US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

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VEHICLE TEST FACILITIES AT ABERDEEN PROVING GROUND

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1. SCOPE. This TOP describes the mobility test facilities of Aberdeen Proving Ground (APG), Maryland. It is designed for use in planning tests of wheeled and tracked vehicles, including vehicular weapon systems. It does not cover the equipment and instrumentation used on the test courses to obtain and measure test data, or laboratory facilities except for the climatic test chambers. (Automotive laboratory instrumentation and field test equipment and instrumentation are covered in TOP/MTP 2-1-002 and 2-1-0051-2**, respectively.) The test facilities at APG are adequate to meet the needs of the DARCOM mobility model, MIL-M-8090F, and the automatic shock test (Procedure 514.2) of MIL-STD-810C.

At APG, there are about 64 km (40 miles) of automotive test courses on more than 1320 hectares (3,300 acres) of land, in addition to the water areas and firing ranges used in vehicle testing. Each course is designed to meet a particular military vehicle specification, and many of the courses exceed commercial standards. Test course severity is covered in TOP 1-1-010.

*This TOP supersedes TOP/MTP 1-1-011 dated 17 March 1976.

**Footnote numbers correspond to reference numbers in Appendix A.

TABLE 1
COURSE COMPOSITION AND LENGTHS

Test Course [described on page in ()]		Type	Length English	Metri
CHURCHVILLE TEST AREA	(4)			
Hilly Cross-Country	(4)			
Course A:		Virgin wooded terrain including brush, stone, stumps, side slopes, ravines		
Course B:		Native soil and stone, grades to 29%		
Hilly Secondary Road (C)	(6)	Grades to 10%	1.5 mi	2.4k
Prepared Mud Slopes	(6)	Loam: 10%	220 ft	67
		15%	250 ft	76
		20%	220 ft	67
DYNAMOMETER COURSE	(7)	Bituminous concrete	1 mi	1.6k
MILE Loop	(8)	Paved and gravel	1 mi	1.6
Winch Test Facility	(10)	Concrete base		
Pothole-Crosstie Course	(10)	Concrete potholes	200 ft	61
		Wooden crossties in concrete	132 ft	40
1-inch Bump Course	(11)	Iron rods in concrete	220 ft	67
MOUNTAIN HIGHWAY	(11)	Paved	40 mi	64.4k
MUNSON TEST AREA	(13)			
High Speed Paved Road	(15)	Bituminous concrete	2,235 ft	681
Improved Gravel Road	(16)	Compacted bank gravel	10,714 ft	3266
Rolling Hill Course	(17)	Compacted stone/dust	2,034 ft	620
Sand Course	(18)	Washed beach sand	503 ft	153
Clay Soil Bin	(19)	Patapsco red clay	326 ft	99
Abrasive Mud Course	(20)	Sand loam	240 x 950 ft	73 x 290
Marsh	(21)	Natural mud		
Fording Basin	(22)	Concrete	270 ft	82
Underwater Fording Facility	(23)	Concrete	315 ft	96
Amphibian Ramp	(23)	Bituminous concrete	20 x 50 ft	6x15
Shallow Water Swimming Area	(24)	Channel, 10 ft deep x 50 ft wide (3 m x 15 m) leading to Bay	1,000 ft	305
Belgian Block Course	(25)	Granite blocks in concrete	3,940 ft	1201
Imbedded Rock Course	(26)	Granite stones in concrete	800 ft	244
Side Slopes	(27)	Concrete: 20%	271 ft	83
		30%	723 ft	220
		35%	100 ft	31
		40%	300 ft	91
Gradeability Slopes	(28)	Asphalt: 5%	483 ft	147
		7%	185 ft	56
		10%	300 ft	91
		15%	256 ft	78
		20%	199 ft	61

Test Course		Type	Length	
Gradeability Slopes		Concrete: 30%	149 ft	45
		40%	112 ft	34
		45%	58 ft	18
		50%	97 ft	30
		60%	81 ft	25
Simulated Loading Ramp	(29)	Concrete	40 ft	12
2-inch Washboard	(30)	Concrete	822 ft	251
2- to 4-inch Radial Washboard	(31)	Concrete	243 ft	74
3-inch Spaced Bump	(32)	Concrete	764 ft	233
6-inch Washboard	(33)	Concrete	798 ft	243
Wave Course	(34)	Concrete	443 ft	135
5- to 12-inch Staggered Bump	(35)	Concrete	230 ft	70
Vertical Walls	(36)	Concrete and wood		
Bridging Device	(37)	Steel		
Ditch Profile	(38)	Concrete	25 ft 6 in	.8
Turning Circle	(38)	Concrete (diameter)	250 ft	76
Winch Test Facility	(40)	Concrete base		
Load Vibration Course	(40)	(miscellaneous)	9,786 ft	983
Fuel Consumption Course	(41)	(miscellaneous)	8,003 ft	2439
PERRYMAN TEST AREA	(42)			
Cross-country Courses:	1	Moderate; native loam with quarry spall/gravel	5.2 mi	8.4k
	2	Moderately rough; native loam with quarry spall	1.8 mi	2.9k
	3	Rough; native loam	3.3 mi	5.3k
	4	Severe; native loam with natural marsh	2.5 mi	4k
Deep Water Fording Facility	(47)	Earth bottom covered with metal screens	200 ft	61
High Speed Paved Road	(47)	Bituminous concrete (including turnarounds)	3.8 mi	6.1k
Mud Bypass Course	(47)	Native loam prepared by tilling	700 ft	213
Mud Mobility Course	(47)	Native soil prepared by tilling	410 ft	125
Mobile Bridge Test Facility		Pond as deep as 2 m (7 ft)	225 ft	60
Secondary Roads: A	(47)	Native soil	2.4 mi	3.9k
B	(47)	Bank gravel/crushed stone	3.2 mi	5.1k
Swamp Quarter Mobility Area		Swamp; soft soil; "rice"	2 ac	.8h
POOLE' S ISLAND	(49)	Beach sand sloping to 5-m (15-ft) water depth	1 mi	1.6k
TANK GUNNERY RANGES	(50)	Ranges for direct fire; moving target; cross-country courses	max. rang 5,500 mi	8851k
		Cross-country loop, native loam	1 mi	1.6k
TILT TABLE	(56)	Steel, 3.7 m x 4 m (12 ft x 12 ft 6 in)		

2. CHURCHVILLE TEST AREA. Purchased in 1942, this area is north of the town of Churchville, and borders the east side of Maryland Highway 136 and the south side of Deer Creek (see Figures 1 and 2). It consists of 97.6 hectares (244 acres) about 19 km (12 miles) from APG, and is used for endurance testing of all types of automotive vehicles. It is well suited for determining the durability and reliability of engines and power train systems. The Churchville area is inspected daily, and a test course committee periodically assesses and initiates corrections in course geometry.

2.1 Hilly Cross-Country Courses. The entire Churchville area is characterized by a series of steep hills with slopes as great as 30 percent, and is heavily wooded in some parts. Test courses are in closed loops over and around the hills.

Course A, more accurately identified as an area, is the most severe of the hilly cross-country courses. It is heavily wooded and includes rocky terrain, ravines, steep grades as great as 30 percent, and side slopes.

Course B (Figures 3 and 4), consists of grades as steep as 29 percent. The terrain is moderate to rough native soil and stone ranging from muddy to dusty, depending on the weather.

