SUSITNA HYDROELECTRIC PROJECT

ENVIRONMENTAL STUDIES

SUBTASK 7.12: PLANT ECOLOGY

PHASE I REPORT

APRIL, 1982

ACRES

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SUSITNA HYDROELECTRIC PROJECT

ENVIRONMENTAL STUDIES - SUBTASK 7.12

PLANT ECOLOGY STUDIES

PHASE I FINAL REPORT

April 1982

By

UNIVERSITY OF ALASKA

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PROPOSED DEVELOPMENT

In the proposed plan for full basin development, two major reservoirs will be formed. The larger reservoir extends 48 miles upstream of the Watana site and has an average width of about one mile and a maximum width of five miles. The Watana reservoir has a surface area of 38,000 acres and a maximum depth of about 680 feet at normal operating level.

The Devil Canyon reservoir is about 26 miles long and one-half mile wide at its widest point. A surface area of 7,800 acres and a maximum depth of about 550 feet represent conditions at normal operating level.

Staged development is planned. An initial installment of 680-MW of capacity at Watana will be available to the system in 1993 and 340 MW will be added in 1994. If the mid-range forecast in growth in energy demand is realized, Devil Canyon will be completed by 2002 with an installed capacity of 600 MW.

The Watana dam will be an earthfill structure with a maximum height of 885 feet, a crest length of 4,100 feet, and a total volume of about 62,000,000 cubic yards. During construction, the river will be diverted through two concrete-lined diversion tunnels, each 38 feet in diameter, in the north bank of the river. Upstream and downstream cofferdams will protect the dam construction area. The power intake includes an approach channel in rock on the north bank. A multi-level, reinforced concrete, gated intake structure capable of operating over a full 140-feet drawdown range will be constructed.

The Devil Canyon dam will be a double-curved arch structure with a maximum height of about 645 feet and a crest elevation of 1463 feet. The crest will be a uniform 20-foot width and the maximum base width will be 90 feet. A rock-fill saddle dam on the south bank of the river will be constructed to a maximum height of about 245 feet above foundation level. The power intake on the north bank will include an approach channel in rock leading to a reinforced concrete gate structure which will accomodate a maximum drawdown of 55 feet. Flow construction will be diverted through a single 30-foot diameter concrete-lined pressure tunnel in the south bank. Cofferdams and the diversion tunnel provide protection during construction against floods.

About 2 1/2 years of average streamflow is required to fill the Watana reservoir. Filling will commence after dam construction proceeds to a point where impoundment concurrent with continued construction can be accomodated. Post-project flows will be lower in summer and higher in winter than current conditions. As one proceeds downstream of the project, differences between pre- and post-project flow conditions become less pronounced, as the entire upper basin contributes less than 20% of the total discharge into Cook Inlet.

The selected access plan consists of a road from the railhead at Gold Creek to Devil Canyon on the south side of the river. At Devil Canyon the road crosses the Susitna and proceeds east to the Watana site on the north side of the river. The plan also includes access by road connecting Gold Creek to the Parks Highway. Limited access between Gold Creek and the Watana site by way of a pioneer road will commence in mid-1983. Road access from the Parks Highway will be deferred until after award of a federal license for the project, and the pioneer road will be rendered impassable if the project does not proceed.

The selected transmission line route associated with the Susitna project roughly parallels, but is not adjacent to, the access route between Gold Creek and the Watana dam site. At Gold Creek, it connects into the Railbelt Intertie. Between Willow and Anchorage, the route extends in a southerly direction to a point west of Anchorage, where undersea cables will cross Knik Arm. Between Willow and Healy, the route would utilize the transmission corridor previously selected by the Power Authority for the Railbelt Intertie.

SUMMARY

The plant ecology group was responsible for mapping in the upper Susitna River basin and along transmission corridors and describing vegetation in the upper basin and downstream areas. The vegetation/habitat types found in the upper Susitna River basin and the floodplain down to Talkeetna were described, classified, and mapped. Many locations throughout the study area were reconnaissanced in summer 1980 to obtain information on species composition and community structure. Ocular estimates of the cover of each species in each layer of vegetation were made, and these data were used to classify the vegetation according to the system developed by Viereck and Dyrness (1980). High altitude (U2) color infrared photography and LANDSAT imagery were used to map the vegetation cover types. Maps were produced at the scales of 1:250,000 and 1:24,000 for the entire basin and direct impact areas, respectively. Additionally, the area extending 16 km in any direction from the upper Susitna River from Gold Creek to the mouth of the Maclaren was mapped at a scale of 1:63,360. A 1:24,000 scale map of apparent wetlands was also produced, based on the 1:24,000 scale vegetation map and the wetlands classification system (Cowardin et al. 1979) used by the U. S. Fish and Wildlife Service. Two additional 1:63,360 scale maps were produced for the northern and southern transmission corridors. The central transmission corridor is included on the 1:63,360-scaled map of portions of the upper basin.

Vegetation successional studies were conducted downstream between the Deshka River and Gold Creek. Vegetation stands at different stages of development in three sections of the river were selected on the basis of aerial photography and field reconnaissance. These areas were sampled quantitatively to obtain vegetation cover estimates for all species, density, ages, heights, crown length and width (shrubs), diameter breast height (trees), and crown dominance measures for woody species.

Results of reconnaissance surveys of the vegetation/habitat types show that at least 255 vascular plant species in 134 genera and 56 families are present in the upper Susitna River basin. Of these species, 21 represented extensions of the previously known ranges of the species. Downstream areas contained 76 identified vascular plant species in 63 genera in 30 families. Nine species represented range extensions according to Hulten (1968). Overall, 277 species were observed which represented 140 genera in 56 families. Twenty-eight appear to be range extensions.

Special effort was made to locate any species which are currently under review by the U. S. Fish and Wildlife Service for possible status as endangered or threatened. Although some potential habitats of these species were located, none of the species were found.

Foot and helicopter surveys were also made of several lakes and ponds within and adjacent to the direct impact areas to determine the composition and structure of plant communities occurring in or near the water.

The major vegetation/habitat types found in the upper basin study area are low mixed shrub, woodland and open black spruce, sedge-grass tundra, mat and cushion tundra, and birch shrub. These vegetation/habitat types are typical of what is found covering vast areas of Alaska and northern Canada. Characteristically, these types are found on cold, wet soils and produce vegetation that grows slowly and often appears stunted. Natural occurrences of wildfire is common to these types and acts to reverse succession to lower stages which are believed to produce more annual growth of browse and herbaceous plants than the later successional stages. Less than 3% of the area is vegetated by deciduous or mixed conifer-deciduous forests which, by contrast, have more robust growth characteristics. Deciduous and mixed conifer-deciduous forests occur primarily along the Susitna River where soils are better drained and a longer growing season exists.

The dominant vegetation on the downstream floodplain was mature forest consisting of mature balsam poplar and mixed birch-spruce. Alder was important below Talkeetna but was less widespread above this area where the river is more channelized. Early successional stages included horsetail, willows, and young balsam poplar on sandy and silty areas with dryas on cobbly areas. Middle successional stages included alder and immature balsam poplar. Later stages included predominantly mature balsam poplar and birch-spruce with some bogs.

Primary vegetation losses in the Watana dam and impoundment area will be in woodland and open spruce stands and open mixed forests while the Devil Canyon facility will impact open and closed mixed forests and open spruce forests. The Watana impoundment is expected to impact 14,691 ha while the Devil Canyon impoundment may impact 3,214 ha of vegetation/habitat types. A large proportion of the deciduous and mixed forests in the study area will be destroyed by the impoundments. Other types that will be affected will involve small areas relative to their availability across the entire upper Susitna River basin. If vegetation/habitat types that might be destroyed are important as sources of browse for moose, replacement browse supplies in adjacent areas may be created by burning or by clearing to stimulate regrowth of palatable shrubs.

The complete development of all borrow areas at both Devil Canyon and Watana will destroy an estimated 1,751 ha of vegetation/habitat types. Woodland and open spruce, low mixed shrub, and birch shrub will be the principal types affected. Many of these areas, along with construction sites and roads, may be revegetated by mulching and seeding with native species to quickly restore ground cover. Natural revegetation following fertilization also appears promising in mitigating temporary losses of vegetation.

Decreased flow rates downstream during the period of reservoir filling and during the period of operation and maintenance will allow vegetation to occupy previously bare areas because of the lack of flooding and will allow new unvegetated areas to become stabilized. Lack of seasonal floods will permit some sites in early successional stages of vegetation to advance to later successional stages.

It is difficult to identify how long it takes an area to become "stabilized". Vegetation may develop, be silted under, and resurface an unlimited number of times. Above-ground ages of woody species in early successional stages were generally less than 10 years. Ten to fifteen years after above-ground growth begins, alder may become the dominant vegetation. Since the amount of newly exposed land at lower flow rates does not appear to vary directly with the flow rate, it is difficult to estimate how much new area would be gained by reduced flow rates and how much would be lost to advanced stages. The area between Whiskers Creek and the Chulitna River would appear to gain about 40 ha of new land while 50 ha of existing bare land would have early successional stands established. Some fluvial and flooding processes dampened by the dams could be largely obviated by the inputs from the Chulitna and Talkeetna Rivers below the three rivers confluence near the town of Talkeetna.

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1 - INTRODUCTION

The overall objective of the Plant Ecology Studies was to map and describe the vegetation/habitat types occurring in the areas to be affected by the proposed Susitna Hydroelectric Project and, for the purposes of regional perspective, the surrounding basin; to predict impacts that will result from the proposed facilities; and to provide preliminary mitigation options. Specifically, during 1980 our objectives were to produce preliminary vegetation maps and qualitative descriptions of each vegetation type mapped. Objectives in 1980 also included mapping the wetlands. Additionally, we were to survey the upper Susitna River impact areas for plant species currently being reviewed by the U. S. Fish and Wildlife Service for protection under the Endangered Species Act of 1973. In 1981 our main objective was expanded to include some quantitative plant community descriptions and predict sequences of vegetation succession on the floodplain downstream from the hydroelectric project. Maps of the transmission corridors were also to be produced in 1981.

2 - METHODS

2.1 - Definition of Study Area

The main study areas included the upper Susitna River basin and downstream floodplain which are located in southcentral Alaska (Figure 1). Transmission corridors from Willow to Cook Inlet and from Healy to Fairbanks were also studied.

The study area during 1980 included all of the upper Susitna River drainage and the floodplain of the Susitna River from Gold Creek to Talkeetna. Some portions of this area were examined more intensively than others. The scale at which the different areas were mapped is presented in Figure 2 and gives some indication of how the effort was distributed; more attention was given to areas that were mapped at larger scales, since these are the areas which will be directly impacted by the proposed hydroelectric project.

During 1981, the floodplain between the Deshka River and Gold Creek was intensively studied. Transmission corridors -- Central, Willow to Cook Inlet, and Healy to Fairbanks -- were mapped and some additional vegetation surveys were conducted in the upper basin (Figure 3).

2.2 - Vegetation Cover/Habitat Mapping

Vegetation of the entire upper Susitna River drainage (Figure 2) was mapped at a scale of 1:250,000. Vegetation adjacent to and within 16 km of the upper Susitna River and within the transmission corridors (Figure 3) was mapped at a scale of 1:63,360. The vegetation within the proposed impact areas (i.e., impoundments, areas within 0.8 km of impoundments, floodplain from Portage Creek to Talkeetna, and borrow sites) was mapped at a scale of 1:24,000. The classification system presented by Viereck and Dyrness (1980) was used on the maps.

Mapping at all three scales for the upper Susitna River basin began by subdividing the entire upper drainage into major physiographic regions by the interpretation of winter and summer LANDSAT imagery. Vegetation units on 1:120,000 scale high altitude (U-2) color infra-red (CIR) photography of representative areas in each physiographic region were then delineated and identified according to Viereck and Dyrness (1980). The 1:120,000 scale prints, with attached overlays, were taken into the field and as many delineated vegetation units verified as possible. Field checks were distributed across each of the major physiographic regions, with emphasis being placed on those vegetation types which were most difficult to interpret on aerial photography. Helicopter availability also was a factor in determining how many and which areas could be checked. Transparent enlargements of CIR imagery at 1:24,000 and 1:63,360 scales were obtained. Vegetation units were then delineated on mylar overlays by using the enlargements. The 1:250,000 scale mapping was done on an overlay of a summer LANDSAT image; in each case, field-checked copies of the 1:120,000 scale CIR imagery were consulted for accuracy. Field experience aided interpretating tones and textures of CIR imagery and the mapping of the vegetation. Finally, overlay maps were traced on subdued positive transparencies of corresponding USGS topographic maps. These final maps were used as masters for duplicating copies.

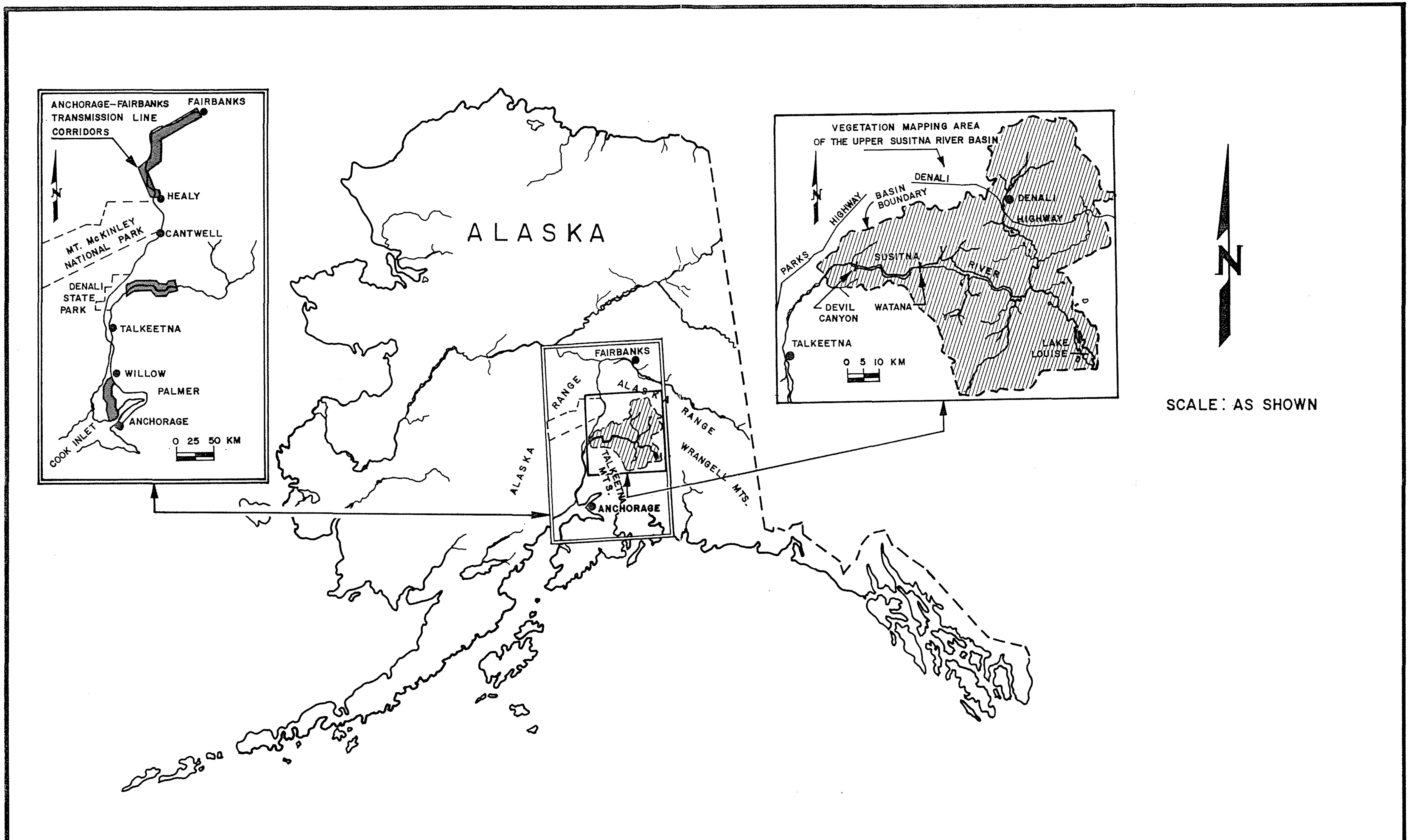

FIGURE 1

LOCATION OF STUDY AREAS
IN THE STATE OF ALASKA

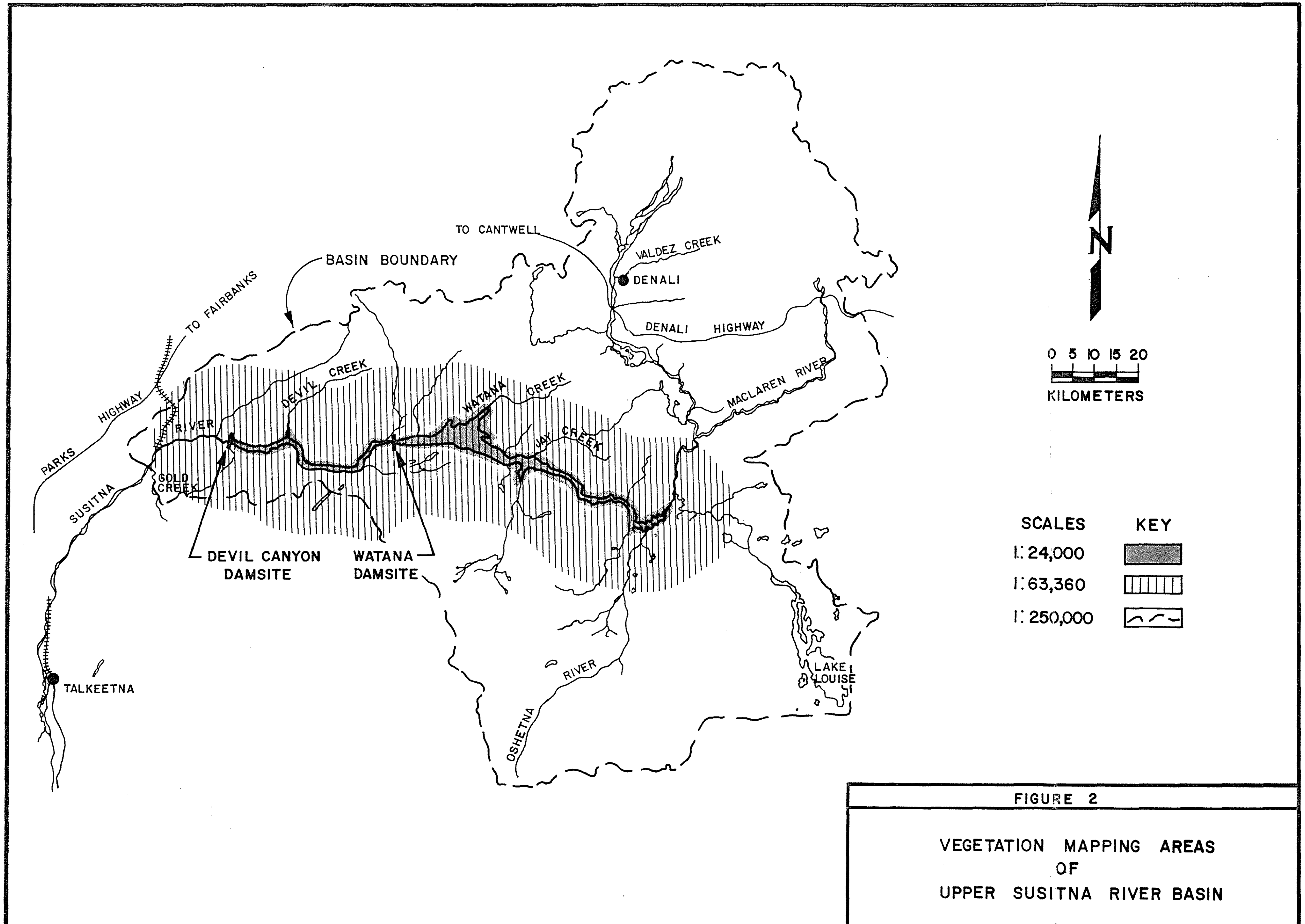

FIGURE 2

VEGETATION MAPPING AREAS OF UPPER SUSITNA RIVER BASIN

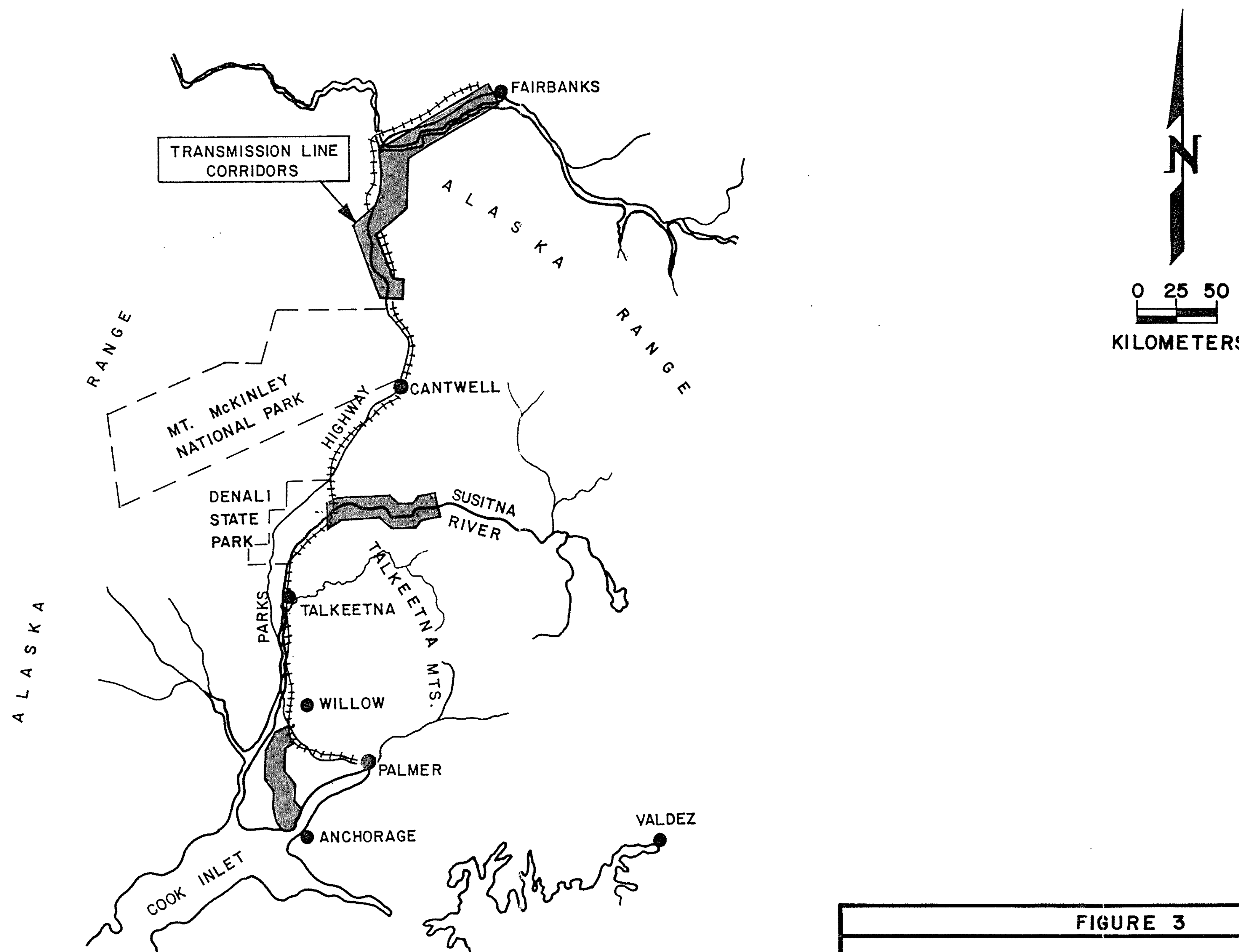

FIGURE 3

VEGETATION MAPPING AREAS FOR TRANSMISSION CORRIDORS

During field checking of transmission corridors, CIR photography at a scale of approximately 1:63,360 was used from Clear, Alaska, to Fairbanks, Alaska, and black and white photography at a scale of 1:48,000 from Healy, Alaska, to Clear, Alaska. These black and white images were used to a lesser extent from Clear to Fairbanks. High altitude CIR transparencies (1:63,360) were used for actual mapping in the laboratory. True color 1:12,000-scaled photographs of the Alaska railroad were used to a limited extent to assist interpreting vegetation in the Healy area. High altitude CIR prints (1:120,000) were used for field checking and mapping of the Willow to Cook Inlet segment.

Areal extents of vegetation/habitat types were determined by cutting each type from a paper reproduction of the map and weighing the cut-out portions according to type. Several areas of known size (about 5-10 sq mi) were cut out, weighed, averaged to calculate actual areas from weights. Percentages were computed as ratios of the individual types to the total area.

2.3 - Qualitative Assessments

(a) Sampling Locations

Each major vegetation type was surveyed at the reconnaissance level. Areas surveyed were selected based on the aerial photography. Some areas were chosen because we were unsure of what vegetation type was represented by certain colors and textures on the photographs. Others were selected because more sample points were needed in a particular vegetation type. The desired number of sample locations in a vegetation type was based on the extent of that type and on severity of impact from the proposed Susitna Hydroelectric Project. In other words, more areas were sampled in vegetation types of large extent and in the impoundment areas. The size and location of an area sampled depended on the size of the homogeneous area, the number of people sampling, and time constraints. The areas and types sampled during the 1980 field season (June, July, and August) are indicated on Table 1 and Figure 4.

(b) Vegetation Characteristics

For purposes of describing each vegetation/habitat type, species composition and community structure data were collected at each area sampled. Cover of each plant species in each layer of vegetation was obtained by the ocular estimate method. Cover is the vertical projection of living plant parts on the ground and is measured as a percentage of area sampled. The ground layer consisted of all herbaceous species and all woody species less than 0.5 m tall. The shrub layer consisted of woody species taller than 0.5 m but less than 2.5 cm dbh (diameter breast height). Understory vegetation was woody species between 2.5 cm and 10.0 cm dbh. Overstory vegetation consisted of species larger than 10.0 cm dbh. "Shrub layer" referred to a layer of vegetation whereas the term "shrub" referred to the life form of woody species, such as resin birch (*Betula glandulosa*), dwarf arctic birch (*B. nana*), alder (*Alnus* spp.), crowberry (*Empetrum nigrum*), and others which are not considered trees. Some tall shrubs such as alder might be taller than short trees such as black spruce (*Picea mariana*). Hence, height was not a good distinguishing characteristic for these life forms in this vegetation.

Table 1. Vegetation/habitat types (and sample location numbers) sampled in upper Susitna River basin, summer 1980.

Vegetation/habitat Type	Sample Location Number[a/]
Mat and cushion tundra	1-8
Sedge-grass tundra	9-10
Herbaceous tundra	11
Wet sedge-grass	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
Low shrub	54-62
Willow shrub	63-64

a/ Sample locations are given in Figure 4.

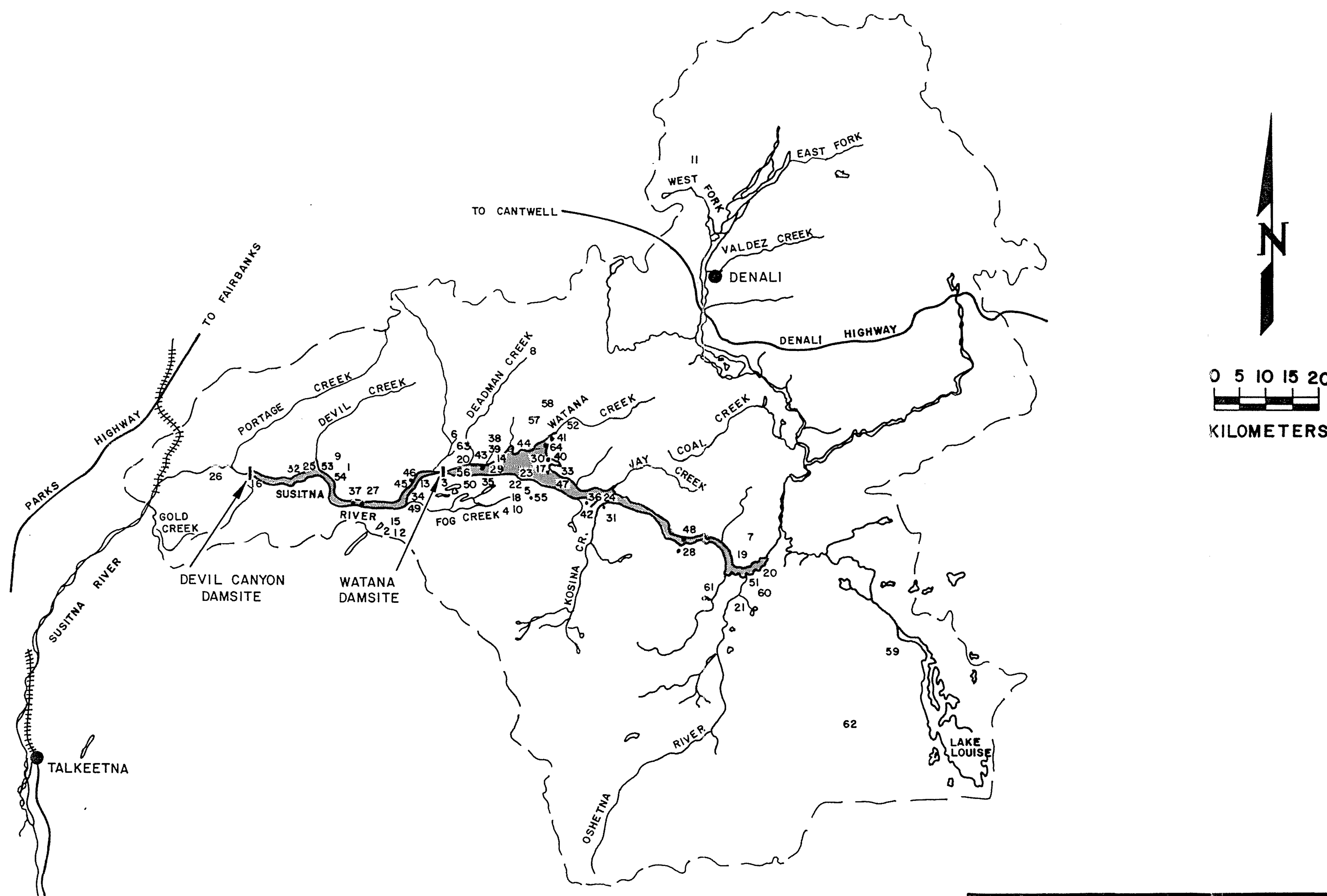

FIGURE 4

VEGETATION/HABITAT TYPES SAMPLE LOCATIONS IN UPPER SUSITNA RIVER BASIN, 1980

A specific woody species could occur in any one or combination of layers in a given stand. Cover was also estimated for each layer of vegetation described. Cover values are not additive because of overlapping layers. In other words, if a species has 15% shrub layer cover and a 10% ground layer cover, its overall cover would be at least 15% but may be less than 25% if parts of the taller individuals occur above the shorter individuals. Similarly, the sum of the cover percentages in a stand may exceed 100%.

(c) Physical Characteristics

The objective of this portion of the qualitative assessment was to collect data that would describe characteristics of the physical environment which could be closely associated with the occurrence of a particular vegetation/wildlife habitat type. One person on the survey team was assigned to record the physical variables at each site where the vegetation was described. Elevation was determined from topographic maps or the altimeter of the helicopter. Degree of slope typical of the site was measured with an Abney level. Aspect was determined with a compass and recorded in degrees. Position was also recorded according to elevation and location of the site with respect to the land form on which it occurred (e.g. canyon site; mid, upper, or lower level; mountain top).

(d) Wildlife Habitat

The focus of this part of the qualitative assessment was describing habitat value of each community/habitat type for ungulates. Secondarily, sign of other wildlife species, such as birds, small mammals, and bears was recorded.

Available browse, browse utilization, browse vigor, pellet groups, and comments relative to wildlife habitat were recorded. Specifics are discussed in the Plant Ecology Procedures Manual (Alaska Power Authority 1980a).

(e) Wetlands

All land within the proposed impact areas was also classified according to Cowardin et al. (1979) into appropriate wetland classes. A map delineating wetland types was constructed using the vegetation/habitat maps following the same procedures described in Section 2.2. The only difference was that the vegetation units were replaced with appropriate wetland classes. This was done with little consideration of soil moisture conditions, since this information was mostly unavailable at the time. Presence of steep slope and likely good drainage was interpreted to rule out classification as wetland in some cases where the vegetation cover did indicate the possibility of wetland. Obviously, this is somewhat questionable without actual soils data for interpretation.

In order to obtain information on aquatic plant species, several ponds and lakes and their peripheral wet areas within the impoundment zone and adjacent uplands were surveyed on foot. During the surveys, species composition, dominance, and total cover (relative to 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 of the remaining ponds and lakes, not surveyed on foot, were examined by helicopter overflights to ensure similarity among ponds and to search for species not previously encountered.

2.4 - Quantitative Descriptions

Quantitative descriptions of downstream floodplain plant communities were based on sampling of 29 stands between the Deshka River and 11 km north of Talkeetna (Figure 5). Reconnaissance of the area in August 1980 and again in early summer 1981 was used to determine the types of floodplain vegetation present. In June 1981 a series of points systematically plotted on aerial photographs was classified by helicopter survey and used to determine the relative availability of each of the types. Sample stands were then selected in each type in each of three reaches of the river -- Deshka River to Sheep Creek, Sheep Creek to Birch Creek Slough, and Birch Creek Slough to Chase.

Stands of middle and late successional stages were required to be of sufficient size and uniformity to allow placement of four randomly oriented, non-overlapping 30-m transects. Initial data analysis indicated that more transects were needed for adequate sampling. In August, two more transects were used in most of these stands (except two alder stands) and four more transects were used in one of the highly variable birch-spruce stands (stand 4). Early successional stands were sampled with four transects in a homogeneous area where possible. However, many of these areas were too small and as few as two transects were used in some places. Sometimes one transect would be taken in one patch and another in a nearby, but not contiguous, area.

Vegetation cover by species was recorded on two to eight transects at points spaced 50 cm along a tape measure. Observation of points in the overstory was aided by use of a set of cross-hairs in a sighting scope. Species occurring within 5 m of one side of the transects, but which were not encountered at any of the points, were listed.

Woody species density was determined by counting the number of individuals by height class rooted within a designated plot alongside the length of the transect. Shrubs <.4 m, .4 m to 2 m, and >2 m but <4 cm dbh were counted in a 1-m wide plot. Shrubs <0.4 m tall were judged unavailable for winter browse because of snow. Browsable stems were those in size class 0.4 m to 2 m tall and >2 m tall but <4 cm dbh. Tall shrubs (>2 m in height and >4 cm dbh) were counted in a 2-m wide plot. Trees (>4 m in height) were counted in a 5-m wide plot. An individual was defined as any stem emerging at the surface of the litter.

Age, height, and dbh of important tall shrubs and trees were measured on two randomly selected individuals along each transect. Important low shrubs were also measured for height, length, and width. Heights of tall individuals were measured with a range finder. The age of each measured tree or shrub was determined by counting growth rings taken

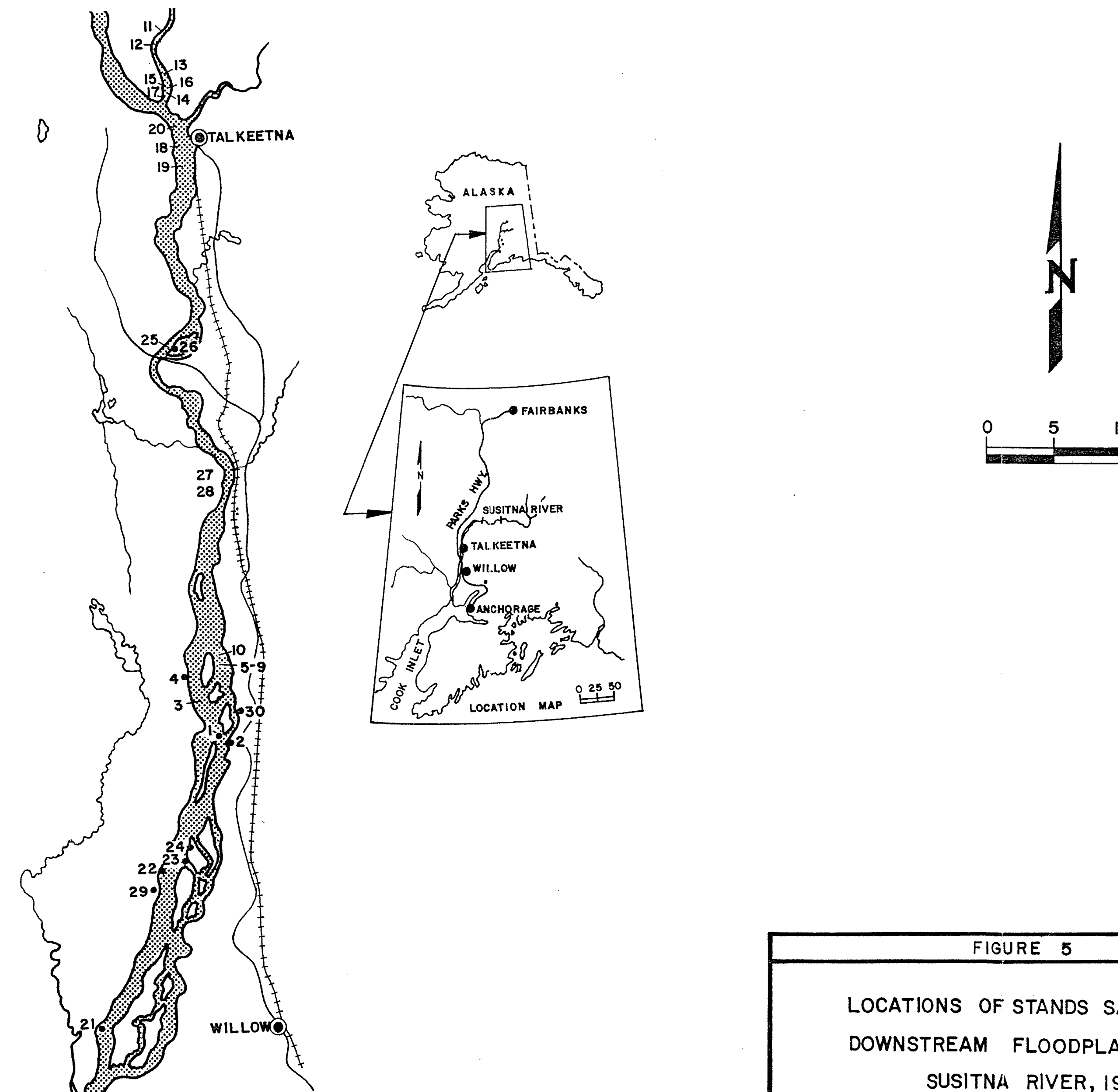

FIGURE 5

LOCATIONS OF STANDS SAMPLED ON DOWNSTREAM FLOODPLAIN OF THE SUSITNA RIVER, 1981 from cross sectional cuttings or cores. Crown dominance was a measure of which species were capturing the canopy sunlight. It had the following values: (1) open grown (not encountered), (2) dominant - received sunlight from above and the sides, (3) codominant - received sunlight from above, but not sides, (4) intermediate - barely reaching main canopy, (5) overtopped - below general level of canopy, (6) subordinate - under overtopped, and (7) ground - lowest level.

The elevation of each stand relative to the level of the adjacent river was measured by rod-and-level technique at two or three different times during the summer. Time of day for each measurement was recorded for later reference to rate of river flow.

2.5 - Endangered and Threatened Species

No plant species are presently officially listed for Alaska by federal or state authorities as endangered or threatened, however, 37 are currently under review by the U. S. Fish and Wildlife Service (USF&WS 1980). Most of these species were also discussed by Murray (1980). The general habitat requirements and occurrence of these plant species were known from previous taxonomic and ecological studies in Alaska and from information on the Alaskan flora by Hulten (1968). Following a review of this information and contact with local experts, 10 species that could possibly occur in the phytogeographic region of the upper Susitna River were identified. Potential habitat for these species was then selected for closer investigation.

In August 1980 and again in early July 1981, each of the selected areas was surveyed from helicopter and on the ground. Special attention was given to selected sites where the species in question might occur. Since calciphilic species were included in the potential endangered category, soils having free carbonates were located by using geologic maps and by testing rocks with 10% hydrochloric acid.

3 - RESULTS

3.1 - General Description of Study Area

The upper Susitna River basin is located in the Pacific Mountain physiographic division in southcentral Alaska (JFSLUPCA 1973). The Susitna basin occurs within an ecoregion classified by Bailey (1976, 1978) as the Alaska Range Province of the Subarctic Division.

The Susitna River system drains parts of the Alaska Range on the north and parts of the Talkeetna Mountains on the south (Figure 1). Many areas along the east-west portion of the river between the confluences of Portage Creek and the Oshetna River are steep and covered with conifer, deciduous, and mixed conifer and deciduous forests. Flat benches occur at the tops of these banks and usually contain low shrub or woodland conifer communities. Rising from these benches are low mountains covered by sedge-grass tundra and mat and cushion tundra.

