

Appendix A

Engineer Planning Calculations

This appendix addresses the detailed engineer planning necessary for a river crossing operation. It also describes the charts and overlays used to synchronize and control execution of the crossing. H-hour, as used in this manual, refers to the specific hour the assault phase begins (see *JCS Publication 1-02*).

Initial engineer planning at corps and division levels focuses on providing sufficient engineer assets to handle crossing requirements. The terrain data base maintained by the terrain teams at division and corps provides potential crossing sites and river widths. The division engineer uses this information to construct a site overlay (see *Figure A-1, page A-3*). He labels assault and raft or bridge sites and shows the site capacity and the estimated preparation time for each site (from the terrain data base).

Preparation time is the time required to improve routes and river banks to support the units that will use the site. It also includes the time required to construct rafts and bridges. Raft site capacity is the number of raft round trips per hour. The engineer calculates raft site capacity by determining the raft trips per hour possible on a centerline (using raft turnaround time and the number of possible rafts from *Figure A-2, page A-4*) and multiplying by the number of possible centerlines at the site. Centerlines must be at least 100 meters apart. Assault-site size is 200 meters for each company that can cross in the first wave. *Figure A-1* shows the determination of rafts per hour and assault site capacity for the division crossing overlay. The site overlay on the planning map provides the additional details necessary to ensure that each brigade has sufficient potential crossing sites within its boundaries.

Rules of thumb for making this determination follow:

- A main attack brigade requires 31 assault boats to cross a battalion with three companies in the first wave. With 70 boats, it can cross two battalions at once. For a supporting attack brigade, 21 assault boats are enough to cross a battalion, with only two companies in the first wave. Generally, the boats with the corps bridge companies can handle these requirements.
- A brigade requires two bridges, or the equivalent bridging configured into rafts. This requires a corps combat engineer battalion to operate the crossing area plus one corps float-bridge company for each 100 meters of river width.
- A division crossing requires an engineer group with two corps combat battalions to conduct the crossing and two corps float-bridge companies for each 100 meters of river width.
- If any bridging is M4T6, additional engineers must be assigned to the crossing force to assemble it. Normally, each M4T6 bridge company requires two additional corps combat engineer companies.

The engineer planner also uses the above rules of thumb to task organize engineers that are supporting each crossing area. The division engineer develops a rough crossing timeline using pure battalions. This provides sufficient information for division planning, without requiring detailed knowledge of the brigade's plan (before they have developed one). *Figure A-3, page A-4*, is based on a 6-bay raft and provides necessary planning factors (field trains are not included). *Figure A-4, page A-5*, illustrates a crossing timeline.

The brigade headquarters does the majority of the detailed crossing planning. During situation analysis, the brigade engineer develops a site overlay force buildup matrix to provide initial buildup rate information to the maneuver planners when they outline possible schemes of maneuver (see *Figure A-5, page A-6*). This overlay is the same as the overlay developed at division and may be provided by the division engineer.

Once the commander identifies the COAs to develop, the staff engineer develops crossing area overlays for each (see *Figure A-6, page A-7*). These overlays take the information from the site overlay, along with additional terrain data, and show staging areas, holding areas, call-forward areas, and routes for each crossing site included in the COA. A crossing-area overlay is necessary for each COA. The overlay for the COA eventually selected is later modified by adding ERPs, TCPs, and crossing-area headquarters information and is used to support the operation.

When maneuver planners develop COAs, they assign crossing sites and the order of crossing to units, and they task organize the pure maneuver battalions into task forces. The engineer uses this information to construct a crossing timeline for each COA. He calculates the number of vehicles and 6-bay raft loads for each unit using pure company figures from *Figure A-7 page A-8*. The company raft requirements do not include the field trains. He can then calculate the crossing time for the unit by using the crossing capacity of the site assigned

to it. The crossing timeline shows these crossing periods, by site, based on the order of crossing. The engineer then develops a detailed task organization of engineers to support each COA (see *Figure A-8, page A-9*).

During the comparison of the COAs, the engineer uses timelines, brigade site overlays, and crossing area overlays to demonstrate the differences in the crossing plans. After the commander has selected the COA for the mission, the staff converts it into a detailed plan. The engineer begins by developing a vehicle crossing capability chart.

The engineer first constructs a chart that displays the capacity of each crossing site in terms of raft loads or bridges. Since the crossing rate for rafts is less during darkness, each site shows total raft trips separately, during darkness and during light. An example of the product of this first step is shown in *Figure A-9, page A-10*.