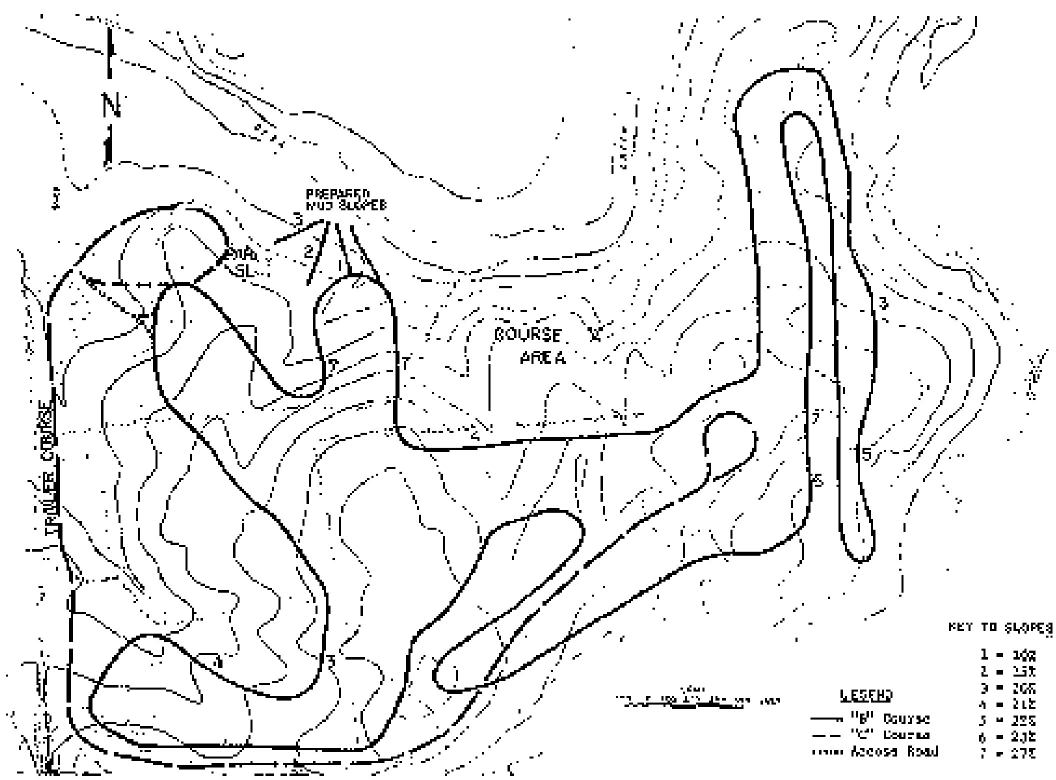


Figure 1. Contour map of Churchville test area.

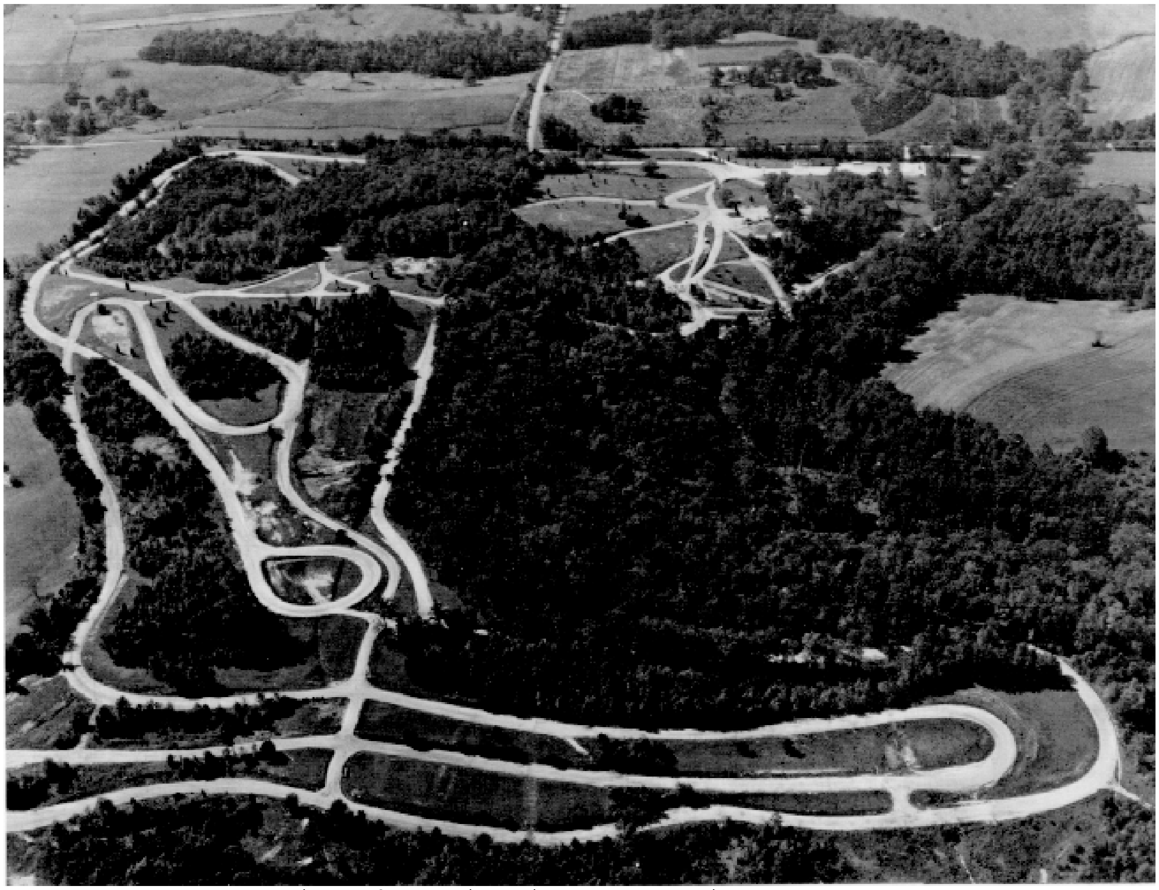


Figure 2. Aerial view of Churchville Test Course.

Figure 3. Hilly cross-country course B.

Figure 4. Hilly cross-country course B.

2.2 Hilly Secondary Road (Course C). A 2.4-km (1-1/2-mile) secondary road test course with controlling grades of 10 percent and turn-arounds at each end is also available, as shown in Figure 1. The course is well suited for tests of trailers and semi-trailers.

2.3 Prepared Mud Slopes. These are used for controlled tests to evaluate the tractive ability of vehicles. The three slopes (10, 15, and 90 percent) are particularly useful for measuring mobility performance and for comparison tests of experimental and standard vehicles.

3. CLIMATIC TESTING FACILITIES. The facilities described in the table below are used for simulated climatic testing of a variety of equipment at APG. Some of these chambers are of the proper size and capacity to accommodate automotive vehicles.

TABLE 2 CLIMATIC TEST CHAMBERS

Facility	Characteristics: Door Size Width	Door Size Height	Chamber Size Width	Chamber Size Length	Chamber Size Height	Temp. Range	Firing: Max Wpn. Bore Cap.
Chamber 1	124 in (315 cm	124 in 315 cm	15 ft 4.6 m	24 ft 7.3 m	10ft10in 3m25cm	-70 to +160F -21 to +71C)	155-mm
Chamber 2	112 in (284 cm	91 in 231 cm	10ft8in 3m20cm	19 ft 5.8 m	10ft9in 3m23cm	-70 to +165F -21 to +74C)	105-mm
Chamber 3	164 in (417 cm	138 in 351 cm	13ft6in 4m15cm	28ft4in 9m10cm	13ft11in 4m28cm	-70 to +165F -21 to +74C)	175-mm
Conditioning Room	177 in (450 cm	140 in 356 cm	23ft8in 7m20cm	41ft7in 13m18cm	14 ft 4 m	0 to +150F 0 to +66C)	N/A
*Stratosphere	98 in (249 cm	72 in 183 cm	8ft2in 2m5cm	9 ft 3 m	6ft6in 2m15cm	-70 to +160F -21 to +71C)	40-mm
Simulated Rain Facility	168 in (427 cm	174 in 442 cm	24ft6in 7m15cm	34ft6in 10m15cm	14 ft 4 m)	(variable rainfall to 61 cm [24 in] per hour)	

*The barometric pressure of the stratosphere chamber can be dropped to a pressure equivalent to 30500-meter (100,000-foot) altitude. The other chambers are at ambient barometric pressure.

