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Throughput Capacity Estimation

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This paper focuses on that aspect of logistic support planning which has broken down in the last two wars in which U.S. forces were involved, namely, throughput capacity. Throughput capacity is made up of three components, post reception, port discharge and port clearance. A simple methodology is developed for defining a port complex in terms of the variables which influence throughput capacity. Such factors as vessel characteristics, both deep draft and lighterage, port facilities, road and rail net capabilities, support units and their equipment, etc. will be considered in the analysis. Once identified and defined, the variables will be interrelated one to the other in an effort to build a simple model that will replicate actual operations at a port complex and estimate potential throughput capacity. This model will be called the Port Capacity Estimator (PORTCAP). Although this paper and PORTCAP are built around the Middle East scenario, it is sufficiently flexible to be used in describing the capabilities and limitations of other port complexes around the world.

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ACKNOWLEDGEMENT

I am deeply indebted to CPT E. T. Smith for his contribution to the development of the Port Capacity Estimator (PORTCAP) model which is an integral part of this project. Without his contribution, PORTCAP could not have been successfully brought to its present stage of development.

SECTION I: INTRODUCTION

Since the end of World War II, U.S. military forces have been involved in two wars which have taken place a considerable distance from their base of supply. Such operations place a significant burden on all aspects of logistics and makes accurate logistics planning very difficult. This is particularly true if U.S. forces have little or no experience in the area of operations prior to the outbreak of hostilities. The problems that require solution are not restricted to one segment of the pipeline, CONUS or the theater, to one aspect of logistics, such as supply or maintenance, or to one mode of transportation, such as sealift or airlift. All activities responsible for logistics must plan and prepare in the event hostilities are initiated.

Experience in the last two wars, however, has revealed that bases in CONUS and overseas supporting U.S. forces in a contingency are far better able to cope with rapidly expanding supply requirements than the theater commander. In the case of Korea, no plans existed for the orderly flow of men, material, and supplies to support committed forces. Discharge and clearance capacity at Pusan was inadequate resulting in chaos and considerable congestion at the port. Needed supplies could not be identified and moved as required. MG Garvin, appointed Chief Logistician by General Dean at the outset of hostilities in 1950, remarked, "The Korean operation was probably the most unplanned operation in the history of our Armed Forces."[1]

Even when considerable effort is made to write logistic support plans for a contingency, the same problems appear. U.S. forces in Vietnam experienced considerable difficulty in locating critical supply items in country. As late as Feb. 1968 some 100 vessels were awaiting discharge off the coast of Vietnam.[2] In the case of Vietnam logistic's planners had recognized the inadequacy of the one major port in the country to support large scale military operations. However, they failed to develop alternatives to cope with shortfalls, nor did they anticipate the size and speed of the buildup that eventually took place.

This paper will focus on that aspect of logistic support planning which has broken down in the last two wars in which U.S. forces were involved, namely, throughput capacity. Throughput capacity is made up of three components, port reception, port discharge and port clearance. A simple methodology will be developed for defining a port complex in terms of the variables which influence throughput capacity. Such factors as vessel characteristics, both deep draft and lighterage, port facilities, road and rail net capabilities, support units and their equipment, etc. will be considered in the analysis. Once identified and defined, the variables will be interrelated one to the other in an effort to build a simple model that will replicate actual operations at a port complex and estimate potential throughput capacity. This model will be called the Port Capacity Estimator (PORTCAP) and will be completed for elective credit in term 3, course 6600. Although this paper and PORTCAP are built around the Middle East scenario, it will be sufficiently flexible to be used in describing the capabilities and limitations of other port complexes around the world.

SECTION II: METHODOLOGY

A. Problem Statement. The specific task of this paper is to:

1. Identify and define, using the country of Dromar in the Middle East scenario, the major variables affecting the capability of a port complex to receive, discharge, and clear cargo in support of deployed forces. (complete for IRR credit)

2. Integrate the variables identified in step one into a working computer model that is capable of describing the networks throughput capabilities and limitations. (complete for 6600 credit)

3. Test the models application by placing supply demands on the system generated by the authors of the 3141 Middle East scenario and other student authors working on the problem. (complete for 6600 credit)

B. Assumptions and Limitations.

In order to define the limits of the problem, to meet time constraints, and to focus attention on important variables, certain assumptions must be made and limitations imposed. A list of the important assumptions and limitations of this study are identified below:

1. Assumptions

a. Airlift. Five percent of all cargo demands placed on the system will be moved to the theater by airlift.[3]

b. Berthing space. All usable berthing space allocated to U.S. military forces will be occupied and working based on a 20 hour day, seven days per week. This assumption is based on the fact that in each of the last two wars lengthy ship queues developed in the early stages of a contingency.

mased berthing space was non-existent.

c. Engineer support. Adequate engineer support to maintain facilities selected for use is available.

d. Civilian manpower. Civilian manpower and equipment from the Broman Ministry of Transportation will be made available to U.S. forces to operate the rail network.

2. Limitations

a. Time constraint. This project is so broad in scope and takes into consideration so many new factors in the changing transportation environment that the time constraint may make it impossible to complete the entire project in this academic year. Other transportation officers having an interest in this area may continue work on the PORTCAP model in the next academic year.

C. Researh Organization.

1. Section III of this paper provides the reader with information on present sealift assets available to Military Sealift Command (MSC). The changes which have occurred in the merchant marine fleet have had a dramatic impact on how transportation planners must balance assets available against requirements. A brief description of the types and characteristics of principal ships in the fleet is also presented. The second part of Section III gives the reader a foundation in the concept of throughput capacity. It describes briefly the three major components of throughput --- reception, discharge, and clearance and discusses their interrelationship.

2. Section IV is divided into three subsections corresponding to the three components of throughput. Each subsection

identifies the facilities network available for use by the planner in the Dromar scenario, i.e., wharf facilities, anchorages, rail and road nets. The key planning factor variables he must take into consideration to calculate overall throughput capacity for a particular port complex are also defined. The range of port facilities and transportation networks evaluated encompass operations at both fixed port facilities as well as logistics over-the-shore (LOTS) operations. In addition to the discharge of traditional breakbulk vessels, the system can handle containerships, roll on/roll off(RORO) ships, and lighter aboard ship (LASH).

3. It does the planner little good to know the capabilities and limitations of a network if he is unable to determine the impact of various size force packages and different ship mixes on the system. Section V of this study effort will be completed in Term 3 for elective credit in course 6600. It will include the design and operation of a simple analytical model that will provide the transportation planner a significant degree of flexibility in applying the planning factors identified in section IV. Test runs of model input and output, with program parameters, will be submitted at the conclusion of term 3.

SECTION III: VESSEL CHARACTERISTICS AND THE CONCEPT OF THROUGHPUT CAPACITY

A. Vessel Characteristics.

1. General. Over the past ten years the determination of throughput capacity has been complicated by changes in our merchant marine fleet. The addition of the containership has resulted in sizeable reductions in the time and number of personnel required to load and unload vessels, thereby upsetting traditionally used planning factors. The military has been slow in changing its doctrine and upgrading terminal units and equipment to deal with these most recent developments in the maritime industry. Only in the last few years have the services accelerated test and development of systems and equipment to deal with containers.[4]

2. Fleet assets available.

Military Sealift Command (MSC) is the operating agency responsible to see that sufficient sealift assets are available to support military forces worldwide. To meet its committments MSC has the following assets:

a. MSC Nucleus Fleet. Since the Vietnam War the MSC nucleus fleet has been steadily declining in size and capacity. At the present time only 35 dry cargo vessels are owned and operated under MSC control, none are containerships.[5] The deep draft vessels of the fleet are normally used on scheduled runs to support overseas bases which are not adequately served by the commercial fleet.

b. National Defense Reserve Fleet (NDRF). Approximately one hundred and fifty deep draft vessels, presently

EXHIBIT III-1
MSC NUCLEUS FLEET[6]

Ship type	Classification	Nr. Avail.
Large ocean going vessel (C4, RoRo)	A	3
Standard ocean going vessel (VC2, C2)	B	11
Small ocean going vessel (C1)	C	3
LST (intracoastal)		18
	Total	35

in moth balls, make up the NDRF fleet.[7] The majority of them, however, are pre-WWII vintage and exceed thirty years of age. their slow speed and age make them of questionable value as support ships in the future.

c. U.S. Merchant Marine Fleet. It is primarily from the U.S. Merchant Marine fleet that MSC procures sealift assets to meet its worldwide requirements both in peacetime and war. In an emergency, requiring the implementation of a contingency OPLAN, commercial carriers can be required, under the Sealift Readiness Program (SRP), to commit a minimum of 50% of their fleet vessels to the Department of Defense. In return for this committment, each carrier receives a share of DOD cargo in peacetime. Presently, more than 230 ships of all types are in the SRP to meet military requirements.[8] In stage 1 of SRP, MSC can obtain forty five vessels, ~~eleven~~ four breakbulk, thirty seven container, and four LASH between days C-11 to C-30.[9] While it is true that the number of vessels in the U.S. Merchant Marine fleet has been steadily declining, actual carrying capacity has increased. This change in emphasis to larger vessels has resulted from the growth of the container industry and the building of very large, fast non-self-sustaining containerships. In addition, new concepts in barge vessels have resulted in the development of the Lighter Aboard Ship (LASH) and Sea Barge (SEABEE) systems.

3. Port Capacity Estimator Model and ship characteristics. Vessels utilized in the PORTCAP model are divided into three types, breakbulk, container, and special purpose vessels like LASH and RoRo. The vessel characteristics of importance to the planner are found in Exhibits III-2, III-3, and III-4. LASH mother ships used in the PORTCAP model can be configured to carry barges only, containers only, or a mix of both barges and containers. In addition, PORTCAP includes the characteristics of the SEABEE, and the SL7, SL18 super containerships. However, none of these vessels are available to MSC under the Sealift Readiness Program.[10] In a 60-90 day conflict it is unlikely that commercial carriers would care to risk berthing one of these vessels in a hostile fire area. It is more likely, in the case of super containerships, that they might be used in a feeder operation with smaller less vulnerable containerships making runs directly into the area of operations.

B. Throughput Concept Defined.

1. General. A terminal's throughput capacity is the amount of cargo, expressed in short tons (STONS), that can be moved through a terminal in one day. It is derived by computing and then comparing the three components of throughput, terminal

EXHIBIT III-2
CONTAINER VESSEL CHARACTERISTICS[11]

Large Ocean Vessels - Class A

	C5/C6	SL7	SL18
Length (ft)	625	947	721
Width (ft)	78	105	95
Draft (ft)	32	34	34
Speed (knots)	20	33	23
Containers	1000 TEU*	896-35' 200-40'	412-35' 321-40'

*TEU represents 20' equivalent containers

EXHIBIT III-3
BREAKBULK AND RORO VESSEL CHARACTERISTICS[12,13]

	Small Ocean Vessel C1	Standard Ocean Vessel C2/VC2	Large Ocean Vessel C3/C4	RoRo
Length (ft)	339	442	506	700
Width (ft)	63	57	73	90
Draft (ft)	23	29	31	28
Speed (knots)	10	15	18	25
Dry Cargo (LTONS)	6000	10700	13000	10000

EXHIBIT III-4
LIGHTER ABOARD SHIP (LASH)[14]

	Config. 1	Config. 2	Config. 3
Length (ft)	893	893	893
Width (ft)	100	100	100
Draft (ft)	30	30	30
Speed (knots)	22	22	22
Dry Cargo (LTONS)	18-20000	18-20000	18-20000
Barges	89[a]	50[b]	0[c]
Containers 20'	0	550	1498

a Configured with maximum barge carrying capacity.
b Configured for mix of barges and containers.
c. Configured for maximum container carrying capacity.

EXHIBIT III-5

SL-7 CONTAINERSHIP

SS-SEALAND FINANCE

* Largest and fastest nonself-sustaining containership in U.S. Merchant Marine fleet. Carries more than 1000 35 and 40 ft cans. Capable of speeds to 33 knots.15

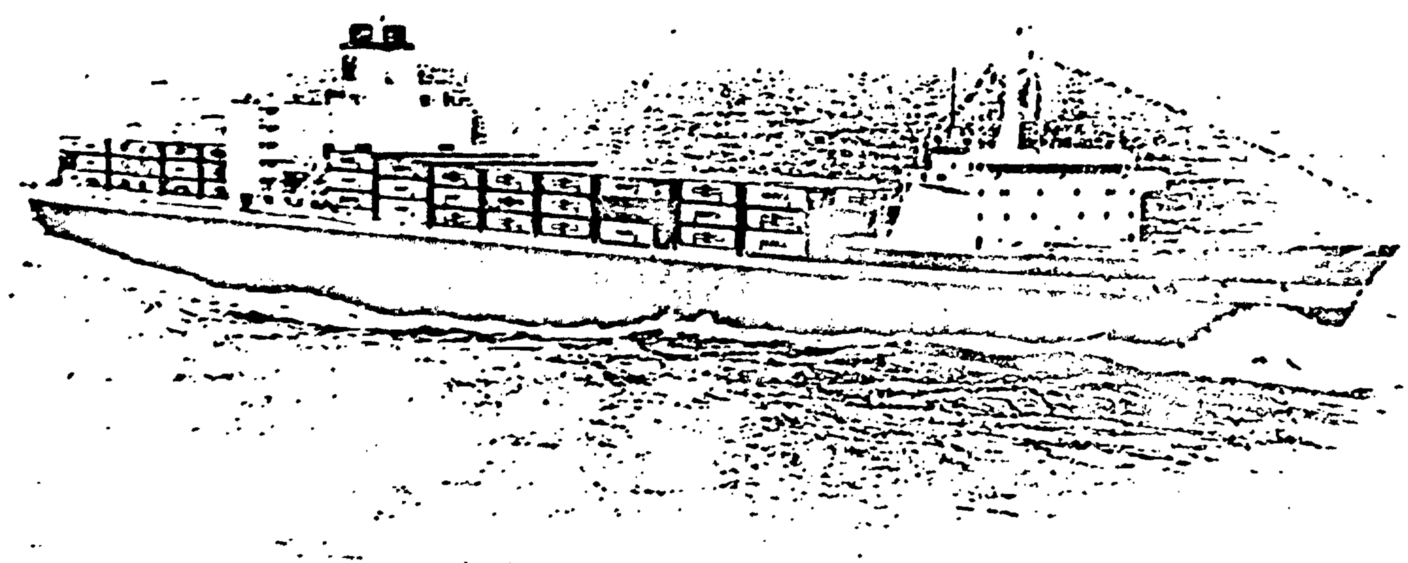


EXHIBIT III-6 16

MATSON ROLL ON/ROLL OFF SHIP

* RoRo vessels are used to transport all types of combat vehicles to AO. Can also carry containers on chassis. Rapid discharge rates are possible.

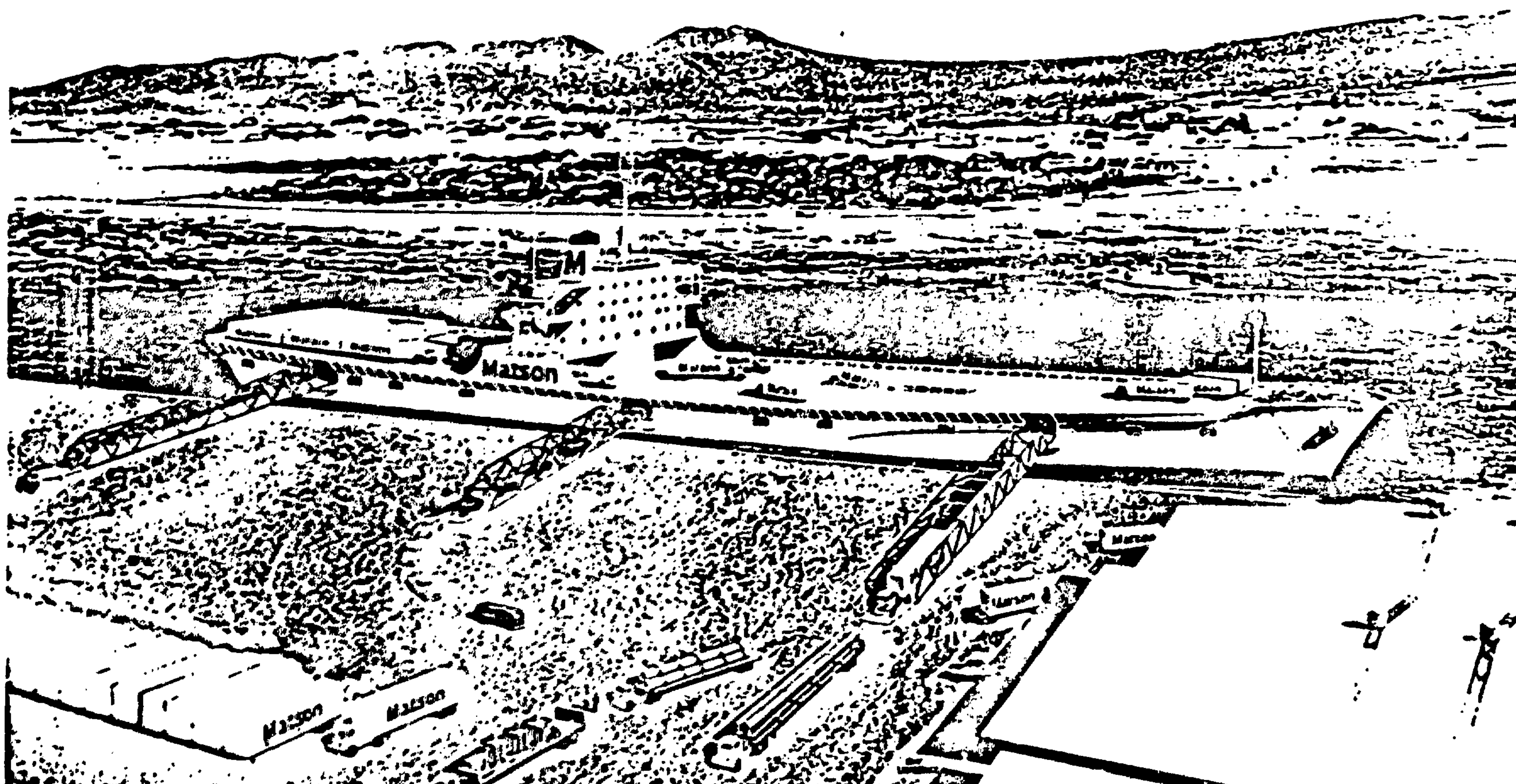


EXHIBIT III-7
LIGHTER ABOARD SHIP (LASH)

* "LASH discharging a barge. The load moves out over the aft well, and the crane then lowers the barge into the water where it is taken under tow by tug..."[17]

