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CONSTRUCTION OF ROADS IN THE CHINA - SOUTHEAST ASIA BORDER AREA THROUGH 1964

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CONSTRUCTION OF ROADS IN THE CHINA - SOUTHEAST ASIA BORDER AREA THROUGH 1964*

Summary and Conclusions

The Chinese Communists have continued to improve the road network adjacent to their borders with the countries of Southeast Asia. This road network not only has facilitated political consolidation of the frontier area and opened up new regions for economic development but also, more importantly, has improved logistical capability by providing vehicular access routes toward Burma, Laos, and North Vietnam.** This program of road construction has been implemented at a sustained pace during the past 15 years (1950-64) and has continued unabated during the recent nationwide retrenchment in construction. The present network of main roads in Yunnan Province, where the greatest amount of new construction has been carried out, was completed by the end of 1957, although many of these roads were of substandard construction and most of the bridges were of temporary construction. Since 1957, construction has consisted primarily of improvement and repair of this network, completion of additional interconnecting and branch roads, and construction of numerous feeder roads.***

In the countries south of the China border, where road networks were established two decades ago, a greater number of roads have deteriorated and disappeared than have been improved or newly constructed. In Burma, sections of the main road network construction through the border states initially were surfaced, but that country's chronic problem of insurgency has prevented adequate maintenance and repair and has limited the amount of new construction. Initially the roads in Laos and North Vietnam were constructed almost entirely of natural earth.† Because of lack of maintenance and repairs, most of the road system in northern Laos has long since become a maze of jungle trails, and, as a consequence, vehicular connections have ceased to exist with other parts of the country. In the border areas of North Vietnam adjacent to Communist China, several roads have been surfaced, a few roads have been constructed, and some cutoffs have been built to shorten the distance of existing routes, but the road system generally is in poor condition and in need of constant repair.

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* The estimates and conclusions in this publication represent the best judgment of this Office as of 1 March 1965.

** See the map, Figure 1, inside back cover. Additional maps are available in the 1:1,000,000 series.

*** For a discussion of the over-all Chinese program of road construction, see CIA/RR ER 61-8, The Construction of Highways in Communist China, 1949-60, March 1961, CONFIDENTIAL.

† For a description of the term natural earth, see the glossary, Appendix D.

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Although most of the roads in the border area* degenerate into trails just short of the border, eight motorable roads continue across the border from Communist China and feed directly into the existing road networks of adjacent countries. Included in these border-crossing routes are two roads into Burma, two roads into Laos, and four roads into North Vietnam. The existing road gaps between Communist China and Burma, Laos, and North Vietnam could be closed by intensive efforts in a relatively short period of time. At present, there is no conclusive evidence, however, that the Chinese Communists are engaged in extending additional routes across the border into Burma or Laos or that any major road construction program is underway by Communist China and North Vietnam to provide substantially improved road connections between these two countries.

Major conditions affecting the construction and maintenance of roads in the entire border area are the nature of the terrain, the adverse seasonal climatic conditions, and the prevalence of a system of roads that are low-grade by Western standards. In spite of these limiting factors, however, the Chinese Communist practice of using mass labor as an expedient means of building, repairing, and keeping routes open, even under the most adverse conditions of weather and terrain, makes any border road or trail a potential access route into Southeast Asia.

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* The term border area as used in this publication refers to territory adjacent to the border in Communist China, northern and eastern Burma, northern Laos, and northern North Vietnam.

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I. Performance in Construction Through 1964

The greatest amount of new road construction in the entire China - Southeast Asia border area has taken place in Yunnan Province, where there was an almost total lack of motorable roads in 1950. Although new roads have been constructed in Kwangsi Province, extensions into the border area within Yunnan amount to more than twice the length added within Kwangsi. At the other end of the scale the smallest amount of road construction has been in northern Laos, but Laos is the only country where new roads have been constructed across the border from Communist China in the past decade. The other six roads that link Communist China with Burma (two) and North Vietnam (four) are improved roads, built before or during the early 1950's. Both Burma and North Vietnam have been engaged more in the reconstruction of existing roads than in new construction.

A. Communist China*

Since 1950 the Chinese Communists have steadily expanded and improved the road system in the border provinces of Yunnan and Kwangsi. At no time during the past 15 years has there been any indication that this construction program has been carried out on a crash basis. The exception occurred in 1953-54, when roads were hastily constructed and improved to provide supply routes to Vietnam during the French-Indochina war. Additionally, there has been no indication that the road construction program in southwestern China suffered a major setback during the years of countrywide retrenchment in construction. The outstanding characteristic of the entire program has been one of steady and sustained effort to extend the network to the border.

During the years 1950-57 the Chinese Communists concentrated their roadbuilding efforts in Kwangsi on lateral routes near the border through the province into Yunnan Province, thus providing a more direct connection between Nan-ning** and K'un-ming. The road system, a remnant of the 1940's, consisted of two north-south roads that branched from the Kweichow-Kwangsi*** trunk road and extended through Kwangsi and across the border into North Vietnam. The new roads, therefore, greatly shortened the distance not only between Nan-ning and K'un-ming and Nan-ning and the border but also between western Kwangsi and central Yunnan by eliminating the necessity of going by way of K'un-ming. In Yunnan the Chinese Communists directed their road construction efforts toward North Vietnam and Burma. Improvement of the Yunnan-Tibet† and Burma Roads and construction of the Hsiang-yun - P'u-erh, Nan-ta, K'un-lo,

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* Including only the areas adjacent to the border in the provinces of Yunnan and Kwangsi.

** For a list of coordinates, see Appendix A.

*** The alignment of this road, constructed before 1940, is Nan-ning (Kwangsi), Kuei-yang (Kweichow), and K'un-ming (Yunnan).

† For a discussion of individual roads, see Appendix B.

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and Shuang-chiang - Meng-hai Roads were started early in the 1950's. Construction and improvement of roads leading to the border of Laos began in 1958-59.

The tendency in road construction throughout the past 15 years has been to construct natural earth roads initially in order to gain access to new areas quickly and then to improve them progressively. Although some sections of the main roads, especially those servicing military installations, had been improved by 1957-58, work on these roads, as well as on secondary roads, is continuing.*

B. Burma

Prolonged civil strife and other internal difficulties have greatly hampered improvement and maintenance of the road system in Burma. Nevertheless, the government has made some attempt to improve the roads, but its efforts have been sporadic and more or less confined to roads that would provide better logistical support for combating insurgency. The new roads that have been constructed serve as alternate connections from central Burma to, or within, its border states** where the use of preexisting roads continues to be threatened by insurgents.

In Burma the highway network is oriented generally in a north-south direction roughly parallel to the major river system except in the northern part of the country, where, by the nature of the terrain, the roads are confined to following water courses. Most of the east-west roads follow the pattern of ancient routes that connected waterways and that led to important mines. There are three national routes that pass through the border states and provide direct connections between the border zone and the central valley of Burma. These routes include the Mandalay-Putao Road*** through the Kachin and the Northern Shan States toward the borders with Tibet and northwestern Yunnan; the old Ledo Road (Myitkyina-Pangsau Pass Road) toward the border with India; and the Meiktila-Tachilek Road through the Southern and Eastern Shan States toward the borders with Thailand, Laos, and southwestern Yunnan.

In addition to these main roads, sections of the Mandalay-Putao and Meiktila-Tachilek routes, where they pass through the

* An outstanding example of this is the Ch'e-li bridge (on the K'un-lo Road) on which construction was resumed after a lapse of 2 years (see road study no. 17, Appendix B).

** Including the Kachin State of northern Burma and the Northern and Eastern Shan States, which form the eastern portion of the country. The Southern Shan State lies between the Eastern Shan State and the central valley of Burma.

*** From Mong Yu, on this road, a secondary road extends to Wan-t'ing (Yunnan Province) and provides the link between the Burma Road in Yunnan and the main road system of Burma.

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Northern and Southern Shan States, are linked by interconnecting secondary roads that run parallel to the border in the area west of the Salween River. Only a few roads branch east from these secondary roads, and, where they do exist, they support local traffic only as far as the river. In the area between the Salween and the Sino-Burmese border, old roads have disappeared and only trails exist. In the Eastern Shan State, sections of old secondary roads connecting Keng Tung (on the Meiktila-Tachilek route) with the border have lapsed into trails, and none can support vehicular traffic.

During the past few years, Burma has made an effort to reconstruct and repair the road system in its northern and eastern regions, but the specific details of many of these projects are unknown. Improvements were underway on the Myitkyina-Putao route north of Myitkyina during 1962-64, and other existing roads in the Kachin State probably were repaired and alternate routes constructed, especially in the area east of Bhamo. Repeated reports of the destruction of bridges and road sections by insurgent forces as well as usual damage from the rainy season in both the Kachin and the Northern Shan States, however, would indicate that most of the roads were frequently impassable because of the difficulties of keeping them repaired. In the Eastern Shan State, reconstruction and repair of roads apparently has met with more success. Although there is no evidence that any new roads were constructed or underway in this border state, repairs on the Meiktila-Tachilek route and on roads branching from it reportedly were undertaken during 1961-64.*

Late in 1963, Burma reached final agreement with Communist China on the construction of two suspension bridges across the Salween River that were to be financed under the $84 million credit of January 1961. The first of these bridges is located in the Northern Shan State at Kunlong on one of the few branch roads extending east from the Mandalay-Putao Road at a point about 32 miles north of Lashio.** The other bridge is to be located at Ta-kaw on the Meiktila-Tachilek Road in the Eastern Shan State.***

C. Laos and North Vietnam

In the northern part of the area of old Indochina a greater length of road has disappeared than has been constructed or rebuilt during the past few years. Initially the road system consisted mainly of natural earth roads, only a few of which were surfaced with gravel or stone. Neglect through the years caused the roads to deteriorate

* For a description of these branch roads, see road studies nos. 14, 27, and 28, Appendix B.

** For a description of the Kunlong bridge, see road study no. 16, Appendix B.

*** For a description of the Ta-kaw bridge, see road study no. 22, Appendix B.

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rapidly. Even the reconstruction and repairs that have been carried out in recent years have not substantially improved the capabilities of this network.

1. Laos

Except for roads connecting Phong Saly* and Muong Sing to the border of Yunnan and the three roads connecting Sop Nao and Samneua with the border of North Vietnam, there are no motorable roads in northern Laos. The road system constructed by the French, of natural earth, has become a maze of trails, thus severing all motorable connections, not only in the northern part of the country but also with central Laos.

In 1963 the Chinese Communists completed a road from Meng-la in Yunnan to Phong Saly. In the following year a second link was established between Communist China and Laos when the trail in the border section between Meng-mang and Muong Sing was made motorable during November-December 1964. There have been reports of plans for construction of additional roads, both into and within Laos, by the Chinese Communists, but there is no evidence that any of these projects has ever been started. Some repair work was carried out around the areas of Muong Sing and Nam Tha** by the Communists, but only a natural earth road suitable for four-wheel-drive vehicles connects Muong Sing with Nam Tha. All other routes in this area are pack trails that possibly are jeepable in dry weather.

Probably with some assistance from North Vietnam, sections of the roads from the vicinity of Sop Nao and Samneua to the border and for a short distance into North Vietnam were reconstructed in the late 1950's. Continuation of these roads in North Vietnam, however, did not have similar improvement at that time. There is no indication that extension of these roads beyond the vicinity of Sop Nao and Samneua, either northwestward toward Phong Saly or southward toward Central Laos, is underway or planned.

2. North Vietnam

Since the early 1950's, road work in the northern border provinces of Vietnam has been directed toward reconstructing and repairing the old road system, including the access routes to Communist China. Only a few new roads were constructed in the 1960's, and although these extend toward the border, they do not cross it.