4. DYNAMOMETER COURSE. This course is in the Michaelsville area of APG, 4 miles from headquarters (see Figure 5). Constructed of reinforced concrete, with a hot mixed bituminous surface, it is suitable for operating the heaviest track-laying vehicles. The course has a total gradient of less than 0.1 percent in its 1.6-km (1-mile) length, and turn-arounds are provided at each end. It is used for closely controlled engineering tests such as drawbar pull and tractive resistance measurements, acceleration and braking tests, and fuel consumption measurements.

Figure 5. M-2 Infantry Fighting Vehicle undergoing drawbar pull test.

5. MILE LOOP. This oval-shaped facility was originally constructed in 1933 as a level concrete course for continuous high-speed operating tests of vehicles (see Figure 6). Situated near APG headquarters, the Mile Loop consists of two straight sections, each .4 km (1/4 mile) long, joined at each end by 0.4-km sections of regular curvature to form an oval totalling 1.6 km in circumference.

The course has been modified by covering and maintaining the surface with hot mixed bituminous concrete and by adding a gravel surface parallel to and outside the oval. Several facilities have also been added in the area, as described below.

Figure 6. Aeriel Veiw of Mile Loop

5.1 Winch Test and Tie-down Facility. This device has a restraining capability of 45360 kg (100,000 pounds), and is used mainly is an anchor during winch endurance testing.

5.2 Pothole-Crosstie Course. This oval facility is situated on a concrete pad within the Mile Loop, and consists of a series of concrete potholes on one straight side of the oval, a series of wooden crossties on the opposite straight side, and two 10.7-m (35-foot) -radius gravel ends connecting the two straight sections.

The pothole section (Figure 7) consists of eight concrete potholes 5.2 m (17 feet) apart (7.6 m [25 feet] center to center) constructed according to requirements of MIL-T-21863D.4 Each pothole is 1.8 m (6 feet) wide, 2.4 m (8 feet) long, and 30.5 cm (12 inches) deep, sunk flush with the concrete surface. The sides of each pothole are sloped 45 percent (24.2 degrees); the ends, 100 percent (45 degrees). The total length of this segment of the course is 61 m (200 feet).

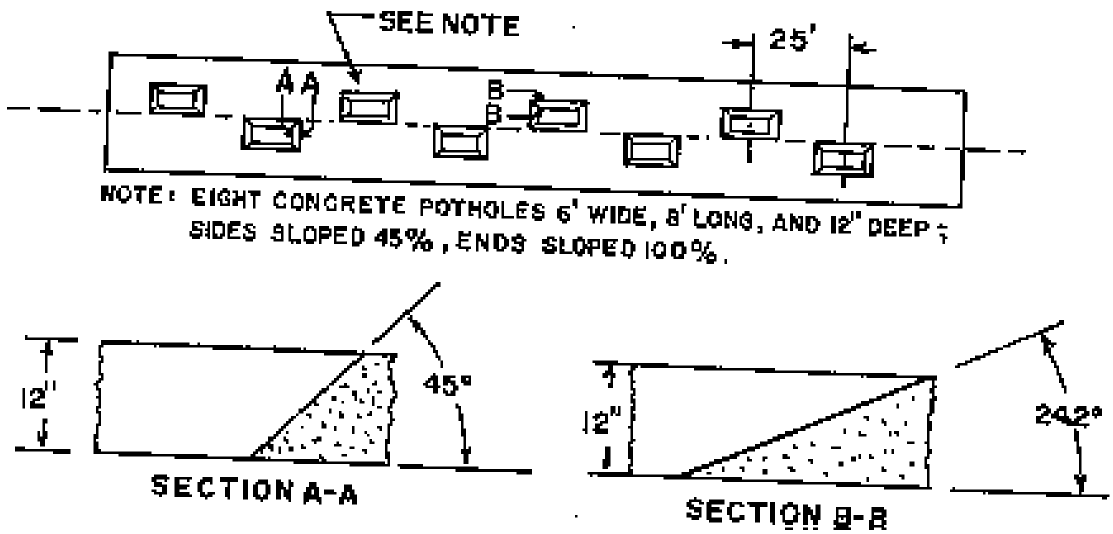


Figure 7. Pothole section of pothole-crosstie course.

The crosstie section of the course consists of 11 crossties 1.8 m long, 15.2 cm (6 inches) high, and 15.2 cm wide, mounted flush with the concrete surface by means of 7.6-cm (3-inch) angle iron. The ties are spaced at 3.7-M (12-foot) intervals (center to center) at alternate right and left sides of the course. The total length of this segment is 40.2 m (132 feet).

5.3 1-Inch Bump Course. The 2.5-cm (1-inch) bumps are iron rods 4.3 m (14 feet) long, 5 cm (2 inches) wide, and 2.5 cm high, mounted on the flat concrete surface in the center of the pothole-crosstie course. A total of 39 1-inch bumps are spaced at random 1.5- and 1.8-m (5- and 6-foot) intervals Perpendicular to the direction of travel in accordance with MIL-M-008090E. The course length is 67 m (220 feet).

6. MOUNTAIN HIGHWAY. This is a 64-km- (40-mile-) long mountainous section of US Route 30 in the vicinity of Jennerstown, Pennsylvania. It is used by APG as a brake test course, and by the brake-manufacturing industry itself as one of the most severe in the East for brake fade testing. With grades as steep as 11 percent and various altitudes (see Figure 8), this section of public highway is admirably suited for testing military wheeled vehicle brakes (test procedures are described in TOP/MTP 2-2-608 5). Standard test conditions are obtained by controlling speed, brake line pressure, and deceleration. Temperatures and stopping distances are measured throughout the test. Figures 9 and 10 show sections of a vehicle equipped for brake testing.

