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PROJECT CHECO SOUTHEAST ASIA REPORT

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INTERDICTION OF WATERWAYS & POL PIPELINES, SEA

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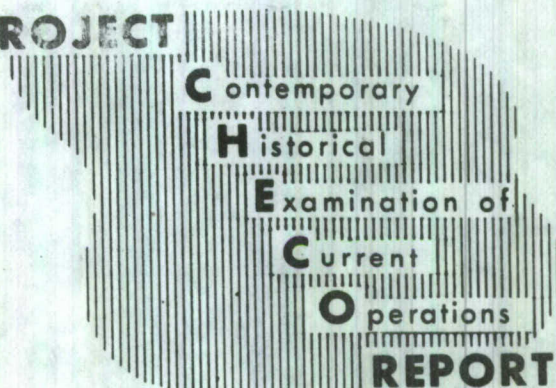


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**INTERDICTION OF WATERWAYS
AND
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11 DECEMBER 1970

HQ PACAF

**Directorate of Operations Analysis
CHECO/CORONA HARVEST DIVISON**

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Prepared by:

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PROJECT CHECO REPORTS

The counterinsurgency and unconventional warfare environment of Southeast Asia has resulted in the employment of USAF airpower to meet a multitude of requirements. The varied applications of airpower have involved the full spectrum of USAF aerospace vehicles, support equipment, and manpower. As a result, there has been an accumulation of operational data and experiences that, as a priority, must be collected, documented, and analyzed as to current and future impact upon USAF policies, concepts, and doctrine.

Fortunately, the value of collecting and documenting our SEA experiences was recognized at an early date. In 1962, Hq USAF directed CINCPACAF to establish an activity that would be primarily responsive to Air Staff requirements and direction, and would provide timely and analytical studies of USAF combat operations in SEA.

Project CHECO, an acronym for Contemporary Historical Examination of Current Operations, was established to meet this Air Staff requirement. Managed by Hq PACAF, with elements at Hq 7AF and 7AF/13AF, Project CHECO provides a scholarly, "on-going" historical examination, documentation, and reporting on USAF policies, concepts, and doctrine in PACOM. This CHECO report is part of the overall documentation and examination which is being accomplished. Along with the other CHECO publications, this is an authentic source for an assessment of the effectiveness of USAF airpower in PACOM.


RONALD A. CAMPBELL, Major General, USAF
Chief of Staff

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MAURICE L. GRIFFITH, Colonel, USAF
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PREFACE

In August 1970, the Chief of Staff of the Air Force and the Commander in Chief, PACAF, evinced considerable interest in the logistic threat posed by the POL pipeline network built by North Vietnam and extending into Laos, and by the waterways system used to float supplies into Laos, Cambodia, and South Vietnam. Specifics regarding length, location, and flow rate of pipelines drew their particular interest, along with pipe dimensions, pumping and control equipment, and the methods being used to locate and interdict the network. These officials expressed equal interest in the free flotation techniques used by the enemy, in the vicinity of the DMZ especially, in the impact these waterways systems had on the enemy supply flow, and in what was being done to counter the threats.^{1/}

This concern had long been recognized and shared by planners at Seventh Air Force Headquarters, who, in the first eight months of 1970 alone, directed the delivery of over 16,050 tons of conventional-bomb ordnance, more than 16,500 canisters of CBU and Rockeye, nearly 10,000 mines and 2,300 cans of napalm, not to mention the quantity of cannon fire and rockets expended into the small geographic area called the Waterway 7 Logistics Complex (WW 7)^{2/}. The WW 7 complex comprised that portion of the Xe (River) Bang Hiang and its tributaries west of the Demilitarized Zone (DMZ) and south to Tchepone (about 25 miles), and the adjacent areas containing enemy storage and transshipment points,

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POL pipelines, and a well-constructed road network. The complex also included an extensive AAA and ground fire threat.^{3/}

Historically, the enemy's use of the road structure in Laos depended upon whether it was the wet or dry season. The predominant use took place in the dry season, but the enemy attempted to "harden" the roads throughout Laos by corduroying, gravelling, and soil stabilization, in an effort to keep the roads motorable as long into the wet season as possible. Nowhere, however, did he accomplish this to the extent as in the area between the DMZ and Tchepone. Extensive hardened road structure was, however, also detected in the Ban Karai and Delta 45 areas.

Where possible throughout Laos, the enemy increased his infiltration options by the use of the available waterways and the construction of POL pipelines. This was particularly noticeable in the area between the DMZ and Tchepone. Waterways and pipelines are addressed as separate topics in this report because of the differences in the build-up and background peculiar to each; however, the concluding chapter shows that these systems, in conjunction with a hardened road structure and heavy AAA threat, constituted a formidable challenge to interdictive efforts when all their component parts were in place and operative.

The time period covered by the report is from 1968 through late 1970. In the fall of 1970, 7th Air Force commenced an air interdiction campaign against input routes into Southern Laos, nominating specific

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"Interdiction Boxes" on these routes for saturation bombing by Arc Light (B-52) aircraft and continuous harassment strikes by Tac air. The interdiction campaign is discussed in further detail in Chapter III. Two of these boxes encompassed portions of the WW 7 Complex, and the areas chosen contained portions of the pipeline, waterway, and road system, as well as transshipment and adjacent storage areas, all in close proximity to each other, in order to maximize the effects of the bombing. The selection of the boxes in the DMZ area was intended to diminish the overall threat posed by the WW 7 Logistics Complex.

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CHAPTER I

THE WATERWAYS

The enemy conducted free flotation experiments in the Xe Kong (in Southern Laos) between 1965 and 1968, including the use of man-made channels through shallow areas. Photography taken in February 1967 revealed enemy use of the Xe Kong to float POL drums south of Ban Bac, and also showed extensive rock channelling. By 1968, intelligence reports showed that the enemy had attempted to use several waterways for flotation of supplies. These attempts were not always successful, as reconnaissance showed that bags of supplies and POL drums often became entrapped in eddies, entangled along the shoreline, or otherwise escaped retrieval.^{4/}

The enemy first used the Nam Ou River in North Laos for controlled experiments at free flotation in 1968, and these began to bear fruit in 1969, near the latter part of the rainy season. One of the first things noticed was the improvement of landing spots and transshipment points along the Nam Ou between Phong Saly and Luang Prabang. After photo recce first detected this new construction on the river, road and river watch teams observed and confirmed both boat traffic and free floating supplies along the waterway.^{5/}

The watch teams came under increasing and extreme enemy pressure because the enemy naturally did not want the system disrupted.^{6/} Most of the equipment being transported came down Route 19 from the northeast to

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the transshipment point on the river approximately eight miles from the confluence of the Nam Ou and Nam Pak rivers.^{7/}

Much of the traffic was boat traffic, which was easily interdictable. Oil drums and supply bags were almost unstoppable by the river watch and strike teams along the banks of the river; however, these teams did succeed to the point that heavy enemy pressure was applied against them. Most of the enemy boat traffic was easily recognized because it was motorized; the enemy controlled the fuel and oil supplies, and confiscated any locally-owned motors. Friendly river traffic engaged in fishing or normal trading was invariably poled or paddled, and so motorized river traffic was considered a legitimate strike target by the Royal Laotian Air Force.^{8/}

The floating supplies posed a different problem in that they proved far more difficult to detect than boats, and seldom comprised "enriched" targets--enough of them in one spot to provide a lucrative target. However, the unloading and transshipment points were detectable through photo reconnaissance, watch teams, and Special Guerrilla Units (SGUs).

As these points were discovered, they were catalogued and placed in files for future targeting. In July 1969 a company-to-battalion-sized enemy force literally built a camouflaged village off the river north of Luang Prabang. They off-loaded and pulled the floatable supplies from the water to hide them, but through the various intelligence sources previously mentioned, the supplies were well pinpointed. The enemy had

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stored this equipment in two large caves which were all but invisible from the air because of camouflage and jungle canopy, but an RLA air-strike put into the area blew enough of the jungle away that the caves were visible. A second strike put bombs "right into the mouth of the cave and literally blew the side of the mountain out." According to the intelligence sources in the area, heavy casualties resulted and "all sorts of equipment" was destroyed.^{9/}

It was during mid-1969 that the enemy began to put more management into his waterways logistics system. "Sea anchor" devices were attached to drums and bags in order to keep them in mid-stream flow. Checkpoints were set up along the river to monitor the passage of the supplies in order to identify them and earmark them for off-loading at specified transshipment points.^{10/}

This activity was not confined to the Nam Ou alone. Using his previous experience, the enemy began an intensive engineering effort along the Xe Bang Hiang waterway from the DMZ southwest to Tchepone. The system was designed to control, monitor, camouflage, and extract the supplies as they floated down the river. In addition, an estimated 25 to 30 37mm and eight to 12 23mm AAA guns, along with an untold number of automatic weapons (12.7mm and 14.5mm heavy machine guns) and small arms, made the stretch of waterway one of the most heavily defended areas in Laos. Finally, the location of six or seven prisoner of war camps to the north and west of Tchepone effectively kept that region from being

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designated a free bomb area. (See figure, following page.) In the area of the POW camps, strikes could be made only under FAC direction in VFR weather. The overall system, while not sophisticated, was ingenious and well-conceived, and provided the enemy with an effective adjunct to his logistics network.