The southeastern portion of the study area between the Susitna River and Lake Louise is characterized by extensive flat areas covered with low shrubland and woodland conifer communities which, because of intergradations are often intermixed and difficult to distinguish in the field or on aerial photographs. To the northeast, the area along the Susitna River between the Maclaren River and the Denali Highway consists of woodland and open spruce stands. Farther east, low shrubland cover increases. The Clearwater Mountains north of the Denali Highway have extensive tundra vegetation. The floodplain of the Susitna River north of the Denali Highway has woodland spruce and willow stands, while the Alaska Range contains most of the permanent snowfields and glaciers in the study area.

Steep portions and some adjacent areas along the east-west reaches of the river are considered to be in the closed spruce-hardwood forest type of Viereck and Little (1972), the moderately high mixed evergreen and deciduous forest map unit of Spetzman (1963), and the upland spruce hardwood forest by the JFSLUPCA (1973). Whichever classification one chooses, this type of vegetation is found mainly along rivers in the southcentral and interior regions of the state.

The benches bordering the east-west portion of the river and the area around the Maclaren River are classified as moist tundra in all three of the previously mentioned references. This classification includes herbaceous meadows as well as shrub-dominated sites, both of which also occur around the Brooks Range, on the Seward Peninsula, and near the Killuck Mountains.

The extensive flats in the lower Oshetna River and Lake Louise areas in the southeastern portion of the upper basin, are considered open, low growing spruce forests by Viereck and Little (1972), low mixed evergreen and deciduous forests by Spetzman (1963) and lowland spruce-hardwood forests by the JFSLUPCA (1973). Viereck and Little's (1972) description appears most appropriate since the area is covered primarily by spruce stands with treeless bogs.

The vegetation along the lower mountains and the lower slopes of the higher mountains was classified as alpine tundra by Viereck and Little (1972) and the JFSLUPCA (1973) and as barren and sparse dry tundra by Spetzman (1963). In the current study some of these areas were mapped as rock while other areas were mapped as sedge-grass tundra or mat and cushion tundra. On the previous maps rock was included in alpine tundra. Some areas which were mapped as rock do have some important pioneering species growing in crevices, but the plants provided negligible ground cover. Regardless of the mapping and classification system used, the habitat is common on mountains throughout the state.

The downstream floodplain is a part of the Cook Inlet-Susitna Lowlands, a portion of the trough which forms a major bifurcation in the Pacific Mountain System (JFSLUPCA 1973). This region is generally flat, occurs below 150 m in elevation and experiences a climate that is transitional between maritime and continental. The growing season is at least one month longer than in the upper basin. The vegetation of this region is considered closed spruce-hardwood forest by Viereck and Little (1972), moderately high mixed evergreen and deciduous forest or high evergreen spruce forest by Spetzman (1963) and upland spruce-hardwood or bottomland spruce-poplar forest by the JFSLUPCA (1973).

3.2 - Floristics

In the upper Susitna River basin and downstream floodplain combined, 277 vascular plant species, occurring in 140 genera in 56 families, were identified (Table 2). Two hundred fifty-five species were found in the upper basin while only 76 were identified downstream. Downstream sites were confined to the floodplain; thus restricting habitat and floristic variability relative to the diversity in the upper basin study. Fifty-four species were found both upstream and downstream. Although 22 species were encountered only downstream, the downstream flora was predominantly a subset of the upper basin flora. Some collected specimens have yet to be identified, and others need to be verified by taxonomic specialists. This situation is particularly true for the *Carex* and *Salix* genera. The families in the upper basin containing the most species were Compositae (Asteraceae), Salicaceae, Rosaceae, Gramineae (Poaceae), Cyperaceae, and Ericaceae. The Salicaceae family was important from the standpoint of canopy cover, wildlife usage, and pioneering on gravel bars, whereas the Compositae contributed relatively minor cover. The genus *Salix* contained 17 species, tentatively, while *Carex* had 11 species and *Saxifraga* had nine species.

Within the non-vascular flora, 11 genera of lichen, which included at least 12 species, were identified in both areas combined, while seven taxa of mosses were identified. More extensive work on lichens and mosses would undoubtedly reveal many more species.

The major floristic and botanical feature observed in the study of the upper Susitna River basin was a tendency for lowland and alpine species of the Cook Inlet and coastal region to extend into the Susitna River

Table 2. Preliminary list of plant species, identified during summers of 1980 and 1981 in the upper Susitna River basin[a/] (U) and downstream floodplain (D).

Pteridophyta		
Aspidiaceae		
Dryopteris dilatata (Hoffm.) Gray	Shield fern	U D
Dryopteris fragrans (L.) Schott	Fragrant shield-fern	U
Gymnocarpium dryopteris (L.) Newm.	Oak-fern	U D
Athyriaceae		
Athyrium filix-femina (L.) Roth	Lady fern	U D
Cystopteris fragilis (L.) Bernh.	Fragile-fern	U
Cystopteris montana (Lam.) Bernh.	Mountain fragile-fern	U
Matteuccia struthiopteris (L.) Todaro	Ostrich fern	D
Woodsia alpina (Bolton) S. F. Gray	Alpine woodsia	U
Equisetaceae		
Equisetum arvense L.	Meadow horsetail	U
Equisetum fluviatile L. ampl. Ehrh.	Swamp horsetail	U
Equisetum palustre L.	Marsh horsetail	D
Equisetum pratense L.	Meadow horsetail	U D
Equisetum silvaticum L.	Woodland horsetail	U
Equisetum variegatum Schleich.	Variegated scouring-rush	U D
Isoetaceae		
Isoetes muricata Dur.	Quillwort	U
Lycopodiaceae		
Lycopodium alpinum L.	Alpine clubmoss	U
Lycopodium annotinum L.	Stiff clubmoss	U
Lycopodium clavatum L.	Running clubmoss	U
Lycopodium complanatum L.	Ground cedar	U
Lycopodium selago L. ssp. selago	Fir clubmoss	U
Thelypteridaceae		
Thelypteris phegopteris (L.) Slosson	Long beech fern	U
Gymnospermae		
Cupressaceae		
Juniperus communis L.	Common juniper	U
Pinaceae		
Picea glauca (Moench) Voss	White spruce	U D
Picea mariana (Mill.) Britt., Sterns & Pogg.	Black spruce	U

Table 2. (Continued, Page 2 of 10)

Monocotyledoneae

Cyperaceae

Carex aquatilis Wahlenb.	Water sedge	U	
Carex bigelowii Torr.	Bigelow sedge	U	
Carex capillaris L.	Hairlike sedge	U	
Carex canescens L.	Silvery sedge		D
Carex concinna R. Br.	Low northern sedge	U	
Carex filifolia Nutt.	Thread-leaf sedge	U	
Carex garberi Fern.	Sedge		D
Carex limosa L.	Shore sedge	U	
Carex loliacea L.	Sedge	U	
Carex media R. Br. ex Richards.	Sedge	U	
Carex membranacea Hook.	Fragile sedge	U	
Carex podocarpa C. B. Clarke	Short-stalk sedge	U	
Carex rhynchophysa C. A. Mey.	Sedge	U	
Carex saxatilis L.	Sedge		D
Carex spp.	Sedge	U	D
Eriophorum angustifolium Honck.	Tall cottongrass	U	
Eriophorum scheuchzeri Hoppe	White cottongrass	U	
Eriophorum vaginatum L.	Tussock cottongrass	U	
Eriophorum sp.	Cottongrass		D
Scirpus microcarpus Presl.	Small-fruit bullrush		D
Trichophorum caespitosum (L.) Hartm.	Tufted clubrush	U	

Gramineae (Poaceae)

Agropyron boreale (Turcz.) Drobov	Northern wheatgrass		D
Agropyron caninum (L.) Beauv.	Wheatgrass		D
Agropyron macrourum (Turcz.) Drobov	Wheatgrass		D
Agropyron sp.	Wheatgrass	U	
Agrostis scabra Willd.	Tickle grass	U	D
Agrostis sp.	Bent grass	U	
Alopecurus alpinus Sm.	Mountain foxtail	U	
Arctagrostis latifolia (R. Br.) Griseb.	Polargrass	U	
Beckmannia syzigachne (Steud.) Fern	Slough grass		D
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint	U	D
Calamagrostis purpurascens R. Br.	Purple reedgrass	U	
Cinna latifolia (Trev.) Griseb. in Ledeb	Woodreed		D
Danthonia intermedia Vasey	Timber oatgrass	U	
Deschampsia atropurpurea (Wahlenb.) Scheele[b/]	Mountain hairgrass	U	
Deschampsia caespitosa (L.) Beauv.	Tufted hairgrass	U	D
Festuca altaica Trin.	Fescue grass	U	
Festuca rubra L. Coll.	Red fescue	U	
Hierochloe alpina (Swartz) Roem. & Schult.	Alpine holygrass	U	
Hierochloe odorata (L.) Wahlenb.	Vanilla grass	U	D
Phleum commutatum Gandoger	Timothy	U	
Poa alpina L.	Alpine bluegrass	U	
Poa arctica R. Br.	Arctic bluegrass	U	
Poa palustris L.	Bluegrass	U	
Trisetum spicatum (L.) Richter	Downy oatgrass	U	D

Table 2. (Continued, Page 3 of 10)

Iridaceae			
Iris setosa Pellas	Wild iris	U	
Juncaceae			
Juncus arcticus Willd.	Arctic rush	U	D
Juncus castaneus Sm.	Chestnut rush	U	
Juncus drummondii E. Mey.	Drummond rush	U	
Juncus mertensianus Bong.	Mertens rush	U	
Juncus triglumis L.	Rush	U	
Luzula campestris (L.) DC. ex DC. & Lam.[b/]	Woodrush	U	
Luzula confusa Lindeb.	Northern woodrush	U	
Luzula multiflora (Retz.) Lej.	Woodrush	U	
Luzula parviflora (Ehrh.) Desv.	Small-flowered woodrush	U	
Luzula tundricola Gorodk.	Tundra woodrush	U	
Luzula wahlenbergii Rupr.	Wahlenberg woodrush	U	
Liliaceae			
Lloydia serotina (L.) Rchb.	Alp lily	U	
Streptopus amplexifolius (L.) DC.	Cucumber root	U	D
Tofieldia coccinea Richards	Northern asphodel	U	
Tofieldia pusilla (Michx.) Pers.	Scotch asphodel	U	
Veratrum viride Ait.	Helebore	U	
Zygadenus elegans Pursh	Elegant death camas	U	
Orchidaceae			
Platanthera convallariaefolia (Fisch.) Lindl.	Northern bog-orchis	U	
Platanthera dilatata (Pursh) Lindl.	White bog-orchis	U	
Platanthera hyperborea (L.) Lindl.	Northern bog-orchis	U	
Potamogetomaceae			
Potamogeton epihydrous Raf.	Nuttall pondweed	U	
Potamogeton filiformis Pers.	Filiform pondweed	U	
Potamogeton gramineus L.	Pondweed	U	
Potamogeton perfoliatus L.	Clasping-leaf pondweed	U	
Potamogeton robbinsii Oakes	Robbins pondweed	U	
Sparganiaceae			
Sparganium angustifolium Michx.	Narrow-leaved burreed	U	
Dicotyledoneae			
Araliaceae			
Echinopanax horridum (Sm.) Decne. & Planch.	Devil's club	U	D

Table 2. (Continued, Page 4 of 10)

Betulaceae[c/]			
Alnus crispa (Ait.) Pursh	American green alder	U	
Alnus sinuata (Reg.) Rydb.	Sitka alder	U	D
Alnus tenuifolia Nutt.	Thinleaf alder		D
Betula glandulosa Michx.	Resin birch	U	
Betula nana L.	Dwarf arctic birch	U	D
Betula occidentalis Hook.	Water birch	U	
Betula papyrifera Marsh.	Paper birch	U	D
Boraginaceae			
Mertensia paniculata (Ait.) G. Don	Tall bluebell	U	D
Myosotis alpestris F. W. Schmidt	Forget-me-not	U	
Callitrichaceae			
Callitriche hermaphroditica L.	Water starwort	U	
Callitriche verna L.	Vernal water-starwort	U	
Campanulaceae			
Campanula lasiocarpa Cham.	Mountain harebell	U	
Caprifoliaceae			
Linnaea borealis L.	Twin-flower	U	
Viburnum edule (Michx.) Raf.	High bush cranberry	U	D
Caryophyllaceae			
Minuartia obtusiloba (Rydb.) House	Alpine sandwort	U	
Silene acaulis L.	Moss campion	U	
Stellaria sp.	Starwort	U	
Wilhelmsia physodes (Fisch.) McNeill	Merckia	U	
Compositae (Asteraceae)			
Achillea borealis Bong.	Yarrow	U	D
Achillea sibirica Ledeb.	Siberian yarrow	U	D
Antennaria alpina (L.) Gaertn.	Alpine pussytoes	U	
Antennaria monocephala DC.	Pussytoes	U	
Antennaria rosea Greene	Pussytoes	U	
Arnica amplexicaulis Nutt. ssp. *prima* Maguire	Arnica	U	
Arnica chamissonis Less. (?)	Arnica		D
Arnica frigida C. A. Mey.	Arnica	U	
Arnica lessingii Greene	Arnica	U	
Artemisia alaskana Rydb.	Alaska wormwood	U	
Artemisia arctica Less.	Wormwood	U	
Artemisia tilesii Ledeb.	Wormwood	U	D
Aster sibiricus L.	Siberian aster	U	D
Erigeron humilis Graham	Fleabane daisy	U	
Erigeron lonchophyllous Hook.	Daisy		D

Table 2. (Continued, Page 5 of 10)

Hieracium triste Willd.	Woolly hawkweed	U	
Petasites frigidus (L.) Franch.	Arctic sweet coltsfoot	U	
Petasites sagittatus (Banks) Gray	Arrowleaf sweet coltsfoot	U	
Petasites sp.	Sweet coltsfoot		D
Saussurea angustifolia (Willd.) DC.	Saussurea	U	
Senecio atropurpureus (Ledeb.) Fedtsch.	Ragwort	U	
Senecio lugens Richards.	Ragwort	U	
Senecio sheldonensis Pors.	Sheldon groundsel	U	
Solidago multiradiata Ait.	Northern goldenrod	U	D
Taraxacum sp.	Dandelion	U	
Cornaceae			
Cornus canadensis L.	Bunchberry	U	D
Crassulaceae			
Sedum rosea (L.) Scop.	Roseroot	U	
Cruciferae (Brassicaceae)			
Cardamine bellidifolia L.	Alpine bittercress	U	
Cardamine pratensis L.	Cuckoo flower	U	
Cardamine umbellata Greene	Bittercress	U	
Draba nivalis Liljebl.	Rockcress	U	
Draba stenoloba Ledeb.	Rockcress	U	
Diapensiaceae			
Diapensia lapponica L.	Diapensia	U	
Elaeagnaceae			
Shepherdia canadensis (L.) Nutt.	Soapberry	U	D
Empetraceae			
Empetrum nigrum L.	Crowberry	U	
Ericaceae			
Andromeda polifolia L.	Bog rosemary	U	
Arctostaphylos alpina (L.) Spreng.	Alpine bearberry	U	
Arctostaphylos rubra (Rehd. & Wilson) Fern.	Red-fruit bearberry	U	
Arctostaphylos uva-ursi (L.) Spreng.	Bearberry	U	
Cassiope tetragona (L.) D. Don	Four-angle mountain-heather	U	
Ledum decumbens (Ait.) Small[c/]	Northern Labrador tea	U	
Ledum groenlandicum Oeder	Labrador tea	U	
Ledum sp.	Labrador tea		D
Loiseleuria procumbens (L.) Desv.	Alpine azalea	U	
Oxycoccus microcarpus Turcz.	Swamp cranberry	U	D

Table 2. (Continued, Page 6 of 10)

Rhododendron lapponicum (L.) Wahlenb.	Lapland rosebay	U	
Vaccinium caespitosum Michx.	Dwarf blueberry	U	
Vaccinium uliginosum L.	Bog blueberry	U	D
Vaccinium vitis-idaea L.	Mountain cranberry	U	
Fumariaceae			
Corydalis pauciflora (Steph.) Pers.	Few-flowered corydalis	U	
Gentianaceae			
Gentiana glauca Pall.	Glaucous gentian	U	
Gentiana propinqua Richards.	Gentian	U	
Menyanthes trifoliata L.	Buckbean	U	D
Swertia perennis L.	Gentian	U	
Geraniaceae			
Geranium erianthum DC.	Northern geranium	U	
Haloragaceae			
Hippuris vulgaris L.	Common marestail	U	
Leguminosae (Fabaceae)			
Astragalus aboriginum Richards.	Milk-vetch	U	
Astragalus alpinus L.[b/]	Milk-vetch	U	D
Astragalus umbellatus Bunge	Milk-vetch	U	
Hedysarum alpinum L.	Alpine sweet-vetch	U	D
Lupinus arcticus S. Wats.	Arctic lupine	U	
Oxytropis campestris (L.) DC.	Field oxytrope		D
Oxytropis huddelsonii Porsild	Huddelson oxytrope	U	
Oxytropis maydelliana Trautv.	Maydell oxytrope	U	
Oxytropis nigrescens (Pall.) Fisch.	Blackish oxytrope	U	
Oxytropis viscida Nutt.	Viscid oxytrope	U	
Lentibulariaceae			
Pinguicula villosa L.	Hairy butterwort	U	
Utricularia vulgaris L.	Common bladderwort	U	
Myricaceae			
Myrica gale L.	Sweet gale	U	D
Nymphaceae			
Nuphar polysepalum Engelm.	Yellow pond lily	U	
Onagraceae			
Circaea alpina L.	Enchanter's nightshade		D
Epilobium angustifolium L.	Fireweed	U	D
Epilobium latifolium L.	Dwarf fireweed	U	D
Epilobium palustre L.	Swamp willow-herb	U	

Table 2. (Continued, Page 7 of 10)

Orobanchaceae		
Boschniakia rossica (Cham. & Schlecht.) Fedtsch.	Poque	U D
Polemoniaceae		
Polemonium acutiflorum Willd.	Jacob's ladder	U D
Polygonaceae		
Oxyria digyna (L.) Hill	Mountain sorrel	U
Polygonum bistorta L.	Meadow bistort	U
Polygonum viviparum L.	Alpine bistort	U
Rumex arcticus Trautv.	Arctic dock	U
Rumex sp.	Dock	U
Portulacaceae		
Claytonia sarmentosa C. A. Mey.	Spring-beauty	U
Primulaceae		
Dodecatheon frigidum Cham. & Schlecht.	Northern shooting star	U
Primula cuneifolia Ledeb.	Wedge-leaf primrose	U
Trientalis europaea L.	Arctic starflower	U D
Pyrolaceae		
Moneses uniflora (L.) Gray	Single delight	U D
Pyrola asarifolia Michx.	Liverleaf wintergreen	D
Pyrola grandiflora Radius	Large-flower wintergreen	U
Pyrola minor L.	Lesser wintergreen	U
Pyrola secunda L.	One-sided wintergreen	U D
Ranunculaceae		
Aconitum delphinifolium DC.	Monkshood	U
Actaea rubra (Ait.) Willd.	Baneberry	D
Anemone narcissiflora L.	Anemone	U
Anemone parviflora Michx.	Northern anemone	U
Anemone richardsonii Hook	Anemone	U D
Caltha leptosepala DC.	Mountain marsh-marigold	U
Ranunculus confervoides (E. Fries) E. Fries	Water crowfoot	U
Ranunculus macounii Britt. (may be R. pacificus or something similar)	Macoun buttercup	D
Ranunculus nivalis L.	Snow buttercup	U
Ranunculus occidentalis Nutt.	Western buttercup	U
Ranunculus pygmaeus Wahlenb.	Pygmy buttercup	U
Ranunculus sp.	Buttercup	U
Thalictrum alpinum L.	Arctic meadowrue	U
Thalictrum sparsiflorum Turcz.	Few-flower meadowrue	U D

Table 2. (Continued, Page 8 of 10)

Rosaceae			
Dryas drummondii Richards.	Drummond mountain-avens	U	D
Dryas integrifolia M. Vahl.	Dryas	U	
Dryas octopetala L.	White mountain-avens	U	
Geum rossii (R. Br.) Ser.	Ross avens	U	
Luetkea pectinata (Pursh) Ktze.	Luetkea	U	
Potentilla biflora Willd.	Two-flower cinquefoil	U	
Potentilla fruticosa L.	Shrubby cinquefoil	U	
Potentilla hyparctica Malte	Arctic cinquefoil	U	
Potentilla palustris (L.) Scop.	Marsh cinquefoil	U	D
Rosa acicularis Lindl.	Prickly rose	U	D
Rubus arcticus L.	Nagoon berry	U	D
Rubus chamaemorus L.	Cloudberry	U	
Rubus idaeus L.	Raspberry	U	D
Rubus pedatus Sm.	Five-leaf bramble	U	
Sanguisorba stipulata Raf.	Sitka burnet	U	
Sibbaldia procumbens L.	Sibbaldia	U	
Sorbus scopulina Greene	Western mountain ash	U	
Spiraea beauverdiana Schneid.	Beauverd spirea	U	D
Rubiaceae			
Galium boreale L.	Northern bedstraw	U	
Galium trifidum L.	Small bedstraw	U	
Galium triflorum Michx.	Sweet-scented bedstraw		D
Salicaceae[c/]			
Populus balsamifera L.	Balsam poplar	U	D
Populus tremuloides Michx.	Quaking aspen	U	
Salix alaxensis (Anderss.) Cov.	Feltleaf willow	U	D
Salix arbusculoides Anderss.	Littletree willow	U	D
Salix arctica Pall.	Arctic willow	U	
Salix barclayi Anderss.	Barclay willow	U	
Salix brachycarpa Nutt.	Barren-ground willow	U	
Salix fuscescens Anderss.	Alaska bog willow	U	D
Salix glauca L.	Grayleaf willow	U	
Salix lanata L. subsp. *richardsonii* (Hook) A. Skwortz.	Richardson willow	U	
Salix monticola Bebb	Park willow	U	
Salix novae-angliae Anderss.	Tall blueberry willow	U	D
Salix phlebophylla Anderss.	Skeletonleaf willow	U	
Salix planifolia Pursh ssp. *planifolia*	Planeleaf willow	U	
Salix planifolia Pursh ssp. *pulchra* (Cham.) Argus	Diamondleaf willow	U	
Salix polaris Wahlenb.	Polar willow	U	
Salix reticulata L.	Netleaf willow	U	
Salix rotundifolia Trautv.	Least willow	U	
Salix scouleriana Barratt	Scouler willow	U	
Salix sp.	Willow	U	D

Table 2. (Continued, Page 9 of 10)

Santalaceae			
Geocaulon lividum (Richards.) Fern.	Sandalwood	U	
Saxifragaceae			
Boykinia richardsonii (Hook.) Gray	Richardson boykinia	U	
Leptarrhena pyrolifolia (D. Don) Ser.	Leather-leaf saxifrage	U	
Parnassia palustris L.	Northern Grass-of-Parnassus	U	
Parnassia kotzebuei Cham. & Schlecht.	Kotzebue Grass-of-Parnassus	U	
Parnassia sp.	Grass of Parnassus		D
Ribes hudsonianum Richards.	Northern black currant		D
Ribes laxiflorum Pursh (may be R. glandulosum)	Trailing black currant		D
Ribes triste Pall.	Red currant	U	D
Saxifraga bronchialis L.	Spotted saxifrage	U	
Saxifraga davurica Willd.	Saxifrage	U	
Saxifraga foliolosa R. Br.	Foliose saxifrage	U	
Saxifraga hieracifolia Waldst. & Kit.	Hawkweed-leaf saxifrage	U	
Saxifraga lyallii Engler	Red-stem saxifrage	U	
Saxifraga oppositifolia L.	Purple mountain saxifrage	U	
Saxifraga punctata L.	Brook saxifrage	U	
Saxifraga serpyllifolia Pursh	Thyme-leaf saxifrage	U	
Saxifraga tricuspidata Rottb.	Three-tooth saxifrage	U	
Scrophulariaceae			
Castilleja caudata (Pennell) Rebr.	Pale Indian paintbrush	U	
Pedicularis capitata Adams	Capitate lousewort	U	
Pedicularis kanei Durand	Kane lousewort	U	
Pedicularis labradorica Wirsing	Labrador lousewort	U	
Pedicularis parviflora J. E. Sm. var. parviflora	Lousewort	U	
Pedicularis sudetica Willd.	Lousewort	U	
Pedicularis verticillata L.	Whorled lousewort	U	
Veronica wormskjoldii Roem. & Schult.	Alpine speedwell	U	
Umbelliferae (Apiaceae)			
Angelica lucida L.	Wild celery	U	
Heracleum lanatum Michx.	Cow parsnip	U	D
Valerianaceae			
Valeriana capitata Pall.	Capitate valerian	U	
Violaceae			
Viola epipsila Ledeb.	Marsh violet	U	
Viola langsdorffi Fisch.	Violet	U	

Table 2. (Continued, Page 10 of 10)

Nonvascular Plant Species		
Lichens		
Cetraria cucullata (Bell.) Ach.	U	
Cetraria islandica (L.) Ach.	U	
Cetraria nivalis (L.) Ach.	U	
Cetraria richardsonii Hook.	U	
Cetraria spp.	U	
Cladonia alpetris (L.) Rabenh.	U	
Cladonia mitis Sandst.	U	
Cladonia rangiferina (L.) Web.	U	
Cladonia spp.	U	
Dactylina arctica (Hook.) Nyl.	U	
Haematomma sp.	U	
Lobaria linita (Ach) Rabh.		D
Nephroma spp.	U	
Peltigera spp.	U	
Rhizocarpon geographicum (L.) DC.	U	
Stereocaulon paschale (L.) Hoffm.	U	D
Thamnolia vermicularis (Sw.) Schaer.	U	
Umbilicaria sp.	U	
Mosses		
Climacium sp.	U	
Hypnum spp. and other feather mosses	U	
Paludella squarrosa (Hedw.) Brid.[d/]	U	
Polytrichum spp.	U	D
Ptilium crista-castrensis (Hedw.) DeNot.	U	
Rhacomitrium spp.	U	D
Sphagnum spp.	U	D

[a/] Vascular plant species nomenclature according to Hulten (1968) except where noted. Lichen nomenclature according to Thomson (1979). Moss nomenclature according to Conard (1979).

[b/] Nomenclature according to Welsh (1974).

[c/] Nomenclature according to Viereck and Little (1972).

[d/] Nomenclature according to Crum (1976).

drainage farther than botanical records previously indicated. Actually, this finding is to be expected because of the paucity of collections in the upper Susitna River basin prior to this study. A list of those species discovered in the upper basin which are outside of the range reported by Hulten (1968) are listed in Table 3.

3.3 - Vegetation/Habitat Type Maps

The following vegetation/habitat type maps were produced for the evaluation of impacts on vegetation resources: a 1:250,000 scale map of entire upper basin (Figure 6, back pocket); 1:63,360 scale maps of transmission corridors (Figures 7 and 8), access route, and the area located 16 km on either side of the Susitna River between Gold Creek and the Maclaren River (Figure 9); and a 1:24,000 scale map of impoundment areas and 1 km buffer zone, other direct impact areas, and the floodplain from Devil Canyon to Talkeetna (Figure 10). A wetland map was prepared from the 1:24,000 scale maps and is presented under Section 3.5 - Wetlands. All the vegetation/habitat maps, except the 1:250,000 scale map included in the back pocket, have been greatly reduced in size.

Users of the maps are reminded that there is seldom a distinct line of demarcation between vegetation/habitat types either viewed in the field or on aerial photographs. Delineation of vegetation/habitat types requires constant judgment by the cartographer as to the boundaries of each type. Another consideration is that the smallest mappable unit practical is 260, 16, and 3 hectares for 1:250,000, 1:63,360, and 1:24,000 scale maps, respectively. Consequently, some mapping units on the larger scale maps (1:24,000 and 1:63,360) are more specific than those on the smaller scale map (1:250,000). The main differences resulted by eliminating complexes and delineating forested areas by dominant tree species on the larger scale maps.

The Viereck and Dyrness (1980) preliminary vegetation classification was used for the mapping and offered a standard nomenclature which other studies on the Susitna project could also use and have consistent results. Level III names were used in most cases. However, Level IV names were used for forested areas on the 1:24,000 and 1:63,360 scale maps. In most cases the key presented by Viereck and Dyrness (1980) was adequate for classification only at Levels I through III, presumably because the classification is preliminary and lacks sufficient information to consistently identify vegetation at Levels IV and V. Also, U-2 aerial imagery is not consistently interpretable at lower hierarchical levels in this preliminary classification. For these reasons, Level III was used.

(a) Upper Basin

Forest, tundra, and shrubland were the basic types found in the upper Susitna River basin. Forest communities were those with at least 10% cover by tree species regardless of the trees' heights. Shrubland communities had at least 25% cover of erect to decumbent shrubs but were not located beyond the elevational limit of trees. Tundra stands were those communities above or beyond the elevational limit of trees and were dominated by shrub or herbaceous species.

Table 3. Vascular plant species in the upper Susitna River basin and downstream areas which are outside their range as reported by Hulten (1968).

Upper Basin Extensions:

Equisetum fluviatile	Swamp horsetail
Lycopodium selago ssp. *selago*	Fir clubmoss
Lycopodium complanatum	Ground cedar
Picea mariana[a/]	Black spruce
Carex filifolia	Thread-leaf sedge
Danthonia intermedia	Timber oatgrass
Luzula wahlenbergii	Wahlenberg woodrush
Veratrum viride	Helebore
Listera cordata[b/]	Heart-leaved twinblade
Platanthera convallariaefolia	Northern bog-orchis
Platanthera hyperborea	Northern bog-orchis
Platanthera dilatata	White bog-orchis
Echinopanax horridum	Devil's club
Senecio sheldonensis	Sheldon groundsel
Myrica gale[a/]	Sweet gale
Ranunculus occidentalis	Western buttercup
Potentilla biflora	Two-flower cinquefoil
Rubus idaeus[a/]	Raspberry
Rubus pedatus	Five-leaf bramble
Pedicularis kanei kanei	Kane lousewort
Pedicularis parviflora	Lousewort
Potamogeton robbinsii	Robbins pondweed

Downstream Extensions:

Echinopanax horridum	Devil's club
Rubus idaeus[c/]	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[c/]	Northern black currant
Arnica chamissonis	Arnica

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

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

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

Figure 6 illustrates the general overall distribution of vegetation/habitat types, and Table 4 gives the percentages for cover by each type in the upper Susitna River basin. However, it should be remembered that much detail is lost at the relatively small scale of Figure 6. Figure 9 is larger scale, providing more detail than Figure 6, but it covers only the impact areas of the upper basin. Table 5 lists the percentages for cover of types delineated in Figure 9 . As a result of these scale differences, total hectares for some types appear to disagree when computed from the two different maps. For example, closed birch forests were often too small to be delineated at the smaller scale of Figure 6 but were circumscribable at the larger scale of Figure 9, and thus, there is an apparent discrepancy in the total number of hectares computed from each map.

Conifer forests cover approximately 19% of the upper basin (Figure 6, Table 4). They occupy a wide range of sites, from the floodplains to the mountains, but seldom above 975 m elevation. Conifer forests are relatively more extensive (25% of total area) in the impact areas (Figure 9, Table 5) than in the upper basin generally. This is because the impact areas are restricted to lower elevations where conifer forests are located.

Deciduous forests (birch, aspen, and balsam poplar) and mixed conifer-deciduous forests are much more restricted in distribution than the conifer types, together covering only 2.5% of upper basin (Figure 6, Table 4). These vegetation/habitat types are found primarily on south-facing slopes below 700 m elevation, and thus, are generally located on canyon sides or the floodplain. Balsam poplar stands are found only on the floodplain (Figure 9). The fact that deciduous and mixed conifer-deciduous forests are restricted to the impact areas is evident in that these types represent nearly 6% of the area described on the impact area map (Figure 9, Table 5).

Tundra vegetation/habitat types are generally located above or beyond the limit of forests. Approximately 24% of the upper basin is covered with tundra (Figure 6, Table 4). Mesic or wet sedge grass types dominate roughly half of the tundra. Mat and cushion tundra and complexes of mat and cushion/sedge grass tundra represent most of the remaining tundra situations. Because the tundra types are characteristic of high elevations (>975 m) in the region, their distribution is primarily associated with the mountains of the Alaska Range and the Talkeetna Mountains (Figure 6). Only in the vicinity of Devil Canyon and Jay Creek are there substantial hectareages of tundra in close proximity to the impact areas (Figure 9, Table 5). Mat and cushion tundra is relatively more abundant in the impact area than the upper basin (14% vs 4%) because nearly all of the mat and cushion tundra found in the upper basin is located within the bounds of the area described in Figure 9.

Shrubland is the largest overall group of vegetation/habitat types occurring in the upper basin, covering almost 40% of the total area (Figure 6, Table 4): 30% is covered by shrub birch and willow. These types are found at intermediate and low elevations throughout the basin, but primarily on the broad flat areas in the central, southern and northeastern portions of the basin. Tall shrub, dominated by alder, is the other principal component of the shrubland, occupying 8% and 7% of

Table 4. Hectares and percentage of total area covered by vegetation/habitat types in the upper Susitna River basin (above Gold Creek).a/

Vegetation/Habitat Type	Hectares b/	Percent of Total Area
Total Vegetation	1,387,607	85.08
Forest	348,232	21.35
Conifer	307,586	18.86
Woodland Spruce	188,391	11.55
Open spruce	118,873	7.29
Closed spruce	323	0.02
Deciduous	1,290	0.08
Open birch	968	0.06
Closed birch	323	0.02
Mixed	39,355	2.41
Open	23,387	1.43
Closed	15,968	0.98
Tundra	394,685	24.20
Wet sedge grass	4,839	0.30
(Mesic) sedge grass	184,358	11.30
Herbaceous alpine	807	0.05
Mat and cushion	65,001	3.99
Mat and cushion/sedge grass	139,680	8.56
Shrubland	644,690	39.53
Tall shrub	129,035	7.91
Low shrub	515,655	31.62
Birch	33,549	2.06
Willow	10,645	0.65
Mixed	471,461	28.91
Unvegetated	243,392	14.92
Water	39,840	2.44
Lakes	25,162	1.54
Rivers	14,678	0.90
Rock	113,712	6.97
Snow and ice	89,841	5.51
Total Area	1,630,999	100.00

a/ Based on maps produced at a scale of 1:250,000.

b/ Differences in resolution as a result of differences in scale may result in some discrepancies for common areas between these figures and those presented in Table 5.

Table 5. Hectares and percentage of total area covered by vegetation/habitat types for the area 16 km on either side of the Susitna River from Gold Creek to the Maclaren River.[a]

Vegetation/Habitat Type	Hectares[b]	Percent of Total Area
Forest	142,306	30.75
Conifer	115,048	24.87
Woodland spruce-black	62,993	13.62
Woodland spruce-white	13,291	2.87
Open spruce-black	28,304	6.12
Open spruce-white	10,460	2.26
Deciduous	4,393	.94
Open birch	1,498	0.32
Closed birch	2,324	0.50
Closed balsam poplar	571	0.12
Mixed	22,865	4.94
Open conifer deciduous	9,639	2.08
Closed conifer deciduous	13,226	2.86
Tundra	114,728	24.81
Wet sedge grass	3,517	0.76
Sedge grass	27,505	5.95
Sedge shrub	20,073	4.34
Mat and cushion	63,633	13.76
Shrubland	177,264	38.34
Open tall shrub	15,524	3.36
Closed tall shrub	15,767	3.41
Birch shrub	42,880	9.27
Willow shrub	8,230	1.78
Mixed low shrub	94,863	20.52
Herbaceous	18	0.01
Grassland	1,079	0.23
Disturbed	24	0.01
Unvegetated	26,979	5.83
Rock	16,603	3.59
Snow and ice	249	0.05
Water		
River	4,236	0.92
Lake	5,891	1.27
Total Area	462,398	99.98

a/ Based on maps produced at a scale of 1:63,360.

b/ Differences in resolution as a result of differences in map scale may result in some discrepancies for common areas between these figures and those presented in Table 4.

the upper basin respectively. Alder is found in steep terrain throughout the basin and in large expanses at the western end of the basin near Portage Creek. For the most part, shrubland was equally important in both the upper basin (Figure 6) and the impact area (Figure 9).

Fifteen percent of the upper basin is classified as unvegetated (Figure 6, Table 4). These areas consist primarily of rock, snow or ice and were most common at the highest elevations (i.e., the mountain tops). Thus, relatively little of the impact area is unvegetated.

(b) Downstream Floodplain to Talkeetna

Open and closed balsam poplar stands are the predominant vegetation types found on the floodplain downstream to Talkeetna; closed tall shrub is important to a lesser extent. The extent of map coverage (Figure 10) of this area is limited to the floodplain, which is very narrow and discontinuous in this reach of the river.

(c) Transmission Corridors

(i) Central (Dams to Intertie)

All three transmission corridors were mapped at the 1:63,360 scale. However, the map of the central corridor is not separate from that of the impact area map which extends 16 km in all directions from the upper Susitna River. Important vegetation types in the central transmission corridor included tall shrub on steep embankments (Figure 9, Table 6). Open spruce forests occurred on slopes and benches whereas mixed and birch forests were found on gentle slopes and benches. Higher elevation types included mat and cushion tundra and sedge-shrub tundra. Area covered by each type is presented in Table 6.

(ii) Willow - Cook Inlet

The Willow - Cook Inlet corridor includes a total of approximately 38,000 hectares (Table 7). It passes through relatively flat terrain which is 67% forested predominantly with conifer-deciduous forests interspersed with approximately 24% small and large wet sedge-grass meadows (Figure 7, Table 7).

(iii) Healy - Fairbanks

The Healy-Fairbanks corridor passes through a dissected plateau in the southern section, the Tanana Flats in the middle, and the Chena Ridge on the north. Different vegetation/habitat types are associated with each of these three segments. The southern portion of the corridor characteristically has open spruce and open spruce/deciduous types along the ridges, with low shrub and sedge-grass occupying the flatter areas. The central segment is covered by a complex mosaic of wet vegetation types, open spruce, and low shrub. The gradations between types and many unmappable small patches of vegetation made it necessary to map much of this area as complexes. The Chena Ridge segment is predominantly covered by open and closed deciduous forest (Figure 8). Forest types accounted for

Table 6. Hectares and percent of total area covered by vegetation/habitat types within the dam to intertie (central) transmission corridor.

Vegetation/Habitat Type	Hectares	Percent of Total Area
Forest	34,388	36.3
Woodland spruce-black	3,028	3.2
Woodland spruce-white	4,957	5.2
Open spruce-black	2,527	2.7
Open spruce-white	4,284	4.5
Open birch	806	.9
Closed birch	1,749	1.8
Closed balsam poplar	449	.5
Open conifer-deciduous	5,119	5.4
Closed conifer-deciduous	11,469	12.1
Tundra	24,975	26.3
Wet sedge-grass	314	.3
Sedge grass	3,670	3.9
Sedge shrub	5,870	6.2
Mat and cushion	15,121	15.9
Shrubland	31,548	33.3
Open tall shrub	4,717	5.0
Closed tall shrub	5,696	6.0
Birch shrub	10,909	11.5
Willow shrub	1,169	1.2
Mixed low shrub	9,057	9.6
Grassland	109	.1
Disturbed	10	.01
Unvegetated	3,778	4.0
Lake	698	.7
River	1,438	1.5
Rock	1,642	1.7
Total Area	94,808	100.0

Table 7. Hectares and percent of total area covered by vegetation/habitat types within the Willow to Cook Inlet transmission corridor.

Vegetation/Habitat Type	Hectares	Percent of Total Area
Forest	25,851	67.0
Woodland spruce	2,457	6.3
Open spruce	3,402	8.8
Closed spruce	3,226	8.4
Open birch	16	.04
Closed birch	3,638	9.4
Open balsam poplar	100	.3
Closed balsam poplar	172	.5
Open conifer-deciduous	1,697	4.4
Closed conifer-deciduous	11,143	28.9
Wet sedge-grass	9,123	23.7
Shrubland	2,213	5.7
Closed tall shrub	92	.2
Low mixed shrub	2,121	5.5
Lakes	1,011	2.6
Disturbed	381	1.0
Total Area	38,579	100.0

almost 78% of this corridor with the open forest types being the dominant form (Table 8). Open spruce covered 28.5% of the area; open deciduous 11.37%; and open mixed conifer-deciduous 11.2% (Table 8).

3.4 - Vegetation/Habitat Type Descriptions

(a) Upper Basin

(i) Forest

Forest vegetation/habitat types were located at the lower elevations of the upper basin (Figures 6 and 9). The average elevation of sampled areas was 523 m. These forest types were divided according to the dominant tree types (conifer, deciduous, or mixed) and then by tree crown cover percentage. Deciduous and conifer types had at least 75% of the tree cover provided by either deciduous or conifer trees, respectively. The woodland type had between 10% and 25% tree cover and was only observed for conifer stands. Open stands contained 25% to 50% tree cover, while closed stands had over 50% tree cover. The boundary percentage between open and closed types was chosen as 50% rather than the 60% that Viereck and Dyrness (1980) used, since it was easier to estimate on the aerial photographs and in the field. Field estimates were performed best from the air because the Venetian blind effect of the trees caused overestimates from the ground.