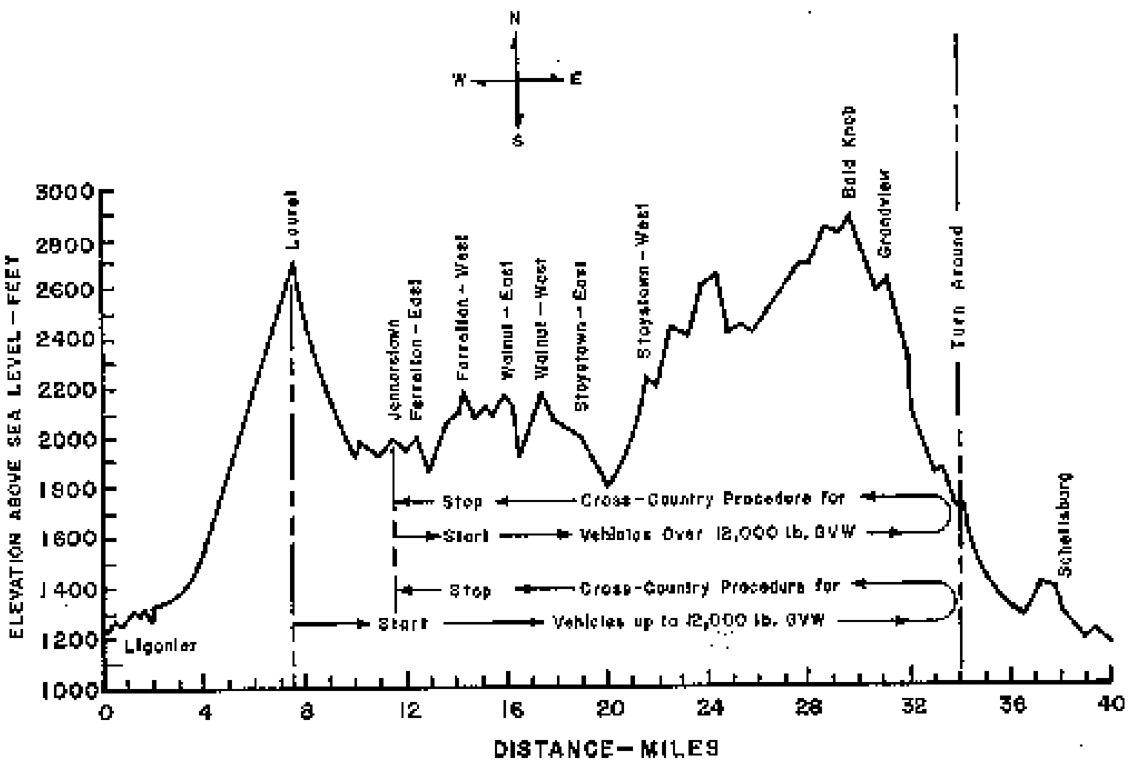


Figure 8. Profile of mountain test course.

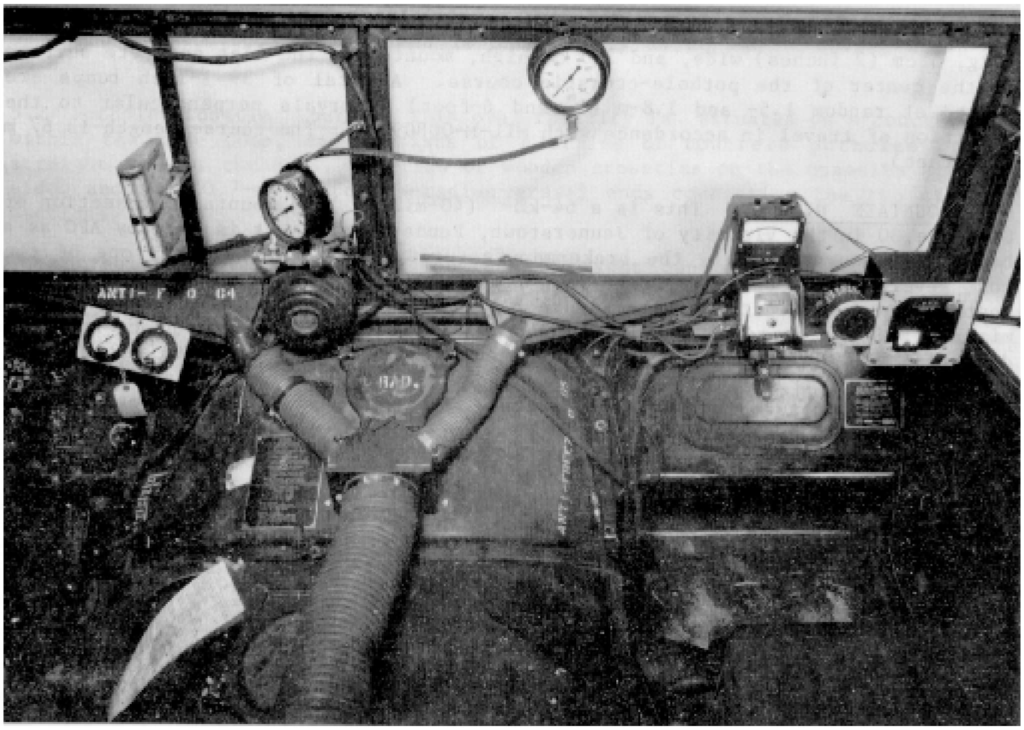


Figure 9. Brake testing instrumentation installed in truck cab.

Figure 10. Fifth wheel attached to M-1 for brake test.

7. MUNSON TEST AREA. Located near the eastern boundary of APG and bordering the shores of the Spesutie Island Narrows portion of the Chesapeake Bay, the Munson Test Area encompasses about 60 hectares (150 acres) of land. The facility is named in honor of Lt. Max Munson who lost his life in 1941 while testing an experimental vehicle.

The test courses are designed for making specific measurements and determinations of vehicle performance in the field. All special obstacles and test roads are permanently constructed and maintained according to specifications. The courses and network of connecting roads total 14.5 km (9 miles). Figure 11 shows relative locations of the courses, and Figure 12 is an aerial view.

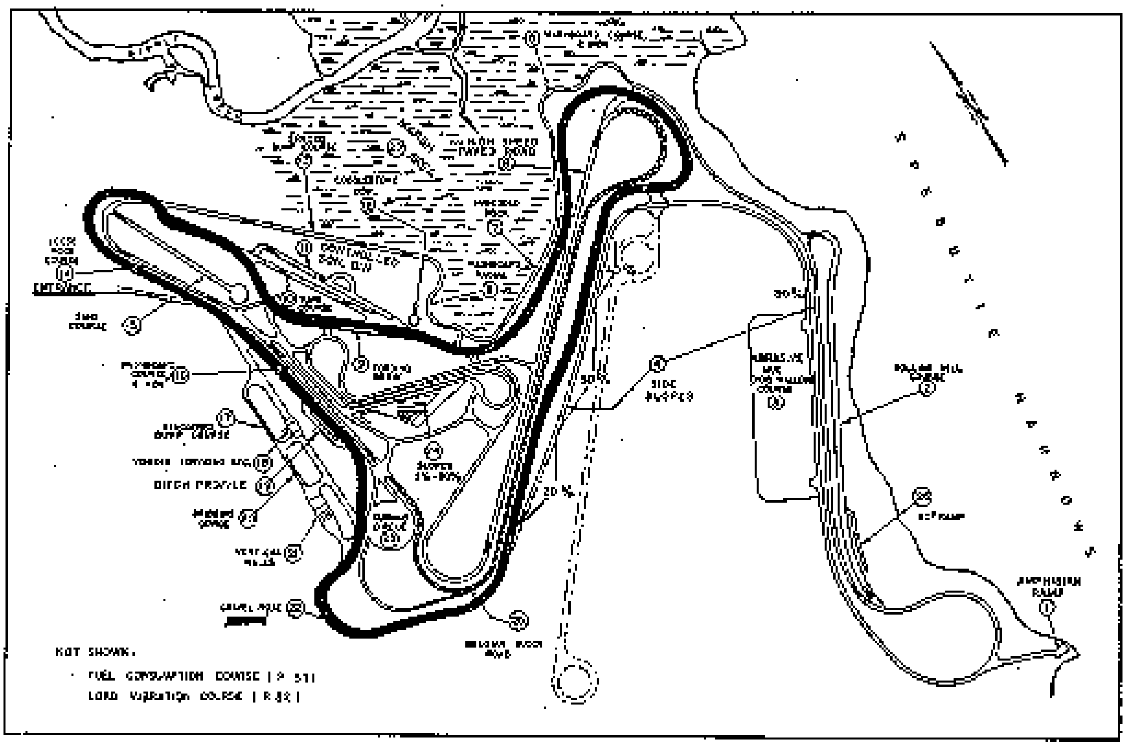


Figure 11. Munson test area.

Figure 12.
Aerial view of Munson test area.

7.1 High Speed Paved Road. This is a level road (see Figures 13 and 14) that permits the operation of most military vehicles at maximum speed. It provides a sharp contrast in operating conditions when used ad part of a loop including the Belgian block course. This road is one of two used for high speed operation; the other is in the Perryman area.