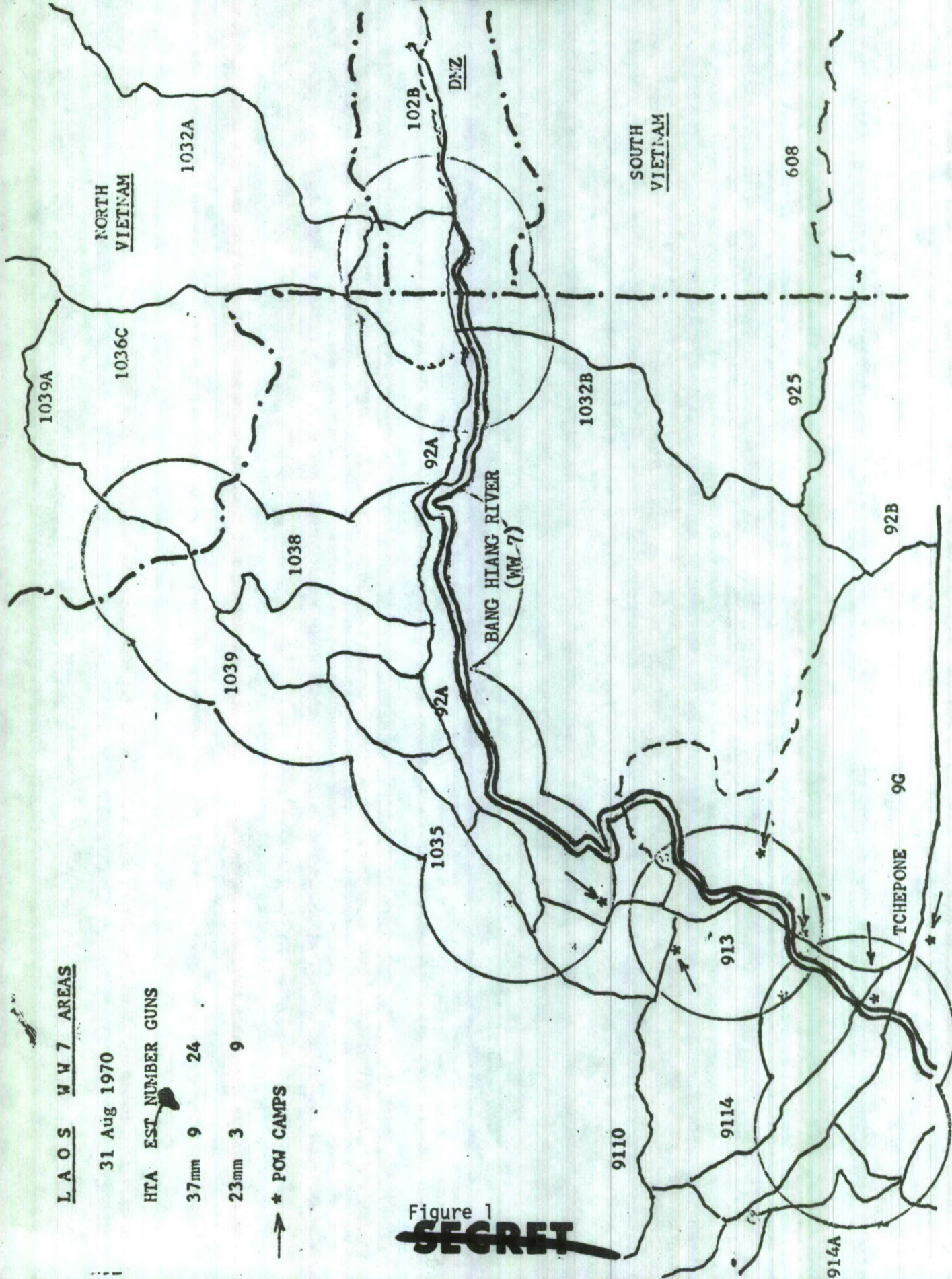
The Enemy Techniques

The NVA/PL undertook an extensive waterways construction campaign in January and February of 1970, especially along the Waterway 7 Logistic Complex. Cabling and bamboo poling, chained or tied together, was extended along the river wherever necessary to keep the floating supplies from being ensnared in the brush along the banks. As can be seen from the reconnaissance photographs on the following pages, in some areas the enemy required two channelling lines; in others, natural current flow allowed the use of but one.

Besides the bamboo poling, the enemy resorted to several other techniques designed to accomplish maximum throughput and minimum loss. Workers constructed jetties and water gates to direct water flow for best channelling. Dams were set up on tributaries to be opened when the water was too low for effective use of the system, and closed when the level was too high. In this way they attempted to minimize the effects of the dry and wet seasons. Previously, during the dry season, the water was so low in places that POL drums bumped along the bottom in places, and flow rate was so slow that little throughput could be achieved. The wet season normally was optimum for many reasons (some of which will be

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LAOS W7 AREAS

31 Aug 1970

HTA EST NUMBER GUNS

37mm 9 24

23mm 3 9

* POW CAMPS



Figure 1

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"TAC RECCE"

CHANNELING WALLS

2.4KM W LAOS/VN BDR W7J

VEYE J3347 FRAME: 154LLS

2 MAR 70 APPRX TOT: 1425H

165304N1663700E

9195

CONF GP-1



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GROUP 1

Figure 2

~~CONFIDENTIAL~~

AZD

"TAC RECCE"

CHA NNELING WALLS
100 METERS W LAOS/VN BDR W7J
UEYE J3347 FRAME: 163RLS
2 MAR 70 APPRX TOT: 1425H
165325N1063315E

9194

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GROUP 1

Figure 3



POL DRUMS

"TAC RECCE"

CHANNELING WALLS W7J
3.4KM W LAOS/VN BORDER
UEYE J3360 FRAME: 132VT
3 MAR 70
165254N1063126E

9196

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GROUP 1

Figure 4

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~~CONFIDENTIAL GP-1~~

"TAC RECCE" 11TRS

JETTY/FLOATING SUPPLIES
2.5NM X DMZ W7J
YT J3350 FRM: 12LLS(4X)
21 JUL 70 TOT: 1601H
ALT: 4.5M
165235N1063045E

10564

CONF GP-1



FLOW

Figure 5

discussed later), but severe flooding did disrupt the system.^{11/} These control devices not only extended the usable period during which the waterways could contribute to the logistics system, but also showed that the enemy was equally concerned with the coming seasons.^{12/} This construction showed long-term planning.

Additionally, to ensure that the entire flow-engineering system continued to operate efficiently, and also to provide for immediate repair if the need should arise, monitor points were placed strategically every kilometer or so along the waterways. At many of these monitor points, boats or rafts made access to the system convenient. On occasion, boats were even used to "shepherd" clumps of drums or floating bags when necessary.^{13/}

Enemy Tactics

The NVA/PL took every conceivable advantage of the elements, the friendly rules of engagement, the laws of physics, and their sanctuary to keep the logistics flow along the waterways, especially WW 7, high. Night and weather were their most effective allies. Normally, having gauged the river flow rate and estimated the arrival time of a given set of floating supplies, they would place these in the water at last light. Then word would be sent ahead to the proper transshipment point to place a net or other trapping device so that the supplies could be extracted prior to first light in the morning.^{14/} The same applied to inclement weather. Knowing that a large extent of the waterway was not a free bomb area

because of numerous "friendly" villages and the POW camps along the river, the enemy often waited until weather conditions precluded FAC-directed, VFR strikes and then sent supplies downstream in the daytime.^{15/} It may be noted that the preceding photographs were taken under a low cloud base from approximately 4,500 feet. This altitude was too low for effective bombing by F-4 and F-105 aircraft, the only aircraft truly capable of surviving the high-threat environment, and for visual strikes they could not dive-bomb through clouds.

A favorite enemy tactic consisted of filling the drums and bags to a point barely under the specific gravity of 1.0, water itself. This tactic left the drums floatable but scarcely protruding above the surface of the stream. To a photo interpreter with a light-table and optics, the barrels were not difficult to detect, but to a strike pilot flying at 500 knots, these targets became extremely difficult to see.^{16/}

When the enemy suspected they had been discovered by a FAC, river patrol teams quickly pulled as many drums as possible into inlets, either natural or artificially made and well-camouflaged with trellising. What few supplies drifted downstream would not be considered an "enriched" target to any Quick Reaction Force (QRF) pilots responding to the FAC's call and so would not be struck. The same inlets were used for daytime staging, oftentimes in preference to extracting the supplies from the water.^{17/}

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Logs, banded with steel, were often floated ahead of the drums in an effort to explode any MK-36 magnetic fuzed mines emplaced in the river prior to the arrival of the supplies. However, observers reported that even when MK-36s did explode under the drums, the explosion merely "hydraulicked" them out of the water without actually sinking them.^{18/} In addition, individual drums did not have enough metal to detonate the mine, or were moving too slowly to activate it.^{19/}

Reports indicated that the enemy preferred to isolate groups of drums, probably for two reasons. One, to prevent accumulations of them constituting lucrative targets and, two, to facilitate lot identification for extraction and storage. A Nail FAC reported that although he had seen up to four or five hundred drums spread along a ten mile stretch of WW 7, seldom were more than 40 or 50 of them collected together.^{20/}

Transshipment and Storage Points

Intelligence estimates based upon photo reconnaissance and FAC reports indicated that virtually every transshipment point had a nearby storage facility.^{21/} These storage sites took one of three forms: First, an inlet adjacent to the river, trellised over with jungle brush which precluded accurate aerial observation; second, a bunkered storage facility capable of holding from 16 to 30 tons of supplies and, finally, usually well camouflaged access roads which led to terminals and transshipment hubs where karst and caves provided hardened storage of up to hundreds of tons of supplies, along with pumping stations, POL control systems, and repair

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facilities. These hardened sites were difficult to detect and even more difficult to destroy.^{22/}

The Waterways Logistics Flow

Estimates on the amount of supplies delivered by flotation varied widely. A September 1970 DIA (Defense Intelligence Agency) estimate stated a 30 drums per day rate, whereas FAC estimates ranged up to 3,000 drums per day.^{23/} Though FACs reported some large sightings (a Nail FAC reported seeing 400 to 500 drums in one ten mile stretch of the river, and a Wolf FAC reported 200 drums at one time in the afternoon)^{24/}, these were considered higher than average quantities. POL input through the pipelines and from WW 7 was impossible to quantify accurately. It was known that the pipes were not in use continuously. Seventh Air Force based its estimates of POL input on the estimated POL consumption within the Laotian Panhandle. This consumption figure was obtained from known levels of truck activity, average distance traveled each night, and fuel consumption. During the dry season, the estimated POL consumption was about 15 to 20 tons per day, or about 150 barrels. In addition to the pipeline and oil drum input, an unknown quantity of supplies was input contained in inflated plastic bags floating down Waterway 7.

