow channels and newly-exposed areas with adequate soils, and the gradual succession of existing and newly-established vegetation stands along the bank and on islands to mature white spruce forest (Figure E.3.3.16). Although the rate of vegetative recession may be reduced by as much as 90 percent, the amount of area affected will be limited by the steep banks and poor substrates found throughout most of this reach.

- <u>Devil Canyon to Talkeetna RM 152 to RM 97)</u> (**)

The Susitna River in this reach comprises alternately single channel and split channel configurations. The channel is armored with boulders and cobbles and alignment has changed little since 1951. A comparison of aerial photographs taken in 1951 with those taken in 1980 showed vegetative recession resulting from minor shifts in the outermost banks of the river. The photography did not allow an estimation of the actual areas affected. The rate of vegetative recession is controlled primarily by ice processes and summer flooding events. R&M (1982c) listed several locations in this reach where channel constrictions cause recurrent ice jamming during breakup. Vegetation patterns just upstream and downstream from these locations are influenced primarily by ice scouring during breakup, but along the majority of this reach summer flooding appears to have the greatest influence on vegetative recession. The fact that the vegetation line at a point 0.5 mi upstream from Gold Creek (RM 137) is at the same elevation as ice staging during freeze-up in fall 1980 is evidence of the influence of ice scouring during breakup in this reach.

The mean annual flood with a 2-year return period at Gold Creek will be reduced from 48,000 cfs to 25,600 cfs by the Watana Stage I project. Ice will still form in this reach, but the ice front at the end of winter is expected to occur near the confluence with Indian River (RM 139), and its formation there will be delayed by 3 to 4 weeks (see Chapter 2, Section 3.2.3). Because air temperatures will be lower once ice formation begins, the ice layer will progress more rapidly than it does under pre-project conditions. Regulated winter flows at Gold Creek will be similar to existing conditions during filling, but during operation will be about five times greater than pre-project winter flows (Chapter 2, Section 3.2.3). This will result in a 2- to 6-foot increase in river stage over existing conditions in reaches where an ice cover is present. Upstream of the ice cover, Stage I river stages would be equivalent to or lower than natural conditions. During the early years of the operation phase, this increased ice staging may scour existing stands of vegetation, thus causing an increase in the width of the unvegetated channel and a decrease in the amount of vegetation found on islands. Because spring flood stage will be reduced considerably and because the ice cover will have a greater tendency to melt in place, ice scouring during breakup will no longer be an important factor causing vegetative recession in this reach.

The area affected by these post-project processes will be directly related to winter flow releases, which will vary depending on downstream flow requirements, power demand, reservoir operating rule curve, and attenuation of discharge due to floodplain storage capacity.

- Talkeetna to Yentna River (RM 97 to RM 28) (*)

There is a dramatic change in the morphology of the Susitna River from a split channel to a braided channel at the confluence of the Susitna, Chulitna, and Talkeetna Rivers. The flows contributed by each of these rivers at the confluence are 40 percent each for the Chulitna and Susitna Rivers, and 20 percent for the Talkeetna River.

Downstream from Talkeetna, the importance of ice processes in vegetative recession is reduced, and large changes in channel position and form presently occur whenever the river attains bankfull stage. The importance of ice processes in vegetative recession in this reach is local and depends on channel morphology.

Upstream and downstream from channel constrictions, ice processes during freezeup and breakup may continue to play a major role in regulating vegetative recession. If ice processes cause greatly increased stages during either freezeup or breakup at such a constricted point, vegetation immediately upstream and/or along overflow channels may be scoured by water and ice action. This increased staging at channel constrictions may occur even at relatively low flows. Because of the localized importance of ice processes, summer flood events likely control vegetative recession on a broader basis as much as ice processes associated with freezeup through their effect on the rate of bank erosion and sediment deposition in this reach. Where the floodplain is wide with braided channels, there is generally a relatively small increase in stage when an ice cover is present, and ice processes have a lesser effect on vegetative recession. In such areas, numerous islands with mature forest stands are present.

It is impossible to predict with certainty the vegetation changes that will occur post-project in this reach. The bankfull flood will have a post-project recurrence interval of about once every 15 as opposed to the present 2-year interval (R&M 1982c). In areas where such floods control the vegetation, early-successional stands may develop for about 15 years before being removed by the next bankfull flood. In some of these stands, however, silt deposition or vegetation growth may be rapid enough to stabilize the area against subsequent floods. Increased winter flows with subsequent increases in ice staging may cause other areas to undergo regular ice scouring during freezeup. The amount of area supporting mature stands of vegetation will be directly influenced by floods and the flow releases from Watana each winter.

- Yentna River to Cook Inlet (RM 28 to RM 0) (o)

  The Yentna River contributes about 40 percent of the mean annual flow entering Cook Inlet from the Susitna River. Between the Yentna confluence at RM 28 and the beginning of the delta at RM 20 (Figure E.3.2.1), the bankfull flows (80 percent of which are contributed from rivers other than the Susitna upstream from Talkeetna) are believed to be the dominant factor in controlling vegetative recession. The river begins to branch out into its delta channels at RM 20. The water surface elevation at this point is approximately 30 feet (9.1m), which corresponds to the 30-foot (9.1-m) tides in Cook Inlet.

  Post-project changes in vegetation cannot be precisely predicted, but they should be substantially mediated by the large flow contribution from the Yentna River and the tidal influence as far north as RM 20. As R&M (1982c) states, "the dilution effect of major and minor tributaries as well as the balancing of changes by the Susitna River system should mask any measurable changes that could occur as a result of the project for several decades."

(iv) Climatic Changes and Effects on Vegetation (**)

The impoundments will moderate local seasonal temperatures, and promote delayed onset of cold temperatures in the fall and prolonged colder temperatures in spring. The effects are not expected to extend beyond one to five miles from the shoreline, depending on the width of the reservoir, with the maximum effect at the prevailing windward shoreline. These effects will be localized around the impoundments and their incremental effects would essentially not be measurable. Slight precipitation increases in both summer rainfall and early winter snowfall precipitation can be expected to occur near the windward shoreline. Similarly hoar frost deposition may form on vegetation near the impoundment margins during the fall prior to ice formation on the reservoir surface. However, hoar frost currently forms under pre-project conditions in surrounding areas not influenced by open water in the river, and the impoundments are not expected to increase the severity of its formation.

The heat-sink/cold-sink effect of the impoundments may delay spring plant phenological development by a maximum of three to five days near the windward shoreline. Plant phenology in and near the river canyon is currently measurably influenced by a number of other factors, such as yearly ambient temperature variations, elevation, slope, aspect, and vegetation type. Other factors such as plant species, site history, snow depth, soil water content, and depth of the moss insulating layer also influence plant phenology. Because so many local factors combine to influence plant phenology, the moderating influence of localized temperature depressions during early spring would be difficult to detect. Factors such as the warming effect of light reflectance from surface waters or ice onto surrounding vegetation, and the warming and subsequent thawing of permafrost soils near the reservoirs, may positively influence early spring plant growth. Dust deposition along impoundment shorelines may promote early snowmelt, thereby exposing the underlying vegetation for use by moose. Because of these many interrelated factors, any measurable change in plant phenology could not be reliably ascribed to the effects of any particular impact mechanism. Similarly, changes in plant species composition are not expected to occur.

Another thermal effect of the impoundment would be its moderation of diurnal changes such that nearby night temperatures during May and June will be higher and daytime temperatures will be lower than prior to development. Average fall temperatures near a lake of similar size to the Watana Reservoir were characterized by a 9.9°F lower maximum and 4.0°F higher minimum than temperatures away from the lake

(Baxter and Glaude 1980). The effects of these thermal changes on the vegetation are difficult to predict in any quantitative way.

(v) Effects of Increased Human Use (**)

During the filling and operation stages of the Watana Stage I facility, project personnel and their families will have an impact on the vegetation of the middle Susitna basin. The most severe human-use impacts will probably be associated with off-road vehicles (ORVs) and accidental fires, assuming that no regulation of project personnel is enforced to mitigate these impacts. Similar but more extensive impacts are expected from use by the general public and are discussed in Section 3.3.3, Access.

- Off-Road Vehicles (o)

The effects on vegetation of ORV use varies with season, soil moisture and depth, the presence or absence of permafrost, vehicle weight, frequency of use, and other factors (Chapin and Van Cleve 1978, Sparrow et al. 1978).

The ground layer of vegetation is more susceptible to damage by ORVs than are other layers, and is most susceptible to damage in summer. In winter, snow and ice layers minimize damage to the underlying vegetation and organic mat. Dry habitats are less susceptible to damage by ORVs but can take long periods to recover if damaged (e.g. alpine areas). A few passes of light-track vehicles over relatively dry well-drained soils may result in slight compaction of the organic and/or plant layer, a net soil temperature gain, and deeper thaw of the active soil layer. The typical result is minor subsidence and an influx of ground water.

Tundra and wetlands, especially sites with underlying permafrost, are the most vulnerable habitats. Repetitive off-road traffic or use of heavy vehicles in moist areas is likely to remove vegetation and also the underlying organic mat. This would cause soil temperature increases, deeper thaw, subsidence to 3 feet (1 m) or more, groundwater input, and severe erosion that typically lasts 5 to 50 years or more (Hok 1969, Rickard 1972, Lawson et al. 1978, Chapin and Shaver 1981).

Near the Denali Highway, Sparrow et al. (1978) observed that, after ORV use, gullies formed as wide as 20 to 26 feet (6 to 8 m) and up to 10 feet (3 m) deep, with severe side erosion and cave-ins, as well as active transport of sediment downhill. A similar effect was noted when firelines were established on Wickersham Dome, near Fairbanks (Lotspeich 1979). The above effects will be most severe where ground ice content is high (Bliss and Wein 1972). Natural restoration of the organic layer of tundra soils may require more than a century (Chapin and Van Cleve 1978). However, some grasses, such as bluejoint, may invade such mineral substrates rapidly (Gartner 1982).

- <u>Fires</u> (**)

Although the results of tundra fires are extremely variable, in most cases many signs of the fire have disappeared after 6 to 8 years. Recovery can take much longer in areas with abundant lichen cover (Viereck and Schandelmeier 1980). In shrubland and forest, a variety of successional patterns may result from a fire, depending on fire intensity and burning patterns, vegetation type, soil moisture and temperature, time of year, and post-fire weather patterns (Figure E.3.3.17). For example, some willow species, while highly adapted for reseeding burned areas, produce seeds that are viable for only short periods of time in the spring or fall (Zasada and Viereck 1975, Zasada and Densmore 1977).

Trees and shrubs, including aspen, birch, willow and alder, resprout and grow vigorously after burns. Shallow-rooted shrubs such as cranberry are destroyed in areas heavily burned to mineral soil; however, burning to mineral soil is necessary for establishment of willow seedlings (Densmore and Zasada 1977, Densmore 1979). In the short term, increased productivity of browse plants such as willow, aspen, and birch is likely as a result of the release of soil nutrients (Figure E.3.3.18). Many berry producing plants also increase in density after fire (Friedman 1981).

The ecological effects of fire on Alaskan vegetation have received considerable attention during recent years, and the accumulated knowledge allows a degree of prediction of the effects of a given type of fire on a specific area. (Viereck and Dyrness 1979). This knowledge plus increasingly effective fire control methods have resulted in fire being used as a land management tool to create desired vegetation changes (see Section 4.4.2).

Wildfire is a common and natural phenomenon throughout the conifer forests of interior Alaska. Characteristics affected by fire in these forests include: live biomass, dead and decaying biomass, available nutrients, soil temperature and soil moisture. Fire in black spruce forest greatly reduces the overstory biomass, although standing dead snags may persist. Intense burning partially or completely oxidizes organic constituents of the forest floor, releasing large quantities of available nutrients such as phosphorus. Soil temperatures become warmer through enhanced absorption of solar radiation. Permafrost, where present, recedes because of several factors including changes in albedo and loss of vegetative insulation. Thus the active layer significantly increases in depth (Viereck and Schandelmeier 1980).

Fire generally causes vegetation to revert to an earlier successional stage. Coniferous forests usually revert to a herbaceous or shrub stage (Foote 1979) characterized by rapid nutrient turnover, high productivity, and relatively high decomposition rates (Viereck and Schandelmeier 1980).

Production of moose browse, especially willow, is often very high during the shrub stage (Figure E.3.3.18). Wolff and Zasada (1979) found that three to seven years after a fire in black spruce forest, the amount of willow browse available to moose increased 680 percent from 6.5 to 44.1 kg/ha. The Bureau of Land Management (unpublished data) reported a 1,280 percent increase in willow density from 1,800 to 23,000 stems/ha in 7 years following a fire of moderate intensity in white spruce.

3.3.2 - Devil Canyon Development (**)

(a) Construction (**)

(i) Vegetation Removal (**)

Because of the narrow, steep configuration of Devil Canyon, vegetation losses will be substantially less than for the Watana Stage I Dam. Construction of the Devil Canyon - Stage II development will result in the direct removal or inundation of 8,838 acres (Table E.3.3.41). This acreage includes the impoundment and dam, Watana-to-Devil Canyon access road, camp and village, quarry and borrow sites, transmission line switchyards, railroad, railheads and construction roads. Of this total, 873 acres will be rehabilitated (regraded, reseeded, etc.) leaving a total of 7,965 acres which will be permanently lost as a result of the construction of the Devil Canyon Stage II development (Table E.3.3.43). Of these 7,965 acres considered permanently lost, 1,945 acres are water and represent no actual loss of vegetation. Thus the total permanent vegetation loss due to the Devil Canyon project amounts to 6,020 acres.

The majority of the vegetation which will be lost to the project is forest. Mixed forest, (4,125 acres, Table E.3.3.43) composed primarily of spruce-birch and spruce-poplar, accounts for about 73 percent of the forested area permanently lost. About four percent of the mixed forest in the RAK vegetation mapping area will be lost as a result of the project (Figure E.3.3.3, Table E.3.3.4).

Conifer forest (1,108 acres, Table E.3.3.43) composed primarily of white spruce and black and white spruce mixed is also a significant component of the total forest loss. Less than 0.5 percent of the conifer forest in the RAK vegetation mapping area will be lost due to the Devil Canyon development.

(ii) Vegetation Loss by Erosion (o)

The most likely source of vegetation loss by erosion at the Devil Canyon site will be rock slides along steep banks, especially on the south side of the reservoir. Although most rockfalls will occur at elevations of 900 to 1,300 feet and thus will be below the eventual fill level, some slides may also occur above this zone. Clearing may be a significant source of erosion which may in turn result in further vegetation loss in adjacent uncleared areas.

(iii) Vegetation Damage by Wind and Dust (o)

Wind-related phenomena such as tree blowdown are less likely at the Devil Canyon site than at the Watana site because the maximum fetch will be far less at Devil Canyon. Dust will be generated by clearing of the Devil Canyon impoundment area, but because the impoundment area is in a narrow valley that is more protected from wind than the Watana impoundment area, resulting impacts to vegetation are expected to be relatively minor.

(iv) Effects of Altered Drainage (*)

Excavation and construction activities will impinge on a number of small lakes and ponds south of the Devil Canyon site. A total of 32 acres are covered by lakes within 10 miles of the Susitna River at the Devil Canyon facility. Excavation in these areas may result in the creation of new aquatic or bog habitat with ensuing development of bog vegetation (Neiland and Viereck 1977). The steep configuration of the canyon will limit other changes in drainage patterns or water table levels. Any downslope cuts made during construction may, however, promote active gully formation and associated vegetation loss. Proposed Borrow Site K (Figure E.3.3.7) may affect an additional 99 acres of potential wetlands.

(v) Effects of Change in Albedo (o)

Clearing of the Devil Canyon impoundment area will result in a warming of underlying soils prior to filling. Since permafrost is not generally present, impacts on adjacent vegetation will be minimal.

(vi) Indirect Consequences of Vegetation Removal (o)

Indirect effects of different clearing methodologies were reviewed previously for the Watana site (Section 3.3.1(a)). These effects are also applicable to the Devil Canyon area.

(b) Filling and Operation (**)

The Devil Canyon impoundment will be filled in two separate phases, with a total time of about two months. No appreciable downstream effects on vegetation should be evident during filling. Upstream from the dam, filling will result in diminished dust in summer and perhaps will slightly alter microclimate, especially on the windward side of the reservoir (see Section 3.3.1.b.iii.).

Because the drawdown zone for the Devil Canyon impoundment will cover up to 50 feet during drier years, the rise and fall of the water table will probably affect vegetation only in a narrow band adjacent to the reservoir. The consolidated, rocky character of the substratum will, in most cases, limit water intrusion and soil waterlogging, and few shifts toward wet or bog vegetation are likely.

Relatively few additional impacts on vegetation are expected during operation of the Devil Canyon development. The old large landslide at RM 177 (Figure E.3.2.1) could move after filling, temporarily blocking river flow and flooding upstream areas. This could cause a loss of mid- and late-successional vegetation in areas such as the mouths and floodplains of Fog and Tsusena Creeks. However, the areal extent of such impact cannot be reliably predicted.

Meso- and microclimatic effects on vegetation will be very small and probably well within the range of normal variation, due to the relatively small size of the reservoir.

(i) Vegetation Succession Following Clearing (o)

The same general vegetational succession patterns will occur on cleared, unsubmerged lands of the Devil Canyon area as were described for the Watana site (see 3.3.1(b)[i]). However, due to the steep, rocky character of Devil Canyon, a much greater mosaic of vegetation types may develop. On some slopes, loss of soil may result in shifts to low-lying alpine communities dominated by mountain-avens, rather than a gradual return to shrubland and forests.

(ii) Erosion and Deposition (**)

Only sporadic concentrations of permafrost have been found in Devil Canyon. Resulting erosional problems and vegetation loss through permafrost melting should therefore be minimal. Due to the geological character of the Devil Canyon region, erosional/depositional changes affecting vegetation will be minimal following filling of the reservoir (ADF&G 1982f). One possible exception is an old landslide at RM 177 that could become unstable and slide further if permafrost in the vicinity melts.

(iii) Effects of Regulated Flows (**)

Downstream effects of the full Susitna development in the reaches downstream of Talkeetna will be similar to those discussed in Section 3.3.1.b.iii. The factors controlling vegetation in the Devil Canyon-Talkeetna reach, however, will change in that the ice front will only reach to between Sherman and Gold Creek (RM 133). Once Devil Canyon is operating, ice scouring will have less influence in this reach, and vegetation will be primarily controlled by peak flows. Since the peak flows will have a stage that is at least 5 feet below that when ice is present, many areas will be available for primary succession after the construction of the Devil Canyon dam. Succession will follow the pattern shown in Figure E.3.3.16.

3.3.3 - Watana Stage III Development (***)

(a) Construction (***)

Construction of the Watana Stage III development will result in the direct removal or inundation of 17,709 acres (Table E.3.3.42). This acreage includes the areas affected by the impoundment, and quarry and borrow sites. Included are 747 acres of vegetation which will be rehabilitated, leaving a total of 16,962 acres permanently lost as a result of the Stage III development (Table E.3.3.43). Of the acreage permanently lost, 588 acres are either barren or water covered and represent no actual vegetation loss. Thus, the total permanent vegetation loss due to the Stage III Watana project amounts to 16,374 acres. Forest vegetation makes up the majority (about 82 percent) of vegetation type acreages which will be permanently lost as a result of the Project. Conifer forests make up the majority of forest types lost (8,523 acres). About three percent of the conifer forest in the RAK vegetation mapping area will be lost (Table E.3.3.4, Figure E.3.3.3). Mixed forest, primarily spruce-birch, is also a major portion of the vegetation lost (4,493 acres). About five percent of the mixed forest in the RAK vegetation mapping area will be lost.

The remainder of the impacts to vegetation due to construction and operation will be similar to those described in Section E.3.3.3.1 for Watana Stage I. Refer to that discussion for a more comprehensive look at these impacts.

Erosion and wind and dust impacts should be less than for Stage I due to the presence of an established infrastructure of roads, construction facilities and of course, the presence of an existing dam.

(b) Filling and Operation (***)

The majority of Stage III effects will be the same as those listed for Stage I in Section 3.3.1.(b). Two topics deserve special attention and are addressed below.

(i) Effects of Erosion and Deposition (***)

Whereas the Stage I impoundment would be mostly contained in the steep canyon walls, the Stage III impoundment would encompass the break onto the gentler-sloping portions of the project area. This, combined with relatively thick overburden, a large drawdown zone, and large areas of permafrost, will create conditions likely to cause slope instabilities.

After the reservoir is filled, the water will warm adjacent hillsides, causing permafrost to melt and slides to occur. For example, on the south side of the Watana impoundment, the permafrost layer is 200 to 300 feet thick and is within 1.8°F of thawing. Slides and land slumpages are therefore likely in this area. If these slides are small and the organic soil layers have not been lost, encroachment by rhizomatous species may enable rapid recolonization. If large slides occur, a full cycle of forest succession on melted permafrost will likely ensue, leading to black spruce and bog vegetation over 100 to 200 years.

Following beach (mudflat) development, flooding of upland areas will occasionally occur during high flows and as a result of water displacement from slumpage (Kerr 1973). This occasional flooding of adjacent areas will likely stimulate new vegetation growth. Propagation of deltas into the reservoir at a number of creek tributary mouths is likely since deposition would occur when fast creek currents empty into slow-moving reservoir water. These deltas may eventually be vegetated in the same manner as downstream floodplain areas (see discussion below).

Although the magnitudes of likely or potential slope stability effects are difficult to predict and quantifications of vegetation types likely affected by such effects is not possible, it is possible to make generalizations about Stage III slope instabilities. A large proportion of the reservoir slopes are susceptible to shallow slides. This is particularly true along the south bank of the Susitna River from the Watana damsite to Vee Canyon due to the presence of thick overburden and permafrost. Major instabilities are possible along both banks of Watana Creek above and below the impoundment level. As mentioned in Stage I, the geologic and soil conditions along this drainage lead to slides under current natural conditions, and these tendencies will likely be augmented by the presence of the reservoir.

The extent of slope instability is not likely the same area as the extent of habitat loss. Some slope instability (e.g. solifluction) generally affects topography without altering the surficial vegetation communities to any extent. In other cases, topographic and hydrologic changes will cause a shift from one community to another. Some affected areas will cause a loss of vegetation. However, areas denuded above the impoundment zone will undergo succession much like downstream areas, and the habitat loss will therefore be temporary.

(ii) Effects of Regulated Flows (***)

Downstream effects of the full Susitna development in the reaches downstream of Talkeetna will be similar to those discussed in Section 3.3.1.iii. The factors controlling vegetation in the Devil Canyon-Talkeetna reach, however, will change in that the ice front will only proceed to about RM 114 between Chase and Curry. Therefore, peak flows will be the only major factor controlling vegetation.

3.3.4 - Access (**)

(a) Construction (**)

The 44-mile long corridor of the Denali Highway-to-Watana access route will remove or disturb 528 acres of primarily low shrub vegetation (418 acres)(Tables E.3.3.44 and E.3.3.41). Permanently lost vegetation is expected to amount to 317 acres since 211 of the 528 acres are expected to be revegetated. The vegetation adjacent to the access road will be subject to indirect effects including dust deposition, erosion, leaching of nutrients in recently drained regions, and waterlogging in areas of blocked drainage. These effects are all discussed in more detail in Section 3.3.1(a).

When the Devil Canyon dam is built, an additional road segment will connect the Devil Canyon and Watana sites along a 39 mi (63 km) corridor north of the Susitna River (Figure E.3.3.7). Construction of this road will remove or disturb 468 acres of vegetation (Table E.3.3.42). The majority of the vegetation within the corridor is low shrub (266 acres) along with tall shrub (65 acres), conifer forest (66 acres) and mixed forest (49 acres). Since 187 acres will be revegetated only 281 acres will be permanently lost.

A 12-mile railroad extension between Devil Canyon and Gold Creek will be constructed on the south side of the Susitna River, removing an additional 73 acres of vegetation (Table E.3.3.42). Of this acreage 22 acres will be revegetated during Stage III development for a total permanent loss due to the railroad of 51 acres.

Many of the same impacts experienced in clearing the Watana and Devil Canyon impoundments (Sections 3.3.1(a), 3.3.2 and 3.3.3.(a)) will occur during and following access-related clearing. These include erosion, dust deposition, and drainage changes.

(b) Operation (**)

Use of the access roads will result in continued dust- and erosion-related effects on vegetation bordering the access road. In addition, access roads will facilitate increased human disturbances, including ORV use and a higher incidence of fire. The completion of the access road across the Stage III dam will likely increase the frequency of disturbances south of the Susitna River. These disturbances and their impact on vegetation are discussed in Section 3.3.1(b).

In contrast to the access roads, the proposed rail connection from Devil Canyon to Gold Creek will have minimal off-road access and fire incidence because it will be closed to the public. The rail connection will primarily traverse spruce and mixed deciduous type forests.

3.3.5 - Transmission Corridors (**)

(a) Construction (**)

Transmission corridors will comprise a total of 10,569 acres and will constitute another source of vegetation alteration (Tables E.3.3.30, E.3.3.31, and E.3.3.32) (see Figure E.3.3.19 for transmission line construction by stages). The transmission lines from Healy to Fairbanks (Table E.3.3.30) cover a total of 3,528 acres. Open spruce forest (1,370 acres), open mixed forest (394 acres), and low mixed shrub (531 acres), constitute the main vegetation types in the right-of-way. The Willow-to-Cook Inlet transmission corridor (total cover 2,056 acres) (Table E.3.3.30) will cover 554 acres of closed mixed forest, 545 acres of wet graminoid herbaceous, and 221 acres of mixed low shrub types. The Willow-to-Healy transmission corridor (3,437 acres, Table E.3.3.31) is composed primarily of shrublands (908 acres), upland spruce-hardwood forest (769 acres) and lowland spruce-hardwood forest (662 acres). A total of 1,548 acres of vegetation are included in the Watana-to-Gold Creek transmission line corridor (Table E.3.3.32). The majority of the vegetation in this corridor consists of low shrub types (741 acres) and spruce-birch mixed forest (455 acres).

Of the area included within the rights-of-way only a negligible fraction of the vegetation will be totally eliminated by intermittent placement of control stations, relay buildings, and towers. The remaining vegetation will be subject to selective clearing of trees and tall shrubs There will be no clearing of low shrub or tundra types. Thus low-lying vegetation and small shrubs will remain largely undisturbed. Such cleared areas have the potential of increased browse production by willow and birch shrubs following over-story removal. Transmission corridor construction is described in Section 3.4.2(a).

(b) Operation (**)

After establishment of the transmission corridors, periodic maintenance via selective clearing or trimming will be required. Such manual clipping may stimulate leaf and twig growth of willow and other browse species (Wolff 1978). On the other hand, evergreen shrubs such as Labrador tea and other woody shrubs are likely to show increased mortality if damaged in the process of clearing (Chapin et al. 1975, Chapin 1980, Chapin and Shaver 1981). But the potentially most damaging aspect of operation may be increased ORV use in the rights-of-way (see Section 3.3.1(b)(v)).

3.3.6 - Impacts to Wetlands (**)

(a) Impoundment Area, Borrow Sites and Construction Facilities (**)

The direct removal or inundation of wetland areas impacted by the three stage development have been quantified in Tables E.3.3.35 through E.3.3.38. The primary types to be removed by the impoundments, dam, and spillways of the Watana development include forests of black and white spruce and balsam poplar; scrub-shrub vegetation consisting mainly of willow, birch, alder, black spruce, Labrador tea, crowberry, bog blueberry and sweet gale; and forest with some scrub-shrub vegetation intermixed (Tables E.3.3.35 through E.3.3.38).

Far more wetland areas will be permanently affected by the Watana (Stages I and III) developments (12,280 acres) than by the Devil Canyon (Stage II) project (2,949 acres). The proportion of the area occupied by wetland types also differs among the 3 stages of development. Riverine habitats (rivers and creeks) occupy the greatest areal extent of wetlands in both Watana Stage I and Devil Canyon Stage II developments, accounting for 55 percent (4,216 acres) and 68 percent (1,996 acres) respectively. Riverine habitat accounts for only 12 percent (557 acres) of the wetlands occurring in the Watana Stage III development, reflecting the fact that the Stage III development inundates little additional river area relative to that inundated by Stage I.

Because of the configuration of Devil Canyon (the steep sloping canyon walls extending to the rivers edge), riverine wetland types occupy a greater proportion of the potential wetlands of the Devil Canyon facility. Palustrine wetland types occupy 45 percent (3,430 acres) of the wetland vegetation in the Watana Stage I development; 32 percent (953 acres) in the Devil Canyon Stage II development and 87 percent (4,042 acres) in the Watana Stage III project area. The palustrine wetlands consist mainly of scrub-shrub vegetation types in both Watana (Stages I and III) developments. Scrub-shrub vegetation types occupies 53 percent of the palustrine wetlands occurring in the Stage I development area and 66 percent of palustrine wetlands occurring in the Stage III project area.

Within each of the Stages I and III development areas, about 3 percent of the wetland areas occur within non-impoundment borrow sites proposed for dam and ancillary facility construction. Less than 1 percent of the wetlands within the

Devil Canyon development occurs in the non-impoundment Borrow Site K.

(b) Access Roads (***)

Completion of the Watana access road will affect about 105 acres of wetlands (Tables E.3.3.36). Most of the impacted acreage (99 percent) consists of palustrine wetlands, mainly scrub-shrub vegetation and scrub-shrub with emergent vegetation intermixed. Completion of the Devil Canyon access road will affect approximately 97 acres of wetlands; 97 percent of which is palustrine wetland consisting mainly of scrub-shrub vegetation with emergent vegetation intermixed (Table E.3.3.37).

(c) Railroad (***)

Construction of the railroad will affect about 19 acres of wetlands (100 percent palustrine wetlands) during Stage II of the three stage project (Table E.3.3.37). Most of the wetland acreage impacted consists of forest with emergent vegetation intermixed.

(d) Transmission Corridors (***)

Completion of the transmission line from the Watana Dam to the intertie during Stage I will affect about 256 acres of wetlands (Table E.3.3.39. Ninety-seven percent of these wetlands are palustrine consisting mainly of scrub-schrub, emergent vegetation and emergent vegetation with scrub-shrub intermixed (Table E.3.3.36). During Stage II an additional 26 acres of wetlands will be affected. Seventy-seven percent of the additional wetland acreage consists of palustrine wetlands, mainly emergent vegetation with some scrub-shrub intermixed (Table E.3.3.37).

Vegetation removal as a result of construction of the Willow-to-Healy, Healy-to-Fairbanks, and Willow-to-Cook Inlet transmission lines has been quantified in Tables E.3.3.30 and E.3.3.31. The reader is referred to these tables to review impacts to wetlands of these transmission corridors.

3.3.7 - Prioritization of Impact Issues (**)

In this section, impacts to vegetation are prioritized in order from most important to least important. Impacts are prioritized based on resource vulnerability, the probability of the impact occurring, and the duration of the impact. Direct losses of vegetation are judged most important because of the important because of the certainty and the permanence of the impact. The importance of losses of particular vegetation communities is in proportion to the total acreage lost and in indirect proportion to the amounts of each type present regionally.

Plant community changes are judged to be less important than actual losses. Changes are less predictable and of a shorter duration than vegetation losses.