It is in the Sino - North Vietnamese section of the border, between Ha Giang and the Gulf of Tonkin, that the greatest concentration of border-crossing routes exists. There are four vehicular routes

* For a list of locations, see Appendix A.
** Also known as Muong Luong Nam Tha.

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between North Vietnam and Communist China, all of which are improved, previously existing roads. Three of these roads branch from the main route in North Vietnam, which parallels the border, and link Cao Bang and Dong Dang to Ching-hsi, Lung-ching, and P'ing-hsiang in Kwangsi Province. The fourth route crosses the border at Mong Cai linking the northeastern coastal route in North Vietnam with Kwangtung Province. West of Ha Giang the border section of an old road (extending northwest from Ha Giang), which had been hastily connected with a road from Wen-shan in Yunnan in 1953-54, has deteriorated into a trail and is no longer passable for vehicular traffic. Recently, however, there has been indication that another old road that passes through Lai Chau to the border was being improved and that an east-west road connecting it with Lao Kay was being constructed.* Completion of these roads, possibly in 1965-66, will provide direct access routes from the border via Ban Nam Coum and the railroad at Lao Kay through northwestern North Vietnam into northern Laos. At present, roads from the provinces of Kwangsi and Kwangtung are the only ones that feed into the main network of North Vietnam. Improvement of the road through Lai Chau, however, will provide additional access into the main network (via Moc Chau to Hanoi) and for the first time in recent years a road from Yunnan into North Vietnam.

II. Problems of Terrain and Climate**

The nature of the terrain and weather in the border area creates serious problems in regard to the location, construction, and maintenance and repair of roads and bridges. The mountains; the high plateaus with a minimum of flat land, deep gorges, and numerous valleys; and the extensive karst*** areas restrict alignments and frequently cause an excessive amount of construction. Optimum conditions for earthmoving, one of the most fundamental tasks in road construction, are limited by the moisture content of the ground, the type of soil, and conditions of natural drainage. In the border area, therefore, the construction season is more or less restricted to the dry season, which is a period of about 6 months (November-April). Throughout the remainder of the year, heavy rains cause landslides and washouts, which necessitate constant maintenance and repair, both during and after completion of construction.

III. Standards and Inputs

In all countries of the border area the standards and methods of road construction and maintenance are substantially the same. Moreover, the environmental conditions and the prevailing economic and

* See road study no. 1, Appendix B.

** For a more detailed discussion, see Appendix C.

*** A limestone plateau marked by caverns and underground streams and by sinkholes interspersed with abrupt ridges and irregular protuberant rocks.

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military situation create similar problems and needs for roads, and, therefore, it is possible to make certain generalizations that are applicable to the entire border area.

A. Standards

1. Design and Construction

The road system of the border areas is low-grade by Western standards because it is characterized by a predominance of soil-aggregate and natural earth roads designed to carry only light traffic. With few exceptions they are single-lane roads averaging in width from 23 feet (including shoulders) to 10 feet with no shoulders* but with passing lanes where the terrain permits. Bridges on the roads include small timber trestle, masonry arch, and reinforced concrete structures; bailey bridges; and steel suspension bridges over deep gorges or wide rivers. Bridge construction is held to a minimum, however, and many streams are forded or crossed by ferry.

Improvement** of the roads has included adding stone or gravel to the road surface, widening the roadbeds, improving drainage, building cutoffs for better alignment, and reducing the number of hairpin turns where it has been feasible. On some roads, where the preparation of the roadbed was particularly poor, the existing roadbed has been reconstructed. In some cases, temporary bridges have been replaced with more permanent structures, and bridges have been constructed to eliminate some of the fords and ferry crossings.

2. Maintenance

Soil-aggregate roads are capable of supporting a limited amount of traffic under all weather conditions when they are constructed properly and are adquately maintained. During the rainy season, roads become potholed or the road foundation fails; landslides not only cover the roadbed but also can take away whole sections; roads become flooded; and bridges are washed out. Therefore, natural earth roads can disappear in one rainy season. In addition, in the cold areas frost heave causes roads with inadequate drainage facilities to buckle, whereas in hot areas encroachment of vegetation is rapid. Therefore, constant maintenance, often requiring major repairs, must be carried out.***

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* The only two-lane roads (averaging 30 feet wide) are the Burma Road and the K'un-ming - K'ai-yuan Road.

** In Asia the usual practice is to improve only the worst sections of a road and to maintain the other sections, both activities tending to be carried out under extreme necessity.

*** This activity is the basis for the majority of reports of road construction in the late fall and early winter of each year.

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B. Inputs

The method of construction in the border area is one that employs mass labor, a minimum of construction equipment, and local materials. The labor force is composed of thousands of unskilled, locally conscripted civilian laborers augmented by troops and supervised by military engineers. Members of civilian organizations, either those attached to the various administrative levels of government or private contractors, also participate in supervision and construction. Responsibility for design usually falls to the civilian organizations. Some bulldozers and pneumatic drills and a few trucks are used, but the use of picks, shovels, hand tampers, primitive spreaders, and manually pulled rollers prevails. Often the handtools are furnished by the conscripted workers or are made by them at the construction site.

The cost of constructing roads in the border area is best measured in terms of the time and effort expended.* In this sense the use of conscripted labor and handtools is expensive. The rate of construction is determined by the number of workers -- that is, as the size of the labor force is increased, the rate of construction is increased. Because laborers must be provided with adequate food, housing, and medical care or their labor productivity will decline rapidly, these necessities must increase in proportion to the corresponding increase of the labor force.** Moreover, the number of technicians must be increased proportionately to train and supervise thousands of laborers rather than hundreds. Failure to provide these necessities obviously results in severe attrition of the labor force, poor quality of construction, and labor inefficiency. In addition to labor inputs, materials further increase the cost of road construction in terms of amounts required and availability. Soil-aggregate roads require an enormous amount of stone or gravel for subbase and surface. Even a substandard road of this type requires from 2,000 to 2,500 cubic yards of stone or gravel per mile. When this material is not readily available, long hauls add greatly to the cost of the road, and quarrying operations are expensive even where the stone or

* An estimate of the cost of road construction could be expressed in US dollars, but the paucity of data and the process of converting and reconciling the exchange rates and implied exchange rates of the various countries would distort the results. In general, however, the cost of constructing roads increases with the remoteness and difficulty of the terrain. In Communist China, for example, where scattered and ambiguous figures have been reported officially, the cost of constructing roads in border areas averages 60,000 to 70,000 yuan (and more) per kilometer as opposed to an average of 50,000 yuan (and less) per kilometer in other areas of the country. For a discussion of the breakdown of the costs of road construction, see CIA/RR ER 61-8, The Construction of Highways in Communist China, 1949-60, March 1961, pp. 8-11, CONFIDENTIAL.

** In Asia a poorly fed worker performing hard manual labor can produce only one-third to one-half the amount produced by an adequately fed worker.

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gravel is available locally on short hauls. When the aggregate reaches the construction site, it must be reduced further to a usable and specified size and then put in place.*

IV. Assessment of Potential Border-Crossing Points

Although there are at present only eight routes for vehicular traffic from Communist China into Southeast Asia, the distribution and extent of road construction in the border area of China have increased substantially the number of potential links. Gaps in road terminals have been shortened to less than 50 miles along the border of Burma and along the border of North Vietnam as far east as about the 105th meridian.** Should the Chinese Communists undertake to extend their road system across the border, there are seven road gaps that they would be most likely to close. All but one of these links could be constructed fairly quickly, especially during the dry season. Estimates of the amount of construction and the time required to close these selected road gaps are as follows:

		Construction of Road Gaps***		
Road Terminals	Road Reference Number (Appendix B)	Length of Road Gap (Miles)	Bridges to be Repaired or Constructed	Approximate Construction Time Required (Working Days†)
China-Burma				
Hpimaw-Myitkyina	31	30	7	330
T'eng-ch'ung - Myitkyina	40	40	30	60
T'eng-ch'ung -Bhamo	7, 41	17	8	45
Meng-lien - Keng Tung	14	33	12	165
China - North Vietnam				
Ban Nam Coum - Moc Chau	1	15	2	60
Wen-shan - Ha Giang	11, 47	15	1	45
Fu-ning - Ha Giang	10, 13	15	5	165

* Although a primitive type of stone crusher is used, the great majority of all stone work is done by hand.

** Roads in Yunnan run near the border of northeastern Laos, but some distance (at least 100 miles) would have to be covered to form a junction with the Meng-la - Phong Saly Road, the road farthest north in Laos.

*** Estimates of construction are for single-lane, graveled roads that can support 100 vehicles (300 tons) each way per day and that allow for limited two-way traffic. A single-lane road has a lane width of at least 10 feet (8 feet plus clearances) and a surface width of about 23 feet (one lane plus shoulders).

† A working day is of 10 hours duration. The size of the work force is sufficient to accomplish the work in the estimated time, using construction methods common to Asia.

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The first four of the above roads would link the main road system of Yunnan with the Mandalay-Putao and the Meiktila-Tachilek Roads in Burma. Of these, the first three would provide alternate routes to the Burma Road and would serve at least to secure the Myitkyina and Bhamo areas, including the railhead at Myitkyina. The fourth connection, which involves the improvement of a well-defined trail, would secure the area of Keng Tung and would give additional access (southward) to Laos and Thailand as well as (westward) to central Burma.*

Improvement of the short trail sections on the remaining three routes not only would provide additional motorable links between the main road systems of Communist China and North Vietnam but also would establish direct connections with Yunnan, where none exists at present. In addition, improvement of the section south of Ban Nam Coum would give direct access to northern Laos through northwestern North Vietnam.

* The other road in this area, which connects with a main road in Yunnan, is the Keng Tung - Mong La Road (see road study no. 14, Appendix B). Further improvement of this road would require about 6 months (or 165 working days).

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APPENDIX A

PLACE NAME LIST

Name	Coordinates	Road Reference Numbers*
Atunze, see Te-ch'in		
Bac Quang	22°29' N - 104°52' E	19, 46
Ban Koa	22°45' N - 104°43' E	46
Ban Nam Coum	22°36' N - 103°10' E	1, 15, 20
Ban Sop Bau	20°43' N - 104°23' E	36
Bao Lac	22°57' N - 105°40' E	2
Bawdwin	23°06' N - 97°18' E	16
Bhamo	24°16' N - 97°14' E	7, 21, 41
Cao Bang	22°40' N - 106°15' E	2, 3, 4, 5, 30
Chan-chiang	21°12' N - 110°23' E	26
Chan-ta, see Lien-shan		
Ch'e-li	21°59' N - 100°49' E	6, 17
Chen-k'ang	24°07' N - 99°25' E	48
Ch'eng-lung-chieh	24°45' N - 98°06' E	7, 41
Chen-pien, see Mu-pien		
Chen-pien	22°37' N - 99°59' E	38
Chen-yuan	23°51' N - 100°57' E	12
Chiang-ch'eng	22°35' N - 101°50' E	8, 39
Chi-chieh	23°30' N - 103°09' E	8
Chien-ch'uan	26°28' N - 99°52' E	35
Chien-shui	23°37' N - 102°49' E	8, 25, 39
Ching-hsi	23°08' N - 106°25' E	3, 4, 30, 43
Ching-ku	23°28' N - 100°42' E	9, 12
Chin-p'ing	22°46' N - 103°15' E	15, 25
Chung-tien	27°50' N - 99°36' E	50
Dien Bien Phu	21°23' N - 103°01' E	44
Dong Dang	21°57' N - 106°42' E	43
Dong Gach	22°50' N - 106°20' E	3, 5
Dong Khe	22°26' N - 106°27' E	43
Dong Van	23°16' N - 105°22' E	10, 11, 13
En-lo, see Chen-yuan		
Fo-hai, see Meng-hai		
Fort Bayard, see Chan-chiang		
Fu-ning	23°37' N - 105°36' E	10, 13

* Road reference numbers are keyed to the road studies in Appendix B and are shown schematically on the map, Figure 2, inside back cover.