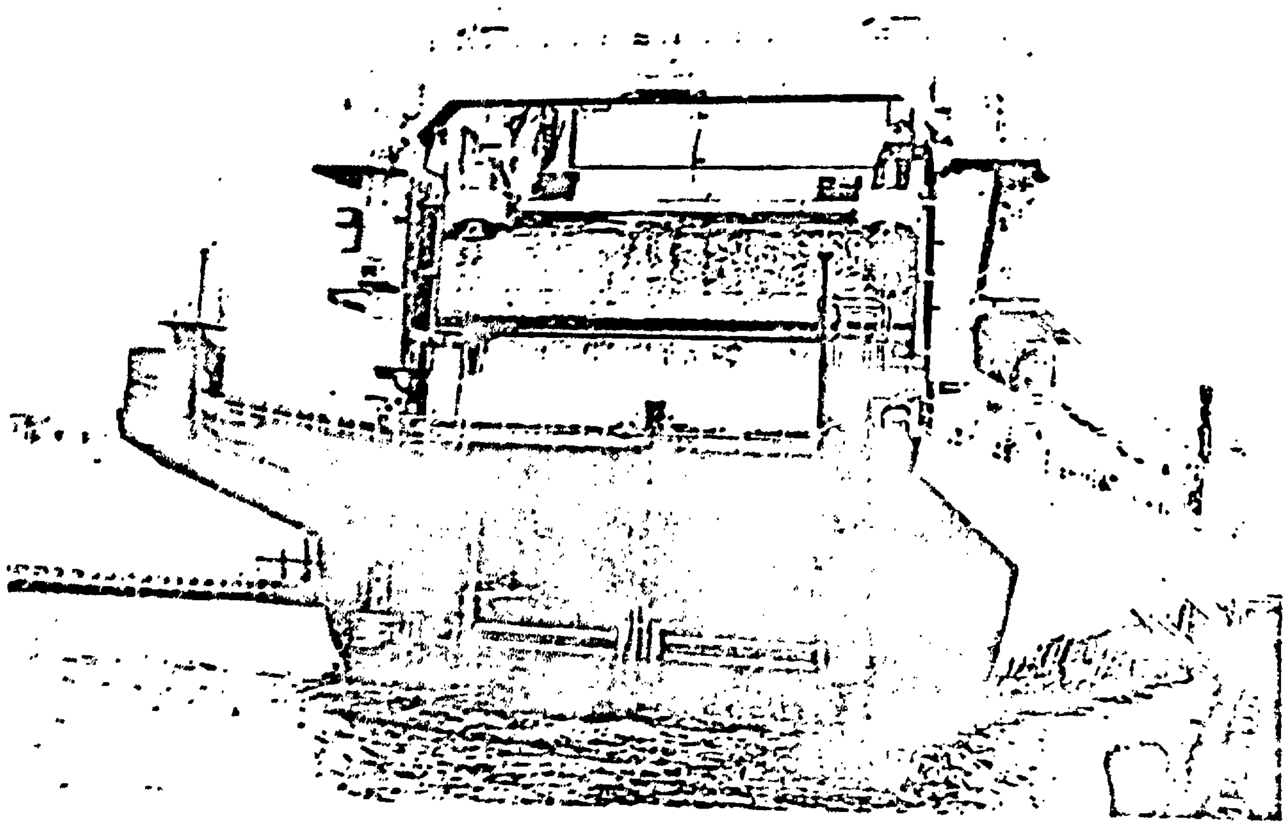
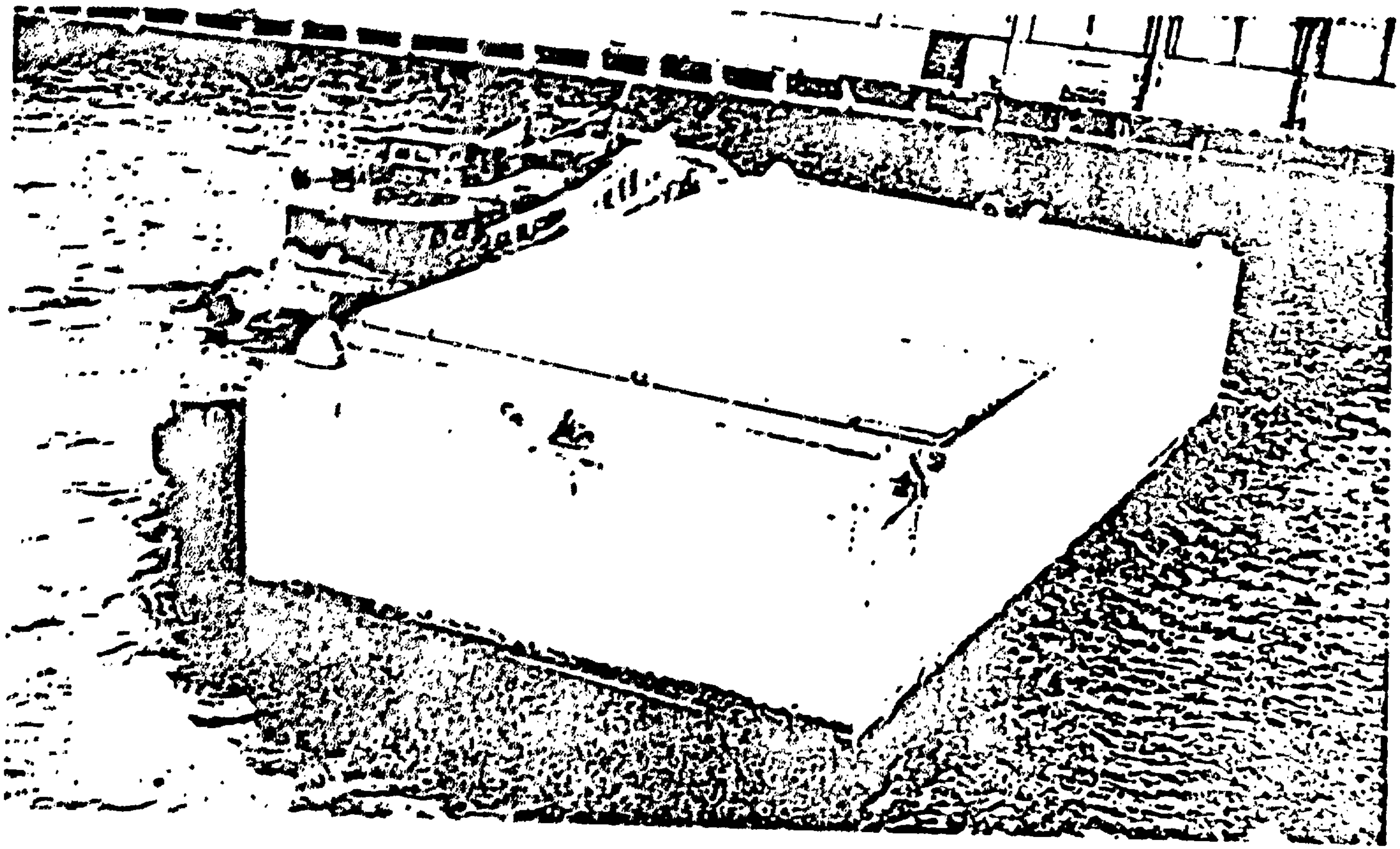


EXHIBIT III-8

LASH BARGE

* "LASH-type barge under tow. These relatively shallow draft barges extend ocean shipping services into otherwise inaccessible areas."18



reception capacity, terminal discharge capacity, and terminal clearance capacity.

2. Terminal Reception Capacity.

Terminal reception capacity is based on the number of deep draft vessels that can be moved into a harbor or coastal area and accommodated for discharge. The capacity is expressed in terms of an estimated tonnage that could be discharged daily, if appropriate support units and equipment discussed under discharge capacity were available. Reception capacity is primarily determined by the set of physical facilities available in a port complex. The physical facilities of most importance are the following:

a. Wharf space available for deep draft vessels.

b. Anchorage areas in stream or roadstead from which discharge to lighters can be accomplished.

c. Wharf space for berthing lighterage craft.

d. Beach areas suitable for LOTS operations.

e. See Exhibit III-9 for a more comprehensive list of factors affecting reception capacity.

3. Terminal Discharge Capacity.

Physical facilities and vessels alone will not insure the arrival of cargo in the AO. Sufficient terminal units, lighterage units, and equipment must be available for discharge operations. Terminal discharge capacity is expressed as the number of STONs that can be discharged from ships accommodated at the port each day. Discharge capacity in the PORTCAP model is based primarily on an evaluation of the following factors:

a. Lighterage craft available

b. Available cargo handling equipment, i.e., cranes, forklifts, ship's gear, etc.

c. Terminal unit or civilian personnel to operate cargo handling equipment.

d. See Exhibit III-9 for additional considerations.

4. Terminal Clearance Capacity.

This figure represents the number of STONs per day that can be moved through and out of the terminal. Terminal clearance capacity is a function of the following:

a. Capability of the rail and highway net adjacent to the terminal to sustain cargo movement.

b. Availability of transport equipment, i.e. rail rolling stock, commercial vehicles, military vehicles, etc.

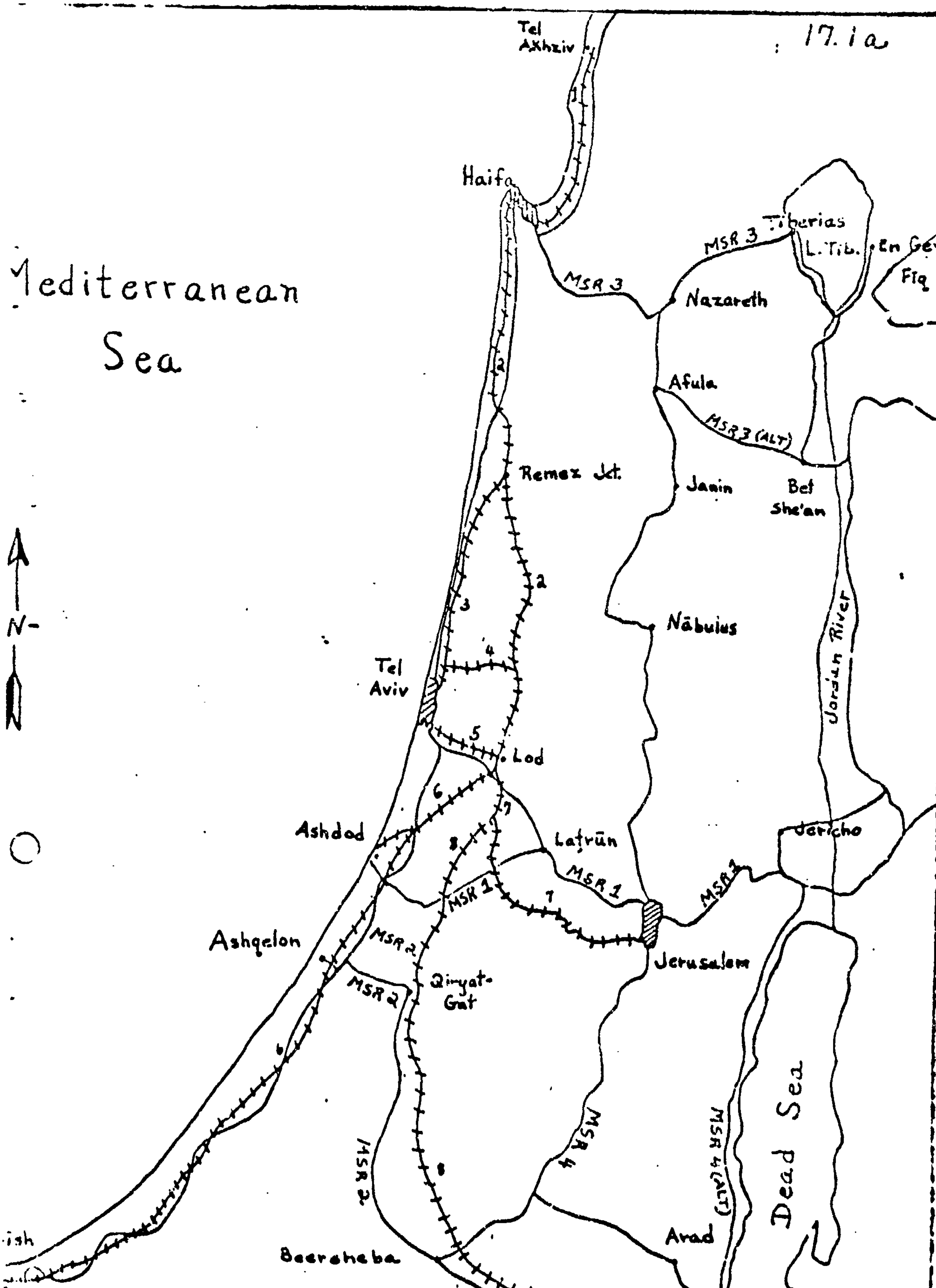
c. Military truck unit and civilian personnel to operate transport equipment.

d. See Exhibit III-9 for additional considerations.

5. The final objective of PORTCAP is to arrive at throughput capacity. This figure is obtained by comparing the values of reception, discharge, and clearance capacity. The most restrictive of the three figures in short tons per day becomes actual throughput capacity.

EXHIBIT III-9
VARIABLES AFFECTING THROUGHPUT CAPACITY[19]

Collect this data	Compute these Components	To determine
Vessel characteristics Channel depths Obstructions Enemy activity Extent of port destruction Weather, climate & tide Anchorage areas Wharf facilities Beach facilities Transit sheds & storage areas Requirements of local economy Tactical dispersion	Water Terminal Reception Capacity	Throughput Capacity
Availability of terminal operating units Availability of indigenous labor Discharge rates Cargo handling equipment Weather & climatic conditions Enemy activity	Water Terminal Discharge Capacity	
Capacity of rail, road, inland water network Avail. of indigenous labor Avail. of mode operating units Avail. of rail operating stock Weather & climatic conditions	Water Terminal Clearance Capacity	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Akhziv
Haifa
Tiberias
L. Tib.
En Gev
Fiq
MSR 3
MSR 3
Nazareth
Mediterranean
Sea
Afula
MSR 3 (ALT)
Remez Jct.
Janin
Bet
She'an
Nābulus
Jordan River
N
Tel
Aviv
Lod
Ashdod
Latrūn
Jericho
MSR 1
MSR 1
MSR 1
Jerusalem
Ashqelon
MSR 2
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Qiryat-
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MSR 4 (ALT)
Dead Sea
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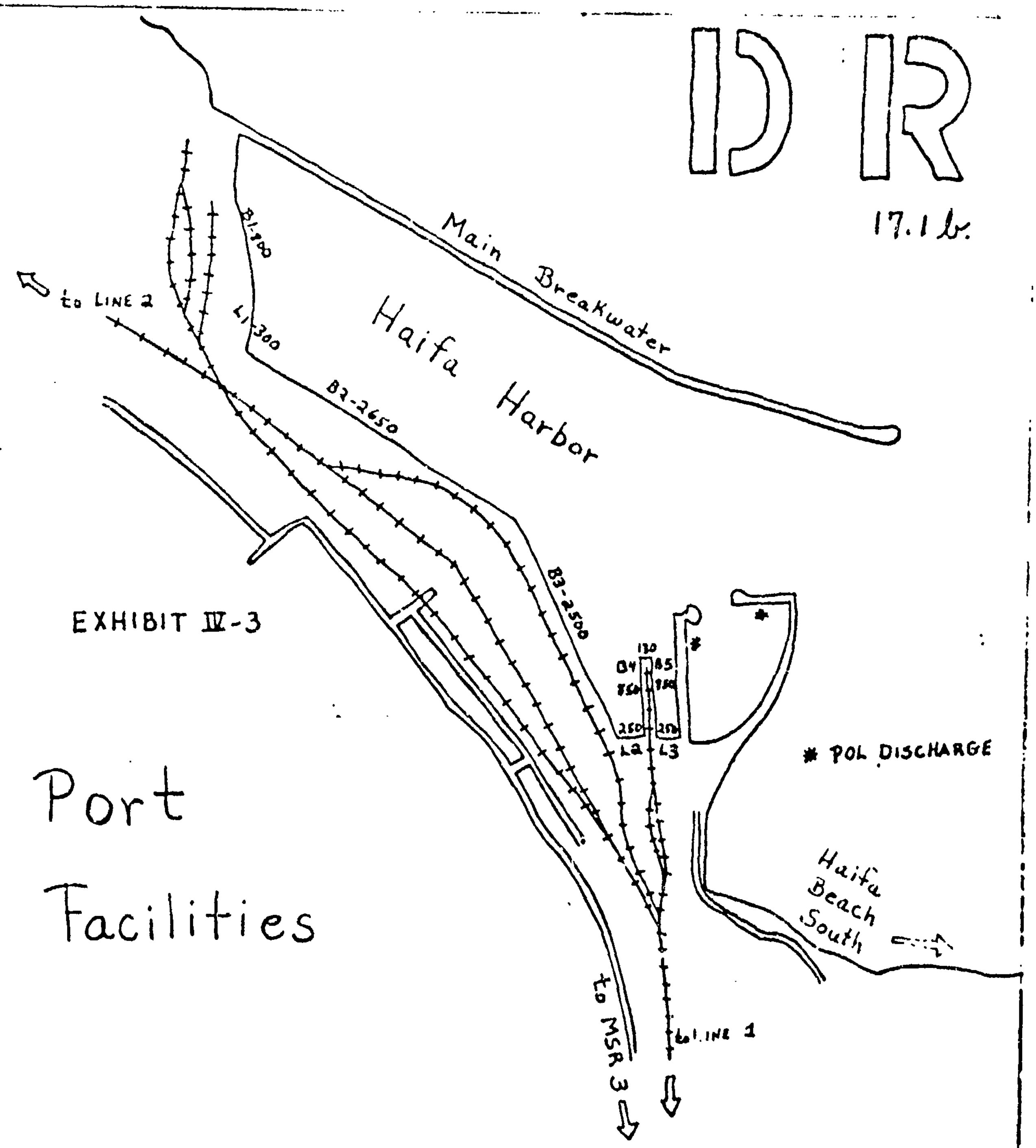
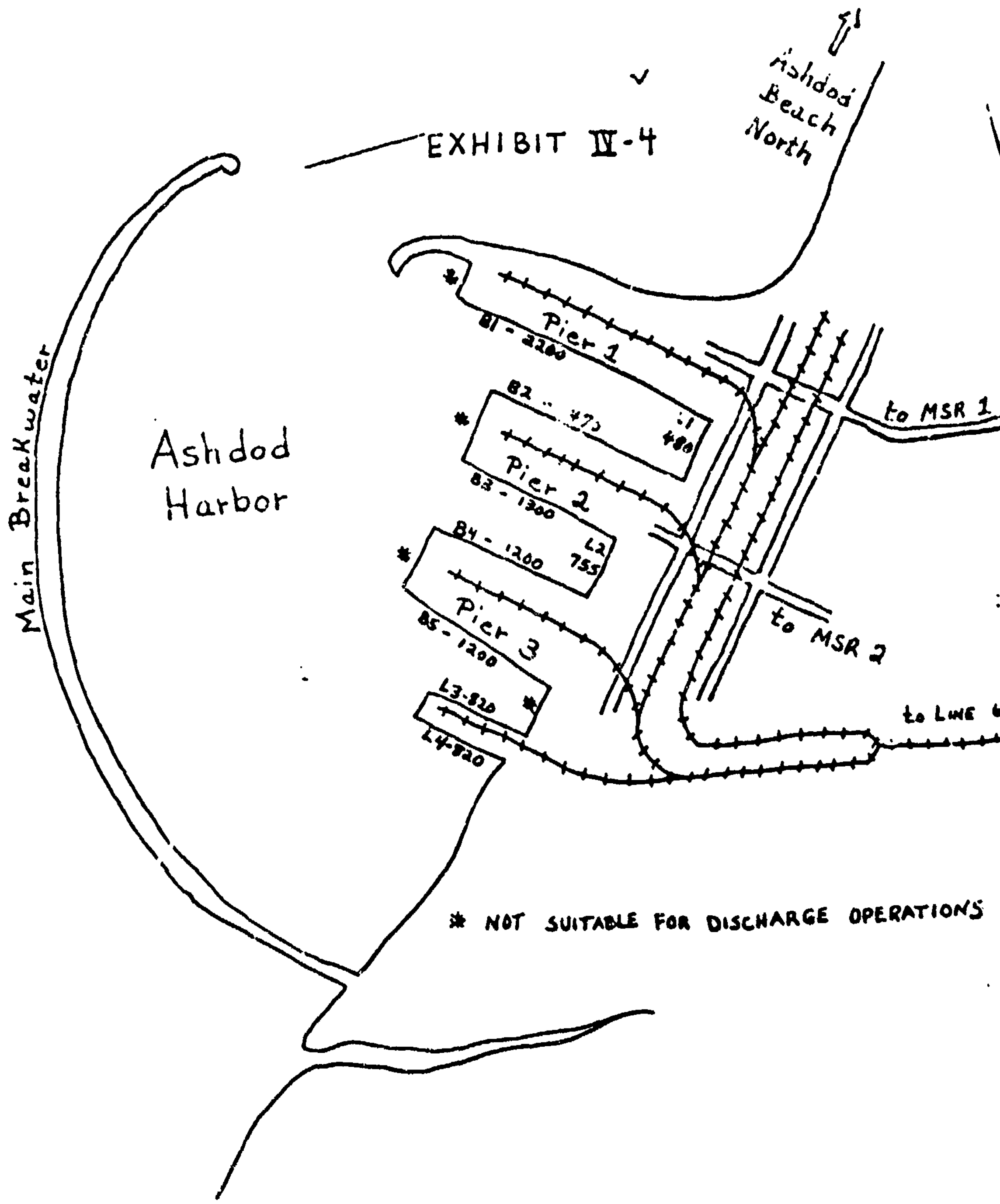


EXHIBIT IV-3

Port Facilities

17.1c.