Conifer, deciduous, and mixed stands were observed in the field with open canopies while only deciduous and mixed stands with closed canopies were located in the field. One closed conifer area that appeared on the aerial photographs in the Lake Louise area was not field checked. All forested stands had almost complete vegetation cover with 80% - 95% ground layer cover.

- Spruce Forests

Spruce stands were dominated either by white spruce (*Picea glauca*) or black spruce (*Picea mariana*) and contained a well-developed ground layer, which itself accounted for most of the vegetation cover (Tables 9 and 10). The layer structure of open black and white spruce stands was similar, except that white spruce stands contained more overstory, a reflection of the generally larger size of white spruce trees (Tables 11 and 12). These units were mapped only at the 1:24,000 and 1:63,360 scales (Figures 10 and 9). Another difference was that the overstory in open white spruce stands was less variable in height among stands than was the overstory in black spruce stands. Maximum overstory heights of trees in open black spruce types varied from about 5 to 11 m while white spruce stands reached heights of 20 m. The forest canopy consisted primarily of one species, and trees averaged 15 to 30 cm/dbh. A few cores of larger trees in some areas indicated that white spruce may range in age from 34 to 78 years while sampled black spruce may be 77 to 171 years old. Several white spruce stands were in areas recovering from disturbances, such as fire, while black spruce stands were less recently disturbed, thus accounting for some of the age differences. Open spruce stands were usually found on slopes or flatlands along the

Table 8. Hectares and percent of total area covered by vegetation/habitat types within the Healy to Fairbanks transmission corridor.

Vegetation/Habitat Type a/	Hectares	Percent of Total Area
Forest	86,830	77.9
Woodland spruce	1,812	1.6
Open spruce	31,739	28.5
Closed spruce	1,347	1.2
Woodland deciduous	993	.9
Open deciduous	12,553	11.3
Closed deciduous	10,384	9.3
Woodland conifer-deciduous	961	0.9
Open conifer-deciduous	12,502	11.2
Closed conifer-deciduous	4,125	3.7
Open spruce/open deciduous	948	0.9
Open spruce/wet sedge-grass/ open deciduous	1,993	1.8
Open spruce/low shrub/wet sedge-grass/open deciduous	7,008	6.3
Open spruce/low shrub	465	0.4
Tundra	4,407	3.9
Wet sedge-grass	2,268	2.0
Sedge grass	277	0.2
Sedge shrub	566	.5
Sedge-grass/mat and cushion	1,296	1.2
Shrubland	17,199	15.4
low mixed shrub	15,405	13.8
willow shrub	58	.05
low shrub/wet sedge-grass	1,736	1.6
Agricultural land	175	.2
Disturbed	431	.4
Unvegetated	2,467	2.2
Lakes	196	.2
River	2,143	1.9
Gravel	128	.1
Total Area	111,509	100.00

a/ 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.

Table 9. Cover percentages for total vegetation, vertical strata, and plant species in open conifer vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
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 blueberry	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

a/ Number of areas sampled was 9.

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

Table 10. Cover percentages for total vegetation, vertical strata, and plant species in woodland conifer vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		99
Overstory (>10 cm dbh)		1
Picea 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

a/ Number of areas sampled was 6.

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

Table 11. Cover percentages for total vegetation, vertical strata, and plant species in open black spruce vegetation/habitat type[a] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b]
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

[a] Number of areas sampled was 3.

[b] Includes only those species with at least 5% cover in any one area sampled.

Table 12. Cover percentages for total vegetation, vertical strata, and plant species in open white spruce vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		100
Overstory (>10 cm dbh)		35
Picea 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	Prickly 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

a/ Number of areas sampled was 5.

b/ Included only those species with at least 5% cover in any one area sampled.

rivers at elevations averaging 487 m. Overstory provided almost one-fourth cover on open stands which contained trees several meters tall (Table 9).

While the white spruce cover was concentrated in the overstory layer, most of the black spruce tree cover was contained in the shrub layer (Tables 11 and 12). Black spruce stands contained low shrubs, such as crowberry (Empetrum nigrum), northern Labrador tea (Ledum decumbens), bog blueberry (Vaccinium uliginosum), and mountain cranberry (V. vitis-idaea) in the ground layer, while prickly rose (Rosa acicularis) and bluejoint (Calamagrostis canadensis) were the most important ground layer species in open white spruce (Tables 11 and 12). Twin-flower (Linnaea borealis) was important in the white spruce stands but was not observed in the black spruce stands, possibly reflecting that ground species' preference for better-drained soils. In each of the mapping units, 30 to 35 identified species were encountered. In these open white and black spruce stands, cover of feather mosses equaled that of the trees (Tables 11 and 12). Low shrubs, such as crowberry, northern Labrador tea, bog blueberry, and mountain cranberry accounted for much of the woody ground layer (Tables 11 and 12). Important herbaceous species included bluejoint and horsetails (Equisetum spp.) (Tables 11 and 12).

Northern Labrador tea, Labrador tea (Ledum groenlandicum), bog blueberry, mountain cranberry, and sphagnum and feather mosses were found in black spruce forests in the upper Susitna River basin and were important along the Chena River in interior Alaska (Viereck 1970). Crowberry, nagoonberry and woodland horsetail (Equisetum silvaticum) were also important in black spruce stands; however, these species were not reported along the Chena River by Viereck (1970).

Meadow horsetail (Equisetum arvense) and feather mosses provided significant amounts of cover in white spruce stands along the Chena River (Viereck 1970) and in the upper Susitna River basin, but bluejoint, twin-flower, and the moss Ptilium crista-castrensis were apparently more important along the Susitna River than along the Chena. Hettinger and Janz (1974) reported that feather mosses were important in the ground layer of white spruce stands in northeastern Alaska, which agreed with our results. They also found crowberry to be an important species, but this accounted for less than 2% cover in the Susitna stands.

All woodland spruce stands visited were black spruce. Here it was observed that, unlike open spruce stands, woodland stands were composed of scattered, stunted trees, and the overstory was almost negligible (Table 10). One reason for this pattern is that this vegetation/habitat type was usually found on the relatively level benches where soils were poorly drained. Average elevation of sampled areas was 620 m. The resulting trees were usually too small to qualify for the overstory layer because trunks were <10 cm dbh. Maximum heights were less than 2 m in some areas.

In these woodland stands, sphagnum mosses, not feather mosses, were the most important cover species; important ground layer species included sedges (Carex spp.), woodland horsetail, and low shrubs similar to those found in the open spruce stands (Table 10). Slightly over 30 identified species were encountered in the woodland spruce vegetation/habitat type.

Woodland spruce sites graded into boggy areas where tree cover might be less than 10% and the vegetation resembled muskegs. Low birch shrub stands and woodland spruce were frequently difficult to distinguish in the field because birch stands sometimes had scattered trees which, on occasion, produced almost 10% cover. On aerial photographs, the overall pattern created by small trees produced similar textures for woodland spruce and for low birch shrub sites. This phenomenon, along with the fact that these areas took on a similar color when photographed (dark gray), made distinguishing between them difficult.

Among black spruce stands, those occupying significant slopes (8-10°) appeared to be more productive of browse species and, in fact, received noticeably greater use by moose than did other black spruce areas. Compared to other vegetation types, browse production was low, but since the browse had incurred heavy use, such stands appeared to provide important cover areas during severe weather. Open black spruce stands on the flats were generally very poor in terms of forage production, but some caribou sign was present. Skoog (1968) considered this forest type to represent a good supply of terrestrial forage lichens for caribou in winter.

- Deciduous Forests

Balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*) stands comprised the deciduous types. They usually had a greater overstory cover than spruce stands, because individual deciduous trees produced more foliage cover than individual conifer trees. These types were restricted mostly to the steep banks and floodplain along the river (Figures 6 and 9). Elevations averaged 582 m with closed stands occurring at average elevations of 560 m and open stands at 625 m. They had almost complete vegetation cover, with an especially well-developed ground layer. While the overstory layer in closed stands covered almost three-fourths of the area, it only covered about three-eighths in open stands (Tables 13 and 14). Overstory was sometimes 15 m tall, and in the balsam poplar stands even taller. Dbh's ranged from 15 to 30 cm. Paper birch, trembling aspen, or balsam poplar dominated the forest canopy, which consisted of one species. Important woody species in the ground layer in both types included crowberry, northern Labrador tea, bog blueberry, and mountain cranberry. Open stands appeared to have more woody cover in the ground layer than did the closed stands, while closed stands had more herbaceous components, such as bunchberry (*Cornus canadensis*), bluejoint, and oak fern (*Gymnocarpium dryopteris*). Approximately 16 species were identified in open deciduous forest types while about 31 were found in closed deciduous forests.

Closed deciduous stands were separated on the 1:63,360 scale map (Figure 9) according to the dominant species: balsam poplar and paper birch. Small stands of trembling aspen also occured but they were usually less than the smallest mappable unit. Closed balsam poplar generally occurred on islands in the river or flat areas alongside the river. Balsam poplar was usually the first tree in the successional stage of vegetation

Table 13. Cover percentages for total vegetation, vertical strata, and plant species in closed deciduous forest (birch and balsam poplar) vegetation/habitat type[a] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b]
Total vegetation		99
Overstory (>10 cm dbh)		76
Picea glauca	White spruce	4
Betula papyrifera	Paper birch	54
Populus balsamifera	Balsam poplar	20
Understory (2.5 - 10 cm dbh)		7
Picea glauca	White spruce	3
Betula papyrifera	Paper birch	4
Populus balsamifera	Balsam poplar	1
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	2
Betula papyrifera	Paper birch	4
Populus balsamifera	Balsam poplar	1
Ground layer (<0.5 m tall)		90
Ptilium spp.		26
Polytrichum spp.		5
Empetrum nigrum	Crowberry	9
Ledum decumbens	Northern Labrador tea	15
Vaccinium uliginosum	Bog blueberry	20
Vaccinium vitis-idaea	Mountain cranberry	10
Equisetum silvaticum	Woodland horsetail	5
Cornus canadensis	Bunchberry	38
Populus balsamifera	Balsam poplar	1
Calamagrostis canadensis	Bluejoint	19
Gymnocarpium dryopteris	Oak-fern	10
Mertensia paniculata	Tall bluebell	6

[a] Number of areas sampled was 4.

[b] Includes only those species with at least 5% cover in any one area sampled.

Table 14. Cover percentages for total vegetation, vertical strata, and plant species in open birch deciduous forest vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		99
Overstory (>10 cm dbh)		38
Picea glauca	White spruce	3
Betula papyrifera	Paper birch	38
Understory (2.5 - 10 cm dbh)		6
Picea glauca	White spruce	1
Betula papyrifera	Paper birch	6
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	2
Betula papyrifera	Paper birch	2
Ground layer (<0.5 m tall)		95
Polytrichum spp.		10
Ledum decumbens	Northern Labrador tea	20
Ledum groenlandicum	Labrador tea	12
Vaccinium uliginosum	Bog blueberry	30
Vaccinium vitis-idaea	Mountain cranberry	26
Cornus canadensis	Bunchberry	11
Rosa acicularis	Prickly rose	5
Picea glauca	White spruce	3

a/ Number of areas sampled was 2.

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

development on alluvial deposits. The balsam poplar trees provided about three-fourths cover in the overstory with relatively unimportant understory and shrub layers (Table 15). The ground layer was well developed and included bunchberry, crowberry, northern Labrador tea, bog blueberry, and mountain cranberry. These areas contained 14 identified species.

Closed paper birch stands occurred on steep, usually south-facing slopes. The vertical layer structure is similar to the closed balsam poplar stands: three-fourths overstory, a well-developed ground layer, and relatively unimportant shrub and understory layers (Table 16). Paper birch was prevalent in the overstory, with a few scattered white spruce. The most important ground layer species were bunchberry, bog blueberry, bluejoint, and oak fern. Approximately 25 species were identified.

The minor, closed trembling aspen stands were usually found on the upper portions of dry, south-facing slopes. The general structure was similar to other closed deciduous stands in that there were well-developed overstory and ground layers but insignificant shrub and understory layers (Table 17). The one stand that was visited had ages ranging from 9 to 24 years.

Hettinger and Janz (1974) reported mountain cranberry and bluejoint as major species in birch forest stands in northeastern Alaska, which was in agreement with the Susitna results. However, feathermosses and alder shrubs, which they also found to be important, were insignificant in the upper Susitna area. The undergrowth in the Susitna stands was taller than that pictured in Hettinger and Janz's (1974) publication. The Susitna stands contained bunchberry, northern Labrador tea, Labrador tea, and bog blueberry as important species which were not considered important in the other study. Both studies reported that birch stands occurred on disturbed sites with southern exposures.

- Mixed Conifer-Deciduous Forests

The mixed conifer-deciduous vegetation/habitat types had overstory cover intermediate between that for spruce stands and that for deciduous stands. This typical interior Alaska forest type is dominated by white spruce and paper birch.

Elevations for mixed conifer deciduous forests averaged 466 m with closed stands having a mean elevation near 425 m and open stands occurring around 482 m. Most of the larger stands occurred on slopes downstream from Tsusena Creek (Figure 9). These were probably successional stands which developed as spruce replaced deciduous trees.

Cover in these vegetation/habitat types was almost complete with a well-developed ground layer containing important amounts of bluejoint, bunchberry, woodland horsetail, and Ptilium (Tables 18 and 19). Overstory cover in closed mixed stands was about 60% while that in open mixed stands was 38%. The height of the overstory was sometimes up to 20 m. Dbh's of individuals in these two-species overstories ranged from 15 to 30 cm.

Table 15. Cover percentages for total vegetation, vertical strata, and plant species in closed balsam poplar forest vegetation/habitat type[a] in upper Susitna River basin, summer 1980.

Category		Cover (%)[b]
Total vegetation		99
Overstory (>10 cm dbh)		80
Picea 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

a/ Number of areas sampled was 1.

b/ Includes only those species with at least 5% cover.

Table 16. Cover percentages for total vegetation, vertical strata, and plant species in closed birch deciduous forest vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
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

a/ Number of areas sampled was 2.

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

Table 17. Cover percentages for total vegetation, vertical strata, and plant species in closed aspen deciduous vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Cover (%)[b/]
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

a/ Number of areas sampled was 1.

b/ Includes only those species with at least 5% cover.

Table 18. Cover percentages for total vegetation, vertical strata, and plant species, in closed mixed conifer deciduous forest vegetation/ habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
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

a/ Number of areas sampled was 3.

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

Table 19. Cover percentages for total vegetation, vertical strata, and plant species in open mixed conifer deciduous forest vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
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

a/ Number of areas sampled was 8.

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

Cores of a few of the larger trees indicated that birch tree ages ranged from 54 to 111 years with most of them near 90 or older. White spruce ages ranged from 50 to 204 years with most trees being somewhat over 100 years. Birch trees, however, frequently had rotten centers which degraded aging accuracy. Thus, their ages may be more comparable to those of the spruce trees if dead centers were accounted for. The shrub layer was more important in the open stands, mostly as a result of tall blueberry willow (Salix novae-angliae). Bog blueberry was an important ground species in the open mixed stands. Forty vascular plant species were identified in open mixed stands while 29 were found in closed mixed stands.

General Discussion of Forest Types

Forested communities in the upper Susitna River basin were similar to those described by Viereck (1975). Black spruce generally occurred in wetter sites than white spruce while deciduous or mixed forests occurred on warmer sites. Closed forests occurred on warmer sites also. The drier of these closed sites were usually deciduous while the moister ones were mixed or dominated by spruce. Deciduous and mixed forest stands were considered earlier successional stages of the conifer stands (Viereck 1970, 1975, and Hettinger and Janz 1974).

In general, the deciduous and the mixed conifer and deciduous forests appeared to represent a relatively poor forage resource for moose and caribou. This was particularly true in the closed stands. Steep slopes often associated with these types might be partially responsible for the low preference by ungulates as well. Natural records of browsing intensity, as indicated by the structure of paper birch suckers, suggested these types may incur heavy use in severe winters. Skoog (1968) stated that these types were little used by caribou at any time of the year. The frequency of berry-filled bear scats in this type in spring suggested it might be an important food resource for black bears as they come out of winter torpor. The open nature of the understory vegetation made sighting of fecal piles easier in these forest types and positively biased comparison with other types.

Prickly rose was reported to be an important species in balsam poplar stands along the Chena River (Viereck 1970) and in northeastern Alaska (Hettinger and Janz 1974) as well as in white spruce stands along the Chena River (Viereck 1970). However, it accounted for less than 8% cover in open white spruce stands and less than 5% cover in the closed balsam poplar stands in the upper Susitna River basin. Hence, prickly rose does not appear to be as important in the upper Susitna River basin forest types as it is in some other parts of the state.

(ii) Tundra Types

Tundra communities which usually occurred above the present limit of tree growth (Figure 6), exhibited approximately 70 identified vascular plant species. Most of the well-vegetated communities occurred on flat to gently sloping areas, while sparser vegetation occurred on steep or rocky terrain. Although aspects of tundra vegetation/habitat types were variable, four distinct subtypes occurred in areas large enough to map: wet sedge-grass tundra, mesic sedge-grass tundra, herbaceous alpine tundra, and closed mat and cushion tundra communities.

Wet sedge-grass tundra communities occurred at an average elevation of 587 m in wet, depressed areas with poor drainage. They had almost complete vegetation cover, with most of it occurring in the ground layer (Table 20). Nineteen species were identified. The most important herbaceous species were two sedges, especially water sedge (Carex aquatilis); bluejoint; and sphagnum as well as several other unidentified mosses. The shrub layer, when it was present, contained scattered individual willows (Salix spp.). Wet sedge-grass communities could potentially contain up to 10% cover of erect shrubs. There was usually a large amount of organic matter in these soils and sometimes there was a thick organic layer on top of mineral soil.

Mesic sedge-grass tundra generally occurred at an elevation of 1372 m on rolling uplands with well-drained soils. The soils were well-developed in some areas, but in others the soil occurred as patches alternating with rocks. Nine species were identified with total vegetation cover between half and three-fourths of the area (Table 21). All vegetation was low in the ground layer, usually less than 30 cm tall. Bigelow sedge (Carex bigelowii) was the most common species and accounted for almost half of the total vegetation cover.

Two types of herbaceous alpine tundra occurred in the upper Susitna River basin, although only one, herb-sedge, occurred in areas large enough to map. Herb-sedge communities occurred at elevations of around 1295 m near the glaciers, particularly the West Fork Glacier, where there existed gentle slopes of fairly well-drained and relatively well-developed soils. These were basically mineral soils containing about 5% organic matter. Some of the soil may have developed from loess. Vegetation cover was almost complete, but cover was dispersed evenly among the many species present so that no group of species dominated the area (Table 22). Cover was not estimated because of the complexity of the vegetation and field time constraints. All vegetation occurred in the ground layer and approximately 42 species were identified in the one area of herb-sedge tundra visited.

The other type of herbaceous alpine community was found in small, isolated rocky areas that were too small to map or to sample. Small forbs and sometimes shrubs grew in the pockets of mineral soil imbedded between the rocks.

The fourth major type of tundra community was the mat and cushion tundra, which was found at high elevations (1013 m) on dry, windy ridges (Figure 6). Vegetation covered about three-fourths of the area and was usually less than 20 to 30 cm tall (Table 23). Lichens and low mat-forming shrubs, such as dwarf arctic birch, crowberry, bearberry, and bog blueberry, dominated these areas. Soils were shallow and coarse.

Table 20. Cover percentages for total vegetation, vertical strata, and plant species in wet sedge-grass tundra vegetation/habitat type[a] in upper Susitna River basin, summer 1980.

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

a/ Number of areas sampled was 3.

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

Table 21. Cover percentages for total vegetation, vertical strata, and plant species in mesic sedge-grass tundra vegetation/habitat type[a] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b]
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

a/ Number of areas sampled was 2.

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

Table 22. Plant species list in herbaceous alpine tundra in upper Susitna River basin, summer 1980.[a/]

Category	Common Names
Lycopodium alpinum	Alpine clubmoss
Lycopodium annotinum	Stiff clubmoss
Lycopodium selago	Fir clubmoss
Equisetum sp.	Horsetail
Carex bigelowii	Bigelow sedge
Carex filifolia	Thread-leaf sedge
Eriophorum angustifolium	Tall cottongrass
Calamagrostis purpurascens	Purple reedgrass
Deschampsia caespitosa	Tufted hairgrass
Festuca rubra	Red fescue
Phleum commutatum	Timothy
Juncus sp.	Rush
Luzula confusa	Northern woodrush
Luzula tundricola	Tundra woodrush
Myosotis alpestris	Forget-me-not
Campanula lasiocarpa	Mountain harebell
Aster sibiricus	Siberian aster
Artemisia arctica	Wormwood
Petasites frigidus	Arctic sweet coltsfoot
Senecio atropurpeus	Ragwort
Sedum rosea	Roseroot
Silene acaulis	Moss campion
Diapensia lapponica	Diapensia
Cassiope tetragona	Four-angle mountain-heather
Epilobium latifolium	Dwarf fireweed
Polemonium acutiflorum	Jacob's ladder
Polygonum bistorta	Meadow bistort
Rumex arcticus	Arctic dock
Aconitum delphinifolium	Monkshood
Anemone narcissiflora	Anemone
Caltha leptosepala	Mountain marsh-marigold
Sanguisorba stipulata	Sitka burnet
Sibbaldia procumbens	Sibbaldia
Salix phlebophylla	Skeletonleaf willow
Salix polaris	Polar willow
Salix reticulata	Netleaf willow
Salix rotundifolia	Least willow
Boykinia richardsonii	Richardson boykinia
Saxifraga tricuspidata	Three-tooth saxifrage
Veronica wormskjoldii	Alpine speedwell
Valeriana capitata	Capitate valerian
Polytrichum spp.	Hairy-cap moss

[a/] Number of areas sampled was 1.

Table 23. Cover percentages for total vegetation, vertical strata, and plant species in closed mat and cushion tundra vegetation/habitat type[a] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b]
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

a/ Number of areas sampled was 8.

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

Diverse wildlife occupied the high elevation tundra communities in summer. Most obvious were whimbrel, caribou, black and brown bears, ptarmigan, hoary marmots, and arctic ground squirrels. Whimbrels were frequently spotted here in early summer. Bear scats indicated over-wintered berries were the major attractant of bears in June although many squirrel dens were found which had been excavated by bears. Caribou were more frequently sighted in the sedge-grass tundra than in any other type. Skoog (1968) considered sedge-grass tundra to be important year-round range for caribou in this region. He considered mat and cushion tundra to be more important as a winter forage supply, since its windswept condition generally kept it relatively snow-free.

Wet sedge-grass communities, more common below tree line, showed use by moose where browse was available. Otherwise, its importance was more important to wading birds and, where topography allowed dam-building, beaver. In many cases, the wet sedge-grass vegetation was likely the result of beaver activity.

(iii) Shrub Types

Shrubland vegetation/habitat types were the most prevalent types in the upper Susitna River basin (Figure 6 and Table 4). They generally occurred at higher elevations than forest communities but at lower elevations than tundra types. Most areas, particularly the low shrub, were found on extensive, fairly level benches at mid-elevations throughout the upper basin. Less extensive areas, usually tall shrub, were found on steep slopes above the river. Two main types were found: tall and low shrub, with each being further divided by the percentage shrub cover into closed and open types. Approximately 65 species were identified in this overall type.

- Tall Shrub Types

Tall shrub communities were dominated by Sitka alder (*Alnus sinuata* or *Alnus crispa* var. *sinuata*) and were found mostly on steep slopes above the river or sometimes above the flat benches at an average elevation of 573 m (Figure 6). Many of these stands were 2 to 4 m in height. Approximately 25 species were identified in the alder stands whether closed or open.

Alder stands frequently occurred as stringers through other vegetation/habitat types along the slopes by the river. Many areas also contained alder as a ring around a mountain at a certain elevation or in a strip along a river drainage as at Portage Creek. The closed stands had almost complete vegetation cover with the ground layer and understory accounting for most of the cover (Table 24). Portions of some stands were thickets. Alder provided the most cover with bluejoint and woodland horsetail accounting for most of the ground layer cover.

Only one open alder stand was visited. It had less vegetation cover than the closed alder sites with most of the vegetation being in the

Table 24. Cover percentages for total vegetation, vertical strata, and plant species in closed tall alder vegetation/habitat type[a] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b]
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

[a] Number of areas sampled was 3.

[b] Includes only those species with at least 5% cover in any one area sampled.

understory layer (Table 25). Bluejoint was the most important ground layer species. White spruce was present in both the overstory and understory. This mixture of alder with white spruce indicated that it was probably a successional stand.

Hanson's (1953) description of alder types was similar to those found in the upper Susitna basin in that these thickets occurred on well-drained slopes and varied from 1 to 4 m in height. Bluejoint dominated the ground layer species in many cases, while Beauverd spiraea (Spiraea beauverdiana) and bog blueberry were other important species. Hanson (1953) also observed birch shrubs (Betula spp.) as an important species in alder stands, but the alder stands encountered in the upper Susitna River basin contained no birch shrubs. In contrast, the Susitna stands contained important quantities of woodland horsetail. As in the Susitna study, Hettinger and Janz (1974) observed that alder stands occurred on steeper slopes and older riparian sites.

One alder stand located on a slope of the Susitna canyon (R11E, T29N) was very heavily used by moose (Figure 9). Currant (Ribes spp.) appeared to be highly preferred browse in this stand. Willow was important browse in all stands, and certain individuals of American green alder (Alnus crispa or Alnus crispa var. crispa) were heavily browsed.

- Low Shrub Types

As in earlier studies in northwestern Alaska (Hanson 1953) and in northeastern Alaska (Hettinger and Janz 1974), low shrub vegetation/habitat types were common in the upper Susitna River basin. Low shrub communities were found on the extensive relatively flat benches where soils were frequently wet and gleyed but usually lacking standing water, except for willow types. Elevation averaged about 781 m. Over 40 species were identified in this vegetation/habitat type. Subtypes included birch, willow, and a mixture of the two. Because of the subtle gradations between the subtypes, descriptions were kept very general (Tables 26, 27).

Birch shrub stands were usually dominated by resin birch (Betula glandulosa) about 1.0 m tall and contained several other species of low shrubs, especially northern Labrador tea. The most important associated species in these stands was bog blueberry, while mosses and lichens contributed an important amount of cover. In some stands, there was a buildup of soil and debris around the bases of each birch shrub clump, creating a large amount of microrelief. Sometimes the stands were dense, like a thicket, while others had large openings between individual birch shrubs. Scattered black spruce occurred in some stands contributing almost 10% cover. Hence, low shrub and woodland black spruce stands were difficult to distinguish on the ground and on the aerial photographs. The two species of birch shrub, resin and dwarf arctic birch (Betula nana), were sometimes difficult to distinguish based on leaf shape and plant height. Viereck (1966) also commented on this problem.

Willow stands were usually found in wetter areas, frequently with standing water. Diamondleaf willow (Salix planifolia subsp. pulchra) sometimes formed thickets along small streams at high elevations. Water sedge was

Table 25. Cover percentages for total vegetation, vertical strata, and plant species in open tall alder vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Cover (%)[b/]
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
Shrub layer (>0.5 m tall, <2.5 cm dbh)		10
Alnus sinuata	Sitka alder	10
Ground layer (<0.5 m tall)		25
Linnaea borealis	Twinflower	5
Alnus sinuata	Sitka alder	5
Calamagrostis canadensis	Bluejoint	10

a/ Number of areas sampled was 1.

b/ Includes only those species with at least 5% cover .

Table 26. Cover percentages for total vegetation, vertical strata, and plant species in closed low shrub vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

Category		Average Cover (%)[b/]
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

a/ Number of areas sampled was 10.

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

Table 27. Cover percentages for total vegetation, vertical strata, and plant species in open low shrub vegetation/habitat type[a/] in upper Susitna River basin, summer 1980.

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

a/ Number of areas sampled was 2.

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

the important herbaceous species in these stands. Because of the wetness, these communities were usually less diverse than birch shrub stands. Willow frequently had soil and debris built up at the bases of the stems with standing or running water in the troughs.

Associated species similar to those noted by Hanson (1953) and Hettinger and Janz (1974) were observed in the Susitna area and included northern Labrador tea and bog blueberry. Crowberry was also common in these studies as well as Viereck's (1966) study on the Muldrow Glacier. The birch-willow type which Hanson (1953) described is 2 to 3 m or more tall, while Susitna birch-willow stands and those near the Muldrow Glacier in the Interior were 1.0 to 1.5 m tall (Viereck 1966). Mountain cranberry was important in northeastern Alaska and the Susitna area but not in the northwestern part of the state.

Birch shrub communities apparently received moderate use by moose most of the year. However, stands with willow were preferred. Willow stands received greater browsing than any other vegetation type. Feltleaf willow (*Salix alaxensis*) and diamondleaf willow were heavily utilized in most areas.

Caribou signs were also frequent in birch communities. Skoog (1968) found that leaves of resin birch were important food for caribou in summer; and in winter, lichens were important. He found that caribou feed on willows in spring and fall and considered willow stands important to the ecology of caribou. We agree with this, but specify that this is apparently true only for stands found above the rim of the river canyon.

(iv) Herbaceous Types

Two herbaceous types were found in the upper basin. Grasslands dominated by bluejoint were present on level to sloping areas at lower elevations along the river and along the Portage Creek drainage (Figure 6). Herbaceous pioneer communities were present on gravel and sand bars that had recently become vegetated. Soils here had little organic matter and often consisted of many cobbles. Pioneer species included horsetails, lupines (*Lupinus* spp.), and alpine sweetvetch (*Hedysarum alpinum*).

(v) Unvegetated Areas

Three classes of unvegetated areas are depicted on the maps (Figures 6, 9, and 10): water, rock, and snow and ice. Lakes and streams were included in the water category. Lakes were generally found along flat benches and ranged in size from small ponds to large lakes such as Big Lake (approximately 450 ha). Rock incorporated those areas of bedrock or deposited geologic materials supporting little or no vascular vegetation. Rock occurred as outcroppings at high elevations or along steep cliffs along the river or as unconsolidated gravel in newly deposited river bars. Snow and ice included permanent snowfields and glaciers. Glaciers and permanent snowfields were most common at the northern end of the study area in the Alaska Range, although some occurred near the southern boundary in the Talkeetna Mountains.

(b) Downstream Floodplain

The Susitna River's structure differs markedly among its various reaches. Current rates vary according to those gradient changes. Flow volumes fluctuate seasonally depending upon air temperatures, particularly at the source, and precipitation levels in summer and autumn. Two distinct reaches are apparent in the downstream region: Gold Creek to Chulitna River (Talkeetna) and Chulitna River to Deshka River (Kroto Creek). The Gold Creek-Chulitna River section is relatively incised and would be most affected by the proposed project. At summer flow rates relatively little of the visible land is unvegetated. The reach below Talkeetna is braided. However, the potential effects of the the project below Talkeetna would be dampened by the Chulitna and Talkeetna Rivers. The Susitna River above Talkeetna accounts for 37% of the Susitna River flow just below Talkeetna and only 17% by the time it reaches Cook Inlet (Alaska Power Authority 1980b). Although the downstream section is braided and highly susceptible to channel changes, the potential effects of the project here would be less.

River bars in braided streams are constantly being reworked by the river. Areas are washed away and others are deposited. Vegetation is often disturbed or destroyed on recently deposited areas even if the soil is not eroded. Vegetation may develop extensively on areas that are undisturbed although floods may later destroy this also. Flows are highest and most variable in the summer and generally low and constant in the winter. The variable summer flows account for much of the vegetation dynamics in the floodplain. Spring ice jams, however, can be significantly disturbing to stream-side vegetation above Talkeetna. No evidence of ice damages were observed in the lower section.

Balsam poplar is distinctly associated with the floodplain of this river. It occurs on some of the most recently deposited sand bars, as well as in middle-aged, mature, and decadent stands. However, the oldest, most stable areas are usually covered with birch-spruce forest. The objectives of the downstream study were to study the vegetation and river dynamics and analyze the effects that river dynamics had on plant communities.

(i) Early Successional Stands

Early successional communities common to the lower Susitna River floodplain are dominated by horsetail (Equisetum), horsetail-willow, horsetail-balsam poplar, or dryas (Dryas drummondii) plant communities. These types account for 5-10% of the vegetated land on the floodplains as determined from aerial transects observed from helicopter in June, 1981. These communities have relatively little total vegetation cover and greater than 50% bare ground (Table 28). Plant species in these types are generally characterized by having rhizomes, or horizontal underground stems, which may extend for many meters and are effective in binding loose sand and silt. Sprouts generally arise from these rhizomes, thus increasing the vegetation cover in the area. Horsetail dominates the aspect in all but the dryas plant community, contributing half of the total cover. Willow and balsam poplar provided 8 and 5% cover, respectively (Table 28).

Table 28. Percent cover on early successional stands[a/] on downstream floodplain of Susitna River, summer 1981.

Category		Mean %
Physical Features		
Water		+
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	+

[a/] Early successional stands were numbers 1, 5, 6, 8, 9, 13, 14, 15, 20, 21, 22, and 25 (Figure 5). Number of transects sampled was 42.

Willow and balsam poplar sometimes were found on newly formed bars lacking horsetail, although horsetail appeared to become established first usually. Rocky or gravelly sites tended to have the least cover of horsetail. In most early successional stands balsam poplar occurred at greater density than other woody species (Table 29). The average age of these balsam poplars was 6 years, whereas associated feltleaf willow (Salix alaxensis) and Sitka alder (Alnus sinuata) were both 5 years; thinleaf alder typically did not appear until 3 years after the balsam poplar. As indicated by the heights of these species (Table 30), alder had a relatively rapid growth rate, which allowed it to exceed the height of willow and balsam poplar within 2 or 3 years. Alder was a minor component in these types.

These early successional stages appeared to last up to 10 years from the last major disturbance. Aging of these stands was difficult because a flood might silt in, but not destroy, established vegetation in some areas. The vegetation would be buried then resurface. Balsam poplar about 50 cm in height might have 10 years of growth since the last major silting and another 10 years in the buried silt layer. This cycle could be repeated a number of times before vegetation succession advanced to a later stage. The vegetation in these seral stages 10 (maybe 15) years after stabilization produce willow and balsam poplar browse suitable for moose.

Dryas dominated the aspect of gravelly sites. However, living dryas accounted for only 4% cover. Balsam poplar and dryas covered 6 and 8%, respectively. Bare ground was 76%, one-third of which was cobbles. Dryas is a nitrogen-fixing plant and presumably benefits non-nitrogen-fixing species by adding nitrogen to the soil. Even so, vegetation on these sites is slow growing until sufficient silts and sands are deposited by wind and water to provide a parent material for soil development. Dryas is important in stabilizing these deposits.

(ii) Mid Successional Stands

Deposition of sands and silts, resulting in the elevation of sites farther above the level of frequent flooding, coupled with freedom from disturbance from ice and fast water, appeared to be necessary for transition of early successional vegetation to mid-successional stages. These mid-successional types accounted for about one-fifth of vegetated land in the floodplain. Mid-successional vegetation was characterized by thinleaf alder, or immature balsam poplar which had developed into tall shrubs or trees. The alder type is the first phase of this mid-successional stage and appeared to last from 10 to 25 years after stabilization. The immature balsam poplar stands appeared to dominate the vegetation 25 to 55 years after stabilization but were much less frequent than the alder stands.

Total vegetation cover in alder stands averaged 87% (Table 31); thinleaf alder provided 59%, whereas balsam poplar provided only 13% cover. A striking difference between early and mid-successional stages was the reduction of bare ground in mid-successional stands. Litter and bluejoint grass covers were 99% and 38%, respectively.

Table 29. Density (stems/ha) of woody species in early vegetation successional stages[a/] on downstream floodplain of Susitna River, summer 1981.

				2 - 4 m Tall			
		< .4 m Tall	.4 - 2 m Tall	< 4 cm dbh	> 4 cm dbh	> 4 m Tall	Total
Populus balsamifera	Balsam poplar	38865	1103	40			40008
Alnus sinuata	Sitka alder	8	643	40			691
Salix alaxensis	Feltleaf willow	4929	8643				13572
							572
Salix novae-angliae	Tall blueberry willow	1762	1850	135			3747
Salix arcticus	Arctic willow		48				48
Salix sp.	Willow	305					305
Total		45865	12287	215			58367

a/ Early successional stands were numbers 1, 5, 6, 8, 9, 13, 14, 15, 20, 21, 22, and 25 (Figure 5). Number of transects sampled was 42. Browsable stems were those taller than .4 m but with dbh < 4 cm.

Table 30. Characteristics of woody species in early vegetation succession stands[a/] on downstream floodplain of Susitna River, summer 1981[b/].

		Mean Height (cm)	Mean Length (cm)	Mean Width (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
Salix alaxensis	Feltleaf willow	60	25	18	5	2	68
Salix novae-angliae	Tall blueberry willow	52	18	12	3	2	24
Salix spp.	Willow	68	31	25	4	2	2
Alnus sinuata	Sitka alder	186	163	145	5	2	12
Alnus tenuifolia	Thinleaf alder	154	100	87	3	2	5
Populus balsamifera	Balsam poplar	44	24	19	6	2	63[b/]

[a/] Early successional stands were numbers 1, 5, 6, 8, 9, 13, 14, 15, 20, 21, 22, and 25 (Figure 5). Number of transects sampled was 42.

[b/] Only 62 observations for height.

Table 31. Percent cover in alder stands[a/] on downstream floodplain of Susitna River, summer 1981.

Category		Mean %
Physical Features		
Bare ground		1
Litter		99
Vegetation Categories		
Standing dead		+
Perennial grasses		38
Perennial forbs		11
Mosses		+
Lichens		+
Low shrubs		6
Tall shrubs		60
Trees		13
Total vegetation		87
Vegetation by Species or Genus		
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	+

[a/] Alder stands were numbers 2, 19, 23, and 27 (Figure 5). Number of transects sampled was 20.

Alder density greatly increased over that of early successional stands (691 up to 6682 stems/ha), whereas balsam poplar declined from 40,000 to 2623 stems/ha (Table 32). Crowding, competition, and preferential browsing by moose may account for some of the reduction of balsam poplar, but more importantly, the fact that balsam poplar is shade intolerant and quickly overtopped by alder is primarily responsible for its decrease. Shade tolerant species such as raspberry, prickly rose, and highbush cranberry appeared in alder stands. These produced 200, 117, and 467 browsable stems (> 0.4 m high, <4 cm dbh)/ha.

The average ages of tall shrub-sized thinleaf alder and balsam poplar in alder stands were 20 and 19 years, respectively (Table 33), indicating the stands probably averaged 20 years in age. Balsam poplar and alder heights were nearly equal, 7.9 and 7.0 m, respectively in the alder stands. However, observation of many different aged alder stands suggested that once balsam poplar reached the top of alder canopies, the balsam poplar quickly doubled its height, thereby overshadowing the alder and developing into the immature balsam poplar phase of the mid-successional stage.

Balsam poplar dominated the overstory of immature balsam poplar stands, producing 62% cover (Table 34); thinleaf alder provided 40% cover. As in alder stands, there was essentially no bare ground and litter and bluejoint provided most of the ground cover. Density of balsam poplar and thinleaf alder declined from that found in alder stands since the balsam poplar trees grew larger (Table 35), Sitka alder, however, tripled in density (Table 35). Feltleaf willow decreased from 3559 to 352 stems/ha. Prickly rose and highbush cranberry substantially increased in density (Table 35), and also developed much more robust growth forms (Table 36).

Balsam poplar trees in immature balsam poplar stands averaged 44 years of age (Table 37) and 18 m in height (more than double their height in the alder phase). Alder ages were about the same in both the alder and the immature balsam poplar phases, suggesting that approximately 20 years is the life expectancy of individual stems. Alder individuals in the immature balsam poplar stands would be second growth, whereas the balsam poplars were among the original colonizers. Heights of alder were also roughly equal between the two phases and it was apparent that thinleaf alder attained a greater height than Sitka alder (Table 37).

White spruce was found as early as the alder phase (34 stems/ha), with the number of individuals only slightly increased in the immature balsam poplar phase (Tables 32 and 35). Age data (Table 37), however, suggest that most white spruce individuals were established sometime after alder stands began developing into the immature balsam poplar phase. This discrepancy could indicate sampling was insufficient to cover stand variability and/or that considerable mortality occurred with young white spruce in this early period of their establishment. Paper birch also was found in both mid-successional phases, but the age differences between phases (Tables 32 and 35) indicated no increase in the number of individuals as the immature balsam poplar phase developed.

Table 32. Density (stems/ha) of woody species in alder stands[a/] on downstream floodplain of Susitna River, summer 1981.

		< .4 m Tall	.4 - 2 m Tall	2 - 4 m Tall		> 4 m Tall	Total
				< 4 cm dbh	> 4 cm dbh		
Populus balsamifera	Balsam poplar	867	900	417	42	397	2623
Alnus tenuifolia	Thinleaf alder	483	1850	633	983	2317	6266
Alnus sinuata	Sitka alder		133	33		250	416
Salix alaxensis	Feltleaf willow	617	2517	167	133	125	3559
Picea glauca	White spruce	17	17				34
Echinopanax horridum	Devil's club		133				133
Rubus idaeus	Raspberry	967	200				1167
Rosa acicularis	Prickly rose	517	117				634
Viburnum edule	Highbush cranberry		467				467
Salix novae-angliae	Tall blueberry willow		83				83
Ribes triste	American red currant	1133					1133
Salix sp.	Willow	783					783
Total		5384	6417	1250	1158	3089	17298

[a/] Alder stands were numbers 2, 19, 23, and 27 (Figure 5). Number of transects sampled was 20. Browsable stems were those taller than .4 m but with dbh < 4 cm.