(a) Direct Loss of Vegetation (**)

(i) Watana Stage I (**)

Direct losses due to the Watana Stage I impoundment include 15,229 acres of vegetation. These potential losses account for less than one percent of all vegetation in the RAK vegetation mapping area (Figure E.3.3.3). Certain types of vegetation will sustain substantial losses due to the project. About 45 percent of the black spruce woodland in the RAK vegetation mapping area will be lost. Almost 37 percent of the spruce-birch-aspen forest will be lost along with 17 percent of the birch-aspen forest. The losses of these and other vegetation types likely represent important habitat losses for some wildlife, especially black bear, moose, pine marten, beaver, raptors, small mammals, and passerine birds.

(ii) Devil Canyon Stage II (**)

Direct losses for the Devil Canyon Stage II impoundment will include 6,020 acres of forests, tundra, and shrubland. Total losses of vegetation will amount to less than 0.5 percent of the total RAK vegetation mapping area. Because of the steepness of Devil Canyon, these losses are small compared to Watana Stage I and comparatively less important for wildlife.

(iii) Watana Stage III (***)

Direct losses due to the Watana Stage III impoundment will include 16,374 acres of vegetation. This acreage represents over one percent of the RAK vegetation mapping area. Of this total, 13,016 acres consist of conifer and mixed forest and woodland. The Watana Stage III impoundment represents the largest single loss of vegetation and wildlife habitat resulting from the project.

(iv) Access Roads (**)

The Watana Stage I access road will result in a permanent loss of approximately 311 acres of vegetation types. Additional losses of about 281 acres for access roads and 52 acres for rail will occur due to the Devil Canyon facility. These routes will span spruce forests, and tall and low shrubland. In relation to possible losses from other aspects of the project, these direct losses are small.

(v) Transmission Corridors (*)

Of the total 10,569 acres of vegetation on right-of-ways for transmission lines, a small portion need be subject to initial clearing since there will be no clearing of low shrub or tundra types. Access trails for transport of personnel and materials, plus smaller areas for placement of control stations, relay buildings, and towers, will need to be cleared. Other portions of the transmission corridors will only require selective clearing or top-cutting of tall shrubs and trees.

(b) Indirect Loss of Vegetation (**)

Additional losses of vegetation may occur due to erosion, permafrost melting and subsequent land slides and slumpage, ORV use, blowdown of trees and other causes (see Section 3.3.1.a.). While some of these losses will be short-term with typical vegetational succession ensuing, or with shifts to new vegetation types for that area, long-term vegetational losses enduring for 30 to more than 100 years may occur on sites of continual erosion, land slumpage, or ORV use. The amounts that will be lost because of these factors are small compared to amounts inundated by the reservoirs.

(i) Watana Stage I (***)

Indirect losses of vegetation around the Stage I reservoir will be slight relative to losses from reservoir inundation. Essentially all of the vegetation indirectly lost as a result of this stage will be inundated by the Watana Stage III Reservoir.

(ii) Devil Canyon Stage II (*)

The smaller, steeper nature of Devil Canyon will severely limit indirect losses of vegetation.

Except for the possibility of one massive flow near RM 177, rock slides occurring above the impoundment represent the greatest threats and these will result in only small scale losses.

(iii) Watana Stage III (***)

Indirect losses of vegetation are projected to be greatest around the Watana Stage III Reservoir, where large areas on the south side of the impoundment are underlain by 200 to 300 feet of permafrost at near melting temperature. Also, because of the expected large size of the reservoir, other erosional processes such as wind erosion, together with effects of dust, may cause very localized vegetation loss, especially in wind-exposed areas.

(iv) Access Roads (*)

Some indirect loss of vegetation is expected due to erosion caused by changes in drainage patterns and dust deposition on the road edges. Increased utilization of ORVs along access roads and road maintenance may damage adjacent areas.

(v) Transmission Corridors (*)

Little indirect loss is likely as a result of direct clearing or construction, but uncontrolled ORV access could affect vegetation on and adjacent to corridors. Forests, shrublands, tundra and wetlands are dispersed along this area.

(c) Alteration of Vegetation Types (**)

Alteration of vegetation types will be caused by succession, changes in drainage patterns, altered river flows, and fire. In many instances, natural succession of cleared or disturbed areas not subject to inundation will result in vegetation type changes. For example, primary herbaceous and weedy vegetation and secondary shrub growth may follow clearing of sites. There may be development of fast-growing algal species and floating vegetation in shallow areas of the impoundments. Successional trends following prescribed fires are generally predictable. These impact issues are discussed further in the mitigation section (Section 3.4).

(i) Downstream Floodplain (**)

The most important alteration to result from the dams will be downstream between Gold Creek and Talkeetna, where annual spring and summer flooding and scour by ice jams will be reduced. As a result, some of the previously pulse-stabilized communities will mature. The willow and balsam poplar shrub will change to mature balsam poplar and thence to spruce. Within the license period, the development of vegetation on newly exposed banks and islands would proceed only to the medium and tall shrub stages.

(ii) Watana Stage I (***)

Much of the alteration of vegetation surrounding the Stage I reservoir will be short term as this area will eventually be inundated by the Watana Stage III Reservoir. All borrow sites will be rehabilitated with the exception of portions of Borrow Site E which will be inundated by the Devil Canyon Stage II Reservoir.

Recovery of vegetation altered during construction activities will depend upon the extent of disturbance. If disturbance causes the active layer of soil to deepen, changes in vegetation may be marked and long term. However, if disturbance results in minimal surfical disturbance of the soil and minor alteration of plant communities, recovery to pre-disturbance conditions could be expected in a relatively short time.

(iii) Devil Canyon Stage II (**)

Outside the actual impoundment and dam site, very few alterations of vegetation types are anticipated at Devil Canyon. Forest types will be subject to minor alterations, primarily near Borrow Sites G and K, and near camp and village sites. Likewise, changes in drainage, waterlogging of soil or permafrost melting will be highly localized because the soil is generally very rocky and well drained, with only sporadic occurrences of permafrost. The smaller, steeper character of Devil Canyon will also act to limit micro-climatic and mesoclimatic alterations.

(iv) Watana Stage III (**)

One area of potentially important impacts is tundra vegetation surrounding the Watana Stage III Reservoir. Disturbance may cause warming of the soil, melting of the permafrost, and deepening of the active layer. In well-drained areas, this may result in increased growth and productivity by the existing plant community, but in waterlogged areas a shift to bog vegetation is likely. If the organic layer is lost during disturbance, long-term losses of vegetation may result.

Most forest and shrub areas disturbed near the reservoir will recover naturally. The ensuing patterns of vegetational succession will be accelerated if the organic layer is retained and if root suckers or seeds of vegetation remain. Whether or not this occurs will depend on the nature of the disturbance.

(v) Access Roads and Railroads (*)

The access roads between the Devil Canyon and Watana sites and between Watana and the Denali Highway, as well as rail construction between Devil Canyon and Gold Creek, will alter surface drainage patterns and may induce dust-related alterations in vegetation at roadsides. The effects of altered drainages have been summarized above.

(vi) Transmission Corridors (*)

Selective clearing or top-cutting of tall vegetation will result in local shifts in plant types from trees to shrubs. Wet and moist tundra areas and their peripheries will be more susceptible to water logging by vehicular traffic with subsequent development of bog species and/or black spruce in place of cottongrass and shrub species.

3.4 - Mitigation Plan (**)

3.4.1 - Introduction (**)

This mitigation plan addresses the impacts to botanical resources described in Section 3.3. Mitigation measures for each impact issue have been developed according to the approach discussed in Sections 1.2 and 1.3, and are prioritized as follows: avoidance, minimization, rectification, reduction, and compensation. Mitigation measures are described with respect to locations, procedures, and costs. Recommendations by State of Alaska and federal agencies are reviewed, and their relationship to the mitigation plan explained.

The mitigation plan is organized as follows.

(a) Section 3.4.2, Option Analysis (**)

- The range of available mitigation options is explained for each of the impact issues prioritized in Section 3.3.7.
- Selected mitigation measures or facilities are described along with the reasons supporting each selection.
- The extent to which mitigation will be achieved by area and over time is indicated where available information allows.
- Residual impact estimates are provided.
- Implementation schedules are presented commensurate with the level of detail provided by Exhibit C, Construction Schedule.
- Implementation costs are provided for measures or facilities which are not included as project capital costs (Section 4.4.3). Project capital costs are described in Exhibit D.
- Mitigation measures or facilities recommended through agency consultation are documented. Where such recommendations have been incorporated in the mitigation plan, explanation is provided. Cases where alternative measures have been adopted are also explained.
- Illustrations of mitigative project design features are presented.

(b) Section 3.4.3, Mitigation Summary (**)

- Mitigation measures for botanical resources are summarized.

(c) Section 4.4.4, Agency Consultation (including wildlife) (**)

- Mitigation recommendations provided through agency consultation are summarized, along with reasons for incorporation of alternative measures where appropriate.

A series of Best Management Practices Manuals have been prepared for construction and operation of the Applicant's projects. Many of the guidelines and techniques presented in these manuals have been incorporated into engineering design and construction planning, resulting in modifications to avoid or minimize adverse impacts to botanical resources during project construction and operation. These measures include changes in facility siting and layout, realignment of access roads and transmission corridors, alterations in road design and construction, and constraints on gravel extraction locations and procedures. Further modifications to avoid or minimize adverse impacts will be made by incorporating these measures into the detailed design of the project. Because removal of vegetation will produce the greatest direct impact to botanical resources of the project area, measures to minimize the areal extent of vegetation removal are treated in greatest detail in the following discussions.

Rectification of adverse impacts to wetlands has also received particular attention, especially with regard to correcting blockage of sheet flow and siltation conditions caused by construction of access and service roads. Rehabilitation measures to rectify vegetation and soil loss at temporary construction sites and borrow areas have also been incorporated, including procedures to conserve and replace soils and to revegetate disturbed areas.

Project planning has emphasized the reduction of adverse impacts to wetlands and downstream riparian vegetation during construction and operation through monitoring and corrective measures to be implemented during the license period. Measures to compensate for impacts to vegetation reflect the importance of botanical resources as components of wildlife habitat, and have been designed primarily to mitigate impacts to wildlife through habitat enhancement and replacement. Thus, the mitigation plans for botanical resources and wildlife complement each other, and measures designed largely to reduce or compensate for loss of wildlife habitat are discussed more fully in Section 4.4.

As detailed engineering design and construction planning proceed, features of this mitigation plan will be correspondingly refined with respect to specific locations, procedures, and costs, utilizing the guidelines and techniques presented in the Best Management Practices Manuals. These details will eventually be directly incorporated into the project contractual documents.

3.4.2 - Option Analysis (**)

(a) Direct Loss of Vegetation (**)

Construction of all project facilities would affect 58,556 acres, of which 51,705 acres are vegetated. These acreages are apportioned in detail by construction stage and feature, area permanently modified, area temporarily lost, and area permanently lost in Table E.3.3.45. A summary of the vegetated area apportionment is as follows:

	Permanently Modified (acres)	Temporarily Lost (acres)	Permanently Lost (acres)	Total (acres)
Stage I	8,877	1,451	15,762	26,090
Stage II	205	873	6,020	7,098
Stage III	1,396	747	16,374	18,517
Total	10,478	3,071	38,156	51,705

Of this cumulative impact, the area permanently lost consists of the impoundments and dams; permanent portions of the access roads, railroad, and construction roads; permanent villages and other miscellaneous facilities. Temporarily lost areas include the quarry and borrow sites; temporary camps and villages; and portions of the access roads, railroad, and construction roads disturbed during construction, but not permanently lost. Permanently modified areas consist of the transmission line rights-of-way; however, only forest and tall shrub will be significantly modified. The areas affected allow application of the following range of mitigation options:

- o Avoidance: Vegetation removal cannot be entirely avoided.

- o Minimization: This measure is feasible by reducing clearing requirements. Options include:

  Minimizing facility dimensions;

  Consolidating structures;

  Siting facilities in areas of low biomass;

  Siting facilities to minimize clearing of less abundant vegetation types;

  Siting facilities to minimize clearing of vegetation types productive as wildlife habitat components;

  Minimizing volume requirements for borrow extraction;

Disposal of spoil within the impoundments or previously excavated areas; and

Designing transmission corridors to allow selective cutting of trees and to accommodate uncleared low shrub and tundra vegetation types within the rights-of-way.

- Rectification: Site rehabilitation measures can rectify impacts of vegetation removal. Options include:

  Dismantling nonessential structures after they are vacated;

  Storing removed organic layer and mineral soil for subsequent replacement;

  Scarification and fertilization; and

  Seeding.

- Reduction: Impacts of construction-related vegetation removal can be reduced over time by:

  Monitoring progress of site rehabilitation to identify locations requiring repeated application of fertilizer and/or seed;

  Systematically identifying and rehabilitating areas where construction activities have ceased and are no longer required; and

  Coordinating rehabilitation efforts with closure or removal of service roads no longer required.

- Compensation: This approach is feasible through the acquisition and management of replacement lands. Options include:

  Acquiring lands with areal coverages of vegetation types equivalent to those lost, and protecting these lands from future development; and

  Prioritizing lost vegetation types relative to value as wildlife habitat, and selectively changing or enhancing vegetation on acquired lands to replace or exceed lost areal coverages of the high-priority vegetation types.

(i) Minimization (**)

All of the minimization options summarized above will be applied to reduce clearing requirements to the least necessary for project construction. Dimensions of the construction camps and villages have been kept small by designing compact arrays of uniformly-sized, contiguous residential modules (as shown in Exhibit F). This approach has afforded significant structural consolidation, enhanced by combining the permanent village or townsite with the temporary construction village and construction camp at Watana. Structural consolidation has been achieved further by confining the entire infrastructure of camps, villages, temporary roads, fuel and equipment storage areas, and other construction support facilities to the vicinity of the damsites. These siting arrangements have been determined after considering engineering, environmental, and economic factors.

A major consolidation feature incorporated into project design is the common corridor of the Watana-to-Gold Creek access and transmission routes (Figure E.3.3.7). Vegetation removal required for both facilities will affect approximately similar plant communities in approximately the same locations. Consolidation of the two routes will minimize traffic-related vegetation removal by reducing distances required for transport of equipment from the nearest road to the transmission corridor. In the stretch between Watana and Devil Canyon, the adjacent access road will allow direct overland entry of equipment across a distance ranging from about 0.1 to 0.75 miles. Equipment will be mounted on flat-tread, balloon-tire vehicles to minimize soil or ground-cover disturbance.

Further consolidation has been achieved by siting borrow areas which may be required for access road construction immediately adjacent to the route. As shown in Figure E.3.3.7, 14 borrow areas have been identified along the access route from the Denali Highway to Devil Canyon. Access routing has been refined to emphasize well-drained soils which will allow maximum use of side-borrow techniques in level terrain and balanced cut-and-fill in sidehill cut areas (Figure E.3.3.20). Therefore, the borrow areas shown in Figure E.3.3.7 are not expected to be fully excavated, as they will be used only to augment material requirements where side-borrow or balanced cut-and-fill techniques cannot be fully utilized. In general, it is expected that each site will be excavated at most to a depth of 8 feet and would range in area from less than 10 to no more than 20 acres.

By minimizing gravel extraction requirements and utilizing borrow areas which, if necessary, will be sited immediately adjacent to the access road, the need for individual access roads to borrow areas has been eliminated, further reducing requirements for vegetation removal.

Minimizing clearing requirements has been a major consideration in the siting of access roads. Low shrub types represent the most common vegetation crossed by both the Denali Highway-to-Watana section and the Watana-to-Devil Canyon section. The forest types encountered are dominantly open and woodland types which require less clearing than closed types.

The Devil Canyon-to-Gold Creek railroad route will traverse mostly closed spruce-birch forest (about 58 out of 74 acres). In this case, constraints imposed by criteria for maximum 2.5 percent grades and 10-degree horizontal curves have necessitated routing through a vegetation type with heavier clearing requirements. However, the rail mode is itself a mitigation measure in this respect, because clearing width (50 feet) is half that required for road construction (100 feet) (see Figure E.3.3.21).

Transmission line rights-of-way traverse a variety of vegetation types with different biomass characteristics (Tables E.3.3.31 and E.3.3.32). Their routing has been determined largely by access and land ownership considerations. Because it shares a common corridor, the Watana-to-Devil Canyon transmission route traverses low-biomass vegetation types similar to those crossed by the adjoining access road. Clearing of vegetation of any type will be minimal during transmission corridor construction. Mitigative clearing techniques specifically designed to minimize vegetation removal by transmission corridors are discussed below.

Construction-related impacts of vegetation removal can be minimized further by siting facilities to avoid productive wildlife habitat and vegetation types with low abundance in the project area. In this sense, the affected vegetation has less value, and thus its removal contributes less to cumulative impact. However, this option applies only to facilities with flexible siting requirements. Because the dam and impoundment sites are fixed, loss of vegetation as a result of their construction cannot be minimized, rectified, or reduced over time, but can be offset only through compensation, as explained later in this section.

Without mitigation, the clearing of vegetation for permanent facilities will reduce carrying capacity for wildlife, as discussed in Sections 4.3 and 4.4.1; mitigation plans to offset this loss are presented in Section 4.4.2. These plans include the selective siting of access roads, transmission corridors, borrow areas, and the Devil Canyon railhead facility to minimize removal or disturbance of wildlife habitat. Siting and route alterations for this purpose have been made through the interaction of environmental specialists with project engineers and are summarized in Figures E.3.3.22 through E.3.3.25.

Vegetation removal resulting from access road construction would be minimized most completely by selection of the shortest alternative route (Access Plan 13) (see Chapter 10, Section 2.3). However, schedule constraints have necessitated selection of the Plan 18 route, which provides road access from the Denali Highway and rail access from Gold Creek. This route incorporates siting and design features which will minimize removal of wildlife habitat. A major advantage is that moose and brown bear habitat south of the Susitna River, particularly near Prairie Creek, Stephan Lake, and the Fog Lakes, will not be directly affected by vegetation removal and other construction-related impacts.

As shown in Figure E.3.3.25, two major realignments have been made to the 43.6-mile Denali Highway-to-Watana segment, progressively moving the route westward from relatively flat, low terrain (2,000 to 3,500) feet to the lower slopes of mountainous terrain in the northern portion of the project area (3,500 to 4,000) feet. These realignments have provided several advantages. First, potential drainage and siltation impacts associated with construction in the low, wet terrain to the east have been avoided. Second, the two earlier route alternatives joining the Denali Highway near

Snodgrass and Butte Lakes were longer and would have crossed more streams and wetland areas. For example, the Butte Lake alternative passes within 100 yards of Deadman Lake for a continuous distance of 2 miles and closely transits Deadman Creek along a 5-mile stretch. In addition, the earlier alternatives crossed flat terrain historically within the range of the Nelchina caribou herd (Section 4.2). The adjusted route follows the transition zone between level range and mountainous terrain, leaving the lowland area uncrossed by any potentially disturbing structure. Third, the adjusted route now follows relatively well-drained terrain and soil types which, for the most part, allow construction using side-borrow or balanced cut-and-fill techniques, rather than the bermed construction mode required for roadbeds crossing wet, poorly drained areas.

As discussed in greater detail below, side-borrow and balanced cut-and-fill techniques provide road sections which present a lesser physical and visual barrier to passing wildlife such as caribou and moose. Thus, where vegetation is replaced by a physical structure, the potential for that structure to block free passage of big game has been reduced by selective siting which allows preferred construction modes.

Using side-borrow and balanced cut-and-fill techniques also reduces gravel requirements, thereby minimizing the areal extent of vegetation removal, and confines gravel extraction to the access corridor itself, thus consolidating the impact. Similar terrain and soil considerations have governed routing of the 38.6-mile Watana-to-Devil Canyon road and the 12.2-mile railroad extension, which will also rely on balanced cut-and-fill construction to minimize removal of wildlife and habitat.

West of the Watana damsite, access routing has been adjusted to avoid potential disturbance to the fox den complex (not shown in Figures E.3.3.10 to E.3.3.12) at Swimming Bear Lake (MP 18 of the Watana-to-Devil Canyon route). Beaver concentrations at MP 34 and 36 in the vicinity of the Devil Canyon damsite have also been avoided by road realignments, as shown in Figure E.3.3.24. Particular attention has been given to the golden eagle nest on the cliff along the north side of Devil Canyon at MP 34.5. The access route in this vicinity was realigned to avoid the nest site by 0.5 mile to the north (Figure E.3.3.24).

Jack Long Creek, a productive beaver stream, occupies a swale approximately 1,700 feet south of the Devil Canyon construction village and campsite (Figure E.3.3.24). This stream and the surrounding wet area are vulnerable to impacts of vegetation removal associated with construction of the camp and village, transmission corridor, and access route. Options to minimize disturbance to Jack Long Creek and resident beaver include resiting the camp and village, selecting road instead of rail access from Gold Creek to provide greater flexibility in access routing, realigning the rail route to the extent feasible, and aligning the transmission corridor away from the creek.

The camp and village are subject to siting constraints imposed by the occurrence of wet graminoid herbaceous vegetation type in the area, and have been sited on locally higher, drier terrain supporting closed mixed forest. Their locations are considered to be sufficiently flat and distant from Jack Long Creek to prevent erosion runoff into the drainage following vegetation removal.

Selection criteria and rationale for rail access from Gold Creek are explained in Exhibit E, Chapter 10, Section 2.3, and are considered sufficiently favorable to prevent changing access from Gold Creek to road instead of rail. Rail alignment has been modified to follow the hillside south of Jack Long Creek at approximately the 1,600 to 1,800 foot contour level, instead of the original alignment on lower ground along the north side of the creek (Figure E.3.3.24). The modified aligmment will keep the railroad extension away from the active drainage area of Jack Long Creek.

The railhead facility at Devil Canyon will consist of a poured concrete pad approximately 2,500 feet long and 800 feet wide, accommodating the main track, two sidings, and areas for equipment, offloading, and storage. The Jack Long Creek drainage and a beaver pond near the head of the drainage system impose difficult constraints on the siting of this facility. The pad was originally sited on the north side of the creek between the streambed and the Devil Canyon campsite. With realigmment of the rail extension to avoid impacts to the drainage, the railhead facility has also been relocated south of the creek on relatively flat ground at an elevation of about 1,500 feet. This siting avoids both Jack Long Creek and the beaver pond, and removes any necessity for the rail extension to cross the drainage at this point (Figure E.3.3.24. Crossing of the drainage to allow access to the camp and construction areas will be accomplished by construction of a bridge with minimal vegetation removal. This issue is discussed further in Section 3.4.2(c) with respect to potential drainage alteration.

The transmission corridor has been aligned to avoid Jack Long Creek and is not expected to produce construction-related impacts on beaver habitat. Access to the corridor for construction will be by temporary bridge across Jack Long Creek from the rail corridor.

In summary, potential effects of construction-related vegetation removal on wildlife habitat have been minimized by routing access and transmission corridors as much as possible away from areas where these structures would disturb big game and fishery resources. In all cases, specific locations of nests, dens, and beaver activity have been entirely avoided by facility siting.

Impacts of vegetation removal during construction have also been minimized by reducing volume requirements for borrow extraction. The options chosen to accomplish this are use of side-borrow and balanced cut-and-fill techniques in access road design, and incorporation of a flexible design speed. As explained above, application of construction procedures depends on types of terrain and soil traversed. Siting of access routes has therefore avoided low, wet areas and made maximum use of well-drained, higher terrain where gravelly soils are available as construction material. This approach has the additional advantage of avoiding potential wetlands and waterbodies, thus minimizing drainage- and siltation-related impacts to aquatic resources.

The section of road from the Denali Highway to the Watana camp follows terrain and soil types which will allow construction using primarily side-borrow techniques. This approach minimizes vegetation removal away from the alignment by confining road construction activities to an approximately 20-foot strip along each side of the roadbed. A typical cross-section of a road constructed by side-borrow is shown in Figure E.3.3.20. The finished road section using side-borrow construction is such that the crown of the road is only 2 to 3 feet above original ground level compared with 5 to 6 feet for a conventional berm-type, end-dumped section. Thus the side-borrow approach not only minimizes vegetation removal and consolidates disturbance, but also produces a lesser visual and physical barrier to passing wildlife.

In side-borrow construction, the road is developed in 800 to 1,000 feet segments. Overburden is removed, hauled to the previously constructed segment, and deposited in the previously excavated borrow trenches. Only at the start of construction is overburden deposited on undisturbed vegetation, and then only within the corridor which will be developed subsequently. As the borrow trenches alongside the roadbed are excavated, the borrow is used to build the road. Upon completion, the removed overburden is hauled back from its temporary storage location in borrow trenches of the previously constructed road segment and used to backfill the newly excavated side trenches to provide a 4:1 to 6:1 slope which helps to stabilize and insulate the shoulder (Figure E.3.3.20). The overburden is then fertilized and seeded.

In contrast to end-dumping, side-borrow does not require the excavation of material sites away from the alignment. As shown in Figure E.3.3.7, nine borrow areas have been identified along the Denali Highway-to-Watana segment as far as MP 32. These will be excavated only on a contingency basis to support road construction and maintenance in cases where side-borrow material is not available in sufficient quantities. In this event, excavation required for maximum material extraction to develop a given segment of road will average about 8 feet in depth and remove vegetation over an area of from 10 to no more than 20 acres.

Removed overburden will be stockpiled temporarily in nearby locations selected and prepared on a site-specific basis to minimize runoff potential (i.e., flat, well-drained upland locations not above streams and with no active or intermittent drainage nearby, with appropriate berms and/or trenches), then deposited back in the borrow area and immediately fertilized, scarified and seeded. Material required to support construction of the Denali Highway-to-Watana segment south of MP 32 will be obtained from damsite Borrow Sites D or E (Figure E.3.3.7).

The connecting road between Watana and Devil Canyon crosses primarily low shrub vegetation types (Table E.3.3.42) underlain by usable soils with bedrock at or near the surface. This road segment will be constructed by sidehill cutting emphasizing balanced cut-and-fill to minimize ancillary material extraction. As shown in Figure E.3.3.7, five potential borrow areas have been identified along the route on a contingency basis in the event that additional fill is needed to augment material obtained from sidehill cuts. These borrow areas, if used, will have excavated dimensions not exceeding those described above for the Denali Highway-to-Watana segment.

Balanced cut-and-fill construction generally is feasible only where excessively deep cuts or large fills are not required to minimize grades. Routing of the Watana-to-Devil Canyon road has followed gentle-to-moderate slopes where deep cuts and large fills will not be required. However, in steeper terrain such as approaches to stream crossings and the high-level Susitna River bridge, requirements for large cuts and fills have been greatly reduced by incorporating a flexible design speed which will allow steeper grades and shorter-radius horizontal curves. Incorporation of design speed flexibility has also allowed the alterations in alignment to avoid biologically sensitive features described above, as shorter-radius curves were required in some cases.

In summary, impacts of construction-related vegetation removal have been minimized by reducing volume requirements for borrow extraction. This has been accomplished by:

- Access alignments which follow well-drained upland terrain with soils suitable for use as construction material;

- Use of side-borrow and balanced cut-and-fill road and railroad construction techniques; and

- o Incorporation of a flexible road design speed to avoid the necessity for deep sidehill cuts with excessive fill requirements.

In general, the plan for borrow area utilization for dam construction minimizes vegetation impacts. Of the 12 potential borrow and quarry sites identified, only five are currently considered likely to be used, which will minimize the overall areal extent of impact. These five, which were selected on the basis of environmental engineering, and economic constraints, consist of Sites A, D, and E for Watana and Sites G and K for Devil Canyon. Site G and about half of the areal extent of Site E are within inundation zones, which will further minimize vegetation impacts. Current plans also call for utilizing Site E for Stage III construction as well as for Stage I construction even though it will be partially inundated during Stage III construction. This will avoid the need for utilization of Site F along Tsusena Creek, which is an alternate for Site E. All five primary sites are close to the dam sites so that the lengths of haul roads are minimized and the areas of disturbance are centralized to the degree possible.

The disposal of spoil from construction and borrow excavations will create a potential for vegetation removal either through direct burial or through clearing for spoil disposal sites. Spoil will be produced primarily from the processing of excavated rock and gravel required for dam construction, concrete aggregate, and support pads for buildings and temporary service roads. The locations of proposed excavation areas are shown in Exhibit E, Chapter 2, Figures E.2.4.3, E.2.4.124, and E.2.4.126, and in Figure E.3.3.7; borrow sites are described in Chapter 10, Sections 2.5.1 (Watana) and 2.5.2 (Devil Canyon).

Large volumes of spoil will be produced by construction of Stages I and III. The only cost-effective way to avoid removing vegetation for disposal of the large volumes of spoil produced by dam construction will be to deposit the spoil within the impoundment areas. However, this option must be limited by the need to prevent fines from being entrained by surface water flow. Thus locations for spoil disposal within the impoundment areas must be carefully selected and clearly designated in areas which will quietly pond during filling, well away from turbulent flows associated with intake structures.

Large amounts of material will be required from Borrow Site D for construction of the impervious core of the Watana Dam (Stages I and III). Wet-processed spoil from Borrow Site D will be deposited on relatively flat sites within the impoundment area away from the diversion tunnel intakes and main intake approach channel (Exhibit F). Exact locations of spoil disposal areas within the Watana impoundment will be determined during detailed engineering design. Prior to the start of filling and while the cofferdams and diversion tunnels are operative, fines will be sequestered by temporary construction berms. However, protection from entrainment during diversion and filling will be provided by locating spoil disposal sites away from areas of turbulence or high-velocity currents, and not solely by berms or other temporary construction measures.

The large amounts of spoil produced by dragline mining and processing of material from Borrow Site E will be disposed of within the excavation limits. It is expected that the mined areas of these sites will pond at river level (1,420 to 1,440 feet) prior to construction of the Devil Canyon Dam, and that a larger area pool will form at reservoir level (1,455 feet) following Devil Canyon development. The pool area will depend on actual excavation limits.

During excavation of Borrow Site E, spoil would be deposited temporarily in the vicinity of the gravel processing plants, generally along the northern perimeter of excavation at any given stage in mining. The fines will be contained by temporary construction berms or in temporary pits. Permanent deposition will be above the estimated 50-year flood elevation of about 1,473 feet. During filling of the Devil Canyon Reservoir, the deposited fines will be covered with vegetation slash and debris produced during reservoir clearing.

Borrow Site G will be excavated between 1998 and 2003 as a source of concrete aggregate for construction of the Devil Canyon Dam and ancillary facilities. This borrow site is a first-level terrace site on the south side of the Susitna River, occupying the area between Cheechako Creek and the Devil Canyon damsite. The terrace elevation ranges from about 925 to 1,175 feet. Aggregate will be processed on the site and spoil deposited in the vicinity of the processing plant, which will change as excavation proceeds. Excavation spoil from construction of the Devil Canyon saddledam will be hauled or transported by conveyor belt and also deposited in Borrow Site G. Fines will be sequestered in bermed cells within excavated portions of the borrow site above the diversion tunnel intake elevation of 870 feet. Spoil will not be inundated until blockage of the diversion tunnel at the start of reservoir filling in 2004. All of Borrow Site G and spoil deposited therein will be entirely inundated by the Devil Canyon Reservoir and will lie about 500 feet below the surface elevation of 1,455 feet.

Access road construction is not expected to produce non-usable spoil requiring separate disposal sites. Geotechnical alignment studies will be conducted during detailed engineering design to provide data necessary to avoid ice-rich soils. Road construction will utilize materials which allow side-borrow and balanced cut-and-fill techniques which generate no excess spoil.