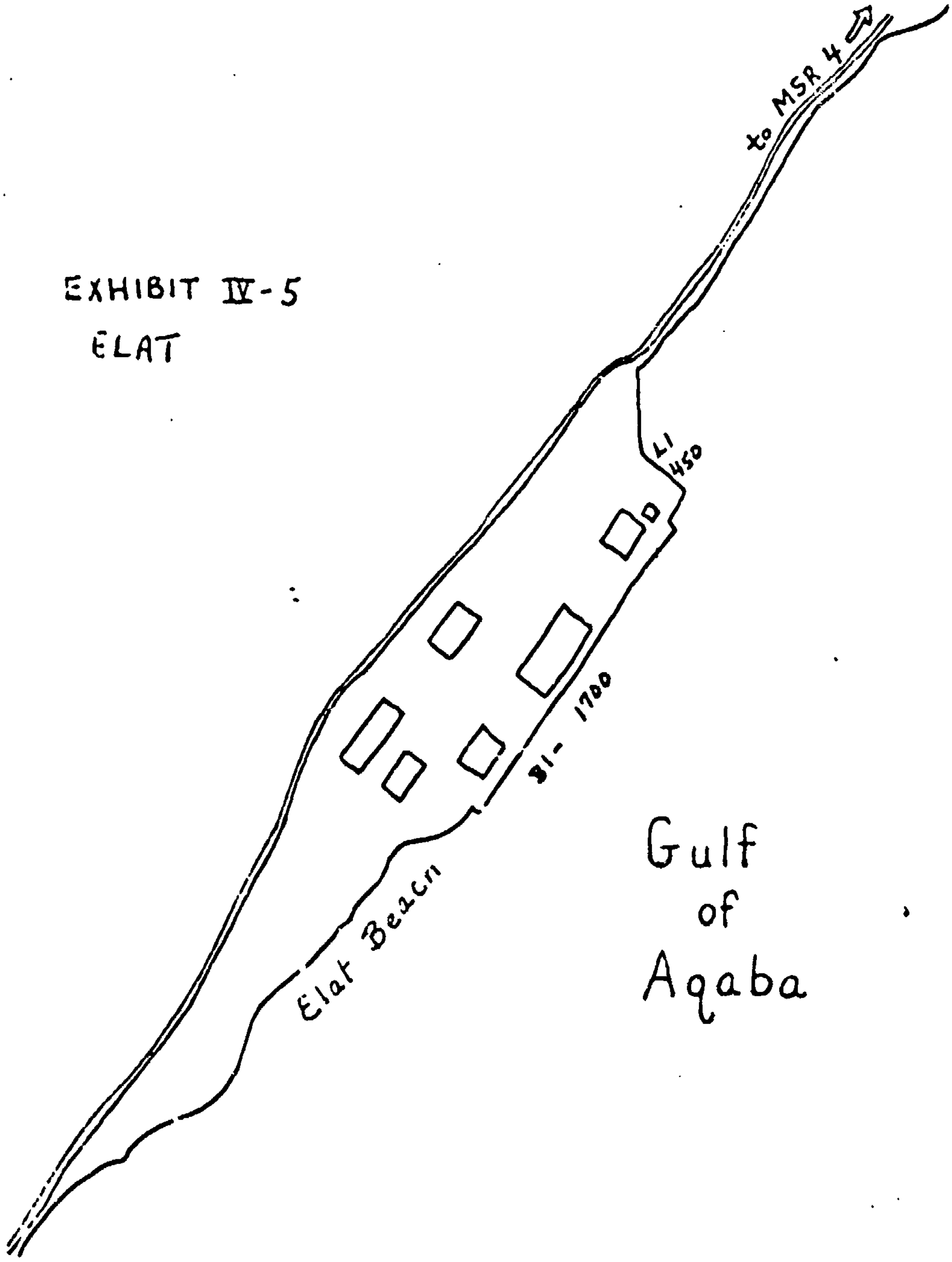
EXHIBIT IV-4



17.1d.

EXHIBIT IV-5

ELAT



SECTION IV: NETWORK ANALYSIS

A. Dromar Reception Analysis.

1. Fixed port facilities available.

a. General. Dromar has three major port complexes. Haifa and Ashdod are located on the Mediterranean Sea. Elat, is located at the northern tip of the Gulf of Aquaba. Since Dromar has little surface trade with neighboring countries, these three seaports are Dromar's international lifeline. Denying their use would bring to a halt better than 90% of Dromar's maritime trade.[20] Haifa is the largest port handling better than 50% of all maritime cargo (excluding POL).[21] Ashdod, the second largest port, was completed in 1965 to relieve congestion at Haifa and to expand Dromar's military capability. Because of its modern facilities, its share of traffic continues to grow and now exceeds 40% of the total.[22] Ashdod's container capability has already exceeded that of Haifa as indicated by the figures below:

EXHIBIT IV-1
CONTAINER CARGO HANDLING STATISTICS - DROMAR
Loaded Units Received

	1971	1972	1973
Haifa	8792	15660	20540
Ashdod	8735	14533	22460
Elat	Data not available		

b. Port of Haifa. Exhibit IV-3, p. 17.1, is a schematic of the port of Haifa. It is located about 17 miles south of the Saidan border. It has approximately 9000 linear feet of wharfage suitable for berthing deep draft vessels and lighterage. Located at the west end of berth 2 is a dedicated container berth stretching 1500 ft in length.[24] This berth has adequate fixed and portable cranes to discharge non self-sustaining ships. It is equipped with one gantry crane.[25] Specific berths at Haifa are described in Exhibit IV-6 below:

EXHIBIT IV-6
WHARFAGE SPACE - PORT OF HAIFA[27]

Berths Deep Draft	Length (ft)	Width (ft)	Depth (ft)	Storage
B1	800	230	All berths dredged to 39 ft	Covered 73196 sq yds
B2	2650	230		
B3	2500	230		55 acres container and open storage area
B4	850	65		
B5	850	65		
Lighter				
L1	300	230		
L2	250	130		
L3	250	130		

* These figures do not include Quishon harbor naval base facilities located east of Haifa main harbor. They are considered fully utilized for naval operations.

Fixed anchorages within the main and lee breakwater are suitable for a minimum of eight vessels.[26] Numerous anchorages are available in the outer harbor and roadstead northeast of the port for LOTS operations.

c. Port of Ashdod. Exhibit IV-4, p. 17.1, is a schematic of available berthing facilities at Ashdod. Unlike Haifa's quay orientation, Ashdod has four finger piers extending into the harbor. Three are suitable for deep draft vessels and one is limited to lighterage. The port is located 20 miles south of Tel Aviv. Piers provide about 10000 linear feet of usable space for discharge operations. A description of berth segments can be found in Exhibit IV-7 below:

EXHIBIT IV-7
WHARFAGE SPACE - PORT OF ASHDOD[29]

Berths Deep Draft	Length (ft)	Width (ft)	Depth (ft)	Storage
B1	2200	325	All berths dredged to 40 ft	Covered 68172 sq yds
B2	1470	600		
B3	1300	600		Open sheds 60000 sq yds
B4	1200	600		
B5	1200	600		48 acres container and open storage area
Lighter				
L1	480	open		
L2	755	open		
L3	820	130		
L4	820	130		

* Ends of piers are not suitable for discharge operations because of sea conditions.

The south side of pier 3, berth B5, is capable of handling the largest containerships in the world today. It is equipped with one gantry crane and two smaller 25-ton portal cranes.[28] A RoRo berth is also available at Ashdod. The port has three anchorages within the breakwater capable of handling large ocean going vessels. Unlimited anchorages are available outside the breakwater for LOTS operations.

d. Port of Elat. Located at the northern tip of the Red Sea, 150 miles south of Tel Aviv, Elat is the smallest of Dromar's major ports. Because of its remoteness from established population centers, its share of traffic is less than 10%. However, this port provides Dromar direct access to the Red Sea bypassing the Suez Canal. The new port area depicted in Exhibit IV-5, p. 17.1 was completed in 1965. The old port area, located to the north, is now a naval installation.

The new port area has a main concrete quay of 1700 feet. One segment of the quay is suitable for discharge of standard containerships and is supported by two 25-ton portal cranes. Two anchorage berths in the roadstead can be used for in the stream discharging. Additional anchorage is available further offshore for LOTS operations.

EXHIBIT IV-8
WHARFAGE SPACE - PORT OF ELAT[30]

Berths Deep Draft	Length (ft)	Width (ft)	Depth (ft)	Storage
B1	1700	open	30	Covered & open 33320 sq ft
Lighter				
L1	450	open	30	

2. Beach areas suitable for logistics over-the-shore (LOTS) operations.

a. General. Fixed port facilities are particularly vulnerable to conventional and nuclear attack. The planner must consider the impact of the loss of part or all of these facilities. In the case of Dromar, entrances into the two major ports, Ashdod and Haifa, can be closed by the sinking of several deep draft vessels at the mouth of the breakwater. The destruction of storage facilities, wharves, and material handling equipment can also degrade the ports throughput capacity. To minimize the impact of such an eventuality and to augment fixed port throughput capacity the planner must evaluate the coastal area of Dromar to locate suitable beaches for LOTS operations.

b. Haifa Beach.

(1) General. This LOTS site located east of

Haifa harbor is capable of supporting a sizeable operation. Although sea approaches are partially obscured by a rocky reef, an unlimited number of vessels can be anchored offshore. Depth is approximately 60 ft in fair holding ground.

(2) Characteristics of Haifa Beach.[31]

Length - 6.9 miles

Nearshore gradient - 1:60 shoreward of 36 ft depths

Surf - 4 feet or higher 20% of time.

Trafficability - Fair for wheeled and good for tracked vehicles over sand and gravel.

Clearance - Fair in dune areas, good where hard surface road and rail line backs beach.

c. Ashdod Beach North.

(1) General. This LOTS site is located north of the port of Ashdod and is also capable of supporting a sizeable operation. Sea approaches are clear with anchorage capacity a function of available ships. Anchorage depths of 60 ft in a mud and sand bottom are more than adequate.

(2) Characteristics of Ashdod Beach North.[32]

Length - 5 miles

Nearshore gradient - 1:60 shoreward of 36 ft

Surf - 4 ft or higher 20% of time.

Trafficability - Fair for wheeled and tracked vehicles over sand

Clearance - Fair across sand to hard or loose surfaced road approximately 50 yds behind beach.

d. Elat Beach.

(1) General. Sea approaches are generally clear.

Protected anchorage is available 800 yards off beach in 148-180 ft depths. Ground is mud and sand offering excellent anchorage. Auxiliary equipment such as pontoon causeways and temporary piers may be used throughout the year because of negligeable surf and currents.

(2) Characteristics of Elat Beach.[33]

Length - 1.5 miles

Nearshore gradient - 1:25 shoreward of 30 ft

Surf - Surf of 4 ft or higher infrequent throughout the year

Trafficability - Fair for wheeled, good for tracked vehicles over sand and gravel

Clearance - Fair over sand to hard surfaced road 55 to 220 yds behind beach.

3. Reception Capacity Planning Factors.

a. General. Given some portion of the facilities in Dromar, the planner's problem is to locate available vessels in such a manner that the maximum daily tonnage is in position to be discharged. The planning factors discussed below are utilized in the PORTCAP model to insure a satisfactory matching of vessels and available facilities.

b. Vessel characteristics. This data has already been discussed and is available in Exhibits III-2, III-3, and III-4, p. 10. PORTCAP also has a vessel description routine which the user may call. The planner must be familiar with the mix of vessels that will be in the AO during an operation.

c. Deep draft wharf requirements.

(1) Wharf length. Normally in the planning

process 100 ft of linear wharf space is required per hatch for the discharge of breakbulk (BB) vessels. However, containerships, which are used in this study, do not have hatches. In order to accomodate them, ship length plus a safety factor of 50 to 75 feet, depending on ship size, was substituted to determine the length of wharf required to berth a vessel. Exhibit IV-9 provides PORTCAP rational in assigning vessels to berths. For example, the berth length required to position a VC2 vessel is equal to the actual length of the vessel (442 ft) plus a safety factor of 50 ft or a total of 492 ft.

(2) Depth alongside. Fluctuations in tide may affect the length of time a berth may be occupied. Required depth alongside a berth for each type vessel measured at low tide is provided in Exhibit IV-9.

EXHIBIT IV-9
CLASSIFICATION OF DEEP DRAFT BERTHS[31]

Vessel Type	Vessel Classif.	Berth Length Required Ship Length + Safety Fact.	Depth Along.
C3/C4, C5/C6, SL7, SL18, RoRo	A Large	Actual ship length Exhibit III-2 + III-3 75 ft	28-34 ft
C2/VC2	B Standard	Actual ship length Exhibit III-2 + 50 ft	29 ft
C1	C Small	Actual ship length Exhibit III-2 + 50 ft	23 ft

(3) Wharf Width. Wharf width refers to the apron area on the deck of a wharf available as a working area. When discharging at a quay, where only one side of the ship can be worked, 60 ft is the minimum requirement.

When discharging ships from both sides of a finger pier, 90 feet is the minimum space required.[35]

(4) Reception capacity. For each vessel positioned at a deep draft BB berth, 720 STONs per day is the reception capacity planning factor.

d. Lighter wharf requirements.

(1) Often, because of a shortage of deep draft berth space, it becomes necessary to discharge cargo from ships anchored in a harbor and to move the cargo by lighter to wharves particularly suited to these smaller craft. When a lighter berthing operation is contemplated, the following planning factors are used in PORTCAP.

(2) Wharf length. For each lighter, 100 ft of wharf length is required.[36] Wharf length greater than 100 ft but less than the next 100 ft increment is disregarded.

(3) Depth alongside. Each lighter berth requires a depth of 7 ft at low tide.

(4) Reception Capacity. For each lighter berth space available, the planner can figure on a reception capacity of 160 STONs per day.

e. Anchorage Areas.

(1) The availability of a substantial number of lighterage spaces in a port is no guarantee that the 160 STON capability per space will be utilized. Suitable anchorage areas must be found with the following characteristics:

(2) Anchorage Depth. Minimum water depth for each vessel must be in accordance with Exhibit IV-9, p. 24.

Vessels cannot be anchored in water depths greater than 210 ft because of restrictions on anchor chain weight and length.[38]

(3) Anchorage Diameter. Requirements for tactical dispersion often dictate the number of ships that can be anchored offshore regardless of the number of suitable sites. However, the minimum diameter required to provide a free swinging anchorage is computed using the formula below:

D = Depth of water in feet

L = Length of vessel in feet

$$\text{Diameter of an Anchorage} = \frac{2(7D + 2L)}{3}$$

For example,. to compute the diameter for a C2/VC2 anchorage the following computation would be required.

$$776 \text{ ft} = \frac{2(7 \times 40^{*} + 2 \times 442^{**})}{3}$$

* Depth of water at Ashdod port (Exhibit IV-7, p. 20.

** Length of C2/VC2 ship (Exhibit III-3, p. 10).

(4) Reception Capacity. Each suitable anchorage area has a potential reception capacity of 720 STONs. Four lighterage spaces (180 STONs per space) or a suitable LOTs beach must be available if ships at anchor are to be considered accomodated and capable of being discharged.

f. Beach Capacity Estimation.

(1) The capacity of a LOTS site to handle cargo is affected by a number of factors, anchorage, tides, surf, beach gradient, weather, and trafficability. The Dromar coastal area has already been evaluated and the three sights selected meet the minimum criteria for effective utilization. Again,

because of the introduction of the containership, present methods of computing beach capacity are inadequate. PORTCAP calculates beach capacity using the planning factors found below.

(2) If BB ships and/or LASH ships only are used in the LOTS operation a maximum of 3000 STONs per day per mile of beach is the planning factor.[39] This number equates to 4.2 ships working for each mile of beach available (each ship @720 STONs per day).

(3) If containerships are positioned at the same four plus anchorages, reception capacity over the same mile of beach will increase dramatically. The potential of each operating anchorage is equal to 180 containers per day. Exhibit IV-19, p. 45 provides the basis for this calculation. If the containers are stuffed with cargo other than ammunition, 2340 STONs can be received per LOTS anchor. Using the same 4.2 vessels per mile of beach, containerships are capable of exceeding 9500 STONs per day per mile of beach. This is a significant increase over BB cargo reception of 3000 STONs per mile of beach.

(4) The planner is cautioned that a density of four vessels per mile of beach may be excessive. PORTCAP permits the planner to designate the number and type vessels he wishes to use in a LOTS operation regardless of the capacity of the beach to handle them.

g. Containership Wharf Requirements.

(1) General. Containerships provide the fastest

means of getting cargo to a theater. In addition, load and discharge times can be improved by as much as 75% over conventional BB vessels. In a fixed port facility such as Haifa or Ashdod piers or quays equipped with special handling equipment are designated for containerships.

(2) Length, Width, and Depth. Length, width, and depth of berth space required for a containership is determined in the same manner as for breakbulk vessels.

(3) Storage area. Based on past experience, an average area of 16 acres is necessary to accomodate a C5/C6 containership berth.[40] This space provides a marshalling area for transhipment of containers, both dry and refrigerated, stuffing and unstuffing when required, and maintenance and administration.

(4) Reception capacity. At a fixed berth facility discharge rates vary dependent on the type cranes available, the size vans, and the type cargo (ammunition or general cargo) in the vans. For planning purposes reception capacity in PORTCAP is determined by using the planning factors identified in Exhibits IV-10 and IV-11. Data to support these figures can be found on pp. 40. . Ashdod and Haifa each have container berths with a single gantry crane capable of handling up to 40 ft vans. In ports where no container handling equipment is available, special equipment must be brought into the theater. This equipment is found in the Transportation Terminal Service Company (Container) which is discussed later in this paper.

EXHIBIT IV-10
CONTAINER BERTH RECEPTION CAPACITY[41]
GANTRY CRANE OPERATION

Type Van	Nr Containers (per day)	STONs Per Day	
20 ft	520	class V	10400
		* gen cargo	6770
40 ft	520	class V	16100
		* gen cargo	10000

EXHIBIT IV-11
CONTAINER BERTH RECEPTION CAPACITY[42]
TERMINAL SERVICE CO. TOE CRANE OPERATION

Type Van	Nr Containers (per day)	STONs per Day	
20 ft	390	class V	7800
		* gen cargo	5070
40 ft	390	class V	12000
		* gen cargo	7800

*Refers to all other cargo except class V.

h. Roll on Roll off Berths. RoRo ships are designed to load and discharge cargo through ramps located in the stern and side ports. They normally transport wheeled and tracked vehicles and containers loaded on semitrailers. Each berth has a reception capacity of 1000 STONs per hour.[43] Since only a few RoRo vessels are in service, the figure of 1000 STONs is applicable only while a RoRo vessel is in position. PORTCAP takes this fact into consideration.

i. Lighter Aboard Ship (LASH). The LASH concept includes two basic components, a mother ship and a family of barges. Cargo is loaded onto a barge, the barge is towed to the mothership and loaded aboard using onboard ship's gear. Port congestion at destination is minimized because, upon reaching its destination, the mothership needs no fixed berth facilities.

Barges are discharged at offshore anchorages and towed to scattered terminal and inland discharge points. Unfortunately, Dromar has no inland water system. LASH vessels therefore are treated in the same way as other cargo vessels discharging to lighters in the stream. Obviously, port planners would give LASH barges priority of lighter space in order to turn the mother ship around as quickly as possible.

4. Terminal reception capacity and the PORTCAP model.

a. General. The preceding analysis of Dromar's facilities and the planning factors associated with reception analysis, provides the reader with the background needed to operate the reception routine of the PORTCAP model. In its introductory set of instructions to the transportation planner, PORTCAP identifies the key elements of data that will be required to use the routine. Before proceding to the second component of throughput capacity, a review of these key data elements is appropriate.

b. Reception capacity estimation - PORTCAP data requirements.

(1) Vessel data - The PORTCAP user must be thoroughly familiar with the vessels that will be available in the AO for the operation. Exhibits III-2, III-3, and III-4, p. 10 provide selected characteristics of vessels used in PORTCAP. Additionally, a subroutine on vessel characteristics has been built into PORTCAP to assist the user.

(2) Port data - The most critical data elements needed to operate the PORTCAP reception routine are related to

port facilities. Prior to sitting down at the console, the user must perform an analysis of the port complexes he desires to utilize in his simulation. A sketch of port facilities such as those of Dromar provided in Exhibits IV.-3,4, and 5, p. 17.1 are essential. For each port complex, the following specific information is required.

(a) The number of port complexes that will be used in the simulation, i. e. Ashdod, Haifa, etc.

(b) The number of breakbulk berths available at each port. (A berth is defined to be a continuous length of wharf space running in a single direction. For example, the berthing space on two sides of a finger pier would represent two different berths).

(c) The number of berths limited to lighterage craft only.

(d) The number of container berths available at each port. If gantry cranes are available, this information will be reqested.

(e) The length, width and depth of water at each berth.

(f) The number of anchorages available to support the lighter berths. (Called Lighter Anchors, these locations normally represent the number of vessels that could be positioned inside the main harbor).

(3) Logistics over-the-shore (LOTS) data. LOTS operations are used to augment throughput capacity at a port complex. LOTS sites are often used for discharge of dangerous

cargo, such as ammunition, to separate it from other cargo handling operations. The planner must conduct an evaluation of beaches in the vicinity of main port areas to determine their suitability. In Dromar, three beaches were found to be adequate. PORTCAP will request the following data on each LOTS site.

(a) The number of beaches available to support the operation.

(b) The length of each beach in miles.

(c) The number of LOTS anchors necessary to support the operation. (A LOTS Anchor is normally outside the main harbor area adjacent to the beach being supported. If no restriction on anchors is entered by the user, PORTCAP will compute reception tonnage based on the maximum number of vessels that could be positioned given the length of beach available).

(4) Type cargo - PORTCAP does make a differentiation between ammunition and other types of cargo. The user must indicate whether a particular port or beach operation will be used for ammunition or general cargo.