Table 33. Characteristics of trees and tall shrubs in alder stands [a/] on downstream floodplain of Susitna River, summer 1981.

		Mean Height (m)	Mean dbh (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
Populus balsamifera	Balsam poplar	7.9	7.2	19	2	28[b/]
Alnus tenuifolia	Thinleaf alder	7.0	7.3	20	2	40[c/]
Alnus sinuata	Sitka alder	3.9	3.4	17	5	4
Betula papyrifera	Paper birch	4.9	4.6	13	4	4
Picea glauca	White spruce	4.7	5.0	11	4	9[d/]

a/ Alder stands were numbers 2, 19, 23, and 27 (Figure 5). Number of transects sampled was 20.

b/ Only 27 observations for dbh.

c/ Only 37 observations for age.

d/ Only 7 observations for dbh.

Table 34. Percent cover in immature balsam poplar stands[a/] on downstream floodplain, summer 1981.

Category		Mean %
Physical Features		
Vegetation Categories		
Litter		95
Standing dead		+
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	+

[a/] Immature balsam poplar stands were numbers 10, 12, and 26 (Figure 5). Number of transects sampled was 18.

Table 35. Density (stems/ha) of woody species in immature balsam poplar stands[a/] on downstream floodplain, summer 1981.

				2 - 4 m Tall			
		< .4 m Tall	.4 - 2 m Tall	< 4 cm dbh	> 4 cm dbh	> 4 m Tall	Total
Populus balsamifera	Balsam poplar		19	407	619		1045
Alnus tenuifolia	Thinleaf alder	74	1759	1704	56	1472	5065
Alnus sinuata	Sitka alder		907	426		19	1352
Salix alaxensis	Feltleaf alder		352				352
Salix sp.	Willow		148				148
Picea glauca	White spruce		37				37
Rubus idaeus	Raspberry	1185					1185
Rosa acicularis	Prickly rose	1037	1519				2556
Viburnum edule	Highbush cranberry	630	463				1093
Salix novae-angliae	Tall blueberry willow		37				37
Ribes sp.	Currant	759					759
Total		3685	5241	2537	675	1491	13629

a/ Immature balsam poplar stands were numbers 10, 12, and 26 (Figure 5). Number of transects sampled was 18. Browsable stems were those taller than .4 m but less than 4 cm dbh.

Table 36. Characteristics of woody species in immature balsam poplar stands[a/] on downstream floodplain of Susitna River, summer 1981.

		Mean Height (cm)	Mean Length (cm)	Mean Width (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
Salix novae-angliae	Feltleaf willow	125	53	45	9	6	8
Ribes sp.	Currant	48	35	35	3	7	1
Rubus idaeus	Raspberry	35	29	21	1	7	6
Betula papyrifera	Paper birch	102	25	22	-	6	1[b/]
Picea glauca	White spruce	10	10	7	2	7	1
Alnus sinuata	Sitka alder	181	153	104	8	6	17[c/]
Alnus tenuifolia	Thinleaf alder	139	73	43	6	6	32[d/]
Populus balsamifera	Balsam poplar	182	63	39	15	6	8
Rosa acicularis	Prickly rose	56	40	32	2	6	29
Viburnum edule	Highbush cranberry	94	69	51	5	6	21

[a/] Immature balsam poplar stands were numbers 10, 12, and 26 (Figure 5). Number of transects sampled was 18.

[b/] No observations for age.

[c/] Only 13 observations for age.

[d/] Only 31 observations for age.

Table 37. Characteristics of trees and tall shrubs in immature balsam poplar stands[a] on downstream floodplain of Susitna River, summer 1981.

		Mean Height (m)	Mean dbh (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
Populus balsamifera	Balsam poplar	17.7	24.8	44	2	36[b]
Alnus tenuifolia	Thinleaf alder	6.6	6.9	22	4	32[c]
Alnus sinuata	Sitka alder	5.1	8.5	22	5	3[d]
Betula papyrifera	Paper birch	6.2	12.4	43	4	1[e]
Picea glauca	White spruce	2.6	--	13	6	1[f]

[a] Immature balsam poplar stands were numbers 10, 12, and 26 (Figure 5). Number of transects sampled was 18.

[b] Only 35 observations for crown dominance.

[c] Only 31 observations for age.

[d] Have 4 observations for age.

[e] Have 2 observations for height.

[f] No observations for dbh.

(iii) Late Successional Stands

As the balsam poplar stands matured, white spruce occasionally appeared in the canopy. Mature balsam poplar stands possibly occurred 75 years after stabilization and extended for another 30 or more years. Eventually, the balsam poplar becomes decadent leaving space for development of more balsam poplar or spruce and birch, if no disturbances interrupt the process. The factors responsible for development of the birch-spruce stands versus continuation of the balsam poplar are still unclear as is the time period for its establishment. However, geographic and topographic locations and continuity of stands suggest that birch-spruce forest occurs on the most stable and oldest sites compared to either mature or decadent balsam poplar forests. Mature and decadent balsam poplar stands characterize 25 to 40% of the vegetated floodplain while mixed stands of birch and spruce occupy 23 to 32% of the area.

Mature and decadent balsam poplar stands, collectively, averaged 90% total vegetation cover. Balsam poplar trees provided 49% cover, alder 44% cover, highbush cranberry 21%, prickly rose 15% and bluejoint 12% (Table 38). Ostrich fern (Matteuccia struthiopteris) was also an important component of the understory (7% cover) not typically found in other floodplain plant communities. Ostrich fern occurred primarily in stands in mature and decadent balsam poplar stands north of Montana Creek but below Portage Creek. It was used heavily by moose in June. We have laboratory data from other fern species which indicate that ferns often contain unusually high nitrogen levels in their early spring growth. That feature could provide ruminants feeding upon fern with a rich source of protein depending upon digestibility of the nitrogen compounds in the fern. Growth characteristics of prickly rose and highbush cranberry, the dominant browse species, were not much different from those in the immature stands (Tables 36 and 39), but densities increased from 2556 to 12361 and from 1093 to 23555, respectively (Tables 35 and 40). This increase in understory is likely a result of reduced competition from the overstory balsam poplar, which experiences natural thinning (from 1045 to 294 stems/ha) as it develops into the mature and decadent stage.

Mature and decadent balsam poplar averaged 26.4 m in height and averaged 98 years in age, according to our measurements (Table 41). These trees were probably older than recorded, because the rotted center portion of the trees was difficult to age. Rot usually occurred at 65 to 80 years. This same problem prevented our accurately aging some paper birch. Of special note was that some stems of Sitka alder were extremely long-lived relative to alder in other successional stages, and thus the mean age was 50 years. Maximum ages of these alder approached those (50-70 years) we examined in another study during 1980 in the lower Susitna Basin above tree-line near the Capps glacier.

Birch-spruce communities were characterized by 42% cover by paper birch and 12% cover by white spruce in the overstory (Table 42). Tall shrubs, predominantly thinleaf alder, accounted for 14% cover. Low shrubs, forbs, and grasses provided 40, 44, and 18% cover, respectively.

Table 38. Percent cover in mature and decadent balsam poplar stands[a/] on downstream floodplain, summer 1981.

Category		Mean %
Vegetation Categories		
Litter		92
Standing dead		+
Perennial grasses		12
Perennial forbs		23
Mosses		+
Low shrubs		36
Tall shrubs		43
Trees		50
Total vegetation		90
Vegetation by Species or Genus		
Populus balsamifera	Balsam poplar	49
Alnus tenuifolia	Thinleaf alder	41
Alnus sinuata	Sitka alder	3
Viburnum edule	Highbush cranberry	21
Rosa acicularis	Prickly rose	15
Calamagrostis canadensis	Bluejoint	12
Ribes spp.	Currant	3
Mertensia paniculata	Tall bluebell	2
Echinopanax horridum	Devil's club	1
Rubus idaeus	Raspberry	4
Dryopteris dilatata	Spinulose shield-fern	1
Gymnocarpium sp.	Oak-fern	5
Matteuccia struthiopteris	Ostrich fern	7
Streptopus amplexicaulis	Cucumber-root	1
Picea glauca	White spruce	1
Cornus canadensis	Bunchberry	+
Heracleum lanatum	Cow parsnip	+
Pyrola sp.	Wintergreen	+
Trientalis europaea	Arctic starflower	+
Galium sp.	Bedstraw	+

[a/] Mature and decadent balsam poplar stands were numbers 3, 17, 24, and 28 (Figure 5). Number of transects sampled was 24.

Table 39. Characteristics of woody species in mature and decadent balsam poplar stands[a] on downstream floodplain of Susitna River, summer 1981.

		Mean Height (cm)	Mean Length (cm)	Mean Width (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
<u>Ribes triste</u>	American red currant	38	29	18	2	7	16
<u>Ribes</u> sp.	Currant	50	45	25	3	7	8
<u>Rubus idaeus</u>	Raspberry	65	45	29	1	7	26[b]
<u>Alnus sinuata</u>	Sitka alder	248	121	87	9	6	8
<u>Alnus tenuifolia</u>	Thinleaf alder	205	78	53	6	6	20
<u>Rosa acicularis</u>	Prickly rose	65	43	31	2	6	48
<u>Viburnum edule</u>	Highbush cranberry	81	45	30	4	6	48

[a] Mature and decadent balsam poplar stands were numbers 3, 17, 24, and 28 (Figure 5). Number of transects sampled was 24.

[b] Only 24 observations for age.

Table 40. Density (stems/ha) of woody species in mature and decadent balsam poplar stands[a/] on downstream floodplain, summer 1981.

		< .4 m Tall	.4 - 2 m Tall	2 - 4 m Tall		> 4 m Tall	Total
				< 4 cm dbh	> 4 cm dbh		
Populus balsamifera	Balsam poplar					294	294
Alnus tenuifolia	Thinleaf alder		1917	2236	14	674	4841
Alnus sinuata	Sitka alder		111	278	7	7	403
Picea glauca	White spruce					3	3
Echinopanax horridum	Devil's club	14	1014				1028
Rubus idaeus	Raspberry	2184	3931				6115
Rosa acicularis	Prickly rose	1611	10750				12361
Viburnum edule	Highbush cranberry	1722	21833				23555
Ribes triste	American red currant	6569					6569
Total		12100	39556	2514	21	978	55169

[a/] Mature and decadent balsam poplar stands were numbers 3, 17, 24, and 28 (Figure 5). Number of transects was 24. Browsable stems were those taller than 0.4 m but with less than 4 cm dbh.

Table 41. Characteristics of trees and tall shrubs in mature and decadent balsam poplar stands[a/] on downstream floodplain of Susitna River, summer 1981.

		Mean Height (m)	Mean dbh (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
Populus balsamifera	Balsam poplar	26.4	53.2	98	2	40[b/]
Alnus tenuifolia	Thinleaf alder	7.1	7.4	28	5	42[c/]
Alnus sinuata	Sitka alder	5.3	16.6	50	5	2[d/]
Betula papyrifera	Paper birch	14.2	23.6	63	2	7[e/]
Picea glauca	White spruce	14.0	23.8	94	3	16[f/]

a/ Mature and decadent balsam poplar stands were numbers 3, 17, 24, and 28 (Figure 5). Number of transects sampled was 24.

b/ Only 33 observations for age and 38 for crown dominance.

c/ Only 32 observations for age.

d/ Only 1 observation for crown dominance.

e/ Only 6 observations for age and crown dominance.

f/ Only 14 observations for age.

Table 42. Percent cover in birch-spruce stands[a/] on downstream floodplain, summer 1981.

Category		Mean %
Vegetation Categories		
Litter		100
Standing dead		+
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	+

[a/] Birch-spruce stands were numbers 4, 11, and 29 (Figure 5). Number of transects sampled was 20.

The average height and apparent age of paper birch trees was 15.5 m and 72 years (Table 43). This age is a low estimate, since unrotted tree trunks were difficult to find. White spruce averaged 16.2 m and 91 years. Thinleaf alder (> 4 m ht) averaged 5.5 m and 28 years.

The density of paper birch trees was 227 stems/ha (Table 44). There were 143 white spruce/ha and 1792 alder (all sizes)/ha. Browsable willow, paper birch, highbush cranberry, and prickly rose had densities of 200, 750, 17050, and 16950, respectively. These shrubs were about 1 m tall (Table 45).

Birch-spruce stands had the greatest variation in stand structure of the vegetation types found on the floodplain. There was some evidence that these stands were self-perpetuating. That is, upon overmaturity the birch overstory falls, making the spruce more susceptible to wind-throw and thereby allowing a paper birch shrub-alder/highbush cranberry-prickly rose community to increase. The shrub community then progresses to the birch-spruce forest condition again. The woody species composition and density of the seral brush phase make it ideal moose habitat, especially as it is interspersed with the more mature forest.

(iv) Moose Habitat Characteristics

Horsetail-willow and horsetail-balsam poplar plant communities provided a substantial forage resource for moose. Close proximity with cover (mid- and late-successional stands) allowed most such areas to receive use by all age classes of moose during all seasons. However, stands which were located far from protective cover may only have been acceptable to older animals. Horsetail and dryas communities were of little or no value to moose at any time of the year, because the browse was either insufficient or too low-growing.

Mid-successional plant communities generally had fewer stems of browse/ha available to moose than horsetail-willow or horsetail-balsam poplar communities, but the diversity of browse was greater with the presence of shade tolerant species such as highbush cranberry, raspberry, and prickly rose. Mid-successional communities also provided a mix of forbs which appeared important in the diets of young calves and lactating cows. Both alder and immature balsam poplar stands provided dense hiding and thermal cover. Alder stands, having very low browse densities (excluding alder, a relatively unpalatable species), exhibited extremely heavy utilization of balsam poplar, indicating moose may have been using these stands during severe weather.

Due to their extensive coverage, mature and decadent balsam poplar and birch-spruce stands were the major food resource for moose living on the downstream floodplain. A variety of browse and forbs were present in these stands. Densities of willow and balsam poplar were less than in early successional stands, but other species such as highbush cranberry, prickly rose, and birch saplings (in birch-spruce stands) were relatively abundant. The dynamic nature of birch-spruce stands (i.e., the cycling of the stands from overmature overstory to wind-throws and brush fields then back to mature birch-spruce) made this type particularly attractive year-round habitat for moose.

Table 43. Characteristics of trees and tall shrubs in birch-spruce stands[a/] on downstream floodplain of Susitna River, summer 1981.

		Mean Height (m)	Mean dbh (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
Alnus tenuifolia	Thinleaf alder	5.5	6.1	28	5	6
Alnus sinuata	Sitka alder	4.3	7.0	45	5	2
Betula papyrifera	Paper birch	15.5	29.2	72	2	30[b/]
Picea glauca	White spruce	16.2	27.1	91	2	32

a/ Birch spruce stands were numbers 4, 11, and 29 (Figure 5). Number of transects sampled was 20.

b/ Only 29 observations for age and crown dominance.

Table 44. Density (stems/ha) of woody species in birch-spruce stands[a/] on downstream floodplain, summer 1981.

		< .4 m Tall	.4 - 2 m Tall	2 - 4 m Tall < 4 cm dbh	2 - 4 m Tall > 4 cm dbh	> 4 m Tall	Total
Alnus tenuifolia	Thinleaf alder		167	1033		408	1608
Alnus sinuata	Sitka alder		17	117		50	184
Betula papyrifera	Paper birch	50	350	400		227	1027
Picea glauca	White spruce		333	133	42	143	651
Echinopanax horridum	Devil's club		1183				1183
Rubus idaeus	Raspberry	3683	167				3850
Rosa acicularis	Prickly rose		16950				16950
Viburnum edule	Highbush cranberry	167	17050				17217
Salix novae-angliae	Tall blueberry willow		200				200
Spiraea beauverdiana	Beauverd spiraea		100				100
Ribes sp.	Currant	10367					10367
Actaea rubra	Baneberry	83					83
Salix sp.	Willow	467					467
Total		14817	36517	1683	42	828	53887

a/ Birch-spruce stands were numbers 4, 11, and 29 (Figure 5). Number of transects sampled was 20. Browsable stems were those taller than 0.4 m but less than 4 cm dbh.

Table 45. Characteristics of woody species in birch-spruce stands[a/] on downstream floodplain of Susitna River, summer 1981.

		Mean Height (cm)	Mean Length (cm)	Mean Width (cm)	Mean Age	Mean Crown Dominance	Number of Individuals Sampled
Salix novae-angliae	Tall blueberry willow	112	34	28	6	6	3
Salix spp.	Willow	78	68	33	7	6	1
Alnus sinuata	Sitka alder	225	101	62	12	6	5
Alnus tenuifolia	Thinleaf alder	226	105	83	11	5	8
Betula papyrifera	Paper birch	116	66	48	6	6	9
Rosa acicularis	Prickly rose	81	49	37	2	6	37
Viburnum edule	Highbush cranberry	94	49	35	5	6	40
Rubus idaeus	Raspberry	57	51	24	1	7	16

a/ Birch-spruce stands were numbers 4, 11, and 29 (Figure 5). Number of transects sampled was 20.

(c) Transmission Corridors

(i) Central (Dams to Intertie)

The central transmission corridor crosses a diverse number of vegetation/habitat types found in the upper basin (Figure 9 and Table 6). Much of the diversity results from the large elevation differences along the corridor. The predominant types encountered at the lower elevations, in the Gold Creek vicinity and in Devil Canyon, are closed mixed conifer-deciduous forest, closed tall shrub, and closed birch forest. Higher elevations north of the river are characterized by birch, low shrub, sedge-shrub tundra, and mat and cushion tundra. Higher elevations south of the river also have shrub and tundra types but support more extensive stands of woodland and open black spruce.

(ii) Willow-Cook Inlet

The mapping units presented on Figures 7 and 8 and in Tables 7 and 8 are based on vegetation characteristics and names according to Viereck and Dyrness (1980). Thus, transmission corridor mapping units are similar to those used in the upper basin. Deciduous mapping units consist of aspen and/or birch and contain broadleaf vegetation. Complexes of types were used where individual types in the field were too small to delineate on the map. Some cover classes may be underestimated since trees had started losing their leaves when the corridors were flown for field-checking.

The Willow-Cook Inlet transmission corridor passes through an area dominated first by closed birch and mixed conifer-deciduous forests, next by large wet sedge-grass marshes, and finally by open and closed spruce stands (Figure 7 and Table 7). Timbered stands in this particular area of the Susitna valley were characterized by generally good stocking of relatively high quality birch, white spruce, and balsam poplar. However, many of the stands have had poor regeneration and developed either a woodland/shrubland or woodland/grassland aspect. Birch was the predominant deciduous species. Localized stands of balsam poplar were associated with the active river floodplain (Willow vicinity).

Wet sedge-grass was the second most dominant vegetation type in this area. Most stands were quite extensive and associated with diverse networks of ponds, lakes, and meandering streams. These areas were generally thought to be unsupportive of other types of vegetation except for scattered islands of black spruce and low shrub along drier margins.

White spruce dominated stand composition for most of interior Alaska but occupied a minority position in this part of the Susitna valley. The vegetation map of this corridor is not specific as to spruce species. However, most communities identified as closed and open spruce which occur in areas dominated by mixed conifer deciduous forest were likely 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 were black spruce.

(iii) Healy - Fairbanks

The northern transmission corridor crosses three distinct physiographically and phytosociologically distinct sections: Healy to Nenana River, Nenana River to Tanana River, and Tanana River to Fairbanks (Figure 8 and Table 8). The Healy-to-Nenana-River section contains 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 spruce, open mixed conifer-deciduous, and open deciduous forest types. The flat area is predominantly low shrub with sedge-grass and open and closed spruce 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 is characterized by a mosaic of wet vegetation types including open spruce (usually with larch (tamarack), *Larix laricina*), low shrub, and wet sedge-grass. Locations of many types appear to be controlled by old stream meanders and drainage patterns. Some patches of deciduous forest stands also occur. Some portions of the mosaic could be delimited on the map while others were too intermingled to separate. Dry streambeds have stringers of other vegetation, such as low shrub, through them, which frequently could not be delimited on the map.

The section from the Tanana River to Fairbanks passes through rolling hills covered predominantly with open deciduous forest with small areas of spruce less common than in the previous section. The woodland mixed patches in this section are generally cutover areas. Many of the closed spruce areas produce very short, scrub-like trees and appear more like a low shrub type.

Most spruce areas between the Tanana River and Fairbanks contain only spruce and little larch, while about half the areas in the Tanana Flats section contain larch as well. Species of spruce were not checked on the ground but stands in low, poorly drained areas were assumed to be black spruce. Individuals in better drained locations may be either species. These species could not be separated confidently without ground-checking many stands. Therefore, this vegetation was mapped as spruce. The spruce-larch mixture was easily visible from the air but could not be distinguished on the aerial imagery. The black spruce-larch type which is confined in Alaska to the interior is generally found only on wet lowland sites with shallow permafrost (Viereck and Dyrness 1980). Larch or tamarack is a deciduous conifer.

3.5 - Wetlands

(a) Identification and Mapping

Apparent wetlands within the direct impact areas were classified and mapped (Figure 11) according to that system (Cowardin *et al*. 1979) recently adopted by the U.S. Fish and Wildlife Service (USF&WS 1980a).

Lakes, ponds, rivers, and streams were not specifically classified. The vegetation/habitat maps were used as a basis for preparing the wetlands map. Table 46 lists the wetland classes and corresponding vegetation types (Viereck and Dyrness 1980) by the landscape that was actually mapped.

As indicated in Table 47 there may be considerable amounts of wetlands within the project area. Our estimates of total palustrine wetland areas (Table 46) were extremely liberal since the wetlands were highly integrated with non-wetlands and because we did not have supporting soil data for each of the types. Also, although the mapping was performed using the U.S. Fish and Wildlife Service system, which is acceptable to the U.S. Army Corps of Engineers for permit applications, there are several wetlands mapped under this system that are outside of the Corp's jurisdiction. Isolated wetlands, for example, with an outflow of less than 5 cfs are included in Table 47, but are not within the Corp's jurisdiction.

(b) Vascular Aquatic Plants

The objective of this study was to assess the aquatic vascular plants growing within and/or adjacent to ponds and lakes. The area of study extended from Devil Canyon to the confluence of the Susitna and Oshetna Rivers. Selected ponds and lakes within the impoundment area as well as on the adjacent upland plateau areas were evaluated. Twenty-four lakes and ponds were assessed from the ground (Figure 12). Many of the remaining lakes and ponds in the area were overflown and inspected from the air to ensure similarity among ponds and to search for new species.

The species were divided into "true" aquatics and "bank" species. Although there is no good definition of aquatic plants, "true" aquatic plants are defined here as those growing directly in water or immediately adjacent to water. Species that dominated the banks or periphery of the ponds or that frequently occurred on floating mats were considered "bank" species. All the species recorded are considered hydrophytes.

The wetland area, as defined here, is primarily restricted to the wet sedge-grass tundra type presented in the vegetation/habitat cover maps, or the Lacustrine-Limnetic-Emergent Wetland-Vascular wetland class of Cowardin et al. (1979).

The Susitna River itself and its tributaries were not specifically assessed for aquatic plants. Because of the high velocity of the tributaries and the velocity and sediment load of the mainstream Susitna, they are nearly devoid of aquatic vascular plants. However, during periods when water is clear, algal growth can be of considerable importance in the Susitna River.

There are very few ponds and lakes within the impoundment areas. Most of the water bodies occur on the upland plateau between the edge of the river canyon and the surrounding mountain. There are a countless number of lakes in the large flats of the upper Susitna basin, such as those in the southeastern portion of the upper basin in the Lake Louise area.

Table 47. Hectares of different wetland types[a] by project component.

Wetland Type	Watana Facility							
			Borrow Areas					
	Impoundment, Dam and Spillways	Camp, Village and Airstrip	A	D	E	F	H	I
Palustrine forested	7,408		252	16	133	80	345	15
Palustrine scrub-shrub	1,126	142	62	212		199	38	
Palustrine emergent	139		8	8				
Lacustrine emergent	4							
Lacustrine	54	8						
Riverine	2,182							
Total	10,913	150	322	236	133	279	383	15

Wetland Type	Devil Canyon Facility		
	Impoundment, Dam and Spillways	Camp and Village	Borrow Area K
Palustrine forested	800		11
Palustrine shrub-scrub	43		29
Palustrine emergent	12		
Lacustrine emergent			
Lacustrine	1		
Riverine	810		
Total	1,666	-0-	40

a/ Wetland types according to Cowardin, *et al*. (1979).

Table 46. Vegetation and wetland classes found in the proposed Susitna Impoundment and borrow areas.

Mapping Unit (Viereck & Dyrness 1980)	FWS Wetland Class (Cowardin et al. 1979)
Lakes, ponds	Lacustrine unconsolidate bottom, aquatic bed, unconsolidated shore
Rivers, streams	Riverine Upper Perennial rock bottom, unconsolidated bottom, rocky shore, unconsolidated shore
Wet sedge-grass	Palustrine or Lacustrine emergent
Low shrub	Palustrine scrub-shrub
Birch shrub	Palustrine scrub-shrub
Willow shrub	Palustrine scrub-shrub
Open black spruce	Palustrine forested
Woodland black spruce	Palustrine forested
Open white spruce	Palustrine forested
Closed white spruce	Palustrine forested
Open balsam poplar	Palustrine forested
Closed balsam poplar	Palustrine forested

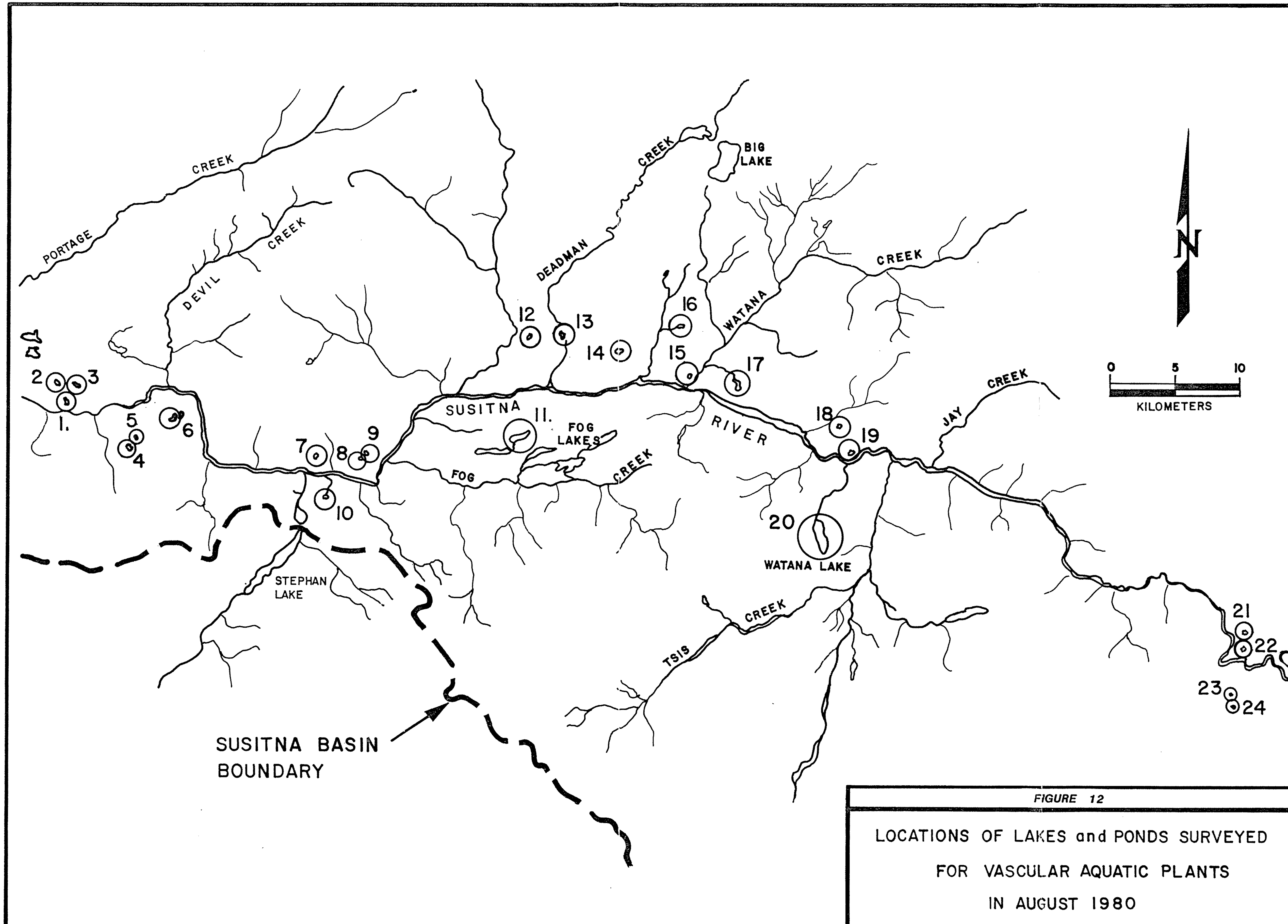

FIGURE 12

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

Most of the lakes and ponds immediately adjacent to the impoundment area are classified according to Cowardin et al. (1979) as: Lacustrine-Limnetic-Unconsolidated Bottom or Aquatic Bed; or Lacustrine-Littoral-Aquatic Bed or Unconsolidated Bottom.

The dominant "true" aquatic species of the water bodies were: horsetail (*Equisetum fluviatile*), bur reed (*Sparganium angustifolium*), sedge (*Carex aquatilis*), yellow pond lily (*Nuphar polysepalum*), mare's tail (*Hippuris vulgaris*), and bladderwort (*Utricularia vulgaris*) (Table 48).

Bur reed and yellow pond lily probably contributed more to total cover than all other species combined. Yellow pond lily, which is a submerged species with large floating leaves, was particularly prominent and formed vast beds in several water bodies. It was absent along the edges of ponds but appeared to grow best at depths ranging from 0.6 to 2.1 m. As a result, a band of yellow pond lily frequently occurred around lakes away from the shores in the area between the shallows and deep water. Bur reed, in contrast, frequently dominated the shallows of the ponds which were about 0.15 to 0.60 m in depth. Horsetail, mare's tail, and bladderwort were also common in these shallows. Horsetail was common on rocky bottoms where little other vegetation occurred. Bladderwort appeared prominent in shallows having a mud bottom or a bottom of organic matter.

Dominant "bank" or edge species included: horsetail, bluejoint (*Calamagrostis canadensis*), cottongrass (*Eriophorum* spp.), sedge (*Carex aquatilis*), marsh fivefinger (*Potentilla palustris*), and buckbean (*Menyanthes trifoliata*). Sedge probably contributed more to total cover than all other edge species combined. It was the prevalent species of the pond shallows from about 0.0 - 0.3 m in depth, along the pond periphery, and also on floating mats, which were sometimes present.

The same species were encountered in many of the water bodies of the area. The one exception was the aquatic vegetation of Watana Lake. This lake was dominated solely by pondweed (*Potamogeton robbinsii*). This pondweed is a submerged rooted aquatic species that grew in water from about 1.2 to 2.4 m in depth. Hulten (1968) reports that this species is known from his area of study, but it has only been collected once at Summit. Welsh (1974) indicates that it is known from southcentral Alaska, but evidently rare. The reason for the lack of other vascular plants in Watana Lake and the presence of *Potamogeton robbinsii* is not understood, although at 914-m elevation, this lake had the highest elevation of any water body assessed.

Total cover of aquatic vegetation and the width of the surrounding emergent wetland area varied from pond to pond (Table 48). Total cover appeared to vary depending upon the proportionate amount of open water (in general, more than 2.1 m in depth) to shallow water present in each pond. The higher the percent of shallow water the greater the area that sufficient light could penetrate to the bottom and, as a result, the higher the cover of aquatic plants. This trend is valid in general, although lakes and ponds above 945 m in elevation usually had sparse

Table 48

Aquatic Plant Survey, Susitna Hydroelectric Project, August 1980

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(a)				c					
<u>Isoetes muricata</u> -- Quillwort											s													
<u>Equisetum fluviatile</u> -- Horsetail	d	d	d					c										d				s		s
<u>Sparganium angustifolium</u> -- Bur reed	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 Robbinsii</u> -- Pondweed																				d				
<u>Potamogeton filiformis</u> -- Pondweed																			s		s			
<u>Eriophorum</u> spp. -- Cotton grass																		s						
<u>Carex aquatilis</u> -- Sedge	d	d			c	c		d	d								c	d						
<u>Nuphar polysepalum</u> -- Yellow pond lily		c				d	d	d	d	d	c	d	d	d		d	c		d		d	d	d	d
<u>Ranunculus confervoides</u> -- Buttercup		c		d		d		s		s					s	s								
<u>Potentilla palustris</u> -- Marsh fivefinger										s														
<u>Callitriche verna</u> -- Water starwort															d									
<u>Hippuris vulgaris</u> -- Mare's tail							c			c	s				d		c		c		s	s		s
<u>Menyanthes trifoliata</u> -- Buckbean																							s	
<u>Utricularia vulgaris</u> -- Bladderwort											c	d		c		c	d	d			s		s	d

a. d=dominant, c=common, s=sparse

Table 48 (Continued, Page 2 of 3)

SPECIES	Pond or Lake (#)																							
"BANK" SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
															(a)									
Sphagnum spp. -- Sphagnum moss															c	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. -- Cotton grass				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														c							
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	

a. d=dominant, c=common, s=sparse

Table 48 (Continued, 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	24
Total Cover (%)	<1	<5	– (b)	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	10-20
Surrounding Wetland Width (Meters)	0	2-3	–	3-6	6-9	3-6	3-6	2-9	–	15-30	0-3	15-25	3-5	15-30	15-25	30-45	3-15	1-2	2-3	0	6-9	12-15	3-6	2-3
Elevation (Feet)	1950	1700	2300	2300	2180	2180	2800	1950	1950	1975	2300	2280	2410	2340	1850	2300	2060	2750	1800	3000	2250	2560	2575	2560

b. data not recorded

aquatic vegetation cover regardless of the bottom morphology. Rocky substrate and rock ledges also appeared to limit the amount of aquatic vegetation cover.

The amount of associated emergent wetland area, which was dominated by sedge and other common bank species, appeared related to surrounding topography, bottom morphology, and the age of the water body. Steep slopes or topographic relief around the water body limited the amount of associated emergent wetland. Ponds in depressions on relatively flat terrain had a well-developed associated wetland around them. Organic matter accumulated over time and probably increased the periphery area dominated by emergent wetlands. A floating mat of vegetation was sometimes a part of the associated emergent wetland. These mats developed over water and were dominated by sedge, sphagnum moss, and common bank species.

A summary of the dominant aquatic species and factors influencing their location in and around many of the water bodies in the upper Susitna basin is presented in Figure 13. The existence and size of each zone indicated varies from pond to pond, although the general trends of the area are presented.

3.6 - Threatened or Endangered Species

No plant species are presently officially listed for Alaska by federal or state authorities as endangered or threatened; however, 37 species are currently under review by the U.S. Fish and Wildlife Service (USF&WS 1980b) for possible protection under the Endangered Species Act of 1973. In a recent publication Murray (1980) discusses the habitat, distribution, and key traits of most of these species.

A species list (Table 49) extracted from Murray (1980) was believed to be the most likely plants of this category to be found in the Susitna River drainage, and in the landscape to be modified by the construction of the proposed dams and associated facilities. Since the upper reaches of the drainage were expected to be the least impacted, the major portion of the survey was devoted to the study of potential habitats in and around the impoundments. The general habitat requirements and occurrence of these plant species were known from previous taxonomic and ecological study in Alaska, and from information given by Hulten (1968). Several of the endangered species and the only threatened species, (*Smelowskia pyriformis*), favored well-drained rocky or scree slopes.

Potential habitats were searched in August, 1980, and early July, 1981. Three to four botanists and agronomists were present on each aerial and ground reconnaissance field trip, thus increasing the probability of finding the plant species being sought.

Specific field surveys were conducted in the following areas: 1) the upper drainage basin, alpine areas near the Susitna and West Fork Glaciers, 2) the lowlands of the upper drainage basin, Maclaren and Tyone Rivers, ridges, terraces, and periglacial features, 3) the lower drainage, outcrops, and promontories along the Susitna River near

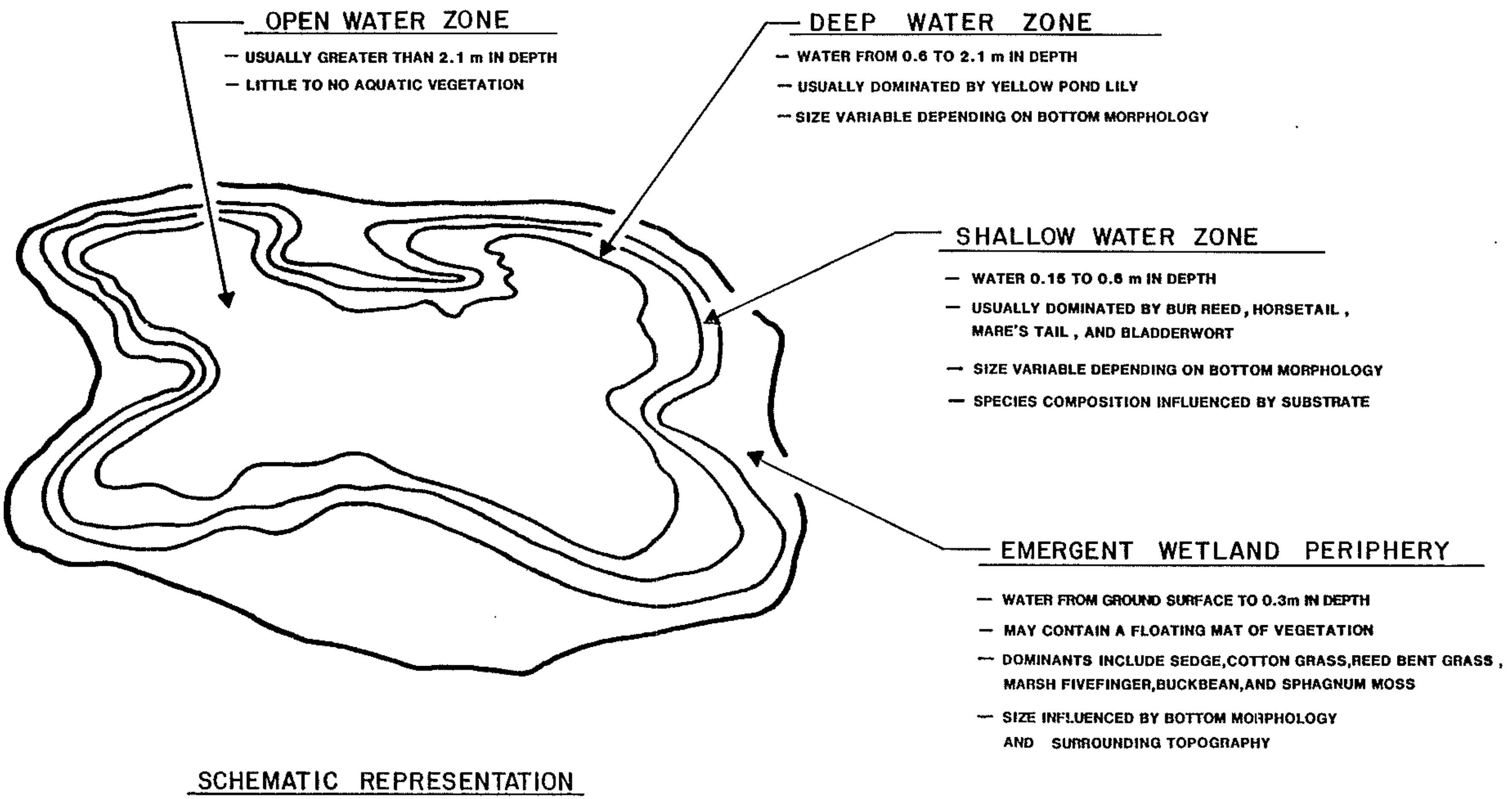

FIGURE 13

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

Table 49. List of endangered and threatened plant species[a] sought in the upper Susitna basin surveys.

Species and Habitat	Unofficial Status [b]
Smelowskia pyriformis Drury & Rollins North America endemic calcareous scree, talus, in upper Kuskokwim R. drainage	Threatened species
Aster yukonensis Cronq. North American endemic river banks, dry streambeds, 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-Beringian well-drained alpine tundra, Wrangell Mtns., St. 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, Mt. McKinley 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

a/ Species information and status from Murray (1980).

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

Watana Creek, Kosina Creek, and gravel bars in the riverbed, 4) alternative access routes, and 5) Borrow Pit "A" area.

Calcareous outcrop areas found in 1980 were re-surveyed at an earlier date in 1981. A prominent light-colored outcrop on the northwest flank of Mt. Watana supported a mat and cushion vegetation type in which many calciphilic species were present. The exposed bench was both well-drained and calcareous, requirements for several of the species being sought.