It must be noted that statistics concerning the number of barrels sighted in the Xe Bang Hiang and other waterways could not be directly used to quantify the tonnage of POL moved into Laos by this method. Strike and SGU reports indicated that a large percentage of the barrels were either empty or contained a quantity of hard supplies such as

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foodstuffs, medicinal supplies, or clothing. This was confirmed by post-strike observations which showed a lack of POL type oil-slicks on the river, and even--in many cases--the inability to set on fire or explode the drums through extensive strafing.^{25/} Seventh Air Force intelligence estimated a daily volume average of about 78 drums and 42 packages a day in the WW 7 Complex although it was obviously difficult to determine the exact nature of these floating supplies.^{26/}

Flotation techniques were used not only on Waterway 7; they took place also on the Nam Ou, the Xe Done, and the Xe Kong waterways, although not with the control and systematization as that displayed in the WW 7 Complex.^{27/}

Interdiction Efforts in the WW 7 Complex

With little question the Waterway 7 Logistics Complex gave the enemy an effective option to his supply system, especially considering its strategic location at the western end of the DMZ. The November 1968 bombing halt allowed him to bring supplies unimpeded literally to the "upper doorstep" of South Vietnam. The Xe Bang Hiang/Houay Namxe River system, starting in the northern portion of the DMZ, provided a convenient point to input floatable supplies, and the proximity of POW camps to the river north of Tchepone restricted the use of radar controlled bombing. The most vulnerable section of WW 7 was from the DMZ westward for approximately 12 miles, but the NVA kept this a high threat area with 37 and 23mm AAA.^{28/} Nonetheless, the numbers of strikes sorties placed on WW 7 and adjacent areas, and the BDA compiled for the first eight months of 1970

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were impressive. The following figures show much of the story: ^{29/}

- . POL Barrels Destroyed 17,885
- . Trucks Dest/Dam 235/194
- . Jetties Dest/Dam 77/31
- . Secondary Explosions 2,796
- . Secondary Fires 1,882
- . Interdiction Points 350
- . AAA Sites Dest/Dam 68
- . Other BDA (POL Lines, etc.) 975

Ordnance expended on the Waterway 7 Complex included: ^{30/}

MK-82	- 57,923	MK-36	- 7,542
MK-83	- 158	M-346/FMU 72	- 2,129
MK-84	- 638	BLU 27/32	- 2,291
M-117	- 2,200	M-36	- 112
CBU-24/25	- 7,809	Rockeye (Cans)	- 562
CBU-42	58	AGM-12	- 94
CBU-46	124	Rockets (Pods)	- 329
CBU-49	7,974	Other	- 128

The figure on the following page shows Tac air strikes by aircraft types: ^{31/}

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It was the general assumption among 7th Air Force planners that the high-threat nature of the area made the use of slow moving aircraft too risky, and this assumption was reflected in the figures. The F-4s, F-105s, (until the F-105's departure from the theatre and a last strike flight flown 6 October 1970), Navy A-4s and A-7s bore the brunt of the mission, along with Arc Light strikes in the SALOA (Special Arc Light Operating Area) portions of the system.

One of the reasons that F-4s flew so many of the strike came from the enemy's pattern of putting the supplies into the waterways at dusk. Wolf (F-4) or Nail (OV-10) FACs made sightings at this time and called for QRF strikes. As Colonel Gordon H. Scott, 7/13 Director of Operations, explained it:^{32/}

Most of the strikes made by the Ubon F-4s wound up as a result of scrambles in the late afternoon. They were usually called out as a result of sightings by Wolf fast-mover FACs of drums floating in the river. The F-4s got into the areas and if they found a large concentration of barrels, they hit it with hard bombs and CBU-24....the CBU worked especially well when river width was sufficient to allow for the entire pattern to hit the water surface. When the river narrowed, and bankside foliage hung over the water, part of the bomblet pattern would explode ineffectively in the trees.

Initially, the scramble birds were hung with all iron bombs, but the effectiveness of the CBU prompted the 8th Tac Fighter Wing to split the load, half CBU and half hard bombs.

The last statement focused attention upon the need for flexible ordnance in order to destroy these targets. In the opinion of Colonel Charles M. Morrison, Chief of the Fighter Division at 7th Air Force,

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one good weaponry mix (assuming that compatible ordnance and aircraft were presently in-theatre) would be 20mm, hard bombs, and CBU on the same aircraft. One basic problem came with the need for rapid reaction when FACs spotted floating supplies. The only Quick Reaction Force aircraft nearby were F-4Ds at Ubon, which unlike the F-4Es at Korat and Danang did not carry internal guns. Aircraft configuration for the F-4Ds did not permit loading of all three types of stores. With bombs and CBU being the preferred option (suitable for more targets) the QRF aircraft did not carry the gun pod, and thus lost one of the most versatile weapons against the floating drums.^{33/} Korat F-4Es were stationed too far away for quick reaction, and while Danang had an alert pad, it was not set up in QRF posture. Later events indicated that a Quick Reaction Force would be put into being at Danang which would enable the 366th TFW F-4Es also to react rapidly to requests from the WW 7 Complex.^{34/}

Armed reconnaissance was routinely fragged over the Waterway 7 Logistics Complex, but not solely for recce of the river itself. When floating targets of opportunity presented themselves, or when FACs requested it, the armed recce aircraft could and did respond rapidly, often with very effective results.^{35/}

In addition to the tactical air campaign, Arc Light strikes were fragged over and around Waterway Seven. The intent was not targeted against the waterway itself, but to strike traffic routes, transshipment points, storage areas, and the POL pipeline adjacent to the river, on a saturation basis. Approximately two cells, or six B-52s, were fragged against

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1 Jan - 31 Aug 70
WW 7 COMPLEX ATTACK SORTIES

ACFT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	TOTAL
F-4	244	254	270	392	289	240	372	206	2267
F-105	10	21	61	48	112	183	281	227	943
A-1	30	8	23	17	40	26	32	6	182
AC-130	13	1	13	43	37	21	13	5	146
A-4	78	80	95	60	201	46	157	137	854
A-6	44	37	0	34	113	46	57	17	348
A-7	55	153	149	156	207	39	57	136	952
B-52	24	64	42	21	78	100	116	121	566
TOTAL	498	618	653	771	1077	701	1085	855	6258

FIGURE 6

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these targets beginning 22 July 1970, and the BDA observed by the B-52 crews for August and September from this effort was much higher than BDA observed on other targets in Laos.^{36/}

All levels of command continued their efforts to devise improved tactics and weaponry to increase destruction or disruption of supplies on the waterways. Huge tetrahedrons with long spikes to impale or trap floating supplies without damming the rivers were suggested, as was some method of laying concertina wire across the waterways. Lazy Dog, simply a hail of small free-falling inert missiles, was mentioned because of the high density of these missiles per square yard of impact area. Fuze extenders on hard bombs to increase surface fragmentation, and CS-2 riot control agent (long lasting tear gas) to deny entry of unprotected personnel to target areas were among other suggestions. One highly recommended item, pending approval and introduction, was the 2.75 inch rocket with an improved motor and a 60-grain flechette warhead.^{37/}

All of the problems encountered in the Waterway 7 Logistics Complex, however, were compounded by the enemy's other options. Among these options was the POL pipeline network, to be addressed in the following chapter.

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CHAPTER II

THE POL PIPELINE

The 1 April 1968 bombing halt north of the 19th parallel gave the enemy an opportunity they had long been denied and which they desperately needed. Extensive allied bombing of POL reserves and facilities in the Hanoi, Haiphong, and Vinh areas had severely hampered North Vietnamese efforts to keep a viable fuel and oil transportation system into Laos and the Ho Chi Minh Trail. The cessation of the bombing allowed the enemy both to begin reconstruction of these facilities, and to initiate the laying of a POL pipeline from Vinh, through Mu Gia Pass into Laos.^{38/}

Vinh, although south of the 19th parallel and therefore vulnerable to airstrikes until November 1968, was selected as the major hub for the pipeline system for several reasons; it was close to Laos and the major passes entering that country, and it afforded easy access for incoming POL products via the inland waterways, the Song (River) Ca, and the road and rail systems.^{39/}

The value of Vinh as an input gate was enhanced by berths for docking of vessels with a draft of 14 feet or less at the Vinh Petroleum Products Storage (PPS) facility itself, with added anchorage capability for large ocean going ships outside the river mouth.^{40/} Large underground and surface tanks were constructed with feeder lines connecting to the pipeline network already under construction to the immediate west of Vinh.^{41/}

High-level photography in July 1968 first identified the existence of the new pipeline about 13 miles northwest of Vinh. Until the total bombing halt of 1 November 1968, progress on the line remained relatively slow, as the various PPS facilities and lines were largely destroyed and damaged. Subsequent to the halt, however, the rate of pipe-laying increased and its operational status was confirmed.^{42/} It continued to be extended through Mu Gia Pass, and was initially identified in Laos in mid-January 1969.^{43/}

Interpretation of high-level photo reconnaissance originally discovered the Laotian segment of the Mu Gia pass pipeline because it was laid in trenches, and in their attempt to lay the trenches in straight lines the enemy disrupted the jungle pattern. Low-level photography then pinpointed it extremely well; this identification was later followed up by CAS/SGU teams which infiltrated and verified its location.^{44/} One of these teams even cut out a section of the pipe at a junction, to bring back for analysis. The analysis showed that the pipe, in most sections, was four inches in diameter, light alloy with 1/8th inch walls and of Russian origin. (Note Russian markings on junction in the photograph on Figure 7.)^{45/} This section was cut about 25 kilometers south of Mu Gia (in April or May of 1969). Construction on the line continued until there was approximately 50 kilometers of pipe, including spurs and parallel lines, in Laos.^{46/}

For more than a few reasons, the North Vietnamese shifted their pipeline efforts. The cessation of air strikes in North Vietnam in

November 1968 prompted the concentration of interdiction efforts against the extension of the POL pipeline south of Mu Gia in Laos. This effort temporarily, at least, appeared to halt construction of the northern line. But, under the bombing halt protection, the North Vietnamese shifted their traffic lines down to the DMZ with impunity and began constructing pipelines in the Ban Raving area (which, to them, was far more convenient in any event).^{47/} It gave them an extra hundred miles of immune territory, and the line entered Laos where they wanted it, near the DMZ.