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Name	Coordinates	Road Reference Numbers
Ha Giang	22°50' N - 104°59' E	2, 10, 11, 13, 47
Hanoi	21°02' N - 105°50' E	1, 11, 37
Hoi Xuan	20°22' N - 105°07' E	37
Hon Gai	20°57' N - 107°05' E	26
Ho Tsai Trai	22°24' N - 104°13' E	19
Houei Sai	20°18' N - 100°26' E	33
Houei Yeui	21°11' N - 102°49' E	44
Hpimaw	26°02' N - 98°37' E	31
Hsenwi	23°18' N - 97°58' E	16
Hsia-kuan	25°34' N - 100°14' E	50
Hsiang-yun	25°29' N - 100°35' E	9, 12
Hsi-meng	22°43' N - 99°26' E	38
Hsiao-wei-hsi	27°29' N - 99°01' E	50
Hwang Luk	20°29' N - 99°56' E	
K'ai-yuan	23°42' N - 103°14' E	8, 13, 30
Kawpa-ta	20°50' N - 100°03' E	38
Keng Lap	20°51' N - 100°31' E	28
Keng Tung	21°17' N - 99°36' E	14, 22
Ko-chiu	23°23' N - 103°09' E	15, 25
Kuei-yang	26°35' N - 106°43' E	
Kunlong	23°25' N - 98°39' E	16
K'un-ming	25°04' N - 102°41' E	8, 17, 18, 34
Lai Chau	22°02' N - 103°10' E	1
Lang Son	21°50' N - 106°44' E	26
Lan-ts'ang, see Chen-pien		
Lao-chang	22°45' N - 99°45' E	38
Lao Kay	22°30' N - 103°57' E	1, 15, 19, 20
Lashio	22°56' N - 97°45' E	16
Laukhaung	25°54' N - 98°11' E	31
Li-chiang	26°48' N - 100°16' E	50
Lien-shan	24°48' N - 97°54' E	7, 41
Lin-ts'ang	23°54' N - 100°02' E	9, 12
Lung-ching	22°24' N - 106°50' E	43
Lung-ling	24°35' N - 98°41' E	42
Ma-kuan	23°02' N - 104°24' E	46, 47
Mandalay	22°00' N - 96°05' E	16, 21
Mang-shih	24°27' N - 98°36' E	18
Man-hao	23°00' N - 103°23' E	15
Man-kaung	21°54' N - 100°15' E	38
Man-pien	22°28' N - 101°32' E	39
Meiktila	20°52' N - 95°52' E	14, 22, 27, 28
Mein-ning, see Lin-ts'ang		
Meng-hai	21°58' N - 100°28' E	38
Meng-hun	21°50' N - 100°23' E	17

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Name	Coordinates	Road Reference Numbers
Meng-la	21°28' N - 101°35' E	23, 24
Meng-lang, see Chen-pien		
Meng-lien	22°21' N - 99°36' E	14, 38
Meng-lung	21°47' N - 100°27' E	6
Meng-mang	21°18' N - 101°18' E	23
Meng-p'eng	24°05' N - 98°59' E	23
Meng-sung	23°21' N - 99°26' E	34
Meng-sung-a-k'a	21°29' N - 100°31' E	6
Meng-ting	23°33' N - 99°05' E	16, 34, 48
Meng-tung, see Ts'ang-yuan		
Meng-tzu	23°22' N - 103°24' E	25
Mien-ning, see Lin-ts'ang		
Moc Chau	20°50' N - 104°38' E	1, 20, 36, 37
Mong Cai	21°32' N - 107°58' E	26
Mong Hpayak	20°53' N - 99°56' E	27
Mong La	21°41' N - 100°02' E	14
Mong Lin	20°44' N - 100°09' E	28
Mong Yang	21°50' N - 99°41' E	14, 38
Mong Yawng	21°11' N - 100°22' E	6, 27
Mong Yu	21°20' N - 100°33' E	27
Mong Yu	23°58' N - 97°59' E	21
Muong Sing	21°11' N - 101°09' E	23, 24, 28, 29
Mu-pien	23°23' N - 105°48' E	5, 30
Myitkyina	25°23' N - 97°24' E	21, 31, 32, 40
Na-fa-tui-hsun	22°37' N - 103°07' E	15
Na Khan	22°47' N - 106°10' E	5
Nam Tha (Muong Luong Nam Tha)	20°57' N - 101°25' E	29, 33
Nan-chiao	22°02' N - 100°15' E	38
Nan-chien	25°04' N - 100°37' E	12, 34
Nan-ning	22°49' N - 108°19' E	
Nguyen Binh	22°39' N - 105°56' E	2
Ning-erh, see P'u-erh		
Pac Muong	22°56' N - 106°32' E	4
Pai-se	23°54' N - 106°37' E	13, 30
Pangsau Pass	27°14' N - 96°10' E	32
Pao-shan	25°07' N - 99°09' E	18, 41, 42, 49
Pa Tan	22°28' N - 103°11' E	20
Phong Saly	21°41' N - 102°06' E	24, 44
Pi-chiang	26°33' N - 98°56' E	35, 45
P'ing-hsiang	22°06' N - 106°44' E	43
P'ing-pien	22°54' N - 103°40' E	25
P'u-erh	23°05' N - 101°03' E	9, 12, 17
Putao	27°21' N - 97°24' E	16, 21

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Name	Coordinates	Road Reference Numbers
Samneua	20°28' N - 104°02' E	36, 37
Shih-p'ing	23°43' N - 102°30' E	8
Shuang-chiang	23°28' N - 99°50' E	38
Soc Giang	22°54' N - 106°01' E	5, 30
Sop Nao	21°10' N - 102°46' E	44
Ssu-mao	22°46' N - 101°05' E	8, 39
Tachilek	20°27' N - 99°53' E	14, 22, 27, 28
Ta-kaw	21°13' N - 98°42' E	22
Ta-lo	21°41' N - 100°05' E	14, 17
Te-ch'in	28°30' N - 98°52' E	50
Te-pao	23°20' N - 106°37' E	43
T'eng-ch'ung	25°02' N - 98°28' E	7, 40, 41, 42
Than Thuy	22°55' N - 104°51' E	11
Thiet Tra	20°18' N - 105°09' E	37
Tien-pao, see Te-pao		
Tien Yen	21°20' N - 107°24' E	26
T'o-kuo-lo	26°47' N - 100°00' E	50
Ts'ang-yuan	23°09' N - 99°15' E	34
Tuan Giao	21°35' N - 103°25' E	1, 44
Wan-t'ing	24°05' N - 98°04' E	7, 18, 21
Wa-yao	25°25' N - 99°16' E	35, 45
Wen-shan	23°22' N - 104°14' E	11, 13, 46, 47
Yang-t'ou-yen	24°12' N - 99°59' E	48
Ying-chiang, see Ch'eng-lung-chieh		
Yun-hsien	24°25' N - 100°07' E	49

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APPENDIX B

ROAD STUDIES*

1. Ban Nam Coum - Moc Chau (North Vietnam) Surface: Varied
Length : 250 to 255 miles

This road extends from Ban Nam Coum on the border southward to Moc Chau, where it continues (as route 6) to Hanoi. The section from the border south to Lai Chau is a narrow, unbridged road, little more than a trail. From Lai Chau to Tuan Giao the section was once a fairly good road but has deteriorated badly, and only a few old bridges still remain. The last section, from Tuan Giao to Moc Chau, has been improved and bridged throughout. Improvement of the latter section was underway in 1957 and included widening the road (still single-lane), adding gravel to the surface, putting in concrete culverts, and replacing timber structures with bailey bridges. Repairs on the road have continued on a yearly basis. There has been some indication that reconstruction might begin shortly on the Lai Chau - Tuan Giao section simultaneously with construction of a connecting road from Lao Kay (see road study no. 20). Depending on the amount of effort expended, both of these roads could be completed in 1965-66, giving the northwestern area of North Vietnam direct access to the railroad at Lao Kay. Possibly included in this construction project is the trail section from Lai Chau to the border. Because a road in Yunnan already extends to the border (see road study no. 15), construction of this section will provide an additional route across the border from Communist China into the main road system (route 6) of North Vietnam and, also, an access route into northern Laos. This road passes through mountainous terrain and has steep grades and hairpin turns. The best period for road construction is November through March, when the ground is dry.** In the area of Ban Nam Coum, however, there are marshes and swamps and the ground is dry for only 3 months (January-March); during the remainder of the year it is wet and flooded.

Burma Road (see road study no. 18)

2. Cao Bang - Bao Lac (North Vietnam) Surface: Partly graveled
Length : 65 to 70 miles

The road running west and north toward the border from Cao Bang to Bao Lac (via Nguyen Binh) was reconstructed after the French-Indochina War.

* The roads described in this Appendix are shown schematically in the map, Figure 2, inside back cover.

** The terms dry and wet as used in this publication describe the state of the ground from the surface to a depth of at least 3 inches. The ground is dry when the pore space is essentially free of water and wet when it is almost or completely filled with water.

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Beyond Bao Lac the road has been extended for about 25 miles and runs westward toward Ha Giang rather than north toward the border. There is no indication that construction is continuing to Ha Giang. Other new construction on the road is a cutoff west of Nguyen Binh. This new section connects the Cao Bang - Bao Lac Road to an old repaired road that runs southwest from Nguyen Binh and joins with the main road (route 3) from Cao Bang farther to the south. The ground is dry for a slightly longer period in this area, but the terrain causes road alignments to be steep and winding and confined to following river valleys. Cao Bang itself, however, is situated in a small area of rolling plains.

3. Cao Bang - Dong Gach (North Vietnam) Surface: Partly graveled
Length : 25 to 35 miles

A potential access road from Cao Bang across the border to Ching-hsi in Kwangsi Province is the one via Dong Gach. It was initially constructed in 1953-54 as a dry-weather road, but sections of the road within Kwangsi have deteriorated from lack of maintenance. In North Vietnam it has been reconstructed but is in poor condition and requires constant repair. The road apparently is suitable only for local traffic up to the border. It is a steep winding mountain road and passes through an area where the ground is dry for most of the period from November through March.

4. Cao Bang - Pac Muong (North Vietnam) Surface: Graveled
Length : 45 to 50 miles

This road, one of several radiating from Cao Bang to the border, is the one probably used as the main through route between Communist China and North Vietnam. The road runs from Cao Bang across the border (at Pac Muong) through Kwangsi Province to Ching-hsi and is the only one in this area of the border that links the main road systems of Communist China and North Vietnam. Initially constructed in the 1940's and reconstructed in 1953-54, it was repaired in the early 1960's on both sides of the border. The road requires constant maintenance and repair because it winds through a mountainous area where the ground is wet from mid-April to about mid-October.

5. Cao Bang - Soc Giang (North Vietnam) Surface: Partly graveled
Length : 25 to 30 miles

This road extends through Soc Giang to the border of North Vietnam but does not cross it. It has had some repairs, and two new cutoffs have been constructed, which provide alternate routes from Cao Bang through Soc Giang to the border. One of these new roads branches from the main road between Na Khan and Soc Giang and extends north to Soc Giang paralleling the main road. The northern half of the new road has not been completed and is only a jeepable trail. Northeast of Soc Giang a local road in poor condition terminates just short of the border opposite a road from Mu-pien in Kwangsi Province (see road study no. 30). Another

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new road bypasses Cao Bang to the north and connects the road to Soc Giang with the Cao Bang - Dong Gach Road. All of the roads have the same soil and terrain conditions as other roads in this area (see road studies nos. 2, 3, and 4). Maintenance of these roads is sporadic, and extensive repairs usually are needed after each rainy season to make them passable.