The Kosina Creek calcareous outcrop area was re-surveyed during the first week of July, 1981, to observe at an earlier phenological time than the 1980 survey, and to obtain flowering specimens of the Taraxacum species collected previously. Several flowering plants of the Taraxacum were collected in 1981 and the preliminary determination indicated that the species was T. alaskanum, a common species in some areas. The aspect of the Kosina Creek outcrops is north-facing and the dark soil around the calcareous rocks is rather fine-grained. The Kosina Creek outcrops are almost accordant with the calcareous outcrops on the northwest side of Mt. Watana, and also the calcareous lag gravel domes west of Watana Creek. The Taraxacum was collected in proximity to the calcareous rocks of the outcrop and none were found in the surrounding vegetation types. Thus it may be assumed that the species has calciphilic tendencies. Saxifraga oppositifolia and Rhododendron lapponicum, two recognized calciphiles, were notably abundant in the Kosina Creek outcrop area.

The northern access road route (alternative route to the Denali Highway, not the proposed route) to the proposed dam site was surveyed in July 1981 by the plant ecology team. Two sites were studied on the ground and the rest of the route was observed from low-level helicopter flights.

A sandy, blowout area on the northwest side of Deadman Mt. on the northern access road route alternative was chosen for ground study. The well-drained habitat was believed to be a favorable site for several of the endangered and threatened species. Vegetation was a shrubby heath-birch-willow type. A second site on the south side of Deadman Mt. was studied in the survey of the north access road route. A series of dry ridges, probably glacial moraines or terraces, was present and the vegetation on two of these ridges was surveyed. The vegetation was typically a mat and cushion type. A later survey was made of the northern access route and a ground study site was chosen on the east side of Deadman Mt. near the 1200-m elevation. The area was characterized by dry, rocky, windblown ridges vegetated by mat and cushion species, and low shrub willow-birch-heath vegetation in the moister and lower sites.

In none of the three survey areas on the northern access route were any of the species in question found. The other access routes were similarly surveyed, but the plants in question were apparently absent there as well.

The vegetation in the vicinity of Borrow Pit A was surveyed in July 1981. The low ridge area was characterized by rocky outcrops intermixed with low areas containing shrubby vegetation up to 0.5 m in height. In shallow depressions or ravines, the vegetation contained more herbs and grasses, and taller shrubs such as alder. No threatened or endangered species were found.

3.7 - Noteworthy Species

Twenty-eight vascular plant species were encountered during the summer of 1980 in the upper Susitna River basin and during 1981 in the downstream areas which were outside the ranges indicated by Hulten (1968) (Table 3). Some of these species may have been reported in the area in the 14 years since Hulten's publication. Some of these range extensions are the result of more intensive botanical surveys in the area while some may represent an actual enlargement of the range for some species.

Because the upper Susitna River drainage is not extremely well-represented in existing plant collections, range extensions, and some new records may be expected from any botanical surveys in the area. The upper Susitna River drainage may represent a phytogeographic region in which the lowland habitats of the Cook Inlet and Talkeetna River valley extend into the upper basin of the Susitna drainage and make contact with the arctic-alpine habitats and flora of the Alaska Range. Alpine habitats close to maritime locations in central Alaska have unique assemblages of plant species, especially those called the amphi-Beringian floristic element. A representative example of this floristic type may be seen at Hatcher Pass in the Talkeetna Mountains.

Two species found upstream represent significant range extensions: *Senecio sheldonensis* and *Danthonia intermedia*. *S. sheldonensis* had not previously been reported in the state except possibly in the Skagway area (Hulten 1968). Our specimen was collected in a mesic midgrass community in August near upper Portage Creek, but has not yet been verified. There is at least one other informal report of the species occurring in the study area. Welsh (1974) reports that the species occurs in the southern Yukon and northern British Columbia.

Danthonia intermedia was found in August in the grass portion of a mosaic of low birch and grass communities in the low shrub areas between the Maclaren River and the Denali Highway. Previous recordings of the species occurred near the upper end of Cook Inlet and the Skagway area (Hulten 1968). Moreover, the only other representative of the genus in the state, *D. spicata*, has only been reported from near Ketchikan. This would represent a significant extension of the genus although *D. intermedia* was found in only the one location in our study area. Welsh (1974), in contrast, reported the occurrence of *D. intermedia* in southcentral Alaska with no specific locations mentioned.

Potamogeton robbinsii, a submerged rooted aquatic, was found in Watana Lake. There has been limited collection of this species in Alaska. Hulten (1968) reported it from his area of study, but it had only been collected once at Summit. Welsh (1974) indicated that it is known from southcentral Alaska, but evidently rare.

The distribution of Picea mariana should also be noted since Hulten (1968) included areas north and south of the upper Susitna River in the range, but excluded our study area. Viereck and Little (1972), however, included the Susitna drainage in their distribution map. This tree is one of the most common species in the study area.

Most other species on the upper basin list represent only slight range extensions. Most of these are extensions to the north (more inland) from their previous observations. The finding of Platanthera dilatata represented a departure from the previously reported distribution which was strictly coastal in Alaska. Platanthera hyperborea and Myrica gale extensions include sites between areas that were previously included in the range. Potentilla biflora and Pedicularis kanei Durand kanei extensions were south of the previously reported range. Both of these species were found on calcareous outcroppings (Kosina Creek and Mt. Watana, respectively) while looking for endangered species. These species are probably adapted to the drier environment associated with the interior or with calcareous outcroppings in the upper Susitna River basin.

The downstream floodplain contained nine species outside their range as reported by Hulten (1968) (Table 3). Two of these, devil's club and raspberry, were extensions in the upper basin also, although Viereck and Little (1972) included both upper and lower Susitna River in the range for raspberry. Devil's club represents a slight extension upriver.

The most notable extension in the downstream portions was small-fruit bullrush (Scirpus microcarpus) which had only been found in four areas outside southeast Alaska. One of those sites was near the confluence of the Yentna and Susitna Rivers. A specimen which appears to be Arnica chamissonis (needs to be verified) represented a significant extension from the Alaska Peninsula and southeast Alaska.

The presence of enchanter's nightshade (Circaea alpina) in the downstream area was an extension inland from the coastal regions. Sweet-scented bedstraw (Galium triflorum) and thinleaf alder were minor extensions while baneberry (Actaea rubra) and northern blackcurrant (Ribes hudsonianum) were extensions from the surrounding areas into the basin. It should be remembered that many of these range extensions are merely the result of more intensive botanical collections rather than an actual expansion of the species' range.

4 - ANTICIPATED IMPACTS

Potential impacts on vegetation were identified by reviewing pertinent literature and by discussing with various specialists knowledgeable of problems associated with hydroelectric development. Anticipated impact areas in the upper basin and transmission corridors were identified by overlaying expected activities on vegetation/habitat maps. Calculations of area size were based on vertical projection. Because of slope, the actual surface area impacted will be somewhat higher than that presented. The general locations of the project components are indicated on Figure 14. Impact analysis for the downstream floodplain consisted of relating general changes in flow during reservoir filling and operation to plant succession trends.

4.1 - Watana Dam, Facilities, and Impoundment

(a) Construction

The obvious impact of constructing the dam and of filling the Watana reservoir will be the eliminating of portions of different vegetation/habitat types. The hectares of each vegetation/habitat affected are presented in comparison with the total hectares of those types in the entire upper Susitna River basin and in an area within 16 km of the upper river (Table 50).

At a maximum pool elevation of 666 m (2185 ft) the Watana impoundment will inundate approximately 14,691 ha. Of those, 12,587 ha are vegetated and represent 0.9 % of all the vegetated area of the upper basin. Much of the impoundment area will be classified as wetland (Table 47). Primary losses will occur in the woodland and open spruce stands and in the open mixed forests. Birch forests will be substantially affected by the impoundment, relatively more so than any other vegetation/habitat type (Table 50). The other types which would experience a relatively major impact are conifer-deciduous forests and balsam poplar forests.

Additional impact on vegetation may occur beyond the impoundment areas, if roads or other activities associated with selective clearing of woody vegetation from the drawdown zone are not restricted to the impoundment zone. As discussed under mitigation (Section 5), restriction of disturbance to the impoundment area will limit the extent of this impact.

Construction activities at the dam site, borrow sites, airstrip, construction camp and village sites will result in a loss of additional hectares of vegetation (Table 50). Proposed camp and village sites, airstrip site, and borrow areas will be located primarily in woodland black spruce and low shrub stands. Borrow areas D and H also cover large mixed forest stands. Borrow areas may eventually be revegetated and are discussed in more detail in Section 4.3 - Borrow Areas.

All of the aforementioned construction activities will be almost entirely contained within the area designated as a construction zone (Figure 14). This zone represents the maximum area of potential construction disturbance.

Table 50. Hectares of different vegetation types to be impacted by the Watana facility compared with total hectares of that type in the entire upper basin and in the area within 16 km of the Susitna River.

Vegetation/Habitat Type	Facility Components												Total b/	% of Upper Basin Total For That Type	% of 16 km Area c/ For That Type
	Dam and Spillways	Impound-ment	Camp	Village	Airstrip	Borrow Areas						Construction Zone a/			
						A	D	E	F	H	I				
Forest	34	10784				181	53	180	81	451	34	7825	18609	5.3	13.1
Woodland spruce-black	8	3870				179	16			224		2564	6434		10.2
Woodland spruce-white		397						71	69			1133	1530	4.2	11.5
Open spruce-black		2864								121	15	1499	4363	4.6	15.4
Open spruce-white		769				2		62	11			303	1072		10.2
Open birch	1	325										286	611	63.1	40.8
Closed birch	13	460					5					38	498 d/	154.2 d/	21.4
Closed balsam poplar		3											3	e/	.5
Open conifer-deciduous	5	1337					32			106		453	1790	7.7	18.6
Closed conifer-deciduous	7	759						47	1		19	1549	2308	14.5	17.5
Tundra		84				70	8					502	586	.2	.5
Wet sedge-grass		84					8					91	175	3.6	5.0
Sedge-grass															
Sedge shrub												29	29	b/	0.1
Mat and cushion						70						382	382	.7	0.7
Shrubland	46	1719	63	62	17	81	224		199	38		4942	6661	1.0	3.8
Open tall shrub	6	227				1							227	.4	1.5
Closed tall shrub	17	287				1	12						287		1.8
Birch shrub	1	443	34	35	13	4	88		195			2915	3358	10.0	7.8
Willow shrub		66							4	17		252	318	3.0	3.7
Mixed low shrub	22	651	29	27	4	75	124			21		1775	2426	0.5	2.6
Herbaceous		45											45		250.0
Grassland															
Disturbed															
Unvegetated	13	2104		8		1	2					456	2560	1.0	9.5
Rock	1	59					2						59	0.05	.36
Snow and ice															
River	12	2007										287	2294	15.6	54.2
Lake		38		8		1						169	207	0.8	3.5
Total	93	14691	63	70	17	333	287	180	280	489	34	13725	28416	1.7	6.2

a/ This area encompasses all facility components except the impoundment, with the exception of minor portions of Borrow Areas F and I.
b/ Impoundment plus construction zone.
c/ An area 16 km on either side of the Susitna River from Gold Creek to the mouth of the Maclaren River (See Figures 4 through 8).
d/ Hectares of closed birch are apparently greater in the impact areas than for the entire basin, because the basin was mapped at a much smaller scale, and many of the closed birch stands did not appear at that scale.
e/ Areas of this type were too small to be mapped at the scale of which the upper Susitna River basin was mapped.

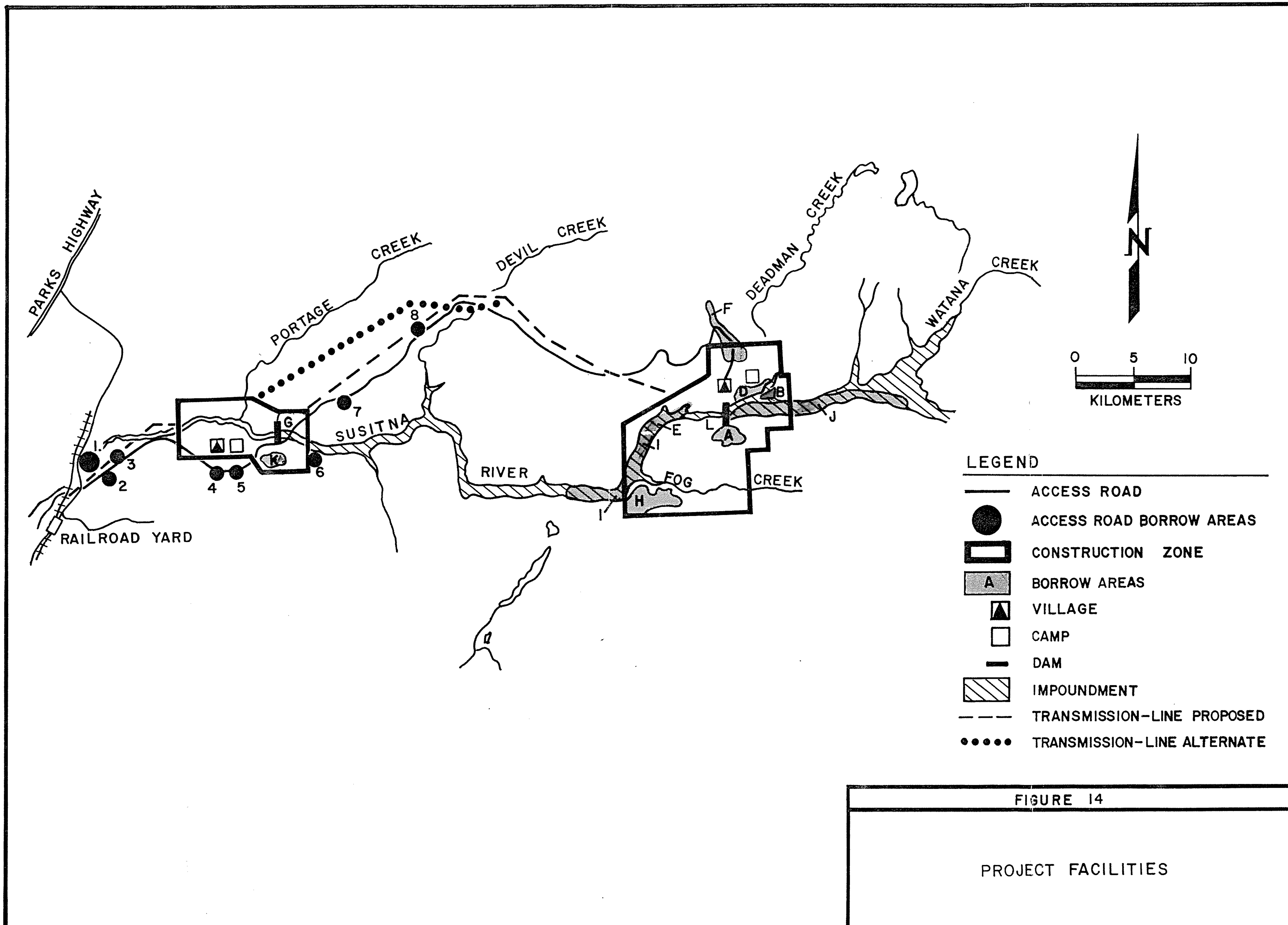

FIGURE 14

PROJECT FACILITIES

It is unlikely that the entire zone will be directly affected; however, if all the vegetation is removed from this zone, 13,725 hectares will be lost in addition to that in the reservoir area lost by inundation (Table 50). This loss represents 0.8% of the entire upper basin. Reclamation of areas that will only be temporarily affected will reduce this loss and is discussed under Section 5.

The significance of these losses, aside from the vegetation loss itself, will be the associated loss of habitat for wildlife. The principal losses for big game will be a reduced food supply for black bears and moose. Browse supplies in the impoundment area are marginal and do not represent a late winter reserve for moose. Birch and mixed forest stands, however, provide bears with substantial berry supplies and are particularly important in this regard in early spring. A more detailed discussion of the impacts on big game is presented in Section 3.6(a)(i) (Alaska Power Authority 1982).

(b) Operation and Maintenance

The pool elevation of the Watana Reservoir will vary an average of 27 m (90 ft), with a low of 639 m (2095 ft) in May, and a gradual increase to a full pool elevation of 666 meters (2185 ft) during September. The drawdown zone (from full pool to low pool) will be essentially unvegetated. During dry years, however, the full pool target elevation may not be attained and exposed areas that are not flooded may temporarily become naturally revegetated with a sparse vegetation characterized by easily-dispersed, weedy plants until they are flooded again. The greatest potential for this type of revegetation exists in areas of gentle slope, such as the Watana Creek area.

The Watana Reservoir is located in a region of discontinuous permafrost. Consequently, there is potential for earthflows and slumps, especially on north-facing slopes, as the relatively warm reservoir thaws adjacent permafrost. This type of disturbance will most likely occur on black spruce sites and may lead, in places, to their replacement by alder stands and possibly by open paper birch stands. Bank erosion from wave actions will probably form terraces at and below the full-pool elevation.

An impact noted by Baxter and Glaude (1980) for northern reservoirs is the potential for peat masses to float to the surface of the reservoir. This type of impact should not be extensive at the Watana reservoir, since only a small amount of the peat-forming wet sedge-grass types will be inundated. Some potential for such occurences exists in the Watana Creek area.

There are two other minor impacts that may occur during the operation of the Watana facility: the potential modification of local climate and the icing of vegetation around the dam outflow. In general, large bodies of water influence the local climate by acting as cold sinks in winter, thereby delaying the initiation of spring, and act as heat sinks in summer, thus extending localized warm weather. It has been estimated that such influence will be restricted to within 1.6 km of the reservoir shoreline.

Local climatic changes may result in minor changes in vegetation phenology. The severity and extent of this potential change in vegetation is difficult to predict. The effects will likely be noted as a slight lag in the phenological cycle of the affected area relative to the surroundings. The influence is not expected to eliminate portions of the cycle, however. Potential impacts on vegetation in the spring may be moderated somewhat, however, since the pool elevation will be at its lowest point then and thus, the distance from the water edge to the vegetation edge will be at its greatest.

At the dam outflow, ice fog and water spray will probably occur during winter months when the temperature is in the approximate range of -12° C to -23° C (+10° F to -10° F). This ice fog will freeze on contact with vegetation and may accumulate to create loads sufficient to break twigs. Although this impact will be very localized, birch trees, because of their many small branches, will be the most susceptible to damage.

4.2 - Devil Canyon Dam, Facilities, and Impoundment

(a) Construction

Construction and filling of the Devil Canyon dam and impoundment will eliminate an estimated 3214 ha of vegetation/habitat types (Table 51). Primary vegetation losses will be of open and closed mixed forests and open spruce forest. Construction activities at the dam, camp, and village sites will further eliminate or modify at least another 223 ha of vegetation, primarily closed mixed forests. An estimated 1706 ha of wetlands are within these direct impact areas (Table 47).

If the entire construction zone (Figure 14) is affected, 5688 ha will be lost in addition to the reservoir area (Table 51). It should be noted that the area of the construction zone represents a maximum potential loss; a certain portion of this area will probably not be disturbed, and reclamation activities can be used to reclaim areas temporarily affected. The maximum potential loss, including the construction zone and reservoir area, represents 8884 ha and 0.5% of the entire upper basin.

Vegetation losses at Devil Canyon will not be significant in terms of moose or caribou, since most of the affected area is situated on steep slopes which are generally inaccessible to these ungulates. However, these areas do provide a relatively large forage supply for black bears. Big game impacts are detailed in Section 3.6(b)(i) (Alaska Power Authority 1982).

(b) Operation and Maintenance

The pool elevation of the Devil Canyon reservoir will fluctuate an average of 17 m (55 ft) during the year. The drawdown zone created by this fluctuation will essentially be devoid of vegetation. As discussed for the Watana reservoir, vegetation may invade in some portions of this zone when the full pool target elevation is not attained. In contrast, since much of the Devil Canyon reservoir is very steep-sided, this invasion may only occur at the very upper reaches of the reservoir in

Table 51. Hectares of different vegetation types to be impacted by the Devil Canyon facility compared with total hectares of that type in the entire upper basin and in the area within 16 km of the Susitna River.

Vegetation/Habitat Type	Facility Component: Dam and Spillways	Impound-ment	Camp	Village	Borrow Area K	Construction Zone a/	Total b/	% of Upper Basin Total For That Type	% of 16 km Area c/ For That Type
Forest	16	2289	36	39	119	4504	6793	1.9	4.8
Woodland spruce-black		133				46	179	.36	.3
Woodland spruce-white		20				480	500		3.8
Open spruce-black	4	300			11	785	1085	1.6	3.8
Open spruce-white		329				474	803		7.7
Open birch		57				126	183	18.9	12.2
Closed birch	3	430				156	586 d/	181 d/	25.2
Open balsam poplar		6					6	e/	
Closed balsam poplar		8				14	22	e/	3.9
Open conifer-deciduous	7	279					279	1.2	2.9
Closed conifer-deciduous	2	727	36	39	108	2423	3150	19.7	23.8
Tundra		11				211	222	0.06	0.2
Wet sedge-grass		11				192	203	4.2	5.8
Sedge grass						18	18	.01	.07
Sedge shrub						1	1	0	.005
Mat and cushion									
Shrubland		70			18	802	872	0.2	0.5
Open tall shrub		2				125	127	.2	.8
Closed tall shrub		1				165	166		1.0
Birch shrub		49			18	266	315	.9	.7
Willow shrub		14				34	48	.5	.6
Mixed low-shrub		4				212	216	.05	.2
Herbaceous									
Grassland									
Disturbed									
Unvegetated	2	826			11	171	997	.4	3.7
Rock		15				2	17	.02	.1
Snow and ice									
River	1	810				137	947	6.5	22.4
Lake	1	1			11	32	33	0.13	0.6
Total	18	3196	36	39	148	5688	8884	0.5	1.9

a/ This area encompasses all facility components except the impoundment.
b/ Impoundment plus construction zone.
c/ An area 16 km on either side of the Susitna River from Gold Creek to the mouth of the Maclaren River (see Figures 4 through 8).
d/ Hectares of closed birch are apparently greater in the impact areas than for the entire basin, because the basin was mapped at a much smaller scale, and many of the closed birch stands did not appear at that scale.
e/ Balsam poplar stands were too small to be mapped at the scale of which the upper Susitna River basin was mapped.

the Tsusena Creek vicinity.

As discussed for the Watana reservoir, erosion of material from above the pool elevation may occur after filling. The extent of this impact will vary, depending on many factors, but the amount of slumping will probably be less than that at the Watana reservoir. Soil surveys are needed to more accurately predict such occurences.

Localized climatic changes may also occur around the Devil Canyon reservoir. Because the reservoir will be long and narrow, the absolute surface area of water adjacent to any given vegetation type will be relatively small; thus the probability of impact due to climate modification ought to be insignificant.

Finally, the operation of the Devil Canyon reservoir will result in changes in downstream flows, downstream water temperatures, and ice conditions. The impacts of these changes on vegetation are discussed in Section 4.6 - Downstream Floodplain.

4.3 - Borrow Areas

The complete development of all borrow areas at both Devil Canyon and Watana will destroy an estimated 1751 ha of vegetation/habitat types (Tables 50 and 51). Those portions of the borrow areas within the impoundment and those associated with access road construction are not included in this estimate. This estimate does include those borrow areas within the construction zones previously discussed. Woodland and open spruce, low mixed shrub, and birch shrub will be the principal types affected. Borrow Area K, which is a quarry associated with the Devil Canyon dam, is covered primarily by mixed forests.

The total impact from borrow areas will probably be less than the 1751 ha estimated, since certain areas (possibly A and H) may not be used and others may be only partially developed. Also, reclamation of all these areas is possible (see Section 5). Areas that are developed should not, therefore, be permanently destroyed as a terrestrial habitat but may remain changed in terms of habitat type for a long period of time.

The development of borrow areas may also influence vegetation in adjacent areas by lowering the water table. This type of impact will probably only occur to any noticeable extent around Borrow Area D, where adjacent land to the north and west may be influenced. This impact will be localized, however, and will probably result in only minor species composition changes in the areas affected.

4.4 - Access Road

(a) Construction

Construction of the Parks Highway-to-Devil Canyon/Watana access road (including railroad yard and all potential borrow areas) will disturb approximately 900 ha of vegetation, providing that machinery stays within 30 m (100 ft) of the center line (Table 52). Primary losses will be to open and closed conifer-deciduous forests and low shrub types.

The total direct impact of the permanent access road may be somewhat less extensive than the aforementioned estimate, since the roadbed will only be about 14 m (45 ft) wide and all the identified borrow areas may not be used. However, the pioneer road will probably cover separate ground from the permanent access route in certain areas, and therefore will result in additional temporary impact.

(b) Operation and Maintenance

During operation of the road, impacts may extend beyond the road base itself. Where the road restricts drainage, woody vegetation types will shift toward sedge-grass tundra and wet sedge-grass conditions. Areas which are presently wet but which will become drier will experience a gradual invasion of shrubs and trees, depending on specific soil/site conditions.

Accumulations of dust on roadside vegetation may cause snow melt to occur 2-3 weeks earlier for a distance of 30-100 m either side of the road (CRREL 1980). This factor, associated with accumulations of some elements, particularly calcium, in road dust and changes in photosynthesis, may substantially reduce the density of four-angled cassiope, stiff clubmoss, sphagnum moss, Cladina, and other mosses and lichens; on the other hand, cottongrass may increase (CRREL 1980). Such shifts in vegetation composition may be imperceptible to any but the trained observer and should not cause any soil erosion problems.

The most significant source of impact associated with the access road could be damage caused by encouraging increased off-road vehicle use on sensitive sites (Sparrow *et al*. 1978). The most extensive impact of such use would be on wet unstable soils and steep slopes. Level terrain, rocky and well-drained sites are most resistant. Use restricted to times when soils are frozen would be least damaging, according to experiences in the Arctic tundra types of the North Slope region.

Considerable potential for fire also exists, especially during the spring. Such an event could be local or extend over vast areas depending upon several factors. In any event, it would cause changes in the vegetation similar to those which have occurred historically due to naturally occurring wildfires (i.e., vegetation would be set back to early successional stages). Neither the wet areas nor the sparsely vegetated upland tundra communities will normally carry a significant fire. However, the birch and low mixed shrub, black and white spruce, and mixed conifer-deciduous forest habitat types may ignite into substantial fires. Fire could revert such types to seral brush communities, highly productive of moose browse.

4.5 - Transmission Lines

(a) Construction

Construction of the transmission lines will result in long-term vegetation

Table 52. Hectares of different vegetation types to be impacted by the access road compared with total hectares of that type in the upper basin and the area within 16 km of the Susitna River.

Vegetation/Habitat Type	Facility Component: Right-of-Way (61 m wide)	Facility Component: Borrow Areas	Facility Component: Rail-road Yard	Total	% of Upper Basin of That Type	% of 16 km Area a/ of That Type
Forest						
Woodland spruce	2.0	16.7		18.7	.001	0.02
Open spruce	38.3	35.5		73.8	.06	0.2
Open birch	10.8			10.8	1.0	0.7
Closed birch	4.4	1.8		6.2	2.0	0.3
Closed balsam poplar	14.7	11.0		25.7		4.0
Open conifer-deciduous	68.7	4.0		72.7		0.7
Closed conifer-deciduous	163.8	141.0	7.8	312.6		2.0
Tundra						
Wet sedge-grass	8.8	1.3		10.1	0.2	0.3
Sedge shrub	17.7			17.7		0.09
Mat and cushion	26.5			26.5	0.04	0.04
Shrubland						
Tall shrub	63.0	11.0		74.0	0.06	0.03
Low birch shrub	108.0	32.0		140.0	0.4	0.33
Low mixed shrub	69.0	3.5		72.5	0.01	0.08
Herbaceous-Grassland			14.6	14.6		1.0
Disturbed	2.0	7.5		9.5		39.0
Unvegetated						
Lakes	13.7			13.7	0.05	0.23
River	2.5			2.5	0.02	0.06
Rock		1.5		1.5	0.001	0.01
Total Area	613.9	266.8	22.4	903.1	0.06 b/	0.20 b/

a/ An area 16 km on either side of the Susitna River from Gold Creek to the mouth of the Maclaren River.
b/ This figure is not a summation of this column, but a percentage determined by dividing the total area to be impacted by the total available area.

impacts where tower structures and permanent access roads are placed. Movement of machinery over the ground will temporarily set back shrub growth. Recovery following such disturbances usually results in improved shrub vigor for a period of time. The major impact of construction will be to reduce the overstory cover of trees. Where spruce trees are cut, spruce bark beetle problems may arise. If the disturbance occurs during winter and the soil surface is not significantly exposed, shrub and tree regeneration can be extremely slow, judging from trails cut in the lower basin during the oil exploration period. Exposing mineral soils in these areas allows trees, shrubs and herbaceous broadleafed plants to reinvade, and the natural forest succeeds more quickly than when the organic mat is left intact and only trees and shrubs removed during right-of-way clearing.

The estimated amounts of different vegetation types that will be within the right-of-way are presented in Table 53. Additional areas may be impacted if access roads are placed outside of this right-of-way.

The transmission line between the dams and the intertie will primarily traverse closed conifer-deciduous forest and birch shrub type (Table 53, Figure 9). Utilization of the access road to the dams will help limit the impact in this area. From Healy to Fairbanks the transmission line traverses open spruce forest, open conifer-deciduous forests, and low mixed shrubs (Table 53, Figure 6). Extensive clearing will be required from the Tanana River to Fairbanks. Within the route segment from Willow to Cook Inlet (Table 53, Figure 7), the primary vegetation types include open spruce, closed conifer-deciduous forest, and wet sedge-grass. Clearing will also be required in the forested areas.

At several places, the transmission lines will cross wetlands. They are especially common in the Tanana Flats region of the northern corridor (from the Nenana crossing to the Tanana River) and along the southern portion of the Willow-to-Cook Inlet corridor. Small wetland areas may be spanned without impact, providing precautions are taken during construction. Larger expanses of wetlands though, will be adversely affected, but impacts could be minimized if construction time is restricted to winter. Potential impacts include direct disturbance of wetland vegetation (and resultant loss of wildlife habitat) as well as changes in drainage patterns and possible erosion problems.

(b) <u>Operation and Maintenance</u>

Maintenance of the transmission right-of-way may require the topping or removal of the taller tree species, such as white spruce, birch, aspen, balsam poplar, and larch. Periodic clearing of trees along transmission right-of-way is expected to benefit wildlife from the standpoint of increased forage production once the animals become accustomed to the sound of the lines [see Section 3.6(b) (Alaska Power Authority 1982)].

Impact on vegetation may also occur in the vicinity of the transmission line as a result of increased ATV use. Such use may be especially common where the transmission lines cross roads or other existing access

Table 53. Hectares of different vegetation types to be impacted by the transmission facility compared with total hectares of that type in the transmission corridors.

Vegetation/Habitat Type	Healy to Fairbanks		Dams to Intertie		Willow to Cook Inlet a/		Total Rights-of-Way
	Right-of-Way b/	% of Corridor	Right-of-Way b/	% of Corridor	Right-of-Way b/	% of Corridor	
Forest	1533.7	1.8	587.1	1.7	713.5	2.8	2834.3
Woodland spruce-black	44.4	2.5	2.5	0.1	20.7	0.8	149.6
Woodland spruce - white			82.0	1.7			
Open spruce-black	685.2	2.2	4.9	0.2	98.0	2.9	812.6
Open spruce-white			24.5	0.6			
Closed spruce	74.6	5.5			61.7	1.9	136.3
Open deciduous	149.7	1.2					149.7
Closed deciduous	76.3	0.7					76.3
Open birch			20.4	2.5			20.4
Closed birch			10.8	0.6	114.8	3.2	125.6
Woodland conifer-deciduous	28.8	3.0					28.8
Open conifer-deciduous	251.0	2.0	95.4	1.9	111.8	6.6	458.2
Closed conifer-deciduous	60.2	1.5	346.6	3.0	306.5	2.8	713.3
Open spruce/open deciduous	30.8	3.2					30.8
Open spruce/wet sedge-grass/open deciduous	43.0	2.2					43.0
Open spruce/low shrub/wet sedge-grass/open deciduous	70.1	1.0					70.1

Table 53. (Continued, Page 2 of 2)

Vegetation/Habitat Type	Healy to Fairbanks		Dams to Intertie		Willow to Cook Inlet a/		
	Right-of-Way b/	% of Corridor	Right-of-Way b/	% of Corridor	Right-of-Way b/	% of Corridor	Total Rights-of-Way
Open spruce/low shrub	19.6	4.2					19.6
Tundra	49.6	1.1	52.8	0.2	100.6	1.1	203.0
Wet sedge-grass	29.8	1.3			100.6	1.1	130.4
Sedge-grass	10.0	4.4					10.0
Sedge shrub	9.8	1.7	52.8	0.9			62.6
Shrubland	308.8	1.8	287.2	0.9	50.3	2.4	646.3
Open tall shrub			61.6	1.3			61.6
Closed tall shrub			34.3	0.6			34.3
Birch shrub			109.1	1.0			109.1
Low mixed shrub	294.1	1.9	82.2	0.9	50.3	2.4	426.6
Low shrub/wet sedge-grass	14.7	0.9					14.7
Disturbed	12.4	2.9					12.4
Unvegetated	18.4	0.75			1.3	0.12	19.7
Lakes	3.7	1.9			1.3	0.12	5.0
River	14.7	0.7					14.7
Total	1922.9		927.1		865.7		3715.7

a/ None of the area east of Cook Inlet is included in these totals.
b/ The right-of-way width was 700 feet for the Devil Canyon dam to intertie route and 400 feet for the remaining routes.

points. Permanency of such damages will largely be a function of effects on soils. Alteration of the soil through erosion would likely result in very long term changes.

4.6 - Downstream Floodplain

(a) Construction

Decreased flows during the period of filling will enable vegetation to descend into the upper portions of what is now river channel between the Devil Canyon dam site and 0.5 km above the confluence of the Susitna and Chulitna rivers. However, the development of vegetation in this area will be relatively negligible, limited to fireweed, horsetails, dryas, sweetvetch, and possibly some other pioneering species. Plants will be restricted to interstices of the rock-armored channel bottom. The period of filling will not be long enough for sufficient windblown soil to accumulate to allow for further vegetation development.

Because of decreased flows, areas that are presently horsetail communities may quickly develop into balsam poplar sapling and willow communities. The rate of this change depends on the synchronization of seed crops with adequate precipitation and suitable temperatures. The areas supporting horsetail communities are relatively limited, however, most occurring within 11 km upstream of the confluence of the Susitna and Chulitna rivers. During the period of reservoir filling impact on vegetation below the Susitna-Chulitna confluence is expected to be negligible.

(b) Operation and Maintenance

At Gold Creek, river flows during the growing season (May to September) will be reduced from an average of about 20,000 cfs to an average of about 10,000 cfs. Seasonal floods will essentially be eliminated. As a result, some of the presently unvegetated bank areas in the reach from Devil Canyon to the Susitna-Chulitna confluence will begin to develop horsetail, dryas, willow, and balsam poplar communities. Barring disturbances by ice jams and floods, willow and balsam poplar reproduction will develop within five years of the last disturbing influence on sites presently having sandy or silty substrates.

It is estimated that the amount of newly exposed land during the lower post-project flows will be less than 50 ha between Whiskers Creek and the Chulitna River. Currently there are about 54 ha bare land exposed at flows of 18,000 cfs at Gold Creek. This was estimated from aerial photographs taken at 18,000 cfs (Gold Creek) on August 24, 1980, and at 5,000 cfs on October 19, 1981. These flow rates are rough approximations to pre- (20,000 cfs) and post- (10,000 cfs) project flows. An increase in bare land from 34 ha to 146 ha may occur on one 2.7-mi stretch below Talkeetna based on photographs taken on August 24, 1981, and August 24, 1980. Flow rates at Susitna Station on these dates were 130,000 cfs and 119,000 cfs respectively, which approximates pre- and post-project flows.

Although post-project flows are expected to be lower, they are not outside the range of variability for pre-project flows below Talkeetna. It should be emphasized that these land estimates are very coarse approximations because of limited photography and differences in scale and quality of photographs between dates. Hydrologists have observed that above Talkeetna the amount of land does not vary directly with the flow rates. The amount of land exposed with any given decrease in flow rate depends upon which side of a certain threshold the change occurs. This is probably related to the channel cross-section slope. Flows confined to the V-shaped portion of the channel may drop substantially without exposing much new ground. When flows over-topping gently sloping channel sides are decreased, substantial surface area may be exposed. Determining the Susitna River's flow rate at the break between the gentle and steep slopes of the channel sides would be most useful in predicting effects of downstream flows on streamside vegetation changes. Because of the lack of information on the downstream hydrology, estimates should be regarded as very coarse.

Establishment of significant cover on rocky sites may require several decades to centuries, and may be beyond the scope of this project. While adequate wind-blown sands and silts accumulate, vegetation will have a short stature for long periods. In the downstream Susitna above Talkeetna, the area above the level of the river during 40,000 cfs flows is already vegetated. Below that level, most of this area has a rocky substrate, not conducive to lush growth. Consequently, the overall increase in vegetation cover for this reach of the river will be minimal for some time.

Below Talkeetna, the effects of either reduced or increased flows will be moderated by the contributions of the Chulitna and Talkeetna rivers. While the degree of moderation is uncertain, certain trends in impacts can be expected. For example, the primary impact of decreased flow during summer below Talkeetna will be to allow early successional vegetation to move down onto sites that are presently eroded by high summer flows. Thus, until a new equilibrium with the river is reached, new early successional stands will migrate toward the new level of peak flows, while older early successional stands (then less affected by high flows) will advance to alder and immature balsam poplar types.

The time required for development of early successional vegetation depends on the frequency and severity of disturbance as well as extent of the area and nearness to a source of seed or established vegetation. Techniques for aging the earliest herbaceous invaders are unknown. Woody individuals with 10 years of above-ground growth have been found in these stands although most woody individuals are in the 4 to 6-year old range. Individuals may grow for a number of years, then be buried by silt and resurface. Approximately 10 to 15 years after stabilization, alder becomes the dominant vegetation and the importance for moose declines. Because of limited knowledge of river and vegetation dynamics in the early stages of succession, it is difficult to estimate how much new area would be gained and how much early successional area would be lost.

Floods from the Chulitna or Talkeetna rivers or, in rare instances, by flood water passing the Susitna project may alter time estimates. Such events may maintain the distribution of vegetation types on the floodplain below Talkeetna similar to the way it is at present.

Since the Devil Canyon-to-Talkeetna reach of the river is expected to remain largely ice-free, a principal environmental force maintaining early successional vegetation will be absent during operation. This will allow present early successional vegetation to advance to later forest types. During some winters, however, accumulations of ice fog on vegetation adjacent to the wider sections of the river may break down trees and tall shrubs creating brush fields of young balsam poplar, willow, and alder. This effect is not expected to proceed beyond bank-side vegetation.

4.7 - Threatened or Endangered Species

None of the plant species under review for possible protection under the Endangered Species Act of 1973 are known to occur in the vicinity of any proposed project facilities, nor were any of these species found during searches of potential habitat. Although some potential habitat does exist in the upper basin, it is distant from any proposed facilities. As a result, it is not anticipated that any of these species will be adversely affected by any project activity.

5 - MITIGATION

The discussion of mitigation of impacts on botanical resources centers around avoidance, minimization, compensation, and rectification. Avoidance and minimization are, in many instances, related. These types of mitigation involve refraining from unnecessary ground disturbance and regulating destructive activities, especially those involving heavy machinery and ATV use when soils are thawed and/or saturated.

Some of these first mitigation considerations have been incorporated into the timing of construction, the layout, and the location of certain proposed facilities. For example, placing the transmission corridor close to the access road would minimize impact on vegetation by encouraging use of the road for access to tower structures. Winter construction would also limit ground disturbance.

Locating some temporary facilities or undertaking some construction activities within the future impoundment zone will also help minimize the impact on vegetation. If, for instance, access roads or other ground-disturbing activities related to the selective clearing of the drawdown area are restricted to the impoundment zone, which will eventually be flooded, then associated impacts will be limited.

The location, too, within the reservoirs of several of the potential borrow areas is another example of how the total impact on vegetation can be minimized.

As mentioned above, regulation of ATV use is an important aspect of avoidance/minimization mitigation methods. During the construction period, if ATV use from the access road is restricted, then a potential impact on vegetation will be minimized. If this restriction is extended into the operation stage (especially from Devil Canyon to Watana) then impact will be further limited.

Another mitigation technique of this type concerns permafrost. In areas along the access road where drainage patterns may be changed, installing culverts or other drainage viaducts will control impacts associated with those changes. A sufficiently thick insulating layer of gravel, placed directly on the vegetation mat, will limit the potential for melting of permafrost. This standard Arch "C" construction technique will avoid impacts on vegetation associated with permafrost disturbance.

Slash from spruce trees that are cut from the access road or transmission right-of-way will increase the potential for spruce bark beetle infestation. The burning of spruce slash would limit or remove this potential.

In areas that will be directly affected, such as the impoundment zones, dams and spillways, airstrip and other permanent facilities, the elimination of vegetation/habitat area cannot be avoided. Compensation for losses of wildlife habitat could be provided, in adjacent open and woodland spruce stands, and/or downstream balsam poplar stands. Downstream balsam poplar stands, in particular, provide the greatest opportunity for increased browse production and are located in prime moose range, where increased browse production can be more fully utilized by a consistently productive herd. Compensation techniques could include clearing (commercial or otherwise) and/or burning to enhance sprouting of poplar, birch, and willow species. Commercial clearing of downstream stands will be economically attractive, will benefit moose, and will probably also increase the value of timber in the area, as decadent and diseased stands of balsam poplar and birch are cut and replaced by younger, healthier growth. Compensation, as a mitigation in technique, for the benefit of wildlife is discussed in greater detail in the Wildlife Section 3.9(b)(iii) (Alaska Power Authority 1982).