(5) Container type - PORTCAP deals in only two types of containers, 20 ft and 40 ft. The planner must estimate the ratio of 20 ft to 40 ft vans entering fixed port facilities. In LOTS operations, all containers are 20 ft in size.

c. PORTCAP output. The objective of the reception capacity routine is to determine the total number of STONs that will be in position for discharge at the port complex under evaluation each day. PORTCAP provides this key piece of information. In addition, PORTCAP also provides the following data:

(1) The number and type vessels (C5/C6, C2/VC2, etc.) that can be accomodated at the port.

(2) The location of each vessel accomodated, i. e. breakbulk berth, container berth, lighter anchor, or LOTS anchor.

(3) The STON reception capacity of each vessel accomodated to include the type cargo, ammunition or general, aboard each vessel.

B. Dromar Discharge Analysis.

1. General.

a. Terminal reception capacity identifies the ability of the physical facilities of a terminal complex to accomodate a given number of vessels for discharge. However, the theater commander cannot utilize this capacity unless he has equipment and personnel to physically move the cargo off the vessels and over the wharf or beach to awaiting transportation. The personnel and equipment to perform the mission can take several forms. Military units such as transportation terminal service companies, boat companies, and amphibian companies may be used. Discharge operations can also be performed by local nationals using existing port equipment. Although a significant part of the civilian work force may be required to support a host nation's economy, it can be a very important source of labor for military terminal operations as well. In the Dromar problem, exact information as to civilian requirements is not available. To overcome this limitation, the PORTCAP model can play various configurations of civilian participation.

b. Terminal discharge capacity represents the total tonnage that all military units and civilian support engaged in military port operations can discharge in one day.

c. The following paragraphs evaluate units capable of performing the discharge mission. Equipment capabilities and planning factors are also reviewed. In this paper every attempt has been made to secure the latest information on the discharge of containerships in both a fixed port and LOTS environment.

2. <u>Transportation Terminal Service Company (Breakbulk)</u>

a. General. The heart of any discharge operation at a port complex is the terminal service company. Its mission is to discharge, backload, and tranship breakbulk cargo or containers at ports or beaches. At the present time, two separate TOE's, one for breakbulk operations and one for container operations, have been prepared and submitted to DA for approval.

b. Capability --- Ships berthed at fixed wharf facilities, lighter anchors, or LOTS anchors.

A terminal service company (breakbulk) with its two ship platoons and ten hatch sections (see Exhibit IV-12) can discharge 720 STONs per day. This figure is calculated based on a 20 hour day with each hatch section discharging 7.2 STONs per hatch per working hour. (see Exhibit IV-13) The 720 STON figure applies whether discharge takes place at a fixed berth, a lighter anchor, or a LOTS anchor. Once TOE 117H410 is approved by DA, the daily STON figure will increase to 1000 STONs.[43a]

3. <u>Transportation Terminal Service Company (Container)</u>

a. Capability --- Ships berthed at fixed wharf facilities.

(1) Exhibit IV-14 shows the organization of a terminal service company in container operations. It has the capability to discharge containers at both a modern port facility where fixed equipment such as gantry or portal type cranes are available or at less improved ports where the company is required to use its own organic cranes. Exhibit IV-15 illustrates how a terminal service company operates at a fixed

wharf facility. To maintain a twenty hour operation, one ship platoon and one shore platoon work the day shift. The other two platoons work the night shift. Each platoon is capable of operating two cranes simultaneously as indicated in the exhibit. The shore platoon supports the ship platoon by moving and staging discharged containers in the marshalling yard. The large commercial gantry cranes in Dromar can average thirteen movements in an hour.[44] One movement includes unloading a full container and backloading an empty. In a 20 hour day a crane set operated by a terminal service company can make 520 movements.

(2) In order to convert movements into a STON figure, one must consider the type van being utilized. A number of different sizes from 20 ft to 40 ft are available. However, PORTCAP utilizes only 20 ft and 40 ft equivalents in this study. Exhibit IV-16 identifies the maximum weight that can be loaded into a 20 ft and 40 ft van. Often, however, the density of cargo loaded makes it impossible to achieve maximum weight utilization. Generally, ammunition, which is very dense, will exceed the maximum weight limitations of a van before reaching cubic capacity. Consequently, PORTCAP assumes each class V van will carry the maximum weight authorized for that size container. On the other hand, all other cargo is loaded at 65% of weighted capacity to take into account the cube limitations of standard size containers.

(3) Exhibit IV-17 provides the planning factors in STONs per day for a terminal service company (container) in

fixed port operations. As an example of how the figures were derived, let's look at line 2 and the figure of 5070 STONs daily capability. This figure is based on the company using its own TOE equipment, handling only 20 ft vans, and moving cargo other than ammunition. The PORTCAP model calculates using the variables and the formula below.

C = Nr cranes discharging each vessel. A terminal svc co. normally works two cranes per vessel.

G = Nr of crane movements per hour.

H = 20 hours in an operating day.

CC = Rated capacity of a 20 ft van in STONs.

.65 = Weight utilization factor for all cargo except class V.

DDC = Daily-discharge capacity for a containership berthed at a fixed facility.

DDC = C X G X H X .65(CC)

5070 STONs = 2 X 9.75 X 20 X .65(20)

EXHIBIT IV-13
TERMINAL SERVICE COMPANY (BREAKBULK)
DISCHARGE CAPACITY

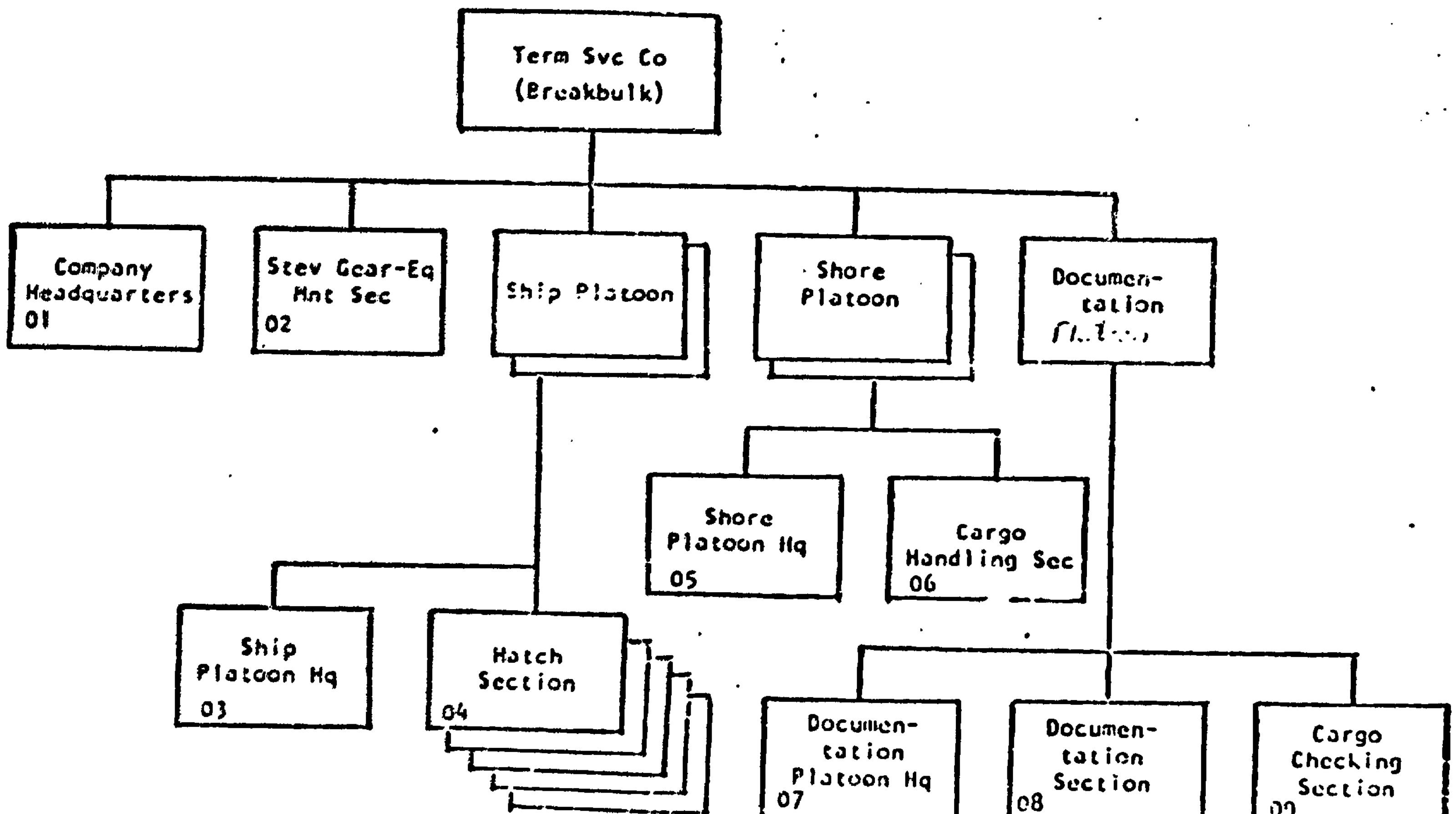
Nr hatches	Capacity per hatch	Hrs per day	Discharge capacity
5	7.2 STONs	20*	720 STONs

* Each ship platoon with five hatch sections works a ten hour shift. In order to maintain operations fo a 20 hour period each day, two ship platoons are assigned to each terminal service company

EXHIBIT IV-16
MAXIMUM CARGO CAPACITY OF CONTAINERS[45]
PORTCAP MODEL

Type van	STONs
20 ft	20
40 ft	31

EXHIBIT IV-12
TRANSPORTATION TERMINAL SERVICE COMPANY
BREAKBULK



37.1

EXHIBIT IV-14

TRANSPORTATION TERMINAL SERVICE COMPANY[46]

CONTAINER

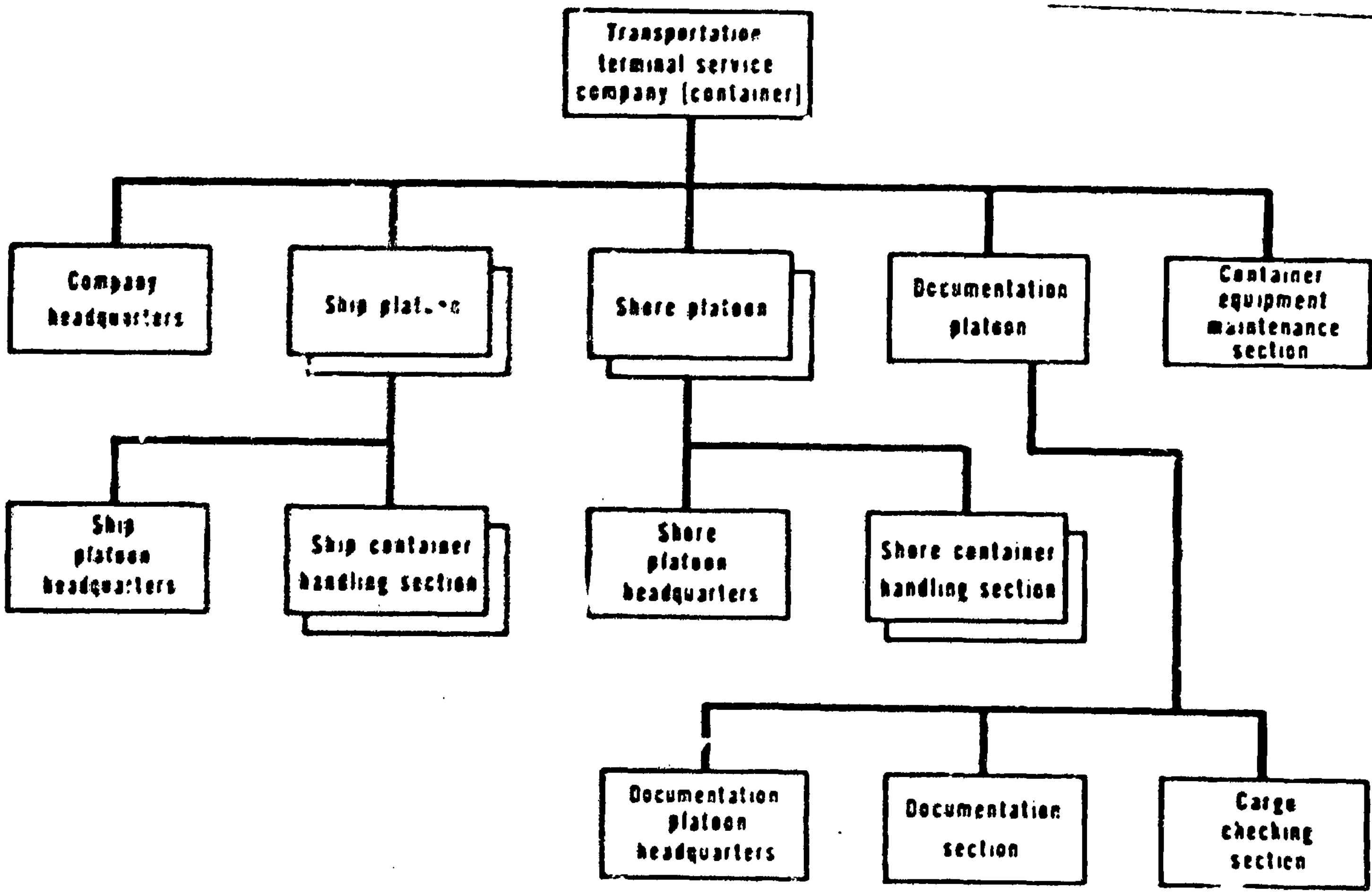


EXHIBIT IV-15

TERMINAL SERVICE COMPANY (CONTAINER)
OPERATING AT FIXED BERTH

*"Company works a ship with two organic cranes. The shore platoons support the ship platoons by moving discharged containers from the crane site to the marshaling area. If the fixed port container handling cranes are available and operable, their use is preferred to those in the terminal service company."47

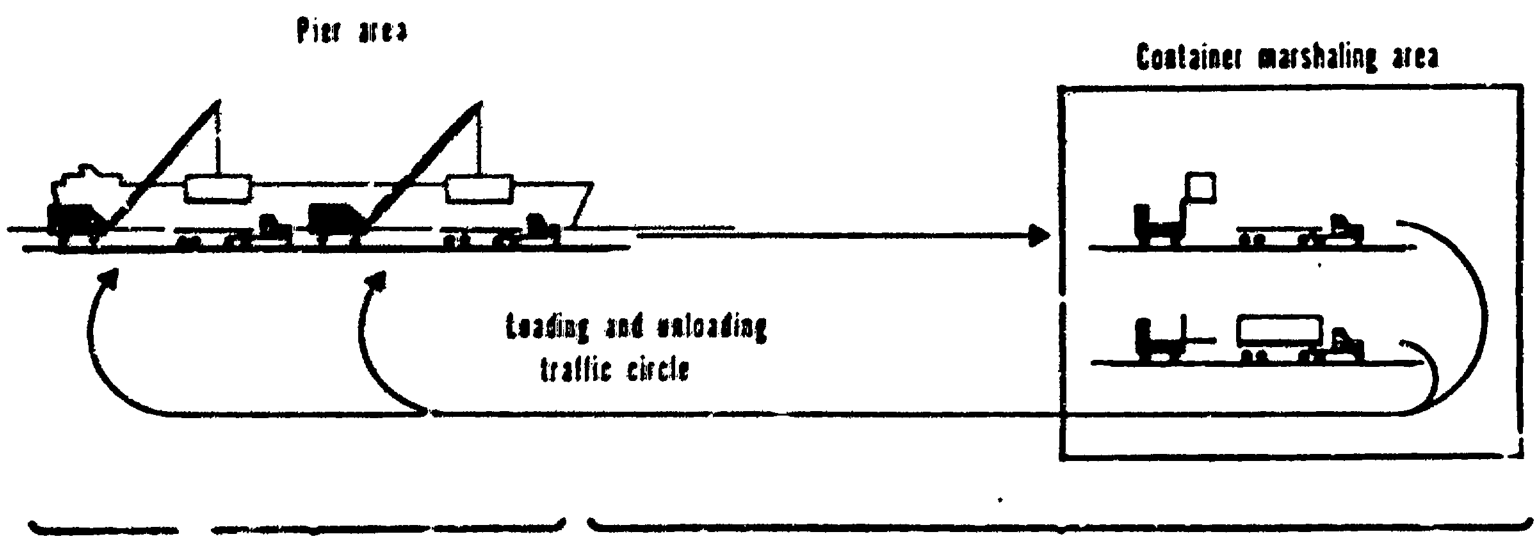


EXHIBIT IV-17

TERMINAL SERVICE COMPANY (CONTAINER)

FIXED PORT OPERATION

DISCHARGE CAPACITY

Type cranes	Nr operated	Movements per hr per crane	Hours per day	Nr cont. disch. per day	Discharge capacity per day (STONS)
1. Port type[48] gantry	2	13	20	520	Small vans 20 ft
					Class V - 10400
					General - 6760
					Large vans 40 ft
					Class V - 16100
					General - 10000
2. Terminal[49] svc co. TOE	2	9.75	20	390	Small vans 20 ft
					Class V - 7800
					General - 5070
					Large vans 40 ft
					Class V - 12000
					General - 7800

b. Capability --- Logistics over-the-shore operation.

(1) General. The U.S. military has never attempted, in wartime, to discharge containers over-the-shore. However, fixed container facilities, such as those at Ashdod and Haifa, present lucrative targets to the enemy. If these facilities were destroyed, dispersed LOTS operations would be the only feasible solution to combat service support on a large scale.

(2) Offshore Discharge of Containerships. In Dec 1970 and again in Oct 1972, tests were made of several systems for LOTS discharge of containerships. Named the Offshore Discharge of Containerships (OSDOC), these studies proved that such a concept, though difficult, was feasible with present day equipment. The principal notion can be divided into three parts:

(a) At shipside - a mobile crane for discharging which is positioned either aboard the containership on hatch covers, or alongside the ship on an LST, barge, or DeLong pier. One ship platoon of the terminal service company is capable of working two mobile cranes on each working ship.[50] (see Exhibit IV-18 for an illustration of the concept)

(b) Transport ship to shore.- A family of lighters LCU's, barges, amphibians, and pontoon causeways, to move discharged containers from ship to shore.

(c) At shoreside - The use of mobile 250 ton cranes of the terminal service company supported by ancillary equipment such as jacked up portable DeLong piers, causeway ramps, etc. to move vans from lighters to shore platoon transport equipment. (Note: In this operation, both ship platoons of the terminal service company are working the same shift, one discharging containers from ship to lighters, the second at shoreside shifting containers from lighters to shore platoon transport equipment. To maintain 20 hour operation during LOTS would require augmentation of the terminal service company's ship platoons).

(3) Planning factors. OSDOC test findings indicate that on the average 4.5 containers per hour for each working crane set, one shipside and one shoreside, can be discharged, moved to the beach, and shifted to transport equipment in a LOTS operation.[52] Identified as System Discharge Capability (SDC), it is this figure which is used as a base in the PORTCAP model. SDC is dependent on many factors --- weather, type lighter, sea state, turnaround time, etc. Further, because of the limitations of the OSDOC II study, short duration, few observations of each subsystem, the SDC figure is subject to challenge. However, it is the best available information that we have today. Future OSDOC studies are being planned to validate the findings of OSDOC I & II.

(4) Exhibit IV-19 provides LOTS discharge capacity for a terminal service company. For example, using the 4.5 containers per hour per crane SDC, the company discharge capacity in STONs for 20 ft general cargo vans is 2340 STONs. The formula used to compute the figure is shown below:

SDC = OSDOC finding of 4.5 containers per hour system discharge capability.

C = Nr of cranes discharging each vessel.

H = 20 hours in an operating day.

CC = Rated capacity of 20 ft van in STONs.

.65 = Weight utilization factor for all cargo except class V.

LDC = Daily discharge capacity for a containership in a LOTS operation.

LDC	=	C	X	SDC	X	H	X	.65(CC)
2340 STONs	=	2	X	4.5	X	20	X	.65(20)

4. Capabilities --- Army water tranport units.

a. General. Terminal service companies discharging cargo from vessels anchored in the stream require lighterage support to accomplish their mission. This support is provided in the PORTCAP model by the four units discussed below.

b. Transportation Medium and Heavy Boat Company.

(1) The mission of both the medium and heavy boat company in this problem is to provide and operace landing craft in support of terminal operations in Dromar. The task lighter is the landing craft, mechanized (LCM8) and landing craft, utility (LCU 1466). The characteristics of these lighters are found in Exhibit IV-20.

(2) Capabilities of medium boat company.[54] At full TOE the medium boat company can transport 720 STONs of general cargo under the following conditions:

(a) Twelve of its sixteen task vehicles (75%) are available to each shift.

(b) Each LCM-8 carries an average of 30 STONs per trip making two trips per day.

(c) Operating day is 20 hours.