In summary, vegetation removal will not be required for major spoil disposal during construction of the Susitna Hydroelectric Project. Spoil produced during the Watana and Devil Canyon developments will be deposited in the impoundment areas in a manner which will avoid entrainment during construction or operation, and entirely inundated. Access road construction is not expected to produce excess spoil.

The areal extents of vegetation types potentially to be affected by the Susitna Project transmission corridors are summarized in Tables E.3.3.31, E.3.3.32 and E.3.3.45. It should be noted that these areas may change to a limited extent as alignments are refined during detailed engineering design and construction planning. It is further emphasized that these quantities do not indicate areas of vegetation which will actually be removed by transmission corridor construction and maintenance. In fact, as stated in Sections 3.3.4(a) and 3.3.6(a)(iv), the 10,569 acres required for transmission corridor rights-of-way will be cleared only to a limited extent, as explained in the following discussion.

The Applicant has developed a mitigative approach for construction and maintenance of transmission corridors in Alaska. Much of the following description is presented in the Applicant's environmental assessment report for the Anchorage-Fairbanks transmission intertie (Commonwealth Assoc. 1982), an integral part of the Susitna transmission system. However, clearing limits apply specifically to the Susitna project.

Surveying will be required along rights-of-way to locate centerlines and transmission tower positions. The survey work will involve limited cutting of trees and shrub vegetation for line-of-sight staking and distance measuring. No roads will be established during surveying.

Clearing of rights-of-way will be done selectively, with typical clearing limits as shown in Figure E.3.3.26. The illustrated clearing limits would apply to guyed X-type towers up to 85 feet tall on level terrain. Detailed criteria for different types and heights of towers and for differing terrain will be prepared during detailed engineering design. In general, clearing will be limited as follows:

- The maximum height of vegetation on the inside buffer edge will be 10 feet.
- The maximum height of vegetation on the outside buffer edge will be 60 feet.
- A corridor of vegetation not exceeding 10 feet in height will be maintained between the transmission lines except at tower sites.
- At tower sites, transverse strips 30 feet in width will be cut through to adjacent lines.
- Tower-to-tower span will be 1,200 to 1,300 feet.
- The area under the lines, including 5 feet beyond the outside phases, will be clear cut to within 6 inches of ground level, with growth under 24 inches left in place.
- At tower sites and in areas occupied by access trails (described below) or temporary construction facilities, all vegetation may be

cut. Grubbing of stumps and stripping of the organic surface layer will be required for tower erection in some cases.

The above clearing limits will apply only to vegetation within rights-of-way. Outside rights-of-way, there will be additional, limited clearing to remove danger trees and to allow access (described below). Danger trees are trees located outside the clearing limits which are of sufficient height to come in contact with towers, guys, or lines if the tree were to fall. Such trees will be located, flagged, and felled by hand tools or portable power saws, then hauled into the right-of-way for disposal. Special permission will be requested of landowners or land management agencies to allow removal of danger trees.

Clearing of vegetation will be done by Hydro-axe, vehicle-mounted shears, and hand-held power saws. Additional equipment, including bulldozers, will be used to stockpile slash and debris within rights-of-way prior to burning. The stockpiled vegetation will be allowed to dry through the summer immediately following clearing and control-burned under constant supervision at the end of the summer. Burning will help to reduce the potential for spread of spruce budworm and other insects.

The Applicant intends that ground access be primarily used for construction and maintenance of the transmission corridors. The use of helicopters may be required in certain instances.

Construction and maintenance contractors will be required to prepare access plans acceptable to the Applicant and controlling agencies or landowners. Minimizing requirements for clearing of vegetation will be an important criterion for the evaluation and approval of these plans. Basic elements of access planning will include:

- Stipulation that existing roads must be used to the nearest point of transmission corridor access;

- Permission for contractors to build construction trails from the nearest points on existing roads to the rights-of-way;

- Stipulation that construction trails be established only after thorough onsite assessment of alternative routes and procedures to ensure minimal environmental disturbance, including avoidance wherever feasible of dense vegetation, stream crossings, wetland and floodplain areas (identified with the concurrence of the COE and USFWS), and extensive switchbacks on steep, erosion-prone terrain; and

- Use of minimum standard trails from tower to tower along the inside cleared portions of the rights-of-way.

For construction of the Watana-to-Gold Creek transmission corridor, the connecting road between the two damsites will be built as planned and maintained year-round. Construction trails from the main access road to the rights-of-way will be cleared along approved alignments. Because use of the construction trails will be limited to flat-tread or balloon-tire vehicles, fill placement or removal of the organic layer will not be required. From the south bank of the Susitna River to Gold Creek switching station, the railroad extension right-of-way will be developed as a minimum-standard (approximately 20 feet or 6 m wide) road to support transmission corridor construction. Equipment access to Gold Creek switching station will be provided along the intertie right-of-way.

It is anticipated that maintenance-related clearing of transmission corridor rights-of-way will be necessary approximately every 10 years. During intervals between periodic clearing, vegetation within the rights-of-way will be allowed to grow without disturbance, except for the occasional removal of danger trees as required, or localized clearing associated with tower and line maintenance or repair. It is the established policy of the Applicant that herbicides are not used for any aspect of transmission corridor construction or maintenance.

The selective clearing of transmission rights-of-way will result in enhanced browse production associated with sprouting and succession. Clearing will thus augment other measures to compensate for project-related loss of browse, as discussed in Section

4.4.2(b). Further benefit will be derived by goshawks, sharp-shinned hawks, and other raptors and owls which will hunt along the rights-of-way as discussed in Section 4.3.4(c). These benefits must be weighed against the potentially adverse effect of increased public access which portions of the rights-of-way may provide. The issue of increased access is discussed in Sections 3.3.1(b)(v) and 4.3.3, and below in Section 3.4.2(b).

On-ground evaluations will be made during detailed engineering design and construction planning regarding appropriate management procedures for specific portions of the transmission corridors (e.g., the extent of clearing, maintenance requirements, and potential seeding of areas disturbed during construction).

Access to transmission corridors has been coordinated closely with access along roads, the railroad extension, and already existing adjacent transmission corridors. Policies on public access during and after construction and along the length of the corridors will be consistent with management policies of agencies and landowners with jurisdiction over the properties traversed by the corridors.

In summary, the direct removal of vegetation as a result of transmission corridor construction and maintenance will be minimized through the application of selective clearing techniques which will remove only vegetation that might impede access, construction, or maintenance of the transmission system. Vegetation removal will be minimized further by constraints imposed on the routing of access trails to the rights-of-way, and especially by alignment of the Watana-to-Devil Canyon access road and transmission rights-of-way together along a common corridor. Herbicides will not be used. Selective clearing repeated approximately every 10 years will enhance browse and hunting habitat for moose and certain raptors, respectively, by maintaining cleared portions of the rights-of-way in early successional stages.

(ii) Rectification (**)

Certain ancillary project facilities will be required on a temporary basis during construction and vacated when construction has been completed. Vegetation removal resulting from development and use of these facilities can be partially rectified by dismantling the structures, rehabilitating the underlying soils, and preparing the soils to allow reestablishment of vegetation. These options will be followed to rectify effects of vegetation removal during construction of the Watana and Devil Canyon dams.

Lands associated with the following temporary facilities will be rehabilitated in accordance with the schedules shown:

WATANA

Facility & Vegetation	Acres	Year of Initial Disturbance	Year Rehabilitation Begins
Access Road Cuts, Fills & Ditches			
Conifer Forest	16	1990	1990
Tall Shrub	3		
Low Shrub	168		
Dwarf Shrub	24		
Construction Camp & Village			
Conifer Forest	1	1990	2112
Low Shrub	191		
Construction Road Cuts, Fills & Ditches			
Conifer Forest	7	1992	1992
Mixed Forest	9		
Low Shrub	14		
Quarry Site A			
Conifer Forest	4	1/3 in 1997	1/3 in 1998
Mixed Forest	24	2/3 in 2005	2/3 in 2006
Low Shrub	312		
Borrow Site D			
Conifer Forest	320	2/3 in 1993	2/3 in 1994
Broadleaf Forst	12	1/3 in 2005	1/3 in 2006
Mixed Forst	87		
Tall Shrub	26		
Low Shrub	279		
Graminoid Herbaceous	14		
Borrow Site E			
Conifer Forest	222	2/3 in 1993	2/3 in 1994
Mixed Forest	289	1/3 in 2005	1/3 in 2006
Dwarf Tree Scrub	40		

DEVIL CANYON

Facility & Vegetation	Acres	Year of Initial Disturbance	Year Rehabilitation Begins
Access Road Cuts, Fills & Ditches			
Conifer Forest	27	1995	1995
Broadleaf Forest	1		
Mixed Forest	20		
Tall Shrub	26		
Low Shrub	106		
Dwarf Shrub	2		
Graminoid Herbaceous	5		
Construction Camp & Village			
Mixed Forest	177	1992	2005
Dwarf Tree Scrub	3		
Graminoid Herbaceous	20		
Construction Road Cuts, Fills & Ditches			
Conifer Forest	3	1997	1997
Broadleaf Forest	2		
Mixed Forest	14		
Railroad Cuts, Fills & Ditches			
Conifer Forest	2	1995	1995
Mixed Forest	19		
Graminoid Herbaceous	1		
Quarry Site K			
Conifer Forest	153	1998	1999
Mixed Forest	99		
Tall Shrub	151		
Low Shrub	42		
TOTAL REHABILITATED AREAS	3,071	1991-2005	1991-2012

Rehabilitation of temporary facility sites will only partially rectify the vegetation loss resulting from their construction. Provided soils are restored, plant succession will proceed at various unquantifiable rates depending on slope, aspect, elevation, soil types, moisture and drainage conditions, and other factors. Without restoration of mineral and organic soils, recovery of forest and shrubland within the project area may require 150 or more years. It may be assumed that some semblance of the original pattern of lost vegetation will be restored within 150 years on lands prepared for rehabilitation, but predictions of how plant succession will proceed on these lands over time are difficult.

Because rehabilitation procedures for disturbed lands in Alaska are best developed on a site-specific basis (Brown et al. 1978a,b), preparation of a comprehensive restoration plan for the Susitna project has been designated as a task for the detailed engineering design phase. An individual restoration plan will be developed for each area to be rehabilitated. Guidelines and techniques presented in the Erosion and Sedimentation Control Best Management Practices Manual will be followed. The individual plans will incorporate the following information for use by rehabilitation contractors and monitors:

- Plan view (drawing) of area to be rehabilitated, with limits clearly delineated along with overburden stockpile locations and areas of special concern (e.g., erosion, slumping, oil saturation from equipment maintenance shops, etc.);
- Specific locations for the stockpiling of organic overburden, with special protective measures against drying, wind erosion, and runoff;
- Specific depths and procedures for ripping and scarification during soil preparation;
- Specific quantities and types of fertilizers to be applied; and
- Specific revegetation mixtures to be used for seeding, with application rates (lbs/acre) and methods (drilling or hand broadcasting).

In general, the following procedural overview gives an indication of the approach which will be used for site rehabilitation, based on experience from other projects involving non-arctic interior regions of Alaska (for example, see Pamplin 1979). However, specific restoration plans will provide much greater detail, as described above.

The land surface of disturbed areas will be ripped prior to application of topsoil, then graded to contour and evenly covered with organic overburden and topsoil previously stockpiled for this purpose. Fertilizer high in phosphorus (e.g., 10-20-10 or 8-32-16, N-P-K) will be applied at a rate sufficient to supply 187 to 242 lbs of nitrogen per hectare.

Following the spreading of organic overburden, topsoil, and fertilizer, the site surface will be scarified to a depth of 12 inches using a rake towed by a mini-Rolligon type vehicle. This procedure will mix the organics with the underlying mineral soil, aerate the mixture, and lightly compact the surface. During the second and third growing seasons, follow-up applications of fertilizer will be made at one-half to one-third the original rates.

Where erosion potential or aesthetic considerations can be demonstrated not to be involved, site rehabilitation will emphasize application of organics and nutrients and minimize seeding. This approach will encourage the reinvasion of native species from the surrounding parent population. For lightly disturbed sites with intact topsoil, fertilization alone should be sufficient to facilitate revegetation.

Sites with high erosion or visual impact potential will be fertilized and seeded with fast-growing native grasses appropriate to the climate and geography of the Susitna Basin. To minimize erosion, all sites will be rehabilitated by the first growing season following removal of structures and equipment. Sufficient quantities of seeds for sites requiring revegetation will be stockpiled, and regrowth potentials of available native strains will be tested prior to project abandonment of disturbed sites. Choice of plants for site rehabilitation will be made after consultation with federal and state natural resource agencies.

In summary, rectification will restore vegetation to approximately 3,071 acres temporarily lost to ancillary facilities. This represents about 7 percent of the cumulative total land area on which vegetation will be totally cleared during project construction and operation (41,227 acres - see Table E.3.3.45.).

(iii) Reduction (**)

Options for the reduction of direct vegetation removal over time involve monitoring project facilities and activities to ensure the most effective use of rehabilitation measures. During project construction and operation, the following three tasks will be performed on a continuing basis:

- Monitoring progress of site rehabilitation to identify locations requiring repeated or altered application of fertilizer and/or seed;

- Systematically identifying and rehabilitating areas where construction activities have ceased and are no longer required; and

- Coordinating rehabilitation efforts with closure and removal of service or temporary access roads no longer required.

These measures will be included in the comprehensive restoration plan described above in Section 3.4.2(a)(ii) and, in fact, will help to focus and implement that plan.

In the construction zone of a large project, disturbed areas partially or wholly without vegetation develop with expansion of the infrastructure of temporary roads, residential quarters, storage yards, equipment maintenance shops, and other ancillary facilities. Although areal extents have been quantified with respect to camps, service roads, contractor work areas, borrow sites, and other facilities, these quantifications are only best estimates of the extent of vegetation removal, because zones of activity will surround these sites.

One objective of monitoring is to maintain awareness of disturbed areas as they enlarge or as activities diminish, so that rehabilitation can begin as early as feasible. Monitoring of vegetation removal during construction will provide for the application of rehabilitation measures in locations other than or adjacent to the areas specifically targeted in the individual restoration plans, and on an as-needed basis throughout the construction period. Monitoring of vegetation loss will also be conducted during pre-construction field activities and throughout the license period to detect later disturbances during operation and maintenance.

The monitoring program described above will be a component of the project-wide monitoring plan to be established formally during the detailed engineering design and construction planning phase of the project (Section 1.3). See Section 4.4.2.2(i) for further description of the construction monitoring program.

(iv) Compensation (**)

By its very nature, a large hydroelectric development such as the Susitna Project will permanently remove a considerable area of vegetation dedicated to the damsites, impoundment areas, access routes, and permanent buildings. For the Susitna Project, the cumulative vegetated area lost in this way will total about 38,156 acres, with 37,209 acres covered by the impoundments and dams.

Because of the large area affected by the impoundments and dams, it is evident that measures for minimization, rectification, and reduction of vegetation loss will apply to a minority of the total area of vegetation affected by the project. Loss of the remaining vegetation can be mitigated only through compensation.

Two compensation options have been selected for mitigating the permanent loss of land areas as wildlife habitat. These options are: habitat enhancement and habitat preservation. Habitat enhancement will involve the management of publicly-owned land areas to increase the productivity of wildlife species requiring early successional vegetation and/or complex patterns of vegetation types. The primary target species is moose, but many other species will benefit as well. Habitat preservation will involve setting aside undisturbed areas that might otherwise be developed containing important habitats. A complete description of habitat compensation on mitigation lands is provided in Mitigation Measure No. 25 in Section 4.4.2(a).

(b) Indirect Loss of Vegetation (**)

Vegetation loss will result from slope instability effects during and after filling of the impoundment areas (Sections 3.3.1, 3.3.2, 3.3.3, and 3.3.7(b)). As reservoir soils become saturated and slopes settle to new angles of repose, slumping and landslides will occur above and below surface levels. Erosion and slumping will result from melting of permafrost, particularly along the south side of the Watana impoundment where deep permafrost occurs (Section 3.3.1(b)(ii)). These effects will be intensified in the Watana reservoir by the yearly periodic freezing, thawing, saturation, and dessication of soils within the drawdown zone, by hydraulic erosion, and by ice formation.

It is evident that vegetation loss from slope instability, erosion, and blowdown along the reservoir margins will produce a cumulative impact in addition to the direct losses described in Section 3.4.2(a). However, the precise vegetation types, locations, areal extents, and elevation ranges which will be affected by these indirect losses cannot be reliably quantified in advance. Without altering fixed characteristics of the dams and reservoirs, there is no way to avoid, minimize, rectify, or reduce these impacts. Loss of low shrub vegetation, important for moose and other wildlife, will be compensated for by the land acquisition and habitat compensation program described in Section 4.4.2.

Additional indirect losses of vegetation will result from increased human activity within the project area during construction and operation (Sections 3.3.1(b)(v), 3.3.4(a) and (b), 3.3.5(a) and (b), and 3.3.7(b). Nonessential disturbances to vegetation and soils by construction workers cannot be avoided entirely, but substantial minimization will be possible through consolidation of facilities and careful planning of traffic patterns and service roads (Section 3.4.2(a)(i)). Particular attention will be given to infrastructure layout during detailed engineering design and construction planning, including design participation and review by project environmental specialists.

Thoughtful planning and implementation of an environmental briefings program requiring the participation of all field personnel will make an important contribution towards minimizing unnecessary disturbances to soil and vegetation during project construction and operation.

Rectification and reduction of vegetation losses, resulting from activities of construction workers, will be accomplished through the rehabilitation and monitoring programs described in Sections 3.4.2(a)(ii) and (iii).

During construction of Stage I, public access along the Denali Highway-to-Watana road will be restricted by use of a gate supervised by security guards. The Watana-to-Devil Canyon road will be closed to the public during Stage II construction. Public use of the Gold Creek-to-Devil Canyon railroad extension will not be available. These measures will avoid or minimize increased impacts to vegetation resulting from recreational users and others attracted by the project during construction. It should again be noted, however, that restricting access along the Denali Highway-to-Watana road will not necessarily deter or diminish the existing pattern of access by ORV and ATV from the Denali

Highway, Parks Highway, and Gold Creek onto public and private lands surrounding the project.

Vegetation loss and soil damage from public access-related vehicle use will occur following construction and throughout the license period and may intensify over time as population growth and recreational and hunting pressures increase (see Exhibit E, Chapter 7 - Recreation). ORV and ATV use already is occurring on lands surrounding the project and has resulted in obvious soil damage and vegetation loss, as discussed in Exhibit E, Chapter 8 - Aesthetics.

Increased public access as an indirect consequence of the project cannot be entirely avoided by the Applicant because access to lands surrounding the project is available through ORV, ATV, and aircraft use. The project access route does, however, avoid areas south of the Susitna River (Stephan Lake, Prairie Creek, Fog Lakes, as well as the Indian River area) which are valuable as wildlife habitat.

A variety of regulatory options are available for reducing human activity on public lands in the project area. For example, measures may be taken by the Boards of Game and Fisheries and by the Commissioner of Fish and Game to relieve hunting and fishing pressures (see Section 4.4.1(b)). These options include entirely closing an area to hunting and fishing or creating a special use area where motorized vehicles are prohibited from hunting. Because hunting and fishing are the primary reasons for use of motorized vehicles within the project area, such measures could substantially change user patterns. Access onto private lands in the area will depend on individual landowner access policies and state trespass laws.

The Susitna Hydroelectric Project Recreation Plan is presented in Exhibit E, Chapter 7. A major objective of the Recreation Plan is to establish patterns of public access that will minimize and localize access-related impacts through the use of trails and designated camping area. The Recreation Plan is consistent with fish and wildlife habitat protection priorities established for the project. In addition, the phased design of the Recreation Plan will ensure that implementation will be gradual and based on monitoring of fish, vegetation, and wildlife impacts as well as recreational user needs. Implementation of each phase will be subject to interagency review and concurrence.

In summary, vegetation loss resulting from instability along the margins of the impoundment areas and from increased public access to lands surrounding the project will produce a cumulative impact augmenting the impact of direct construction-related vegetation removal. Loss of shrubland browse species will be compensated for by habitat management on mitigation lands. Vegetation loss resulting from increased public access will be minimized by confining access routes to areas north of the Susitna River, use of signs and possibly of special regulatory designation to discourage ORV and ATV use, and by phased implementation of the project Recreation Plan with interagency review and concurrence. In addition, a variety of regulatory options are available to resource management agencies to limit access on public lands under their jurisdiction.

(c) Alteration of Vegetation Types (**)

Alteration of vegetation types will be caused by plant succession, changes in drainage patterns, regulated downstream flows, and fire. Plant successional changes will occur along the margins of the impoundment areas as a result of the slope instability processes described in Section 3.4.2(b). Because such changes cannot be quantitatively predicted and because they will involve an increase in productive early-successional stages of value as browse or forage, special mitigative measures are not planned.

Potential changes in surface drainage patterns are of greatest importance where wetland areas are involved. Under Army Corps of Engineers regulations promulgated by Sections 301 and 404 of the Clean Water Act (33 USC 1344), wetlands are defined as "those areas that are inundated or saturated by surface or ground water at a frequency and duration to support, and that, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 323.2(c)).

It is not anticipated that the Susitna Project will produce major impacts on wetlands outside the impoundment areas. Two locations of concern have been identified:

- The 14-mile portion of the Denali Highway to-Watana access route (MP 24-38) passing near the Deadman Creek drainage (Figures E.3.3.22 and E.3.3.23); and

- The Jack Long Creek area (Figure E.3.3.24).

Major impacts to wetlands in these areas will be avoided by the routing changes and special siting and construction procedures described in Section 3.4.2(a)(i).

During detailed engineering design and construction planning, coordination with the COE and USFWS will continue so that incorporation of proper engineering design to mitigate for potential drainage alterations is assured. The high-resolution wetlands mapping currently available, along with color aerial photographs, will be an important tool in this regard. Proper engineering design and construction planning for wetland areas are considered to be a top-priority component of the project civil engineering program.

During detailed alignment studies for the transmission corridors, project engineers, hydrologists, and environmental specialists will inspect the corridors from the air and ground and make site-specific alignment adjustments to minimize wetland and floodplain crossings. No fill placement will be associated with transmission corridor construction.

As explained in Section 3.3.1(b)(iii), regulated flows may produce changes in vegetation distribution and successional patterns in the downstream floodplain. These changes will be monitored during the postconstruction years of the license period in conjunction with ongoing studies of moose, raptors, and other wildlife. Downstream aerial photography of the floodplain will be conducted at ten-year intervals to document and facilitate analysis of floodplain configuration and vegetation changes in coordination with hydrology and wildlife monitoring.

The effect of fire as a natural process in regulating patterns of plant succession was discussed in Section 3.3.1(b)(v). Fire control will be the responsibility of resource management agencies with jurisdiction over public lands of the project area. Plans and procedures for subsequent controlled burning by the Applicant as a habitat-enhancement measure will be closely coordinated with the BLM and ADNR.

3.4.3 - Mitigation Summary (**)

As discussed in Section 3.4.2, project impacts to vegetation will be important mainly from the standpoint of loss of wildlife habitat. Therefore, mitigation plans for botanical resources have been determined primarily to support the wildlife mitigation program. Major mitigation plan elements described in Section 3.4.2 are as follows.

(1) Minimizing facility dimensions.

(2) Consolidating structures.

(3) Siting facilities in areas of low biomass to minimize clearing.

(4) Siting facilities to minimize clearing of less abundant vegetation types.

(5) Siting facilities to minimize clearing of vegetation types productive as wildlife habitat components.

(6) Minimizing volume requirements for borrow extraction, minimizing the areal extent of borrow sites, locating borrow and quarry sites close to the dams, and avoiding high quality wildlife habitat areas for borrow sites.

(7) Disposal of spoil within the impoundments or previously excavated areas.

(8) Selective cutting of trees and to accommodate uncleared low shrub and tundra vegetation within transmission rights-of-way.

(9) Dismantling nonessential structures as soon as they are vacated.

(10) Development of a comprehensive site rehabilitation plan.

(11) Monitoring progress of rehabilitation to identify locations requiring further attention.

(12) Dedication of lands for implementation of habitat enhancement measures.

(13) Planning and development of an environmental briefings program for all field personnel.

(14) Avoidance of the Prairie Creek, Stephan Lake, Fog Lakes, and Indian River areas by access routing.

(15) Restriction of public use of project access road during construction.

(16) Possible regulatory designations and measures to discourage use of ORVs and ATVs.

(17) Phased implementation of the project Recreation Plan.

(18) Siting and alignment of all facilities to avoid wetlands to the maximum extent feasible.

(19) Agency coordination and participation in detailed engineering design and construction planning of civil engineering measures to minimize potential wetlands impacts.

A summary of agency consultation is provided in Section 4.4.4.

TABLES

TABLE E.3.3.1: VASCULAR PLANT SPECIES IN THE WATANA AND GOLD CREEK WATERSHEDS AND DOWNSTREAM FLOODPLAIN WHICH ARE OUTSIDE THEIR RANGE AS REPORTED BY HULTEN (1968)

Middle and Upper Basin Extensions:	
Equisetum fluviatile	Swamp horsetail
Lycopodium selago ssp. *selago*	Fir clubmoss
Lycopodium complanatum	Ground cedar
*Picea mariana*1/	Black spruce
Carex filifolia	Thread-leaf sedge
Danthonia intermedia	Timber oatgrass
Luzula wahlenbergii	Wahlenberg woodrush
Veratrum viride	Hellebore
*Listera cordata*2/	Heart-leaved twinblade
Platathera convallariaefolia	Northern bog-orchid
Platathera hyperborea	Northern bog-orchid
Platathera dilatata	White bog-orchid
Echinopanax horridum	Devil's club
Senecio sheldonensis	Sheldon groundsel
*Myrica gale*1/	Sweet gale
Ranunculus occidentalis	Western buttercup
Potentilla biflora	Two-flower cinquefoil
*Rubus idaeus*1/	Raspberry
Rubus pedatus	Five-leaf bramble
Pedicularis kanei ssp. kanei	Kane lousewort
Pedicularis parvilflora	Lousewort
Potamogeton robbinsii	Robbins pondweed
Downstream Extensions:	
Echinopanax horridum	Devil's club
*Rubus idaeus*3/	Raspberry
Scirpus microcarpus	Small-fruit bullrush
Galium triflorum	Sweet-scented bedstraw
Alnus tenuifolia	Thinleaf alder
Circaea alpina	Enchanter's nightshade
Actaea rubra	Baneberry
*Ribes hudsonianum*3/	Northern black currant
Arnica chamissonis	Arnica

1/ Viereck and Little (1972) include the upper Susitna River basin in the range of this species.

2/ This species was recorded by the bird and small mammal survey group from the University of Alaska Museum.

3/ Viereck and Little (1972) include the downstream area in the range of this species.

Source: McKendrick et al. 1982

TABLE E.3.3.2: CANDIDATE ENDANGERED AND THREATENED PLANT TAXA[1/] SOUGHT IN THE WATANA AND GOLD CREEK WATERSHED SURVEYS WITH NOTES ON THEIR HABITATS AND KNOWN LOCALITIES

Species and Habitat	Unofficial Status[2/]
Smelowskia pyriformis Drury & Rollins North American endemic calcareous scree, talus, in upper Kuskokwim R. drainage	Threatened species
Aster yukonesis Cronq. North American endemic river banks, dry steambeds, river delta sands and gravels Kluane Lake, Koyukuk River	Endangered species
Montia bostockii (A. E. Porsild) S. L. Welsh North American endemic wet, alpine meadows, St. Elias Mtns., Wrangell Mtns.	Endangered species
Papaver alboroseum Hult. Amphi-Berlingian well-drained alpine tundra, Wrangell Mtns., S. Elias Mtns. Cook INlet lowlands, Alaska Range	Endangered species
Podistera yukonensis Math & Const. North American endemic S.-facing rocky slopes, grasslands at low elevations, Eagle area, Yukon border	Endangered species
Smelowskia borealis (Greene) Drury & Rollins var. villosa North American endemic alpine calcareous scree, Denali National Park, Alaska Range	Endangered species
Taraxacum carneocoloratum Nels. North American endemic alpine rocky slopes, Alaska Range, Yukon Ogilvie Mtns.	Endangered species
Other Endangered Species Possibilities	
Cryptantha shackletteana	Upper Yukon River
Eriogonum flavum var. aquilinum	Eagle, Alaska
Erysimum asperum var. angustatum	Upper Yukon River

1/ Information and status from Murray (1980).

2/ All species are under review by the U.S. Fish & Wildlife Service for inclusion in the Endangered Species Act of 1973.

Source: McKendrick et al. 1982

TABLE E.3.3.3: VEGETATION TYPES (AND SAMPLE LOCATION NUMBERS) SAMPLED IN WATANA AND GOLD CREEK WATERSHEDS

Vegetation Type	Sample Location Number[1/]
Mat and cushion tundra	1-8
Sedge-grass tundra	9-10
Herbaceous tundra	11
Wet sedge-grass tundra	12-14
Open black spruce	15-17
Woodland black spruce	18-22
Open white spruce	23-27
Woodland white spruce	28
Closed birch forest	29-32
Open birch forest	33-34
Closed balsam poplar	35-36
Open balsam poplar	37
Closed aspen	38
Closed mixed conifer-deciduous forest	39-41
Open mixed conifer-deciduous forest	42-49
Closed tall shrub	50-52
Open tall shrub	53
Mixed low shrub	54-62
Willow shrub	63-64

1/ Sample locations are given in Figure E.3.3.13.

Source: McKendrick et al. 1982

TABLE E.3.3.4: ACRES OF EACH VEGETATION TYPE IN THE VEGETATION MAPPING AREA (See Figure E.3.3.3)

Vegetation Type	Area	% of Total Area
Conifer Forest		
White Spruce	33,895	2.1
Black Spruce	25,067	1.6
Black & White Spruce	148,996	9.3
White Spruce Woodland	37,444	2.3
Black Spruce Woodland	819	0.1
Black & White Spruce Woodland	24,915	1.6
	271,136	17.0
Broadleaf Forest		
Paper Birch	5,852	0.4
Birch - Aspen	2,257	0.1
Other Broadleaf	3,710	0.3
Broadleaf Woodland	1,420	0.1
	13,239	0.8
Mixed Forest		
Spruce - Birch	94,031	5.9
Spruce - Birch - Poplar	1,215	0.1
Spruce - Birch - Aspen	3,614	0.2
Spruce - Poplar	2,726	0.2
Mixed Woodland	8,819	0.5
	110,405	6.9
Dwarf Tree Scrub		
Conifer	37,703	2.4
Other Tree Shrub	220	+2/
	37,923	2.4
Tall Shrub		
Alder	73,915	4.6
Other Tall Shrub	12,650	0.8
	86,565	5.4
Low Shrub		
Dwarf Birch	136,115	8.5
Low Willow	149,736	9.4
Ericaceous Shrub	8,006	0.5
Dwarf Birch - Low Willow	248,829	15.6
Dwarf Birch - Ericaceous Shrub	136,120	8.5
Other Low Shrub	597	+
	679,403	42.6
Dwarf Shrub	238,248	14.9
Graminoid Herbaceous		
Wet	10,621	0.7
Mesic	3,550	0.2
Dry	115	+
	14,286	0.9
Forb & Bryoid Herbaceous	208	+
Sparse Vegetation	38,324	2.4
Barren	74,043	4.6
Water	31,671	2.0
Cultural - Urban Developed	110	+
TOTAL	1,595,561	

1/ Based on the Viereck et al. (1982) classification system with modifications (see text). Although complexes were mapped in many cases, only the major component was considered here in order to simplify the table. Also, all closed and open types in the forest, scrub, and shrub categories were combined.