Although permanent facilities will eliminate certain areas as vegetation/habitat types, impact from temporary facilities or activities can be somewhat rectified by reclamation. Standard construction practices of either recontouring or creating gentle slopes will help avoid erosion problems and will aid reclamation efforts. Borrow areas, access road cuts, areas of construction activity, and temporary facility sites will be revegetated upon completion of construction. This revegetation process will be greatly simplified and accelerated by stockpiling both topsoil and the organic layer during construction.

The stockpiling and redistribution of this material is the most important part of reclamation. Redistribution of these materials and subsequent fertilization will, in many instances, restore the vegetation cover. The first step in the process is to mix organic material into the upper 10 cm of mineral soils. Adequate fertilization can then be accomplished by using fertilizer mixtures high in phosphorus [such as (N,P,K) 10-20-10, 8-32-16, etc.] and applying the fertilizer at a rate sufficient to supply 85 to 110 kg of nitrogen per hectare (75 to 100 lbs of nitrogen per acre). During the second and third growing seasons, follow-up treatments at one-half to one-third the original rate will probably be warranted.

With topsoil in place, fertilization alone will often provide the necessary impetus for natural revegetation. Where erosion potential or aesthetic considerations are great, however, more intensive revegetation practices involving mulching and seeding, preferably with native species, could be employed. Experience in other regions of Alaska indicates that a relatively light seeding rate, which would establish a sparse stand of grass, is the best way to encourage rapid re-invasion of native plants. Ten to 20 well-established grass plants per square meter (one or two per square foot) would be adequate on sites not threatened by erosion.

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Anchorage, Alaska

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Paula Krebs, Remote Sensing Specialist
- Telephone call from B. Collins 9 July 1980; request for preliminary vegetation map of the Denali study. (Copies of maps received Aug 1980.)

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Anchorage, Alaska

Fred Larson, Research Forester
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Fairbanks, Alaska

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State Agencies:

Alaska Dept. of Fish and Game

Paul Arneson, Biologist
Suzanne Miller, Statistician
- 13 May 1980; met with B. Collins to discuss needs of lower Susitna moose habitat study.
- 6 June 1980; met in the field with B. Collins to test techniques for sampling moose browse production/ utilization.

Charles Swartz, Biologist
- 27 May 1980; met with B. Collins and J. McKendrick to discuss methods for evaluating moose habitat and nutritional value of browse species.

Karl Schneider, Biologist
- 5 June 1981; telephone call to B. Collins concerning ADF&G's discontinuance of browse production/utilization work in Phase I.

Sterling Miller, Biologist
- 23 Nov. 1981; telephone call from B. Collins explaining how to use the vegetation classification by Viereck and Little (1980), as it pertained to our vegetation maps.

Butch Young, Biologist
- June 1981; telephone call to B. Collins asking for information concerning areas of research being conducted by plant ecology study team. Requested pertinent literature references.
- 24 June 1981; letter from B. Collins giving references to vegetation succession papers.

Local Agencies:

Matanuska-Susitna Borough

Lee Wyatt, Acting Borough Manager
- 8 May 1980; letter from B. Collins to request cooperative purchase of 1:63,360 scale CIR photography of upper Susitna basin.

APPENDIX

Vegetation/Habitat Maps

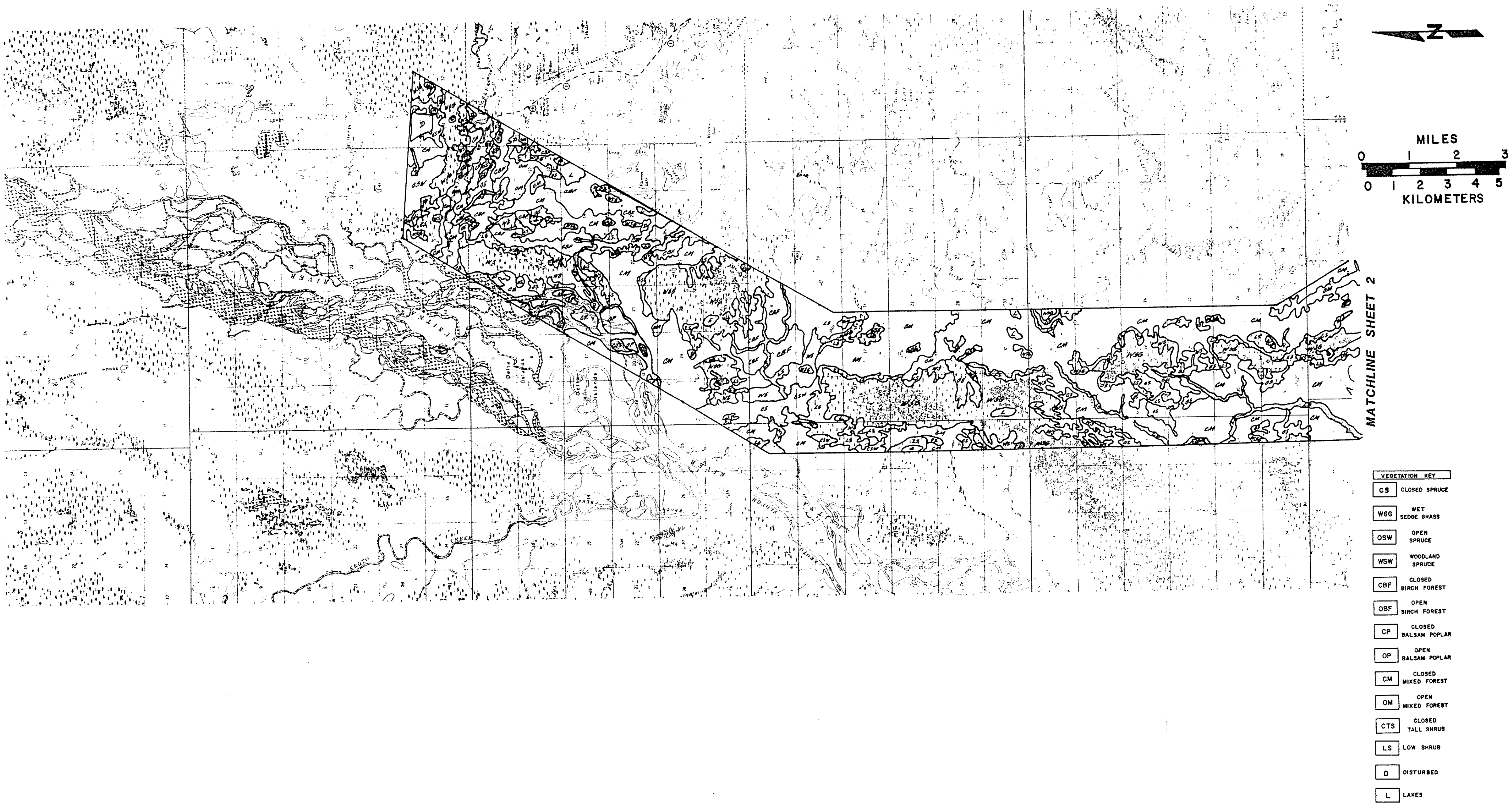
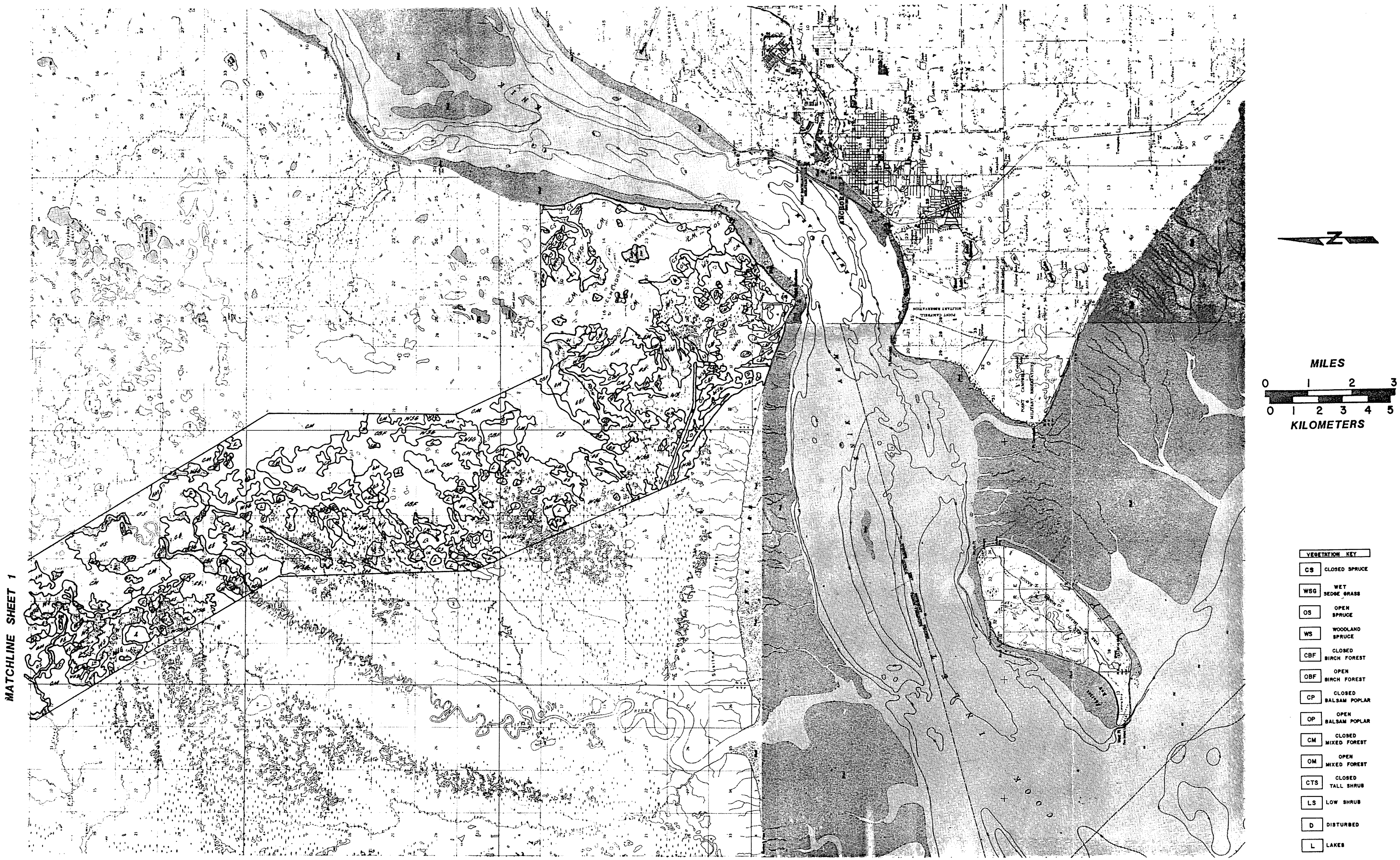


FIGURE 7

VEGETATION MAP OF PROPOSED WILLOW - COOK INLET TRANSMISSION CORRIDOR

SHEET 1 of 2



VEGETATION MAP OF PROPOSED WILLOW - COOK INLET TRANSMISSION CORRIDOR

FIGURE 7

SHEET 2 of 2

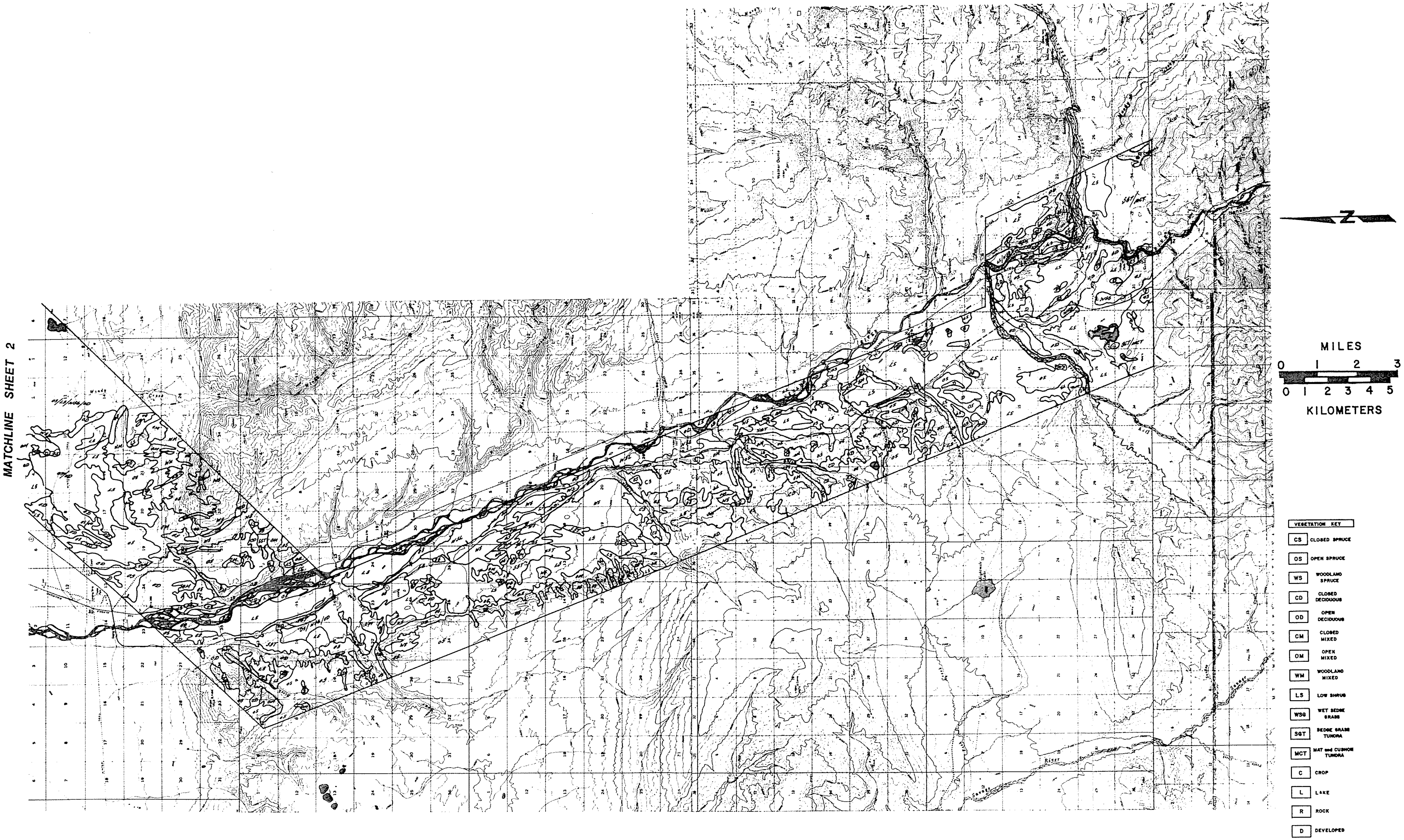


FIGURE 8

VEGETATION MAP OF PROPOSED HEALY - FAIRBANKS TRANSMISSION CORRIDOR

SHEET 1 of 3

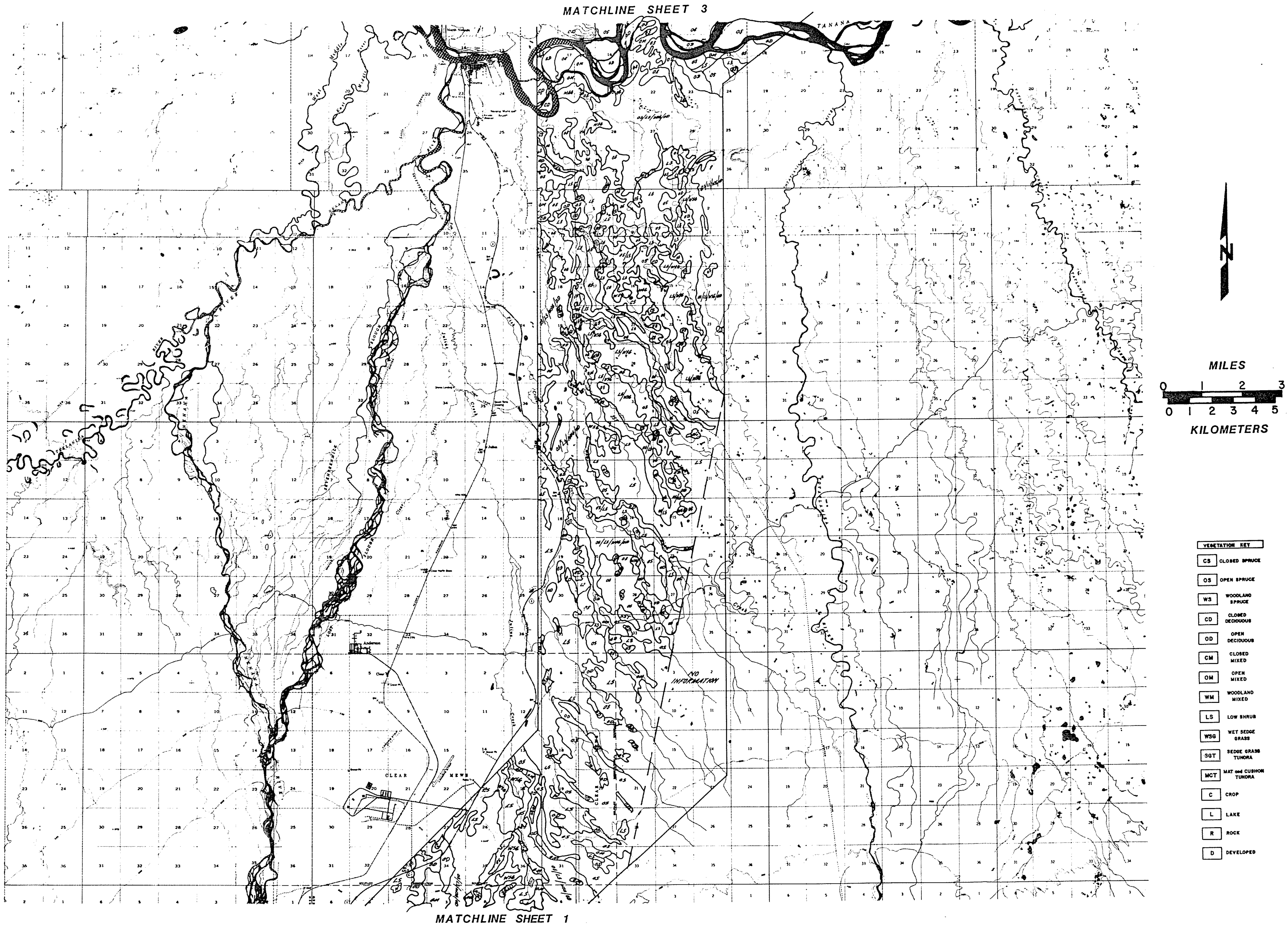
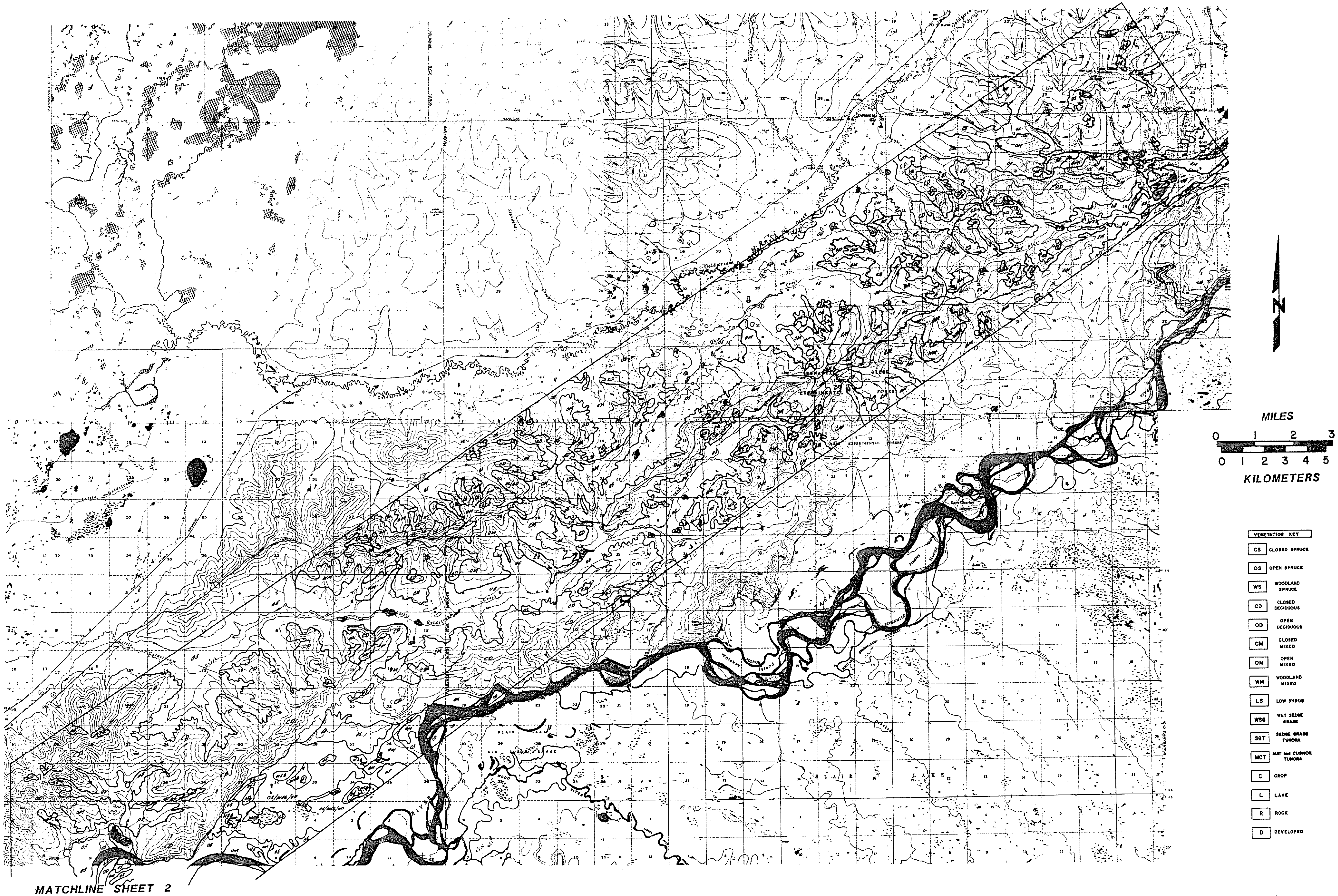


FIGURE 8

VEGETATION MAP OF PROPOSED HEALY - FAIRBANKS TRANSMISSION CORRIDOR

SHEET 2 of 3



VEGETATION MAP OF PROPOSED HEALY – FAIRBANKS TRANSMISSION CORRIDOR

FIGURE 8

SHEET 3 of 3

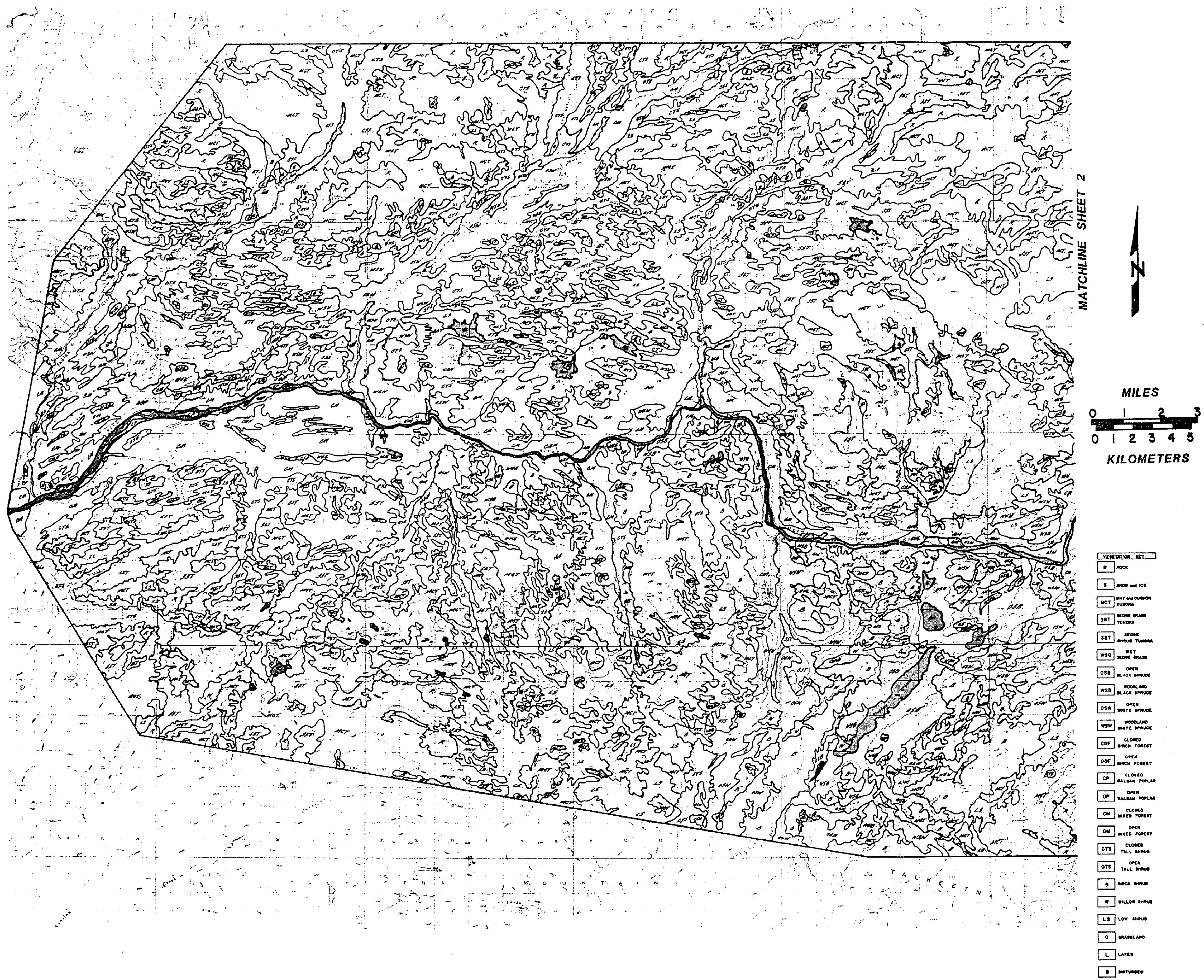


FIGURE 9

VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREA

SHEET 1 of 3

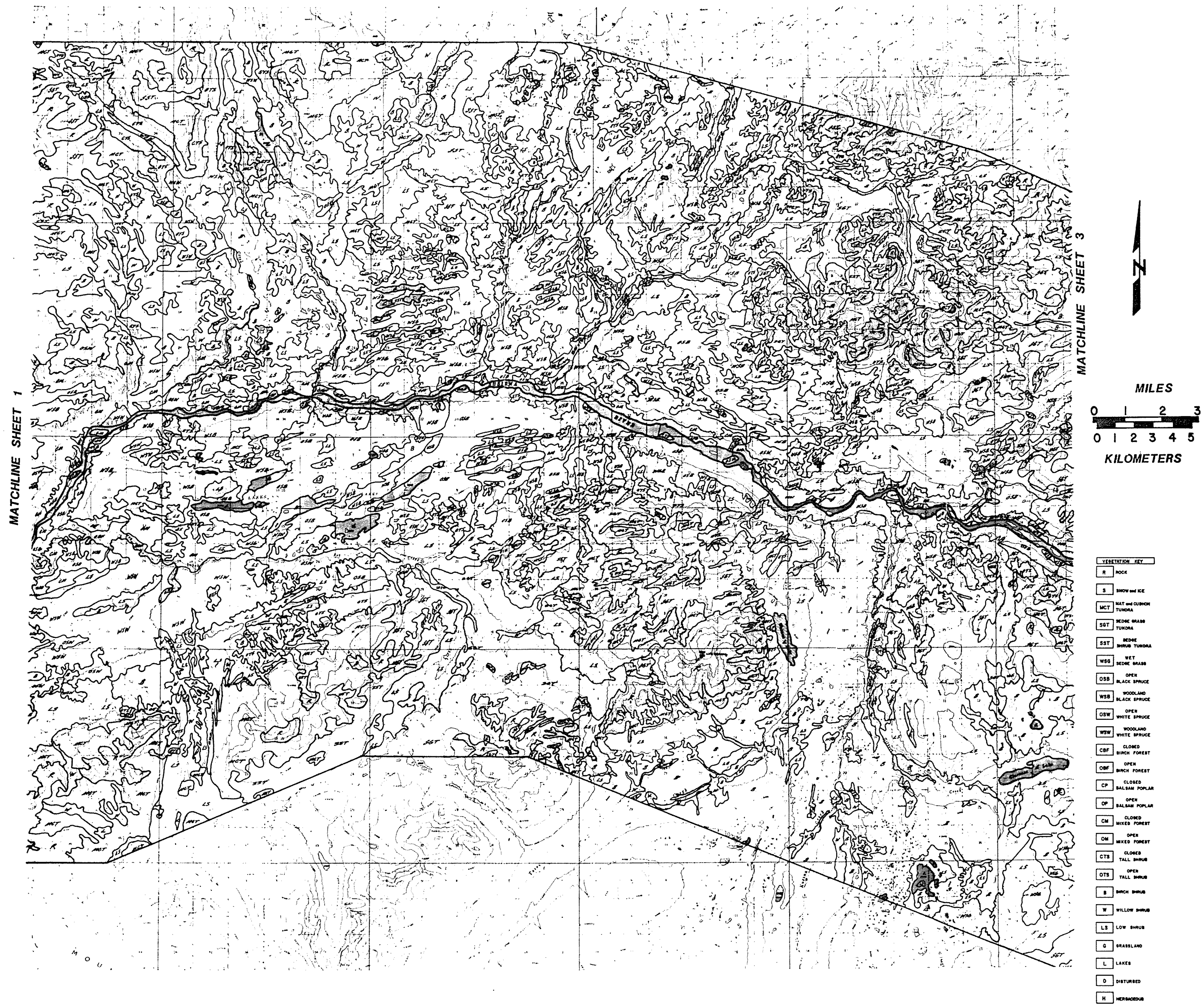


FIGURE 9

VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREA

SHEET 2 of 3

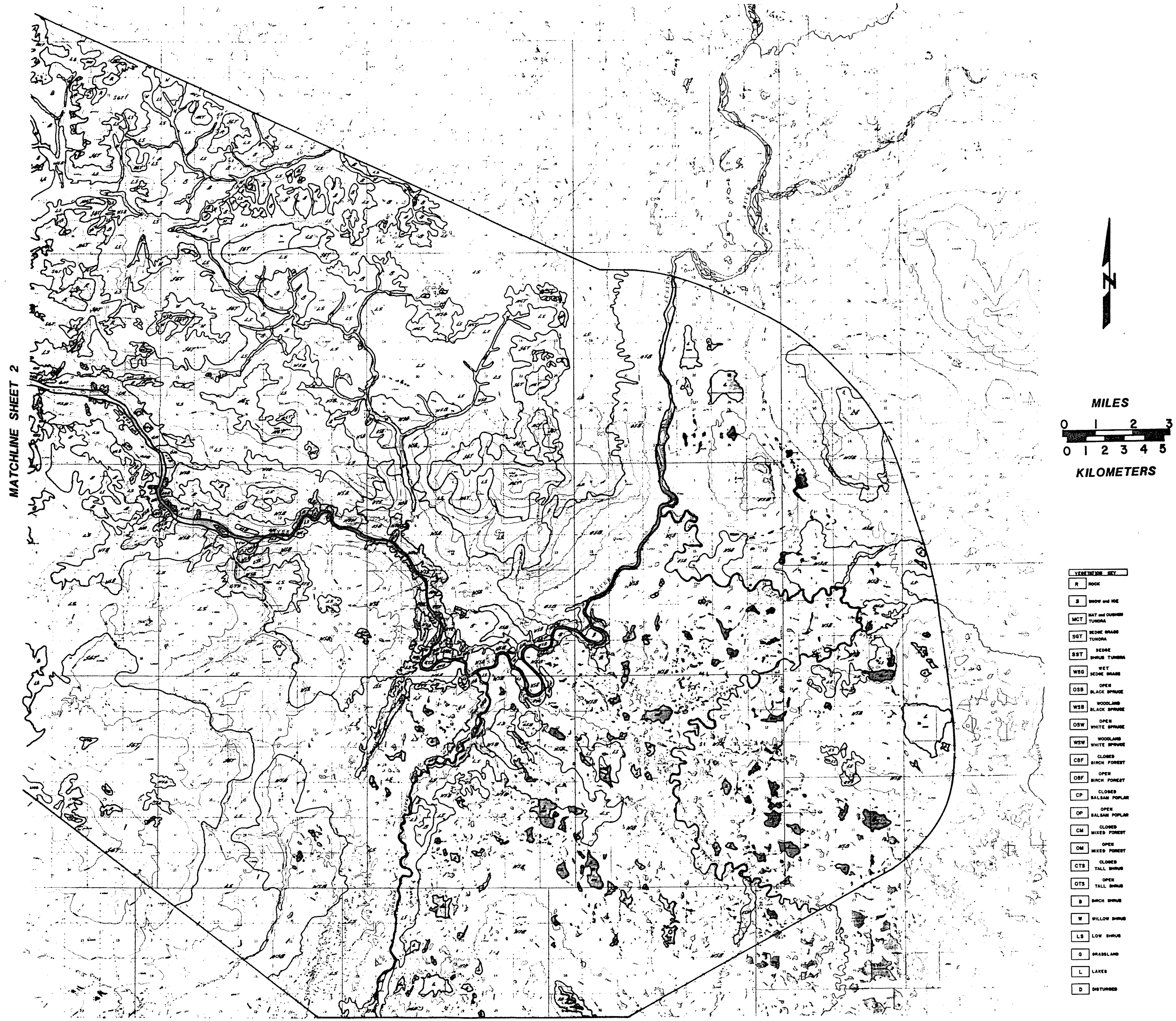
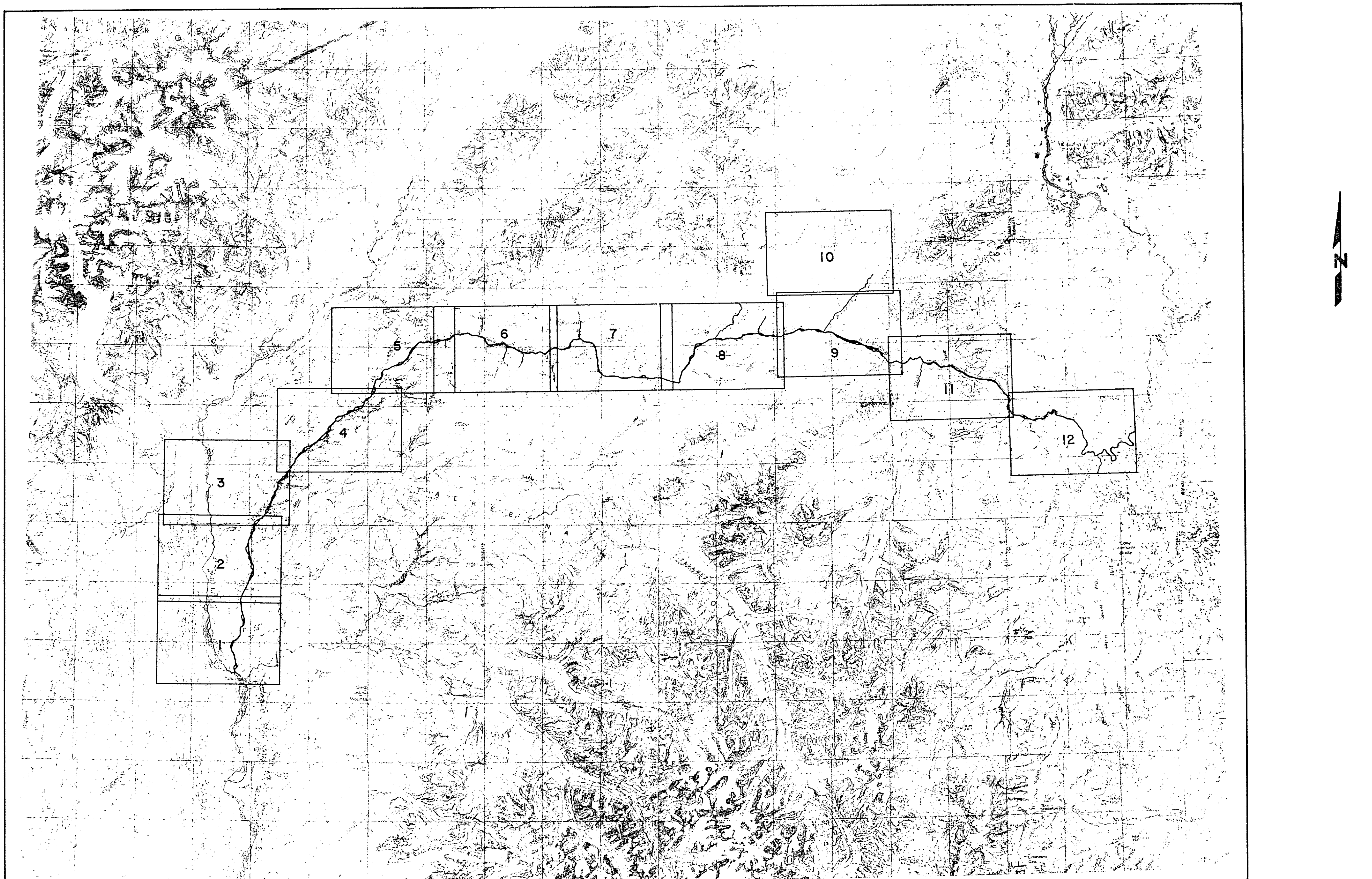


FIGURE 9

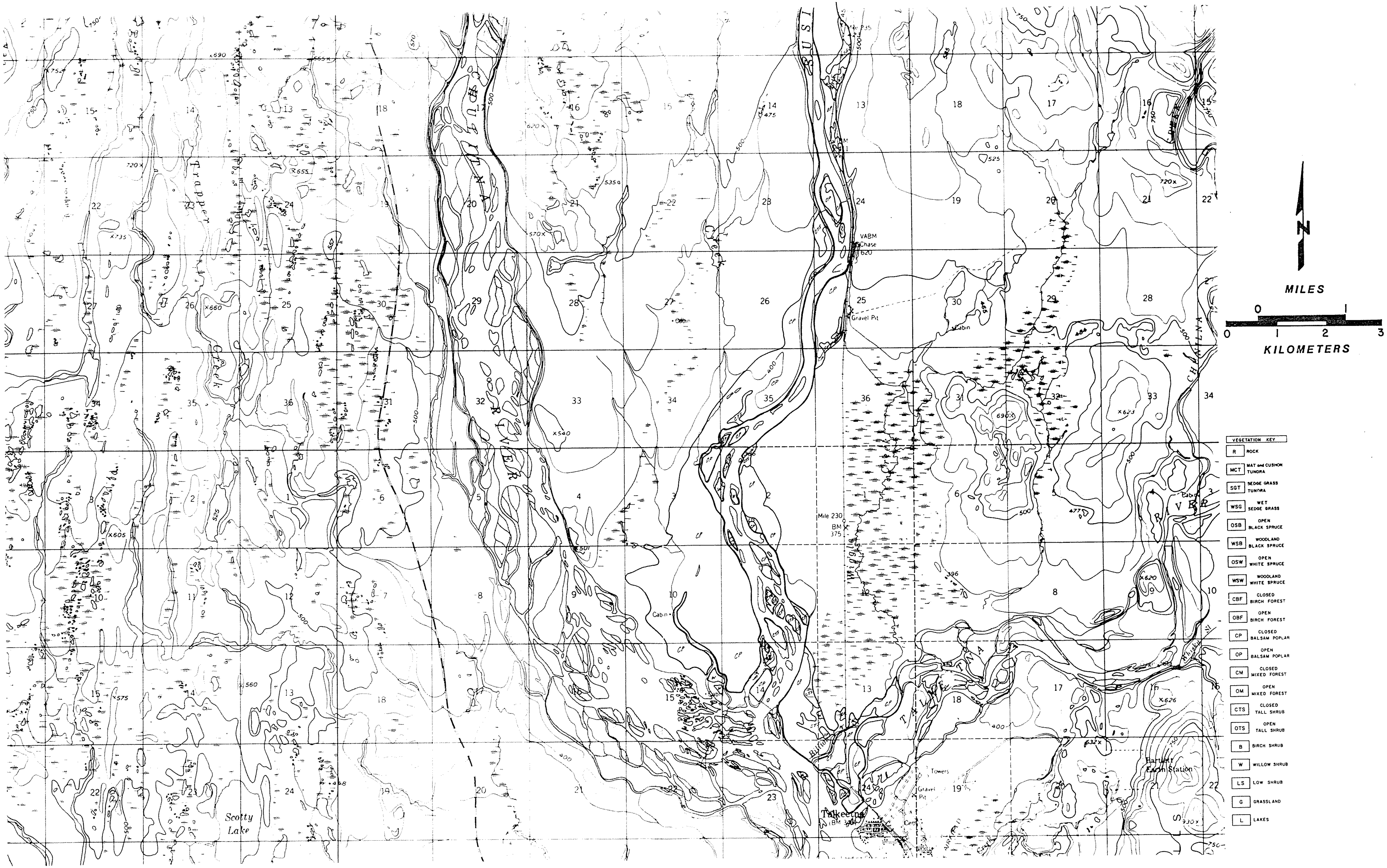
VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREA

SHEET 3 of 3



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

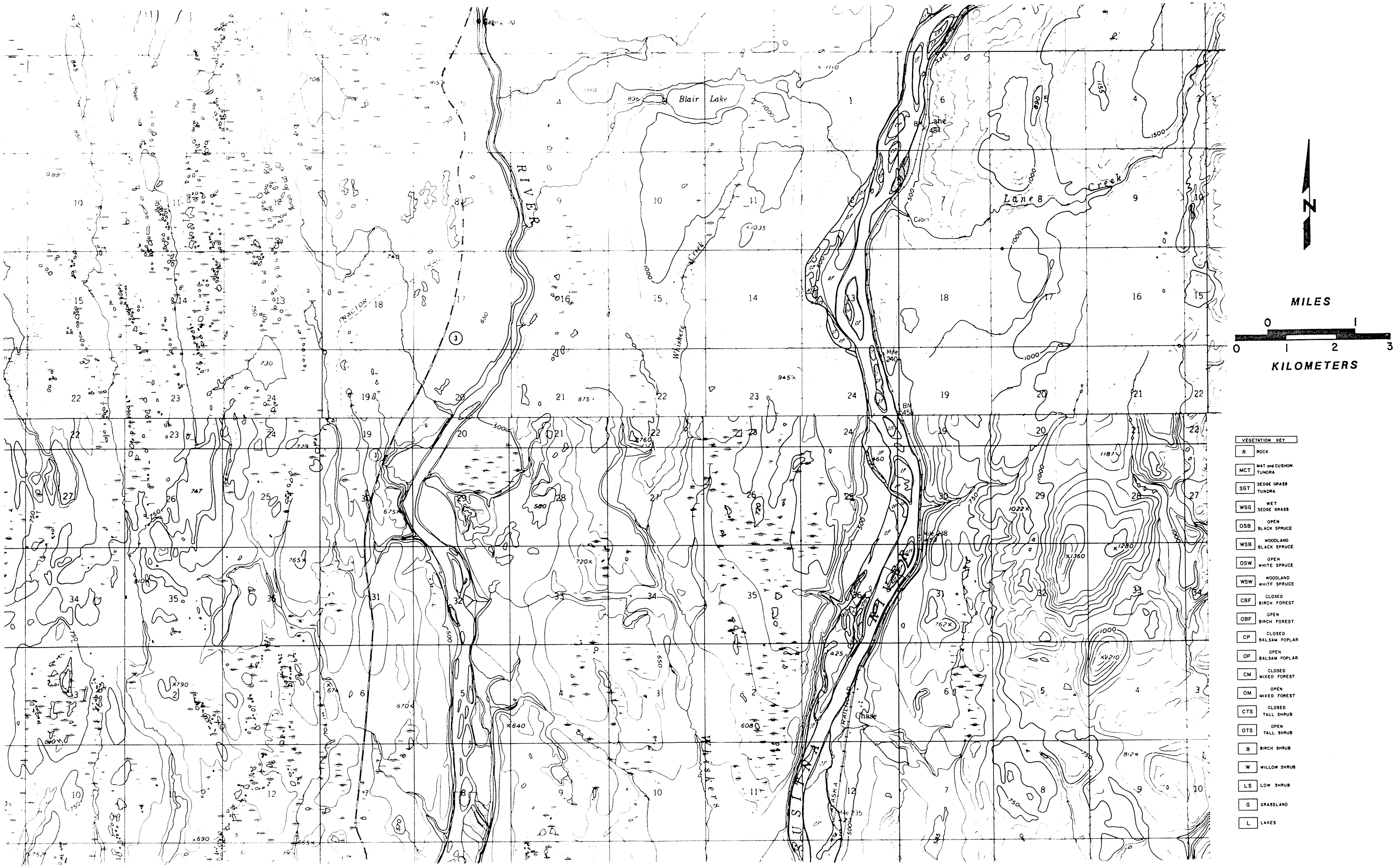
FIGURE 10
INDEX MAP



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

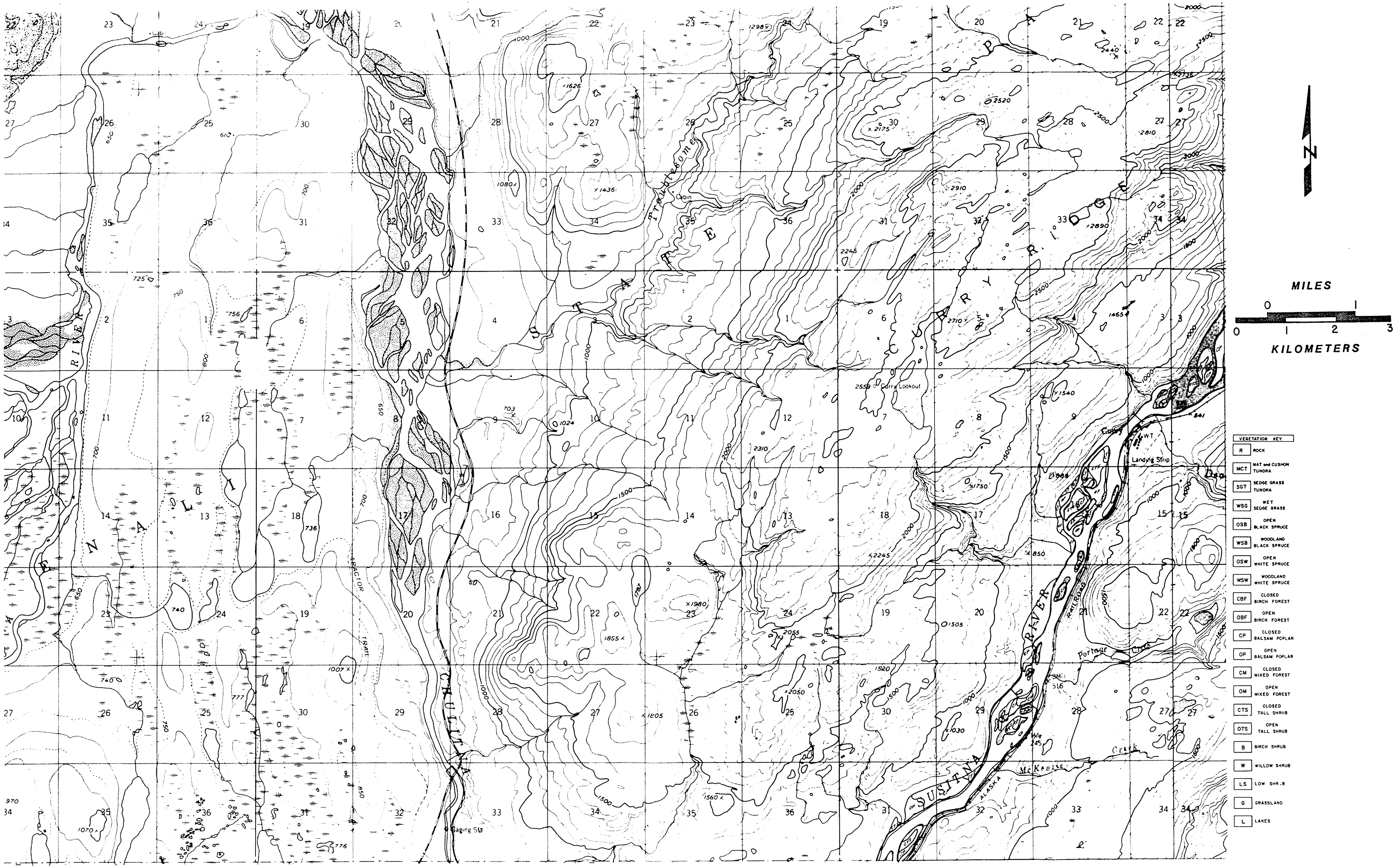
FIGURE 10

SHEET 1 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

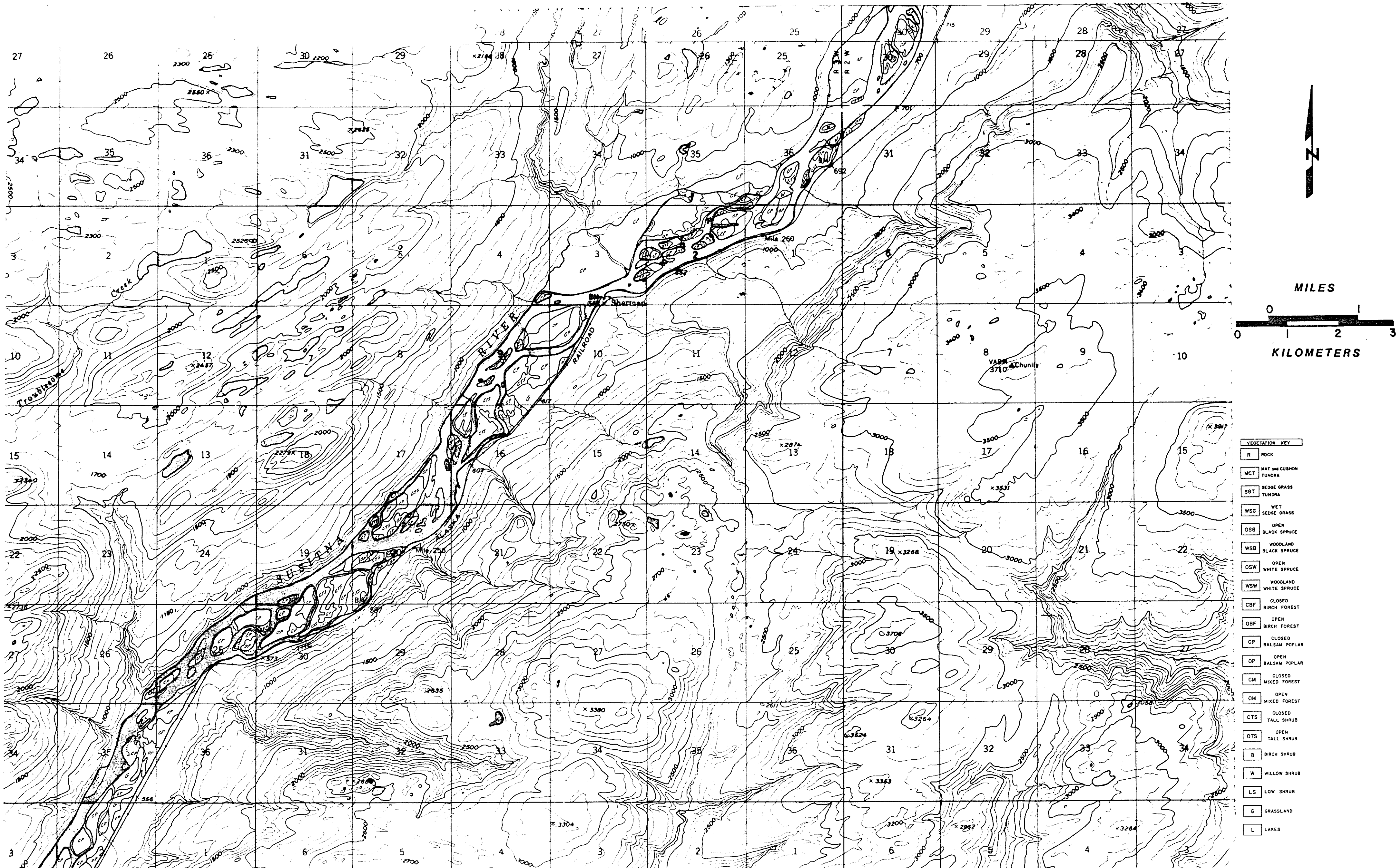
FIGURE 10
SHEET 2 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10

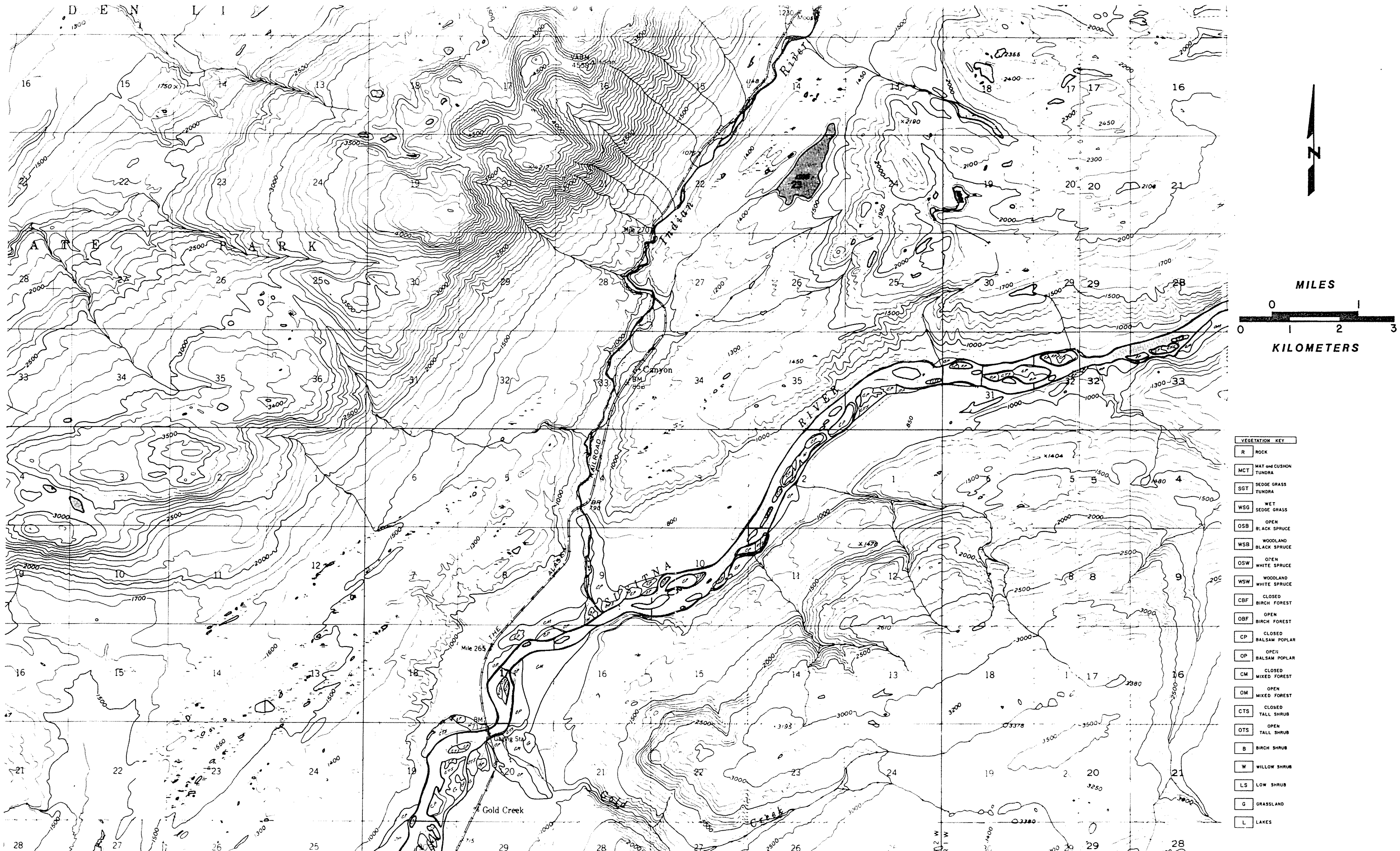
SHEET 3 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10

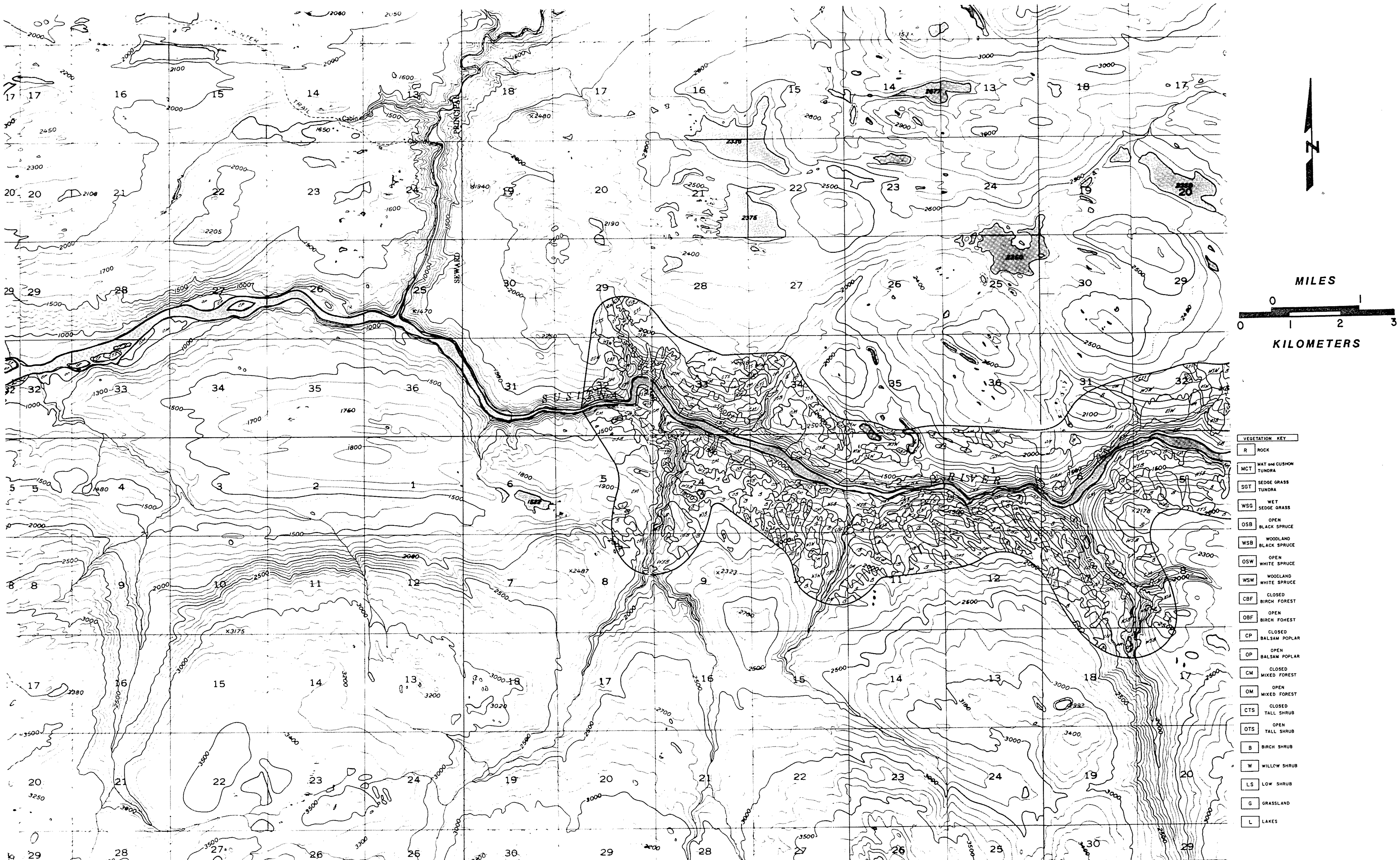
SHEET 4 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10

SHEET 5 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10

SHEET 6 of 12

VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

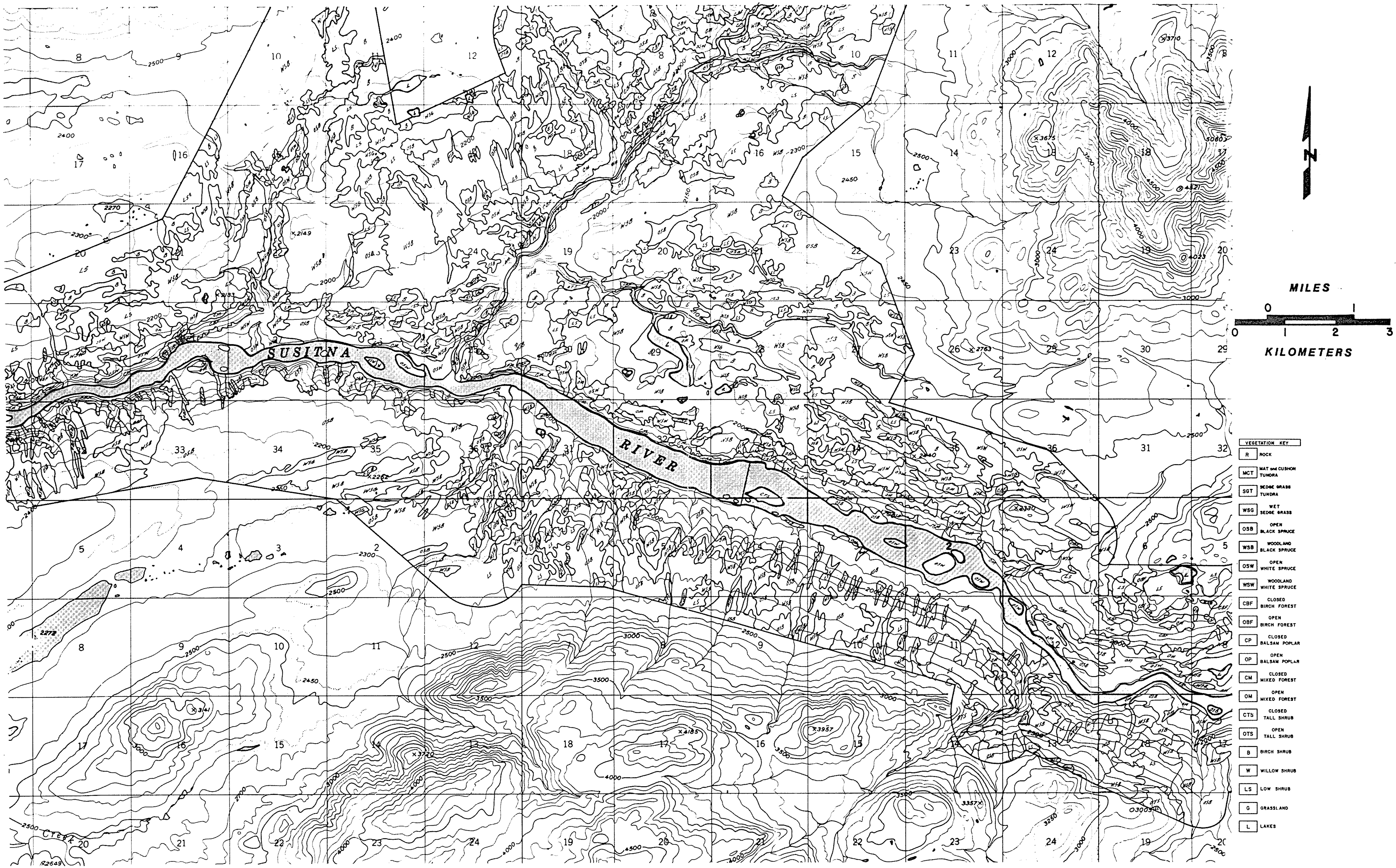
FIGURE 10

SHEET 7 of 12

VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10

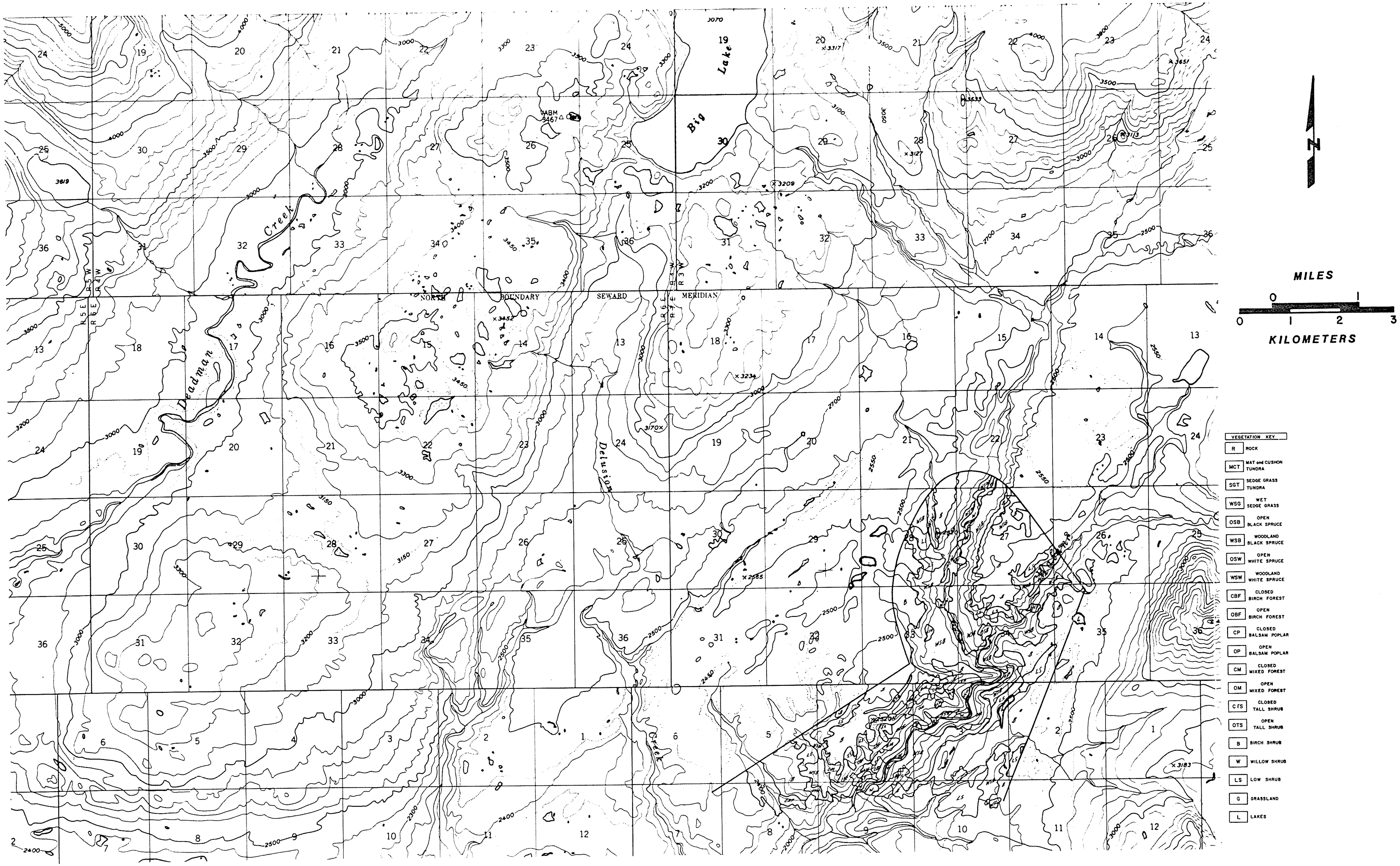
SHEET 8 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10

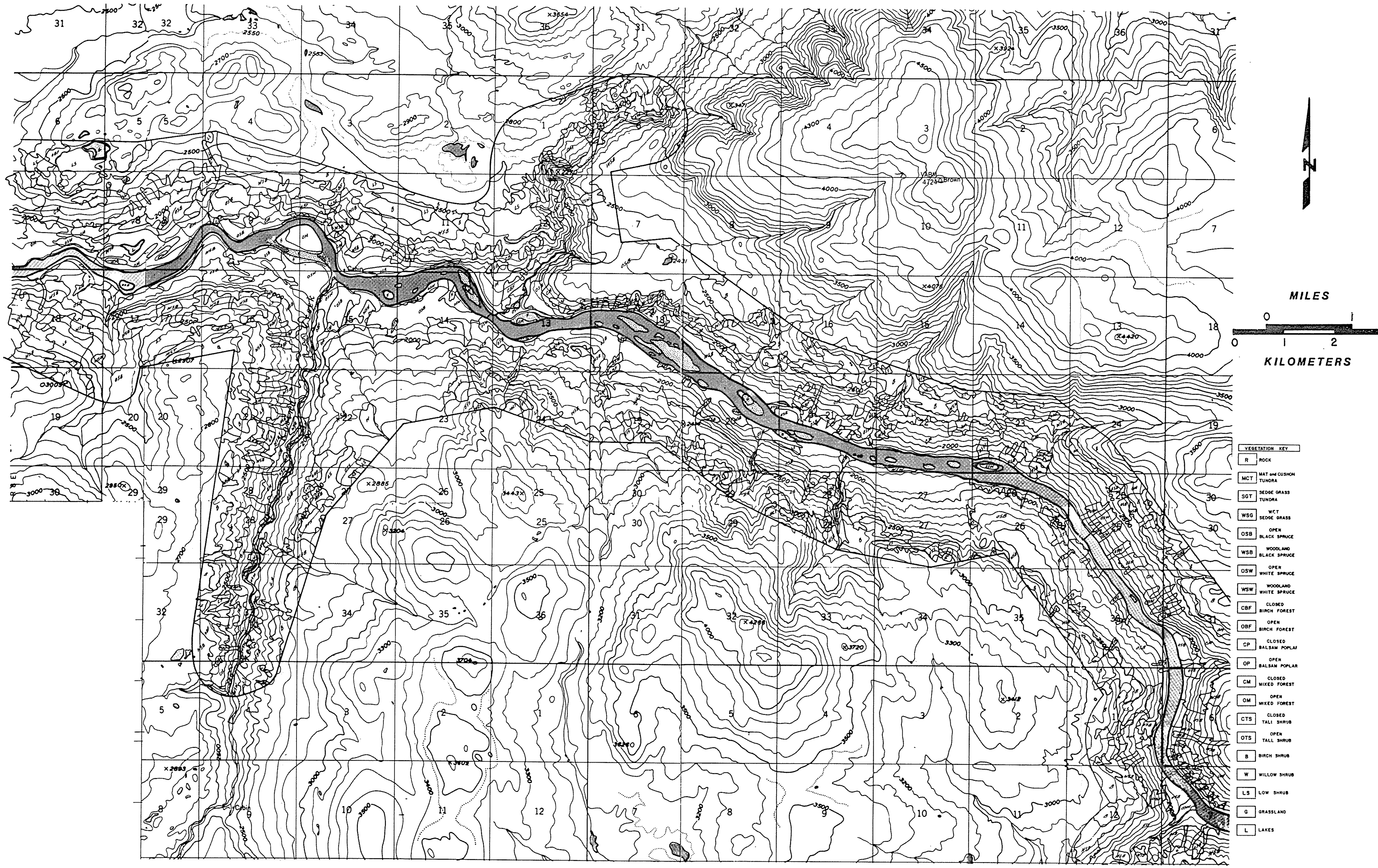
SHEET 9 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10

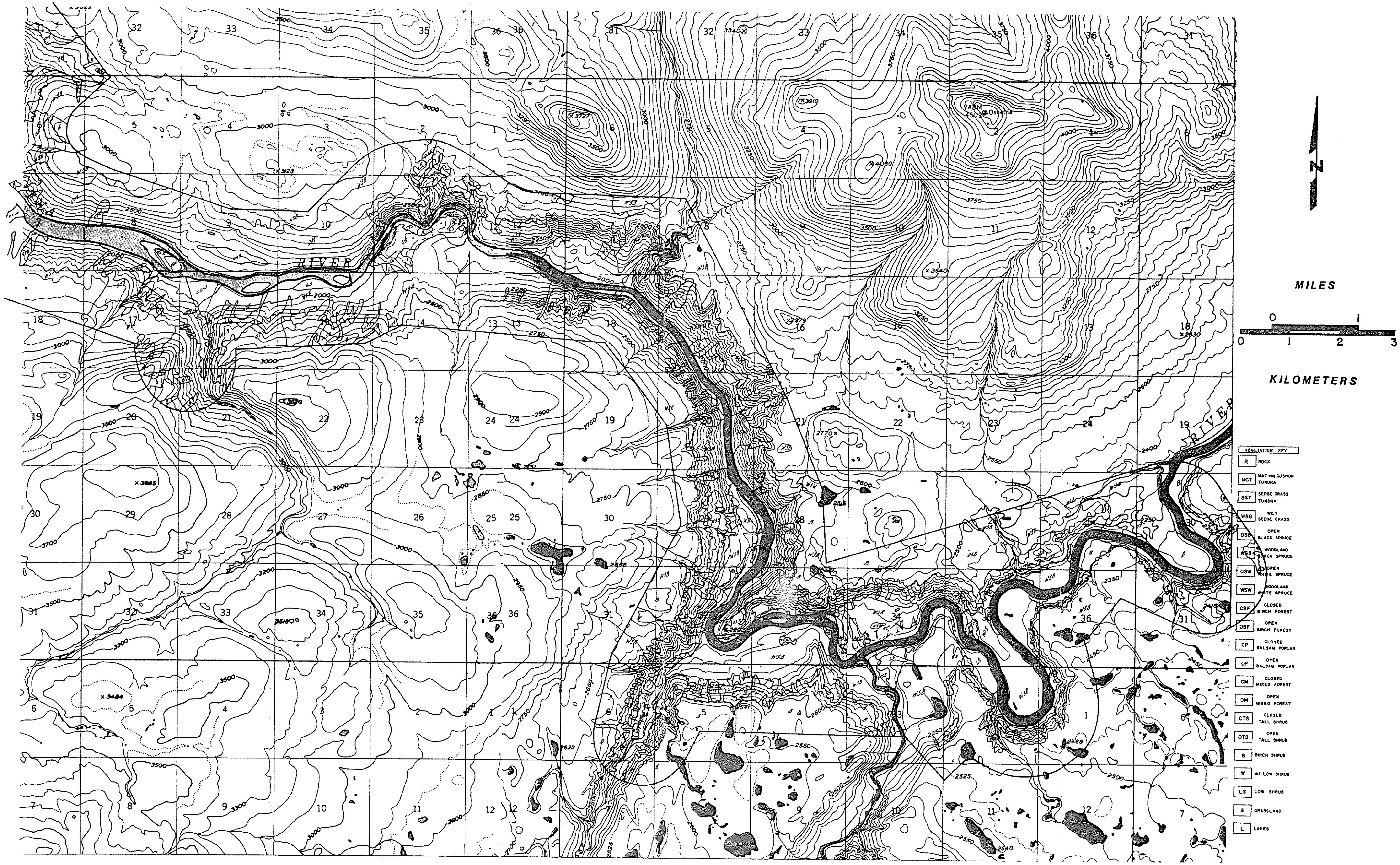
SHEET 10 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

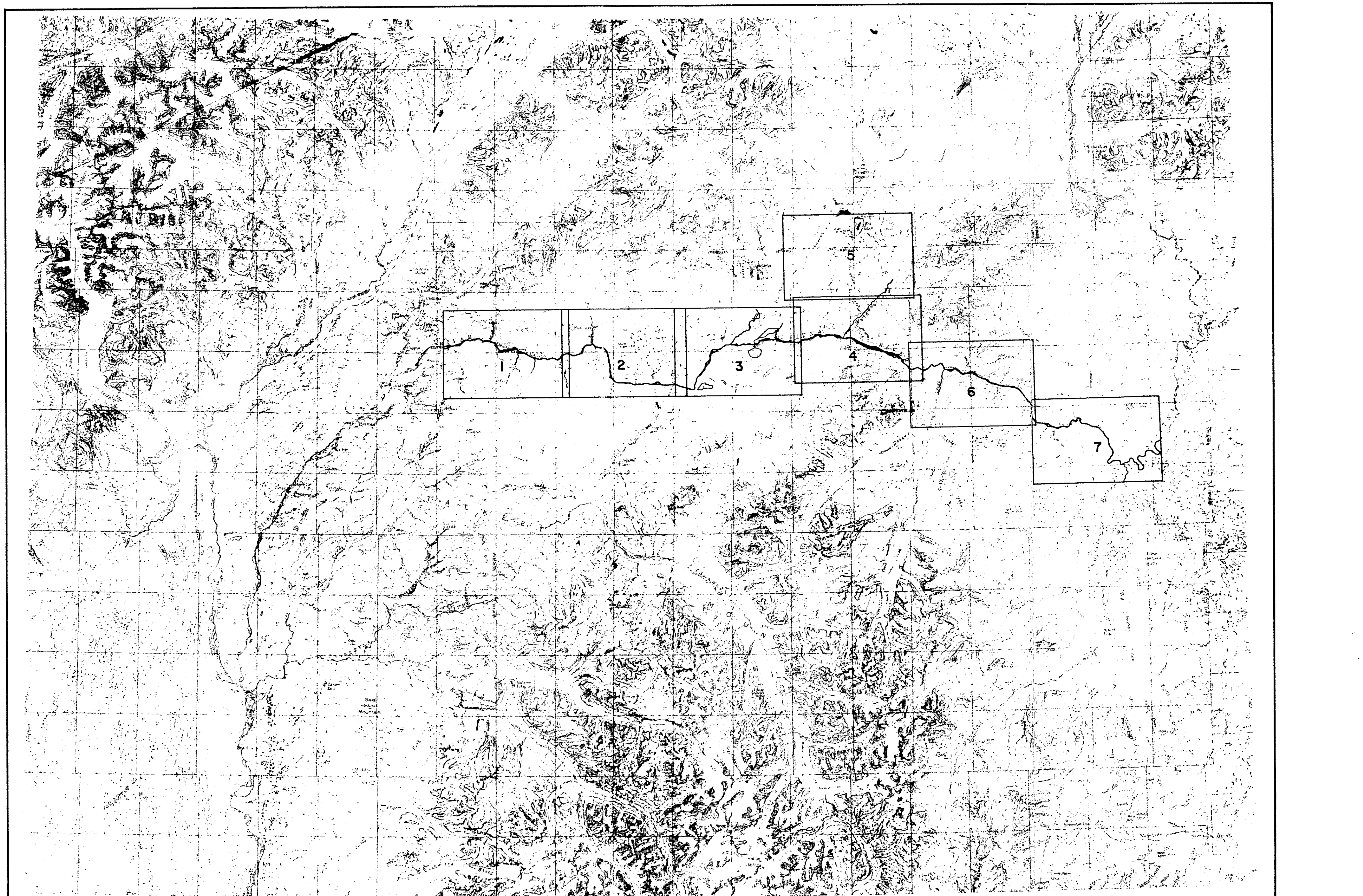
FIGURE 10

SHEET 11 of 12



VEGETATION MAP OF PROPOSED SUSITNA HYDROELECTRIC IMPACT AREAS

FIGURE 10
SHEET 12 of 12



WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS

FIGURE 11
INDEX MAP

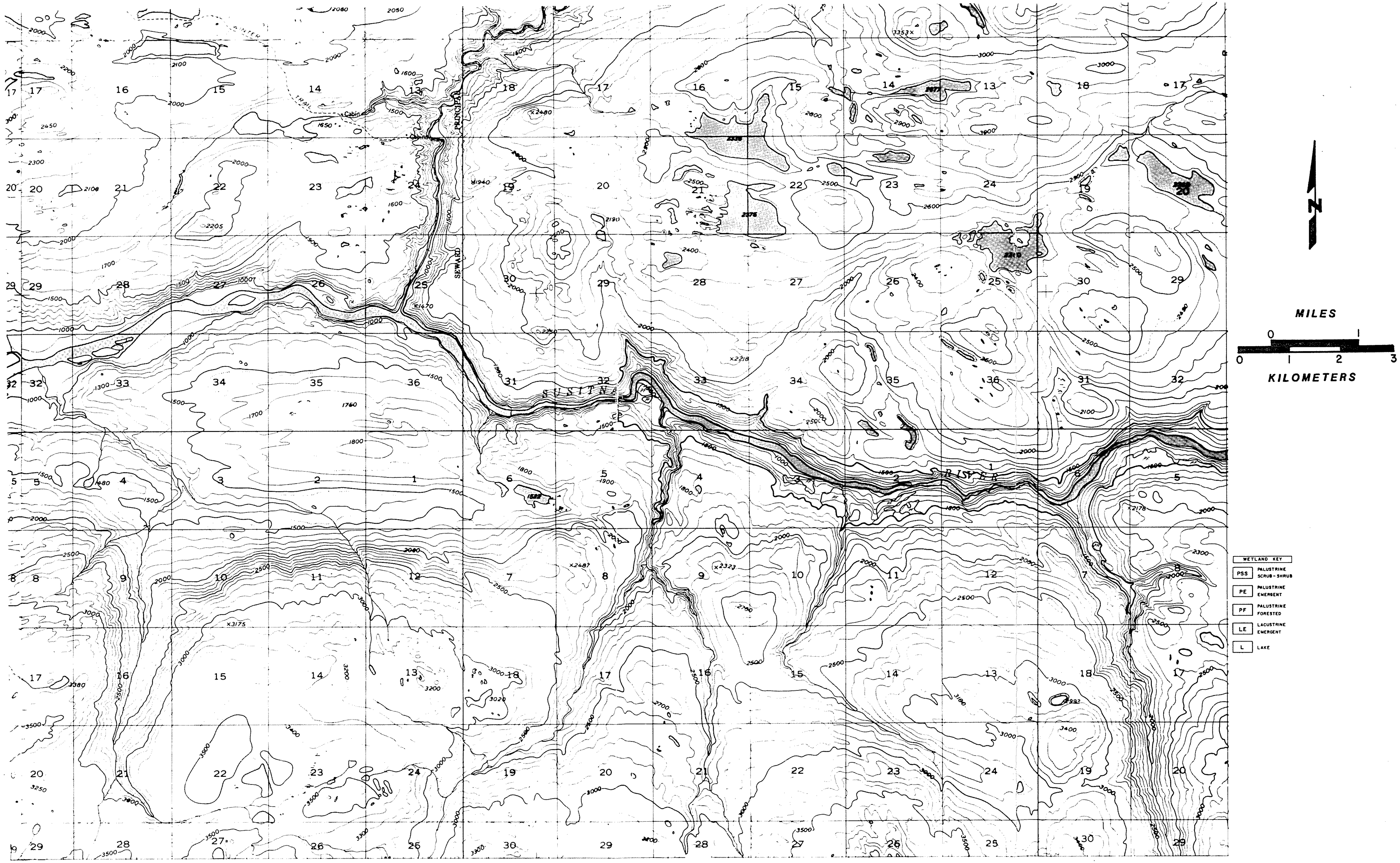
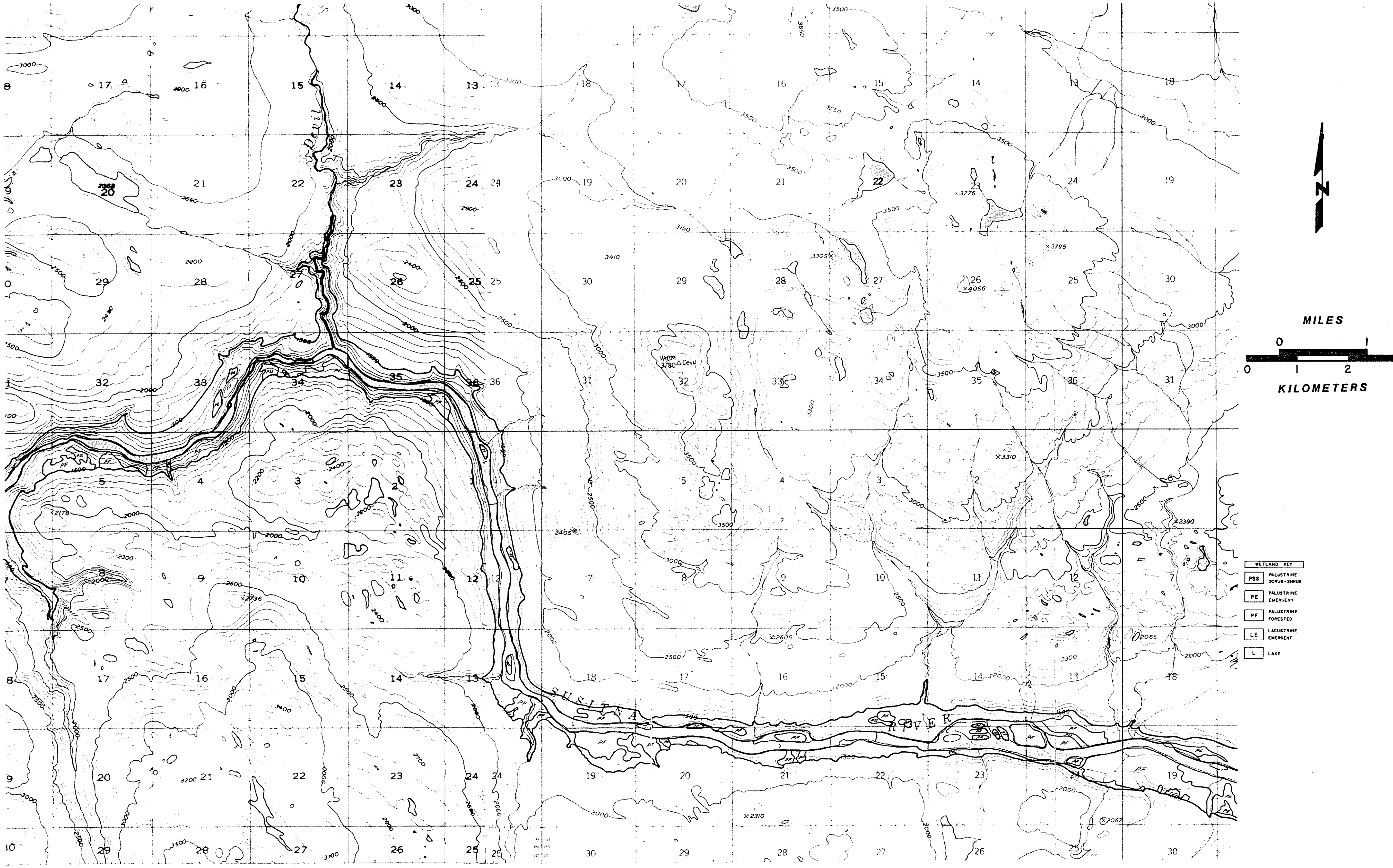