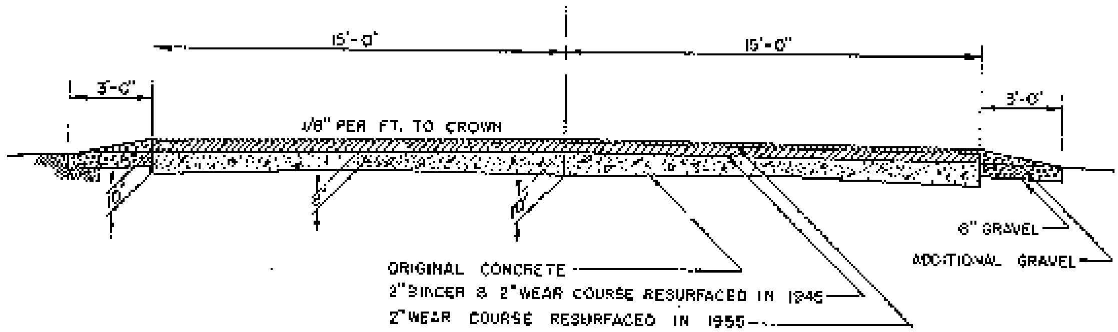


Figure 13. Cross-section of high speed paved road.

Figure 14. High speed paved road.

7.2 Improved Gravel Road. This is a loop of about 3.2 km (2 miles) with left and right curves (see Figures 15 and 16); the surface is compacted gravel maintained by grading. The gravel road is one of four basic courses used for endurance testing; the others are a paved road and level cross-country in the Perryman area and the cross-country hill course in the Churchville area.

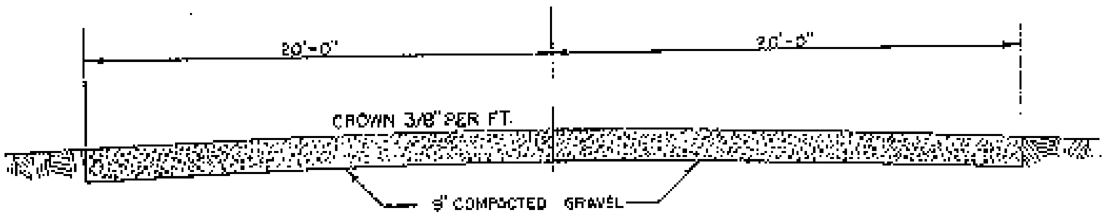


Figure 15. Cross-section of gravel road.

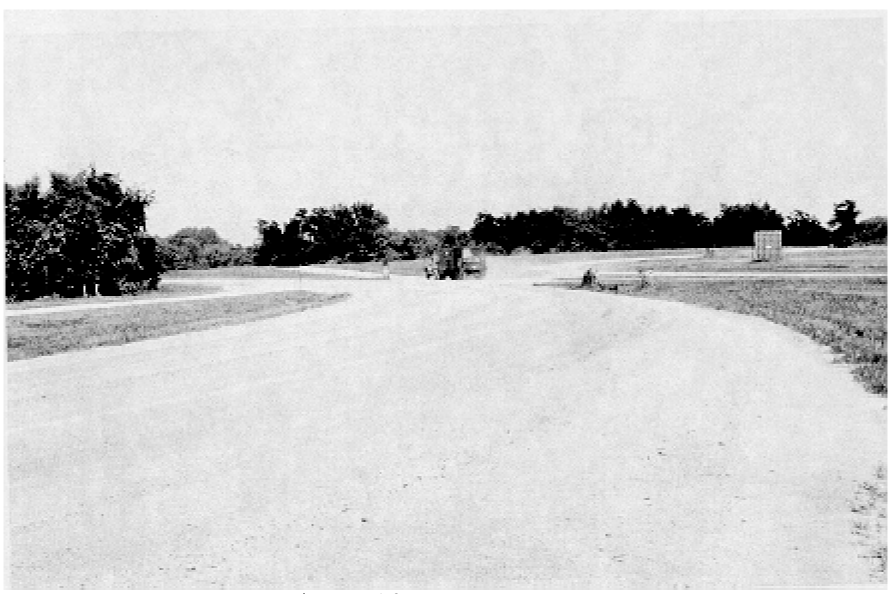


Figure 16. Improved gravel road.

7.3 Rolling Hill Course. This was designed to provide short, closely spaced grades. As a vehicle alternates between up- and down-grades on this course (see Figures 17 and 18), the engine and power train are subjected to rapid variations in loading. The surface consists of crushed stone compacted with stone dust binder.

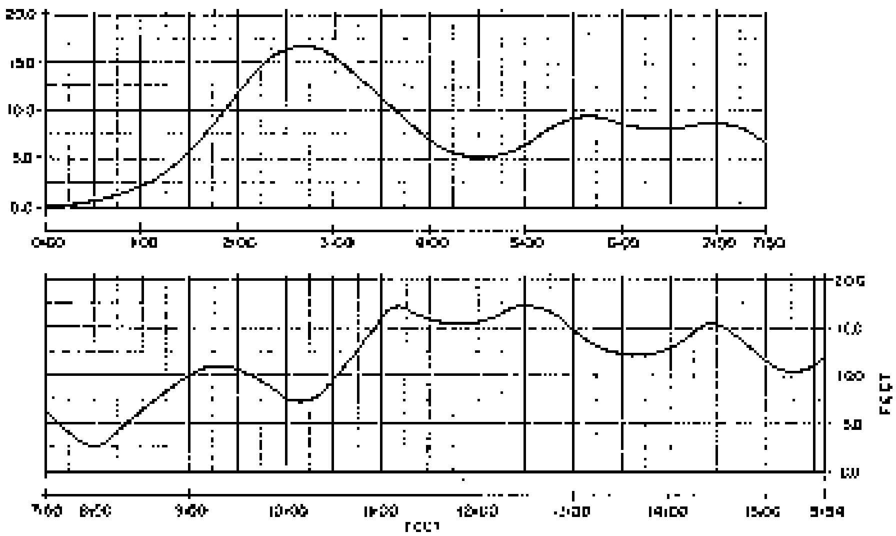


Figure 17. Profile of rolling hill course.

Figure 18. Rolling hill course.

7.4 Sand Course. This provides a standard for evaluating drawbar pull of wheeled and track-laying vehicles under Controlled conditions (see Figures 19 and 20). The sand is contained in a concrete bin that facilitates tilling and drainage, and prevents contamination from the surrounding soil. The straight portion of the course has sufficient length to produce stabilized data for a given condition. The circular bed at the end of the course is useful for evaluating the ability of vehicles to steer in sand, and for determining track-throwing tendencies and the effect of sand accumulation in suspension systems.

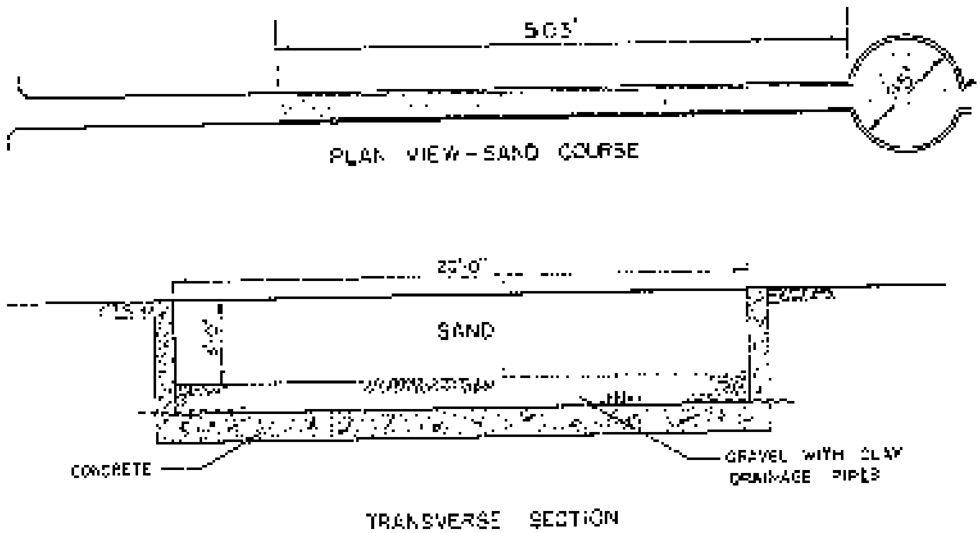


Figure 19. Plan view and transverse section of sand course.