2/ + indicates less than 0.05.

TABLE E.3.3.5: ACTUAL R.A. KREIG MAPPING UNITS (BASED ON 1984 REVISIONS TO VIERECK ET AL. 1982), COMPARED TO COMBINED TYPES USED FOR SUMMARY TABLES IN THIS DOCUMENT

Mapping Units	Summary Table Types
Conifer Forest	
Closed White Spruce	White Spruce
Open White Spruce	
Closed Black Spruce	Black Spruce
Open Black Spruce	
Closed Black & White Spruce	Black & White Spruce
Open Black & White Spruce	
Woodland White Spruce	White Spruce Woodland
Woodland Black Spruce	Black Spruce Woodland
Woodland Black & White Spruce	Black & White Spruce Woodland
Broadleaf Forest	
Closed Paper Birch	Paper Birch
Open Paper Birch	
Closed Birch - Aspen	Birch - Aspen
Open Birch - Aspen	
Closed Balsam Poplar	Other Broadleaf
Open Balsam Poplar	
Closed Aspen	
Open Aspen	
Closed Birch - Poplar	
Open Birch - Poplar	
Woodland Balsam Poplar	Broadleaf Woodland
Woodland Paper Birch	
Woodland Birch - Poplar	
Mixed Forest	
Closed Spruce - Birch	Spruce - Birch
Open Spruce - Birch	
Closed Spruce - Birch - Poplar	Spurce - Birch - Poplar
Open Spruce - Birch - Poplar	
Closed Spruce - Birch - Aspen	Spruce - Birch - Aspen
Open Spruce - Birch - Aspen	
Closed Spruce - Poplar	Spruce - Poplar
Open Spruce - Poplar	
Woodland Spruce - Birch	Mixed Woodland
Woodland Spruce - Poplar	
Woodland Spruce - Birch - Aspen	

TABLE E.3.3.5 (Page 2 of 3)

Mapping Units	Summary Table Types
Dwarf Tree Scrub	
Closed Conifer	Conifer
Open Conifer	
Woodland Conifer	
Open Broadleaf	Other Tree Scrub
Woodland Mixed	
Tall Shrub	
Closed Alder	Alder
Open Alder	
Closed Willow	Other Tall Shrub
Open Willow	
Closed Alder - Willow	
Open Alder - Willow	
Open Shrub Birch	
Open Shrub Birch - Willow	
Open Shrub Birch - Ericaceous Shrub	
Low Shrub	
Closed Dwarf Birth	Dwarf Birch
Open Dwarf Birch	
Closed Dwarf Birch - Grass	
Open Dwarf Birch - Grass	
Closed Low Willow	Low Willow
Open Low Willow	
Closed Low Willow - Grass	
Open Low Willow - Grass	
Closed Ericaceous Shrub Tundra	Ericaceous Shrub
Open Ericaceous Shrub - Grass	
Closed Dwarf Birch - Low Willow	Dwarf Birch - Low Willow
Open Dwarf Birch - Low Willow	
Closed Dwarf Birch - Low Willow-Grass	
Open Dwarf Birch - Low Willow-Grass	
Closed Dwarf Birch - Ericaceous Shrub	Dwarf Birch - Ericaceous Shrub
Open Dwarf Birch - Ericaceous Shrub	
Closed Dwarf Birch - Ericaceous Grass	
Open Dwarf Birch - Ericaceous Grass	
Closed Low Alder	Other Low Shrub
Open Low Alder	
Closed Low Alder - Low Willow	
Open Low Alder - Low Willow	

TABLE E.3.3.5 (Page 3 of 3)

Mapping Units	Summary Table Types
<u>Dwarf Shrub</u>	
Closed Dwarf Shrub	Dwarf Shrub
Open Dwarf Shrub	
Closed Dwarf Ericaceous Shrub	
Open Dwarf Ericaceous Shrub	
Closed Dwarf Willow	
Open Dwarf Willow	
Closed Mat & Cushion - Grass	
Open Mat & Cushion - Grass	
Open Dwarf Birch - Ericaceous Shrub	
<u>Graminoid Herbaceous</u>	
Wet	Wet
Mesic	Mesic
Dry	Dry
<u>Dry Forb Herbaceous</u>	Other Herbaceous
<u>Lichen Bryoid Herbaceous</u>	
<u>Sparse Vegetative</u>	
Forest	Sparse Vegetation
Scrub	
Herbaceous	
<u>Barren</u>	
Barren	Barren
Barren - Bedrock	
<u>Cultural - Urban Developed</u>	Cultural - Urban Developed
<u>Water</u>	Water

TABLE E.3.3.6: COMPARISON OF 1:63,360 VEGETATION MAPPING UNITS USED BY R.A. KREIG (1985) AND McKENDRICK ET AL. (1982).

(Page 1 of 3)

			Kreig Units[1]	McKendrick Units[2]	
1. Forest	A. Conifer	1. Closed (60-100%)	K) White Spruce L) Black Spruce M) Black & White Spruce	Closed Spruce (50-100%)	
		2. Open (25-60%)	F) White Spruce G) Black Spruce H) Black & White Spruce	Open Spruce (25-50%)	a) White b) Black
		3. Woodland (10-25%)	C) White Spruce D) Black Spruce E) Black & White Spruce	Woodland Spruce (10-25%)	a) White b) Black
	B. Broadleaf	1. Closed (60-100%)	B) Black Cottonwood C) Balsam Poplar D) Paper Birch E) Aspen F) Birch - Aspen	Closed Deciduous (50-100%)	a) Balsam poplar b) Paper birch
		2. Open (25-60%)	A) Paper Birch B) Aspen C) Balsam Poplar D) Paper Birch - Poplar	Open Deciduous (25-50%)	a) Birch b) Poplar
		3. Woodland (10-25%)	A) Paper Birch B) Poplar C) Paper Birch - Poplar		
	C. Mixed	1. Closed (60-100%)	A) Spruce - Birch B) Spruce - Birch - Poplar C) Spruce - Birch - Aspen D) Aspen - Spruce E) Spruce - Poplar	Closed Mixed Forest (50-100%)	
		2. Open (25-60%)	A) Spruce - Birch B) Aspen - Spruce C) Spruce - Birch - Poplar D) Spruce - Poplar	Open Mixed Forest (25-50%)	
		3. Woodland (10-25%)	A) Spruce - Birch B) Spruce - Poplar C) Spruce - Birch - Poplar	Woodland Mixed Forest (10-25%)	
2. Scrub	A. Dwarf Tree (<5m)	Conifer			
		1. Closed (60-100%)		Closed Spruce (50-100%)	
		2. Open (25-60%)		Open Spruce (25-50%)	
		3. Woodland (10-25%)		Woodland Spruce (10-25%)	
		Broadleaf			
		1. Closed (60-100%)		Closed Deciduous (50-100%)	
		2. Open (25-60%)		Open Deciduous (25-50%)	

			Kreig Units[1/]	McKendrick Units[2/]	
		3. Woodland (10-25%)			
	Mixed	1. Closed (60-100%)		Closed Mixed Forest (50-100%)	
		2. Open (25-60%)		Open Mixed Forest (25-50%)	
		3. Woodland (10-25%)		Woodland Mixed Forest (10-25%)	
	B. Tall Shrub	1. Closed (75-100%) (>1.5m)	A) Willow		a) Willow
			B) Alder	Closed Tall Shrub (50-100%)	
			C) Shrub Birch		c) Birch
			D) Alder - Willow	Closed Tall Shrub	
			E) Shrub Birch - Willow		
			*) Alder - Shrub Birch - Willow	Closed Tall Shrub	
		2. Open (25-75%) (>1.5m)	A) Willow		a) Willow
			B) Alder	Open Tall Shrub (10-50%)	
			C) Shrub Birch		b) Birch
			D) Alder - Willow	Open Tall Shrub	
			E) Shrub Birch - Willow		
			*) Alder - Shrub Birch	Open Tall Shrub	
	C. Low Shrub	1. Closed (75-100%)	A) Dwarf Birch	Low Shrub	a) Birch
			B) Low Willow		b) Willow
			C) Dwarf Birch - Low Willow		
			D) Ericaceous Shrub Tundra		
		2. Open (25%-75%) (<1.5m)	A) Dwarf Birch	Low Shrub (10-100%)	
			B) Low Willow		
			C) Dwarf Birch - Willow		
			D) Low Alder		
			J) Ericaceous Shrub - Sphagnum Bog	Sedge Shrub Tundra (<10% Low Shrub)	
			S) Willow Grass Tundra		
			T) Birch & Ericaceous Shrub		
			*) Ericaceous Shrub		
			*) Ericaceous Shrub-Grass		
			*) Birch-Ericaceous-Grass	Low Shrub (10-100%)	
			*) Birch - Willow - Grass		
	D. Dwarf Shrub (<20cm)	1. Closed (75-100%)			
			A) Mat & Cushion - Sedge	Mat and Cushion Tundra	
			B) Mat & Cusion - Grass		
			D) Cassiope	Sedge Shrub Tundra (<10% low shrub) (<30cm tall)	
			G) Low Ericaceous Shrub		
		2. Open (25-75%)	E) Low Willow		
			*) Ericaceous Shrub		
3. Herbaceous	A. Graminoid	1. Dry		Grassland	
		2. Mesic		Sedge Grass Tundra	
		3. Wet		Wet Sedge Grass	
			A) Wet Sedge Meadow		

			Kreig Units[1/]	McKendrick Units[2/]
			C) Wet Sedge - Herb M) Sedge - Moss Bog	
	B. Forb	1. Dry	C) Alpine Herbs	Herbaceous
		2. Mesic 3. Wet		
	C. Bryoid	1. Mosses 2. Lichens		
	D. Aquatic	1. Fresh water		Lacustrine Emergent
4. Sparse Vegetation (5-10%)	A. Forest			Palustrine Forested
	B. Scrub			Palustrine Scrub-Shrub
	C. Herbaceous			Palustrine Emergent
5. Barren (<5%)				Snow and Ice
	A. Bedrock			Rock
6. Cultural-Urban Developed				Disturbed, Developed
7. Agricultural				Crop
8. Water				Lakes and Streams

1/ Based on the Viereck et al. (1982) classification system incorporating modifications from the Alaska Vegetation Classification Workshop (February 21, 1984) and this mapping project. Although complexes were mapped in many cases, only the major component was considered here in order to simplify the table. Also, all closed and open types in the forest, scrub, and shrub categories were combined.

2/ Based on Viereck and Dyrness (1980)

TABLE E.3.3.7: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN OPEN CONIFER VEGETATION TYPE[1] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2] (percent)
Total vegetation		98
Overstory (>10 cm dbh)		24
Picea glauca	White spruce	24
Picea mariana	Black Spruce	2
Understory (2.5 - 10 cm dbh)		10
Picea glauca	White spruce	3
Picea mariana	Black spruce	2
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	1
Picea mariana	Black spruce	3
Ground layer (<0.5 m tall)		94
Mosses, unidentified		11
Feather Mosses	Feather moss	29
Ptilium spp.		13
Empetrum Nigrum	Crowberry	6
Ledum decumbens	Northern Labrador tea	5
Vaccinium uliginosum	Bog blue berry	7
Vaccinium vitis-idaea	Mountain cranberry	6
Equisetum arvense	Meadow horsetail	6
Equisetum silvaticum	Woodland horsetail	8
Linnaea borealis	Twinflower	8
Picea mariana	Black spruce	1
Calamagrostis canadensis	Bluejoint	14

1/ Number of areas sampled was 9.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.8: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN OPEN WHITE SPRUCE VEGETATION TYPE 1/ IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover 2/ (percent)
Total vegetation		100
Overstory (>10 cm dbh)		35
Pica glauca	White spruce	35
Understory (2.5 - 10 cm dbh)		11
Picea glauca	White spruce	3
Alnus sinuata	Sitka alder	6
Shrub layer (>0.5 m tall, <2.5 cm dbh)		4
Picea glauca	White spruce	1
Alnus crispa	American green alder	4
Rosa acicularis	Pri kly rose	3
Ground layer (<0.5 m tall)		94
Feather mosses	Feather moss	30
Ptilium spp.		24
Equisetum arvense	Meadow horsetail	11
Equisetum silvaticum	Woodland horsetail	6
Linnaea borealis	Twinflower	15
Betula glandulosa	Resin birch	6
Rosa acicularis	Prickly rose	5
Calamagrostis canadensis	Bluejoint	23

1/ Number of areas sampled was 5.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.9: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN OPEN BLACK SPRUCE VEGETATION TYPE[1] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2] (percent)
Total vegetation		96
Overstory (>10 cm dbh)		14
Picea glauca	White spruce	13
Picea mariana	Black spruce	5
Understory (2.5 - 10 cm dbh)		10
Picea glauca	White spruce	4
Picea mariana	Black spruce	5
Shrub layer (>0.5 m tall, <2.5 cm dbh)		7
Picea mariana	Black spruce	8
Salix spp.	Willow	2
Ground layer (<0.5 m tall)		93
Mosses, unidentified		34
Feather mosses	Feather moss	30
Cladonia spp.		7
Empetrum nigrum	Crowberry	14
Ledum decumbens	Northern Labrador tea	14
Vaccinium uliginosum	Bog blueberry	10
Vaccinium vitis-idaea	Mountain cranberry	15
Equisetum silvaticum	Woodland horsetail	12
Salix spp.	Willow	7
Picea mariana	Black spruce	4

1/ Number of areas sampled was 3.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.10: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN WOODLAND CONIFER VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		99
Overstory (>10 cm dbh)		1
Pica glauca	White spruce	
Understory (2.5 - 10 cm dbh)		12
Picea mariana	Black spruce	11
Shrub layer (>0.5 m tall, <2.5 cm dbh)		17
Picea mariana	Black spruce	15
Ground layer (<0.5 m tall)		93
Feather mosses	Feather moss	5
Sphagnum spp.	Sphagnum moss	62
Empetrum nigrum	Crowberry	8
Ledum decumbens	Northern Labrador tea	5
Ledum groenlandicum	Labrador tea	5
Vaccinium uliginosum	Bog blueberry	23
Equisetum silvaticum	Woodland horsetail	10
Rubus arcticus	Nagoonberry	15
Rubus chamaemorus	Cloudberry	5
Picea mariana	Black spruce	3
Carex bigelowii	Bigelow sedge	7
Carex spp.	Sedge	6

1/ Number of areas sampled was 6.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.11: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN CLOSED BIRCH DECIDUOUS FOREST VEGETATION TYPE[1] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2] (percent)
Total vegetation		99
Overstory (>10 cm dbh)		80
Pica glauca	White spruce	1
Populus balsamifera	Balsam poplar	75
Understory (2.5 - 10 cm dbh)		5
Populus balsamifera	Balsam poplar	5
Shrub layer (>0.5 m tall, <2.5 cm dbh)		10
Populus balsamifera	Balsam poplar	5
Ground layer (<0.5 m tall)		85
Ptilium spp.		20
Polytrichum spp.		5
Empetrum nigrum	Crowberry	30
Ledum decumbens	Northern Labrador tea	40
Vaccinium uliginosum	Bog blueberry	40
Vaccinium vitis-idaea	Mountain cranberry	20
Cornus canadensis	Bunchberry	40
Populus balsamifera	Balsam poplar	1
Spiraea beauverdiana	Beauverd spiraea	5

1/ Number of areas sampled was 1.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.12: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN CLOSED BIRCH DECIDUOUS FOREST VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		99
Overstory (>10 cm dbh)		73
Picea glauca	White spruce	8
Betula papyrifera	Paper birch	68
Understory (2.5 - 10 cm dbh)		9
Picea glauca	White spruce	5
Betula papyrifera	Paper birch	3
Shrub layer (>0.5 m tall, <2.5 cm dbh)		3
Picea glauca	White spruce	1
Betula papyrifera	Paper birch	3
Ground layer (<0.5 m tall)		95
Ptilium spp.		15
Polytrichum spp.		5
Vaccinium uliginosum	Bog blueberry	15
Vaccinium vitis-idaea	Mountain cranberry	5
Equisetum silvaticum	Woodland horsetail	10
Cornus canadensis	Bunchberry	16
Calamagrostis canadensis	Bluejoint	38
Gymnocarpium dryopteris	Oak-fern	20
Mertensia paniculata	Tall bluebell	10

1/ Number of areas sampled was 2.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.13: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN CLOSED ASPEN DECIDUOUS VEGETATION TYPE[1] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2] (percent)
Total vegetation		99
Overstory (>10 cm dbh)		80
Betula papyrifera	Paper birch	5
Populus tremuloides	Trembling aspen	80
Understory (2.5 - 10 cm dbh)		5
Betula papyrifera	Paper birch	5
Populus tremuloides	Trembling aspen	5
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	5
Betula papyrifera	Paper birch	5
Betula glandulosa	Resin birch	5
Rosa acicularis	Prickly rose	5
Salix spp.	Willow	5
Populus tremuloides	Trembling aspen	5
Ground layer (<0.5 m tall)		85
Ptilium spp.		5
Polytrichum spp.		5
Ledum decumbens	Northern Labrador tea	20
Vaccinium uliginosum	Bog blueberry	10
Linnaea borealis	Twinflower	5
Cornus canadensis	Bunchberry	80
Mertensia paniculata	Tall bluebell	5
Epilobium angustifolium	Fireweed	5
Geocaulon lividum	Sandalwood	5
Spiraea beauverdiana	Beauverd spiraea	5
Vaccinium vitis-idaea	Mountain cranberry	10
Betula nana	Dwarf arctic birch	5
Viburnum edulis	Highbush cranberry	5
Lycopodium annotinum	Stiff clubmoss	5
Lycopodium clavatum	Running clubmoss	5

1/ Number of areas sampled was 1.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982.

TABLE E.3.3.14: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN OPEN MIXED CONIFER-DECIDUOUS FOREST VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		100
Overstory (>10 cm dbh)		38
Picea glauca	White spruce	20
Betula papyrifera	Paper birch	12
Understory (2.5 - 10 cm dbh)		7
Picea glauca	White spruce	5
Betula papyrifera	Paper birch	1
Shrub layer (>0.5 m tall, <2.5 cm dbh)		17
Picea glauca	White spruce	2
Betula papyrifera	Paper birch	2
Salix novae-angliae	Tall blueberry willow	11
Ground layer (<0.5 m tall)		79
Feather mosses	Feather moss	18
Ptilium spp.		34
Empetrum nigrum	Crowberry	6
Ledum decumbens	Northern Labrador tea	6
Vaccinium uliginosum	Bog blueberry	16
Vaccinium vitis-idaea	Mountain cranberry	9
Equisetum silvaticum	Woodland horsetail	3
Cornus canadensis	Bunchberry	13
Picea glauca	White spruce	2
Calamagrostis canadensis	Bluejoint	11
Gymnocarpium dryopteris	Oak-fern	8

1/ Number of areas sampled was 8.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982.

TABLE E.3.3.15: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN CLOSED MIXED CONIFER-DECIDUOUS FOREST VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		98
Overstory (>10 cm dbh)		60
Picea glauca	White spruce	33
Betula papyrifera	Paper birch	35
Understory (2.5 - 10 cm dbh)		8
Picea glauca	White spruce	3
Betula papyrifera	Paper birch	4
Shrub layer (>0.5 m tall, <2.5 cm dbh)		4
Picea glauca	White spruce	3
Ground layer (<0.5 m tall)		88
Ptilium spp.		40
Empetrum nigrum	Crowberry	3
Vaccinium vitis-idaea	Mountain cranberry	8
Equisetum silvaticum	Woodland horsetail	24
Cornus canadensis	Bunchberry	13
Rubus arcticus	Nagoonberry	7
Calamagrostis canadensis	Bluejoint	30

1/ Number of areas sampled was 3.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982.

TABLE E.3.3.16: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN CLOSED TALL ALDER VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		96
Understory (2.5 - 10 cm dbh)		57
Alnus sinuata	Sitka alder	25
Alnus crispa	American green alder	32
Shrub layer (>0.5 m tall, <2.5 cm dbh)		38
Alnus sinuata	Sitka alder	28
Alnus crispa	American green alder	10
Ribes spp.	Currant	8
Ground layer (<0.5 m tall)		62
Equisetum silvaticum	Woodland horsetail	31
Ribes spp.	Currant	8
Alnus sinuata	Sitka alder	7
Calamagrostis canadensis	Bluejoint	35

1/ Number of areas sampled was 3.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.17: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN OPEN TALL ALDER VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total Vegetation		85
Overstory (>10 cm dbh)		10
Picea glauca	White spruce	10
Understory (2.5 - 10 cm dbh)		45
Picea glauca	White spruce	5
Alnus sinuata	Sitka alder	40
Ground layer (<0.5 m tall)		25
Linnaea borealis	Twinflower	5
Alnus sinuata	Sitka alder	5
Calamagrostis canadensis	Bluejoint	10

1/ Number of areas sampled was 1.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.18: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN CLOSED LOW SHRUB VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		93
Shrub layer (>0.5 m tall, <2.5 cm dbh)		42
Betula glandulosa	Resin birch	10
Salix planifolia ssp. *pulchra*	Diamondleaf willow	8
Ground layer (<0.5 m tall)		52
Mosses, unidentified		17
Feather mosses	Feather moss	6
Empetrum nigrum	Crowberry	7
Ledum decumbens	Northern Labrador tea	18
Ledum groenlandicum	Labrador tea	4
Vaccinium uliginosum	Bog blueberry	8
Vaccinium vitis-idaea	Mountain cranberry	8
Arctostaphylos rubra	Red-fruit bearberry	6
Betula glandulosa	Resin birch	34
Betula nana	Dwarf arctic birch	9

1/ Number of areas sampled was 10.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.19: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN OPEN LOW SHRUB VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		100
Shrub layer (>0.5 m tall, <2.5 cm dbh)		17
Betula glandulosa	Resin birch	5
Ground layer (<0.5 m tall)		83
Feather mosses	Feather moss	13
Ledum groenlandicum	Labrador tea	5
Vaccinium uliginosum	Bog blueberry	15
Betula glandulosa	Resin birch	15
Carex aquatilis	Water sedge	43

1/ Number of areas sampled was 2.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982

TABLE E.3.3.20: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN CLOSED MAT AND CUSHION TUNDRA VEGETATION TYPE[1/] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2/] (percent)
Total vegetation		78
Ground layer (<0.5 m tall)		78
Lichens, unidentified		14
Cladonia spp.		8
Empetrum nigrum	Crowberry	8
Ledum decumbens	Northern Labrador tea	7
Vaccinium uliginosum	Bog blueberry	8
Arctostaphylos spp.	Bearberry	7
Betula glandulosa	Resin birch	6
Betula nana	Dwarf arctic birch	10

1/ Number of areas sampled was 8.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982.

TABLE E.3.3.21: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN WET SEDGE-GRASS TUNDRA VEGETATION TYPE[1] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2] (percent)
Total vegetation		99
Shrub layer (>0.5 m tall, <2.5 cm dbh)		13
Salix planifolia ssp. *pulchra*	Diamondleaf willow	8
Salix ssp.	Willow	5
Ground layer (<0.5 m tall)		86
Mosses, unidentified		20
Spaghnum spp.	Sphagnum moss	22
Salix fuscescens	Alaska bog willow	5
Calamagrostis canadensis	Bluejoint	14
Carex aquatilis	Water sedge	38
Carex bigelowii	Bigelow sedge	23

1/ Number of areas sampled was 3.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982.

TABLE E.3.3.22: COVER PERCENTAGES FOR TOTAL VEGETATION, VERTICAL STRATA, AND PLANT SPECIES IN MESIC SEDGE-GRASS TUNDRA VEGETATION TYPE[1] IN WATANA AND GOLD CREEK WATERSHEDS

Category		Average Cover[2] (percent)
Total vegetation		65
Ground layer (<0.5 m tall)		65
Polytrichum spp.	Hairy-cap moss	5
Salix spp.	Willow	13
Carex bigelowii	Bigelow sedge	30
Carex spp.	Sedge	4

1/ Number of areas sampled was 2.

2/ Includes only those species with at least 5 percent cover in any one area sampled.

Source: McKendrick et al. 1982.

TABLE E.3.3.23: AQUATIC PLANT SURVEY, SUSITNA HYDROELECTRIC PROJECT, AUGUST 1980 (Page 1 of 3)

SPECIES "TRUE" AQUATICS	Pond or Lake (#)																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<u>Climacium</u> sp. -- Moss															d[1/]				c					
<u>Isoetes</u> <u>muricata</u> -- Quillwort											s													
<u>Equisetum</u> <u>fluviatile</u> -- Horsetail	d	d	d					c										d				s		s
<u>Sparganium</u> <u>angustifolium</u> -- Burreed	c	d	d	d			d			d	d	c	d	c		c	d	s			s	c	c	c
<u>Potamogeton</u> sp. -- Pondweed (narrow-leaved)		c					c	s																
<u>Potamogeton</u> sp. -- Pondweed (broad-leaved)								s										s				c		d
<u>Potamogeton</u> <u>robbinsii</u> -- Pondweed																				d				
<u>Potamogeton</u> <u>filiformis</u> -- Pondweed																			s		s			
<u>Eriophorum</u> spp. -- Cotton grass																		s						
<u>Carex</u> <u>aquatilis</u> -- Sedge	d	d			c	c		d	d								c	d						
<u>Nuphar</u> <u>polysepalum</u> -- Yellow pond lily		c				d	d	d	d	d	c	d	d	d		d	c		d		d	d	d	d
<u>Ranunculus</u> <u>confervoides</u> -- Buttercup		c		d		d		s		s					s	s								
<u>Potentilla</u> <u>palustris</u> -- Marsh fivefinger										s														
<u>Callitriche</u> <u>verna</u> -- Water starwort															d									
<u>Hippuris</u> <u>vulgaris</u> -- Mare's tail							c			c	s				d		c		c		s	s		s
<u>Menyanthes</u> <u>trifoliata</u> -- Buckbean																							s	
<u>Utricularia</u> <u>vulgaris</u> -- Bladderwort											c	d		c	c	d	d				s		s	d

[1/] d = dominant
c = common
s = sparse

TABLE E.3.3.23 (Page 2 of 3)

SPECIES "BANK" SPECIES	Pond or Lake (#) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Sphagnum spp. -- Sphagnum moss															c	[1]d							d	
Equisetum fluviatile -- Horsetail		d	d					d		s														
Woodsia sp. -- Woodsia												s												
Calamagrostis canadensis -- Reed bent grass				d	d			d		c							c							s
Eriophorum spp. -- Cottongrass				d	d	c			d			d	d	c				s			d		c	
Carex sp. -- Sedge						d							d								d			
Carex aquatilis -- Sedge		d	d	d	d	d	d	d	d	d		d	s	d	d	d	d	d		d	d	d	d	
Carex rhyncophysa -- Sedge			s														s							
Iris setosa -- Iris		s																						
Salix sp. -- Willow					c							s												s
Potentilla palustris -- Marsh fivefinger				c	d		c	c		d		c			c	d	c	s	s			c	d	c
Andromeda polifolia -- Andromeda					c																			
Menyanthes trifoliata -- Buckbean		s						c		c			d								s		c	

[1] d = dominant
c = common
s = sparse

Source: McKendrick et al. 1982

ABLE E.3.3.23: (Page 3 of 3)

	Pond or Lake #																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	2
otal over(%)	<1	<5	– 2/	0-1	–	–	10-20	<5	–	0-5	0-1	1-5	1-2	80-90	80-100	50-60	1-5	0-1	5-10	40-50	15	20-30	20-35	10-
urrounding etland idth eet)	0	7-10	–	10-20	20-30	10-20	10-20	7-30	–	50-100	0-10	50-80	50-100	50-100	50-80	100-150	10-50	3-7	7-10	0	20-30	40-50	10-20	7-
levation eet)	1950	1700	2300	2300	2180	2180	2800	1950	1950	1975	2300	2280	2410	2340	1850	2300	2060	2750	1800	3000	2250	2560	2575	25

/ data not recorded

Source: McKendrick et al. 1982

TABLE E.3.3.24: PERCENT COVER IN EARLY SUCCESSIONAL STANDS[1/] ON DOWNSTREAM FLOODPLAIN OF SUSITNA RIVER

Category		Mean Cover (Percent)
Physical Features		
Water		+[2/]
Bare ground		53
Gravel, cobbles		2
Vegetation Categories		
Litter		13
Standing dead		+
Perennial grasses		1
Perennial forbs		25
Mosses		+
Lichens		+
Low shrubs		4
Tall shrubs		+
Trees		8
Total vegetation		38
Vegetation by Species or Genus		
Equisetum variegatum	Variegated horsetail	25
Populus balsamifera	Balsam poplar	8
Salix alaxensis	Feltleaf willow	4
Salix novae-angliae	Tall blueberry willow	1
Salix arbusculoides	Little tree willow	+
Salix sp.	Willow	+
Astragalus sp.	Milk-vetch	+
Hedysarum sp.	Sweet-vetch	+
Calamagrostis canadensis	Bluejoint	+
Eriophorum sp.	Cottongrass	+
Scirpus sp.	Bullrush	+
Alnus tenuifolia	Thinleaf alder	+
Alnus sinuata	Sitka alder	+
Artemisia telesii	Wormwood	+
Nephroma sp.	Nephroma	+

1/ Early successional stands were numbers 1, 5, 6, 8, 9, 13, 14, 15, 20, 21, 22 and 25 shown in Figure E.3.3.4. Number of transects sampled was 42.

2/ Less than 1 percent cover.

Source: McKendrick et al. 1982

TABLE E.3.3.25: PERCENT COVER IN ALDER STANDS[1/] ON DOWNSTREAM FLOODPLAIN OF SUSITNA RIVER

Category		Mean Cover (Percent)
<u>Physical Features</u>		
Bare ground		1
Litter		99
<u>Vegetation Categories</u>		
Standing dead		+[2/]
Perennial grasses		38
Perennial forbs		11
Mosses		+
Lichens		+
Low shrubs		6
Tall shrubs		60
Trees		13
Total vegetation		87
<u>Vegetation by Species or Genus</u>		
Calamagrostis canadensis	Bluejoint	38
Alnus tenuifolia	Thinleaf alder	59
Alnus sinuata	Sitka alder	3
Viburnum edule	Highbush cranberry	1
Epilobium angustifolium	Fireweed	3
Populus balsamifera	Balsam poplar	13
Artemisia tilesii	Wormwood	3
Salix alaxensis	Feltleaf willow	5
Salix novae-angliae	Tall blueberry willow	+
Salix sp.	Willow	+
Stellaria sp.	Starwort	+
Epilobium latifolium	Dwarf fireweed	+
Rosa acicularis	Prickly rose	+
Ribes spp.	Currant	+
Hedysarum sp.	Sweet-vetch	+
Rubus arcticus	Nagoonberry	+
Rubus idaeus	Raspberry	+
Trientalis europaea	Arctic starflower	+
Galium sp.	Bedstraw	+
Poa sp.	Bluegrass	+

1/ Alder stands were numbers 2, 19, 23, and 27 shown in Figure E.3.3.4. Number of transects sampled was 20.