EXHIBIT IV-18

TERMINAL SERVICE COMPANY (CONTAINER) OPERATING AT A LOTS SITE

* "In a LOTS operation, one ship platoon of the terminal service company (container) normally works the ship anchored offshore and the other ship platoon works at the water's edge, where it transfers containers from (lighterage) to shore platoon semitrailers for further movement of the containers to the marshaling area."51

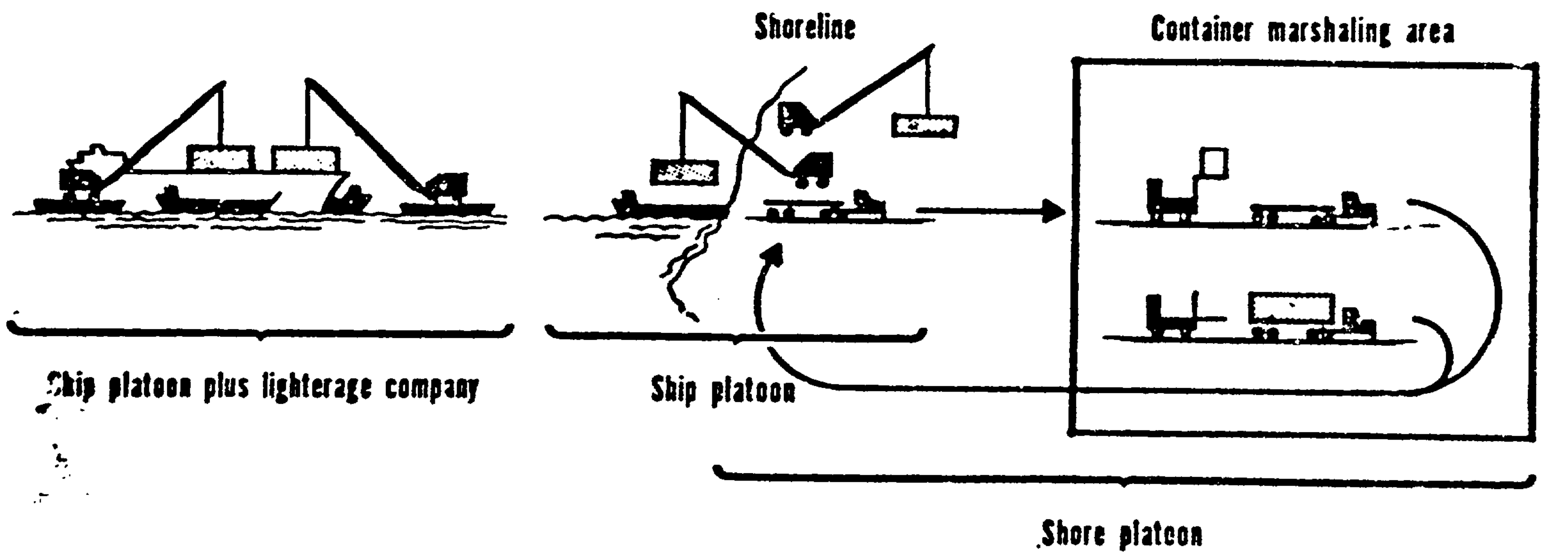


EXHIBIT IV-19

TERMINAL SERVICE COMPANY (CONTAINER)

LOTS OPERATION

DISCHARGE CAPACITY

Type cranes	Nr operated	Movements per hr per crane	Hours per day	Nr cont. disch. per day	Discharge capacity per day (STONs)
Terminal svc co. TOE	2	4.5[53]	20	180	Small vans 20 ft Class V - 3600 General - 2340

* Discharg of 40 ft vans not tested in OSDOC series.

(3) Capabilities of Heavy Boat Company (Breakbulk).[55]

At full TOE the heavy boat company can transport 1440 STONs of general cargo per day provided that:

(a) Ten of its twelve task vehicles (75%) are available to each shift.

(b) Each LCU carries 150 STONs per trip making one round trip per day.

(c) Operating day is 20 hours.

(4) Capabilities of Heavy Boat Company (Container).[5]

(a) This is the only lighter unit in PORTCAP used to handle containers in a LOTS operation. Each company can transport 2080 STONs of containerized cargo from ship to shore provided that:

(b) Each LCU makes four round trips per day. (container discharge is considerably faster than BB)

(c) Each LCU carries a minimum of four 20 ft containers per trip.

(d) Average STON load per van is 13 STONs. (Based on 65% of rated capacity of a 20 ft van)

c. Transportation Medium Amphibian Company.

(1) The mission of the medium amphibian company is to provide lighterage for the movement of general cargo, ammunition, and small vehicles between ships at anchor and inland transfer areas in LOTS operations. The task vehicle is an amphibious cargo lighter (LARC-15). For characteristics of the craft see Exhibit IV-20.

(2) Capabilities of Medium Amphibian Company.[57]

At full TOE strength the medium amphibian company is capable of transporting 1000 STONs of general cargo per day provided that:

(a) Nineteen of its 25 task vehicles (75%) are available to each shift.

(b) Each LARC carries 10.2 STONs of cargo per trip.

(c) Each LARC averages 5-6 trips per day.

(d) Operating day is 20 hours.

d. Transportation Heavy Lighter Team (FN).

(1) The primary mission of the heavy lighter team is to transport heavy, outsize cargo, containers, and bulky equipment in LOTS operations. The task vehicle is an amphibious heavy cargo lighter (LARC-60).

(2) Capabilities of Heavy Lighter Team[58] At full TOE the team can transport 450 STONs of cargo daily based on the following:

(a) Three of its four task vehicles (75%) are available to each shift.

(b) Each LARC-60 carries 60 STONs per trip.

(c) Five trips are made each day.

(d) Operating day is 20 hours.

NOTE: A summary of the capabilities of the lighter units used in the PORTCAP model are provided in Exhibit IV-21.

5. Terminal discharge capacity and the PORTCAP model.

a. General. Now that the capabilities of the units available in the PORTCAP model have been described and their capabilities defined, the planner can interact with PORTCAP to determine the second component of throughput, terminal discharge capacity. PORTCAP is capable of approaching the problem

EXHIBIT IV -20

CHARACTERISTICS OF LANDING CRAFT AND AMPHIBIANS

Name & nomenclature	Length ft	Width ft	Max. Draft	Speed Land	Speed Water	Range Land	Range Water	Max. capacity
Landing craft, mechanized (LCM-8)[59]	73.5	21	5		10		310 mi.	53.5 STONS
Landing craft, utility (LCU-1466)[60]	115	34	6		7.5		700 mi.	148 STONS
Lighter, amphibious (LARC-15)[61]	45	14.5	5.5	29 mph	9 mph	300 mi.	54 mi.	12 STONS
Lighter, Amphibious (LARC-60)[62]	62.5	26.5	8	7	24	150 mi.	75 mi.	60 STONS

EXHIBIT IV-21
ARMY WATER TRANSPORT UNITS
DISCHARGE CAPACITY

Task lighter	Lighters Avail 75%	Operating day hrs	STONs per lighter	Trips per day	Discharge capacity STONs per day	
Medium Boat Co (LCM-8)	12	20	30	2	720	
Heavy Boat Co (LCU 1466)						
BB cargo	10	20	150	1	1440	
Containers *	10	20	52	4	2080	General
			80		3200	Ammo
Medium Amphibian Co (LARC-15)	19	20	10.2	5-6	1080	
Heavy Lighter Team (LARC-60)	3	20	60	5	450	

* Only PORTCAP unit that can handle containers in a LOTS operation.

in two different ways.

(1) Option 1. The planner may desire to know the number of units, both terminal service and lighter, required to discharge the entire reception capacity of a port complex calculated during the reception routine. This option might be used in the early stages of planning when supply requirements are not firm.

(2) Option 2. If the planner is aware of daily resupply and buildup tonnage required to support the contingency force, he can use that figure, not reception capacity, to determine the number of units necessary to move the tonnage requirement from ship to shore.

b. Discharge capacity estimation - PORTCAP data requirements.

(1) Daily tonnage requirement. Since unit data and planning factors are already built into the model, PORTCAP requires a minimum of input from the user. The key data elements which drive the discharge routine are the daily ammunition tonnage and the daily general cargo tonnage needed by the supported force. These two numbers combined represent the total daily requirement needed in the theater. PORTCAP will decrement this figure by 5% to allow for airlift support of emergency supplies and equipment. Discharge capacity will be based on the resulting figure. However, if the planner selects option 1, no entry is required. PORTCAP will determine discharge capacity by substituting reception capacity for the daily tonnage requirement.

(2) Civilian labor support. If the user has

civilian assets to assist military units in discharge operations, he will be asked to input this data during execution of the discharge routine. Military units required will be reduced accordingly.

c. PORTCAP output. As a minimum the planner needs to know the total daily discharge capacity of units assigned to perform the mission. PORTCAP provides this figure in STONs per day broken down into two classes of supply, ammunition and other cargo. Further, a list of the type and number of terminal service and lighter units required to support the operation will be furnished to the planner.

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C. Dromar Clearance analysis.

1. General. The final component of throughput is Terminal Clearance Capacity. Clearance is expressed in STONs per day and reflects the capacility of the transportation net and transportation units to move cargo from the port to inland supply points. In this analysis both rail and highway modes are participating in clearance operations. Inland waterways are non-existent.

2. Rail Clearance Capacity - Dromar

a. General Characteristics of Dromar Rail Net.

(1) The Dromar rail net is generally rated in good condition. The net has 477 miles of standard gauge (4'8½") single track.[63] The rail system primarily serves the densely populated coastal plain area giving the line a north to south orientation. Rail service connects major ports except Elat. The system has no tunnels, but does have 100 bridges, some over 400 ft in length. The ruling grade is 2 percent on the number seven line from Lod to Jerusalem.[64] Passing tracks are numerous and are between 900 to 1920 ft in length.[65] Exhibit IV-2,p. 17.1, is a map of the rail network of Dromar. Each route is numbered to coincide with Exhibit IV-22 which identifies critical planning factors for each segment of the rail net.

(2) Rail Lines of Communication.

Routes 6 and 8, Ashdod to Beersheba, and routes 6 and 7, Ashdod to Jerusalem, are the key rail lines of communication affecting clearance operations. Exhibit IV-23 is a schematic of these routes with their principle characteristics. Although line 2, Haifa to Lod, and lines 2 and 3, Haifa to

Tel Aviv, could be used in clearing Haifa of military cargo, their north-south orientation does not support the contingency operation and is therefore reserved for civilian traffic.

(3) Engines and Rolling Stock.

Engines and rolling stock available in Dromar can be found in Exhibit IV-24. Military operations have first priority on all assets. Further, if deemed necessary, augmentation of Dromar's assets can be obtained from the Military Traffic Management Command's (MTMC) interchange fleet. In view of the short length of trackage available for military operations, and the two assumptions made above, rolling stock is not considered a constraint in this problem and is not played in the PORTCAP model.

(4) Operating personnel.

It is further assumed that if the rail system remains operational, personnel from the Dromar Ministry of Transportation will continue to man and operate the system.

(5) Vulnerability.

The rail system of Dromar is subject to severe disruption in time of war. Critical marshalling and turnaround areas such as those located at Lod and Jerusalem are crucial to the effective and efficient operation of the line. Destruction of these key marshalling centers would disrupt traffic over the entire system and prevent normal rail operations.

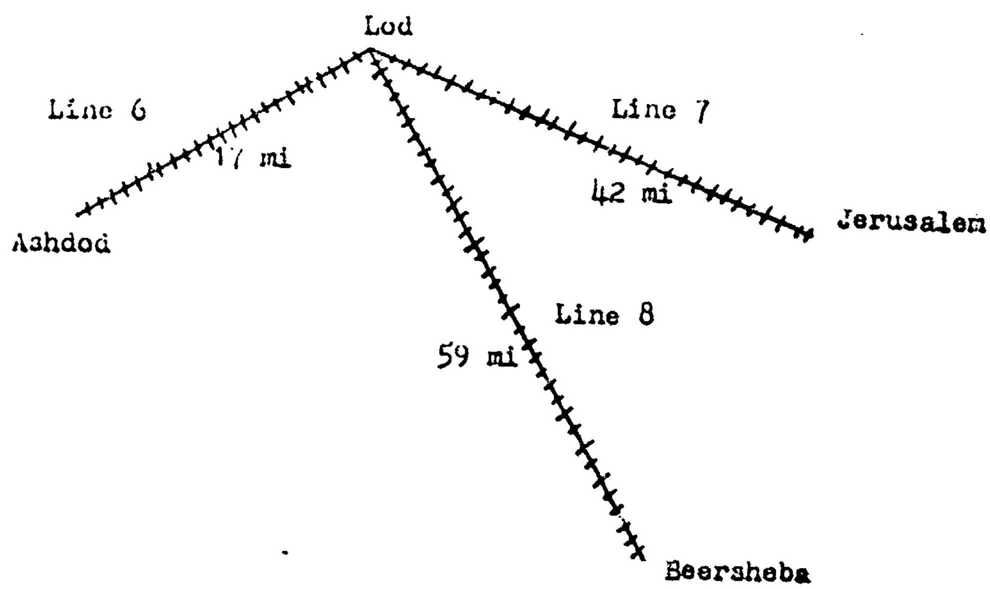
b. Planning Factors - Rail Clearance Operations.

(1) General. Setting aside the problems of available rolling stock and operating personnel, the planner

EXHIBIT IV-22
DROMAR RAILROAD CHARACTERISTICS
SELECTED LINES

Route	Terminals	Length mi.	Max Grade	Weather Factor	Nr Pass. tracks	Degree of Curve
1	Haifa-Akhziv	25	1.1	95%	4	11.4
2	Haifa-Remez Jct.		1.0	95%	1	5.85
2A	Remez Jct.-Lod		1.0	95%	4	5.85
3	Remez Jct.-Tel Aviv	29	.7	100%	4	3.91
4	Tel Barukh- Rosh Ha'ayin	8	.9	100%	2	3.59
5	Tel Aviv-Lod	11	.8	100%	0	8.73
6	Ashdod-Lod	17	1.1	100%	1	3.57
	Lod-Jerusalem	42	2.0	100%	3	12.80
8	Lod-Oron	92	1.8	100%	5	8.76

EXHIBIT IV-23
KEY RAILWAY DIVISIONS - DROMAR[66]



	Line 6	Line 7	Line 8
Length	17 mi.	42 mi.	59 mi.
Ruling Grade	1.1%	2.0%	1.8%
Ruling Curve	3.57°	12.80°	8.76°
Weather Factor	100%	100%	100%
Nr. Pass. Tracks	1	3	3

EXHIBIT IV-24 67,68
RAILWAY ENGINES & ROLLING STOCK
DROMAR

Engines	Nr	Remarks
Main Line	35	1. Diesel Power 2. Continuous tractive effort of 31000 lbs 3. Weight of locomotive 120 STONS
Switch	30	1. Diesel power

Rolling Stock	Nr	Remarks
Box cars	1100	1. Ave capacity all cars 20 Stons.
Gondolas	500	
Flat cars	400	
Miscellaneous	600	

must concentrate on determining the tonnage of supplies and equipment that can be moved over a given division of track and delivered at the opposite end. Capacity must be calculated for each division or line separately. In the Dromar scenario, two factors are critical, first, the planner must determine a road engine's hauling capability over a given division of track. How much tonnage can be pulled behind an engine? This figure is known as the net trailing load (NTL). The second factor is train density (TD). How many trains can be moved between origin and destination each day. Once these two pieces of information have been calculated the net tonnage that can be delivered at the end of each division can be calculated. Finally, once the planner knows the tonnage for each division, he can estimate the total number of tons that can be delivered at the forward most terminal point or points on the line. This figure is called end delivery tonnage (EDT) and is the clearance capacity of the rail system in this problem.[69]

For purposes of illustration, and to provide the reader some incite into PORTCAP's rail clearance routine an example of the calculations for determining net trailing load (NTL) and train density (TD) on the line from Ashdod to Jerusalem and Beersheba are provided.

(2) Net Trailing Load (NTL) - Line 6, Ashdod to Lod

Returning to Exhibit IV-23, let us assume that the planner wishes to calculate rail clearance capacity from Ashdod to Jerusalem and Beersheba. Three segments of track are involved:

Division	Line Nr
Ashdod to Lod	6
Lod to Jerusalem	7
Lod to Beersheba	8

Calculations for each division must be made separately. The first calculation is to determine the net trailing load for division 6 from Ashdod to Lod. Several variables are involved in calculating NTL:

TE - The power of an engine to move itself and a trailing load from a stopped position is referred to as starting tractive effort. Continuous tractive effort refers to a locomotives ability to keep itself and its load moving once underway.[70] For purposes of this problem and the PORTCAP model a 0-4-4-0 diesel electric standard road engine with a continuous tractive effort of 31000 pounds will be used. The engine weighs 120 STONS.[71]

DBP - Drawbar pull is the pulling power of a locomotive minus the effort required to move itself. Twenty pounds per ton of locomotive weight is subtracted from the continuous tractive effort to determine DBP.[72]

DBP = TE - (Eng Wgt X Planning factor)

28600 lbs = 31000 lbs - (120 Stons X 20 lbs/ton)

The 28600 lbs figure represents the maximum trailing load an engine in the Dromar fleet can pull on level track with no resistance to movement. However, when a train moves on tracks, it encounters three types of resistance which tends to degrade its pulling capability. These three factors, rolling resistance, grade resistance, and curve resistance differ from one division of a net to another.

RR - Rolling resistance refers to several factors such as friction between track and wheels, undulation of track as a train moves over it, air etc., all acting to hold back a trains' forward movement. Track quality is the primary factor on which the applied planning factor for rolling resistance is based. Exhibit IV-25 provides planning data for this variable. All lines in Dromar are considered good to fair.

EXHIBIT IV-25
VALUES OF ROLLING RESISTANCE[73]

Track Rating	lbs per ton of train
Exceptionally good	5
Good to fair	6
Fair to poor	7
Poor	8
Very poor......................	9

GR - Grade resistance refers to the gravitational pull on a train as it attempts to climb a hill. The value assigned to this force for planning purposes is equal to 20 lbs per ton of train for each percent increase in grade.[74] In railroad terminology, percent of grade represents the number of verticle feet increase for each 100 feet of horizontal distance. 75
The planner is interested only in the ruling grade on the division of track he is evaluating. By taking into account the ruling grade, other grades will have no impact on the trailing load. To determine the impact on pulling capacity of grade resistance on line 6, Ashdod to Lod, PORTCAP applies the following factors:

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P = 20 lbs per ton of train. Planning factor.

R = % of ruling grade. See exhibit IV-23, p. 55 for ruling grade on line 6.

GR = Calculated grade resistance

GR = P X R

22 lbs/ton = 20 lbs / ton X 1.1

CR - Curve resistance. Curves offer further resistance to train movement. A locomotive must exert .8 lbs of force per ton of train, per degree of curvature to overcome curve resistance.[76] For example, on line 6, the ruling curve is 3.57 degrees. The impact of CR on an engines trailing load is calculated below:

P = .8 lbs/ton of train. Planning factor.

C = Degree of curve on ruling curve. See Exhibit IV-23, p. 55.

CR = Calculated curve resistance.

CR = P x C

2.86 lbs/ton = .8 X 3.57

W - Weather. Low temperatures affect a locomotives pulling power. The following table identifies planning factors used in PORTCAP.

EXHIBIT IV-26

WEATHER EFFECT ON LOCOMOTIVE POWER[77]

Temperature Range	Loss in Power	Applied Weather Factor
*Above 32	0%	100%
16 to 32	5%	95%
0 to 15	10%	90%
-1 to -10	15%	85%
-11 to -20	20%	80%

* Initially, PORTCAP computes bases on 100%. User may alter the weather effect.

GTL- The gross trailing load of a train represents the weight of cars that are under load as well as the freight that is in them.

NTL - Net trailing load is equal to the GTL minus the weight of the cars themselves. Rather than calculating each car separately, rail planners apply a planning factor of 50% of the GTL to determine NTL.[78]

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Using the variables explained in the preceding paragraphs, PORTCAP determines the net trailing load of a locomotive moving over line 6, Ashdod to Lod, as follows:

$$\text{Gross trailing Load} = \frac{\text{Drawbar Pull} \times \text{Weather Factor}}{\text{Rolling Resistance} + \text{Grade Resistance} + \text{Curve Resistance}}$$

$$926.77 \text{ Stons} = \frac{28600 \text{ lbs} \times 1.0}{6 \text{ lbs/ton} + 22 \text{ lbs/ton} + 2.86 \text{ lbs/ton}}$$

$$\text{Net trailing Load} = \text{Gross Trailing Load} \times .50$$

$$463.39 \text{ Stons} = 926.77 \times .50$$

(3) Train Density - Line 6, Ashdod to Lod.

The 463.39 Ston figure represents the maximum tonnage that can be hauled by a single engine between the beginning and end of line 6. The planner is interested in knowing, not only the NTL on the line, but also the number of trains each day than can be moved. Called train density (TD), this figure is multiplied by NTL to detemine a divisions total clearance capacity each day. The variables affecting train density are numerous and include the length and number of tracks on the main line, the number and location of passing tracks, capacity of yards and terminals, and the amount of rolling stock, train crews and motive power available. For the PORTCAP application, personnel to operate the system are provided by the ministry of transportation and rolling stock is considered adequate to meet train densities.. To compute train density from Ashdod to Lod, the following planning factors are utilized.