6. Ch'e-li - Meng-sung-a-k'a (Yunnan) Surface: Natural earth
Length : 50 to 60 miles

Construction of this road, which extends directly south from Ch'e-li toward the border and terminates opposite Mong Yawng (Burma), apparently was started after 1957 but had been surveyed before that time. By the end of 1961, it had been completed as far as Meng-lung and was extended to Meng-sung-a-k'a by 1963-64. There is no indication that the road is being extended across the border. The road reportedly is in very poor condition and, although short stretches have been covered with gravel, it is impassable during the monsoon season. The road passes through an area that is seldom dry except during November through February and because the area is mountainous the road is restricted to following river valleys and, therefore, subject to inundation.

7. Ch'eng-lung-chieh - Wan-t'ing (Yunnan) Surface: Partly graveled
Length : 85 to 95 miles

This road is a continuation of an old realigned and reconstructed section of the T'eng-ch'ung - Lien-shan Road (see road study no. 41). It continues west of Ch'eng-lung-chieh and turns south near the border a few miles east of where the old road (now a trail) connecting T'eng-ch'ung and Bhamo continued across the border. From this point, it runs south roughly paralleling the border and connects with the Burma Road at Wan-t'ing. Reports of dates for construction of this road are ambiguous, but it probably was completed by the end of 1957. The following year improvements, consisting of adding gravel or stone to the surface of some sections, were started and have continued through 1964. In this area the alignment is confined to following river valleys through the mountainous terrain. The area is wet during most of the year, except from November through February, and much damage is caused by landslides and washouts caused by heavy rains.

8. Chien-shui - Border (Yunnan) Surface: Partly graveled
Length : 80 to 95 miles

An improved road runs south from Chien-shui to a point about 30 air miles from the border with North Vietnam. From this point a natural earth road swings westward and continues for about 30 to 35 miles, where construction has stopped. The road was officially announced as open to traffic in April 1964, and construction probably has been underway since 1960. Eventually it probably will connect with the Ssu-mao - Chiang-ch'eng Road (see road study no. 39) and will form a new lateral route close to the borders of both North Vietnam and Laos. Chien-shui is connected to

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the main network by improved roads. One of these, which was in very poor condition in 1956, runs west via Shih-p'ing and connects with the K'un-lo Trunk Road (see road study no. 17). This west road plus another extending from Chien-shui southeast to Chi-chieh and then north to K'ai-yuan forms the main link with the K'ai-yuan - Pai-se Road (see road study no. 13), which creates a direct southern route between western Kwangsi and central Yunnan and bypasses K'un-ming. There is a shorter, more direct route that runs northeast from Chien-shui to K'ai-yuan, but this road has not been improved and probably is in poor condition. In the area of the southernmost and western sections of the Chien-shui - Border Road the ground is never completely dry and is wettest from about March to mid-October. Along the northern section of the road and around the area of Chien-shui, the ground is dry from December through April but can be very wet from May through September. Both of these moisture conditions also are found along the roads to Shih-p'ing and K'ai-yuan. The terrain in this area varies from dissected plains, hills, and mountains in the northern part to mountainous terrain farther south.

9. Ching-ku - Lin-ts'ang (Yunnan) Surface: Probably natural earth
Length : 60 to 70 miles

This road connects two main north-south routes by branching west from the Hsiang-yun - P'u-erh Road to a point on the Nan-ta Road (see road study no. 34) south of Lin-ts'ang (Mien-ning). A regular bus service from P'u-erh to Lin-ts'ang reportedly was running over this road by the end of 1958, indicating that construction was started about 1956-57. The road passes through varied terrain composed of mountains, hills, and plains. The ground in this area is dry much of the year but is very wet during July and through October.

10. Ha Giang - Dong Van (North Vietnam) Surface: Partly graveled
Length : 100 to 125 miles

This new road was completed after 4 years of construction. According to the North Vietnamese press of October 1963, assistance in planning and construction of the road was provided by the Chinese Communists. The road was reported to have an average of three bridges per mile of road and to be surfaced with gravel and stone for about three-fourths of its length. The road stops short of the border, but it is one of the convenient points along the border where a connection with the border road from Fu-ning in Kwangsi Province could be made (see road study no. 13). This road winds through mountainous terrain and follows river valleys. In this area the ground is dry during November-December, increases in wetness in April, and remains wet into October.

11. Ha Giang - Than Thuy (North Vietnam) Surface: Partly graveled
Length : 15 to 20 miles

This is the northernmost section of a main road (route 2) in North Vietnam. (The route south of Ha Giang to Hanoi is a reconstructed road

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some sections of which have a gravel surface.) It has not been improved and becomes a trail before it crosses the border into Yunnan. This section was part of a road hastily constructed in 1953-54 from Wen-shan to Ha Giang for use as a supply route during the French-Indochina war (see road study no. 47). The trail section within North Vietnam is less than 5 air miles in length and is one of the most likely points along the border where a connection might be reconstructed. The terrain and moisture conditions of the ground in this area are similar to those of the Ha Giang - Dong Van road (see road study no. 10).

12. Hsiang-yun - P'u-erh (Yunnan) Surface: Graveled
Length : 200 to 250 miles

This main north-south soute connects the Burma Road at Hsiang-yun with the K'un-lo Road at P'u-erh. The northern section of the road, between Hsiang-yun and Nan-chien, links the Nan-ta Road to the Burma Road (see road study no. 34). The road is single-lane (with shoulders) and generally is 23 feet wide throughout. Although it reportedly is an all-weather road, some sections are dangerous in wet weather. Construction started in 1951-52 and was completed between 1955 and 1957. Most of the terrain along the road consists of mountains, high hills, and dissected plains. Two sections of the road, however, pass through rugged terrain very similar to that of northwestern Yunnan. These sections are located from the area of Nan-chien to the vicinity of Chen-yuan (En-lo) and just to the north of P'u-erh. Moisture conditions of the ground are similar to those of the Ching-ku - Lin-ts'ang Road (see road study no. 9) except in the rugged terrain areas, where wetness persists for a longer period during the year.

13. K'ai-yuan - Pai-se (Yunnan-Kwangsi) Surface: Graveled
Length : 280 to 300 miles

Running at a distance of 20 to 50 miles from the border of North Vietnam, this main road, which is connected to the Kun-lo Road west of K'ai-yuan, greatly shortens the distance between western Kwangsi and central Yunnan (see road study no. 8). Construction on this road, which started in the early 1950's, was completed in 1955-56, but it probably was not entirely surfaced until after 1958-59. Two roads extending from it toward the border converge at Wen-shan (see road studies nos. 46 and 47). A third road runs south from Fu-ning for a distance of 20 to 25 miles and terminates near the border opposite Dong Van in North Vietnam. The gap from the end of the road to Dong Van is less than 10 air miles, but the trail distance probably is about 15 miles. Converting this trail section into a road would provide a connection from the K'ai-yuan - Pai-se Road into the main road network of North Vietnam via Ha Giang (see road study no. 11). The K'ai-yuan - Pai-se Road passes through an area of dissected plains, hills, and mountains where its alignment is restricted in some places to river valleys. The ground in this area is predominantly dry from December through April but is frequently wet from that time into October.

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14. Keng Tung - Mong Yang - Mong La (Burma) Surface: Varied
Length : Varied

Two roads branch off the Meiktila-Tachilek Road at Keng Tung and extend toward the border with Communist China. The road which extends 50 to 60 miles northward to Mong Yang is narrow and winding. Initially constructed by Thai troops during World War II, the Burmese have continued to improve this old road, especially since 1960-61, by adding gravel to some of the sections and by repair and construction of bridges. Beyond Mong Yang, two well-defined trails continue northward through Burma and across the border of Communist China to Meng-lien (see road study no. 38). From Keng Tung the other road extends 40 to 45 miles northeast toward Ta-lo in Yunnan via Mong La, a town located in Burma near the border (see road study no. 17). Except for sections near Keng Tung and Mong La, it has been a narrow natural earth road, little more than a trail and not passable for vehicles. According to a press report of November, the Burmese planned to improve but not to surface the trail section immediately. Reports on improvements are ambiguous, but there are good indications that construction has been started and that the road should have been passable for vehicles by February 1965. Further improvements of this road would require about 6 months. Except for the small plains on which Mong Yang and Keng Tung are located the terrain in this area is mountainous, and roads are confined to river valleys and ridges. The plains are wet or flooded from May through October, and the slow-drying ground of the uplands is wet from May through September.

15. Ko-chiu - Chin-p'ing - Border (Yunnan) Surface: Partly graveled
Length : 65 to 75 miles

This road runs from Ko-chiu through Chin-p'ing to Ban Nam Coum on the border of North Vietnam a distance of 65 to 75 miles. The road was completed as far south as Chin-p'ing by 1957 and to the border by 1963. Also completed by 1963-64 are the piers and abutments of a large bridge over the Red River at Man-hao that has been under construction since about 1960-61. Most of the unfordable streams throughout the entire length of the road are bridged. Ferries are needed to cross the Hung Ho at Man-hao and the river near the border at Na-fa-tui-hsun where another bridge is believed to have been under construction for some time. Construction apparently has been abandoned on a branch road running southwest from Man-hao along the river toward Lao Kay after it was completed for a short distance. The terrain through which the road passes is generally mountainous, but there are some plains and hills. The ground in this area, never completely dry, is driest from December through February and wettest from March into October.

K'un-lo Road (see road study no. 17)

16. Kunlong-Hsenwi (Burma) Surface: Graveled
Length : 52 miles

This road was constructed before 1940 along the alignment of an ancient route used by the Chinese for carting lead and silver ores from

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the Bawdwin mines into China. The road, which is in fair condition, branches to the east from Hsenwi, a town on the Mandalay-Putao Road about 32 miles north of Lashio. Kunlong is reached by ferry across the Salween River. East of Kunlong the road is no more than a jeepable trail that continues across the border into Yunnan to a point just west of Meng-ting. Between the Salween River and the border a natural earth road, which was under construction in 1957, runs east and north from Kunlong. Kunlong is the site of the suspension bridge over the Salween River that is to be constructed by Communist China. Preliminary construction started in May 1964, and by late June some 62 Chinese Communist technicians and engineers had arrived at the site. By November 1964, construction had not progressed much beyond the initial stages of building a construction camp and storage facilities. According to a press release of 27 January 1965, construction of the bridge has been rescheduled for completion in 1966-67 from the original completion date of June 1965. The best construction season in this area is October into May, when the ground is dry.

17. K'un-ming - Ta-lo (Yunnan) Surface: Graveled
Length : 850 to 900 miles

Designated as a military highway by the Chinese Communists, this road is called the K'un-lo Road and is sometimes referred to as the South Burma Road. The road is single-lane, from 23 to 26 feet wide including shoulders, and is well maintained. The road reportedly was designed with a maximum loadbearing capacity of 50 metric tons and the bridges with a capacity of 15 metric tons. Construction was started in late 1951 and completed to Ta-lo by 1957. Originally the road was constructed of natural earth, and improvements were begun about 1953 on some of the completed sections. The road was surfaced with gravel or stone throughout most of its length by the end of 1957, and many sections have been and are continuing to be realigned and reconstructed to provide better gradients. The section nearest the border, from the vicinity of Meng-hun through Ta-lo, probably is the least improved. Reportedly, there are only temporary wooden bridges on this section. Along the entire road, however, both repair of existing briges and building of new ones is continuing. One of the largest of these, which will replace a ferry, is a 10-span, reinforced concrete structure some 340 to 395 meters (1,115 to 1,300 feet) long over the Mekong River about 3 miles west-northwest of Ch'e-li. Construction of the bridge, which was resumed in May 1964, is completed except for the approach roads and finishing work and reportedly was to be officially opened to traffic in January 1965. The terrain over which the road passes is mountainous and interspersed with plains, especially in the area between P'u-erh and Ta-lo. Along the latter section the ground is never as dry as it is along the remainder of the road from December through April. Over the entire alignment the ground is wettest in the period from early May through early October.