The engineer then blocks out the crossing periods for all units, based on the site assignment and the crossing order in the scheme of maneuver. He uses the factors from *Figure A-7*, bridge capacity, and the final task organization for the scheme of maneuver. After adding the unit crossing periods to the chart (see *Figure A-10, page A-11*), he coordinates it with the S3 to ensure that units will arrive on the far shore by the times they are needed in the plan. If not, the S3 and engineer work together to adjust the crossing order of subordinate units. The basic technical information remains constant

as different crossing sequences are checked until one meets far-shore requirements. The vehicle-crossing capability chart is the primary tool for finalizing the crossing plan.

After the crossing order has been established, the engineer develops the crossing synchronization matrix (see *Figure A-11, page A-12*). This is the tool that the CAC and CAE will use to synchronize the execution of the crossing. It is constructed as a chart, with unit locations and activities by time displayed on the upper half and terrain occupation displayed by time on the lower half. The staff can follow each unit's location as the operation progresses and can easily see potential conflicts resulting from changes. The matrix also provides critical information for traffic control.

The crossing synchronization matrix is constructed backwards, by first portraying the unit crossing times established from the vehicle crossing capability chart, then using road movement times to show route usage and staging-area times. The assaulting unit and assault overwatch element times are added also. Once all of the units are displayed, the same information is transferred to the lower terrain portion of the matrix. The staff immediately resolves any conflicts they discover while preparing the matrix.

The final engineer planning step is the development of the engineer execution matrix (see *Figure A-12, page A-13*). It displays subordinate unit task assignments, by time. It is useful both for tracking unit execution and for aiding decisions if changes to the plan are required.

	Note 1	A Note 2	X B Note 3	Note 4	X C Note 5	= D	XX	
Site	River Width (M)	Raft Round Trip/Hour/Centerline	Number of Rafts	River Front (M)	Number of Centerlines	Rafts/Hour		
1	175	5.4	2	300	3	32	1 Hour Prep 32 Rafts/Hour	Site 1
Assault A and 2	160	5.4	2	410	4	43	3 Hour Prep 43 Rafts/Hour	2 CO Site 2 and Assault A
3	180	5	2	400	4	40	.5 Hour Prep 40 Rafts/Hour	Site 3
Assault B and 4	140	6	2	600	6	72	1 Hour Prep 72 Rafts/Hour	3 CO Site 4 and Assault B
5	150	6	2	250	2	24	1.5 Hour Prep 24 Rafts/Hour	Site 5
6	150	6	2	310	3	36	2.0 Hour Prep 36 Rafts/Hour	Site 6
7	165	5.4	2	300	3	32	.5 Hour Prep 32 Rafts/Hour	Site 7
Assault C	150	6	2	390	NA	NA	2 CO	Assault C
8	150	6	2	350	3	36	2 Hour Prep 36 Rafts/Hour	Site 8
Assault D and 9	160	5.4	2	610	6	65	0 Hour Prep 65 Rafts/Hour	3 CO Site 9 and Assault D
10	170	5.4	2	375	3	32	0 Hour Prep 36 Rafts/Hour	Site 10
Assault E	175	5.4	2	415	NA	NA	3 CO	Assault E
11	180	5	2	300	3	30	1 Hour Prep 30 Rafts/Hour	Site 11
Assault F	175	5.4	2	585	NA	NA	3 CO	Assault F
12	170	5.4	2	250	2	21	1 Hour Prep 21 Rafts/Hour	Site 12

Notes

1. River width taken from terrain data base and/or recon.
2. Raft round trips per hour per centerline from Figure A-2.
3. Number of rafts per centerline from Figure A-2.
4. Available river frontage determined from terrain data base and/or recon.
5. Number of centerlines is 1 per every 100 m of river frontage.