2/ Less than 1 percent cover.

Source: McKendrick et al. 1982

TABLE E.3.3.26: PERCENT COVER IN IMMATURE BALSAM POPLAR STANDS[1] ON DOWNSTREAM FLOODPLAIN

Category		Mean Cover (Percent)
Physical Features		
Vegetation Categories		
Litter		95
Standing dead		+[2]
Perennial grasses		23
Perennial forbs		9
Mosses		+
Low shrubs		6
Tall shrubs		48
Trees		62
Total vegetation		91
Vegetation by Species or Genus		
Populus balsamifera	Balsam poplar	62
Alnus tenuifolia	Thinleaf alder	40
Alnus sinuata	Sitka alder	8
Calamagrostis canadensis	Bluejoint	23
Viburnum edule	Highbush cranberry	3
Artemisia tilesii	Wormwood	3
Heracleum lanatum	Cow parsnip	1
Mertensia paniculata	Tall bluebell	1
Rosa acicularis	Prickly rose	3
Picea glauca	White spruce	+
Salix novae-angliae	Tall blueberry willow	+
Pyrola secunda	One-sided wintergreen	+
Pyrola sp.	Wintergreen	+
Rubus idaeus	Raspberry	+
Sanguisorba stipulata	Sitka burnet	+
Galium sp.	Bedstraw	+
Matteuccia struthiopteris	Ostrich fern	+
Streptopus amplexicaulis	Cucumber-root	+

1/ Immature balsam poplar stands were numbers 10, 12, and 26 shown in Figure E.3.3.4. Number of transects sampled was 18.

2/ Less than 1 percent cover.

Source: McKendrick et al. 1982

TABLE E.3.3.27: PERCENT COVER IN BIRCH-SPRUCE STANDS[1/] ON DOWNSTREAM FLOODPLAIN, SUMMER 1981.

Category		Mean Cover (Percent)
Vegetation Categories		
Litter		100
Standing dead		+[2/]
Perennial grasses		18
Perennial forbs		44
Mosses		1
Low shrubs		40
Tall shrubs		14
Trees		52
Total vegetation		93
Vegetation by Species or Genus		
Betula papyrifera	Paper birch	42
Picea glauca	White spruce	12
Alnus tenuifolia	Thinleaf alder	10
Alnus sinuata	Sitka alder	5
Viburnum edule	Highbush cranberry	19
Ribes spp.	Currant	5
Rosa acicularis	Prickly rose	20
Calamagrostis canadensis	Bluejoint	18
Dryopteris dilatata	Spinulose shield-fern	7
Gymnocarpium sp.	Oak-fern	4
Echinopanax horridum	Devil's club	4
Cornus canadensis	Bunchberry	1
Mertensia paniculata	Tall bluebell	1
Rubus idaeus	Raspberry	3
Epilobium angustifolium	Fireweed	1
Epilobium latifolium	Dwarf fireweed	+
Salix novae-angliae	Tall blueberry willow	+
Rubus sp.	Bramble	+
Rubus arcticus	Nagoonberry	+
Trientalis europaea	Arctic starflower	+

1/ Birch-spruce stands were numbers 4, 11, and 29 shown in Figure E.3.3.4. Number of transects sampled was 20.

3/ Less than 1 percent cover.

Source: McKendrick et al. 1982

TABLE E.3.3.28: AREA AND PERCENT OF TOTAL AREA COVERED BY VEGETATION TYPES WITHIN THE HEALY-TO-FAIRBANKS TRANSMISSION LINE STUDY CORRIDOR

Vegetation Type[1/]	Acres	Percent of Total Area
Forest	214,557	77.9
Woodland spruce	4,477	1.6
Open spruce	78,427	28.5
Closed spruce	3,328	1.2
Woodland deciduous	2,454	0.9
Open deciduous	31,018	11.3
Closed deciduous	25,659	9.3
Woodland conifer-deciduous	2,375	0.9
Open conifer-deciduous	30,892	11.2
Closed conifer-deciduous	10,193	3.7
Open spruce/open deciduous	2,343	0.9
Open spruce/wet sedge-grass/ open deciduous	4,925	1.8
Open spruce/low shrub/wet sedge-grass/open deciduous	17,317	6.3
Open spruce/low shrub	1,149	0.4
Tundra	10,890	3.9
Wet sedge-grass	5,604	2.0
Sedge grass	684	0.2
Sedge shrub	1,399	0.5
Sedge-grass/mat and cushion	3,202	1.2
Shrubland	42,499	15.4
Low mixed shrub	38,066	13.8
Willow shrub	143	0.1
Low shrub/wet sedge-grass	4,290	1.6
Agricultural land	432	0.2
Disturbed	1,065	0.4
Unvegetated	6,096	2.2
Lakes	484	0.2
River	5,295	1.9
Gravel	316	0.1
TOTAL	275,539	100.0

1/ The Tanana Flats portion of the transmission corridor is an area of extremely complex mosaics of various vegetation types. As a result, various complexes were recognized.

Source: McKendrick et al. 1982

TABLE E.3.3.29: AREA AND PERCENT OF TOTAL AREA COVERED BY VEGETATION TYPES WITHIN THE WILLOW-TO-COOK INLET TRANSMISSION LINE STUDY CORRIDOR

Vegetation Type	Acres	Percent of Total Area
Forest	63,878	67.0
Woodland spruce	6,071	6.3
Open spruce	8,406	8.8
Closed spruce	7,971	8.4
Open birch	40	+1/
Closed birch	8,989	9.4
Open balsam poplar	247	0.3
Closed balsam poplar	425	0.5
Open conifer-deciduous	4,193	4.4
Closed conifer-deciduous	27,534	28.9
Wet sedge-grass	22,543	23.7
Shrubland	5,468	5.7
Closed tall shrub	227	0.2
Low mixed shrub	5,240	5.5
Lakes	2,498	2.6
Disturbed	941	1.0
TOTAL	95,328	100.0

1/ Less than 0.1 percent of total

Source: McKendrick et al. 1982

TABLE E.3.3.30: ACRES OF DIFFERENT VEGETATION TYPES TO BE CROSSED BY THE HEALY-TO-FAIRBANKS AND WILLOW-TO-COOK INLET TRANSMISSION LINE RIGHT-OF-WAY[1/]

Vegetation Type	Healy to Fairbanks	Willow to Cook Inlet
Forest		
Woodland spruce	117	188
Open spruce	1,370	97
Closed spruce	40	187
Open deciduous	232	0
Closed deciduous	93	0
Closed birch	0	147
Woodland conifer-deciduous	23	0
Open conifer-deciduous	394	101
Closed conifer-deciduous	17	554
Open spruce/open deciduous[3/]	13	0
Open spruce/wet sedge-grass/ open deciduous[3/]	13	0
Open spruce/low shrub/wet sedge-grass/open deciduous[3/]	245	0
	2,557	1,274
Tundra		
Wet sedge-grass	255	545
Sedge-grass (mesic)	16	0
Sedge-shrub	20	0
	291	545
Shrubland		
Low mixed shrub	531	221
Low shrub/wet sedge-grass[3/]	80	0
	611	221
Disturbed	17	17
River	52	0
TOTAL[2/]	3,528	2,057

1/ Based on development of all stages. A right-of-way width of 91 m (300 ft) was used for the Healy to Fairbanks corridor, and 121 m (400 ft) was used for the Willow to Cook Inlet corridor.

2/ For the purpose of calculation of total acreages it was assumed that vegetation types along the unmapped portion of the route were representative of the vegetative portions of the mapped corridor.

3/ The Tanana Flats portion of the Transmission Corridor is an area of extremely complex mosaics of vegetation types. As a result, various complexes were recognized.

TABLE E.3.3.31: ACRES OF DIFFERENT VEGETATION TYPES TO BE CROSSED BY WILLOW-TO-HEALY TRANSMISSION LINE RIGHT-OF-WAY1/

Vegetatation Type4/	Healy to Gold Creek3/	Gold Creek*** to Willow	Healy to Willow3/	Percent of Total
Forest				
Upland Spruce/hard wood (mixed forest, conifer forest, deciduous forest)	473	296	769	22.4
Lowland spruce/hard wood (mixed forest, conifer forest)	0	662	662	19.3
Bottomland spruce/poplar (mixed forest, conifer forest)	10	261	271	7.9
Tundra				
Wet tundra (wet sedge grass)	187	0	187	5.4
Moist tundra (mesic sedge grass)	0	174	174	5.0
Alpine tundra (herbaceous alpine)	30	17	47	1.4
Shrubland				
Shrublands (tall shrub, low shrub)	699	209	908	26.4
Low brush, muskeg bog (low shrub)	0	419	419	12.2
TOTAL	1,399	2,038	3,437	100.0

1/ Calculated from vegetation maps in Commonwealth Associates Environment Assessment Report (EAR), March, 1982.
2/ Healy to Gold Creek right-of-way width used was 130 feet (300 feet minus Intertie ROW of 170 feet).
3/ Willow to Gold Creek right-of-way width used was 230 feet (400 feet minus Intertie ROW of 170 feet).
4/ Classification in parentheses are equivalent classifications according to Viereck and Dyrness (1980).

TABLE E.3.3.32: ACRES OF EACH VEGETATION TYPE TO BE AFFECTED BY THE TRANSMISSION LINE RIGHT-OF-WAY FROM DAM SITES TO GOLD CREEK SWITCHYARD

	Middle Susitna Basin		
Vegetation Type	Stage I	Stage II	Total
Conifer Forest			
White Spruce	33	5	38
Black Spruce	0	0	0
Black & White Spruce	31	0	31
White Spruce Woodland	33	0	3
Black Spruce Woodland	0	0	0
Black & White Spruce Woodland	4	0	4
	101	5	106
Broadleaf Forest			
Paper Birch	7	7	14
Birch - Aspen	0	0	0
Other Broadleaf	3	0	3
Broadleaf Woodland	8	0	8
	18	7	25
Mixed Forest			
Spruce - Birch	273	182	455
Spruce - Birch - Poplar	0	0	0
Spruce - Birch - Aspen	0	0	0
Spruce - Poplar	0	0	0
Mixed Woodland	0	0	0
	273	182	455
Dwarf Tree Scrub			
Conifer	2	1	3
Other Tree Scrub	0	0	0
	2	1	3
Tall Shrub			
Alder	133	0	133
Other Tall Shrub	0	0	0
	133	0	133
Low Shrub			
Dwarf Birch	78	0	78
Low Willow	147	0	147
Ericaceous Shrub	8	0	8
Dwarf Birch - Low Willow	394	0	394
Dwarf Birch - Ericaceous Shrub	114	0	114
Other Low Shrub	0	0	0
	741	0	741
Dwarf Shrub	51	0	51
Graminoid Herbaceous			
Wet	19	10	29
Mesic	0	0	0
Dry	0	0	0
	19	10	29
Sparse Vegetation	0	0	0
Barren	0	0	0
Water	3	2	5
TOTAL	1,341	207	1,548

1/ Based on the Viereck et al. (1982) classification system with modifications (see text). Although complexes were mapped in many cases, only the major component was considered here in order to simplify the table. Also, all closed and open types in the forest, scrub, and shrub categories were combined.

2/ Assumes 300 ft. right-of-way width for 2 circuits between Watana and Gold Creek.

3/ Assumes 210 ft. additional right-of-way width for 2 circuits between Devil Canyon and Gold Creek.

TABLE E.3.3.33: DOMINANT VEGETATION FOR PALUSTRINE WETLAND TYPES BASED ON COWARDIN ET AL. (1979)

Wetland Type	Dominant Species
Palustrine	
Forest	Black spruce (*Picea mariana*), greater than 6 meters tall
	Poplar (*Populus balsamifera*)
	White spruce (*Picea glauca*)
Scrub-shrub	Willow (*Salix* spp.)
	Birch (*Betula glandulosa*)
	Alder (*Alnus* spp)
	Black Spruce (*Picea mariana*), less than 6 meters tall
	Labrador tea (*Ledum palustre*)
	Crowberry (*Empertrum nigrum*)
	Bog blueberry (*Vaccinium uliginosum*
	Sweetgale (*Myrica gale*)
Emergent Vegetation	Horsetail (*Esquistum* spp.)
	Cottongrass (*Eriophorum* spp.)
	Sedges (*Carex* spp.)
	Sitka burnet (*Sanaguisorba sitchensis*)
	Bluejoint (*Calamagrostis canadensis*)
	Northern grass of parnassus (*Parnassia palustris*)
	Marsh cinquefoil (*Potentilla palustris*)
	Round-leaf sundew (*Drosera rotundifolia*)
	Rush (*Juncus oreganus*)
	Buckbean (*Menyanthes trifoliata*)
	Creeping spikerush (*Eleocharis palustris*)
	Peat moss (*Sphagnum* spp.)

TABLE E.3.3.34: ACRES OF EACH WETLAND PERMANENTLY LOST AS A RESULT OF EACH PROJECT STAGE[1/]

Wetland Type[2/]	Watana (Stage I)	Devil Canyon (Stage II)	Watana (Stage III)	Total Stages I and II	Total All Stages
Palustrine					
Forested	636	609	497	1,245	1,742
Forested with Scrub-shrub	844	91	705	935	1,640
Forested with emergent vegetation	8	47	7	55	62
Scrub-shrub	1,578	69	1,763	1,647	3,410
Scrub-shrub with forest	12	8	110	20	130
Scrub-shrub with emergent vegetation	217	63	798	280	1,078
Emergent vegetation	42	49	87	91	178
Emergent vegetation with forest	16	0	0	16	16
Emergent vegetation with scrub-schub	37	7	57	44	101
Ponds (open water)	40	10	18	50	68
	3,430	953	4,042	4,383	8,425
Lacustrine					
Lakes (open water)	0	0	50	0	50
Riverine					
Rivers and creeks (open water)	3,769	1,958	522	5,722	6,244
Gravel/Sand Bars	432	43	35	475	510
	4,201	1,996	557	6,197	6,754
TOTAL	7,631	2,949	4,649	10,580	15,229

1/ All quarry and borrow site areas disturbed will be rehabilitated after construction.

2/ Based on the Cowardin et al. (1979) classification system.

TABLE E.3.3.35: ACRES OF EACH WETLAND TYPE TO BE AFFECTED BY STAGE I[1]

Wetland Type[2]	Impoundment and Dam	Access Road	Camps and Villages	Quarry and Borrow Sites	Other Facilities	Total
Palustrine						
Forested	636	0	0	51	0	687
Forested with scrub-shrub	843	1	0	0	0	844
Forested with emergent vegetation	8	0	0	0	0	8
Scrub-shrub	1,553	41	0	42	1	1,637
Scrub-shrub with forest	12	0	0	0	0	12
Scrub-shrub with emergent vegetation	155	42	53	85	21	356
Emergent vegetation	36	8	4	13	0	61
Emergent vegetation with forest	16	0	0	0	0	16
Emergent vegetation with scrub-shrub	29	11	0	10	2	52
Ponds (open water)	31	1	24	0	0	56
	3,319	104	81	201	24	3,729
Lacustrine						
Lakes (open water)	0	0	0	0	0	0
Riverine						
Rivers and creeks (open water)	3,768	1	0	10	0	3,779
Gravel/Sand Bars	432	0	0	0	0	432
	4,200	1	0	10	0	4,211
TOTAL	7,519	105	81	211	24	7,940

1/ Includes all facilities and features for which total clearing will take place. Revegetation of some of these areas will occur following construction. Does not include transmission line rights-of-way for which only tall vegetation would be cleared.

2/ Based on the Cowardin et al. (1979) classification system.

TABLE E.3.3.36: ACRES OF EACH WETLAND TYPE TO BE AFFECTED BY STAGE II[1]

Wetland Type[2]	Impoundment and Dam	Access Road	Camps and Villages	Quarry and Borrow Sites	Other Facilities	Total
Palustrine						
Forested	608	0	10	1	1	620
Forested with scrub-shrub	91	0	0	0	0	91
Forest with emergent vegetation	30	0	0	0	21	51
Scrub-shrub	59	15	0	1	2	77
Scrub-shrub with forest	6	3	0	0	0	9
Scrub-shrub with emergent vegetation	8	65	24	0	18	115
Emergent vegetation	45	7	15	0	0	67
Emergent vegetation with forest	0	0	0	0	0	0
Emergent vegetation with scrub-shrub	4	4	27	4	2	41
Ponds (open water)	10	0	0	2	0	12
	861	94	76	8	44	1,083
Lacustrine						
Lakes (open water)	0	0	0	0	0	0
Riverine						
Rivers and creeks (open water)	1,951	3	0	0	0	1,954
Gravel/Sand Bars	43	0	0	0	0	43
	1,994	3	0	0	0	1,997
TOTAL	2,855	97	76	8	44	3,080

[1] Includes all facilities and features for which total clearing will take place. Revegetation of some of these areas will occur following construction. Does not include transmission line rights-of-way for which only tall vegetation would be cleared.

[2] Based on the Cowardin et al. (1979) classification system.

TABLE E.3.3.37: ACRES OF EACH WETLAND TYPE TO BE AFFECTED BY STAGE III[1/]

Wetland Type[2/]	Impoundment and Dam	Quarry and Borrow Sites	Total
Palustrine			
Forested	497	26	523
Forested with scrub-shrub	705	0	705
Forest with emergent vegetation	7	0	7
Scrub-shrub	1,763	22	1,785
Scrub-shrub with forest	110	0	110
Scrub-shrub with emergent vegetation	798	51	849
Emergent vegetation	87	16	103
Emergent vegetation with forest	0	0	0
Emergent vegetation with scrub-shrub	57	10	67
Ponds (open water)	18	0	18
	4,042	125	4,167
Lacustrine			
Lakes (open water)	50	0	50
Riverine			
Rivers and creeks (open water)	522	5	527
Gravel/Sand Bars	35	0	35
	557	5	562
TOTAL	4,649	130	4,779

1/ Includes all facilities and features for which total clearing will take place. Revegetation of some of these areas will occur following construction. Does not include transmission line rights-of-way for which only tall vegetation would be cleared.

2/ Based on the Cowardin et al. (1979) classification system.

TABLE E.3.3.38: ACRES OF EACH WETLAND TYPE TO BE AFFECTED BY THE PRIMARY BORROW AND QUARRY SITES NOT TO BE INUNDATED BY STAGES I, II, AND III[1]

Wetland Type[2]	Quarry A	Borrow D	Borrow E	Quarry K	Total
Palustrine					
Forested	2	0	75	1	78
Forested with scrub-shrub	0	0	0	0	0
Forested with emergent vegetation	0	0	0	0	0
Scrub-shrub	3	51	10	1	65
Scrub-shrub with forest	0	0	0	0	0
Scrub-shrub with emergent vegetation	17	119	0	0	136
Emergent vegetation	16	11	2	0	29
Emergent vegetation with forest	0	0	0	0	0
Emergent vegetation with scrub-shrub	11	0	9	4	24
Ponds (open water)	0	0	0	2	2
	49	181	96	8	334
Lacustrine					
Lakes (open water)	0	0	0	0	0
Riverine					
Rivers and creeks (open water)	0	0	15	0	15
Gravel/Sand Bars	0	0	0	0	0
	0	0	15	0	15
TOTAL	49	181	111	8	349

1/ All quarry and borrow site areas disturbed will be rehabilitated after construction.

2/ Based on the Cowardin et al. (1979) classification system.

TABLE E.3.3.39: ACRES OF EACH WETLAND TYPE TO BE AFFECTED BY THE TRANSMISSION LINE CORRIDORS FROM DAMSITES TO GOLD CREEK SWITCHYARD

	Middle Susitna River		
Wetland Type[1/]	Stage I[1/]	Stage II[3/]	Total
Palustrine			
Forested	4	2	6
Forested with scrub-shrub	1	0	1
Forested with emergent vegetation	0	0	0
Scrub-shrub	30	1	31
Scrub-shrub with forest	0	0	0
Scrub-shrub with emergent vegetation	156	0	156
Emergent vegetation	27	5	32
Emergent vegetation with forest	0	0	0
Emergent vegetation with scrub-shrub	29	12	41
Ponds (open water)	2	0	2
	249	20	269
Lacustrine			
Lakes (open water)	0	0	2
	0	0	0
Riverine			
Rivers and creeks (open water)	7	3	10
Gravel/Sand Bars	1	0	1
	8	3	11
TOTAL	257	23	280

1/ Based on the Cowardin et al. (1979) classification system.

2/ Assumes 300 ft. right-of-way width for 2 circuits between Watana and Gold Creek.

3/ Assumes 210 ft. of additional right-of-way width for 2 circuits between Devil Canyon and Gold Creek.

TABLE E.3.3.40: ACRES OF EACH VEGETATION TYPE TO BE AFFECTED BY STAGE I[1/]

Vegetation Type[2/]	Impoundment & Dam[3/]	Access Road[4/]	Camps & Villages[5/]	Quarry & Borrow Sites[6/]	Other Facilities[7/]	TOTAL
Conifer Forest						
White Spruce	1,066	21	0	1	0	1,088
Black Spruce	1,636	3	0	16	8	1,663
Black & White Spruce	3,135	6	0	245	5	3,391
White Spruce Woodland	348	1	0	7	6	362
Black Spruce Woodland	377	0	0	0	0	377
Black & White Spruce Woodland	77	9	1	139	+[8/]	226
	6,639	40	1	408	19	7,107
Broadleaf Forest						
Paper Birch	242	0	0	8	0	250
Birch - Aspen	389	0	0	0	0	389
Other Broadleaf	89	0	0	0	0	89
Broadleaf Woodland	0	0	0	0	0	0
	720	0	0	8	0	728
Mixed Forest						
Spruce - Birch	4,013	0	0	194	39	4,246
Spruce - Birch - Poplar	0	0	0	14	0	14
Spruce - Birch - Aspen	1,333	0	0	0	0	1,333
Spruce - Poplar	389	0	0	51	0	440
Mixed Woodland	6	0	0	0	0	6
	5,741	0	0	259	39	6,039
Dwarf Tree Scrub						
Conifer	1,719	0	0	27	0	1,746
Other Tree Scrub	0	0	0	0	0	0
	1,719	0	0	27	0	1,746
Tall Shrub						
Alder	63	6	0	17	0	86
Other Tall Shrub	0	2	0	0	0	2
	63	8	0	17	0	88
Low Shrub						
Dwarf Birch	12	77	214	93	32	428
Low Willow	164	158	10	4	1	337
Ericaceous Shrub	7	0	0	0	12	19
Dwarf Birch - Low Willow	125	158	63	10	15	371
Dwarf Birch - Ericaceous Shrub	+	25	+	183	33	241
Other Low Shrub	0	0	0	0	0	0
	308	418	287	290	93	1,396
Dwarf Shrub	0	60	0	0	0	60
Graminoid Herbaceous						
Wet	25	1	0	9	0	35
Mesic	0	0	0	0	0	0
Dry	0	0	0	0	0	0
	25	1	0	9	0	35
Sparse Vegetation	14	0	0	0	0	14
Barren	68	1	0	0	0	69
Water	4,146	+	12	0	0	4,158
TOTAL	19,443	528	300	1,018	151	21,440

1/ Indicates all facilities and features for which total clearing will take place. Revegetation of some of these areas will occur following construction (see footnotes below). Does not include transmission line rights-of-way for which only tall vegetation would be cleared. See Table 3.3.45 for this acreage.

2/ Based on the Viereck et al. (1982 classification system with modifications (see text). Although complexes were mapped in many cases, only the major component was considered here in order to simplify the table. Also, all closed and open types in the forest, scrub, and shrub categories were combined.

3/ Includes only the area of the Stage I impoundment and dam.

4/ Includes only the Denali Highway-Watana access road. Assumed average clearing width for this 43.6 mile road is 100 ft. Approximately 40 ft. of this width (or 211 out of 528 acres) will be revegetated after the access road is constructed.

5/ Includes Watana construction camp and village and permanent village. Approximately 200 acres will be rehabilitated at the completion of Stage III.

6/ Includes 1/3 of the area of Quarry Site A, 2/3 of the area of Borrow Site D, and 2/3 of the area of Borrow Site E that is above the Devil Canyon impoundment. The remainders of these quarry and borrow sites are assumed to be used for Stage III. All quarry and borrow site areas distributed will be rehabilitated after construction of each stage.

7/ Includes the airport (44 acres), Watana construction roads (80 acres), and the transmission line switchyards at Watana (12 acres) and Gold Creek (16 acres). Approximately 30 acres for the construction roads will be rehabilitated after the roads are constructed.

8/ + indicates less than 1/2 acre.

TABLE E.3.3.41: ACRES OF EACH VEGETATION TYPE TO BE AFFECTED BY STAGE II[1/]

Vegetation Type[2/]	Impoundment & Dam[3/]	Access Road[4/]	Camps & Villages[5/]	Quarry & Borrow Sites[6/]	Other Facilities[7/]	TOTAL
Conifer Forest						
White Spruce	644	22	0	137	10	813
Black Spruce	180	0	0	0	0	180
Black & White Spruce	216	29	0	0	16	261
White Spruce Woodland	8	15	0	16	0	39
Black Spruce Woodland	0	0	0	0	0	0
Black & White Spruce Woodland	0	0	0	0	0	0
	1,048	66	0	153	26	1,293
Broadleaf Forest						
Paper Birch	277	3	0	0	6	286
Birch - Aspen	74	0	0	0	0	74
Other Broadleaf	38	0	0	0	1	39
Broadleaf Woodland	4	0	0	0	0	4
	393	3	0	0	7	403
Mixed Forest						
Spruce - Birch	2,834	47	177	99	133	3,290
Spruce - Birch - Poplar	213	0	0	0	0	213
Spruce - Birch - Aspen	0	0	0	0	0	0
Spruce - Poplar	897	0	0	0	0	897
Mixed Woodland	52	2	0	0	0	54
	3,996	49	177	99	133	4,454
Dwarf Tree Scrub						
Conifer	101	0	3	0	0	104
Other Tree Scrub	0	0	0	0	0	0
	101	0	3	0	0	104
Tall Shrub						
Alder	59	65	0	54	0	178
Other Tall Shrub	0	0	0	97	0	97
	59	65	0	151	0	275
Low Shrub						
Dwarf Birch	0	54	0	0	0	54
Low Willow	0	91	0	0	0	91
Ericaceous Shrub	0	1	0	0	0	1
Dwarf Birch - Low Willow	0	116	0	28	0	144
Dwarf Birch - Ericaceous Shrub	9	4	0	14	+[8/]	27
Other Low Shrub	0	0	0	0	0	0
	9	266	0	42	0	317
Dwarf Shrub	0	6	0	0	0	6
Graminoid Herbaceous						
Wet	0	12	20	0	9	41
Mesic	0	0	0	0	0	0
Dry	0	0	0	0	0	0
	0	12	20	0	9	41
Sparse Vegetation	0	0	0	0	0	0
Barren	0	0	0	0	0	0
Water	1,944	1	0	0	0	1,995
TOTAL	7,550	468	200	445	175	8,838

1/ Indicates all facilities and features for which total clearing will take place. Revegetation of some of these areas will occur following construction (see footnotes below). Does not include transmission line rights-of-way for which only tall vegetation would be cleared. See Table E.3.3.45 for this acreage.

2/ Based on the Viereck et al. (1982) classification system with modifications (see text). Although complexes were mapped in many cases, only the major component was considered here in order to simplify the table. Also, all closed and open types in the forest, scrub, and shrub categories were combined.

3/ Includes only the area of the Stage II impoundment and dam.

4/ Includes only the Watana-Devil Canyon access road. Assumed average clearing width for this 38.6 mile road is 100 ft. Approximately 40 ft. of this width (or 187 out of 468 acres) will be revegetated after the access road is constructed.

5/ Includes Devil Canyon construction camp and village will be rehabilitated at the completion of Stage II.

6/ Includes Quarry Site K which will be rehabilitated following completion of Stage II.

7/ Includes the railroad (73 acres), railhead facility (40 acres), Devil Canyon construction roads (50 acres), and the Devil Canyon transmission line switchyard (12 acres). Approximately 22 acres cleared for the railroad and 19 acres cleared for construction roads will be rehabilitated after construction.

8/ + indicates less than 1/2 acre.

TABLE E.3.3.42: ACRES OF EACH VEGETATION TYPE TO BE AFFECTED BY STAGE III[1/]

Vegetation Type[2/]	Impoundment & Dam[3/]	Quarry & Borrow Sites[4/]	TOTAL
Conifer Forest			
White Spruce	1,454	1	1,455
Black Spruce	1,406	8	1,414
Black & White Spruce	2,980	181	3,161
White Spruce Woodland	1,878	4	1,882
Black Spruce Woodland	232	0	232
Black & White Spruce Woodland	573	80	653
	8,523	274	8,797
Broadleaf Forest			
Paper Birch	181	4	185
Birch - Aspen	128	0	128
Other Broadleaf	16	0	16
Broadleaf Woodland	7	0	7
	332	4	336
Mixed Forest			
Spruce - Birch	3,544	109	3,653
Spruce - Birch - Poplar	0	7	7
Spruce - Birch - Aspen	748	0	748
Spruce - Poplar	130	25	155
Mixed Woodland	71	0	71
	4,493	141	4,634
Dwarf Tree Scrub			
Conifer	1,258	13	1,271
Other Tree Shrub	0	0	0
	1,258	13	1,271
Tall Shrub			
Alder	214	9	223
Other Tall Shrub	0	0	0
	214	9	223
Low Shrub			
Dwarf Birch	143	47	190
Low Willow	132	2	134
Ericaceous Shrub	144	0	144
Dwarf Birch - Low Willow	576	5	581
Dwarf Birch - Ericaceous Shrub	313	247	560
Other Low Shrub	0	0	0
	1,308	301	1,609
Dwarf Shrub	0	0	0
Graminoid Herbaceous			
Wet	225	5	230
Mesic	0	0	0
Dry	0	0	0
	225	5	230
Sparse Vegetation	21	0	21
Barren	2	0	2
Water	586	0	586
TOTAL	16,692	747	17,709

1/ Includes all facilities and features for which total clearing will take place. Revegetation of some of these areas will occur following construction (see footnotes below). Does not include transmission line rights-of-way for which only tall vegetation would be cleared. See Table E.3.3.45 for this acreage.

2/ Based on the Viereck et al. (1982) classification system with modifications (see text). Although complexes were mapped in many cases, only the major component was considered here in order to simplify the table. Also, all closed and open types of forest, scrub, and shrub categories were combined.

3/ Includes only the area inundated by Stage III. Does not include the area of the Stage I impoundment and dam.

4/ Includes 2/3 of the area of Quarry Site A, 1/3 of the area of Borrow Site D, and 1/3 of the area of Borrow Site E that is above the Devil Canyon impoundment. The remainders of these quarry and borrow sites were assumed to be used for Stage I. All quarry and borrow site areas disturbed will be rehabilitated after construction of each stage.