Several pipelines, associated pumping and control equipment facilities, junctions, and parallel lines were constructed. The two primary ones were the 1036/1039 line, and the Route 103 line, discovered 10 April 1970.^{48/} These lines crossed the Laotian border in and near the DMZ area to interlink with the Waterway 7 Logistics Complex and provide a secondary option to POL products flow. To supplement their network, the North Vietnamese may have laid line through the Ban Karai Pass, about midway between the DMZ and Mu Gia.^{49/} Foliage prevented confirmation of the pipeline trace along Route 137 in North Vietnam, but visual reconnaissance followed by a FAC-directed strike against a suspected POL line on 30 July 1970, confirmed segments of a pipeline on the Laotian side of the Ban Karai Pass.^{50/}

Finally, in late 1970, there were indications that the enemy may have begun the construction of pipeline for throughput into South Vietnam. Controlled American Sources and SGU teams reported traces of pipeline along Routes 921 and 922, east and southeast of Tchepone, leading toward the A Chau Valley in South Vietnam.^{51/} The reported sections of

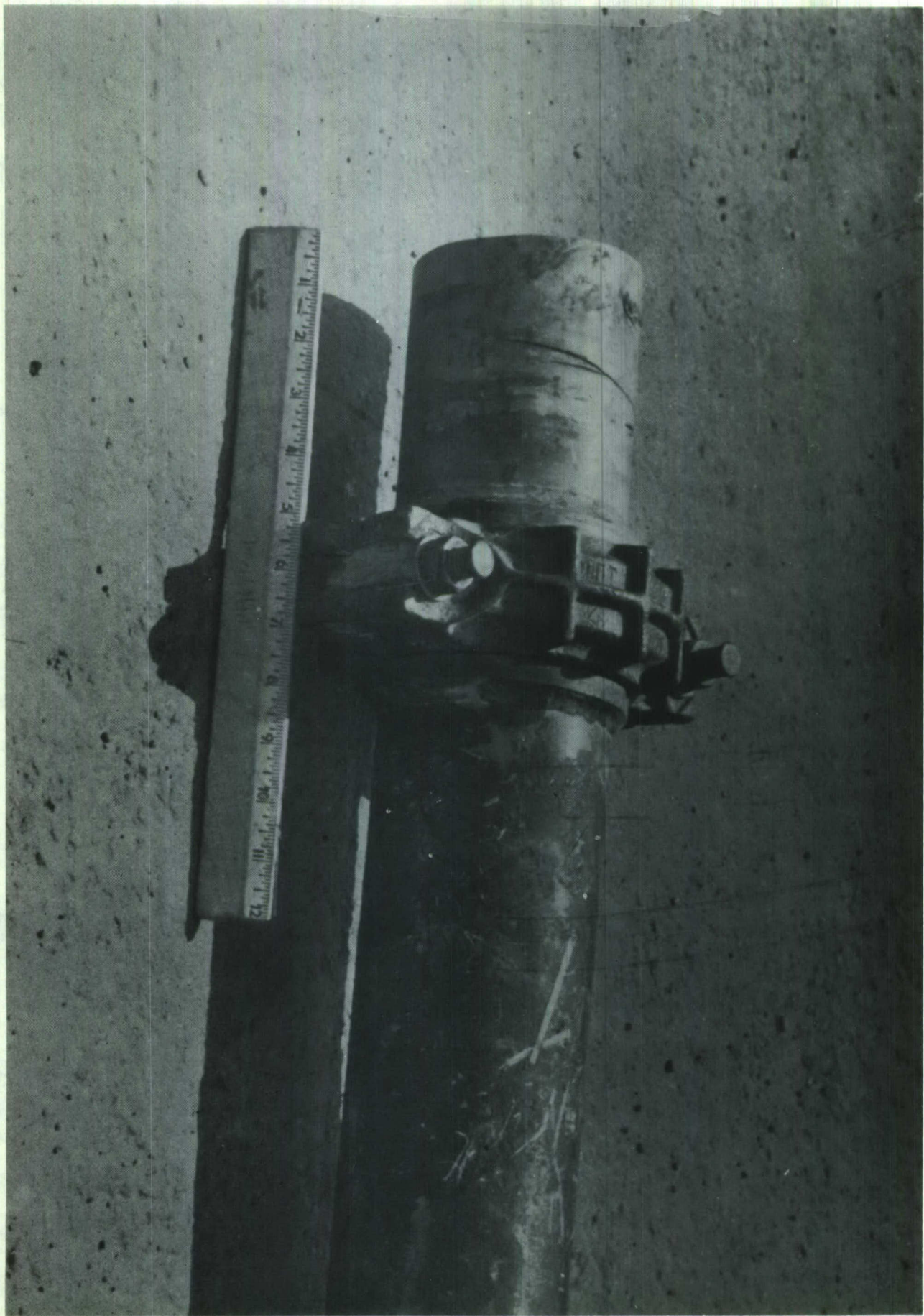


Figure 7

all the lines, with the possible links between them are plotted in the following figure. Construction during the 1969-70 dry season may have linked the Mu Gia and WW 7 pipelines; however, dense foliage prevented all but a few short segments being confirmed by photography or visible to CAS teams.

The Technology, and the Difficulties of Interdiction

The major part of the North Vietnamese POL pipeline system and associated control equipment consisted of Russian-made pumps, pipe, control valves, observation globes and gauges, and storage tanks. The pipe, already described, came in several varieties to suit whatever usage was needed. Light-alloy, rigid pipe, used in straight trenches whenever possible; flexible plastic piping, laid across river beds or around karst where terrain did not permit trenching; and rubber hosing, used for rapid repair of the POL pipeline in the event of interdiction, were among them.^{52/}

Numerous pumping stations serviced the lines. Intelligence estimates showed that, along relatively level terrain, one pump per kilometer provided sufficient pressure to keep the flow going; in more difficult terrain, such as the pass areas, pumps as close together as 50 to 100 meters were needed.^{53/} Since the NVA normally revetted and covered the pumps, exact identification of all the types used was not possible, but pumps seen at known service stations along infiltration routes, along with other intelligence, indicated the use of two primary types--the Russian-made MPG-23 and TSVS-53. Aerial photography in 1969 showed MPG-23.

pumps as deck cargo aboard Haiphong-bound Soviet ships, and CAS observations noted increased use of the TSVS-53 type pump in the Ban Phanop area south of Mu Gia.^{54/}

Detailed information appears unnecessary, but extracts from a September 1965 report show the following characteristics and capabilities of the before mentioned pumps:^{55/}

- . MPG-23. Powered by a one cylinder water-cooled gasoline engine. Includes a centrifugal turbine self-priming pump with a capacity of between 87 and 108 gallons per minute (GPM) depending upon hose size, use of filters, meters, etc.
- . TSVS-53. Cart or truck mounted mobile pump. Centrifugal turbine, self-priming, driven by one cylinder, air cooled two horsepower engine. Pumping capacity, 45 to 60 GPM depending upon hose size and associated equipment.

The housed or revetted pumps serving the network were considered most likely the MPG-23 type. (See following figure.) The highly mobile TSVS-53s probably were used as interim pumps when MPGs were out of service, and would be invaluable in the event a ruptured or interdicted line required rapid repair. Two additional pump-types may have had varying degrees of use in Laos. The MPG-25/27 with a higher GPM pumping capacity was confirmed in use south of Mu Gia Pass. The MPG-30, with an even greater capacity was noted to exist in the NVA POL-equipment inventory, however its use in Laos was not yet confirmed.

The POL pipeline network could not be construed as a straight through-put system to its terminus. POL was transferred from the main line via short spur lines to storage areas or to points where tank trucks or POL