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18. K'un-ming - Wan-t'ing (Yunnan) Surface: Graveled
Length : 500 to 600 miles

Since it was initially completed 20 years ago, the Burma Road has undergone constant improvement, repair, and realignment of sections which makes the exact length difficult to determine. It is a two-lane road (averaging 30 feet in width) with a gravel surface, except for a bituminous-treated section west of K'un-ming. It is the only two-lane road that extends to the border of Southeast Asia from Communist China. Since the mid-1950's, there have been rumors of discussions and agreements between Burma and Communist China about "opening" the Burma Road. Sections on both sides of the border were in need of repair, however, before the road could be opened to traffic. In 1963-64, there was evidence that local traffic was moving back and forth across the border, implying that those sections of the road had been repaired. This and other evidence indicates that traffic from Yunnan to the main highway system of Burma is now possible. The road passes through difficult terrain, especially southwest of Pao-shan where the terrain is similar to that found in northwestern Yunnan. Except for the section west of Mang-shih to the border, which is never very dry, the ground along the road is mostly dry from early December through April and wet from early May into October.

Ledo Road (see road study no. 32)

19. Lao Kay - Bac Quang (North Vietnam) Surface: Partly graveled
Length : 70 to 75 miles

At one time there was a road between Lao Kay and Bac Quang, but two-thirds of it has deteriorated into a trail. The 25-mile section from Lao Kay to Ho Tsao Trai was reconstructed by 1960. Nothing has been done to the 50-mile eastern section where the bridges are lacking, which, for all practical purposes, makes it unusable. Although a system of roads exists around the Lao Kay area, none of them is connected with the main roads. Most of these roads are natural earth roads which were repaired after 1954 and which are maintained only to the extent necessary to support local traffic. The terrain and moisture conditions of the ground are very similar to those associated with roads radiating from Cao Bang (see road studies 2, 3, and 4).

20. Lao Kay - Pa Tan (North Vietnam) Surface: Natural earth
Length : 70 to 80 miles

Construction of this road has been underway since 1959. At the end of the dry season in 1963 the road had been completed for a distance of about 30 miles west of Lao Kay. A 20-mile jeepable section also had been completed eastward from Pa Tan toward Lao Kay, but the middle section still remains little more than a well-defined trail. Because Pa Tan is located on the Ban Nam Coum - Moc Chau Road (see road study no. 1), completion of this road together with the northern sections of the Ban Nam Coum - Moc Chau Road will provide a direct route into northeastern North Vietnam from the railroad at Lao Kay. The terrain west of

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Lao Kay is mountainous, but it is dryer for a longer period (November into April) than for most of the area to the east where it becomes increasingly wet after March.

21. Mandalay-Putao (Burma) Surface: Varied by section
Length : 708 miles

This is the main trunk road (route 3) in Burma that links the central valley with the far northern part of the country via the Northern Shan and Kachin border states. It is the only main road in Burma that is connected directly with the main road system of Communist China. The connection is made by a secondary road, once a section of the old Burma Road, which branches from the Mandalay-Putao Road at Mong Yu and runs northeast to Wan-t'ing in Yunnan Province (see road study no. 18). For a distance of about 380 miles from Mandalay to just beyond Bhamo the road has a bituminous-treated surface that was applied in World War II. It was reported in 1962 to be in generally good condition, although the edges were eroded and the shoulders washed out in the hill sections. During 1962-63 about 125 additional miles, including a 25-mile section north of Myitkyina, reportedly were tarred. Beyond that point to Putao it is a natural earth road passable only in the dry season, although some sections have been surfaced with gravel or stone. Even though the road has been repaired recently, it is doubtful that it is in better than fair condition throughout most of its length. Not only has annual maintenance and repair been hindered by the presence of insurgent forces, but also they are reported to have severely damaged several sections. The moisture conditions of the ground along most of the road are similar to those in the Eastern Shan State (see road studies nos. 14, 22, 27, and 28). From the area of Bhamo to the area of Myitkyina, however, the land is wet or flooded from mid-May into November. The center of the plain on which Putao is located also is subject to flooding at that time of year.

22. Meiktila-Tachilek (Burma) Surface: Varied by section
Length : 499 miles

A trunk road (route 4) extends east from the central region of Burma into the Eastern Shan State to Keng Tung where it turns south to the Thai border. From Meiktila for a distance of about 175 miles the road has an old bituminous-treated surface that has eroded edges and washed-out shoulders; beyond this point the road is narrower and has a graveled surface. Although it has been repaired annually since 1962, it is in generally poor condition and requires almost constant maintenance to keep it trafficable. South of Keng Tung all the way to the border the road is very narrow and has many sharp turns. Along the Keng Tung - Tachilek section, four roads branch north and east toward the borders of Communist China and Laos (see road studies nos. 14, 27, and 28). Ta-kaw, which is about 113 miles west of Keng Tung, is the site of the suspension bridge to be constructed by the Chinese Communists across the Salween River.

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According to a press report of 27 January 1965, construction of the bridge is scheduled to start in 1966-67. On the Shan Plateau the road generally follows river courses through hilly terrain, but it does cross two fairly high mountain ridges. Along most of the length of the road the ground is wet from April through October. The southernmost section near the Thai border and the sections around Keng Tung pass through plains that are wet or flooded in the period May through October.

23. Meng-la - Meng-p'eng - Meng-mang (Yunnan) Surface: Graveled
Length : 25 to 30 miles

A road that was completed before 1957 runs west and southwest from Meng-la across southern Yunnan to Muong Sing in Laos. As a continuation of the improvement on the road to Meng-la in Yunnan in 1958-59 (see road study no. 24), it was widened and graveled probably as far as the junction of the roads to Meng-p'eng and Meng-mang (21°25' N - 101°23' E). Conversion of the trail, which runs south of Meng-mang to the border, into a road for vehicular traffic by adding gravel or stone to the surface reportedly continued after 1959, but the project was suspended and the road was allowed to deteriorate into a trail. It was not until after mid-November 1964 that construction was resumed, and by the end of the year a road was completed connecting Meng-mang with the border and on across the border to Muong Sing. The road is a single-lane, unbridged, natural earth road, probably surfaced in the worst spots, and usable by 4-wheel-drive vehicles. The terrain in this area is a mixture of mountains, hills, and scattered plains. The ground is never completely dry and is the wettest starting in early March and continuing into October.

24. Meng-la - Phong Saly (Yunnan-Laos) Surface: Graveled
Length : 185 to 200 miles

By January 1962, when the agreement for construction of this road was officially announced, it is believed not only that the Chinese Communists had completed the survey but also that construction probably had begun on the section in Laos. The section in Yunnan from the K'un-lo road to Meng-la (100 to 115 miles) was completed in 1955-56. At that time, it was a narrow earth road incompletely bridged. Graveling and widening of the road to its present width (single-lane plus shoulders) was started in 1958-59, and additional improvements including construction of reinforced concrete bridges continued through 1963. Construction and improvement of the section from Meng-la to the border, which is the first section of the Meng-la - Phong Saly Road, also was underway in 1958-59. From the border the road was built along the alignment of old trails and was continued beyond Phong Saly to the river. Although the road reportedly was designed with a load-bearing capacity of 60 tons, it was constructed with a substandard foundation and a minimum of bridging and drainage. Since its completion in May 1963, it has suffered severe damage from heavy rains and flooding and has required constant repairs to keep it trafficable. This road, however, together with the one to Muong Sing, is the only new road constructed across the border from

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Communist China in 10 years (see road study no. 23). Except for a few stretches of flat land in Yunnan, the road for most of its length is steep and winding, especially through Laos. The ground in the area is seldom dry and is wettest in the period March through October. The section in Laos varies somewhat from Yunnan in that the ground becomes wetter a month later (in April) and can be fairly dry during November-December.

25. Meng-tzu - P'ing-pien (Yunnan) Surface: Natural earth
Length : 30 to 40 miles

Little information is available on construction of this road, but it probably is intended for local traffic, although it does not extend all the way to P'ing-pien. It has been improved for about 15 to 20 miles south of Meng-tzu, but there is no evidence that construction is continuing. The alignment roughly follows a road constructed from Meng-tzu into North Vietnam in 1953-54 and a road that was constructed during World War II to supplement rail traffic on the railroad between Yunnan and North Vietnam. The terrain and moisture conditions of the ground along the road are similar to those in the area of the road from Chien-shui to the border and from Ko-chiu to Chin-p'ing (see road studies no. 8 and 15).

26. Mong Cai - Tien Yen (North Vietnam) Surface: Graveled
Length : 45 to 50 miles

This coastal road (route 4) in North Vietnam connects with a road in Kwangtung Province that runs to Chan-chiang (Fort Bayard). In North Vietnam the road was opened to traffic in 1950 and was improved for through traffic with Communist China when the bridge at Mong Cai was completed in 1958. At Tien Yen the main road turns west and continues to Lang Son, and another road continues south to the port of Hon Gai. Both these roads are reported to be in poor condition. The Mong Cai - Tien Yen Road passes through an area of rolling plains situated between high mountains, and west of Tien Yen it becomes a mountain road. The ground in the area is driest during November-December and wettest from May through September.

27. Mong-Hpayak - Mong Yawng - Mong Yu (Burma) Surface: Varied by section
Length : 60 to 65 miles

From Mong Hpayak on the main Meiktila-Tachilek Road, this road runs eastward through Mong Yawng to Mong Yu. From Mong Yu a trail continues through Burma and across the border into Communist China. The road is surfaced with gravel probably as far as Mong Yawng (47 miles) but continues as a natural earth road to Mong Yu. The Burmese initially opened this road to vehicular traffic in 1962, at which time it was narrow and unsurfaced. Since then they have widened and surfaced it, although it still is single-lane. Further improvements on the section to Mong Yawng are continuing, and it is believed that the Mong Yawng - Mong Yu section also

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will be improved. Except for the plain on which Mong Yawng is located the terrain is mountainous and hilly, and the road follows river valleys and clings to ridges. The area is wettest from late May to October, but the plain can be wet or flooded all of May through all of October.

28. Mong Lin - Keng Lap - Muong Sing (Burma-Laos) Surface: Natural earth
Length : 90 to 100 miles

Closely paralleling the Mekong River, a road-trail runs northeastward from the Meiktila-Tachilek Road through Keng Lap to Muong Sing in Laos. There is no bridge where the route crosses the Mekong River, but traffic can be ferried across the river. Reports on this road within Burma are conflicting, but apparently the Burmese had made some repairs to the road and bridges and had opened it to traffic by late 1963. Improvement of the road is continuing and some sections are being surfaced with gravel. Within Laos a jeepable trail continues from the river to Muong Sing. In 1963-64 the trail was improved to some extent but only in the vicinity of Muong Sing. The terrain on both sides of the border is mountainous, and the ground has the same seasonal moisture conditions -- that is, driest in November-December and wettest from May through September.

29. Muong Sing - Nam Tha (Laos) Surface: Natural earth
Length : 30 to 35 miles

During the period 1961-64, there were numerous reports that this road was under construction. Probably it was not until 1963-64 that it became usable by 4-wheel-drive vehicles. It is still a narrow, unsurfaced, and unbridged road passable only in dry weather and subject to extensive repair after each rainy season. Repairs have been carried out for a short distance on trails extending north and south of Nam Tha, but there is no indication that further work is underway. All of the old roads that connected Nam Tha to the other areas of Laos have deteriorated into trails. The area is mountainous causing the roads and trails to follow water courses or ridges. The ground in the area is driest in November-December and wettest from May through September.