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NT - Number of passing tracks on the main line. Exhibit IV-23, p. 55, indicates that line 6 has one passing track between Ashdod and Lod. (Passing tracks within five miles of each other do not enhance train density and are ignored).[79]

1 - Constant. (Takes into account the number of trains that could be run if no passing tracks were available.)

2 - Constant. Converts train density to one direction.

S - Average speed. Speed is a function of track condition and the ruling grade. The most restrictive of the two factors applies. Exhibit IV-27 provides average speed values for Dromar's rail net.

EXHIBIT IV-27

AVERAGE SPEED VALUES[80]

DROMAR RAIL NET

Track Cond.	% of Ruling Grade	Ave Speed MPH
Exceptionally good	1.0	12
*Good to fair	1.5 or less	10
Fair to poor	2.5 or less	8
Poor	3.0 or less	6

* Utilized by PORTCAP unless the user elects to change the speed value.

LD - Length of division in miles. Division 6 is 17 miles. See Exhibit IV-23, p. 55.

Formula for computing train density.

$$TD = \frac{NT + 1}{2} \times \frac{H \times S}{LD}$$

$$14.12 \text{ or } 15 = \frac{1 + 1}{2} \times \frac{24 \times 10}{17}$$

Now that we know the number of trains that can be moved over line 6, it is a simple matter to determine the amount of tonnage that can be delivered at the end of the line each day.

NDT - Net division tonnage. This figure is determined by multiplying the train density obtained above by the net trailing load each train is capable of pulling, which was calculated on p. 60.

NDT = TD X NTL

[illegible]

The figure of 6950.85 STONS will be achieved if all 15 trains moving on the line each day are freight trains. If other types of trains such as hospital, maintenance or passenger trains are used NDT must be reduced accordingly. Net division tonnage (NDT) for lines 7 and 8 are computed in the same manner. The resulting short ton figure may be higher or lower than for line 6. The tonnage capability of the most restrictive division of track in the network becomes the rail clearance capability of the port.

The PORTCAP model is capable of manipulating the data elements described above and computing NTL, TD, and NDT for any division of railroad provided it is given the input in the requested format. A great deal more can be done with this routine such as determining rolling stock and personnel requirements, but time precludes expanding the model at this time.

3. Highway Clearance Capacity - Dromar

a. General Characteristics of Dromar Highway Network.

(1) The highway network of Dromar is one of the most highly developed in the Middle East. Accounting for the movement of 90% of all internal cargo movement, it covers approximately 2500 miles, not including occupied territory.[81] Over 75% of the roads are bituminous surfaced with the remainder of crushed stone, gravel and dirt.[82] The width of most bituminous roads is 16-20 ft. Narrower roads prevail in hilly and mountainous areas. The main highways are in good condition while secondary roads have been allowed to deteriorate in order to expand the

system into occupied territory and build bypasses around towns and other obstacles.

(2) There are approximately 125 bridges 20 ft. or more in length. Constructed of reinforced concrete, stonemasonry arch, or steel-truss type, most bridges can support heavy loads including tanks.[83]

(3) The Dromar civilian transport industry has a substantial capability. Generally owned by cooperatives, the country has more than 50,000 trucks and buses to support the economy.[84] During wartime these assets could be used to meet military requirements. PORTCAP, however, does not attempt to utilize these assets in the problem.

(4) Vulnerability. Because of the quality and number of roads, the Dromar road net is not particularly vulnerable to disruption. However, seasonal climatic conditions such as winter rains and summer dust may present temporary obstacles to movement.

b. Road Lines of Communication.

For military purposes the main road lines of communication extend from principal sea and air terminals inland. See Exhibit IV-2, p. 17.1, for a sketch map of the road network of Dromar.

(1) Ashdod Port Clearance - Highway.

Clearance capacity from the port of Ashdod to the east is crucial to the success of the Dromar operation. Writers of the scenario indicate that major Army support installations, both GSU and DSU, will be located in the vicinity of Jericho along MSR1. Along MSR2 to the south, Beersheba will contain major Air Force units and installations. PORTCAP utilizes direct haul throughput distribution from Ashdod to both Jericho and Beersheba. Other hauling methods, such as shuttle, piggyback, etc., can certainly be built into the model, but time precludes their inclusion at this time.

(2) Elat Port Clearance - Highway.

Although a substantial distance from the AO, Elat is a suitable port for clearance with a road LOC along MSR4 to Beersheba and Jerusalem via Sedom. In the event that road and rail clearance capacity from Ashdod port is insufficient to meet the daily resupply and buildup requirements of both the Army and Air Force, it may be necessary to open MSR4 from Elat to Jerusalem.

(3) Haifa Port Clearance - Highway.

Current plans for Dromar do not require Haifa to be operational until airborne units are dropped into the Lake Tiberias area around D+20. The road net from Haifa to the east to Tiberias and Irbid, via Nazareth, has a significant clearance capacity capable of supporting the two airborne brigades and link up forces. PORTCAP can evaluate this capability.

c. Road Net Capability.

(1) The key road segments under evaluation in PORTCAP are described in Exhibit IV-28. Others can be added as required. A number of intelligence surveys are conducted annually which provide data on the rated clearance capacity of the road nets in many countries of the world. Recognizing the possibility that more accurate data may be available to the planner from these sources, PORTCAP will accept predetermined

EXHIBIT IV-28
DROMAR HIGHWAY CHARACTERISTICS
SELECTED ROADS

Origin - Destination	Distance mi.	Surface	Minimum width ft.	Condition
Ashdod to Jericho	65	bituminous		
Mile 1-24 Latrun	24	Bituminous	18	good
Mile 24-40 Jerusalem	16	Bituminous	22	good, hilly alignment, steep grades, sharp curves
Mile 40-65 Jericho	25	Bituminous	16	good, hilly alignment, steep grades, sharp curves
Ashdod to Beersheba	44	Bituminous		
Mile 1-10 Ashqelon	10	Bituminous	20	good
Mile 10-19 Qiryat Gat	9	Bituminous	16	fair to good
Mile 19-44 Beersheba	25	Bituminous	25	good
Haifa to Nazareth	21	Bituminous	23	good, hilly alignment
Nazareth to Tiberias	17	Bituminous	20	good, sharp curves, steep grades
Nazareth to Jordan River	27	Bituminous	20	fair to good, sharp curves in Bet She'an area

input. In those cases where specific clearance data is available the general planning factors described below are bypassed.

(2) Roadnet Planning Factors.

(a) Maximum daily forward tonnage is dependent on whether principal MSR's lie in the rear area or in the combat zone. Dromar main MSR's are considered capable of sustaining COMMZ traffic density initially. Maximum tonnage may be reduced dependent on road type, width, and terrain characteristics. Other factors such as weather may also cause the planner to reduce capacity estimates. Exhibit IV-29 provides information to assist the planner in determining the capacity of a road segment. The data in the exhibit is built into the PORTCAP model.

EXHIBIT IV-29
HIGHWAY CAPACITY PLANNING DATA[85]

Highway type	Daily Fwd Tonnage		**Reductions Applicable to Various conditions		
	COMMZ	Combat Zone	Narrow	Hilly w/ Curves	Mountainou
Concrete	36[illegible]00	8400	25%	30%	60%
Bituminous	*27000	7300	25%	30%	60%
Gravel	6090	3400	25%	40%	70%

* Maximum for main MSR's in Dromar scenario.
** When two or more reduction factors are applicable, apply narrow roadway factor first. To that newly computed tonnage, apply the second limiting factor etc.

(b) Illustration. PORTCAP uses the planning factors in Exhibit IV-29 to determine the total tonnage that could be moved over an MSR given sufficient motor transport units. For example, MSR1, Ashdod to Jericho, can sustain [illegible]175 STONS of traffic per day. This figure was calculated based on the characteristics of MSR1 found in Exhibit IV-28 and the following formula:

DFD - Daily Forward Tonnage. (Exhibit IV-29 gives a planning factor for Dramar main MSR's as 27000 STONs per day.)

NR - *Narrow Road Reduction. 25%

H - **Hilly Terrain Reduction. 30%

DCC - Daily Port Clearance Capacity MSR1

DCC	=	DFD	X	NR	X	H
14175 STONs per day	=	27000	X	.75	X	.70

* 18ft considered minimum width withoug applying reduction factor. MSR1 minimum width equals 16ft.
** Exhibit IV-28 identifies MSR1 from Latrun to Jericho as hilly with sharp curves.

If the MSR under evaluation was considered to be in a vulnerable area subject to frequent attack, the planner may reduce capability to combat zone traffic of 7300 STONs per day and then apply the reduction factors. PORTCAP can play any scenario.

d. Capabilities - Transportation Truck Companies.

(1) General. To determine if the maximum capability of a particular road segment can be used fully, an evaluation of transport units available must be made. In the PORTCAP model, three types of motor transport units are played in clearance operations. Others are available and could be added if desired.

(2) Light Truck Co (TOE 55-17)

(a) Mission & Organization. This company provides general hauling service for terminal clearance, and depot operations. It is particularly suited for port clearance in a LOTS operation over uneven beaches. The company is organized into a company headquarters, maintenance section, and three truck platoons.

(b) Equipment. The company can be equipped with 2½ ton or 5 ton trucks. Sixty task vehicles are assigned to perform the mission. In the FASTCAT model light truck companies are equipped with the 5 ton truck.

(c) Capabilities. Gross planning factors for a Transportation Light Truck Company (5 ton) are found below:

EXHIBIT IV-30
LIGHT TRUCK COMPANY (5 ton)[86]
GROSS PLANNING FACTORS

Type Opera.	Assigned Vehicles		Avail.		STONs/ Vehicle		Trips/ Day		STONs/ Day
Local haul	60	X	.75	X	6	X	4	=	1080
Line haul	60	X	.75	X	6	X	2	=	540

Each company normally can field 75% of its available task vehicles each day (45 vehicles). The 5-ton truck is capable of hauling a minimum of 6 STONs per load on good road. Engaged in local haul, no more than 15 miles one way distance, each task vehicle can make 4 trips per day, two each shift. In line haul operations, the planning factor is two trips per day, onw each shift.[87] If distances and load unload times are known, the planner can determine more precise planning capabilities.

(2) Transportation Medium Truck Co (TOE 55-18H)

(a) Mission & Organization. This company has recently been reorganized. It can now be configured to handle general cargo, reefer cargo, bulk petroleum products, and containers depending on the type equipment assigned. In this problem the medium truck company will be tasked to move only general

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cargo, ammunition, and containers. It is particularly suited for line haul relay operations on improved highways. Regardless of mission the company is organized with a company headquarters, a maintenance section, and three truck platoons.

(b) Equipment. Two equipment configurations can be all.ged in the problem.

- Conventional. Unit is equipped with 60 5-ton 6X6 truck tractors and 120 12-ton cargo semitrailers.

- Multi-purpose. Unit is equipped with 60 6X4 commercial truck tractors and 120 25-ton semitrailers. Semitrailers are capable of carrying two 20' or one 40' van. The 6X4 tractor and 25-ton semitrailer are under development at this time.

(c) Capabilities. The medium truck company, when equipped in the conventional manner, is capable of moving 2160 STONS of cargo per day in short haul operations and 1080 STONS in line haul operations. See Exhibit IV-31 for calculations. Under development are two new pieces of equipment for the medium truck company --- the 6X4 commercial truck tractor and the 25-ton semitrailer. These vehicles will be assigned to a multipurpose company capable of handling both breakbulk and container cargo. Hauling conventional BB cargo, the multipurpose companies capability jumps to 4500 STONS per day in a short haul operation and 2250 STONS in a line haul operation. See Exhibit IV-31 for calculation. In addition to its role in moving BB cargo, the new semitrailer is capable of moving vans up to 40' in size. In a normal operating day of 20 hours, the company can

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[illegible] vans or 100 40' vans in a long haul operation. Other planning factors for the multipurpose medium truck company can be found in Exhibit IV-32.

EXHIBIT IV-31
MEDIUM TRUCK CO.
GROSS PLANNING FACTORS
[illegible] CARGO

Type Co	Assigned Vehicles		Avail.		STONs/ Vehicle		Trips/ Day		STONs/ Day
Conventional[88]									
Local Haul	60	X	.75	X	12	X	4	=	2160
Line Haul	60	X	.75	X	12	X	2	=	1080
Multipurpose[89]									
Local Haul	60	X	.75	X	25	X	4	=	4500
Line Haul	60	X	.75	X	25	X	2	=	2250

EXHIBIT IV-32
MEDIUM TRUCK CO
GROSS PLANNING FACTORS
CONTAINERS 90

Type Co	Assigned Vehicles	Avail.	STONs / Container	Trips/ Day		Cont./ Day	STONs/ Day
Multipurpose							
Local Hauls							
20' vans	60	.75	13 Gen 20 Ammo	4	=	360*	4680 Gen 7200 Ammo
40' vans	60	.75	20 Gen 31 Ammo	4	=	180**	3600 Gen 5580 Ammo
Line Hauls							
20' vans	60	.75	13 Gen 20 Ammo	2	=	180	2340 Gen 3600 Ammo
40' vans	[illegible]	.75	20 Gen 31 Ammo	2	=	90	1800 Gen 2790 Ammo

* Semitrailer carries 2 20' vans per trip.
** Semitrailer carries only 1 40' van per trip.

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(3) Transportation Heavy Truck Company (TOE 55-28)

(a) Mission Organization. This company's mission is to move heavy and outsized equipment such as tanks and bulldozers over the highway. It is organized in the same manner as the other two truck companies.

(b) Equipment. The company consists of 24 10-ton or larger truck tractors and 24 heavy equipment transporter semitrailers, 60 ton capacity.

(c) Capabilities. Under normal conditions on improved highway the company has the following capability.

EXHIBIT IV-33
HEAVY TRUCK COMPANY[91]
GROSS PLANNING FACTORS

Type Opera.	Assigned Vehicles		Avail.		STONs/ Vehicle		Trips/ Day		STONs/ Day
Local Haul	24	X	.75	X	40	X	4	=	2880
Line Haul	24	X	.75	X	40	X	2	=	1440

e. Motor Transport Operations.

(1) General. The gross planning factors for truck units presented in the preceding paragraphs can be used to determine clearance capacity. However, when distances from ports to inland points, speeds, and other factors needed to determine turnaround time are known, a much more accurate prediction of the number and type units required to support an operation can be made.

(2) Computing Turnaround Time-Breakbulk Cargo. To compute turnaround time along a route from port to supply point requires the use of several variables. To compute TT

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from Ashdod to Jericho, a distance of 65 miles, the following information is required:

DIS - One way distance from Ashdod to Jericho (See Exhibit IV-28, p. 65.)

2 - Constant to convert to round trip distance.

R - Rate of march. This figure includes short periods for rest and refueling. 20 MPH is the speed factor on Bromar LOR's in the PORTCAP model. User can change this figure as required. The planner must consider road condition, terrain, weather and enemy interdiction in determining a rate of march.

D - Delays. Time consumed in loading, unloading and/or relay operations (when used). Planning factors for load and unload times for this operation are as follows:

Straight trucks - 2.5 hours
Semitrailers - 2.5 hours (distance is too short for relay operations)
Semitrailers carrying containers - 1.5 hours

TT - Turnaround time for a single vehicle from origin to destination and return.

$$TT = \frac{DIS \times 2}{R} + D$$

$$9 \text{ Hours} = \frac{65 \times 2}{20} + 2.5$$

(3) Computing Truck Co's Required-Breakbulk Cargo.

Assuming a requirement to move 5000 STONs of breakbulk cargo per day from Ashdod to Jericho, how many units would be required. Here are the calculations.

DFD - Daily Forward Tonnage. (Determined for this example to be 5000 STONs per day. This figure will normally be related to the discharge capacity of the port being cleared.)

TT - Turnaround Time. (Computed in the preceding para. as 9 hours)

TS - Tons per vehicle. Med Truck Co - 12 STONs per semi.
Light Truck Co - 6 STONs per truck.

TA - Trucks available per Co. Planning factor is 75% or 45 vehicles.

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H - Hours in operating day. Planning factor is 20 hours.

CO's - Companies required to move 5000 STONs of cargo per day.

$$CO's = \frac{DPT \times TT}{TS \times TA \times H}$$ 93

(a) Using only Light Truck Co's.

$$\underset{CO's}{8.33^{*}} = \frac{5000\,STONs \times 9\,hrs}{6\,Tons/Veh \times 45 \times 20}$$

* Each Company can move 600.24 STONs/day

(b) Using only conventional Medium Truck Co's.

$$4.17^{*} = \frac{5000\,STONs \times 9\,hrs}{12\,tons/Veh \times 45 \times 20}$$

* Each Company can move 1199 STONs/day

The plann.r can now select a combination of units to perform the cl-arance mission for breakbulk cargo.

(4) Computing Turnaround Time - Container Cargo. The same calculations are required to determine the number of multipurpose Medium Truck Companies required to move containers from the port. However, delay time for loading and unloading containers is reduced from 2.5 to 1.5 hours and unit requirements are calculated on the basis of number of containers to be moved rather than STONs. Let's assume that to clear the port a minimum of 700 20' containers must be moved out of the port each day. To compute the number of CO's required can be done as follows:

$$TT = \frac{DIS \times 2}{R} + D$$

$$8\,hrs = \frac{65 \times 2}{20} + 1.5$$

DRAFT

(5) Computing Truck Co's Required - Container cargo.

$$\text{Co's} = \frac{\text{Daily Containers Forward} \times TT}{\text{Containers/Semi} \times 45 \times H}$$

$$3.47 = \frac{780 \times 8 \text{ hrs}}{2 \times 45 \times 20}$$

A total of 3.47 companies can clear 780 20' containers from the port of Ashdod to Jericho daily. Depending on the type of cargo, ammo or general cargo, 780 containers amounts to 10,140 to 15000 STONS per day. Added to the 5000 STONS of breakbulk cargo, a total of between 15,140 and 20600 STONS can be cleared by highway if the units requested are provided. To determine total clearance capacity, the planner must add his rail clearance capacity to his highway clearance capacity.

D. Throughput Capacity.

1. The final step performed by PORTCAP is to examine the tonnage capacity of the three components reception, discharge, and clearance capacity, find the most restrictive element and designate it as the throughput capacity of the port complex. In addition, PORTCAP will develop a troop list of the number and type required to achieve the throughput capacity tonnage daily.

2. By running a number of separate iterations of PORTCAP, the planner can balance his requirements against vessels, facilities, terminal units, and truck units until he achieves a satisfactory mix to meet the supported force's requirements.

SECTION V: PORT CAPACITY ESTIMATOR MODEL (PORTCAP)

To be completed separately for elective credit in Course 6600

SECTION VI: CONCLUSION

Rapid technological changes in the U.S. maritime industry and our failure in past conflicts to adequately deal with the problems of throughput capacity prompted the initiation of this research project. The paper comes to grips with the complex set of factors the planner must consider in determining the capability of a port complex to support a military operation. Rather than ignoring recent shifts in cargo handling methods and techniques, this paper recognizes and deals with them. Some of the data is admitedly speculative and requires further testing and refinement, but it is the best we have today.

To further assist the planner, the Port Capacity Estimator (PORTCAP) model has been partially developed. When used in conjunction with this paper, it should considerably reduce the time and effort required to estimate the throughput capacity of a port complex. In addition, PORTCAP provides a troop list required to conduct the reception, discharge and clearance operatior

Unfortuneately, the magnitude of the project prevented its being completed within a single acodemic year. This paper and PORTCAP require considerable review and revision before they can be made available for general use. Some of the areas requiring work are as follows:

(1) Refinement of planning factors.

(2) Development of the clearance and throughput routines for the PORTCAP model

(3) Documentation of the PORTCAP program and development of a user's manual.

However, despite its weaknesses, this paper and PORTCAP clearly establishes a framework from which adjustment, revisions, and refinements can be made to provide strategic planners a tool which can materially assist them in the planning process.

The writer plans to continue working on the paper and the model. It is hoped that several students in the next class having an interest in this subject area will carry on with the development of PORTCAP.

FOOTNOTES

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1

05/26/75 LOGGED IN AT 21.40.56.
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COMMAND- EDITOR

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INDICAT INPUT BY USER.

YOU ARE ABOUT TO INTERACT WITH THE PORT CAPACITY ESTIMATOR (PORTCAP) MODEL. IT WILL ASSIST YOU IN CALCULATING THE THROUGHPUT CAPACITY OF A TERMINAL COMPLEX. THROUGHPUT IS MADE UP OF THREE COMPONENTS, RECEPTION, DISCHARGE, AND CLEARANCE CAPACITY. IF YOU ARE UNFAMILIAR WITH THESE TERMS ANSWER YES TO THE NEXT QUESTIONAND A BRIEF DESCRIPTION OF THEIR MEANING WILL BE PROVIDED.