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NVA POL Pipeline in Laos

Oct 1970

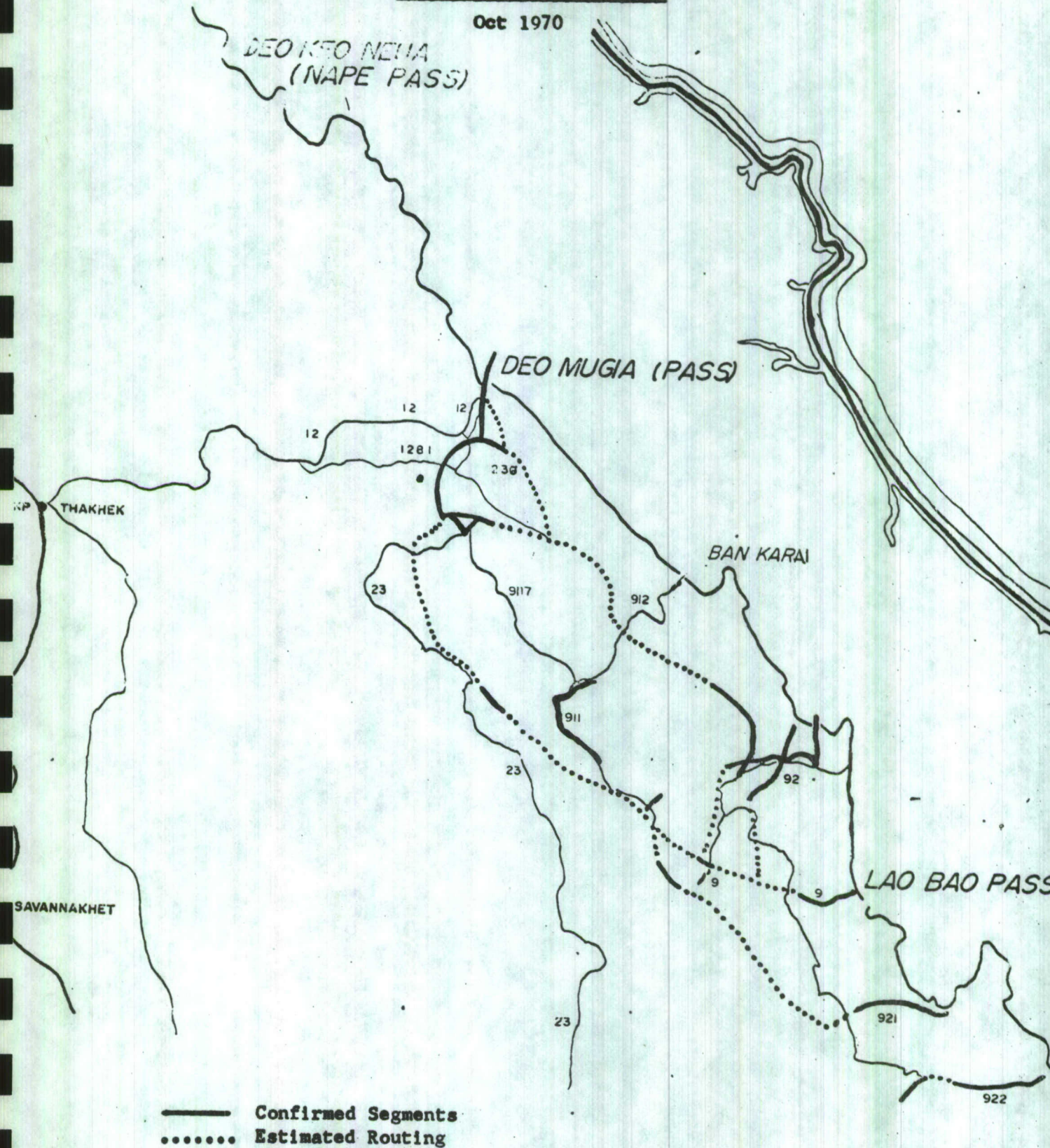
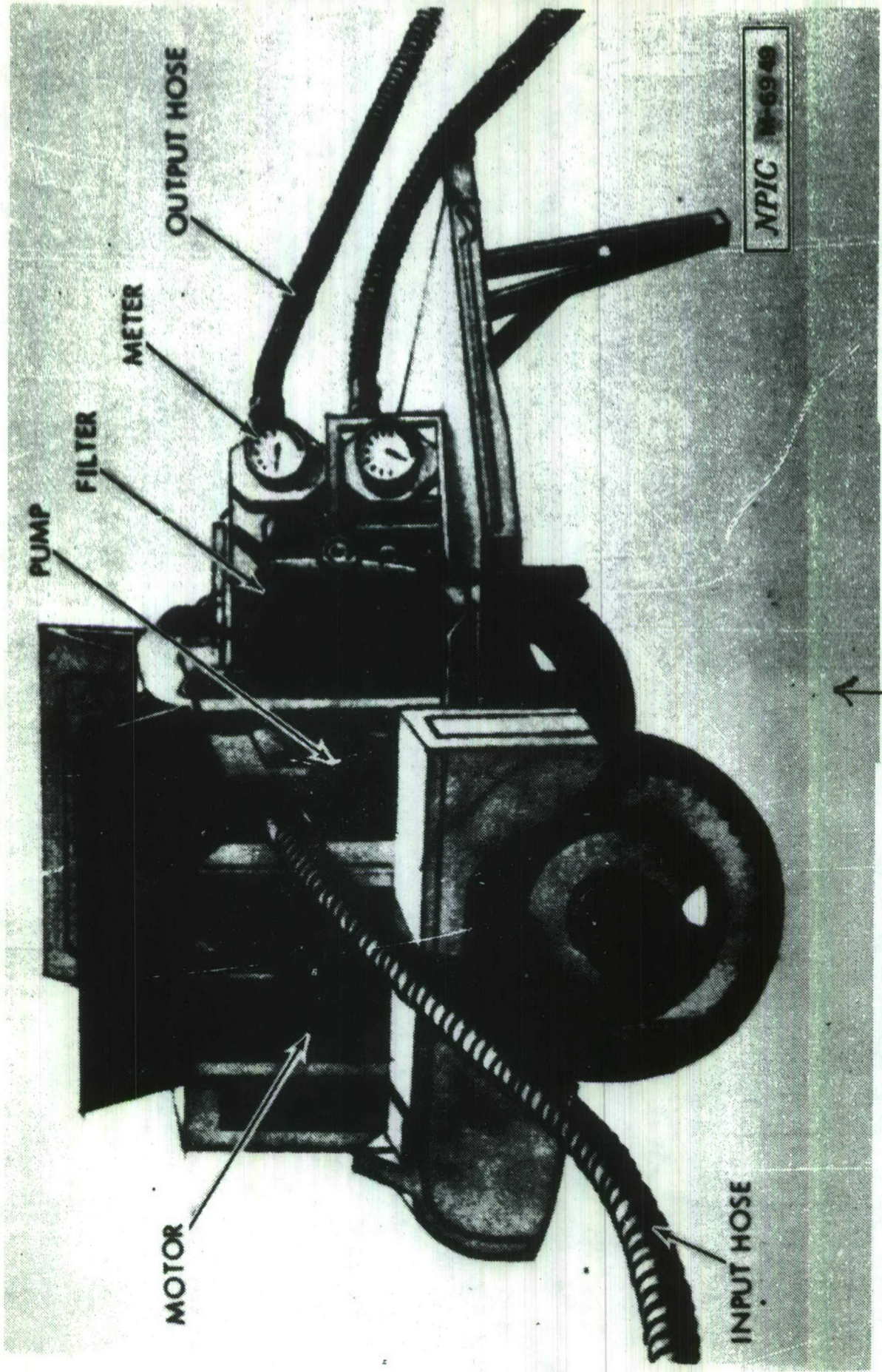


Figure 8

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SOVIET MPG-23 PUMP

Figure 9

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drums could be filled. In late 1969, the pipeline serviced at least eight known major operational storage areas. These areas often consisted of numerous partially buried tanks, with both a 2,500 and 5,000 gallon capacity, bunkered individually or in small groups within the overall storage site.^{56/}

The North Vietnamese learned their lessons well. They carefully hid these storage areas deep under dense vegetation or in karst formations, and it was often only a pumping station, short spur line or a road, that led to their discovery. These tactics made accurate measurements of their storage capacity difficult if not impossible. Some estimates indicated that there was a daily potential throughput of up to 1,100 metric tons in the lines. Many felt that this potential was never realized; however, the Navy Fleet Intelligence Center was of the opinion that the pipeline network released a significant number of trucks previously used to transport POL products and freed them for use in hauling other war-related supplies.^{57/}

The enemy carefully applied the lessons learned from air strike interdictions and SGU forays, and built multiple lines, installed cut-off valves at points vulnerable to bombing, such as major river crossings, and skillfully camouflaged the line traces. When trenching was employed, it could usually be identified through photo interpretation initially, but vegetation grew so rapidly that within a few days all traces of the line were obliterated. Where river crossings were necessary, flexible plastic hosing was employed (usually two parallel lines) which simply

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sagged underwater and was undetectable from the air unless the water level fell so low as to expose the pipe. (See photos, following pages.) Oftentimes, scarring along the bank was the only indication that pipe had been laid through the river.^{58/}

These precautions, along with stockpiling of repair materials at strategic points along the network, constant line patrol, and skillful technology, gave the North Vietnamese a valuable POL pipeline network extremely difficult to interdict. Militarily, they were aided to a major extent by the bombing halts, which allowed them to place much of their system in virtual sanctuary, but even in Laos they managed to develop an extensive and well equipped POL pipeline network, a key portion of which was located in the Waterway 7 Logistics Complex. There, north of Tchepone, air strikes against the pipeline were subject to the same AAA defenses, and restrictions due to the proximity of POW camps, as were strikes against the waterway.

Interdiction Efforts Against the System

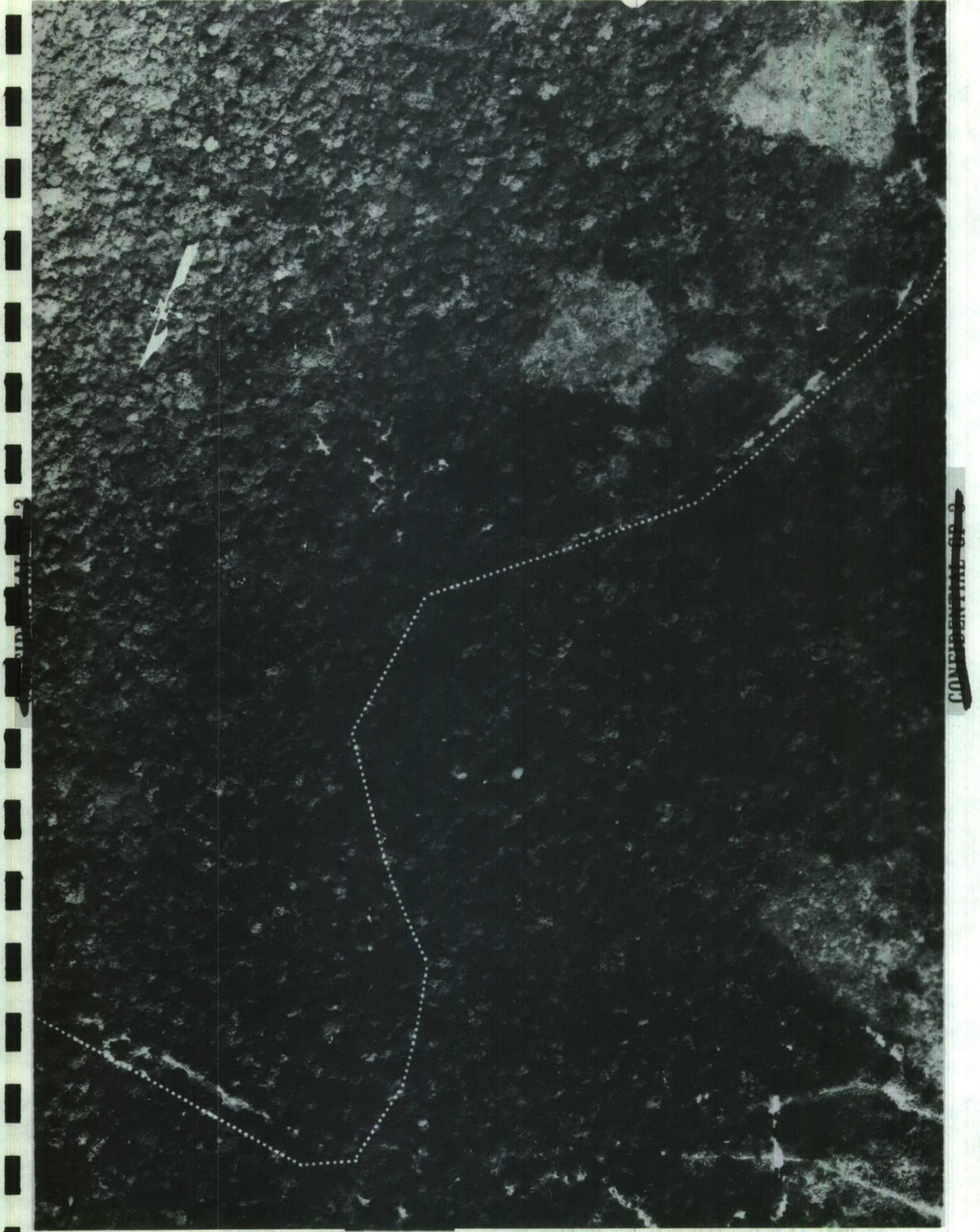
Planners at all echelons recognized that the POL pipeline network made up an integral part of the NVA logistics system, and a difficult one to interdict. Said one fighter pilot, intimately familiar with both the waterways and pipeline system, "How do you see, much less hit, a four inch pipe with a fighter aircraft?"^{59/}

Multiple suggestions to interdict the pipelines were offered, from the exotic to the routine. Better exploitation of photo recce, Arc Light strikes in SALOAs upon known or suspected pipe segments, contamination of