30. Mu-pien - Ching-hsi (Kwangsi) Surface: Partly graveled
Length : 40 to 45 miles

This road was constructed initially in the early 1950's and reconstructed about 1961. Although there is some evidence that a road once ran from Mu-pien north to the Kai-yuan - Pai-se Road, this connection no longer exists. Another road was constructed southeast from Mu-pien to the border of North Vietnam opposite Soc Giang (see road study no. 5). The condition of sections of the roads varies from poor to good but is adequate for local traffic. Continuation of the road across the border to Soc Giang would provide an alternate route from Ching-hsi to Cao Bang and a main road (route 4) in North Vietnam. The terrain in the area is composed of dissected plains, hills, and mountains. Throughout most of the area the ground is dry from December through April. In the border

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area, however, the terrain is more rugged and the ground is never completely dry.

31. Myitkyina-Hpimaw (Burma) Surface: Natural earth
Length : 100 to 125 miles

This is an old road constructed along an old trade route before 1940. It is jeepable most of the year within a short distance of Laukhaung, and from there it is passable in dry weather only. The road ends in a trail that continues across the border to Hpimaw. The route climbs fairly rapidly from a plain through hill country to high rugged terrain. The ground in the area is wet from May through September, and snow in the mountains is not a serious problem during the winter.

32. Myitkyina - Pangsau Pass (Burma) Surface: Partly graveled
Length : 228 miles

The Ledo Road, constructed in World War II, is trafficable most of the year for a distance of about 120 miles west of Myitkyina. Beyond this point, it has not been repaired or maintained, and bridges over several rivers are out. It is possible for jeep vehicles to travel the entire route during the dry season, but the road is impassable during the monsoon season. The road passes through an area of intermontane basins and plains until it reaches the mountains in the west. These flat areas are wet or flooded from May through September.

33. Nam Tha - Houei Sai (Laos) Surface: Natural earth
Length : 95 to 100 miles

This narrow old road has deteriorated considerably. In the vicinity of Nam Tha the road was repaired in 1963-64, but only for a short distance south of the town. From Houei Sai it is possible during dry weather to travel about 30 miles, but during the rainy season the road is impassable. The road runs through mountainous terrain and follows water courses and ridges. The ground, which is wettest from May through September, is never very dry.

34. Nan-chien - Meng-ting (Yunnan) Surface: Graveled
Length : 380 to 390 miles

Designated as a military highway, this road is in good condition and is well maintained. Reportedly the road, referred to as the Nan-ta Road, was designed for a maximum load-bearing capacity of 40 metric tons and the bridges for a capacity of 15 metric tons. Beyond Meng-ting the road is in bad condition and terminates in a trail a short distance west of the town. Construction of the road started in the dry season in 1952-53 and was scheduled to be completed by 1957. Because sections of this road closely paralleled the alignment of the proposed K'un-ming - Burma rail line, those responsible for the construction of the road were cautioned not to use or damage the old abandoned railroad bed. In

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1955-56, construction also was underway on a 30-mile branch road that extended south from the vicinity of Meng-sung toward the border via Ts'ang-yuan (Meng-tung). Construction of the main road to Meng-ting apparently was completed at the end of 1956 or early 1957 and the southern branch road in 1959-60. The terrain through which this road passes is very similar to the high, rugged terrain of northwestern Yunnan. Although the easternmost section of the road is in an area where the ground is dry from December through April, most of the area is never very dry. Rains occur most frequently along the entire road in July, August, and October.

Nan-ta Road (see road study no. 34)

35. Pi-chiang - Chien-ch'uan (Yunnan) Surface: Natural earth
Length : 100 to 200 miles

This road crosses high mountain ranges and deep valleys and connects with the Wa-yao - Pi-chiang and Yunnan-Tibet Roads. Little information is available on the construction of this road, but it probably was built after 1957. Because it traverses extremely rugged terrain, it is steep and winding and undoubtedly much longer than estimated. Although the ground in this area generally is dry from November through April, it increases in wetness in the mountains starting with the spring thaw in early March and remains wet until it freezes in October-November. At lower elevations the ground is wettest from May into October, and where it is fed by melting snow it is wet for a much longer period.

36. Samneua - Moc Chau (Laos-North Vietnam) Surface: Natural earth
Length : 70 to 75 miles

The road in Laos, including several small bridges, has been improved. There is a ferry crossing at Ban Sop Bau. Across the border in North Vietnam the road is in poor condition. Repairs to the entire length of the road have been carried out yearly at least since 1960. The surface of the road, especially the section in Laos, may have been stabilized with stone or gravel. The road continues for a short distance beyond Samneua but ends in a trail. Another road that branches from this one near the border and runs for some distance along the river within Laos toward the border has not been improved. The roads in this area wind through steep mountainous terrain where the ground is wettest from May through September. For a 20-mile section within Laos from Samneua eastward, however, the ground is wet for a longer period than in the area traversed by the remainder of the road.

37. Samneua - Thiet Tra (Laos-North Vietnam) Surface: Natural earth
Length : 85 to 90 miles

During the dry seasons of 1962-63 and early 1964 the road was bridged and repairs were made to the surface, which probably is stabilized in some sections. The road is in fairly good condition and is connected with the Hanoi - Moc Chau Road (route 6) in North Vietnam by

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a road which runs north of Thiet Tra via Hoi Xuan. This latter road is in poor condition. The terrain and seasonal moisture conditions of the ground are similar to those in the area of the Samneua - Moc Chau Road (see road study no. 36).

38. Shuang-chiang - Meng-hai (Yunnan) Surface: Graveled
Length : 140 to 150 miles

This main north-south route parallels the Burma border and connects the Nan-ta Road at Shuang-chiang with the K'un-lo Road at Meng-hai. The road is in good condition and receives adequate maintenance. The road was completed in 1955-56 and was improved during 1957-58. Three roads branch westward from it toward the border. Just south of Nan-chiao a narrow road, probably graveled part way, extends toward the border opposite Mong Yang in Burma. Originally it was planned to extend this road to Kawpa-ta, but construction was either suspended or abandoned in 1961, when the road had reached Man-kaung (5 to 10 miles). Farther north a second road branches from Chen-pien (Meng-lang) for a distance of 85 to 90 miles via Meng-lien to within a short distance of the border. After it was completed in mid-1955 the road was realigned, bridges were constructed, and gravel or stone was added to the surface between 1956 and 1958. There have been reports that roads were under construction south from Meng-lien connecting it with Mong Yang in Burma, but only well-defined trails exist between these two towns. A third road branches westward (40 to 45 miles) from the main road via Lao-chang and Hsi-meng but stops short of the border. The latter road was completed in 1958-59 and reportedly is in good condition. There are indications that widening and bridging is underway on both this road and the one from Chen-pien. Both the main road and its branches generally follow river valleys through mountainous terrain. Throughout most of the area the ground is never dry, except in the northernmost section of the main road, and is most frequently wet in the period May through October.

39. Ssu-mao - Chiang-ch'eng (Yunnan) Surface: Partly graveled
Length : 60 to 70 miles

This road, which branches off of the K'un-lo Road, was completed to Chiang-ch'eng by late 1957. Improvements were made later, and the road was continued eastward as far as the Li-hsien Chiang (Black River). Eventually it probably will be extended to connect with the road running south of Chien-shui (see road study no. 8) when the bridge over the river, which has been under construction for some time, is completed. From this road a branch runs toward the border of Laos as far as Man-pien where it ends in a trail. For about 30 to 35 miles from Ssu-mao the road is fairly good, but for the remaining distance it is in poor condition. The terrain in this area is mountainous interspersed with plains and hills. Except near the Li-hsien Chiang where it is never completely dry, the ground is dry from December through April. It is wettest from May into October, and the mid-section of the road generally is wetter than the other sections of the road during the rainy season.

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40. T'eng-ch'ung - Border (Yunnan) Surface: Natural earth
Length : Varied

The Chinese Communists started construction on several roads radiating north and northwest from T'eng-ch'ung toward the border with Burma in the early 1950's. About 1957, improvement of these roads was started and continued over the next 4 or 5 years. Sections of the road near T'eng-ch'ung have been surfaced with gravel. One of these roads is a reconstructed section of the old T'eng-ch'ung cutoff that was built during World War II through rugged terrain between T'eng-ch'ung and Myitkyina in Burma. The mountainous border section of the road is no longer passable. East of Myitkyina the 10-mile section of the road in Burma has an old bituminous surface and is jeepable under all weather conditions. Except in the mountains, where the ground is wet for longer periods, the area is dry from December through April and is wettest from May through October.

41. T'eng-ch'ung - Lien-shan (Yunnan) Surface: Partly graveled
Length : 75 to 85 miles

Sometimes called the T'eng-ch'ung - Bhamo Road, this is an old road that the Chinese Communists reconstructed in 1952 and repaired in 1958. The road has been realigned and now passes through Ch'eng-lung-chieh. It is on the T'eng-ch'ung - Ch'eng-lung-chieh section that the greatest amount of improvement has been carried out. The border section of the road no longer exists, however, and the road on west of Lien-shan generally is in poor condition. The terrain and moisture conditions of the ground in this area are similar to those of the Burma Road (see road study no. 18), but because the road lies farther to the north, it escapes the particularly rugged terrain south and west of Pao-shan.

42. T'eng-ch'ung - Pao-shan - Lung-ling (Yunnan) Surface: Graveled
Length : Varied

Two roads extend south and east of T'eng-ch'ung and connect with the Burma Road at two points, Lung-ling and just south of Pao-shan. The road south to Lung-ling (40 to 45 miles) was constructed in the 1940's and reconstructed and improved during the 1950's, whereas the road east to Pao-shan (60 to 80 miles) was completed about 1955 and later improved in 1958. Both of these roads are surfaced with gravel or stone and are trafficable under all weather conditions. Except for the plain surrounding T'eng-ch'ung, these two roads pass through rugged terrain where the ground at lower elevations is dry from December through April and wettest from May into October.

43. Te-pao - Lung-ching - P'ing-hsiang (Kwangsi) Surface: Graveled
Length : 140 to 150 miles

This road parallels the northeastern border of North Vietnam and connects the main north-south road (to Ching-hsi) with other main roads in

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Kwangsi. The road probably was completed by 1957 and improved by 1963. From Lung-ching a road runs westward across the border to Dong Khe in North Vietnam and another crosses the border and connects P'ing-hsiang with Dong Dang. The gravel-surfaced branch roads into North Vietnam have been improved and are maintained sporadically. They are important supply routes into North Vietnam from Communist China and provide the main links between the system of main roads on both sides of the border. The terrain in the area is composed of dissected plains, hills, and low mountains. To the north of Lung-ching the road alignment is restricted more to river valleys than it is to the south. The ground in the area north of Lung-ching is drier than that to the south where it is never dry during the period from December through April. Throughout the area the ground is wettest from March through November.

44. Tuan Giao - Sop Nao (North Vietnam-Laos) Surface: Graveled
Length : 75 to 80 miles

This road is improved as far as Houei Yeui in Laos where it becomes a natural earth road and a trail about 6 miles beyond Sop Nao. The section from Tuan Giao to the border was widened to about 26 feet by mid-1960. Since then it has been progressively surfaced with gravel and surfacing is continuing. The road is being improved further by the construction of a bridge approximately 15 miles south of Dien Bien Phu. There is no indication, however, that the road is being extended beyond Sop Nao across northern Laos toward Phong Saly. Except for an area of rolling plains extending from just south of Dien Bien Phu to Sop Nao the terrain in this area is mountainous and steep. The ground is dry in November-December but increases in moisture in January. It is wettest from May through September but not quite as wet as areas around Tuan Giao to the north or around Samneua to the south.

45. Wa-yao - Pi-chiang (Yunnan) Surface: Graveled
Length : 125 to 130 miles

According to the provincial plans of Yunnan the road originally was scheduled for completion in 1957. It was not until early 1962, however, that it was officially announced as open to traffic. Apparently this road was surveyed and a rough alignment made before 1957, but it is doubtful that actual construction was started until 1957-58. Although it follows the Salween River valley, it traverses rugged mountainous terrain. Two large suspension bridges reportedly have been constructed, probably over the Salween River. The road is in fair condition but requires constant maintenance and repair to keep it open to traffic. Along the entire length of this road the ground tends to be wet more frequently than dry. In some areas around Pi-chiang the ground is frozen from mid-October into March and is wet the remainder of the year. In other areas it is wettest from May to about mid-October.