DO YOU WISH TO HAVE THROUGHPUT CAPACITY DEFINED?
?
YES

TERMINAL RECEPTION CAPACITY - TRC IS BASED ON THE NUMBER OF DEEP DRAFT VESSELS THAT CAN BE MOVED INTO A HARBOR OR COASTAL AREA AND ACCOMODATED FOR DISCHARGE IN THE PORT COMPLEX. THE PHYSICAL FACILITIES NEXESSARY TO ACCOMODATE SHIPS ARE WHARF SPACE FOR DEEP DRAFT WHARF SPACE FOR LIGHTERS, ANCHORAGES, BEACHES, ETC. TRC IS EXPRESSED IN TERMS OF STONS PER DAY.

TERMINAL DISCHARGE CAPACITY - PHYSICAL FACILITIES AND VESSELS ALONE WILL NOT INSURE THE ARRIVAL OF CARGO IN THE AREA OF OPNS, IF THERE ARE INSUFFICIENT UNITS AND EQUIPMENT AVAILABLE FOR DISCHARGE OPERATIONS. TERMINAL DISCHARGE CAPACITY IS EXPRESSED AS THE NUMBER OF STONS PER DAY THAT TERMINAL UNITS AND LIGHTERAGE UNITS CAN ACTUALLY DISCHARGE FROM SHIPS IN POSITION AT THE PORT COMPLEX.

TERMINAL CLEARANCE CAPACITY - THIS FIGURE REPRESENTS THE NUMBER OF STONS PER DAY THAT CAN BE MOVED THROUGH AND OUT OF THE PORT COMPLEX. IT IS A FUNCTION OF THE CAPABILITY OF THE TRANSPORTATION NET, BOTH RAIL AND HIGHWAY, ADJACENT TO THE PORT AND OF THE TRANSPORT UNITS AVAILABLE TO USE THE NETWORK.

THROUGHPUT CAPACITY - THE FINAL OBJECTIVE OF PORTCAP IS TO ARRIVE AT THE THROUGHPUT CAPACITY OF THE PORT COMPLEX. THIS FIGURE IS OBTAINED BY COMPARING THE VALUES OF RECEPTION, DISCHARGE, AND CLEARANCE CAPACITY. THE MOST RESTRICTIVE TONNAGE FIGURE IN STONS PER DAY BECOMES THROUGHPUT CAPACITY.

ONCE PROVIDED CERTAIN INFORMATION CONCERNING VESSELS, PHYSICAL FACILITIES AT THE PORT, AND THE TRANSPORTATION NET ADJACENT TO THE PORT, PORTCAP WILL CALCULATE THROUGHPUT CAPACITY. THE USER CAN ALTER THE INPUTS TO TEST VARIOUS CONFIGURATIONS OF VESSELS, FACILITIES, AND UNITS IN ORDER TO ACHIEVE SATISFACTORY THROUGHPUT RESULTS. IF SEVERAL ATTEMPTS TO SATISFY TONNAGE REQUIREMENTS FAIL, THE CONSTRUCTION OF ADDITIONAL FACILITIES IN THE THEATER OR THE ADDITION OF UNITS MAY BE THE ONLY SOLUTION.

BEFORE BEGINNING AN ANALYSIS OF RECEPTION CAPACITY IT IS ESSENTIAL THAT YOU HAVE AVAILABLE CERTAIN INFORMATION REGARDING THE SHIPS THAT YOU CAN USE AND THE PHYSICAL FACILITIES OF PORTS YOU PLAN TO PLAY IN THE PROBLEM.

IF YOU HAVE NOT USED THE MODEL BEFORE, ANSWER YES TO THE NEXT QUESTION AND YOU WILL BE PROVIDED A LIST OF THE DATA REQUIREMENTS FOR PORTCAP.

DO YOU WANT TO HAVE A LIST OF DATA REQUIREMENTS FOR PORTCAP.
?YES

SHIP DATA
YOU MUST KNOW THE NUMBER AND TYPE SHIPS AVAILABLE AT EACH PORT ARE AVAILABLE FOR USE.

PORT DATA
YOU SHOULD HAVE A SKETCH OF EACH PORT COMPLEX YOU PLAN TO USE. THE FOLLOWING DATA WILL BE REQUESTED IN THE EXECUTION OF PORTCAP.

1. HOW MANY BREAKBULK BERTHS ARE AVAILABLE.
2. HOW MANY LIGHTERAGE WHARVES ARE AVAILABLE?
3. HOW MANY CONTAINER BERTHS ARE AVAILABLE? THE NUMBER OF GANTRY CRANES AVAILABLE AT EACH BERTH WILL ALSO BE REQUIRED.
   **A BERTH IS CONSIDERED TO BE A CONTINUOUS LENGTH OF WHARF SPACE RUNNING IN A SINGLE DIRECTION. FOR EXAMPLE THE BERTHING SPACE ON TWO SIDES OF A FINGER PIER WOULD REPRESENT TWO DIFFERENT BERTHS.
4. THE LENGTH, WIDTH AND DEPTH OF WATER AT EACH BERTH.
5. THE NUMBER OF ANCHORAGES AVAILABLE WITHIN THE MAIN PORT COMPLEX.

LOGISTICS OVER THE SHORE (LOTS) DATA.

1. HOW MANY BEACHES ARE AVAILABLE IN THE VICINITY OF THE PORT?
2. HOW LONG IS EACH BEACH?

NOW LET US PROCEED WITH PORTCAP EXECUTION.
HOW MANY PORTS WILL BE USED IN THIS PROBLEM?
?1

INPUT THE NAME OF PORT NUMBER 1
?ASHDOD

FOR THE REST OF THE PROBLEM, THE PORTS
WILL BE ASSIGNED NUMBERS AS INDICATED

PORT NAME PORT NUMBER

ASHDOD 1

IN A MOMENT YOU WILL BE ASKED FOR INFORMATION
ON THE MIX OF VESSELS AVAILABLE FOR DISCHARGE
AT ASHDOD
BEFORE ASKING FOR THAT DATA, DO YOU WANT A BRIEF
DESCRIPTION OF THE TYPE VESSELS AVAILABLE
IN THE PORTCAP MODEL
YES

SL 7 - LARGEST AND FASTEST NONSELF-SUSTAINING
CONTAINERSHIP IN U.S. MERCHANT MARINE FLEET
CARRIES MORE THAN 1000 35' AND 40' VANS.
CAPABLE OF SPEEDS TO 33 KNOTS.

SL 18 - LARGE NONSELF-SUSTAINING CONTAINERSHIP.
CARRIES MORE THAN 700 35' AND 40' CONTAINERS.
CAPABLE OF SPEEDS TO 23 KNOTS.

C5 C6 - STANDARD SIZE CONTAINERSHIP. CARRIES
EQUIVALENT OF 1000 20' VANS AT SPEEDS OF 20 KNOTS

LASH 1, 2, 3, - LARGE VESSELS WHICH UTILIZE
BARGES TO ACT AS HOLDS. BARGES ARE PLACED IN
THE WATER WITH SHIP'S GEAR AND ARE TOWED TO
INDIVIDUAL LIGHTER BERTHS FOR DISCHARGE. LASH
SHIPS CAN BE CONVERTED TO CONTAINERSHIPS IN
12 HOURS.
LASH 1 - CONFIGURED TO CARRY 89 BARGES AT SPEEDS
OF 22 KNOTS.
LASH 2 - CONFIGURED TO CARRY 50 BARGES AND 550
20' EQUIVALENT CONTAINERS AT SPEEDS OF 22 KNOTS.
LASH 3 - CONFIGURED TO CARRY 1498 20' EQUIVALENT
CONTAINERS AT SPEEDS OF 22 KNOTS. VESSELS IN
THIS MODE ARE CONSIDERED CONTAINERSHIPS.

C3/C4 - LARGE SUSTAINING BREAKBULK VESSEL CAPABLE
OF CARRYING 12000 STONS OF CARGO AT SPEEDS OF
20 KNOTS.

C1 - SMALL BREAKBULK VESSELS IN MSC NUCLEUS FLEET.
CARRIES ABOUT 5000 STONS OF CARGO AT SPEEDS OF
10 KNOTS.

RORO - VESSELS USED TO TRANSPORT ALL TYPES OF COMBAT
VEHICLES TO AO. CAN ALSO CARRY CONTAINERS ON
CHASSIS. RAPID DISCHARGE RATE OF 1000 STONS PER
HOUR. AVERAGE CARRYING CAPACITY OF 19000 STONS AT
SPEEDS OF OVER 20 KNOTS.

C2 VC2 - STANDARD BREAKBULK VESSELS OF VICTORY CLASS
CARRIES OVER 10000 STONS OF CARGO AT SPEEDS OF
15 KNOTS.

YOU WILL NOW BE ASKED FOR INFORMATION CONCERNING
VESSELS AVAILABLE AND ALSO ABOUT THE PORT OF ASHDOD

THIS INPUT WILL REQUIRE YOU TO TYPE IN THE NUMBER OF
SHIPS TO BE USED AT THIS PORT BY TYPE. WHEN YOU SEE
THE QUESTION MARK (?), TYPE IN THE QUANTITY OF THE
SHIPS IN THE ORDER SHOWN BELOW.

SL7 ? 1

SL18 ? 1

C5/C6 ? 1

LASH 3 ? 1

LASH 2 ? 1

LASH 1 ? 2

C3-C4 ? 1

C1 ? 1

ROPO ? 1

C2/VC2 ? 25

HOW MANY BREAKBULK BERTHS AT ASHDOD
? 1

INPUT LENGTH, WIDTH & DEPTH OF BERTH 1
? 2500,600,60

HOW MANY LIGHTERAGE WHARVES AT ASHDOD
? 1

INPUT LENGTH WIDTH & DEPTH OF WHARF 1
? 1600,600,60

HOW MANY CONTAINER BERTHS AT ASHDOD
1

INPUT LENGTH, WIDTH & DEPTH OF BERTH 1
? 1200,600,60

ARE THERE UNLIMITED ANCHORAGES AVAILABLE AT ASHDOD
PORT TO SUPPORT LIGHTER BERTHS.
NO

HOW MANY ANCHORAGES ARE AVAILABLE.
BERTHS.
0

DO YOU HAVE BEACHES AVAILABLE WHICH ARE SUITABLE
FOR LOTS OPERATIONS?
?

HOW LONG IS BEACH 1 IN MILES?
?3

THE LOTS OPN CAN HANDLE APPROX 11 SHIPS
THIS PROGRAM ONLY ALLOWS THE USE OF
LASH 1, C5/C6, OR C2/VC2 SHIPS IN LOTS MODE

SHIPS AVAILABLE FOR LOTS OPERATION

C5/C6	LASH 1	C2/VC2
1	1	24

TOTAL= 26

DO YOU WANT TO USE CONTAINER SHIPS IN LOTS OPN?
?YES

DO YOU WANT TO SPECIFY THE SHIPS TO BE USED IN THE LOTS
OPERATION. IF YOU DO NOT, 11 SHIPS WILL BE
POSITIONED FOR DISCHARGE WHICH IS THE MAXIMUM NUMBER THAT
CAN BE ACCOMODATED AT THE LOTS SITE.
?YES

REMEMBER, ONLY CERTAIN SHIPS CAN BE USED IN
LOTS MODE

INPUT NR OF C5/C6 SHIPS YOU WANT
?1

INPUT NR OF LASH 1 SHIPS YOU WANT
?1

INPUT NR OF C2/VC2 SHIPS YOU WANT
?1

SHIP	TYPE	BERTH TYPE
1	SL7	CONTAINER
2	C3/C4	BREAK BULK
3	C1	BREAK BULK
4	RORO	BREAK BULK
5	C2/VC2	BREAK BULK
6	L3	LTR ANCHOR
7	L2	LTR ANCHOR
8	L1	LTR ANCHOR
9	C5/C6	LOTS ANCHOR
10	L1	LOTS ANCHOR
11	C2/VC2	LOTS ANCHOR

WILL THIS PORT COMPLEX HANDLE ANY AMMO?
?YES

IF AMMO WILL BE DISCHARGED STRICTLY IN THE LOTS
OPERATION INPUT 1
IF AMMO WILL BE DISCHARGED STRICTLY IN THE PORT
OPERATION INPUT 2
IF AMMO WILL BE DISCHARGED IN BOTH THE LOTS OPERA-
TION AND THE PORT OPERATION INPUT 3
?1

HOW MANY GANTRY CRANES AT ASHDOD
?2

THE NEXT TWO ENTRIES REQUIRE YOU TO ESTIMATE THE
PERCENT OF CONTAINERS ARRIVING AT THE PORT COMPLEX
THAT WILL BE 20' AND THE NUMBER THAT WILL BE 40'.
FOR EXAMPLE, IF ALL CONTAINERS ENTERING THE PORT WILL
BE 20', ENTER 1,0. IF 80% WILL BE 20' AND THE
REMAINDER 40', ENTER .8,.2. AT ANY RATE, THE TWO
NUMBERS ENTERED MUST TOTAL 1.

WHAT % OF CONTAINERS BEING HANDLED WILL BE 20'?
WHAT % WILL BE 40'?
?.8,.2

SHIP	DAILY RECEPT. CAP	TYPE CARGO 1=GC 2=AMMO
1	7502.9	1
2	720	1
3	720	1
4	1005.53	1
5	720	1
6	720	1
7	720	1
8	720	1
9	3600	2
10	720	2
11	720	2

TOTAL DAILY RECEPTION CAPACITY - ASHDOD

AMMO	GEN CARGO	GRAND TOTAL
5040	[illegible]	17669.9

THE RECEPTION ROUTINE IS NOW COMPLETE. IF YOU HAVE NOT USED THE DISCHARGE ROUTINE BEFORE AND WANT A DESCRIPTION OF IT, ANSWER YES TO THE NEXT QUESTION.

DO YOU WANT A DESCRIPTION OF THE DISCHARGE ROUTINE?
YES

THE FACT THAT RECEPTION CAPACITY IS 5440 STONS OF AMMO AND 12822.4 STONS OF GEN CARGO IS NO GUARANTEE THAT THE CARGO CAN ACTUALLY BE DISCHARGED. ADEQUATE TERMINAL UNITS MUST BE PROVIDED IF RECEPTION CAPACITY IS TO BE CONVERTED TO PHYSICAL MOVEMENT OF CARGO OVER BEACHES AND WHARVES.

BEFORE EXECUTING THE DISCHARGE ROUTINE THE USER MUST IDENTIFY THE AMOUNT OF GENERAL CARGO, AND/OR AMMO THAT MUST BE DISCHARGED EACH DAY AT ASHDOD TO SUPPORT THE CONTINGENCY FORCE.

TWO APPROACHES TO SOLVING THIS PROBLEM ARE POSSIBLE.

1. THE USER MAY WISH TO DETERMINE THE NUMBER AND TYPE UNITS REQUIRED TO DISCHARGE THE ENTIRE TONNAGE CALCULATED DURING THE RECEPTION ROUTINE. TO USE THIS OPTION, THE USER NEED ONLY ANSWER YES TO THE NEXT QUESTION.
2. THE USER S REQUIREMENT MAY NOT APPROACH TOTAL RECEPTION CAPACITY OR, HE MAY WISH TO REDUCE THE REQUIREMENT TO TAKE INTO ACCOUNT CARGO ARRIVING IN THE THEATER BY AIR. TO INITIATE THIS OPTION THE USER ANSWERS NO TO THE NEXT QUESTION AND INPUTS THE NEW REQUIREMENT.

DO YOU WISH TO DISCHARGE THE ENTIRE RECEPTION CAPACITY OF ASHDOD
YES

THE FOLLOWING SHIPS WILL BE DISCHARGED AT ASHDOD

SHIP	TYPE	BERTHTYPE	TYPE CARGO 1=GC 2=AMMO
1	SL7	CONTAINER	1
2	C3 C4	BREAKBULK	1
3	C1	BREAKBULK	1
4	RORO	BREAKBULK	1
5	C2/VC2	BREAKBULK	1
6	L3	LTR ANCHOR	1
7	L2	LTR ANCHOR	1
8	L1	LTR ANCHOR	1
9	C5 C6	LOTS ANCHOR	2
10	L1	LOTS ANCHOR	2
11	[illegible]	LOTS ANCHOR	2

THE FOLLOWING UNITS ARE REQUIRED TO SUPPORT DISCHARGE
OPERATIONS AT THE PORT AND/OR LOTS SITE.

UNIT IDENTIFICATION	NR UNITS AT PORT	NR UNITS AT LOTS SITE
TERMINAL SVC CO (CONTAINER)	1	1
TERMINAL SVC CO (BREAKBULK)	2	2
HEAVY BOAT CO (LCU)	0	1
MEDIUM BOAT CO (LCM8)	0	0
HVY LIGHTER TM (LARC 60)	0	1
MED AMPHIBIAN CO (LARC 15)	0	0

TOTAL DAILY DISCHARGE CAPACITY AT ASHDOD

AMMUNITION	GENERAL CARGO	GRAND TOTAL
5040	12828.9	17868.9

WOULD YOU LIKE TO RECOMPUTE DISCHARGE CAPACITY?
?NO

..B.B

COMMAND-LOGOUT

CPA 35.629 SEC. 35.629 ADJ.
CPB .000 SEC. .000 ADJ.
SYS TIME 43.950
CONNECT TIME 0 HRS. 14 MIN.
05/26/75 LOGGED OUT AT 21.54.40.

9

[illegible] – INPUT B
USER

[illegible]
[illegible]
[illegible]

[illegible] LOGIN
[illegible]

[illegible]

[illegible] M31K6N

[illegible]

[illegible]

[illegible]

[illegible] THE PORT CAPACITY [illegible] [illegible] WILL [illegible] THROUGHPUT CAPACITY [illegible] DISCHARGE [illegible] CAPACITY. IF YOU ARE [illegible] WITH THESE [illegible] A BRIEF DESCRIPTION OF THEIR MEANING WILL BE PROVIDED.

DO YOU WISH TO HAVE THROUGHPUT CAPACITY DEFINED?

[illegible]

[illegible] CERTAIN INFORMATION CONCERNING VESSELS [illegible] FACILITIES AT THE PORT, AND THE TRANSPORTATION [illegible] TO THE PORT. [illegible] WILL [illegible] THROUGHPUT CAPACITY. [illegible] FACILITIES, AND UNITS [illegible] THROUGHPUT RESULTS. IF [illegible] TONNAGE REQUIREMENTS FAIL, THE [illegible] OF ADDITIONAL FACILITIES IN THE [illegible] ADDITION OF UNITS MAY BE THE ONLY SOLUTION.

[illegible] AN ANALYSIS OF RECEPTION CAPACITY IT IS ESSENTIAL THAT YOU HAVE AVAILABLE CERTAIN INFORMATION: [illegible] THE SHIPS THAT YOU [illegible] THE [illegible] YOU [illegible] IN THE PROBLEM.

*IF YOU HAVE NOT USED THE MODEL BEFORE, ANSWER YES TO THE NEXT QUESTION AND YOU WILL BE PROVIDED A LIST OF THE DATA REQUIREMENTS FOR PORTCAP.

DO YOU WANT TO HAVE A LIST OF DATA REQUIREMENTS FOR PORTCAP.

?[illegible]

HOW MANY PORTS WILL BE USED IN THIS PROBLEM?

?1

[illegible] THE NAME OF PORT NUMBER 1

[illegible]

FOR THE REST OF THE PROBLEM, THE PORTS WILL BE ASSIGNED NUMBERS AS INDICATED

PORT NAME	PORT NUMBER
[illegible]	1

[illegible] YOU WILL BE ASKED FOR INFORMATION ON THE MIX OF VESSELS AVAILABLE FOR DISCHARGE AT [illegible]

BEFORE ASKING FOR THAT DATA, DO YOU WANT A BRIEF DESCRIPTION OF THE TYPE VESSELS AVAILABLE IN THE PORTCAP MODEL

?[illegible]

[illegible] INPUT WILL REQUIRE YOU TO TYPE IN THE NUMBER OF SHIPS TO BE USED AT THIS PORT BY TYPE. WHEN YOU SEE THE QUESTION MARK (?), TYPE IN THE QUANTITY OF THE SHIPS IN THE ORDER SHOWN BELOW.