~~CONFIDENTIAL CP-3~~

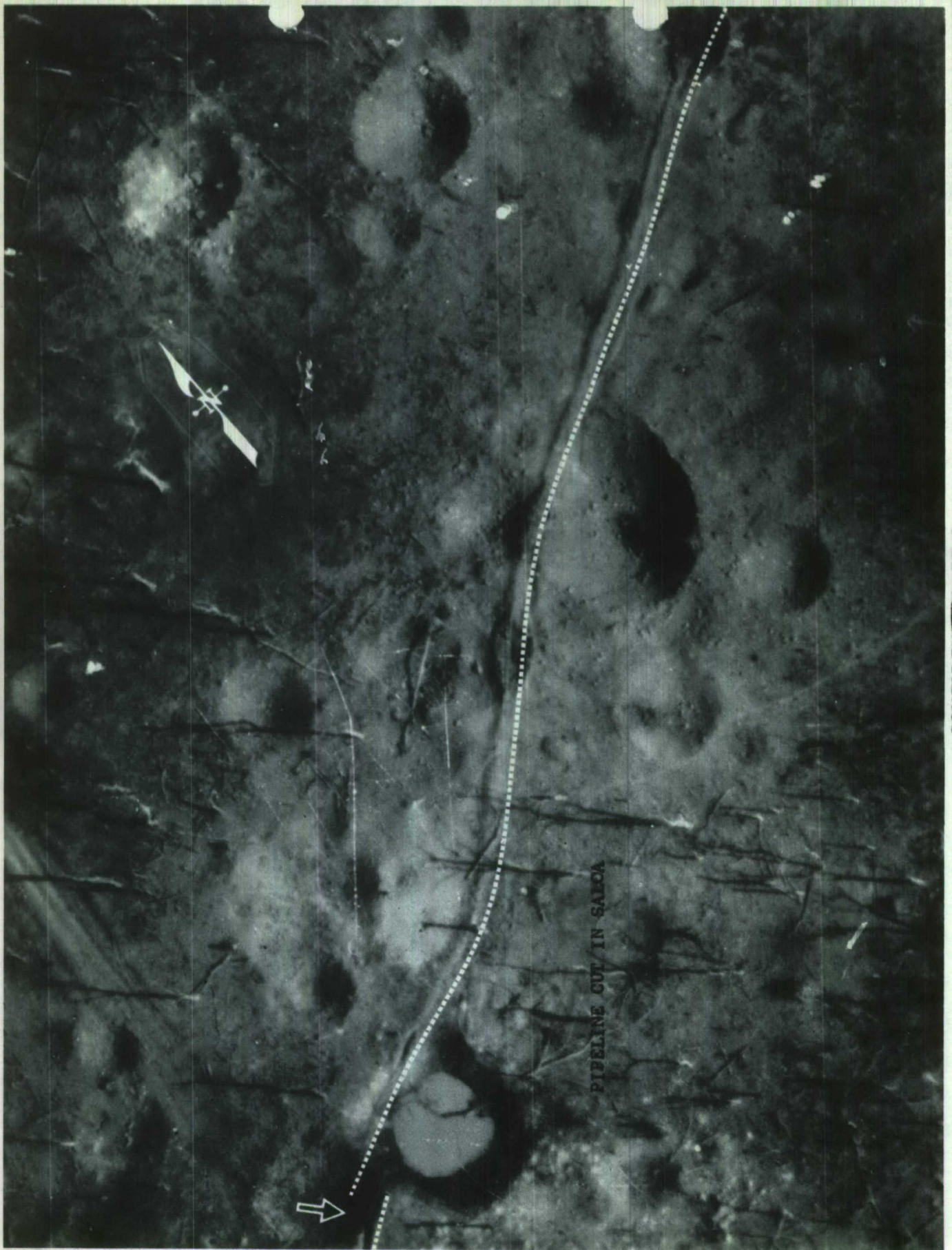
Figure 10



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Figure 11



~~CONFIDENTIAL GP-8~~

Figure 12



MULTIPLE PIPELINE CUTS

CONFIDENTIAL CP-8

Figure 13

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the POL flow by ground teams, seismic detection of flow in the pipelines in operation, Paveway designation-and-strike upon the service components such as pumps; all were tried.^{60/}

Analysis of recovered samples revealed that the pipeline was carrying gasoline under high pressure from north to south. Evidence of the high pressure was demonstrated by several "geyser" type POL fires following bombing strikes in the Mu Gia Pass area.^{61/} According to CAS sources, the pipes actually carried anything from gasoline, kerosene, to various grades of motor oil, depending upon the enemy's needs. To achieve this, the North Vietnamese simply shut off the flow of whatever they did not need, injected a "segment" of water into the pipe, then restarted the flow of whatever POL they did need. It was a simple matter at the terminus (or whatever interim storage point the new flow was needed) to detect the water, dump it, purge the lines for a few moments, and then divert the needed flow into the proper storage tanks.^{62/}

Controlled American Sources and Special Guerrilla Units interdicted the lines on several occasions, and such interdiction was considered probably the most cost-effective method of accomplishing the task. Usually, however, the parallel-line, check-valve construction, coupled with handy stockpiles and nearby repair crews, enabled the enemy to have the line back in operation within hours.^{63/} (See following photo--the circle shows stockpiled 20 foot lengths of pipe.)

CAS and other intelligence communities made a feasibility study on the possibility of contaminating the POL without actually interdicting

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the line. They considered a number of contaminants, sugar (molasses or dissolved sugar) to caramelize vehicle engines. This was, of course, the primary idea--ruin both the fuel and the truck at the same time. The feasibility study indicated that it would take approximately six thousand pounds of contaminant for 50,000 gallons of oil or fuel. The difficulties involved in this sort of an accomplishment ruled out its use. Friendly forces would have to transport about two helicopter loads of contaminant, plus the troops to make the injection into the pipe, plus the troops needed to protect them against the heavily patrolled pipeline. The helicopters would be easily detected by the enemy, and compromise would very likely take place rapidly.^{64/}

All these difficulties indicated that contaminants, although highly desirable, presented too many problems to overcome, and as a result, it appeared that continued interdiction of the lines by ground teams, by Arc Light strikes in the SALOAs and interdiction boxes, and by tactical air using Paveway munitions when a good target could be pinpointed, would continue to be the preferred options.^{65/}

Some of the best results came from multi-purpose ground operations. One team inserted during April and May 1969 had been tasked to monitor road traffic, reconnoiter the pipeline itself, map it if possible, and interdict it. On their egress to the pickup point, the team located a truck park with over 50 vehicles, so at their exfiltration point, the men turned back with charges which they placed under each truck's engine block, and destroyed them. So in one operation, the SGU team mapped

CONFIDENTIAL CP-2

CONFIDENTIAL CP-2

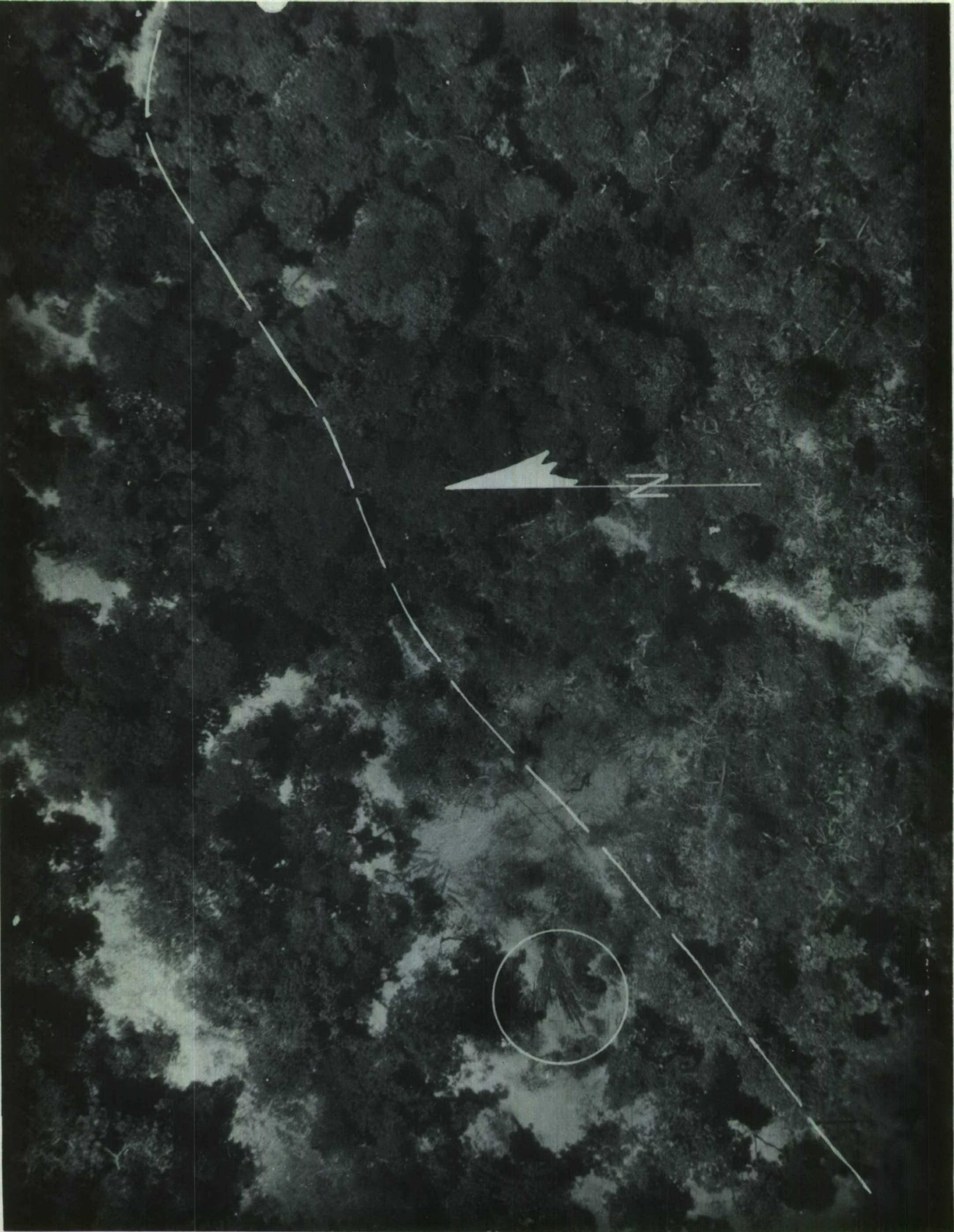


Figure 14

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the line, interdicted it, and destroyed an entire truck park. In all, a highly successful operation.^{66/}

Notwithstanding the individual successes, locating and cutting the pipeline and assessing the POL flow remained a difficult proposition. Task Force Alpha attempted tests, implanting seismic devices next to pipelines at Nakhon Phanom, Thailand, to see if they could detect flow-- and if possible, the rate of flow--in the lines. The tests made near NKP appeared to be successful, but the same type tests made at U-Tapao were not. It was suspected that the heavy aircraft traffic and noise negated the results of the U-Tapao tests. However, TFA concluded that it was worth trying against the NVA/Laos pipeline, and in October 1970 intended to implant one or more next to the line to determine whether this could develop into a successful technique. One drawback was the short life of the sensors--30 days--which would mean replanting them every month.^{67/} Results, as of this writing, had not been reported.