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46. Wen-shan - Ma-kuan - Border (Yunnan) Surface: Natural earth
Length : 50 to 60 miles

Construction of the road from Wen-shan south to the border of North Vietnam (via Ma-kuan) was completed between 1957 and 1963. The terminal of the road at the border is roughly 10 air miles from the end of a new road near Ban Koa in North Vietnam. Although these roads service the border areas within each country, a connection would provide access from Communist China to Bac Quang located on a main road (route 2) in North Vietnam. The terrain in this area is one of dissected plains, hills, and mountains. From December through April the ground is drier around Wen-shan and for a distance of 25 to 30 miles to the south than it is in the mountains, where it is never really dry. Along the entire road the area is wettest from May into October.

47. Wen-shan - Border (Yunnan) Surface: Natural earth
Length : 55 to 65 miles

The road was hastily constructed in 1953-54 to supply the North Vietnamese during the French-Indochina war. By 1962 it had been reconstructed and improved, but it is not in very good condition, especially the last 25 to 30 miles to the border, where it is barely passable. Recently construction has been underway on the southernmost section of the road, indicating that annual maintenance is being carried out. It also is possible that the trail section across the border will be improved (see road study no. 11). The terrain and moisture conditions of the ground in this area are the same as those in the area of the Wen-shan - Ma-kuan Road (see road study no. 46).

48. Yang-t'ou-yen - Chen-k'ang (Yunnan) Surface: Natural earth
Length : 80 to 85 miles

This road branches from the Nan-ta Road at Yang-t'ou-yen and continues for only a short distance beyond Chen-k'ang. Although it reportedly was opened to traffic in early 1959, construction was continuing and was scheduled to be completed by the end of that year. Apparently construction was abandoned when it reached its present terminal. The road passes through extremely rugged terrain similar to that of northwestern Yunnan. In the area between Yang-t'ou-yen and Chen-k'ang the ground is dry at lower elevations from December through April, but beyond Chen-k'ang the ground is never dry. The ground is wettest during May and through October throughout the entire area between Yang-t'ou-yen and Chen-k'ang.

49. Yun-hsien - Pao-shan (Yunnan) Surface: Natural earth
Length : 140 to 145 miles

The Chinese Communists claimed that this was a new road when it was opened to traffic in April 1964. The road, however, was initially completed about 1956-57. The central portion had a poor foundation, and

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the reconstruction and probable realignment of the damaged section prompted its designation as a new road. The road passes through fairly rugged mountainous terrain. Although the ground in this area is generally dry from December through April, the mountain sections are wet. The ground is wettest in the area from May into October.

50. Yunnan-Tibet (Yunnan) Surface: Graveled
Length : Varied

From Hsia-kuan on the Burma Road the road runs due north for a distance of 90 to 100 miles. It is a two-lane road in level areas, narrowing to a single-lane road in hilly areas. At the northern terminal, T'o-kuo-lo, roads diverge northwest to Te-ch'in (Atunze) and Chung-tien and east to Li-chiang. All of these roads are single-lane and graveled, except for the road toward Te-ch'in which is surfaced only part way. Before 1950 the Chinese Nationalists constructed a natural earth road to Li-chiang and for some distance toward Te-ch'in. The Chinese Communists started reconstruction of these roads in 1950-51 and by 1957 had completed the road to Li-chiang and had extended the one to Te-ch'in as far as Hsiao-wei-hsi, well beyond the old terminal of the road. In addition, a road had been constructed over an old trail north of T'o-kuo-lo to Chung-tien, and construction was continuing northward into Sikang, which is now part of Szechwan Province. Since that time, these roads have not been extended for any great distance beyond their 1957 terminals. Recently, the Chinese Communists announced that a steel suspension bridge had been completed over the Mekong River in Te-ch'in Tibetan Autonomous County. The new bridge, which replaces a rope-way, probably is located on the road to Te-ch'in. Its location and the fact that it was completed in 6 months indicates that it probably is a steel chain suspension bridge suitable only for pack trains. The alignment of the road to T'o-kuo-lo and from there to Li-chiang lies through a narrow area of rolling plains and hills flanked on each side by extremely rugged mountains. The ground throughout this area is dry from December through April and wet from May through October. In the mountain areas, however, the ground is always wet and is frozen and snow-covered from October to early March, when the spring thaw begins.

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APPENDIX C

TERRAIN AND CLIMATE IN THE CHINA - SOUTHEAST ASIA BORDER AREA

1. Terrain

The China - Southeast Asia border area is an integrated land mass dominated by mountains and the Yunnan plateau, which slopes downward and outward from southwestern China. The extensions of this high plateau form the mountain and plateau areas of eastern Burma, northern Laos, and northern North Vietnam. Along the entire border the terrain is rugged, averaging in elevation between 6,000 and 8,000 feet above sea level, with the most rugged section in northwestern Yunnan and the gentlest in southeastern Kwangsi.

a. Southwestern China

In northwestern Yunnan Province, there are deep parallel trenches located a few dozen miles apart that have been cut by three of the world's largest rivers, the Salween, the Mekong, and the Yangtze. South of the 26th parallel the plateau is dissected by numerous narrow malaria-ridden valleys that render road construction difficult. Farther south and east the plateau slopes gradually downward, forming the low ranges of southern Kwangsi Province. Road alignments are restricted by such terrain, generally are winding, and in many places have very short-radius curves or hairpin turns. Grades range from moderate to very steep, and the number of passing lanes is limited. Many bridges are required, and most of their approaches are difficult. Timber for bridge construction for the most part is available locally. Silty clay, which is prevalent here and usually is stony (or gravelly), provides a fair subgrade but a poor base course and a poor wearing surface because it is dusty when dry and spongy when wet. Generally throughout the area, therefore, the base course must be improved and the wearing surface stabilized. Materials for this purpose, such as sand and gravel and rock suitable for crushing, are available locally. Grading requires the movement of very large quantities of earth and rock,* but the amount of clearing and grubbing is moderate. Although natural drainage in most of the region generally is good, landslides and damage from flashfloods are common. Roads throughout the region, therefore, require an excessive amount of construction, and adequate maintenance is essential.

b. Burma

Burma is naturally isolated by a great horseshoe shaped barrier composed of mountains, escarpments, and difficult hill country. The

* In the rugged area of northwestern Yunnan, construction involves excessive and difficult rock excavation, necessitating much drilling and blasting.

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western mountain ranges arc to the northeast and merge with the higher eastward extension of the Himalayan ranges, forming the northern border of Burma with India and Tibet. In this area, very few roads are passable through the extremely rugged terrain. From Putao southward to Myitkyina, alignments are restricted to valleys and passes through the hills and mountains. Around Putao and between Myitkyina and Bhamo, there are areas of intermontane basins and relatively flat upland plains. Road alignments through this type of terrain generally are unrestricted except for isolated hills and swamps and numerous streams. Throughout most of the border areas the soils are fairly well suited for foundations and fills but poorly suited for base course or wearing surface. In the hills and mountains, and to some extent in the basins and plains, sand, gravel, and hard rock for crushing are abundant locally. In the mountain area, extensive clearing and grubbing of thick jungle are required, with little to none required elsewhere.

The eastern part of the country, or the Shan plateau as it is called in Burma, averages about 3,000 feet in elevation and is well defined along its western edge, where it rises abruptly from the central basin and the Irrawaddy River Valley. The Salween River flows through the plateau, where its rapid current has cut a deep trench, creating a barrier between the eastern border area and central Burma. Terrain conditions in the Shan States are similar to those of northern Burma, except that there are no high mountains. The Shan States, however, have an extensive karst area through their center, where road alignments are restricted by cliffs, gorges, and steep slopes.

c. Laos and North Vietnam

Except for the Tonkin Plain the entire region of northern Laos and northern North Vietnam generally is unsuited for road construction. Alignments are restricted to narrow valleys in the mountains and to ridges at lower elevations. Numerous steep grades and winding roads with many hairpin turns are encountered. The soils provide a fairly good foundation, but generally they are unsuited for base course or wearing surface. Construction of roads requires much clearing and grubbing, many cuts and fills, and numerous culverts and bridges. Landslides occur frequently in the steep mountains, especially during the monsoon season.

2. Climate

The border area has a tropical monsoon type of climate.* In general, there are three seasons: the rainy season, from about the middle of June to about the end of October (the southwest monsoon), when the rain cools the atmosphere and the temperature is lower; the cool season, extending from about the first of November to about the end of February (the northeast monsoon), when there is little rainfall; and the hot season, also

* The term monsoon usually is used among climatologists to mean the periodic winds of Asia, but it is used also to mean a season.

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mostly rainless, from about the end of February to about the middle of June.*

As summer approaches, the land tends to heat rapidly, and the great high pressure system is replaced by a succession of low pressure areas. The winds blowing in from the Indian Ocean, which vary in strength and regularity, are heavily moisture-laden and bring torrential rains to the areas in their path. In winter the northeast winds pass over land with the result that much of the border region is relatively dry, receiving less than 10 inches of rain. In January the 32-degree Fahrenheit (F) line follows the mountain barriers across northern Burma and Yunnan, but temperatures at higher elevations are very cold. Farther south the 60-degree line dips irregularly below the Tropic of Cancer ($23^{\circ}27'$ N) pushed southward by the mountains and plateaus of Burma, northern Laos, and North Vietnam.

a. Southwestern China

Even though a large part of the Yunnan plateau lies within the tropics, the climate of the high plains is temperate. Between the higher and lower altitudes, however, the climate ranges widely from cold wind-swept ranges with permanent snowfields to hot steamy jungle valleys. The southwest monsoon brings frequent and, at times, torrential rainfall, and the region is drenched by heavy rains occurring 3 to 8 times per month, especially during July and August. During October the heavy rains taper off, and the ground begins to dry out. It is from November to mid-May, during the northeast monsoon, that optimum conditions for road construction prevail throughout most of this area of China. In the high mountainous region of northwestern Yunnan, however, the ground in the valleys is wet all year except for a short period during midsummer, when conditions become most favorable for road construction.

b. Burma

Throughout the border region of Burma, rainfall ranges from 40 to 80 inches per year. However, in the eastern part of the Kachin State an area 600 miles from the ocean receives more rainfall than the coast** because, as the warm air is pushed rapidly northward in March and meets the cold air, heavy rains are produced before the monsoon reaches the area. During the southwest monsoon the plains and uplands in the border area become increasingly wet during April and May, when they become flooded or waterlogged -- a condition that lasts into December. The dry season in the plains areas lasts only briefly, thus reducing the optimum

* The months given here are a rough approximation because the length of these seasons varies from place to place.

** The western and southern coastal mountains (Arakan and Tenasserim) and the Irrawaddy Delta have nearly 200 inches of rain per year. In contrast, the central dry belt has as little as 20 inches per year.

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construction season to about 3 months. These plains are located along the Ledo Road; around Myitkyina, Bhamo, Keng Tung, and Hwang Luk; and along the Burma-Laos border. During the northeast monsoon and through April the uplands are almost continuously dry. Frozen ground and snow cover occur only in a narrow zone along the border in the far north.

c. Laos and North Vietnam

In northern Laos, more than 70 percent of the annual precipitation occurs during the southwest monsoon season, with rain falling 20 to 26 days per month. From late April through June, violent thunderstorms produce severe turbulence, high gusty surface winds, torrential rains, and occasional hail. All of northern North Vietnam, except the east coast (Tonkin Gulf), has similar climatic conditions. The southwest monsoon brings strong sea breezes to the Tonkin Plain area, followed in the early fall by typhoons with high winds and heavy rains. Throughout the area the northeast monsoon is relatively cold and dry from November to March, with the heaviest precipitation occurring along the east coast, which lies in the path of the moisture-laden northeast winds.