Figure 20. Sand Course

7.5 Clay Soil Bin. The mobility of test vehicles is quantitatively determined in the finely grained Patapsco clay of the soil bin (see Figures 21 and 22). Soil preparation between test programs consists of leveling the clay surface and maintaining a wet, slippery condition.

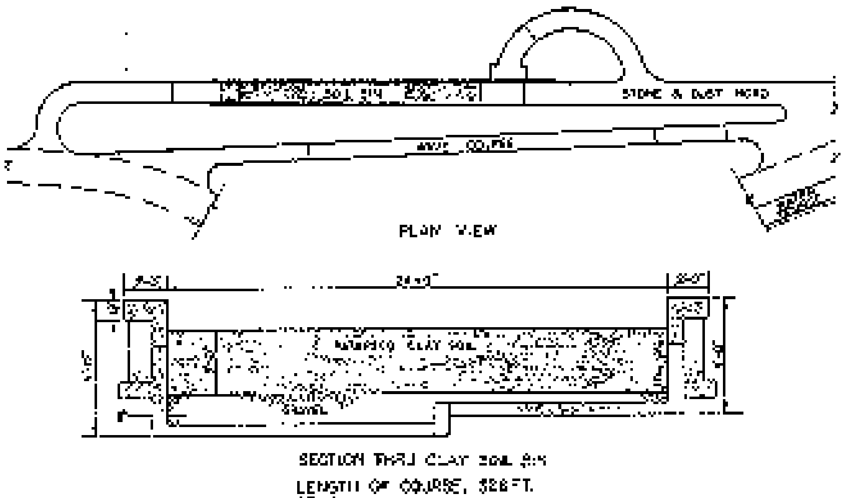


Figure 21. Plan view and cross-section of clay soil bin.

Figure 22. Vehicle in clay soil bin.

7.6 Abrasive Mud Course. Also known as the "hog wallow", this facility (see Figures 23 and 24) has an independent piped water supply that provides the means for maintaining muddy conditions, regardless of the season. The soil is sandy, with some clay and silt, making it particularly useful for evaluating the effects of abrasion on seals, brakes, and other components, as well as the effectiveness of seals. The ability to control the moisture content in dry periods makes it possible to adjust the course conditions (within limits) to suit test requirements of any particular vehicle. The course can be tilled to various depths to a maximum of 0.6 m (2 feet).

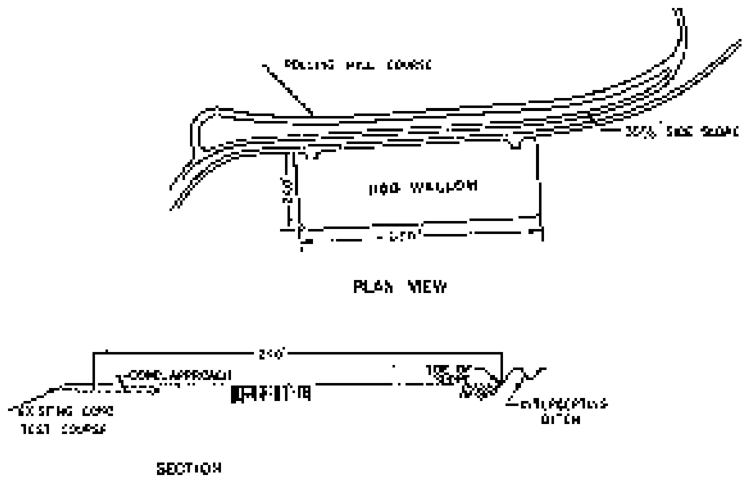


Figure 23. Plan view and section through abrasive mud course.

Figure 24. Abrasive mud course.

7.7 Marsh. Between the Munson area and Dipple Creek is a marsh with terrain of varied firmness that provides realistic conditions for mobility testing (see Figure 25). The marsh has a heavy growth of vegetation such as cattails and grass, much of which is periodically flooded by tidal action. In some sections, the mud is virtually bottomless insofar as operation of conventional vehicles is concerned. This variety of swampy conditions provides different degrees of severity for testing.

Around the edge of the marsh a water-filled jungle trail has been cut in a woody area by vehicular traffic. It passes through heavy vegetation consisting of vines, swamp grass, matted roots, etc.

Figure 25. Marsh.

7.8 Fording Basin. Also known as the "bathtub", this facility was designed to provide still water at controlled depths to 1.8 m (see Figures 26 and 27). Ramps at both ends permit gradual immersion if desired. Length and width of the basin are sufficient for running preliminary flotation tests on some amphibious vehicles. The main uses of the basin are for determining fording characteristics of nonfloating vehicles and for studying the effects of water on running gear components such as brakes, seals, and universal joints.

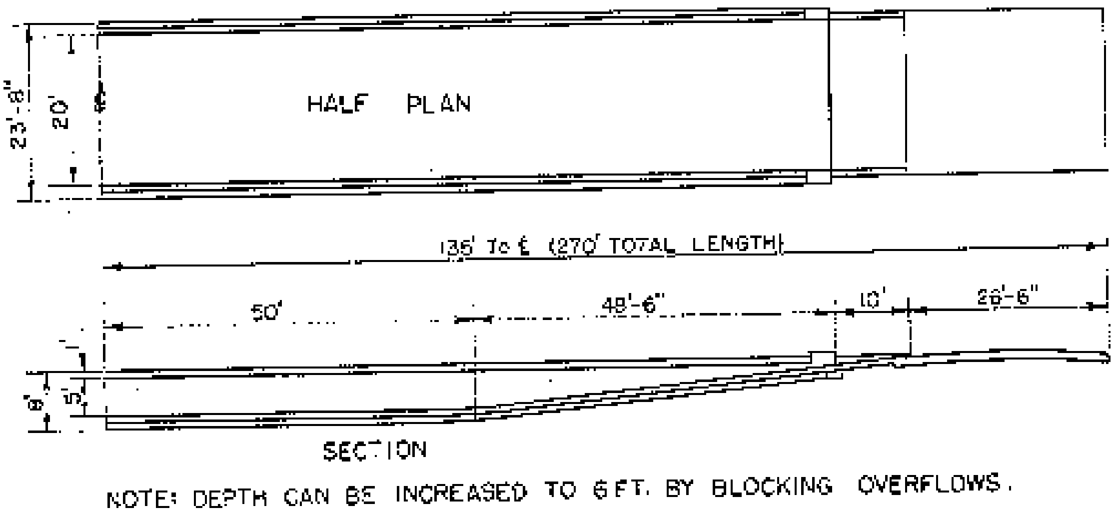


Figure 26. Half plan and section of fording basin.

Figure 27. Fording basin.

7.9 Underwater Fording Facility. Some vehicles can neutralize water obstacles by submerging. Vehicle effectiveness while submerged is tested in this facility (see Figure 28) in which water depths can be adjusted to 6.1 m (20 feet). Performance and safety of operations are evaluated under water and on the 40- and 50-percent entrance and exit slopes.