[illegible] ?1

[illegible] ?1

[illegible] ?[illegible]

[illegible] ?[illegible]

[illegible] ?1

[illegible] ?[illegible]

[illegible] ?[illegible]

[illegible] ?1

[illegible] ?[illegible]

[illegible] ?[illegible]

HOW MANY USEABLE BERTHS AT ASHDOD
[illegible]

ENTER LENGTH, WIDTH & DEPTH OF BERTH 1
[illegible]

ENTER LENGTH, WIDTH & DEPTH OF BERTH 2
[illegible]

HOW MANY LIGHTERAGE WHARVES AT ASHDOD
[illegible]

ENTER LENGTH WIDTH & DEPTH OF WHARF 1
[illegible]

ENTER LENGTH WIDTH & DEPTH OF WHARF 2
[illegible]

HOW MANY CONTAINER BERTHS AT ASHDOD
[illegible]

ENTER LENGTH, WIDTH & DEPTH OF BERTH 1
[illegible]

ARE THERE UNLIMITED ANCHORAGES AVAILABLE AT ASHDOD
PORT TO SUPPORT LIGHTER DEPTHS.
[illegible]

HOW MANY ANCHORAGES ARE AVAILABLE.
[illegible]

ARE THERE ANY BEACHES AVAILABLE WHICH ARE SUITABLE
FOR LOTS OPERATIONS?
[illegible]

HOW MANY BEACHES ARE AVAILABLE?
[illegible]

HOW LONG IS BEACH 1 IN MILES?
[illegible]

THE LOTS OPERATION WILL REQUIRE APPROX 11 SHIPS
THIS PROGRAM ONLY ALLOWS THE USE OF
LASH, LST/C6, OR C2/C3 SHIPS IN LOTS MODE

SHIPS AVAILABLE FOR LOTS OPERATION

LST C6	LASH	C2/C3
[illegible]	[illegible]	19

TOTAL= 22

DO YOU WANT TO USE CONTAINER SHIPS IN LOTS OPN?

IF YOU WANT TO SPECIFY THE SHIPS TO BE USED IN THE LOTS OPERATION. IF YOU DO NOT, 11 SHIPS WILL BE POSITIONED FOR DISCHARGE WHICH IS THE MAXIMUM NUMBER THAT CAN BE ACCOMMODATED AT THE LOTS SITE.

REMEMBER, ONLY CERTAIN SHIPS CAN BE USED IN LOTS MODE

INPUT NR OF C5/C6 SHIPS YOU WANT

INPUT NR OF C2/MC2 SHIPS YOU WANT

SHIP	TYPE	BERTH TYPE
1	SL18	CONTAINER
2	C5/C6	BREAK BULK
3	RORO	BREAK BULK
4	C2/MC2	BREAK BULK
5	C2/MC2	BREAK BULK
6	[illegible]	LTR ANCHOR
7	C2/MC2	LTR ANCHOR
8	C2/MC2	LTR ANCHOR
9	C2/MC2	LTR ANCHOR
10	C2/MC2	LTR ANCHOR
11	C5/C6	LOTS ANCHOR
12	C2/MC2	LOTS ANCHOR
13	C2/MC2	LOTS ANCHOR
14	C2/MC2	LOTS ANCHOR

WILL THIS PORT COMPLEX HANDLE ANY AMMO?

IF AMMO WILL BE DISCHARGED STRICTLY IN THE LOTS OPERATION INPUT 1
IF AMMO WILL BE DISCHARGED STRICTLY IN THE PORT OPERATION INPUT 2
IF AMMO WILL BE DISCHARGED IN BOTH THE LOTS OPERATION AND THE PORT OPERATION INPUT 3

[illegible] GANTRY CRANES AT ASHDOD
(!)

THE NEXT TWO ENTRIES REQUIRE YOU TO ESTIMATE THE PERCENT OF CONTAINERS ARRIVING AT THE PORT COMPLEX THAT WILL BE 20' AND THE NUMBER THAT WILL BE 40'. FOR EXAMPLE, IF ALL CONTAINERS ENTERING THE PORT WILL BE 20', ENTER 1,0. IF 80% WILL BE 20' AND THE REMAINDER 40', ENTER .8,.2. AT ANY RATE, THE TWO NUMBERS ENTERED MUST TOTAL 1.

WHAT % OF CONTAINERS BEING HANDLED WILL BE 20'?
WHAT % WILL BE 40'?
? [illegible]

SHIP	DAILY RECEPT. CAP	TYPE CARGO 1=GC 2=AMMO
[illegible]	[illegible]5.65	1
[illegible]	[illegible]	1
[illegible]	[illegible]5.33	1
[illegible]	720	1
[illegible]	720	1
[illegible]	720	1
[illegible]	720	1
[illegible]	[illegible]	1
[illegible]	720	1
[illegible]	720	1
[illegible]	[illegible]	2
[illegible]	720	2
[illegible]	720	2
[illegible]	[illegible]	2

TOTAL DAILY RECEPTION CAPACITY ASHDOD

AMMO	GEN CARGO	GRAND TOTAL
5760	13331.	19091.

THE RECEPTION ROUTINE IS NOW COMPLETE. IF YOU HAVE NOT USED THE DISCHARGE ROUTINE BEFORE AND WANT A DESCRIPTION OF IT, ANSWER YES TO THE NEXT QUESTION.

DO YOU WANT A DESCRIPTION OF THE DISCHARGE ROUTINE?
NO

DO YOU WISH TO DISCHARGE THE ENTIRE RECEPTION CAPACITY
OF ASHDOD
?[illegible]

THE FOLLOWING SHIPS WILL BE DISCHARGED AT ASHDOD

SHIP	TYPE	BERTHTYPE	TYPE CARGO 1=GC 2=AMMO
1	LL18	CONTAINE	1
2	C3/C4	BREAKBULK	1
3	RORO	BREAKBULK	1
4	C2/UC2	BREAKBULK	1
5	C2/UC2	BREAKBULK	1
6	L1	LTR ANCHOR	1
7	C2/UC2	LTR ANCHOR	1
8	C2/UC2	LTR ANCHOR	1
9	C2/UC2	LTR ANCHOR	1
10	C2/UC2	LTR ANCHOR	1
11	C5/C6	LOTS ANCHOR	2
12	C2/UC2	LOTS ANCHOR	2
13	C2/UC2	LOTS ANCHOR	2
14	C2/UC2	LOTS ANCHOR	2

THE FOLLOWING UNITS ARE REQUIRED TO SUPPORT DISCHARGE OPERATIONS AT THE PORT AND/OR LOTS SITE.

UNIT IDENTIFICATION	NR UNITS AT PORT	NR UN AT LOTS
TERMINAL SVC CO (CONTAINER)	1	1
TERMINAL SVC CO (BREAKBULK)	9	3
HEAVY BOAT CO (LCU)	0	1
MEDIUM BOAT CO (LCM8)	4	0
HVY LIGHTER TM (LARC 60)	0	1
MED AMPHIBIAN CO (LARC 15)	0	2

TOTAL DAILY DISCHARGE CAPACITY AT ASHDOD

AMMUNITION	GENERAL CARGO	GRAND TOTAL
5760	13331.	19091.

WOULD YOU LIKE TO RECOMPUTE DISCHARGE CAPACITY?
?NO

INPUT YOUR NEW TONNAGE REQUIREMENT FOR GEN CARGO,
THEN YOUR NEW TONNAGE REQUIREMENT FOR AMMUNITION,
FOR EXAMPLE, 9000,6500
?11000,4500

THE FOLLOWING SHIPS WILL BE DISCHARGED AT ASHDOD

SHIP	TYPE	BERTHTYPE	TYPE CARGO 1=GC 2=AMMO
1	SL18	CONTAINER	1
2	C3/C4	BREAKBULK	1
3	RORO	BREAKBULK	[illegible]
4	C2/UC2	BREAKBULK	1
5	C2/UC2	BREAKBULK	1
6	C1	LTR ANCHOR	1
7	C2/UC2	LTR ANCHOR	1
11	C5/C6	LOTS ANCHOR	2
12	C2/UC2	LOTS ANCHOR	2
13	C2/UC2	LOTS ANCHOR	2

THE FOLLOWING UNITS ARE REQUIRED TO SUPPORT DISCHARGE OPERATIONS AT THE PORT AND/OR LOTS SITE.

UNIT IDENTIFICATION	NR UNITS AT PORT	NR UNITS AT LOTS SITE
TERMINAL SVC CO (CONTAINER)	1	1
TERMINAL SVC CO (BREAKBULK)	6	2
HEAVY BOAT CO (LCU)	0	1
MEDIUM BOAT CO (LCM8)	1	0
HVY LIGHTER TM (LARC 60)	0	1
MED AMPHIBIAN CO (LARC 15)	0	1

TOTAL DAILY DISCHARGE CAPACITY AT ASHDOD

AMMUNITION	GENERAL CARGO	GRAND TOTAL
5040	11171.	16211.

WOULD YOU LIKE TO RECOMPUTE DISCHARGE CAPACITY?
?

NO

.BYE

COMMAND- LOGOUT

```
CPU        22.022 SEC.        22.022 ADJ.
I/O          .002 SEC.          .002 ADJ.
CRU TIME                      30.262
CONNECT TIME    0 HRS. 26 MIN.
 06/03/75  LOGGED OUT AT 13.22.16.
```

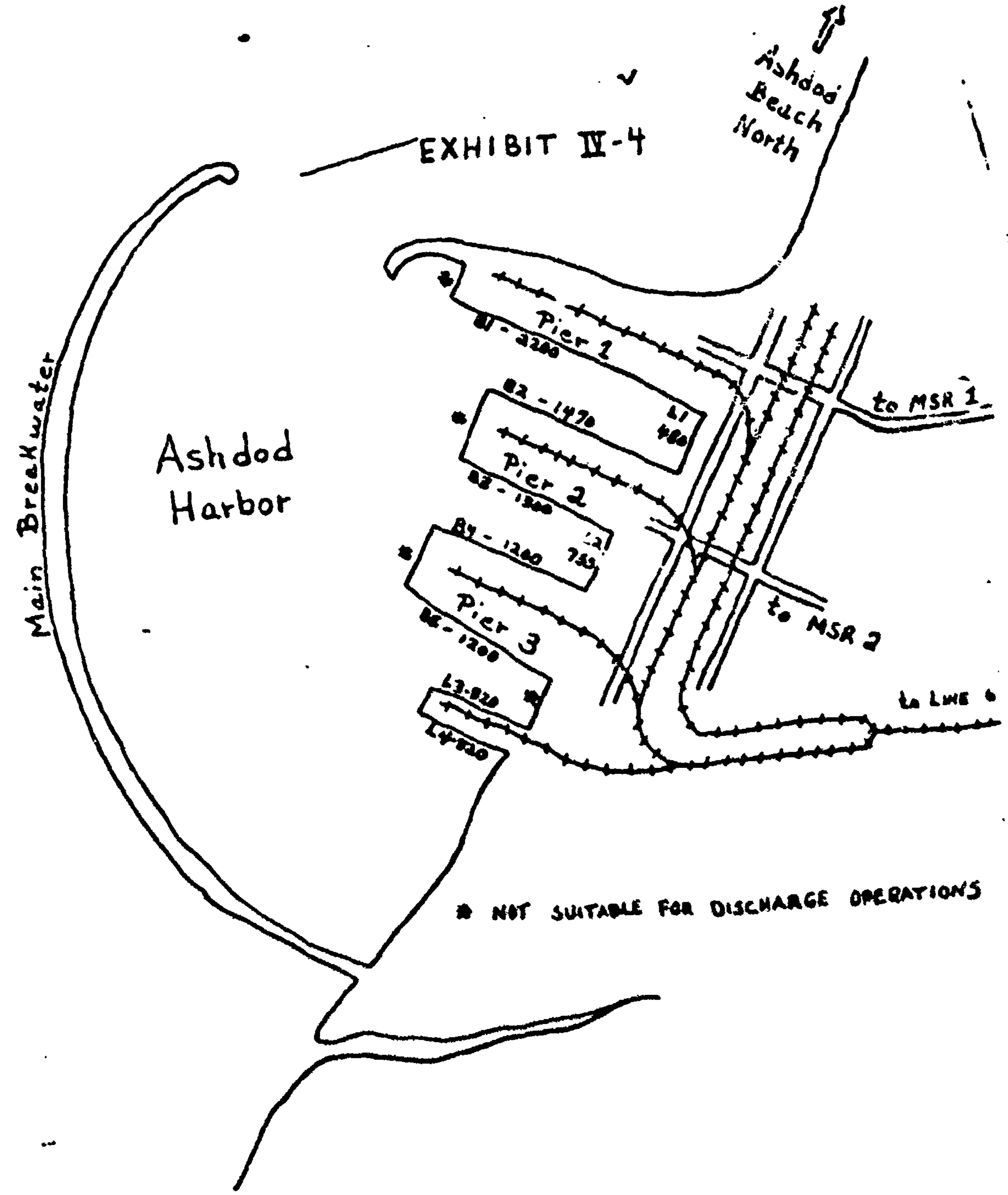
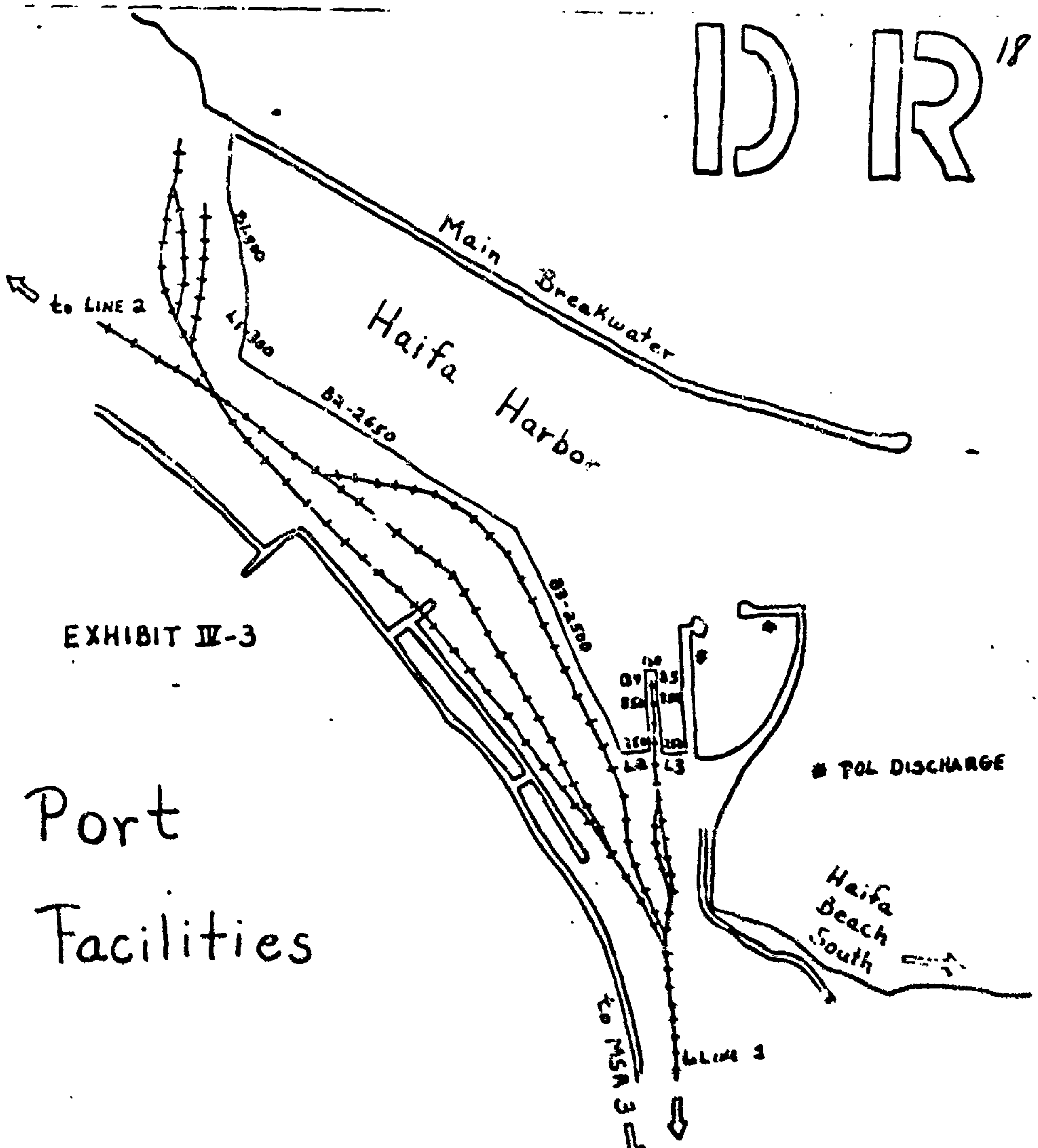
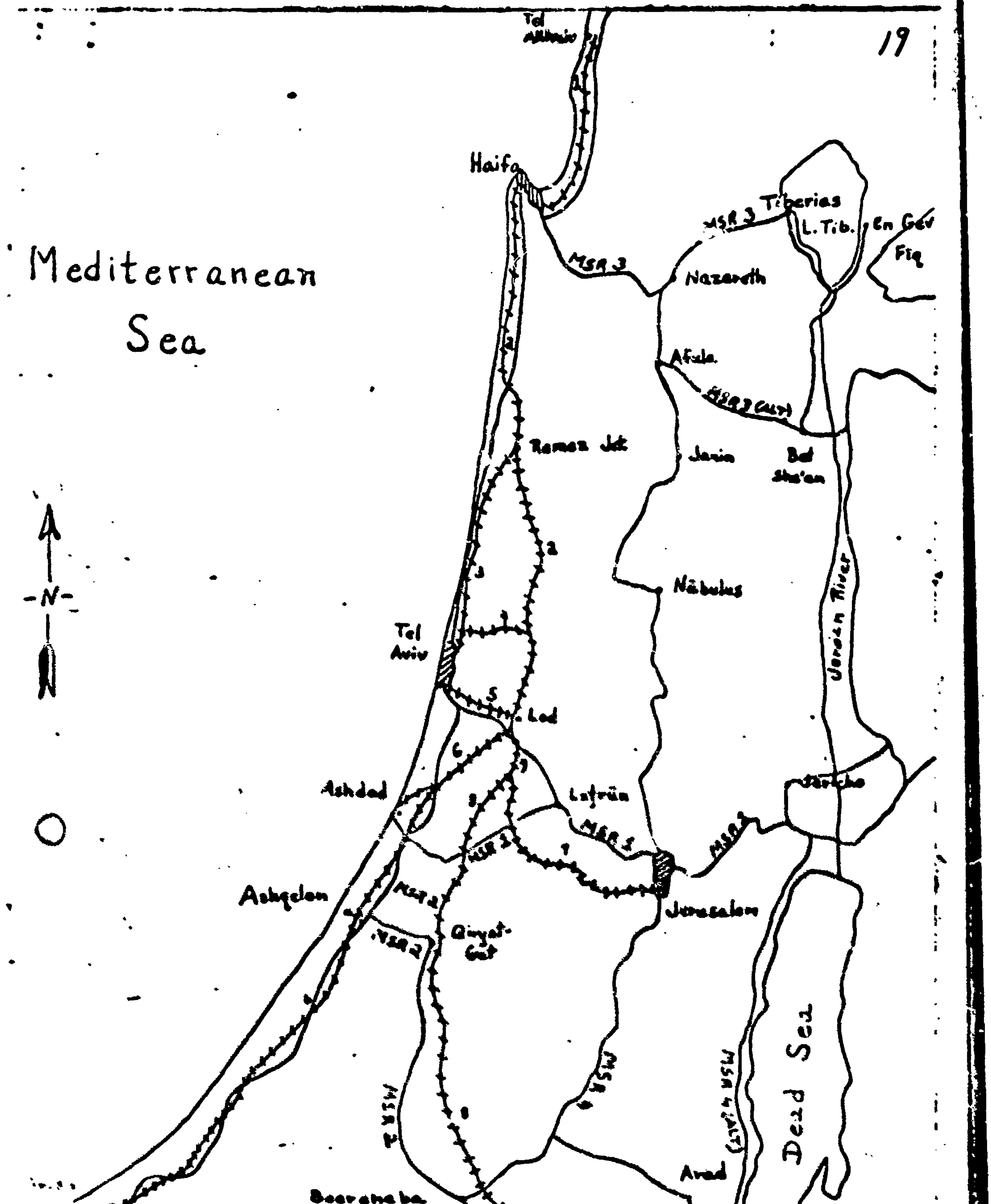


EXHIBIT IV-4
Ashdod Beach North
Main Breakwater
Ashdod Harbor
Pier 1
B1 - 2200
B2 - 1470
L1 480
Pier 2
B3 - 1200
B4 - 1200
Pier 3
L3-820
L4-820
to MSR 1
to MSR 2
* NOT SUITABLE FOR DISCHARGE OPERATIONS

EXHIBIT IV-3

Port Facilities




Mediterranean Sea
N
Haifa
Tiberias
L. Tib.
En Gev
Fiq
MSR 3
MSR 3
Nazareth
Afula
MSR 3 (ALT)
Janin
Bet Sha'an
Nabulus
Jordan River
Tel Aviv
Lod
Ashdod
Latrun
MSR 1
MSR 1
Jerusalem
Jericho
Ashqelon
MSR 2
MSR 2
Qiryat-Gat
MSR 4
MSR 4 (ALT)
Dead Sea
Arad
Beersheba