In northern Laos and northern North Vietnam, ground moisture conditions are similar. From November through March the ground is predominantly dry, with wetness increasing in April and continuing through September. In October and November the ground generally becomes dry enough to be workable. Most of the area of the Tonkin Plain is wet all year, with the extent of the wet area being greatest in the period May through September. Flooding, prevalent from December through April, causes the water table to lie just below the surface of the plain. As a result, roadbeds are constructed above the level of the plain and require extensive initial development and constant maintenance and repairs to keep them stable throughout the year.

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APPENDIX D

GLOSSARY OF TERMS

Information contained in this glossary is based on standard US practice.

Bituminous pavements: There are four general types of bituminous pavements: (1) surface treatments, consisting of a thin bituminous layer usually less than three-fourths of an inch of penetration on a prepared road surface; (2) road mixes, in which the bituminous material is mixed with the aggregate by manipulation on the roadbed; (3) bituminous macadam, in which the top course of broken stone is penetrated with bituminous binder; and (4) bituminous concrete and sheet asphalt, in which aggregates and bituminous material are mixed under controlled conditions at a central plant.

Macadam roads: The term macadam has come to mean road surfaces and bases constructed of crushed or "broken" stone fragments cemented together by action of traffic or by rolling and water. The term is applied also to broken-stone surfaces and bases where aggregate particles are bound by cement or bituminous materials. Macadam roads are flexible or semi-rigid in nature, so that preparation and conditions of the subgrade are vital. Failures or deformation in the subgrade show up in the base and wearing surface. Surface irregularities in this type of road are much more difficult to correct than in some other types of construction.

Maintenance: Maintenance operations consist of maintaining the road surface, shoulders, drainage and drainage structures, roadsides, and bridges. Maintenance operations also include snow and ice control and special services such as relining pavements and repainting signs.

Natural earth roads: Natural earth roads are the lowest type of roads and are composed of natural soils as they exist. The natural soil is bladed to the center to form a crown with a ditch along each side. The condition of such roads depends on the nature of the soil and the effectiveness of drainage. Where the natural soil is gravelly or is sand mixed with some clay, the surface will be fairly stable; in silty or clay soils the surface will be muddy during rains and will dry out into ruts at other times.

Soil-aggregate mixtures: A wide variety of materials is used in soil-aggregate mixtures, including sand-clay, gravel, and stone or slag screening; sand, crushed stone, or slag combined with soil as a binder; and various combinations of these materials.

Soil-aggregate roads: Soil-aggregate roads are roads that consist of a substantial layer of properly proportioned and blended mixture of

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of soil and aggregate compacted to form a road which is capable of supporting traffic in all weather conditions. This type of road includes those constructed from sand-clay mixes and various coarse-graded aggregate materials that generally require smaller maintenance operations. Coarse-graded aggregate surfaces consist of a wide range of mineral aggregates such as gravel, crushed stone, crushed slag, or similar substances combined with clay, stone dust, or other binder material to produce stability. Water-bound and traffic-bound macadam surfaces are included in the coarse aggregate group. In addition to serving as wearing courses, generally for light traffic, soil-aggregate mixtures are used widely as bases and subbases.

Soil stabilization: Soil stabilization may be defined as the combination and manipulation of soils, with or without admixtures, to produce a firm mass that is capable of supporting traffic in all weather conditions. In other words a stabilized road surface is one that will stay put, and stabilization is the process by which it has been made that way. In some instances, unfavorable natural soils are modified through the use of gravel or of crushed stone or of clay binder. In other instances, bituminous materials, cement, salt, or lime are used for effective stabilization. The type and degree of stabilization required in any given instance is largely a function of the availability and cost of the required materials, as well as the use that is to be made of the stabilized soil mixture. Stabilized soil mixtures lend themselves readily to the process of "stage construction." A properly designed stabilized soil mixture might function as a wearing surface, receive a thin bituminous surface treatment as traffic increases, and eventually serve as a support for a high type of bituminous pavement for a heavy volume of traffic.

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Figure 1

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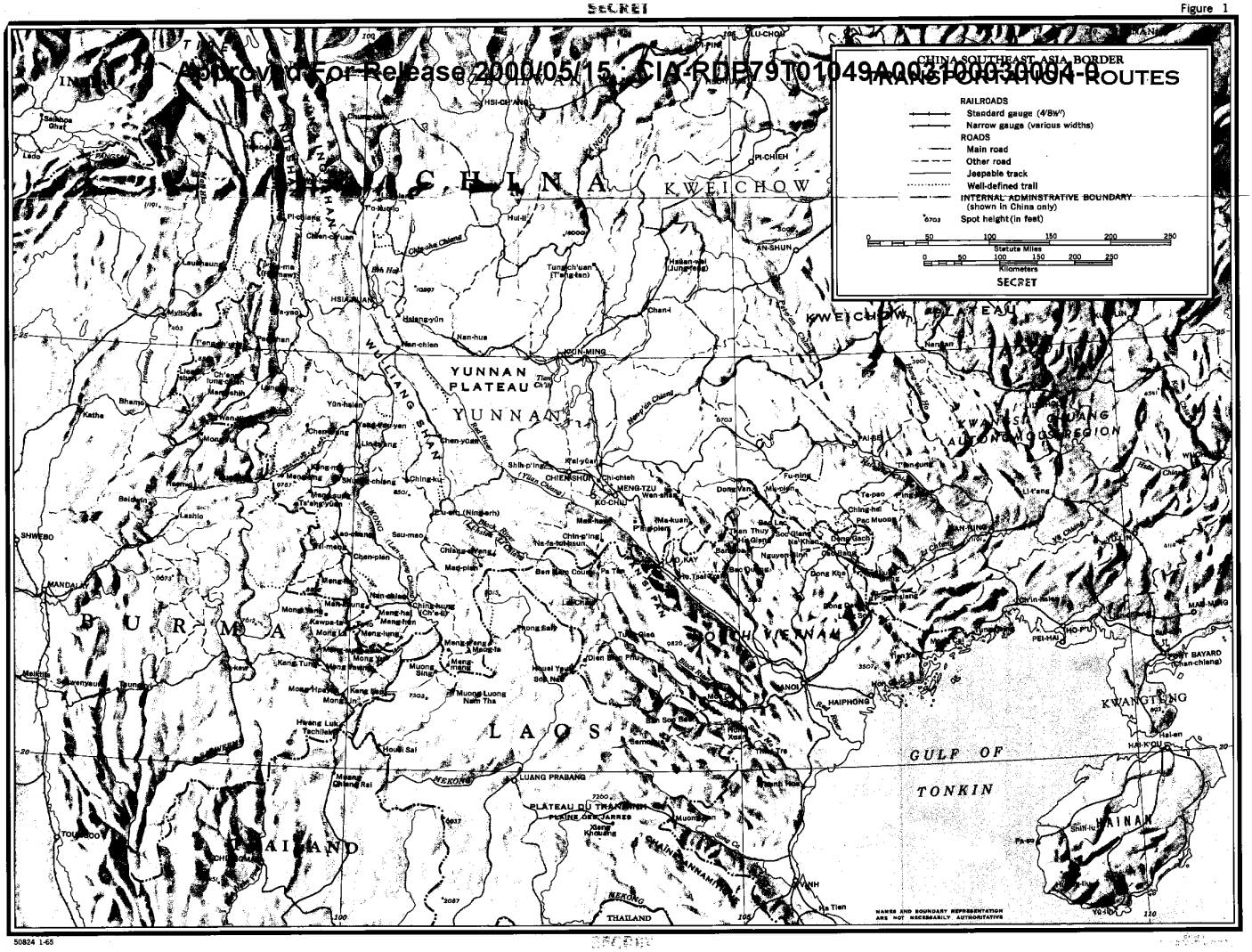

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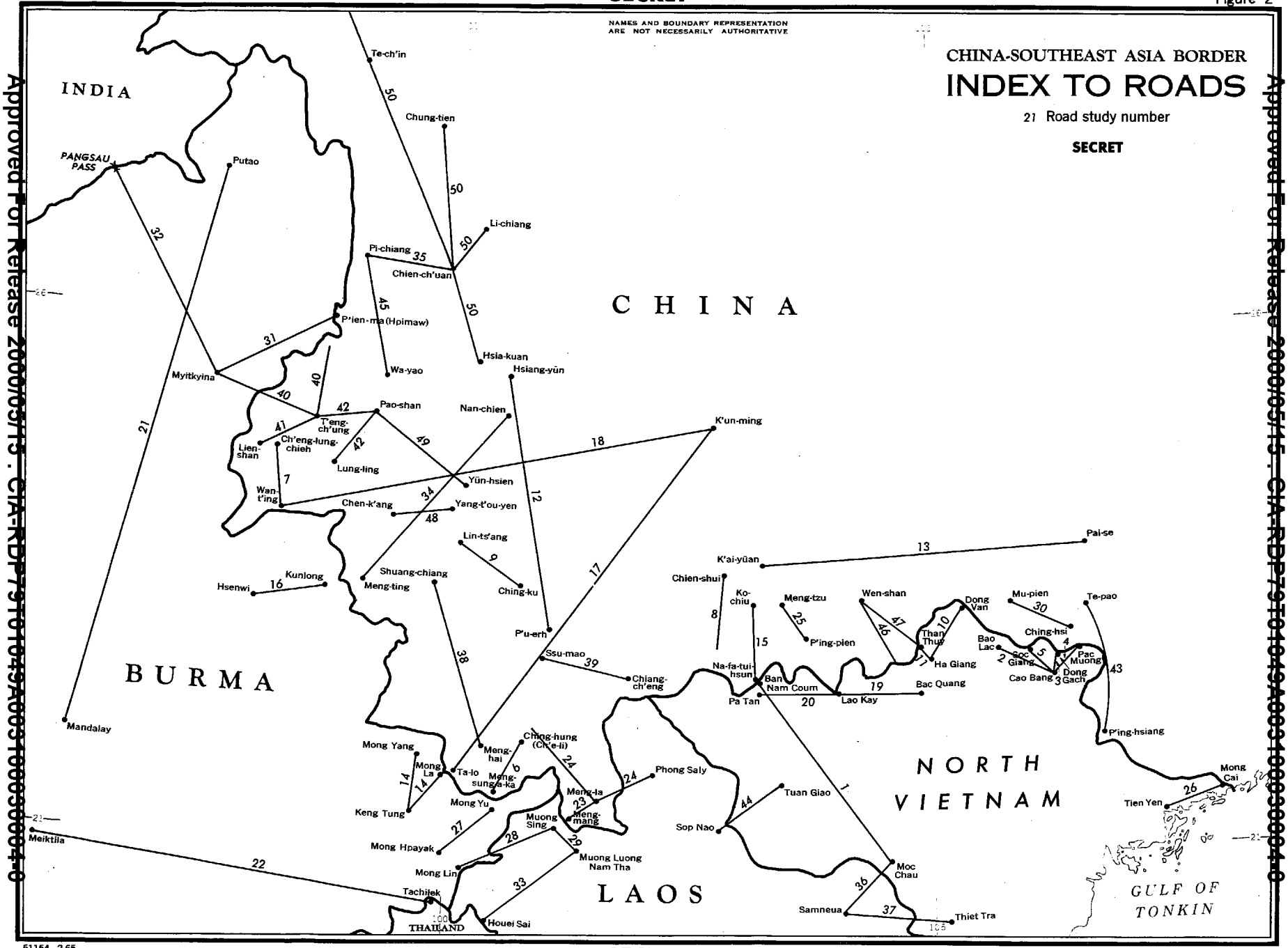
Figure 2



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