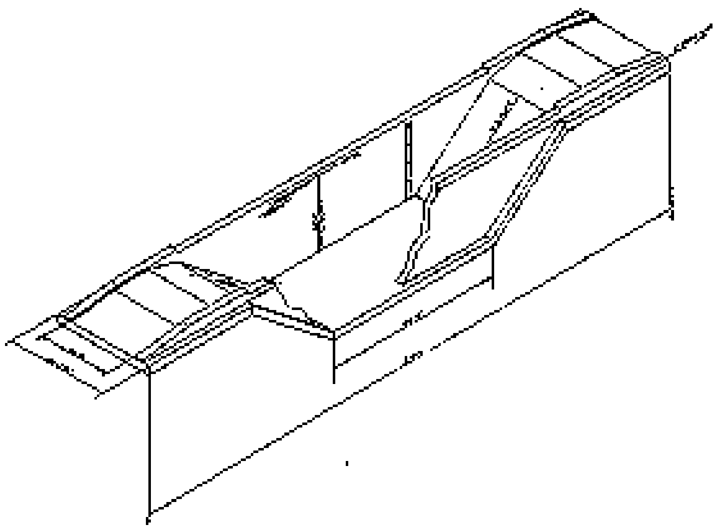


Figure 28. Underwater fording facility

7.10 Amphibian Ramp. This is used for evaluating the ability of vehicles to enter and leave a natural body of water by means of a concrete ramp (see Figures 29 and 30). The moderately sloped ramp extends into the water sufficiently to permit the safe launching of test vehicles whose flotation characteristics are unknown. For water entrance and exit interface tests, earthen slopes are constructed by grading.

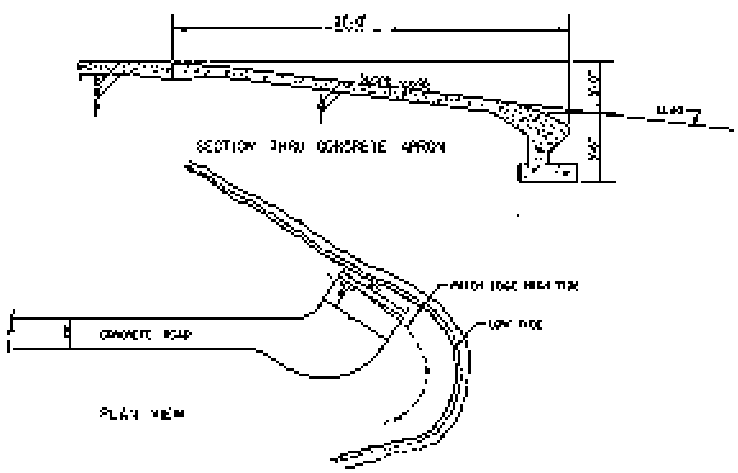


Figure 29. Plan view and section, amphibian ramp.

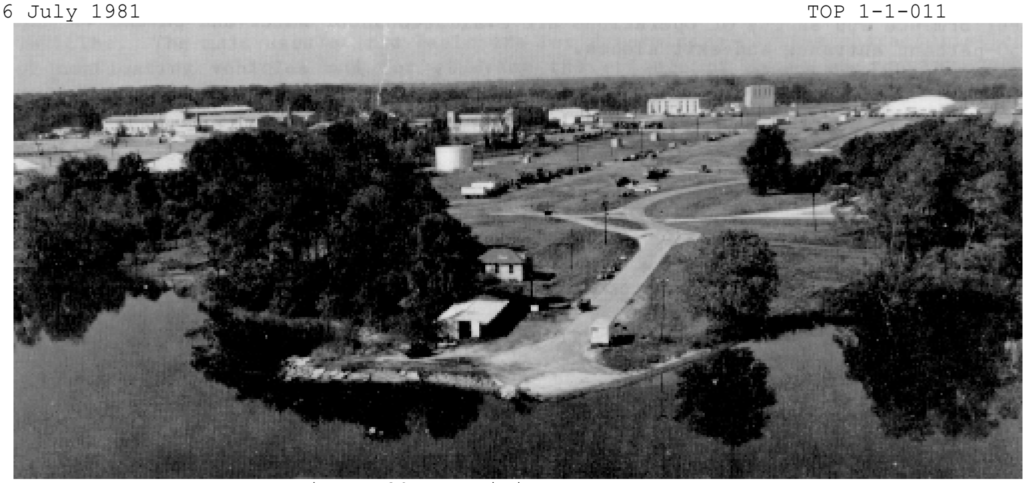


Figure 30. Amphibian ramp.

7.11 Shallow Water Swimming Area. The Spesutie Island Narrows has a 305-m (1,000-foot) dredged channel 3 m (10 feet) deep and 15 m (50 feet) wide, suitable for evaluating the swimming and floating capabilities of amphibious vehicles in still water. Fuel consumption and speed tests, as well as tests to evaluate floating bridges and rafts, are conducted here. Entering Spesutie Narrows is by way of the amphibian ramp. The Spesutie Narrows leads to deeper waters of the Chesapeake Bay where further tests may be conducted if necessary. Rather large vessels such as landing craft can gain access to the Munson area through the Chesapeake Bay and the Spesutie channel.

7.12 Belgian Block Course. This facility is paved with unevenly laid granite blocks forming an undulating surface (see Figures 31 and 32). It duplicates the rough cobblestone road found in many parts of the world. About 1.2 km (3/4 mile) long, the course is useful as a standard rough road for accelerated tests of wheeled vehicles, and is generally included in cycles of courses used for vibration studies. The motion imparted to a vehicle is a random combination of roll and pitch and high-frequency vibrations imparted by the granite paving blocks.

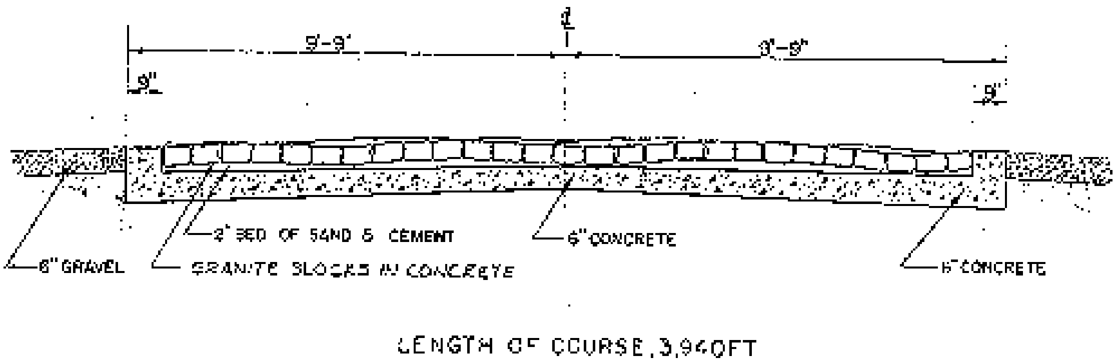


Figure 31. Transverse section, Belgian block course.

Figure 32. Belgian block course.

7.13 Imbedded Rock Course. This course (see Figures 33 and 34) provides an extremely rough surface for testing wheeled vehicles. It not only has an irregular surface suitable for evaluating suspensions, but is also a severe test for pneumatic tires.