TABLE E.3.3.43: ACRES OF EACH VEGETATION TYPE PERMANENTLY LOST AS A RESULT OF EACH PROJECT STAGE1/

Vegetation Type2/	Watana Stage I	Devil Canyon Stage II	Watana Stage III	Total Stages I & II	Total All Stages	% of Mapping Area Total for Each Vegetation Type3/
Conifer Forest						
White Spruce	1,078	665	1,454	1,743	3,197	9.4
Black Spruce	1,643	180	1,406	1,823	3,229	12.9
Black & White Spruce	3,141	246	2,980	3,387	6,367	4.3
White Spruce Woodland	353	17	1,878	370	2,248	6.0
Black Spruce Woodland	377	0	232	377	609	74.3
Black & White Spruce Woodland	83	0	573	83	656	2.6
	6,675	1,108	8,523	7,783	16,306	6.0
Broadleaf Forest						
Paper Birch	242	283	181	525	706	12.1
Birch - Aspen	389	74	128	463	591	26.2
Other Broadleaf	89	39	16	128	144	3.1
Broadleaf Woodland	0	4	7	4	11	0.8
	720	400	332	1,120	1,452	11.0
Mixed Forest						
Spruce - Birch	4,043	2,962	3,544	7,005	10,549	11.2
Spruce - Birch - Poplar	0	213	0	213	213	17.5
Spruce - Birch - Aspen	1,333	0	748	1,333	2,081	57.6
Spruce - Poplar	389	897	130	1,286	1,416	52.0
Mixed Woodland	6	53	71	59	130	1.5
	5,771	4,125	4,493	9,896	14,389	13.0
Dwarf Tree Scrub						
Conifer	1,719	101	1,258	1,820	3,078	8.2
Other Tree Scrub	0	0	0	0	0	0
	1,719	101	1,258	1,820	3,078	8.1
Tall Shrub						
Alder	67	98	214	165	379	0.5
Other Tall Shrub	1	0	0	1	1	+4/
	68	98	214	166	380	0.4
Low Shrub						
Dwarf Birch	158	32	143	190	333	0.2
Low Willow	262	55	132	317	449	0.3
Ericaceous Shrub	19	1	144	20	164	2.0
Dwarf Birch - Low Willow	254	70	576	324	900	0.4
Dwarf Birch - Ericaceous Shrub	40	11	313	51	364	0.3
Other Low Shrub	0	0	0	0	0	0
	733	169	1,308	902	2,210	0.3
Dwarf Shrub	36	4	0	40	40	+
Graminoid Herbaceous						
Wet	26	15	225	41	266	2.5
Mesic	0	0	0	0	0	0
Dry	0	0	0	0	0	0
	26	15	225	41	266	1.9
Sparse Vegetation	14	0	21	14	35	0.1
Barren	69	0	2	69	71	0.1
Water	4,150	1,945	586	6,095	6,681	21.1
TOTAL	19,981	7,965	16,962	27,946	44,908	2.8

1/ Includes areas occupied by the impoundments, dams and those portions of permanent project features that cannot be revegetated.

2/ Based on the Viereck et al. (1982) classification system with modifications (see text). Although complexes were mapped in many cases, only the major component was considered here in order to simplify the table. Also, all closed and open types in the forest scrub and shrub categories were combined.

3/ Mapping area totals for each vegetation type are given in Table E.3.3.4. Total mapping area is 1,595,561 acres or 2,493 square miles in size and is shown in Figure E.3.3.3.

4/ + indicates less than 0.05.

TABLE E.3.3.44: ACRES OF EACH VEGETATION TYPE TO BE AFFECTED BY PRIMARY BORROW AND QUARRY SITES NOT TO BE INUNDATED BY STAGES I, II OR III

Vegetation Type 2/	Quarry A	Borrow D	Borrow E	Quarry K	TOTAL
Conifer Forest					
White Spruce	0	0	2	137	139
Black Spruce	0	0	24	0	24
Black & White Spruce	119	111	196	0	426
White Spruce Woodland	0	11	0	16	27
Black Spruce Woodland	0	0	0	0	0
Black & White Spruce Woodland	21	198	0	0	219
	140	320	222	153	835
Broadleaf Forest					
Paper Birch	0	12	0	0	12
Birch - Aspen	0	0	0	0	0
Other Broadleaf	0	0	0	0	0
Broadleaf Woodland	0	0	0	0	0
	0	12	0	0	12
Mixed Forest					
Spruce - Birch	24	87	192	99	402
Spruce - Birch - Poplar	0	0	21	0	21
Spruce - Birch - Aspen	0	0	0	0	0
Spruce - Poplar	0	0	76	0	76
Mixed Woodland	0	0	0	0	0
	24	87	289	99	499
Dwarf Tree Scrub					
Conifer	0	0	40	0	40
Other Tree Scrub	0	0	0	0	0
	0	0	40	0	40
Tall Shrub					
Alder	0	26	0	54	80
Other Tall Shrub	0	0	0	97	97
	0	26	0	151	177
Low Shrub					
Dwarf Birch	0	140	0	0	140
Low Willow	0	6	0	0	6
Ericaceous Shrub	0	0	0	0	0
Dwarf Birch - Low Willow	0	15	0	28	43
Dwarf Birch - Ericaceous Shrub	312	118	0	14	444
Other Low Shrub	0	0	0	0	0
	312	279	0	42	633
Dwarf Shrub	0	0	0	0	0
Graminoid Herbaceous					
Wet	0	14	0	0	14
Mesic	0	0	0	0	0
Dry	0	0	0	0	0
	0	14	0	0	14
Sparse Vegetation	0	0	0	0	0
Barren	0	0	0	0	0
Water	0	0	0	0	0
TOTAL	476	738	551	445	2,210

1/ All quarry and borrow site areas disturbed will be rehaiblitated after construction.

2/ Based on the Viereck et al. (1982) classification system with modifications (see text). Although complexes were mapped in may cases, only the major component was considered here in order to simplify the table. Also, all closed and open types in the forest, scrub, and shrub categories were combined.

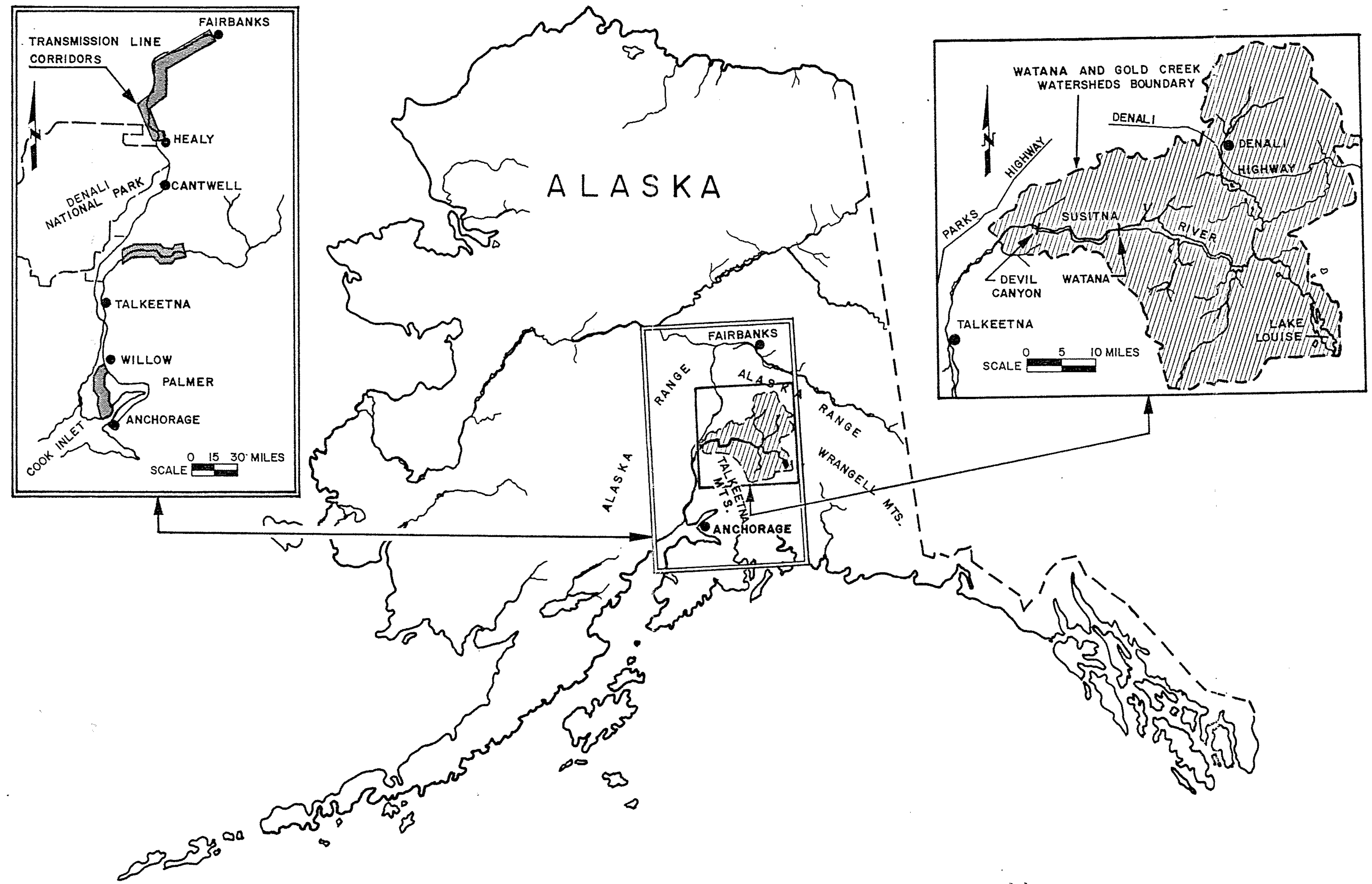
TABLE E.3.3.45: TOTAL AREA AND VEGETATION AREA PERMANENTLY MODIFIED, TEMPORARILY LOST, OR PERMANENTLYLOST BY CONSTRUCTION STAGE AND FEATURE

	Area (acres)							
	Permanently Modified[1/]		Temporarily Lost		Permanently Lost		Total Area Affected	
Construction Stage/Feature	Vegetated	Total[2/]	Vegetated	Total[2/]	Vegetated	Total[2/]	Vegetated	Total[2/]
Stage I								
- Impoundment and Dam	0	0	0	0	15,229	19,443	15,229	19,443
- Access Roads	0	0	211	211	316	317	527	528
- Camps and Villages	0	0	192	200	96	100	288	300
- Quarry and Borrow Site	0	0	1,018	1,018	0	0	1,018	1,018
- Transmission Line ROW's	8,877	8,962	0	0	0	0	8,877	8,962
- Other Stage I Facilities	0	0	30	30	121	121	151	151
SUBTOTAL	8,877	8,962	1,451	1,459	15,762	19,981	26,090	30,402
Stage II								
- Impoundment and Dam	0	0	0	0	5,606	7,550	5,606	7,550
- Access Roads	0	0	187	187	280	281	467	468
- Camps and Villages	0	0	200	200	0	0	200	200
- Quarry and Borrow Sites	0	0	445	445	0	0	445	445
- Transmission Line ROW's	205	207	0	0	0	0	205	207
- Other Stage II Facilities	0	0	41	41	134	134	175	175
SUBTOTAL	205	207	873	873	6,020	7,965	7,098	9,045
Stage III								
- Impoundment and Dam	0	0	0	0	16,374	16,962	16,374	16,962
- Quarry and Borrow Sites	0	0	747	747	0	0	747	747
- Transmission LIne ROW's	1,396	1,400	0	0	0	0	1,396	1,400
SUBTOTAL	1,396	1,400	747	747	16,374	16,962	18,517	19,109
TOTAL	10,478	10,569	3,071	3,079	38,156	44,908	51,705	58,556

1/ Total transmission line right-of-way areas are included even though only forest and tall shrub areas are significantly modified.

2/ Includes the vegetated area plus the area classified as water, barren or disturbed.

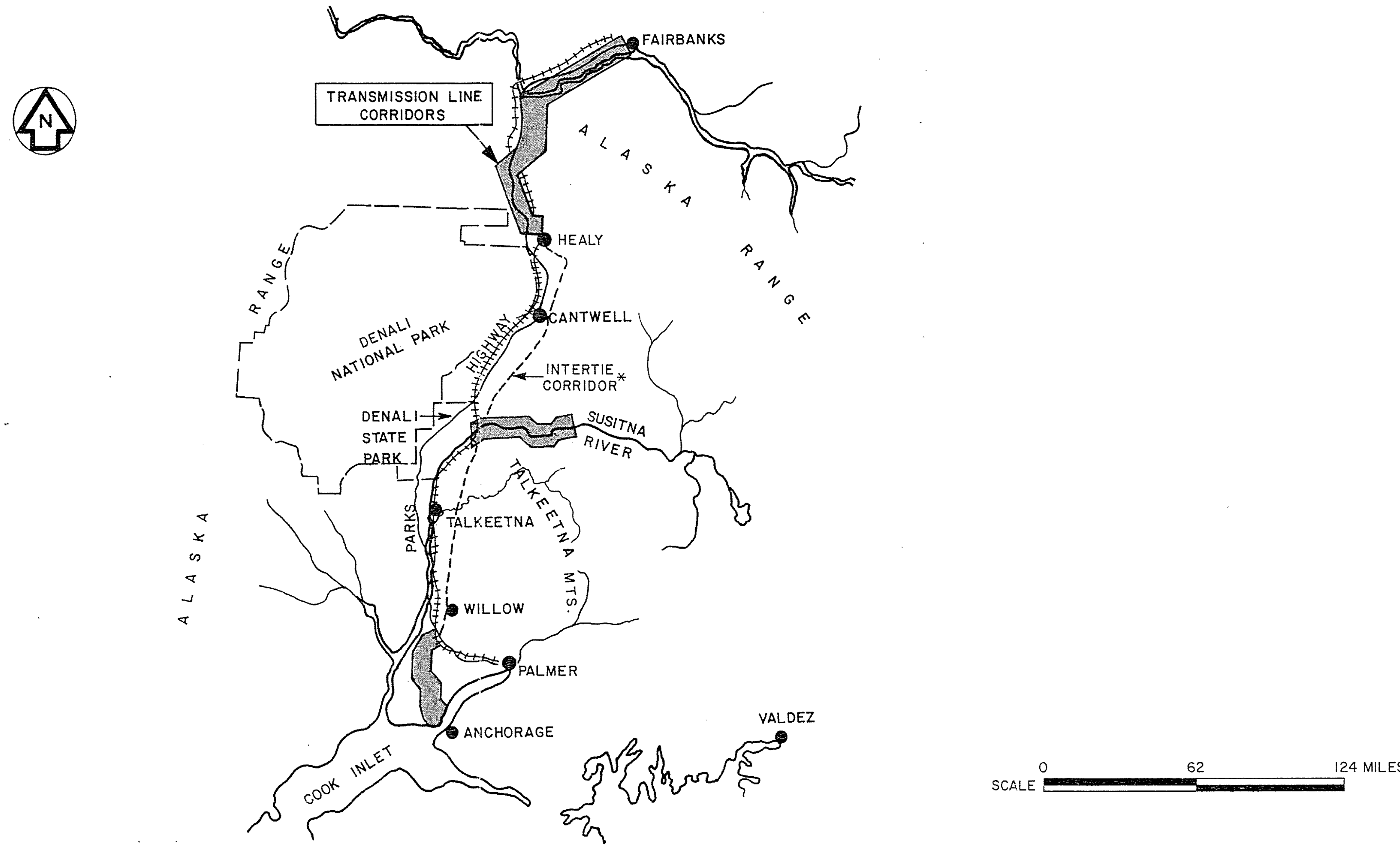
FIGURES



STUDY AREA FOR BOTANICAL RESOURCES AND WILDLIFE

FROM McKENDRICK et al. 1982

FIGURE E.3.3.1

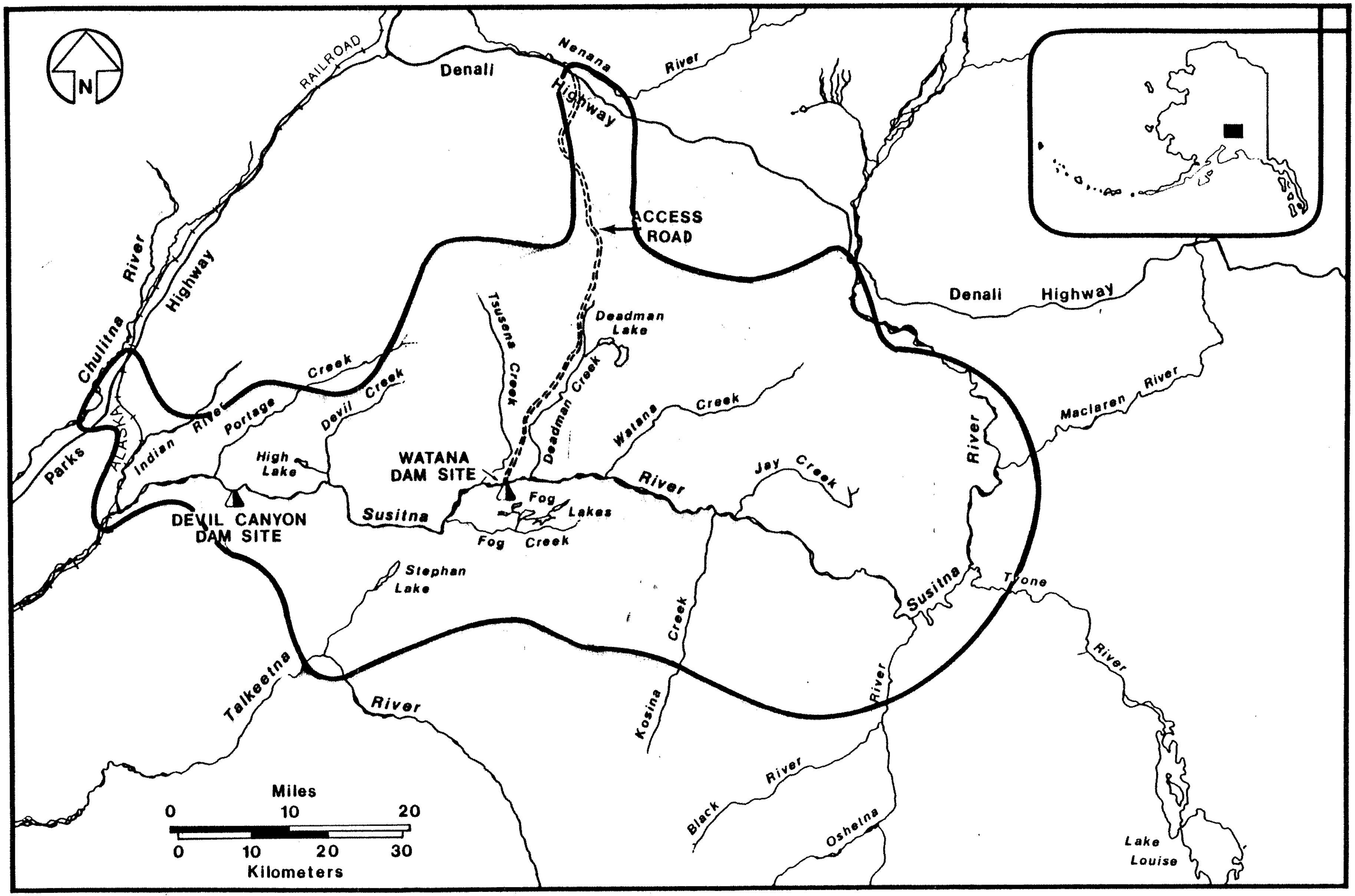


*INTERTIE CORRIDOR CONNECTS WILLOW AND HEALY THROUGH GOLD CREEK SWITCHING STATION (SEE FIGURE E.3.3.7 AND COMMONWEALTH ASSOCIATES 1982)

VEGETATION MAPPING AREAS FOR TRANSMISSION CORRIDORS

FROM McKENDRICK et al. 1982

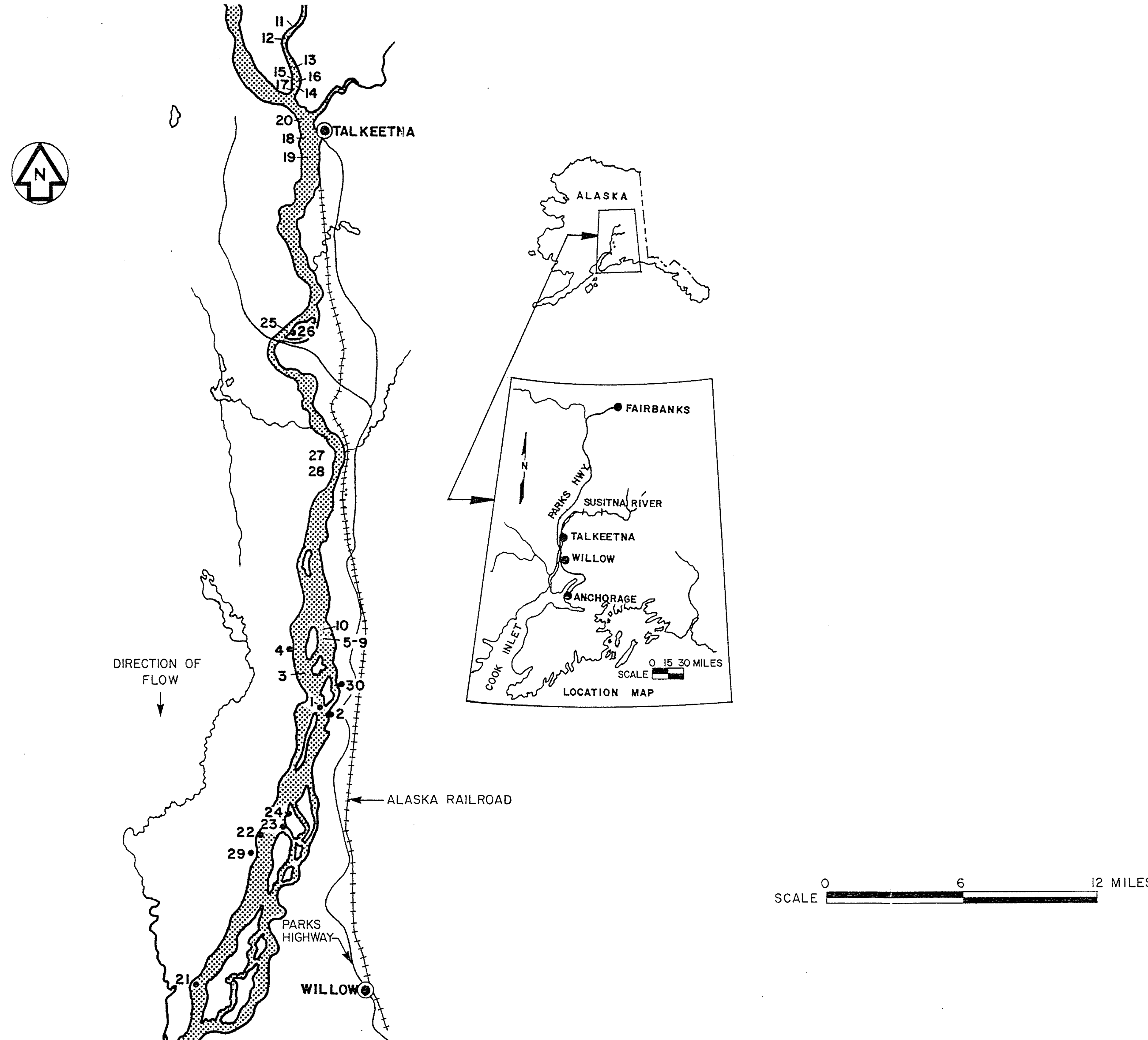
FIGURE E.3.3.2



SOURCE: R. A. KREIG & ASSOC.(1985)

VEGETATION MAPPING AREA

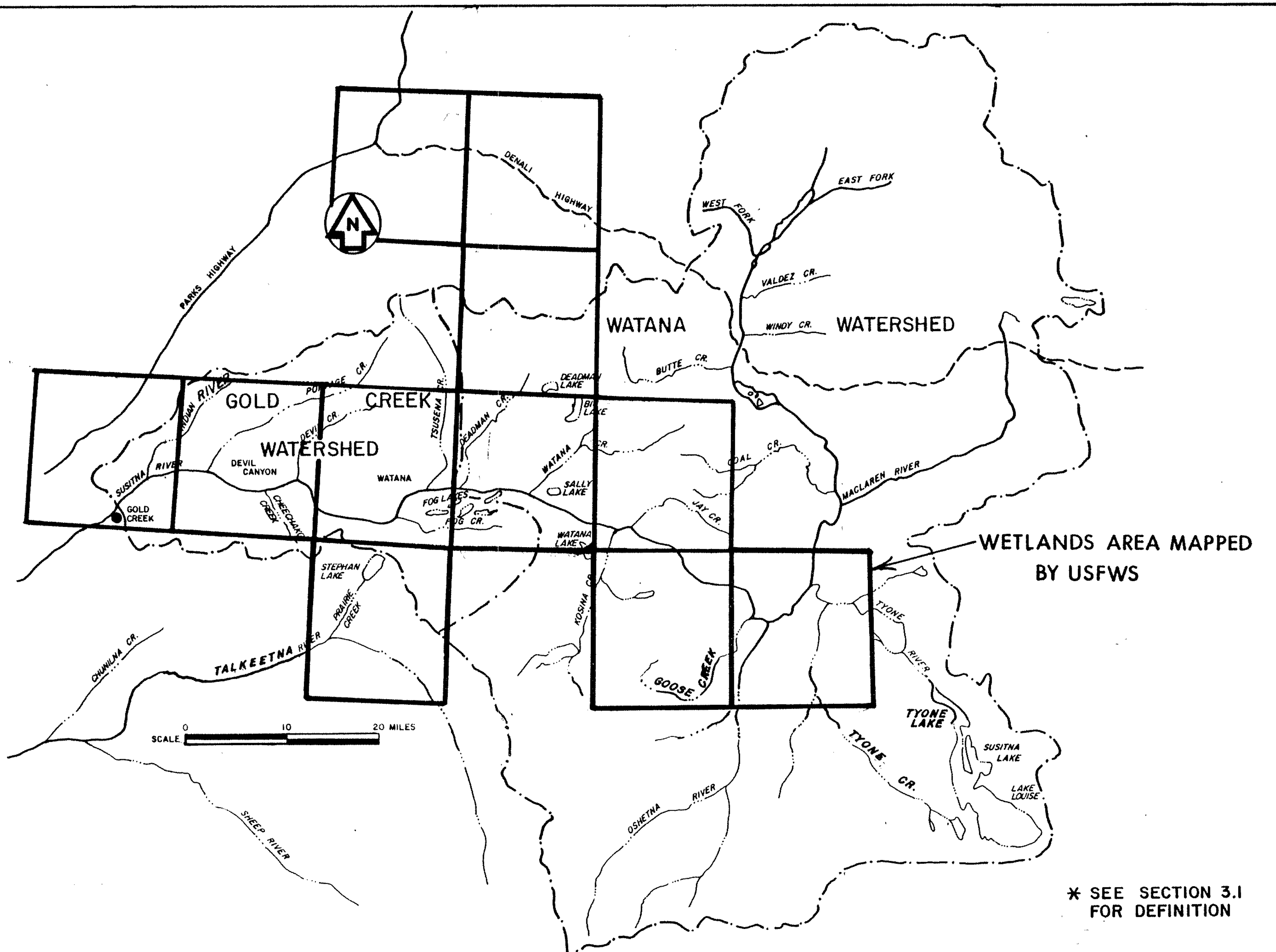
E.3.3.3



*STANDS ARE DESCRIBED IN TABLES E.3.3.24 THROUGH E.3.3.27

LOCATIONS OF STANDS SAMPLED* ON DOWNSTREAM FLOODPLAIN OF THE SUSITNA RIVER, 1981

FROM McKENDRICK et al. 1982



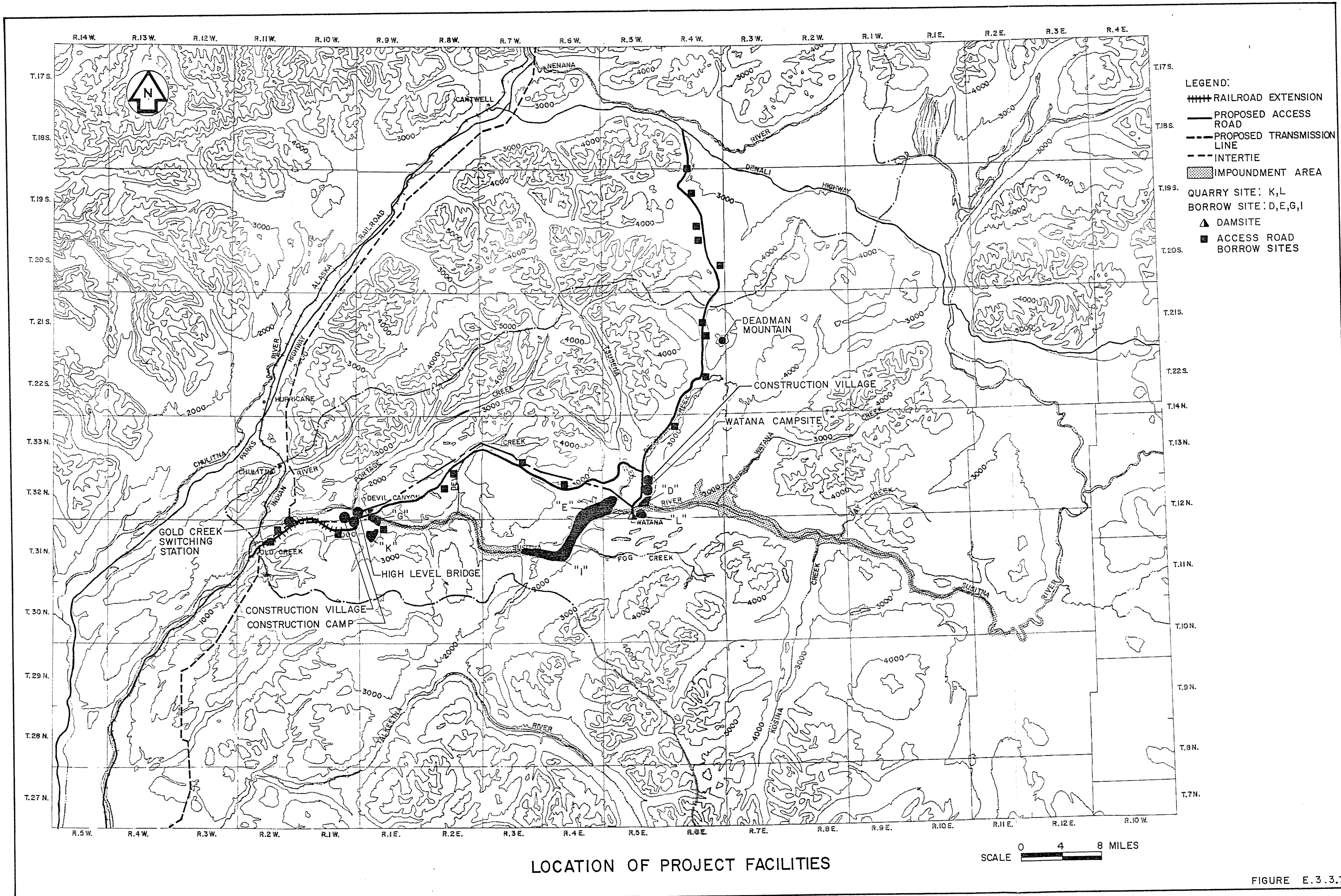
* SEE SECTION 3.1 FOR DEFINITION

THE WATANA AND GOLD CREEK WATERSHEDS* WITH MAJOR WATER BODIES

FIGURE E.3.3.5

FIGURE E.3.3.6

Inserted in pocket inside back cover



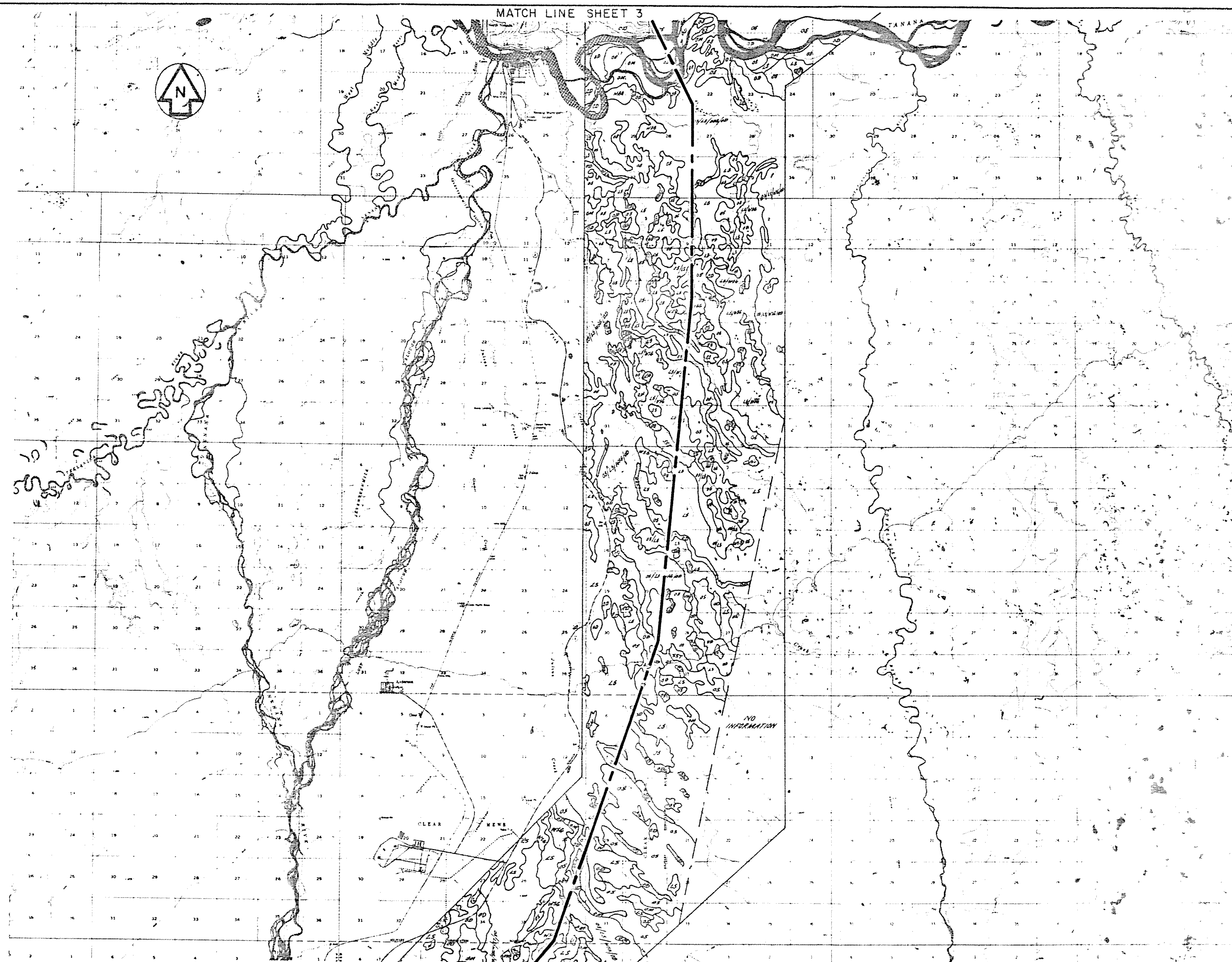
LOCATION OF PROJECT FACILITIES

FIGURE E.3.3.7

FIGURE E.3.3.8

LEGEND:

CS	CLOSED SPRUCE
OS	OPEN SPRUCE
WS	WOODLAND SPRUCE
CD	CLOSED DECIDUOUS
OD	OPEN DECIDUOUS
CM	CLOSED MIXED
OM	OPEN MIXED
WM	WOODLAND MIXED
LS	LOW SHRUB
WSG	WET SEDGE GRASS
SGT	SEDGE GRASS TUNDRA
MCT	MAT AND CUSHION TUNDRA
C	CROP
L	LAKE
R	ROCK
D	DEVELOPED
— — —	PROPOSED TRANSMISSION LINE



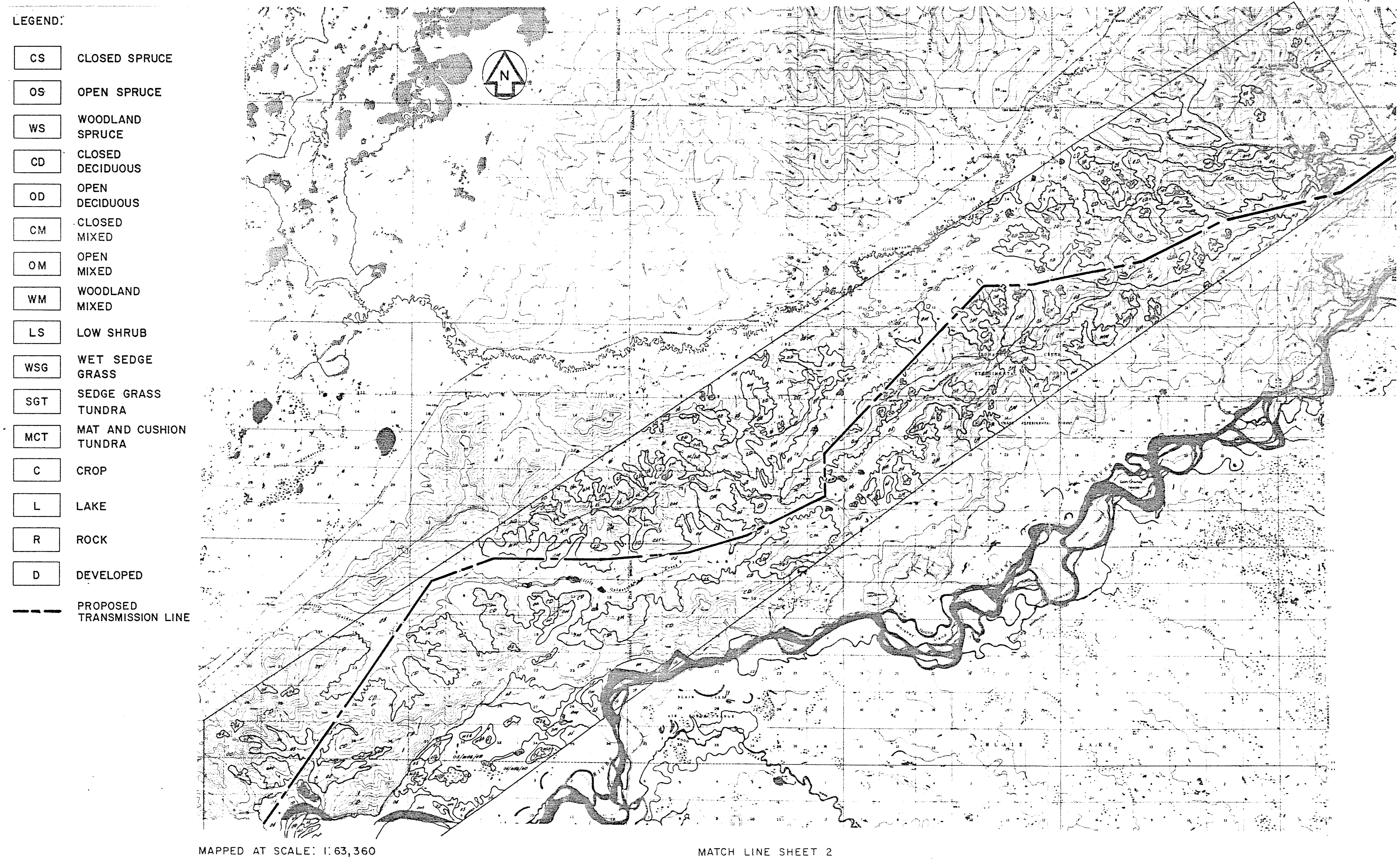
MAPPED AT SCALE: 1: 63,360

SCALE 0 2 4 MILES

VEGETATION MAP OF PROPOSED HEALY-FAIRBANKS TRANSMISSION CORRIDOR

FROM McKENDRICK et al. 1982

FIGURE E.3.3.9



VEGETATION MAP OF PROPOSED HEALY–FAIRBANKS TRANSMISSION CORRIDOR

FROM McKENDRICK et al. 1982

FIGURE E.3.3.10

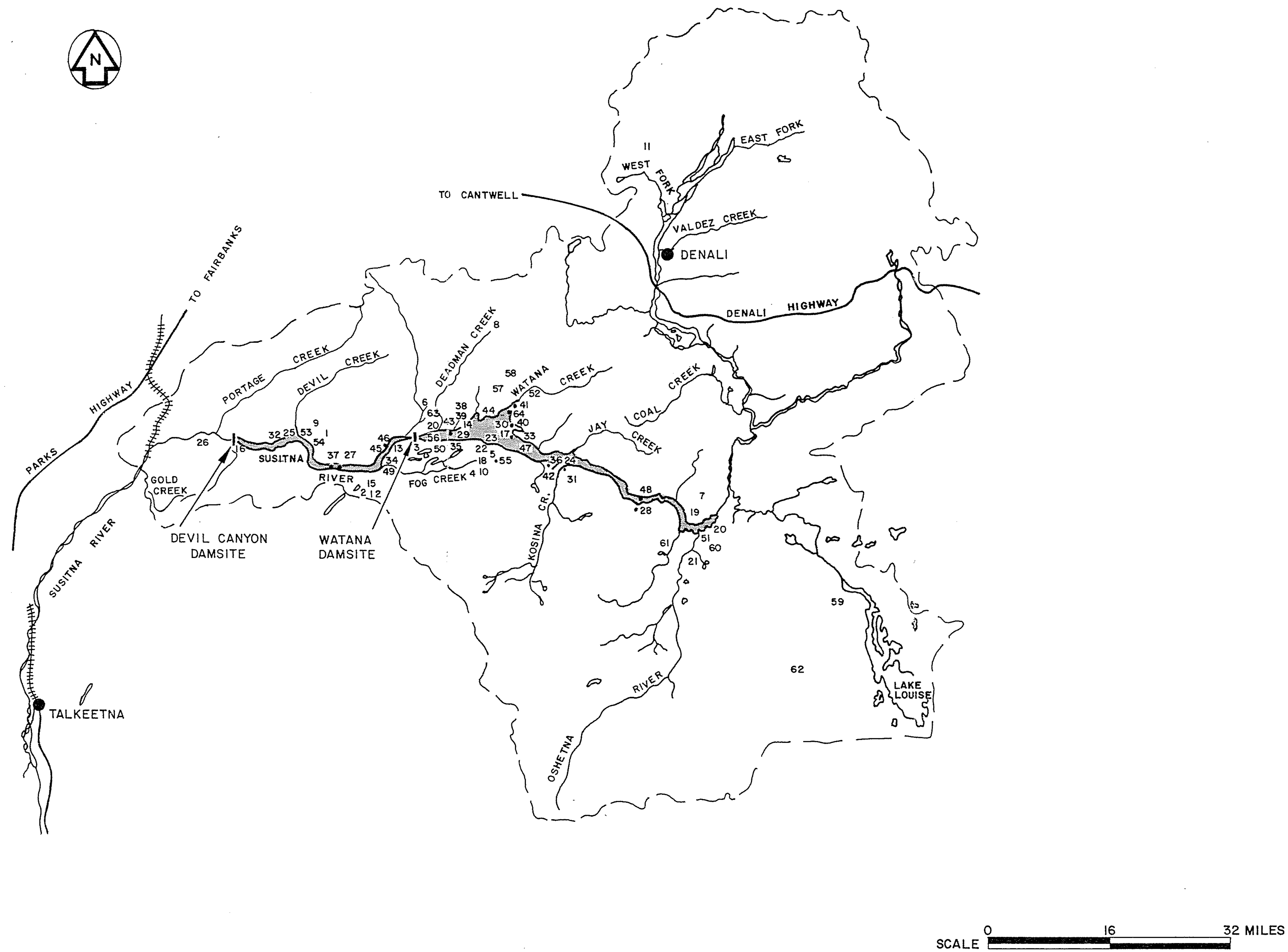
MAPPED AT SCALE: 1:63,360

VEGETATION MAP OF PROPOSED WILLOW-COOK INLET TRANSMISSION CORRIDOR

SCALE 0 2 4 MILES

FROM McKENDRICK et al. 1982

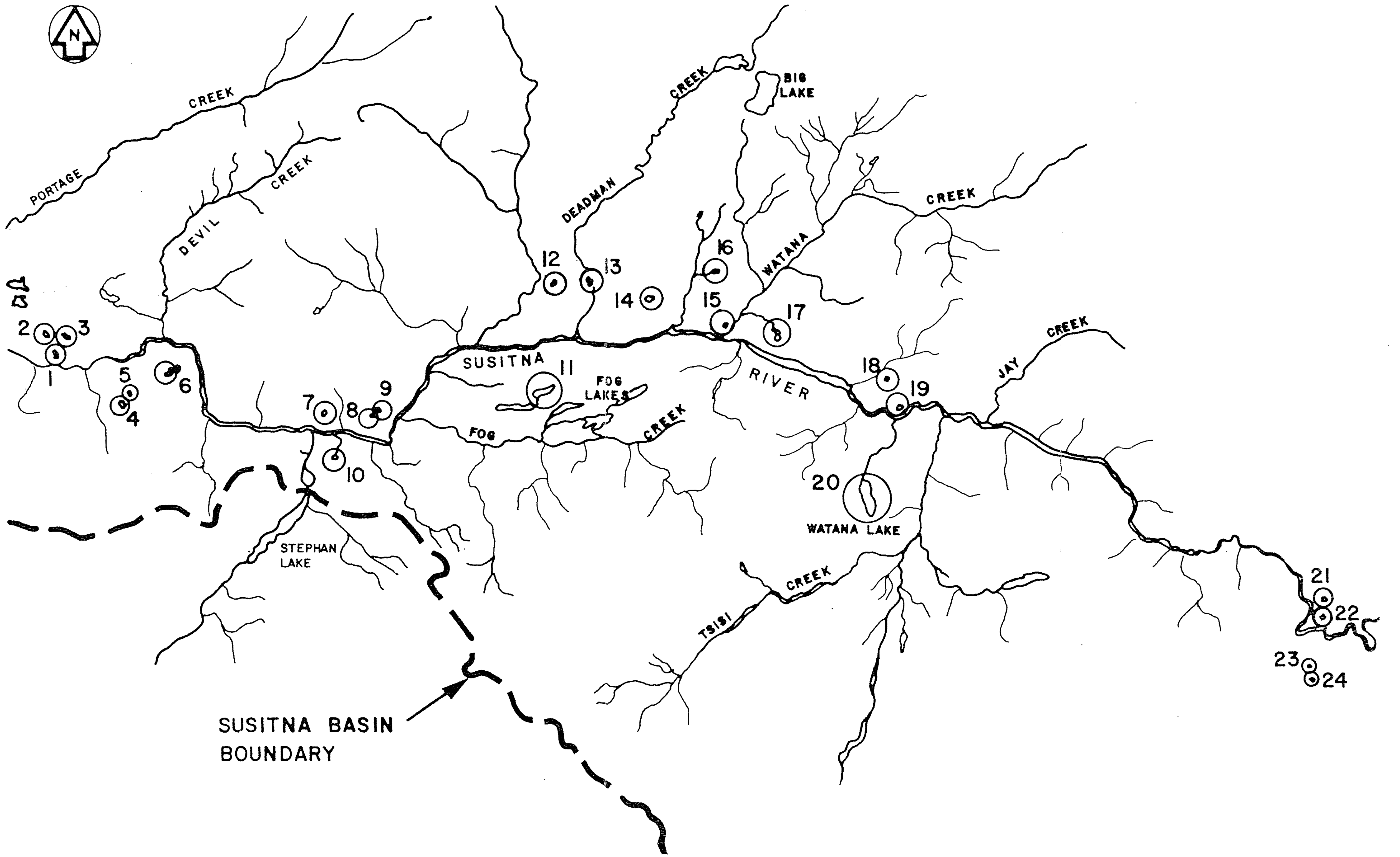
FIGURE E.3.3.12



VEGETATION SAMPLE LOCATIONS
IN SUSITNA RIVER BASIN, 1980

FROM McKENDRICK et al. 1982

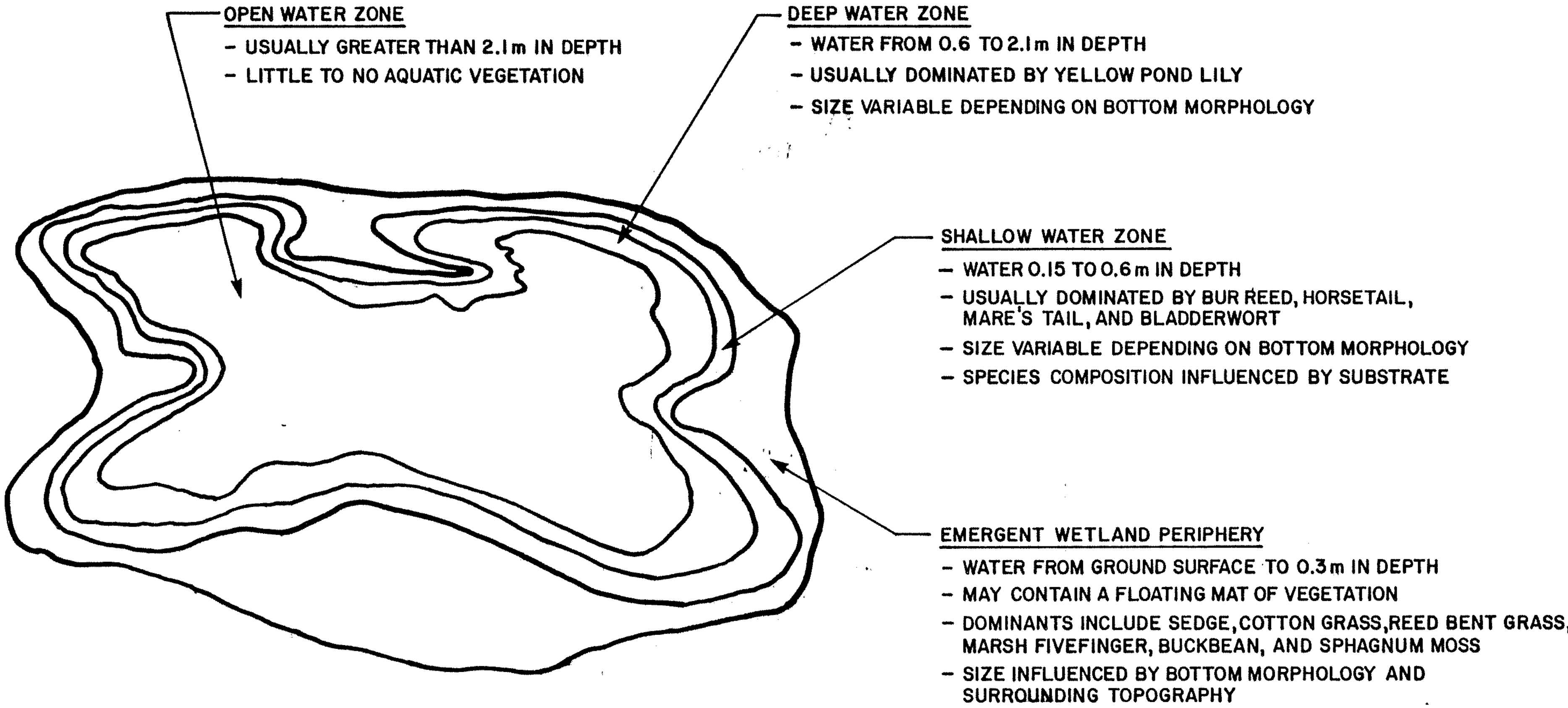
FIGURE E.3.3.13



LOCATIONS OF LAKES AND PONDS SURVEYED
FOR VASCULAR AQUATIC PLANTS IN AUGUST 1980

FROM McKENDRICK et al. 1982

FIGURE E.3.3.14

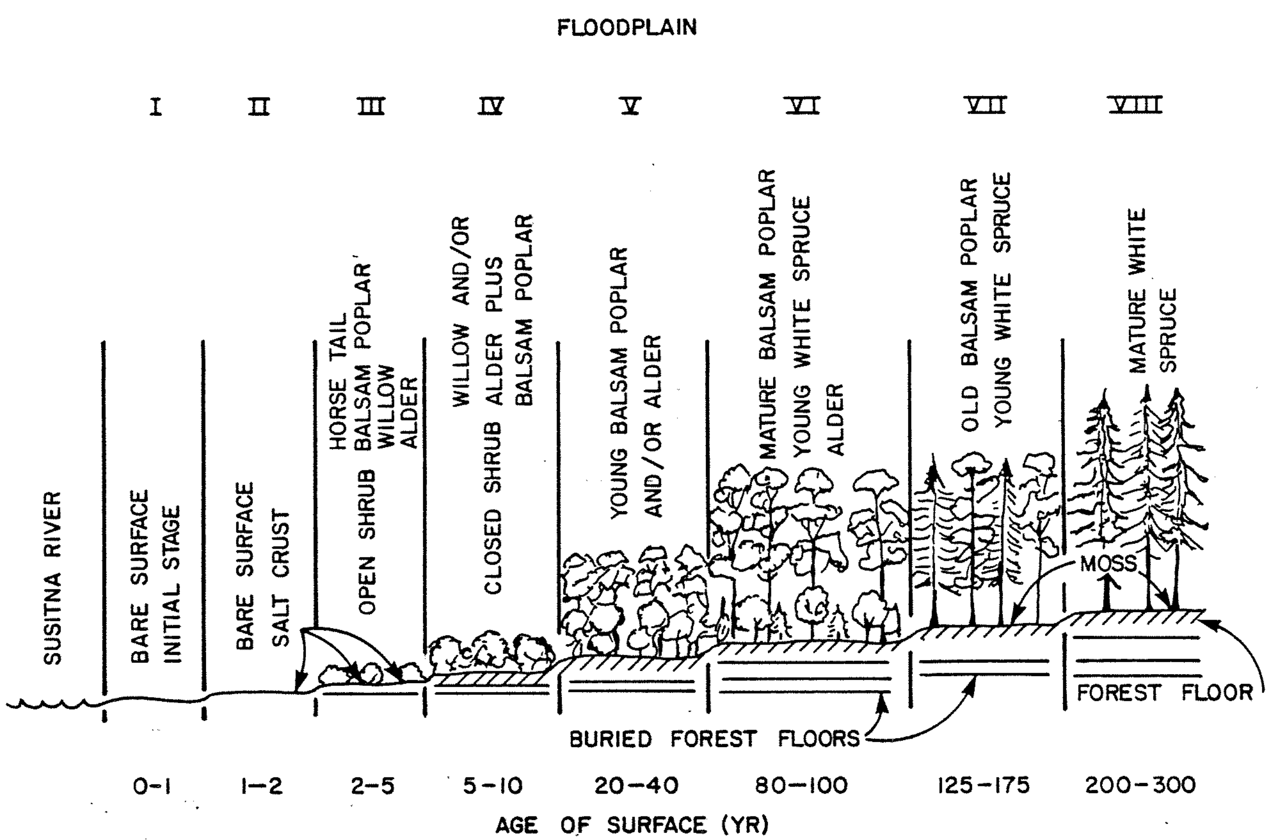


SCHEMATIC REPRESENTATION

A SCHEMATIC REPRESENTATION OF THE DOMINANT VEGETATION ASSOCIATED WITH MANY OF THE LAKES AND PONDS OF THE SUSITNA BASIN

(FROM McKENDRICK et al. 1982)

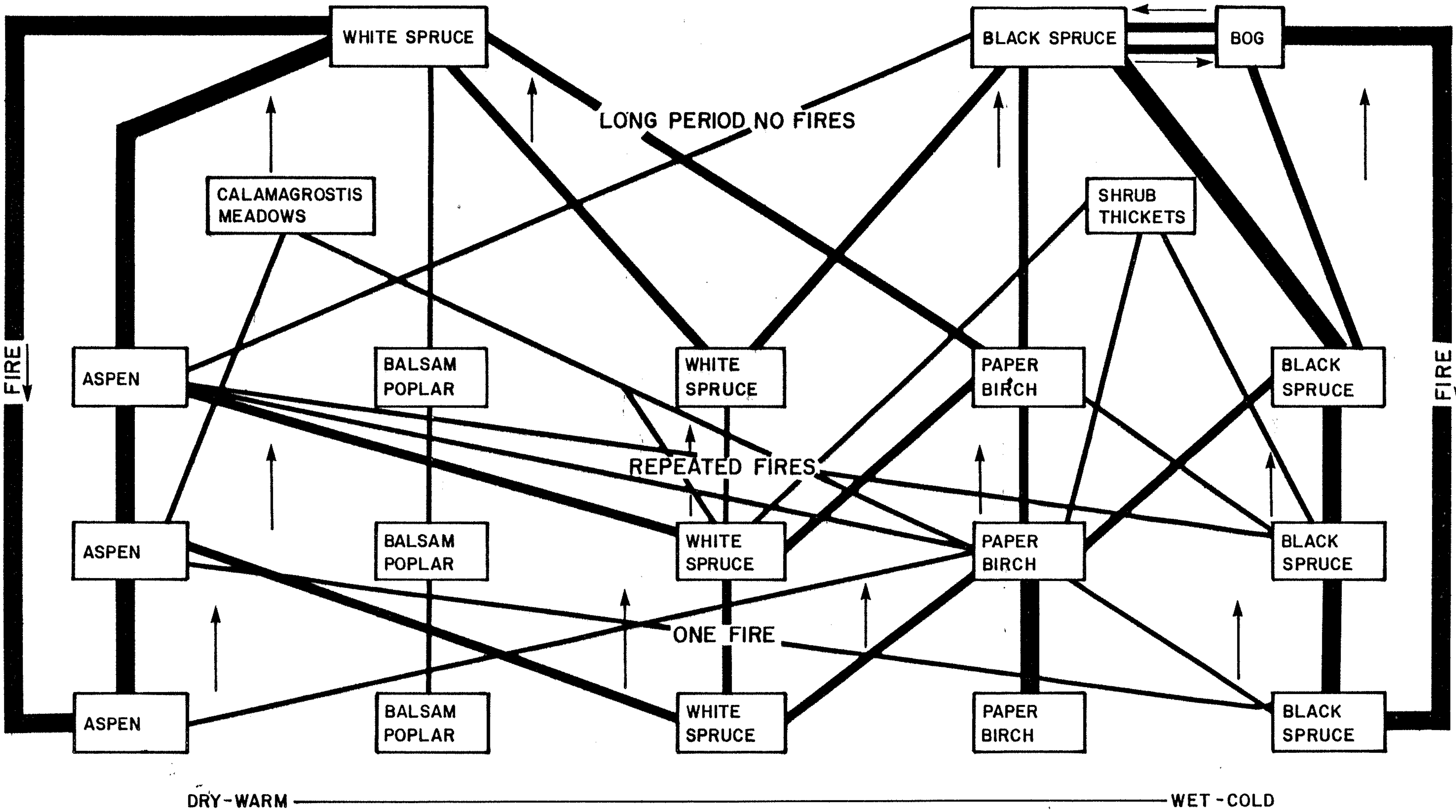
FIGURE E.3.3.15



PRIMARY SUCCESSION ON THE SUSITNA FLOODPLAIN

SOURCE: VAN CLEVE AND VIERECK 1981

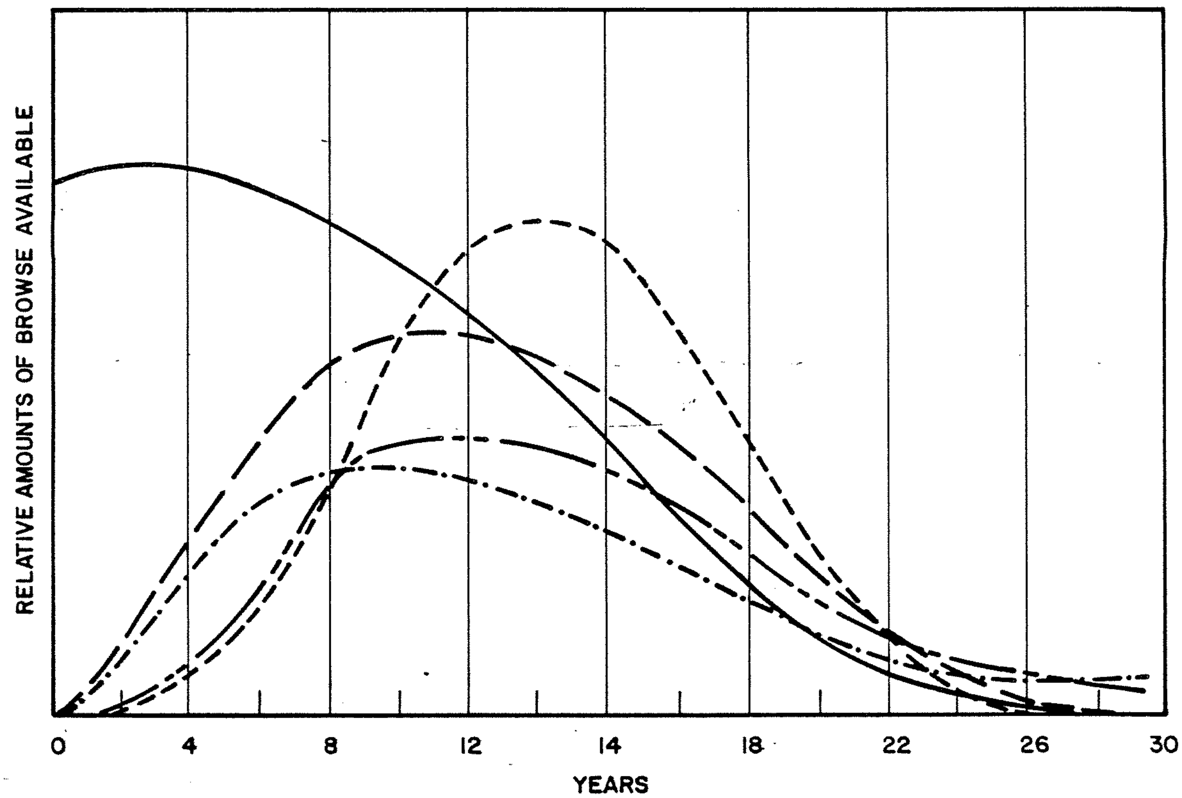
FIGURE E.3.3.16



PATTERNS OF FOREST SUCCESSION
FOLLOWING FIRE IN ALASKA

FROM VIERECK & SCHANDELMEIER 1980

FIGURE E.3.3.17



LEGEND:

ASPEN, VEGETATIVE REPRODUCTION

BIRCH, VEGETATIVE REPRODUCTION

BIRCH, SEED REPRODUCTION

WILLOW, SEED REPRODUCTION

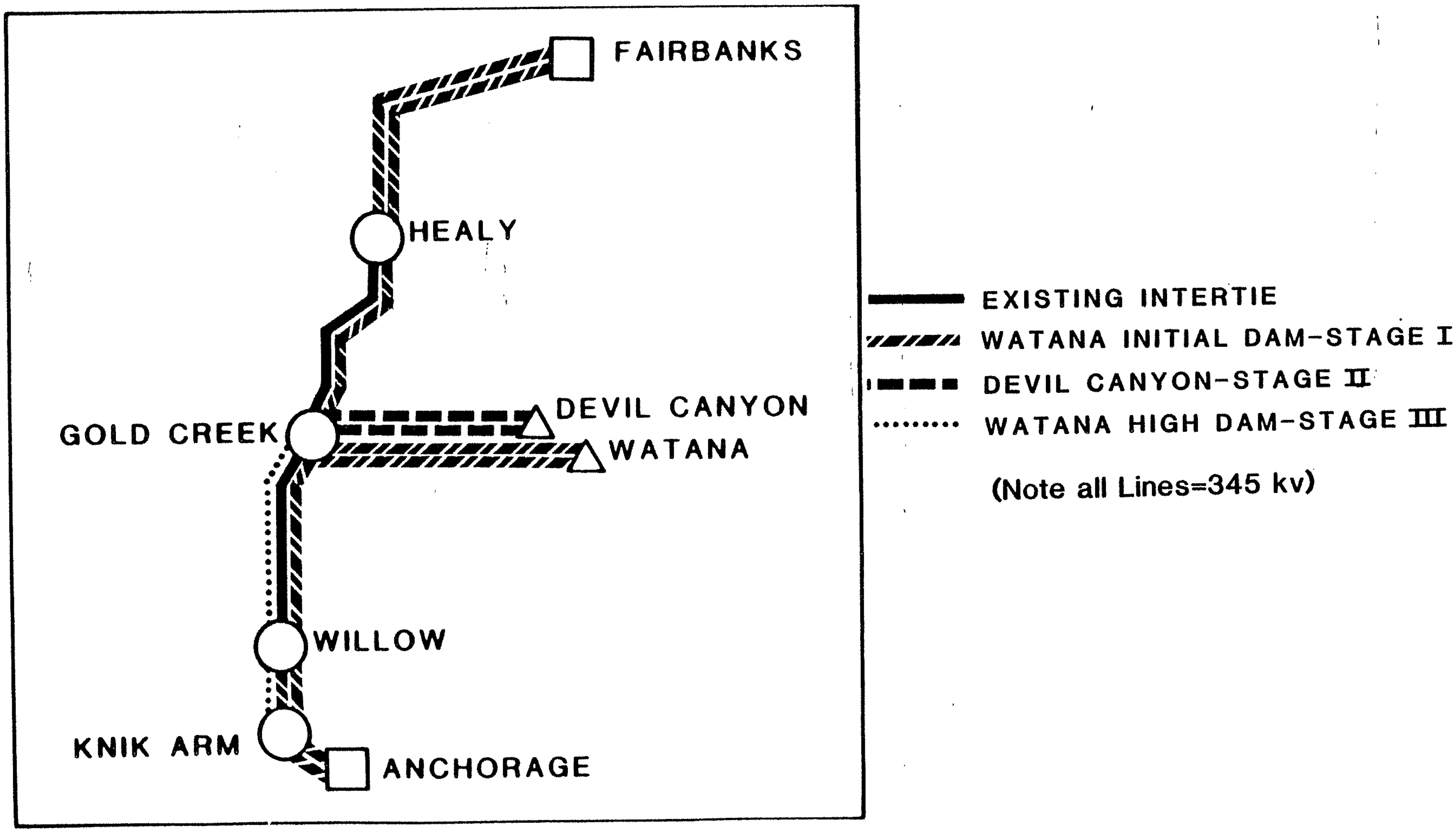
WILLOW, VEGETATIVE REPRODUCTION

RELATIVE AMOUNTS OF MOOSE BROWSE AVAILABLE COMPARED WITH THE TIME SINCE FIRE OR OTHER DISTURBANCE IN INTERIOR ALASKA

SOURCE: WOLFF AND ZASADA 1979

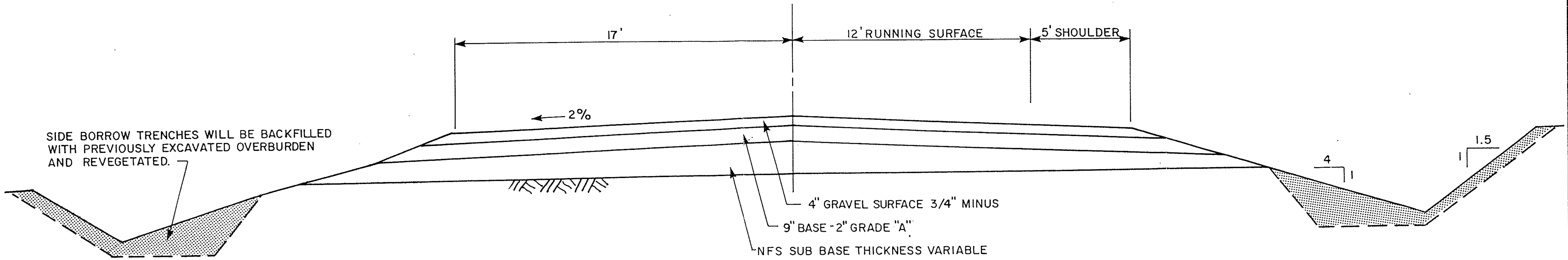
FIGURE E.3.3.18

SUSITNA HYDROELECTRIC PROJECT
TRANSMISSION LINES

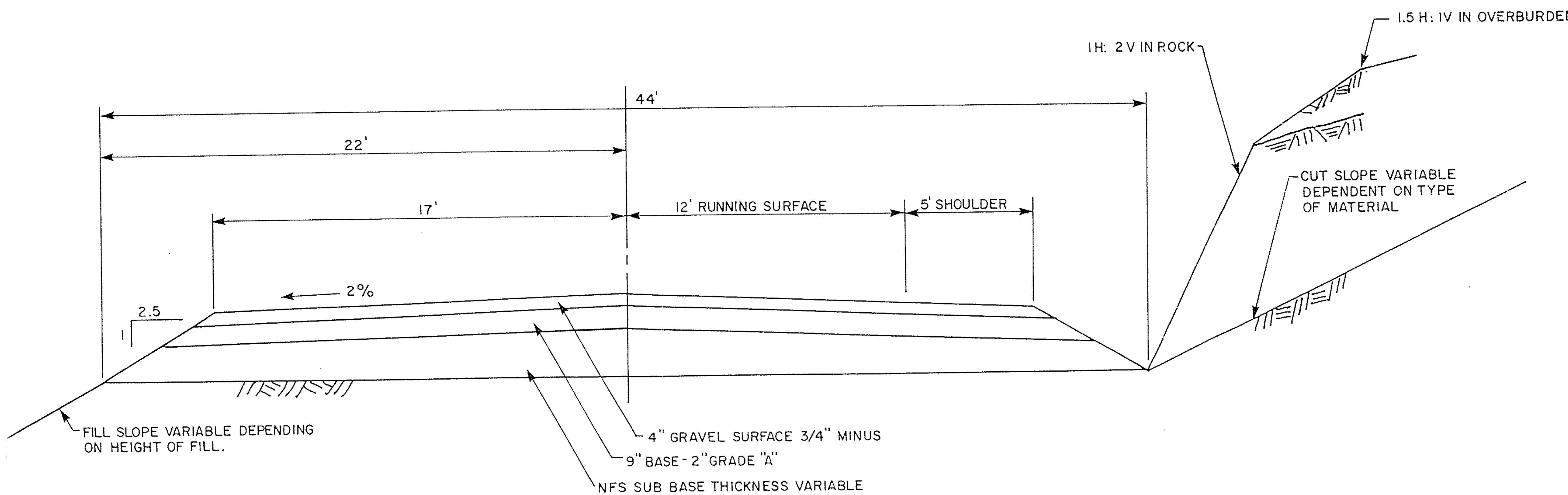


SOURCE: APA 1985h

FIGURE E.3.3.19



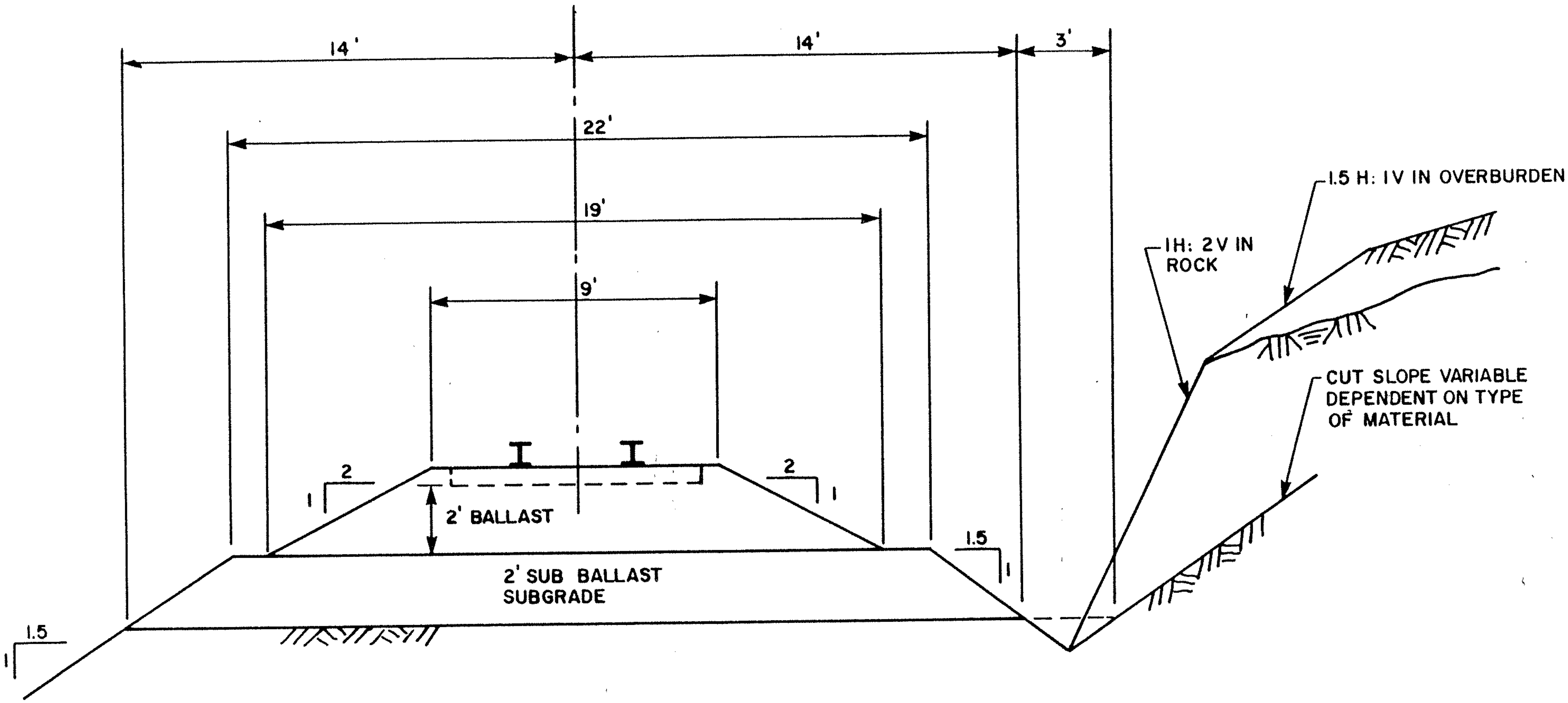
TYPICAL 'SIDE BORROW' SECTION



TYPICAL 'HILLSIDE CUT' SECTION

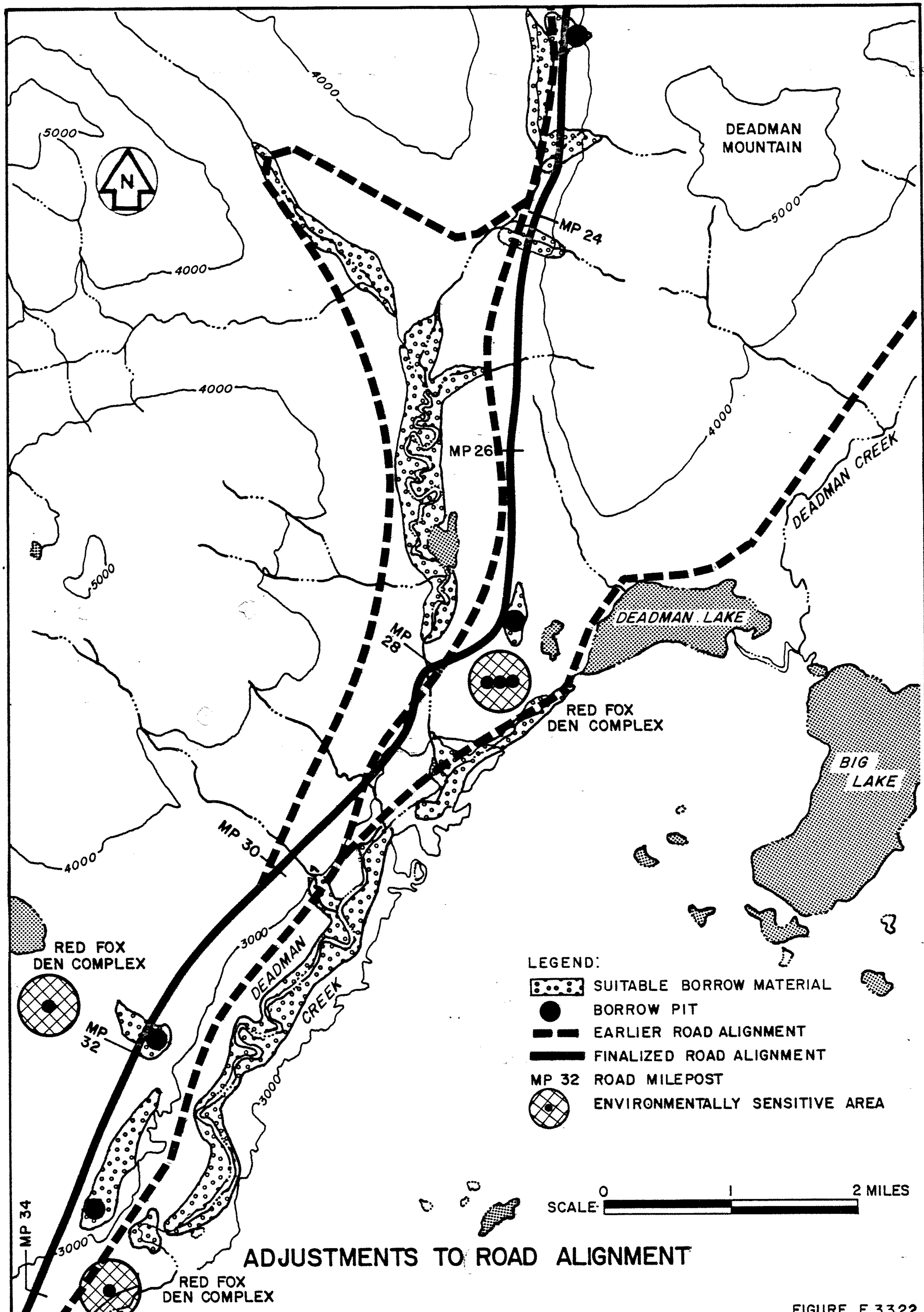
COMPARISON OF ROAD CONSTRUCTION TECHNIQUES

FIGURE E.3.3.20



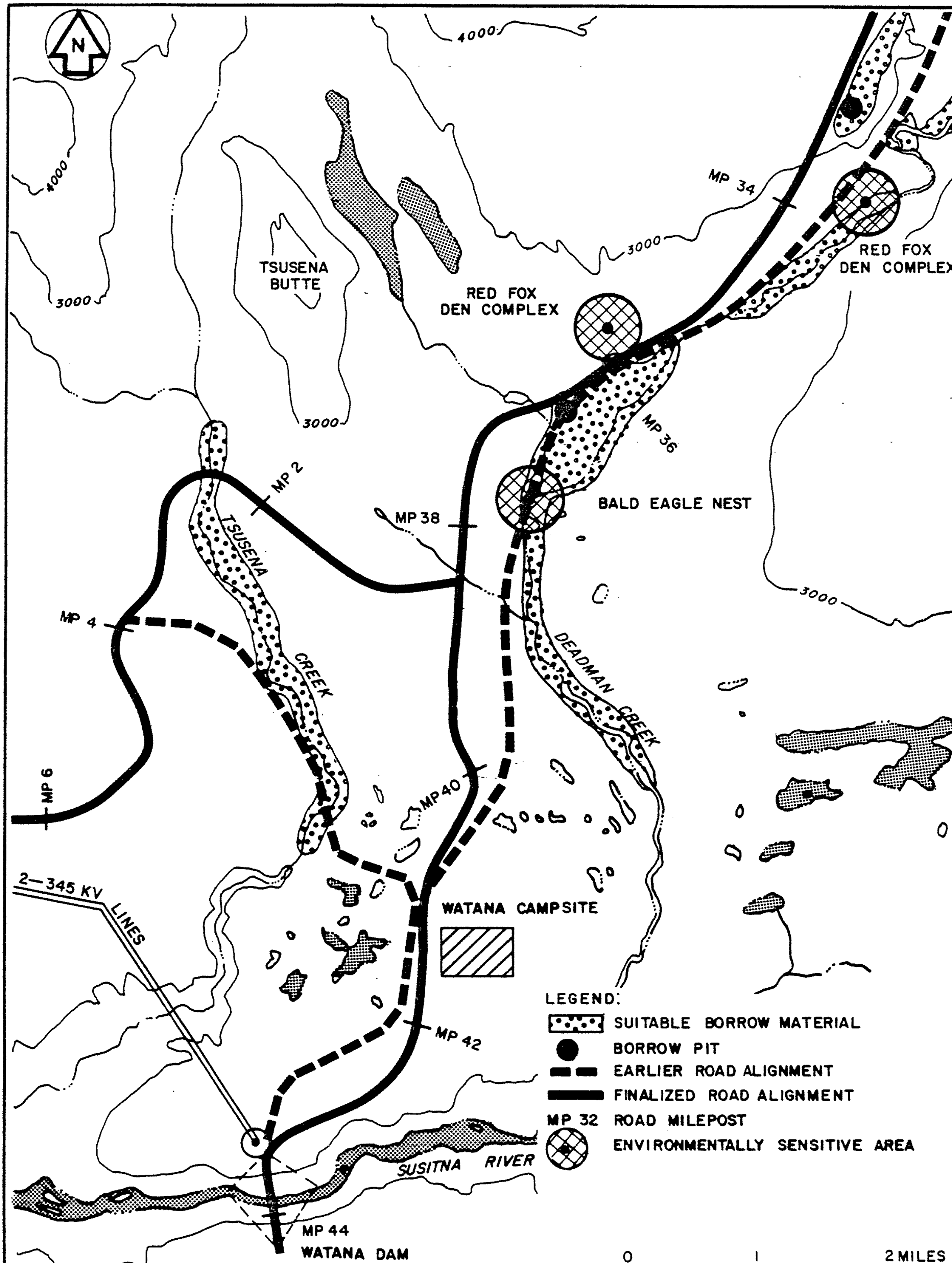
TYPICAL HILLSIDE CUT OF RAILROAD CROSS SECTION

FIGURE E.3.3.21



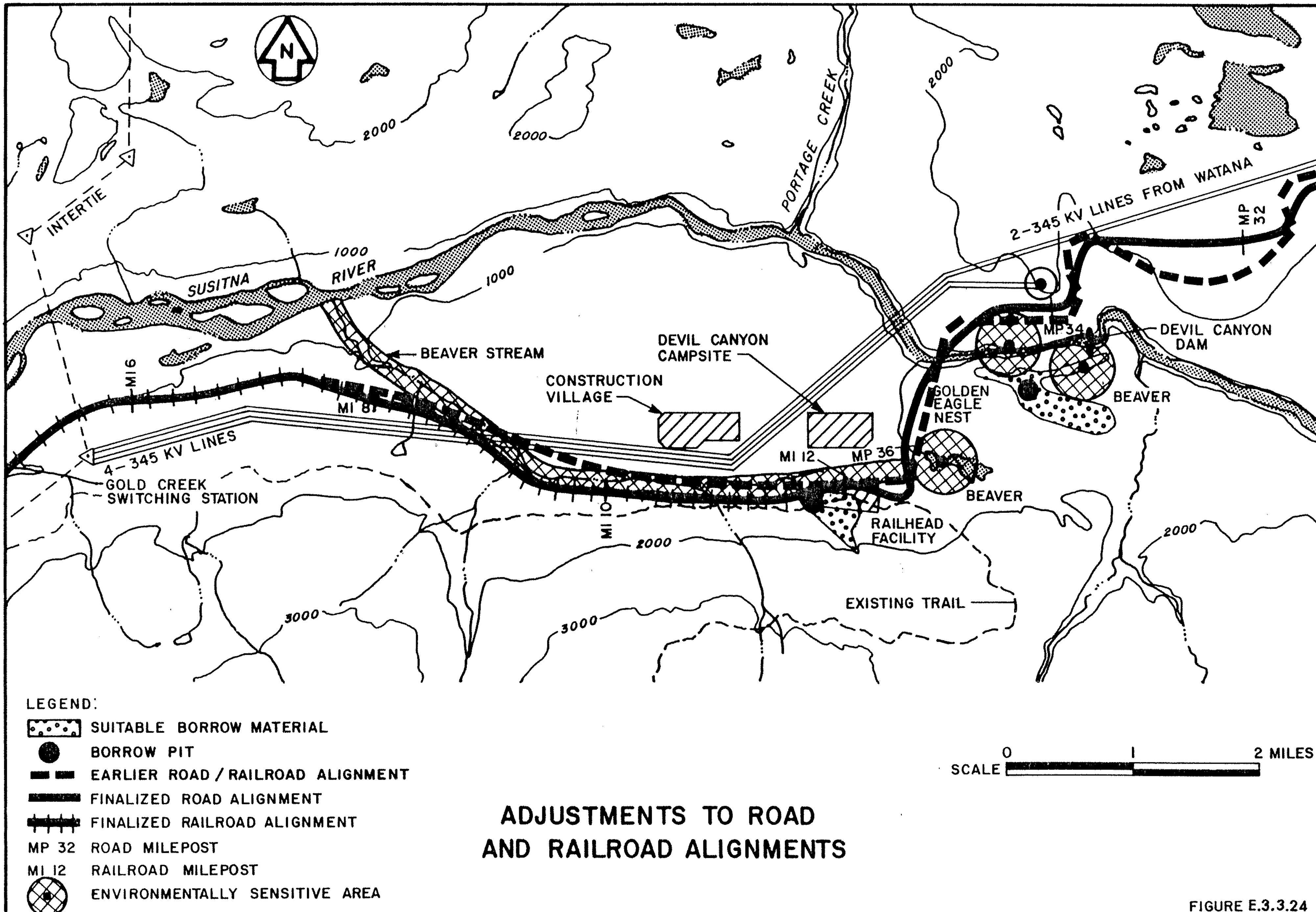
ADJUSTMENTS TO ROAD ALIGNMENT

FIGURE E.3.3.22



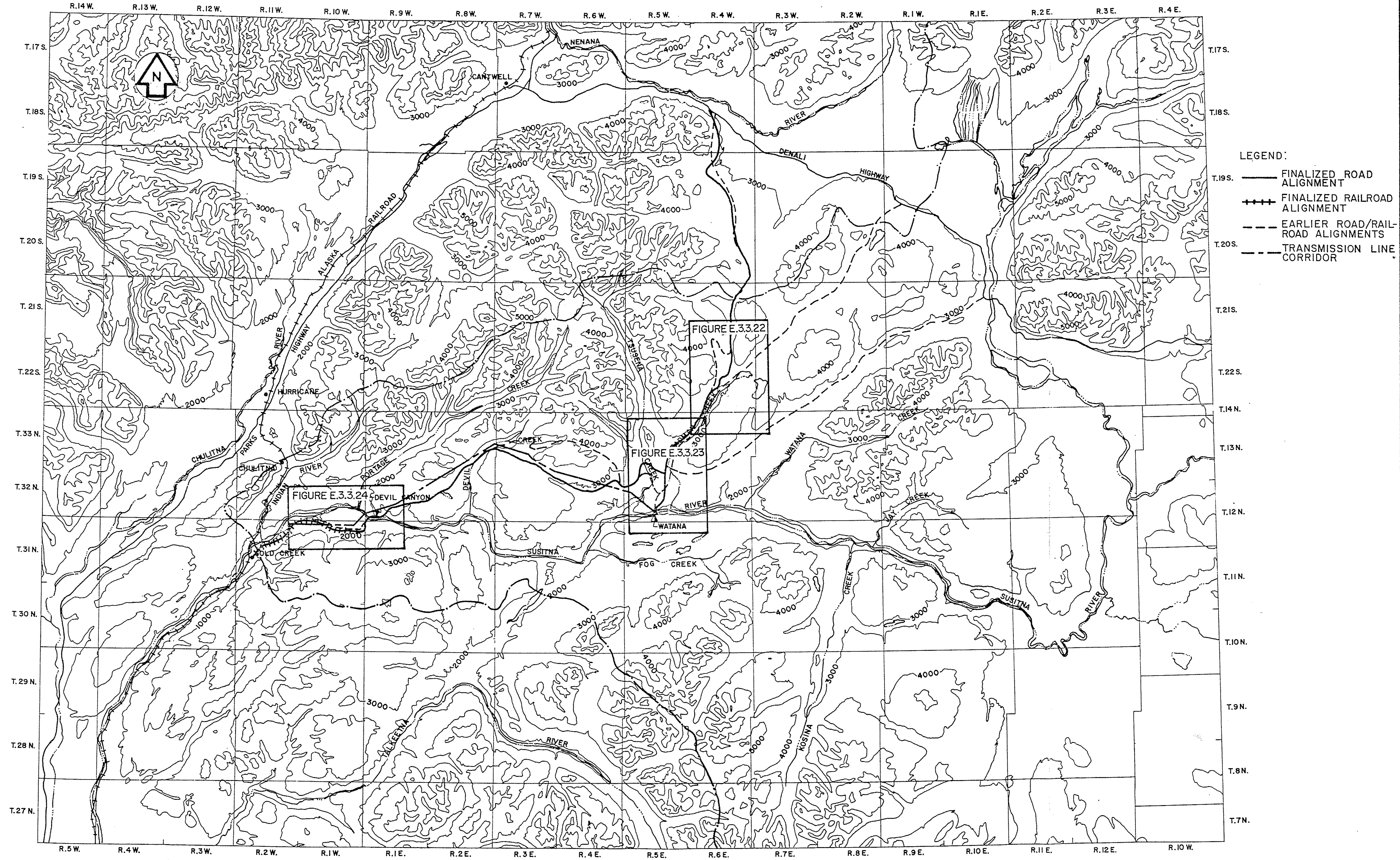
ADJUSTMENTS TO ROAD ALIGNMENT

FIGURE E.3.3.23



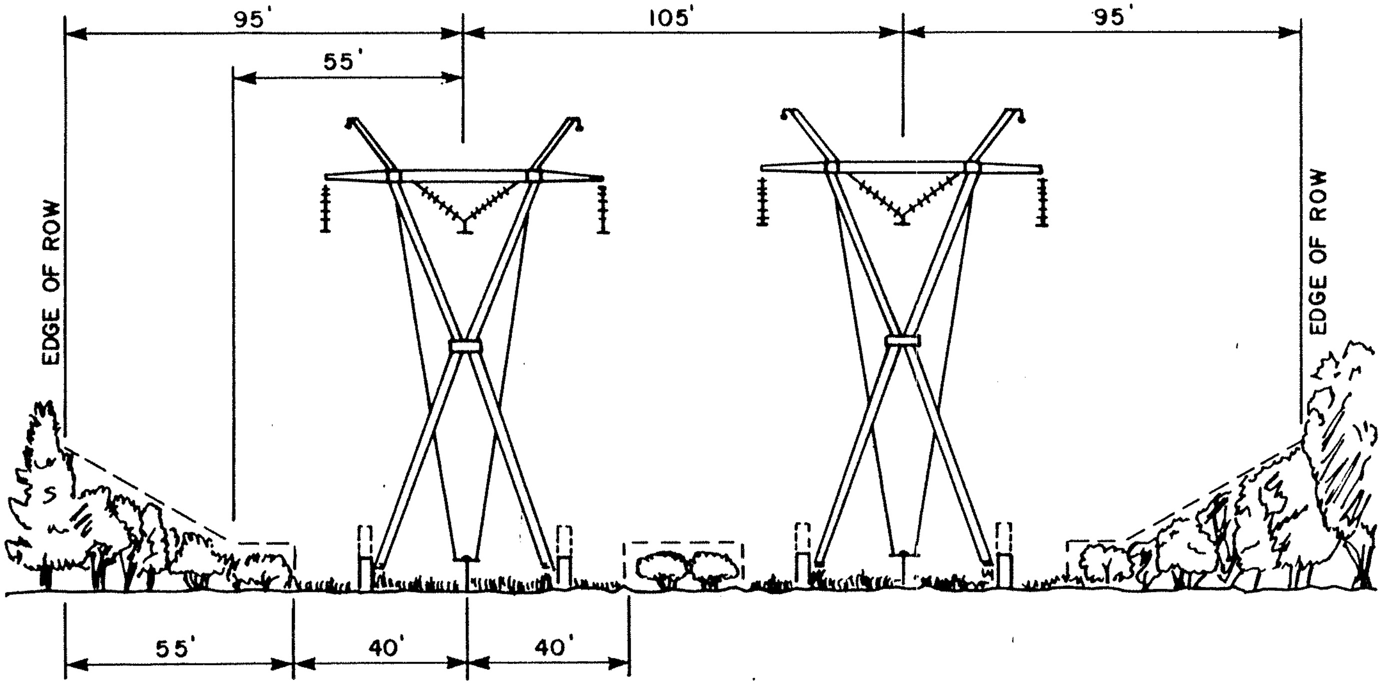
ADJUSTMENTS TO ROAD AND RAILROAD ALIGNMENTS

FIGURE E.3.3.24



ADJUSTMENTS TO ROAD/RAILROAD ALIGNMENTS
INDEX MAP

FIGURE E.3.3.25



NOTE:
TOWER SPACING CENTERLINE TO CENTERLINE DISTANCE 105'.
TOWER SPACING CENTERLINE TO EDGE OF RIGHT-OF-WAY 95'.

NUMBER TOWERS	RIGHT-OF-WAY WIDTH
1	190 FEET
2	300 FEET
3	400 FEET
4	510 FEET

TYPICAL TRANSMISSION RIGHT-OF-WAY CROSS SECTION

FIGURE E.3.3.26