Figure A-1. Division site overlay

River Width (meters)	Round Trip (minutes)	Number of Round Trips per hour	Number of Rafts
75	7	8.6	1
100	8	7.5	1
125	9	6.7	1
150	10	6	2
175	11	5.4	2
225	12	5	2
300	16	3.75	3 to 5

Figure A-2. Raft centerline data

Unit	Vehicles	Raft Trips Required
Armor Battalion	121	88
Mechanized Battalion	145	51
Field Artillery Battalion	65	23
Engineer Battalion (ERI)	89	48
Air Defense Artillery Battery	52	12

Figure A-3. Unit raft requirements

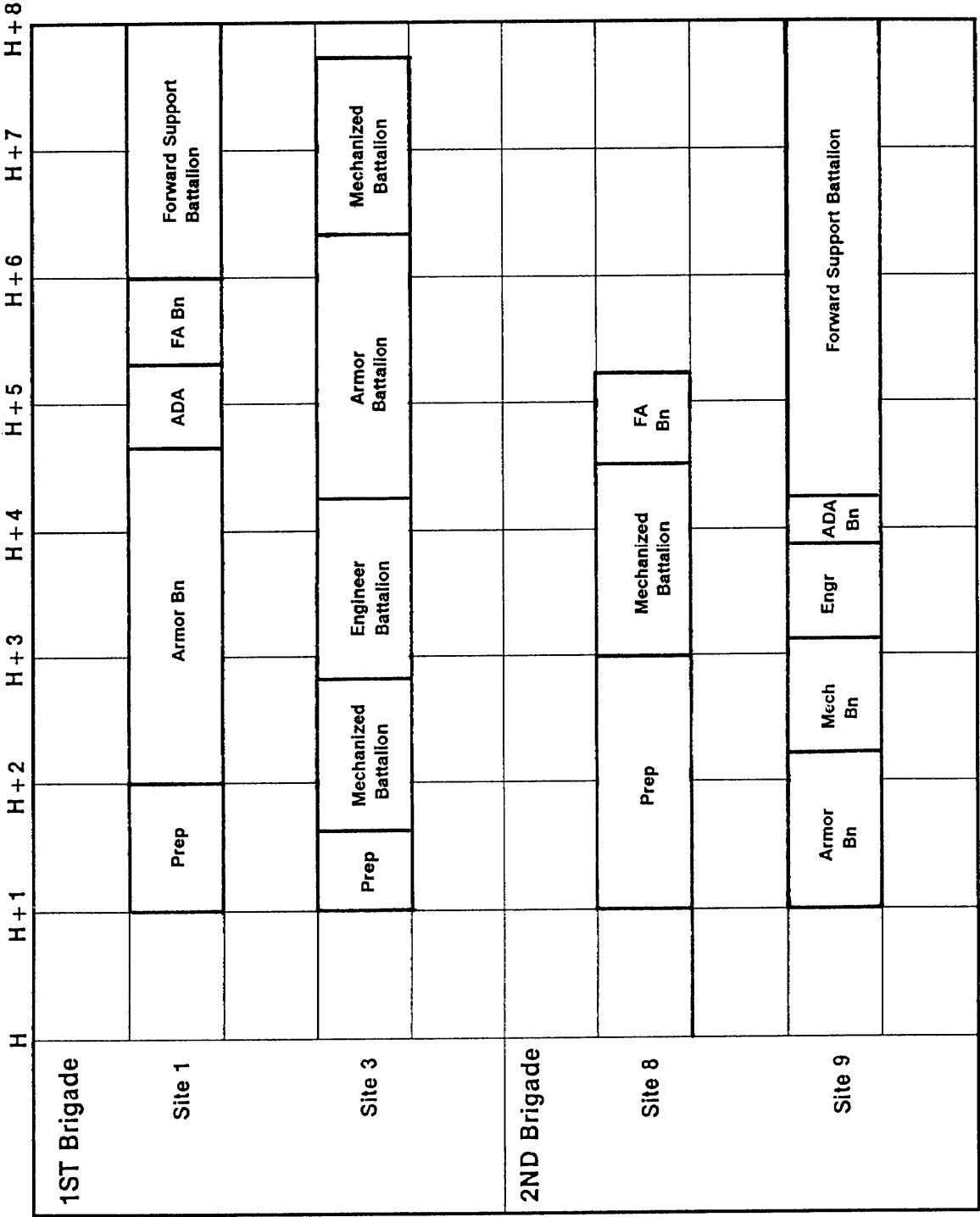


Figure A-4. Rough division crossing timeline

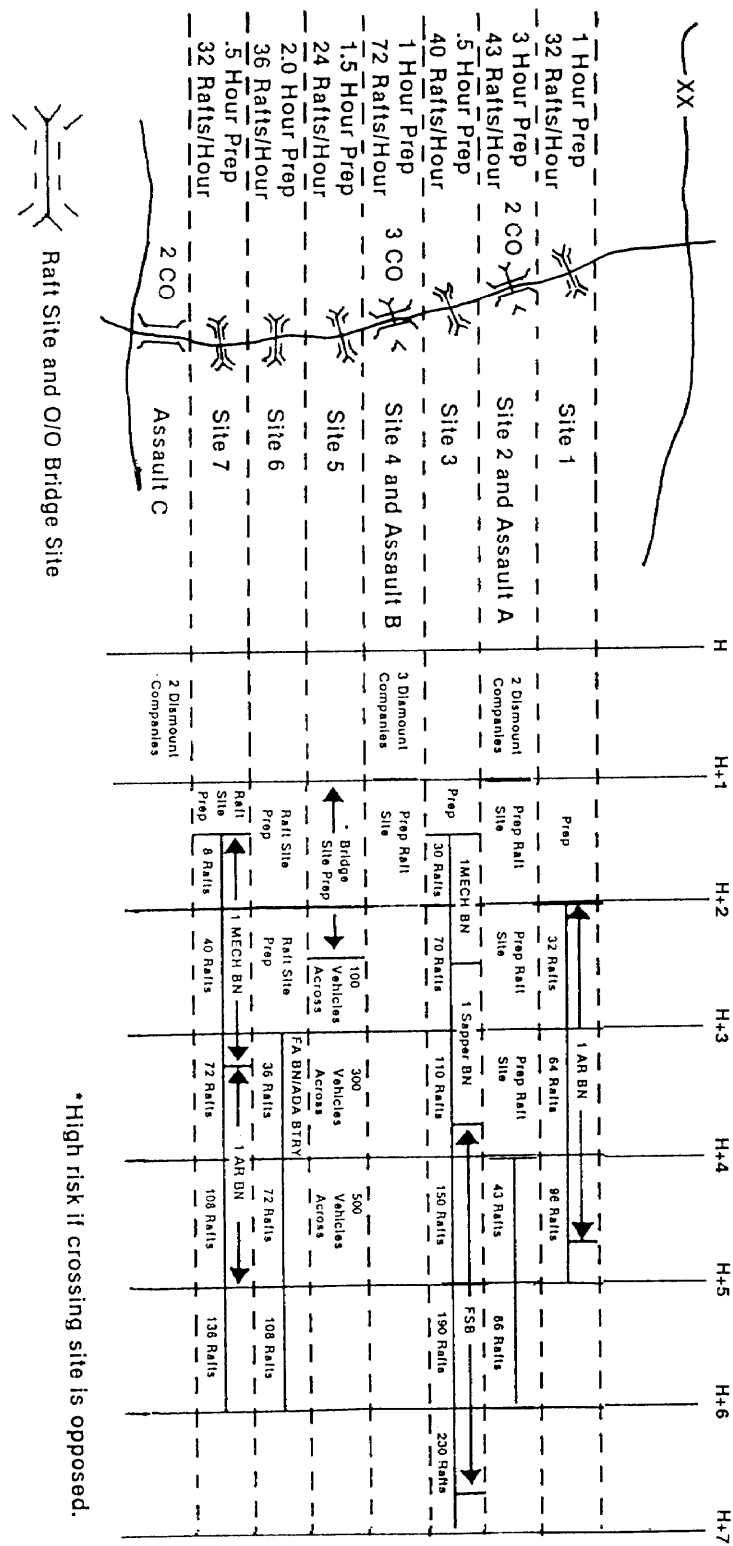


Figure A-5. Brigade crossing site force buildup matrix for COA 1