FIGURE 11
SHEET 1 of 7

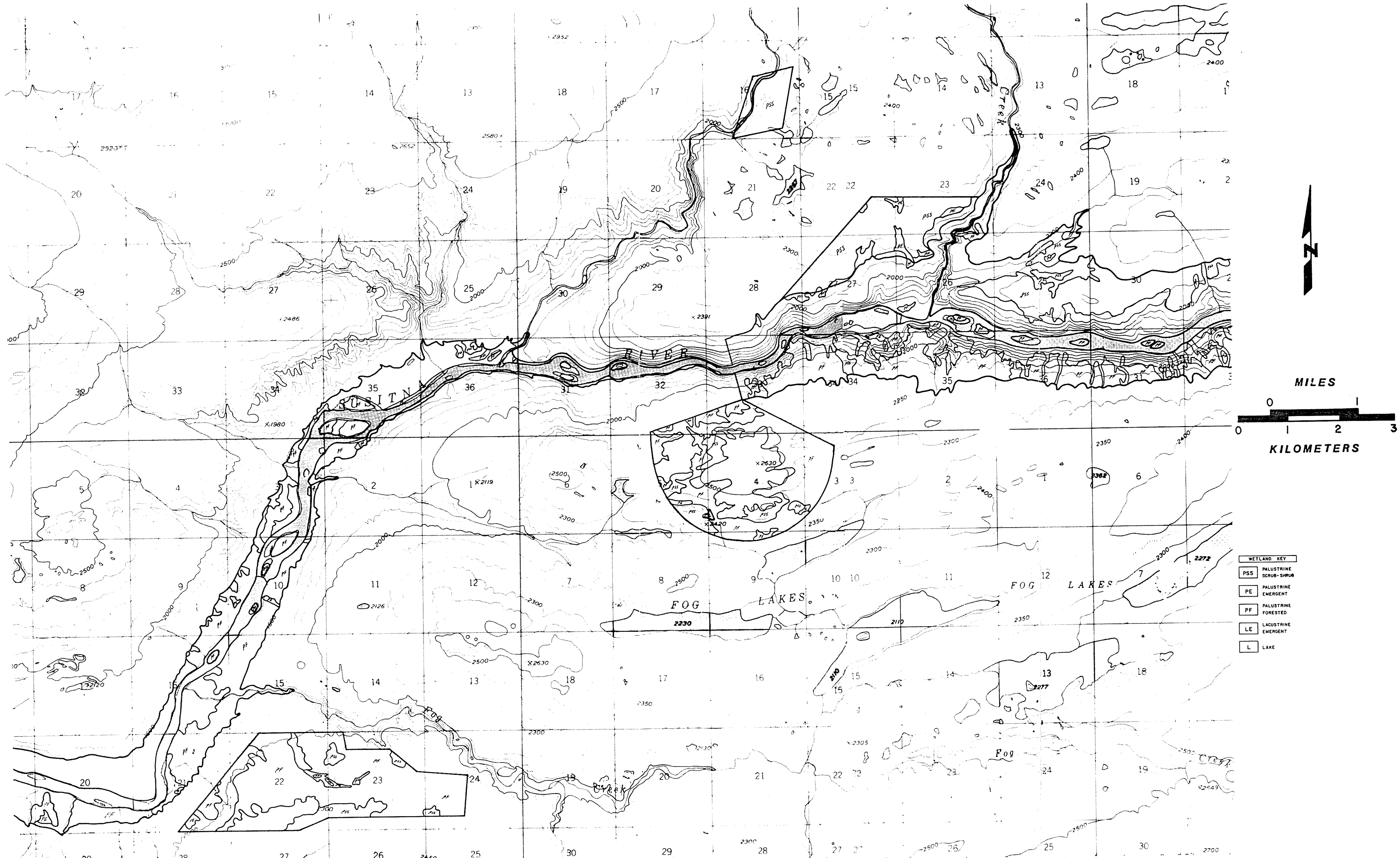
WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS



WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS

FIGURE 11

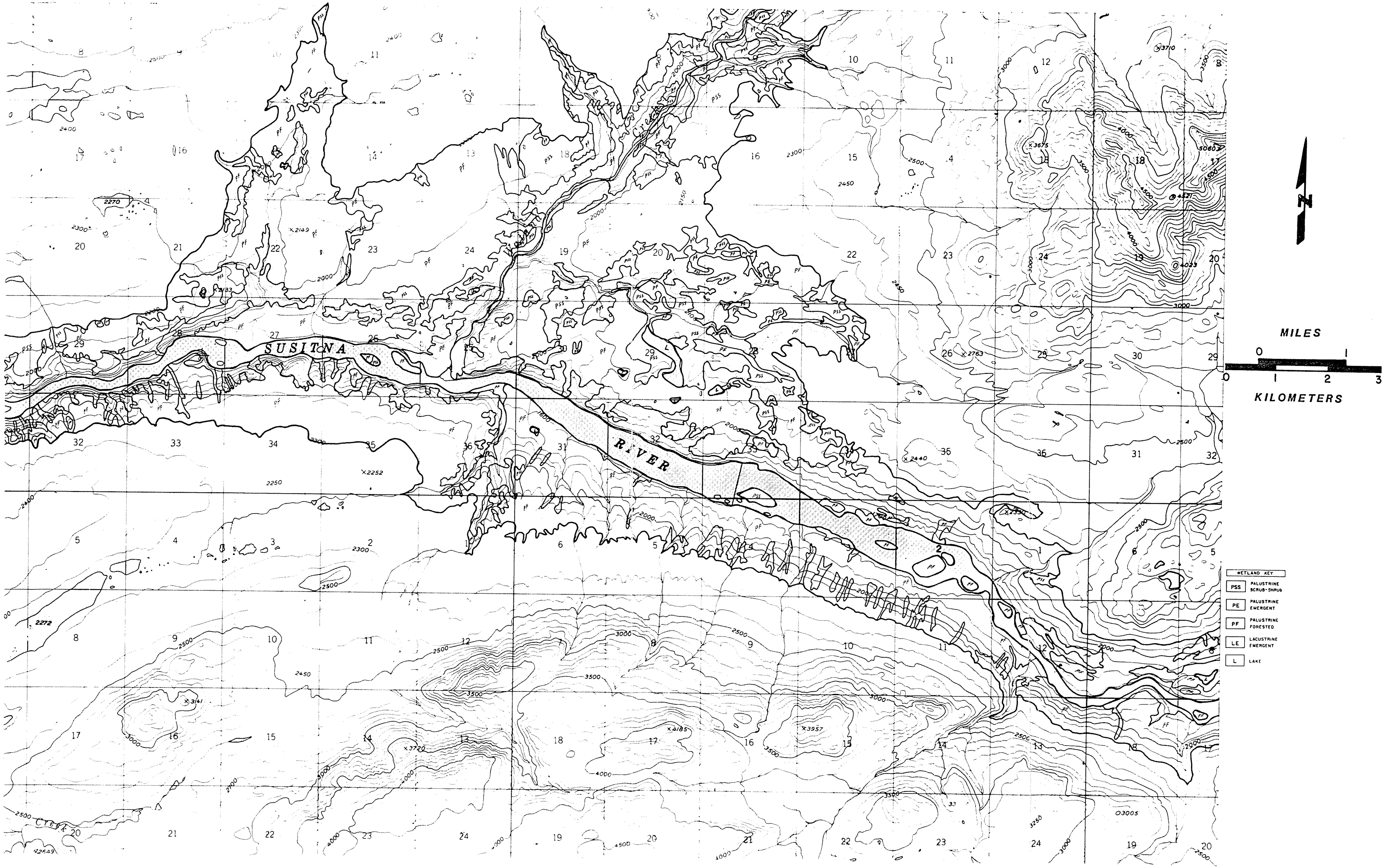
SHEET 2 of 7



WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS

FIGURE 11

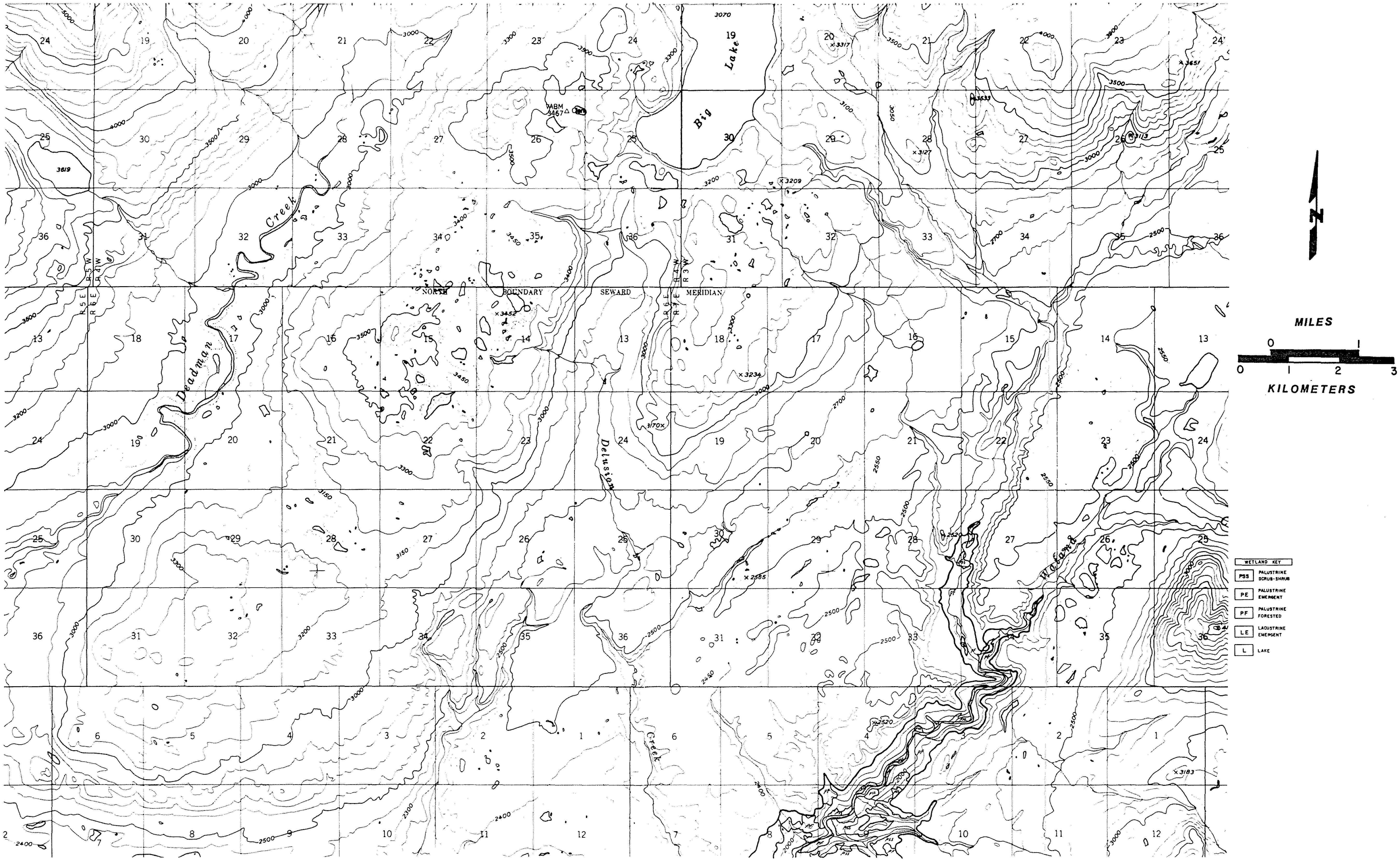
SHEET 3 of 7



WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS

FIGURE 11

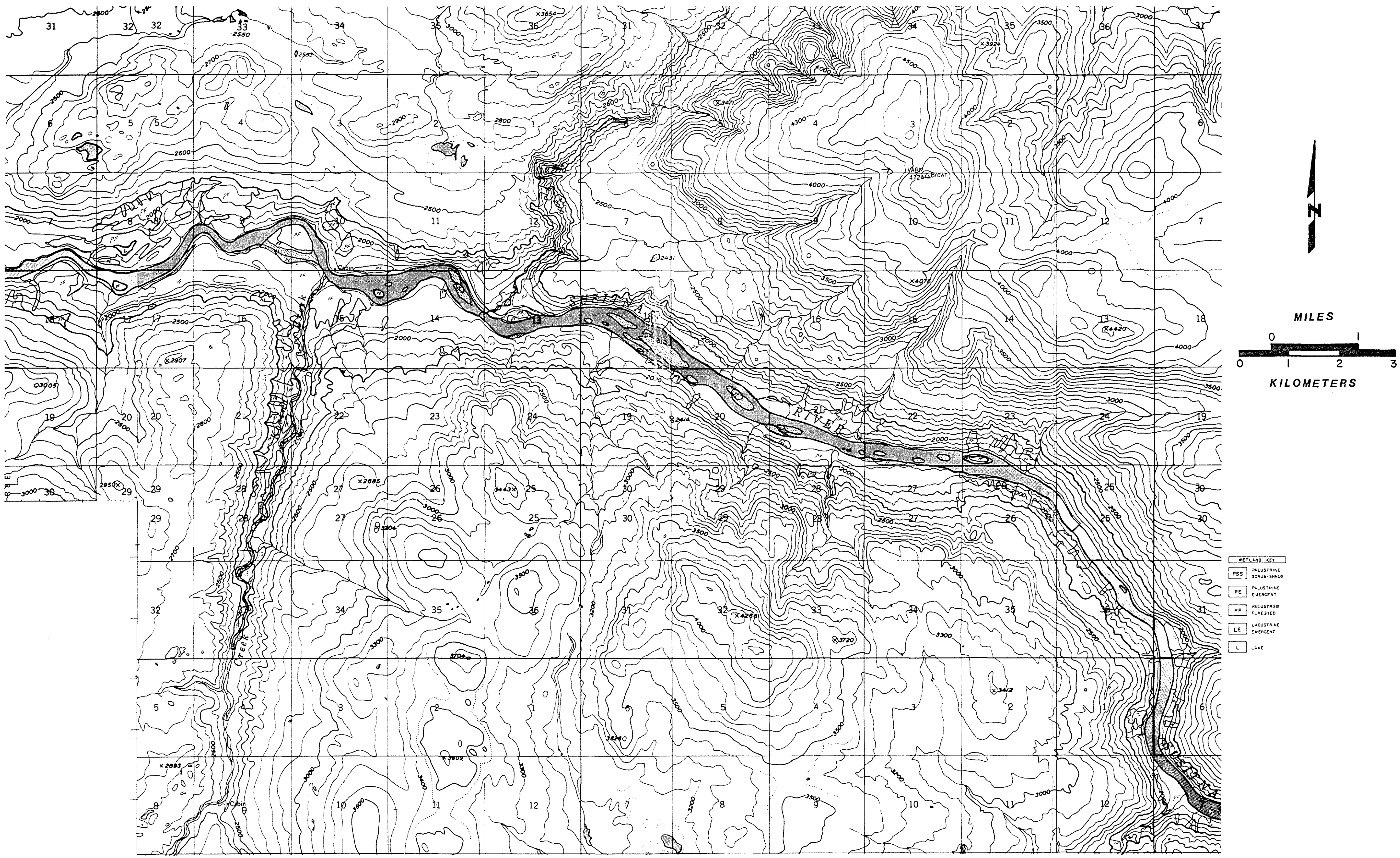
SHEET 4 of 7



WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS

FIGURE 11

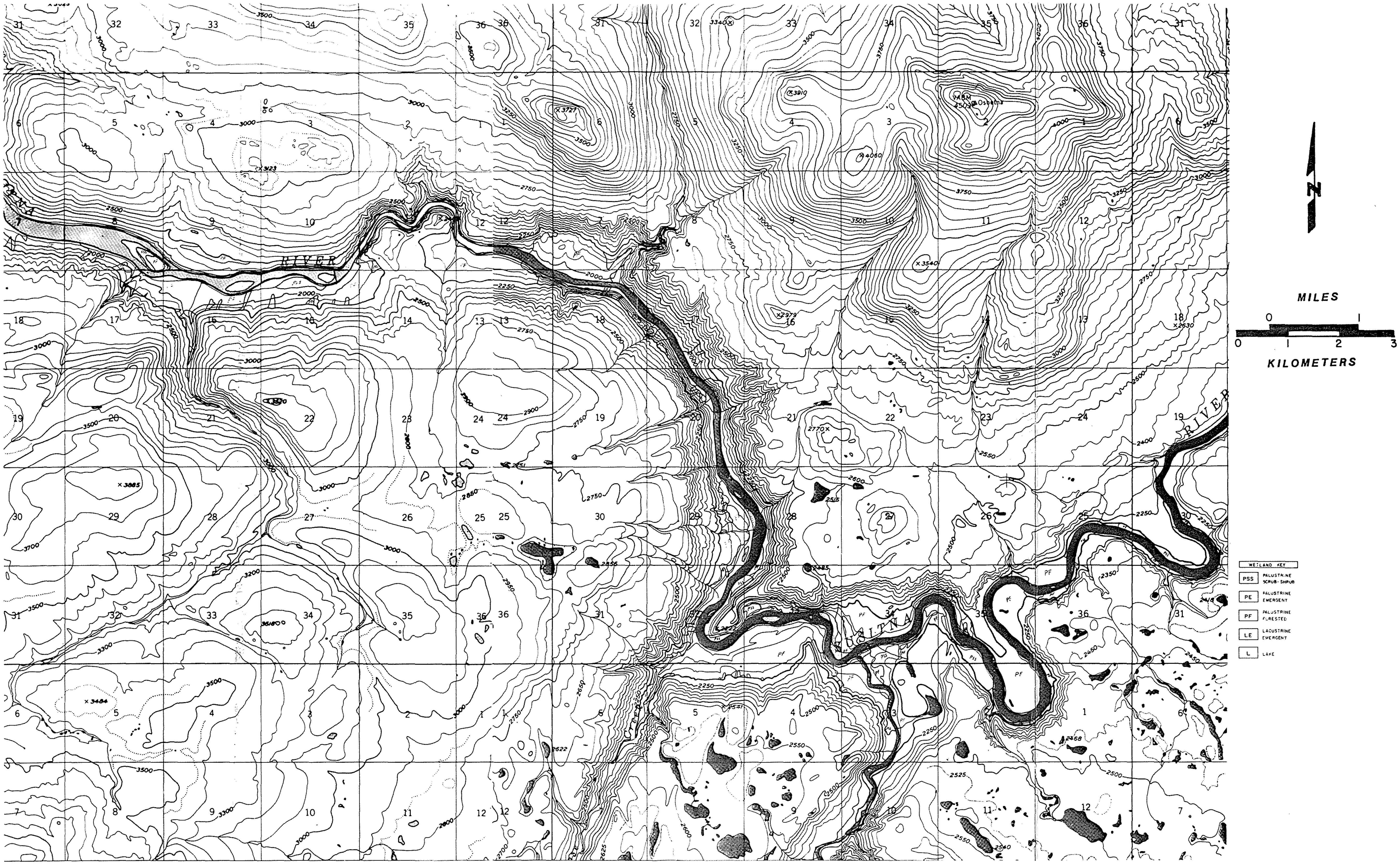
SHEET 5 of 7



WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS

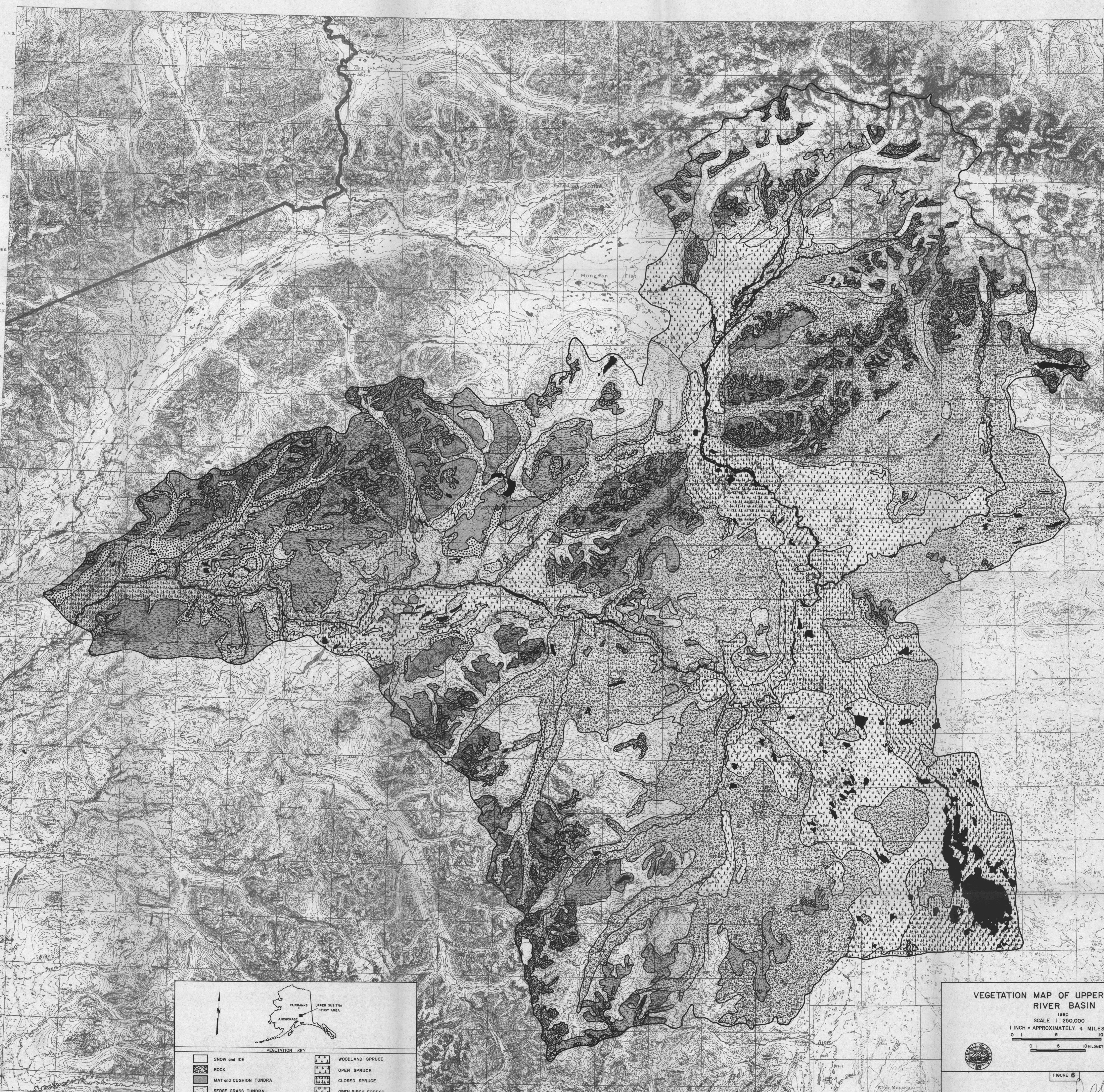
FIGURE 11

SHEET 6 of 7



WETLAND MAP OF SUSITNA HYDROELECTRIC PROJECT IMPOUNDMENT AND BORROW AREAS

FIGURE 11
SHEET 7 of 7



VEGETATION MAP OF UPPER SUSITNA RIVER BASIN

1980

SCALE 1 : 250,000

1 INCH = APPROXIMATELY 4 MILES

0 1 5 10 MILES

0 1 5 10 KILOMETERS

UNIVERSITY OF ALASKA 1917

Agricultural Experiment Station
University of Alaska
Palmer, Alaska

FIGURE 6

Superceded

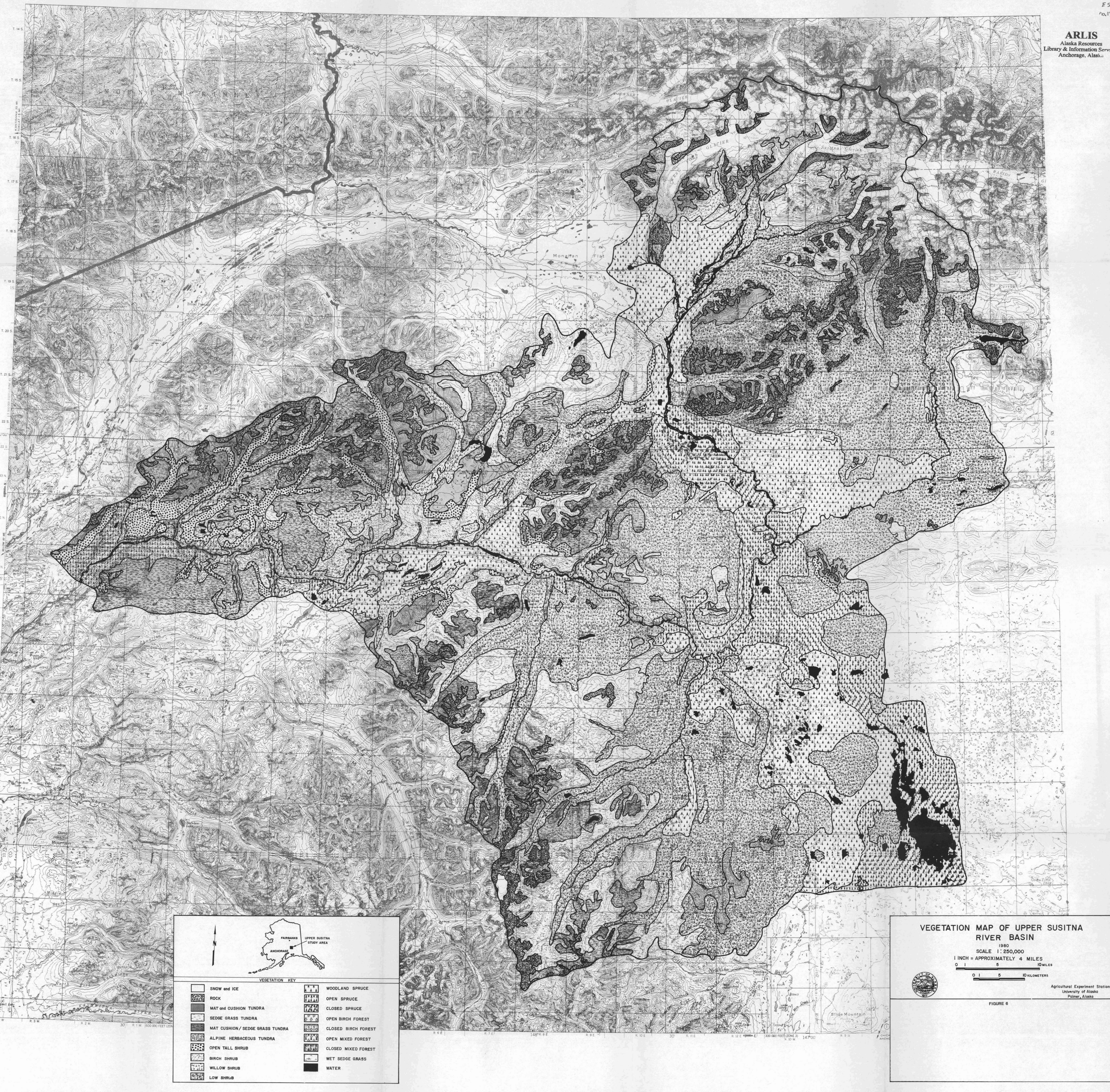
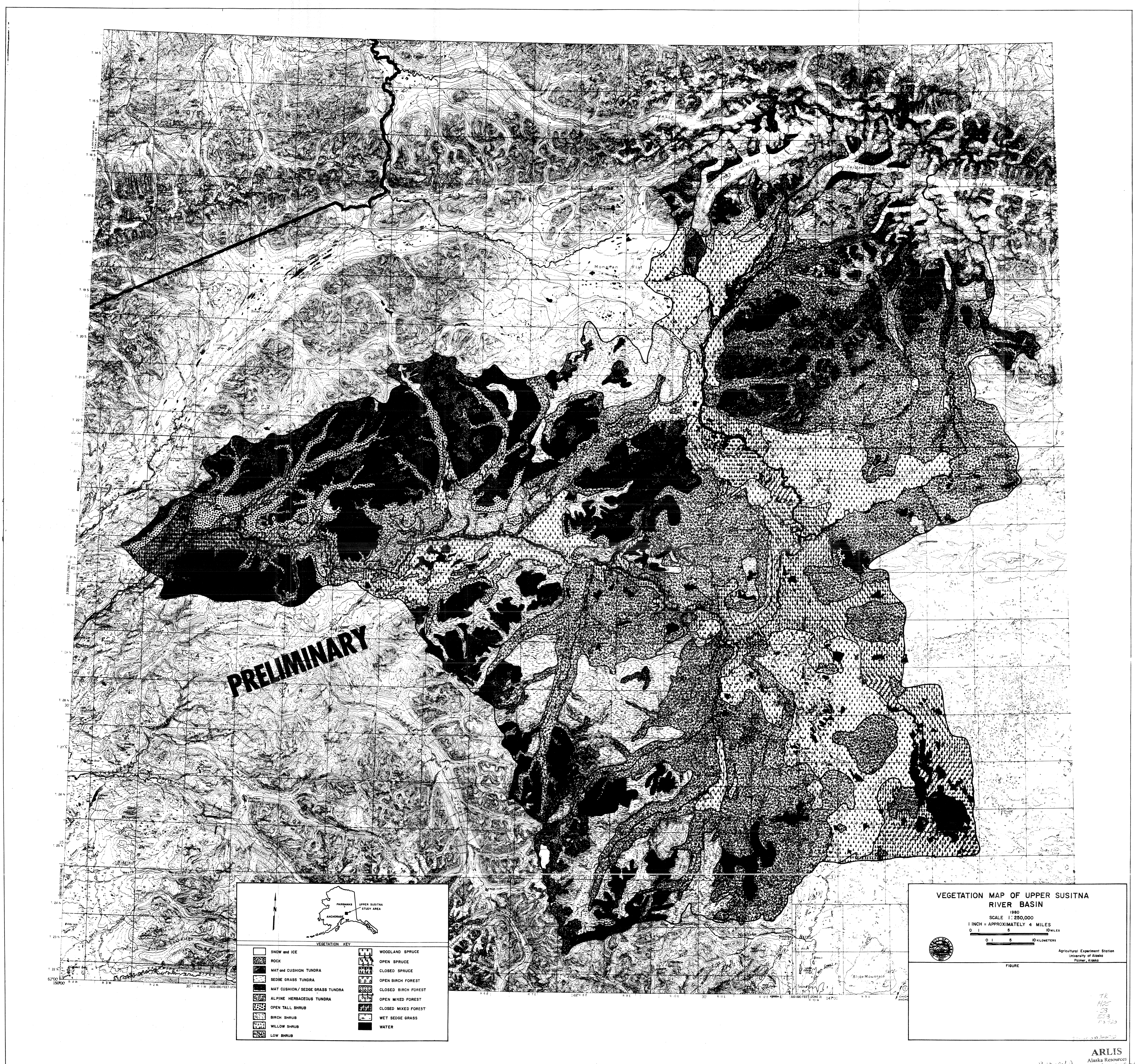

Monahan Flat
FAIRBANKS
UPPER SUSITNA STUDY AREA
ANCHORAGE
VEGETATION KEY
SNOW and ICE
ROCK
MAT and CUSHION TUNDRA
SEDGE GRASS TUNDRA
MAT CUSHION / SEDGE GRASS TUNDRA
ALPINE HERBACEOUS TUNDRA
OPEN TALL SHRUB
BIRCH SHRUB
WILLOW SHRUB
LOW SHRUB
WOODLAND SPRUCE
OPEN SPRUCE
CLOSED SPRUCE
OPEN BIRCH FOREST
CLOSED BIRCH FOREST
OPEN MIXED FOREST
CLOSED MIXED FOREST
WET SEDGE GRASS
WATER
VEGETATION MAP OF UPPER SUSITNA RIVER BASIN
1980
SCALE 1 : 250,000
1 INCH = APPROXIMATELY 4 MILES
0 1 5 10 MILES
0 1 5 10 KILOMETERS
UNIVERSITY OF ALASKA
AD SUMMUM
1917
Agricultural Experiment Station
University of Alaska
Palmer, Alaska

FIGURE 6


PRELIMINARY
VEGETATION MAP OF UPPER SUSITNA
RIVER BASIN
1980
SCALE 1:250,000
1 INCH = APPROXIMATELY 4 MILES
0 1 5 10 MILES
0 1 5 10 KILOMETERS
UNIVERSITY OF ALASKA
Agricultural Experiment Station
University of Alaska
Palmer, Alaska
FIGURE
N
FAIRBANKS
ANCHORAGE
UPPER SUSITNA
STUDY AREA
VEGETATION KEY
SNOW and ICE
ROCK
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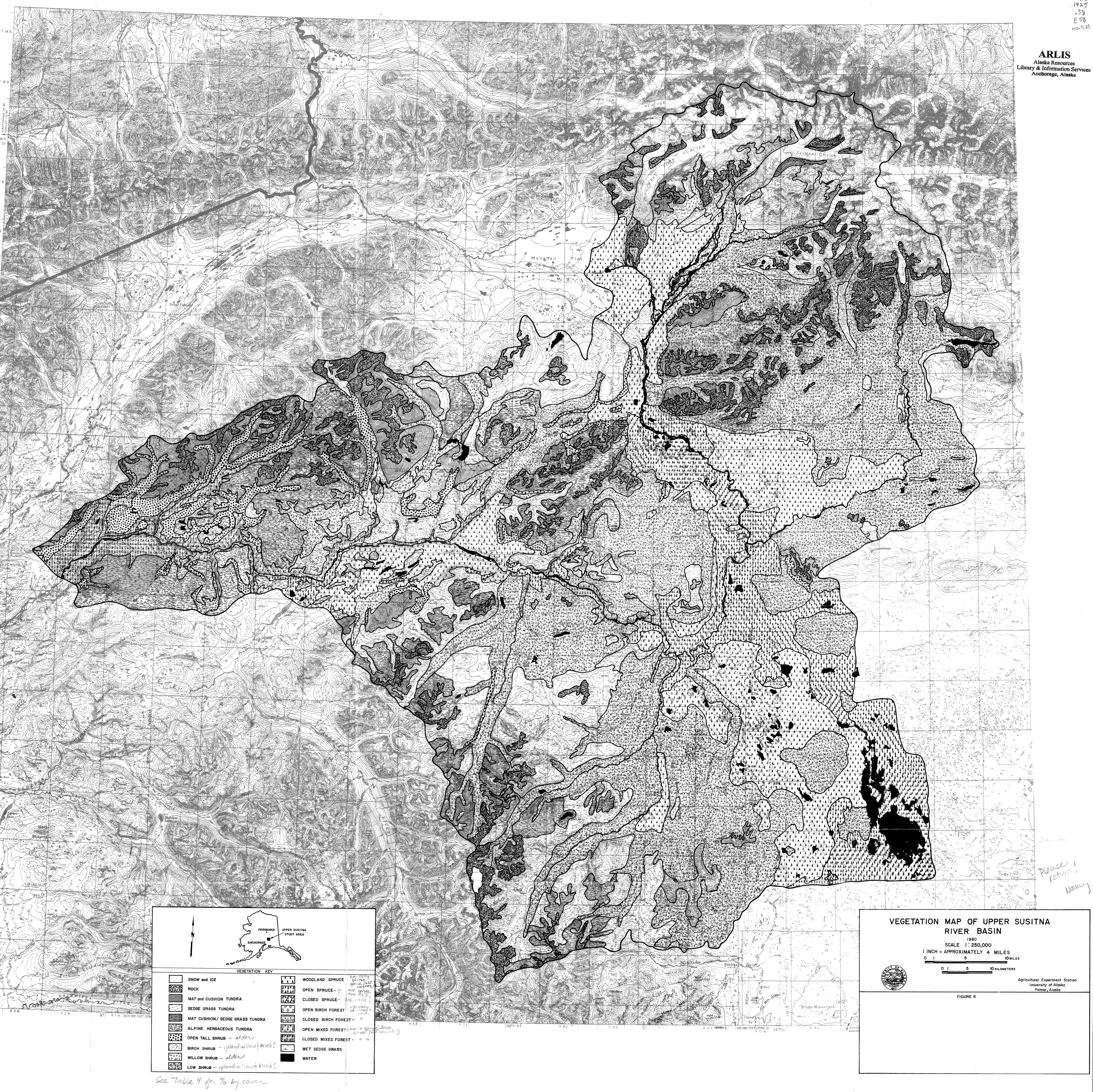
WOODLAND SPRUCE
OPEN SPRUCE
CLOSED SPRUCE
OPEN BIRCH FOREST
CLOSED BIRCH FOREST
OPEN MIXED FOREST
CLOSED MIXED FOREST
WET SEDGE GRASS
WATER

Nancy - how accurate? Polygons seem very large

How does it compare to DNR map & PJ of Landsat



See Table 4 for % by cover