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CHAPTER III

THE TOTAL INTERDICTION AIM

Although the title and thrust of this report have concentrated on the waterways and pipelines in Laos, and have been focused primarily on that area west of the DMZ and south to Tchepone, these logistics systems cannot be taken out of context. The road system remained the major infiltration network, and it was against this network that the primary air interdiction effort was directed. The POL pipelines and waterways provided the enemy with the options he needed to increase the viability of his entire infiltration system.

The figure on the following page depicts the major route structure in the Panhandle of Laos as of mid-1970.^{68/} The main north-south LOCs roughly paralleled Routes 9, 92, and 96 in the eastern portion, and Routes 23 and 23/16 in the western segment of the enemy's most strongly dominated areas. The easterly heading roads, over which the NVA attempted throughput into South Vietnam ranged from Route 9 (entering Quang Tri Province near Khe Sanh), Routes 922, 923, 165, and 110, near the tri-border area of Laos, Cambodia, and South Vietnam.

On its scale, however, the map is necessarily over-simplified. From 1965 through 1970, the major routes have been interdicted innumerable times, and on each occasion - if road repair could not be immediately effected - bypasses were constructed or new roads built. To attempt to trace each new bypass, road, or trail (along with its numerical

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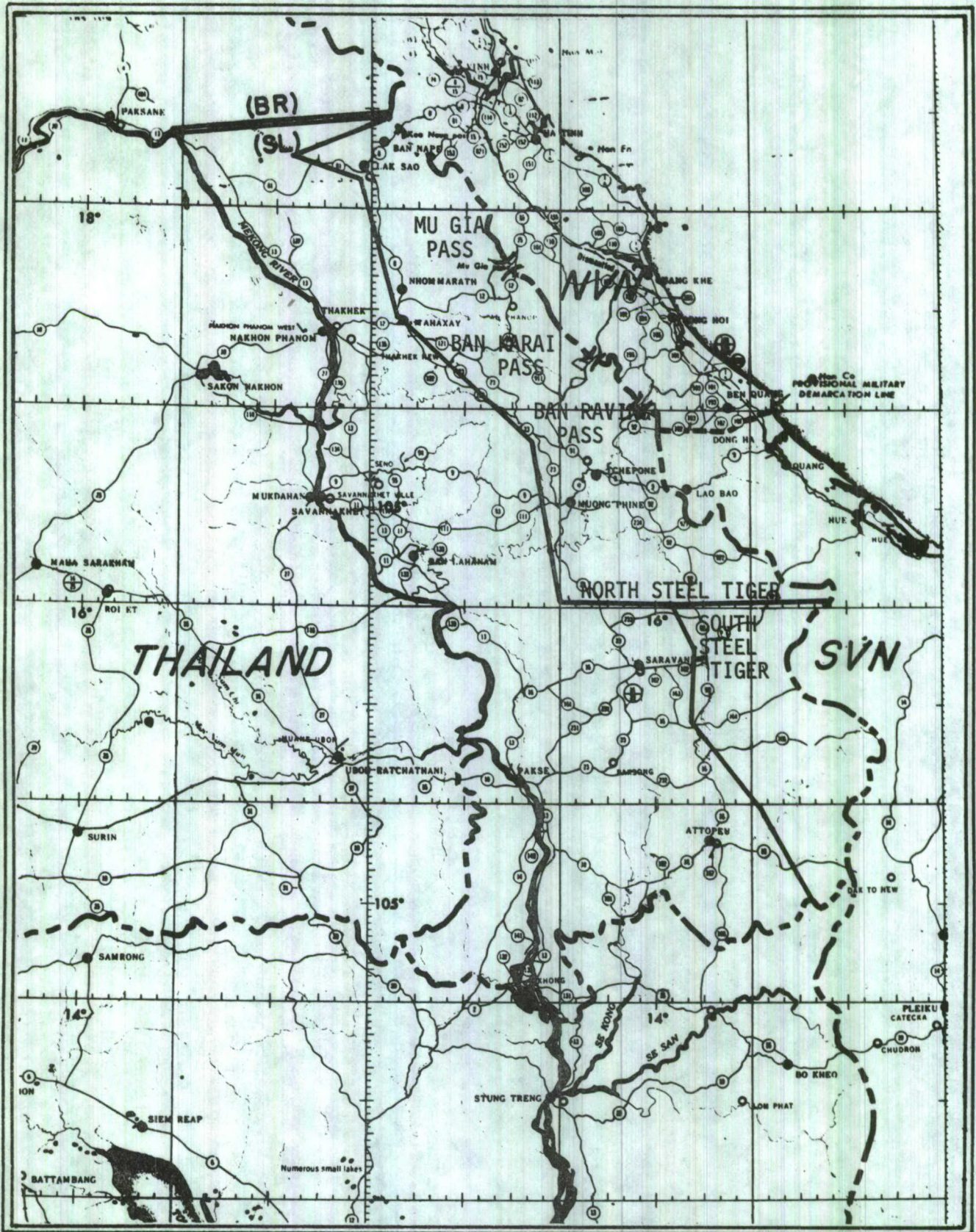


Figure 15

designator) would make the map a nearly indecipherable maze - which, in effect, is what the Ho Chi Minh Trail was. For example, at last count, Route 92 alone had route designators ranging from 92, 92A through 92G.

Nowhere in Laos was this road-trail complex so complicated as in that area west-southwest of Mu Gia Pass, to the south past the input roads leading from Ban Karai and Ban Raving Passes, around Tchepone, Delta 45, and Base Area 612, leading toward the A Shau Valley of South Vietnam. Because this route structure was so important to the enemy, it was understandably protected by the heaviest AAA, heavy machine gun, and small arms fire defenses in Laos.

The enemy attempted extensive hardening of this road network through soil stabilization, corduroying, and gravelling, from Mu Gia south to the approaches to the A Shau Valley, in order to extend the motorable period as long as possible. Rock quarries were opened, both within North Vietnam and Laos, to provide gravelling for the route structure.
^{69/}

The Boxes

If this road network was as important as the enemy indicated, and it was, then it was equally important that interdiction efforts be made to reduce its effectiveness as an LOC complex. Daytime, VFR attacks could accomplish but so much, and the NVA had long demonstrated their ability to repair road cuts rapidly and efficiently, given any respite. Twenty-four hour a day pressure was considered necessary if the interdiction program was to achieve a desired degree of success.

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Previously, several things had mitigated against effective 24 hour pressure. Even during the dry season, monsoonal "spillover" from the Annamite Chain of mountains made the area under consideration either marginal or totally under instrument conditions. Night normally precluded accurate bomb placement for road interdiction. Although the state of the art of all-weather precision target acquisition and bombing equipment (LORAN and MSQ) had progressed greatly, until cartographic update of the error-laden maps and charts covering Southeast Asia was made, such bombing was of questionable value.^{70/} This updating, through constant photo reconnaissance, interpretation and comparison brought, by September 1969, the beginning of the Laos LOC Data Base. This updating continued and, by 1970, was considered to be adequate for target planning in most instances.^{71/}

In October 1970, to counter the anticipated enemy dry season push, an Interdiction Box (IDB) program was instituted in the eastern Steel Tiger area against these LOCs. After intensive photo interpretation, analyses of CAS reports, and other intelligence inputs, four boxes, containing the heaviest concentration of road intersections, choke points, pipelines and waterways, were developed for saturation bombing by Arc Light forces.^{72/}

These boxes, one kilometer wide by two-to-five kilometers long*,

* The use of the metric determination of box sizes was based on the map used for targeting, the Army Map Service (AMS) 1:50,000 scale map which was laid out in Universal Transverse Mercator (UTM) grids measuring 1,000 meters, or one kilometer.

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were located at or near the primary NVA input passes. Box "Alpha" was located south and west of Mu Gia Pass; Box "Bravo" west of Ban Karai; "Charlie" near the southward turn of the Xe Ban Hiang west of Ban Raving; and Box "Delta" across the southwest corner of the DMZ, where Routes 92A and 1032B intersected at the Xe Bang Hiang/Houay Nam Xe river system.

All of the boxes were intended to cover the enemy at his most vulnerable points, enriched with intersections, chokes, and narrow throughways; doubly lucrative where pipelines and waterways provided secondary logistics flow. It became apparent, however, that as the campaign progressed, some of the original boxes became more easily repairable or bypassed, and they were accordingly modified or rotated to suit the situation. (See figures, following pages, which show various box configurations used in the Charlie and Delta areas.)

In addition to the continuing Arc Light strikes, the boxes were scheduled to receive Tac Air in the target areas to deter road repair efforts following the B-52 attacks. On a non-scheduled basis, fighter-bombers unable to strike specific fragged targets because of weather or other reasons could be diverted to drop their ordnance in the boxes by LORAN or MSQ direction. ^{73/}

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CHAPTER IV

SUMMARY

It has been apparent throughout this report that the focus of attention return again and again to the relatively small area of Indo-China called the Waterway 7 Logistics Complex. This focus was inescapable for several reasons. The enemy used, and continued to use throughout the time period covered, free flotation techniques from Phong Saly in the north of Laos, down to the Mekong River in Cambodia, but nowhere with such systematic organization and control as in the WW 7 Complex.

The POL pipeline system in North Vietnam and Laos was intricate and widespread, from Mu Gia Pass in the north to Route 922 at the entry of the A Shau Valley in the south, but in no area was it so interlinked with the waterways and road structures as it was in the Waterway 7 area.

The implications appeared clear; this was - as later events proved - the key area for the North Vietnamese regarding logistics flow and infiltration. It was literally "turning the corner" for them. From their sanctuary in North Vietnam to the fighting areas of South Vietnam, this was the one area that had to be open, one way or another, at all times. Hardened roads linked to waterways; POL pipelines linked to the roads; even walkable trails supplemented the others. In other words, it was basically in this small area that the NVA gave themselves as many options as possible in order to keep the transport of their supplies going.