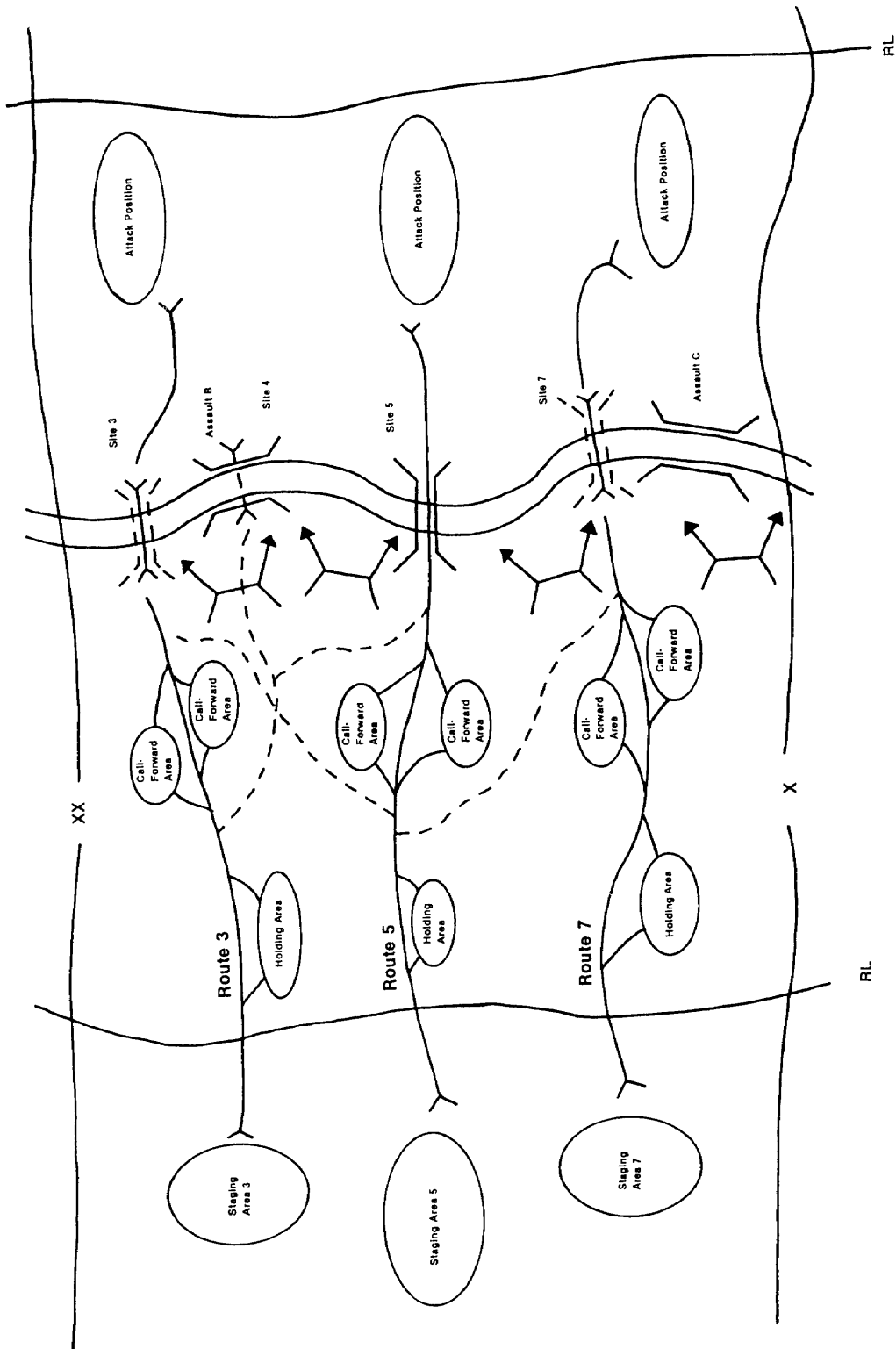


Figure A-6. COA crossing area overlay for COA 3

Unit	Vehicles	6-Bay Rafts Required
Tank Company	18	17
Mechanized Company (Bradley)	19	7
Mechanized Company (M113)	18	4
Antitank Company (ITV)	17	4
Armored TF HQ	8	4
Mechanized TF HQ	8	2
Armored TF Combat Trains	29	12
Mechanized TF Combat Trains	30	13
Mortar Platoon	8	2
Scout Platoon	6	2
Engineer Platoon (+)	10	5
Engineer Company HQ	6	3
ADA Pit	5	1
Division Cavalry Troop	9	9
Armored Cavalry Regiment Troop	29	16
Armored Cavalry Regiment Squad HQ	10	5
155-SP Artillery Battery (Division)	20	6
155-SP Artillery Battery (Corps)	16	5
Brigade TAC CP	8	1

Figure A-7. Pure company raft requirements

H												H+1	H+2	H+3	H+4	H+5	H+6	H+7	H+8	H+9	H+10		
Site 1	NOT USED																						
Site 2	NOT USED																						
Site 3																							

Figure A-8. Brigade crossing timeline for COA 3

SITE	CROSSING MEANS	TRIPS/HR		BMNT						
		DAY	NIGHT	H	H + 1	H + 2	H + 3	H + 4	H + 5	H + 6
3	8 Six-Bay Ribbon Rafts; Convert to Bridge	40	26							
					Site Prep & Const	26 Rafts	40 Rafts	Const Bridge	Bridge	
5	Bridge	200	200							
					Site Prep/ Const Bridge	85 Veh	200 Vehicles	Bridge 200 Vehicles/Hour		
7	6 Six-Bay Ribbon Rafts; Convert to Bridge	36	24							
					Site Prep & Const	24 Rafts	48 Rafts	Const Bridge	Bridge	