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Phou Phasang

Phou Japha

Route 1039B

Ban Sôphali

XD 424675

XD 375667

INTERDICTION BOX "CHARLIE"

XD 377657

XD 426663

Ban Namhon

Ban Phabang Nua

Ban Phabang Nua

Ban Ryo

Phou Pata

Ban Thav

Ban Khounhon

Approximate depiction of some of the IDBs known as Interdiction Box "Charlie", where they cover the corner of the Xe Bang Hiang and cut Route 1039B. Several other "Charlie" boxes making up the entire complex are not shown on this map. (Map: Series L7015, Sheet 6242I, 1:50,000 scale.)

FIGURE 16

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It was so stated by Colonel Charles Morrison, Chief of the Fighter Division of 7th Air Force: ^{74/}

The enemy has many options, and this is a hard thing to get across to people; they are so heavily truck-oriented. But, he has pipelines, waterways, all-weather roads and he has trails. If one is interdicted, he switches to another. He has hardened storage areas which are almost impossible to get. And he has concentrated these in the Waterway 7 Logistics Complex. As important as it is for him to keep it open, it is just as important for us to shut it off, and this we must do by every means possible.

They [the enemy] "told" us clearly how important this waterways, POL pipeline, road complex was to them. They told us when they constructed it in the face of concentrated airstrikes, regardless of what losses they had to take. They told us when they set up one of the heaviest AAA threat areas in all of Laos, Cambodia and South Vietnam. They don't set up that kind of triple-A in areas that aren't critical to them. Ban Karai, Ban Raving, Waterway 7, Tchepone, Route 922, and Route 9, this is where he turns the corner.

There was little question but that the WW 7 Logistics Complex, with the Xe Bang Hiang and the POL pipelines as integrating factors along with the road network, comprised one of the most critical, if not the most critical, segments of the enemy's entire logistics system. There also appeared to be little doubt that it would require a massive rollback of the NVA AAA threat to make the area permissive to gunships, helicopters, and other slow movers, with their unique capabilities.

Fraggers planned on continued heavy Arc Light strikes in the boxes and SALOAs, and intensified day-night Tac Air strikes to interdict the waterways and pipelines which, along with the roads, gave the enemy the

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multiple options he needed to attempt his "end run" around the DMZ and south.

Lack of knowledge of the enemy's intent made it difficult to assess the effectiveness of the overall interdiction campaign in the Waterway 7 Logistics Complex. A lower level in input was noted, compared to previous periods, but whether this came about because of the interdiction pressure or because the enemy did not choose to increase his own efforts could not be determined. The combined entry-interdiction, normal armed reconnaissance, and QRF campaign was still on-going through December 1970, and a full assessment of the results remained to be seen. ^{75/}

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FOOTNOTES

1. (S) Msg, CINCPACAF to FTD/TDPT, Wright Patterson AFB, Ohio, Subj: "Request for Information on Soviet POL Pumps", 110109Z Aug 70. Also, Msg, CSAF to CINCPACAF, Subj: "Interdiction of Waterways and POL Pipelines", 212120Z Aug 70.
2. (S) Briefing Slides, Hq 7th AF DCS/O, Sep 70.
3. (S) Discussions with Col Charles M. Morrison, Chief, Fighter Division, Hq 7th AF, 18 - 25 Oct 70. Hereafter cited as "Discussions with Col Morrison."
4. (S) Paper, "Task Force Alpha Waterway Briefing," undtd (Circa Sep 70) (SUPDOC 1)
5. Ibid.
6. (S) Interview by CHECO personnel with Captain Daniel Adair, JUSMAGTHAI, 2 Nov 70. (Hereafter cited as "Interview with Capt Adair", (Notes taken, SUPDOC 2)
7. Ibid.
8. Ibid.
9. Ibid.
10. Ibid; Also, (S) Task Force Alpha Waterway Briefing.
11. (S) Discussions with Col Morrison. Also (S) Interview with Capt Adair. Also (S) TFA Waterway Briefing.
12. (S) TFA Waterway Briefing. Also, (S) Discussion with Captain Steven Wilson, TFA Targeting, 4 Nov 70, hereafter cited as "Discussion with Capt Wilson."
13. Ibid; Also, (S) Interview with Capt Adair.
14. (S) Discussions with Col Morrison.
15. Ibid.
16. Ibid; Also, (S) Discussions with Lt Col Edmund V. Everett, Operations Officer, 23rd TASS, Nakhon Phanom, Thailand, 4 Nov 70, hereafter cited as Discussions with Lt Col Everett.

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17. (S) Discussion with Capt Wilson. Also, Discussions with Col Morrison.
18. (S) Hq 7th AF DOPF Talking Paper, Subj: "Supply Destruction on Waterway Seven", hereafter cited as "Supply Destruction on Waterway Seven." (SUPDOC 3) Also, Discussion with Col Marvin O. Weber, Director of Operations, 56th SPOPW, NKP, Thailand, 4 Nov 70.
19. (S) "Supply Destruction on Waterway Seven." Also, Discussion with Col Morrison (Notes included as SUPDOC 4).
20. (S) Discussion with Lt Col Everett.
21. (S) TFA Waterway Briefing. Also (S) 7AF IN Comment, 12 Feb 71.
22. (S) Interview by CHECO personnel with Colonel Morrison. Also (S) TFA Waterway Briefing.
23. (S) Briefing paper, titled "RAPIDS" (River and Pipeline Interdiction Detection Study), Hq 7th AF, Sep 70, hereafter cited as "RAPIDS". (SUPDOC 5) Also, 7AF Intel Targets Comment, 12 Feb 71.
24. Ibid; Also (S) Discussions with Lt Col Everett; Also, (S) Interview by CHECO personnel with Colonel Gordon H. Scott, Director of Operations, 7/13th AF, 30 Oct 70, hereafter cited as "Interview with Col Scott."
25. (S) RAPIDS; Also (S) 7AF Intel Targets Comments, 12 Feb 71; Also (S) "Interview with Col Scott."
26. (S) Supply Destruction on Waterway Seven (WW 7).
27. (S) "RAPIDS".
28. (S) Supply Destruction on WW 7.
29. (S) Briefing Slides, Hq 7th AF DCS/O, Sep 70 (Extracts, SUPDOC 6.)
30. (S) Discussion with Captain James W. Kellogg, Hq 7th AF DOPF, 7 Dec 70, hereafter cited as Discussion with Capt Kellogg. Also, (S) Briefing Slides, Hq 7th AF DCS/O, Sep 70.
31. Ibid.

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32. (S) Interview with Col Scott.
33. (S) Supply Destruction on WW 7.
34. (S) Discussion with Capt Kellogg.
35. Ibid.
36. (S) Information supplied by Hq 7th AF INX/INTTT during coordination of this report.
37. (S) "RAPIDS."
38. (S) TFA POL Pipeline Study, undtd, late 1970. (SUPDOC 7)
39. (S) 12th Reconnaissance Intelligence Technical Squadron Report; Titled, "Development of North Vietnamese Pipelines and their Extension into Laos, Apr 69 - Oct 70", hereafter cited as "12th RITS 1970 Pipeline Report" (SUPDOC 8). Also, (C) NPIC Report; Titled, "Status of POL Pipeline in North Vietnam and Laos", hereafter cited as "NPIC Report, POL Pipeline, NVN/Laos" (SUPDOC 9).
40. Ibid.
41. Ibid.
42. Ibid.
43. Ibid.
44. (S) Interview with Capt Adair.
45. Ibid.; Also (S) Photo interpretation by 12th RITS.
46. (C) 12th RITS 1970 Pipeline Report. Also, (S) Interview with Capt Adair.
47. (C) 12th RITS 1970 Pipeline Report.
48. Ibid.
49. Ibid.
50. (S) TFA POL Pipeline Study.
51. Ibid.
52. Ibid.; Also, (S) Interview with Capt Adair.
53. (S) TFA Pipeline Study. Also, (C) NPIC Report, POL Pipeline, NVA/Laos.

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54. Ibid.
55. (S) U.S. Army TSTC Study, Sep 65, extracted. (SUPDOC 10)
56. (C) NFIC Report, POL Pipeline, NVA/Laos.
57. Ibid; Also, (S) Extract from Department of the Navy Fleet Intelligence Center, Pacific; "POL Pipeline in North Vietnam", undtd, hereafter cited as "FIC, Pacific, Report". (SUPDOC 11)
58. (C) 12th RITS 1970 Pipeline Report. Also, (S) Discussions with Captains Wilson and Adair.
59. (S) Discussions with Col Morrison.
60. (S) "RAPIDS".
61. (S) FIC, Pacific, Report.
62. (S) Interview with Capt Adair.
63. Ibid.
64. Ibid.
65. Ibid; Also, (S) Discussions with Col Morrison.
66. (S) Interview with Capt Adair.
67. (S) Discussion with Capt Wilson.
68. (C) Alfa-Topo CART (Cartographically Accurate Route Trace), History and Evaluation, TFA, 25 Aug 1970. Hereafter cited as Alfa-Topo CART.
69. (S) PACAF (IN-Estimates) Comments, 12 Feb 1971.
70. (C) Alfa-Topo CART.
71. Ibid.
72. (S) Hq 7AF "For Comment Draft", "Preliminary Analysis of Entry Interdiction Program - First 60 Days," undtd. Prepared by Hq 7AF DOA. Hereafter cited as "7AF for Comment Draft."
73. Ibid.
74. (S) Discussion with Col Morrison.
75. (S) Hq "7AF For Comment Draft."

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GLOSSARY

AAA	Antiaircraft Artillery
AMS	Army Map Service
BDA	Bomb Damage Assessment; Battle Damage Assessment
CAS	Controlled American Source; Close Air Support
CBU	Cluster Bomb Unit
DIA	Defense Intelligence Agency
DMZ	Demilitarized Zone
FAC	Forward Air Controller
GPM	Gallon Per Minute
IDB	Interdiction Box
LOC	Line of Communication
LORAN	Long-Range Navigation
NKP	Nakhon Phanom
NVA	North Vietnamese Army
POL	Petroleum, Oil, and Lubricants
POW	Prisoner of War
PPS	Petroleum Products Storage
QRF	Quick Reaction Force
RLAF	Royal Laotian Air Force
SALOA	Special Arc Light Operating Area
SGU	Special Guerrilla Units
TFA	Task Force Alpha
UTM	Universal Transverse Mercator
VFR	Visual Flight Rules
WW 7	Waterway 7