Figure A-9. Initial vehicle-crossing capability

SITE	CROSSING MEANS	TRIPS/HR		BMNT						
				H	H+1	H+2	H+3	H+4	H+5	H+6
3	8 Six-Bay Ribbon Rafts; Convert to Bridge	DAY 40	NIGHT 26				MECH TF-1	EN BN HQ		Follow-On Forces
						Site Prep & Const	26 Rafts	40 Rafts	Const Bridge	Bridge
							AR TF 1	FA BN	AR TF 2	Field Trains
5	Bridge	200	200 Vehicles/ Hour				Site Prep/ Const Bridge	85 Veh	200 Vehicles	Bridge 200 Vehicles/Hour
								MECH TF-2		Follow-On Forces
7	6 Six-Bay Ribbon Rafts; Convert to Bridge	36	24			Site Prep & Const	24 Rafts	48 Rafts	Const Bridge	Bridge

Figure A-10. Final vehicle-crossing capability

	H-5	H-4	H-3	H-2	H-1	H	H+1	H+2	H+3	H+4	H+5	H+6
MECH TF-1	Staging Area 3											
	Route 3											
	Support Assault B				Assault B		Cross Site 3					
	Staging Area 7											
MECH TF-2	Route 7											
	Support Assault C				Assault C		Cross Site 7					
	Staging Area 5											
	Route 5				Route 5							
AR TF-1	Support Assault B				Route 5		Cross Site 5					
	Staging Area 5											
	Route 5				Route 5		Cross Site 5					
	Support Assault C				Cross Site 5							
AR TF-2	MECH TF-1											
	Route 5				Staging Area 5		Route 5		Cross Site 5			
	Support Assault C											
	EN BN HQ											
Staging Area 3	Follow-On Forces											
	AR TF-1											
					FA BN							
	Follow-On Forces											
Staging Area 5	AR TF-2											
	Follow-On Forces											
	MECH TF-2											
	Follow-On Forces											
Staging Area 7	Follow-On Forces											
	MECH TF-1											
	MECH TF-1				EN		Follow-On Forces					
	AR1				FA		AR2		Follow-On Forces			
Site 3	MECH TF-2											
	Follow-On Forces											
	EN BN HQ											
	Follow-On Forces											
Site 5	AR TF-1											
	AR TF-2				AR TF-1		FA		AR2		Follow-On Forces	
	MECH TF-2											
	Follow-On Forces											
Site 7	Follow-On Forces											
	AR TF-1											
	AR TF-2				AR TF-1		FA		AR2		Follow-On Forces	
	MECH TF-2											
Route 3	Follow-On Forces											
	AR TF-1											
	AR TF-2				AR TF-1		FA		AR2		Follow-On Forces	
	MECH TF-2											
Route 5	Follow-On Forces											
	AR TF-1											
	AR TF-2				AR TF-1		FA		AR2		Follow-On Forces	
	MECH TF-2											
Route 7	Follow-On Forces											
	AR TF-1											
	AR TF-2				AR TF-1		FA		AR2		Follow-On Forces	
	MECH TF-2											

H-3		H-2	H-1	H	H+1	H+2	H+3	H+4	H+5
A/237	Move to Site B Move to Site 3	Prep RB15s Establish ERPs	Assault boat operations Assault Site B		Prep Site 3	Route maintenance of Route 3 Operate crossing Site 3			
B/237	Move to Assault Site C	Position and prepare boats	Assault boat operations Assault Site C			Route maintenance of Route 7			
C/237		Move to Site 7	Establish ERPs		Prep Site 7	Operate crossing Site 7			
D/237		Move to Site 5	Establish ERPs		Prep Site 5	Route maintenance of Route 5 Operate crossing Site 5			
203 AFB CO	Deliver Assault rafts			Move to equipment Park 3	Build rafts; Site 3	Operate raft Site 3	Bridge; Site 3		
204 AFB CO	Deliver Assault rafts			Move to equipment Park 5	Construct bridge; Site 5	Bridge; Site 5			
205 AFB CO	Deliver Assault rafts			Move to equipment Park 7	Build rafts; Site 7	Operate raft Site 7	Bridge; Site 7		

Figure A-12.Engineer execution matrix