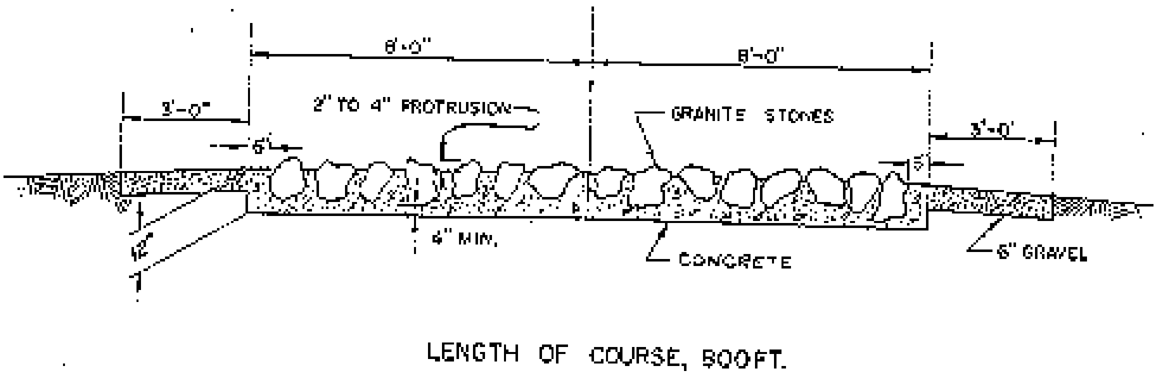


Figure 33. Transverse section of imbedded rock course.

Figure 34. Imbedded rock course.

7.14 Side Slopes. Side slopes of 20, 30, 35, and 40 percent are used as standards for testing the stability and controllability of tactical vehicles (see Figures 35 and 36). In addition to being used in engineering tests to measure steering efforts and lateral loading effects, the courses are sufficiently long to be incorporated in endurance tests involving other types of operation. A 1.8-m level gravel shoulder adjoining the slopes permits operation at gradients less than those of the actual slopes. When required for specific tests, side slopes with other gradients are constructed with a grader. The course lengths are shown in Table 1.

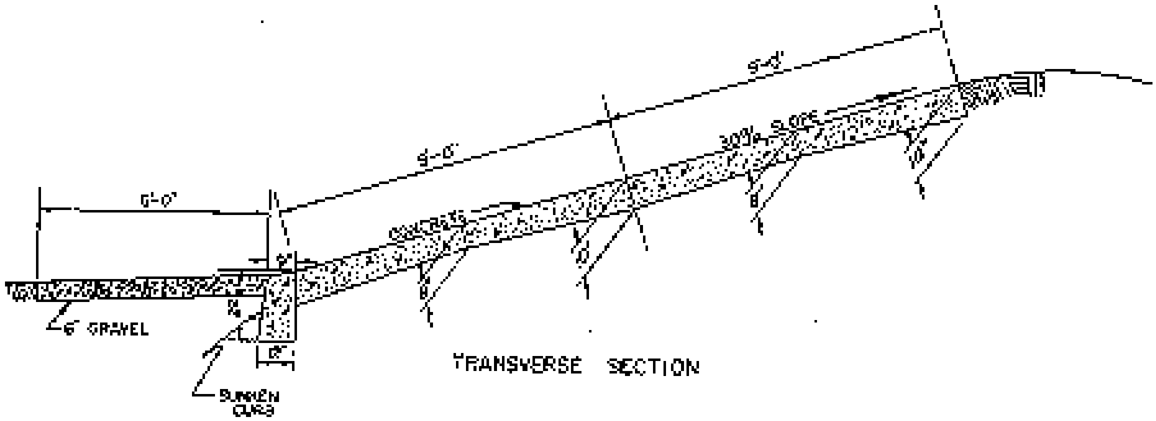


Figure 35. Transverse section of 30-percent side slope.

Figure 36. The 40-percent side slope in the Munson area

7.15 Gradeability (Longitudinal) Slopes. Gradeability of vehicles is a basic characteristic usually given in design specifications of military vehicles. The Munson gradeability slopes (see Figures 37 and 38) cover a range of 5 to 60 percent. They are used to determine optimum drive ratios and maximum attainable speeds on each slope, as well as brake-holding ability and adequacy of angles of approach and departure. With the test vehicle in ascending and descending at titudes, functions such as lubrication, fuel flow, and carburetion are investigated. The effect of imbalance on turret-traversing efforts and functioning of turret drive systems may also be studied on the slopes. The 5-, 10-, 15-, and 20-percent slopes, about 4.3 m (14 feet) wide, are paved with asphalt; the 30-, 40-, 45-, 50-, and 60-percent slopes with concrete. A 7-percent vertical slope is asphalt.

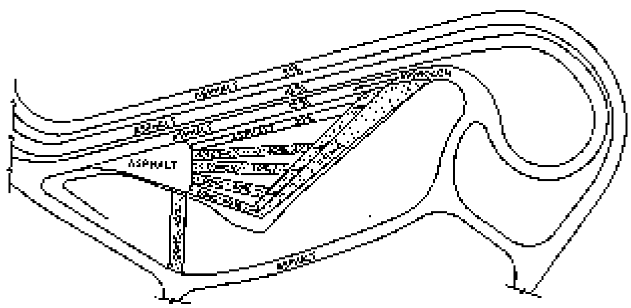


Figure 37. Plan view of slopes.

Figure 38. Standard gradeability slopes.

7.16 Simulated Loading Ramp. Tactical vehicles designed for transportation by either aircraft or ramp-equipped landing craft must be capable of entering and leaving the transporting vehicle by means of an inclined surface or ramp. The simulated loading ramp (see Figures 39 and 40) enables vehicles to be tested not only for adequacy of approach and departure angles, but also for adequate ground clearance and freedom from interference at the point of articulation between towing and towed vehicles.

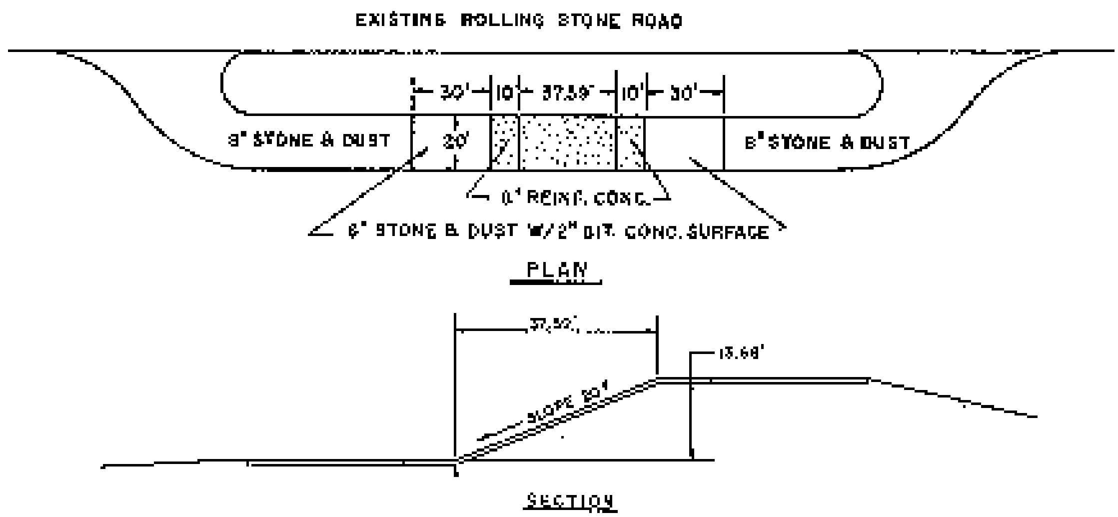


Figure 39. Plan view and section of simulated loading ramp.

Figure 40. Vehicle on simulated loading ramp.

7.17 2-Inch Washboard. This facility (see Figures 41 and 42) is on 0.6-m (2-foot) centers and provides a regular series of periodic humps with special value for testing wheeled vehicle suspensions. It can be used for one phase of endurance tests involving other courses in the area. Shocks imposed on the vehicle are influenced by design factors such as axle spacing and wheel size.

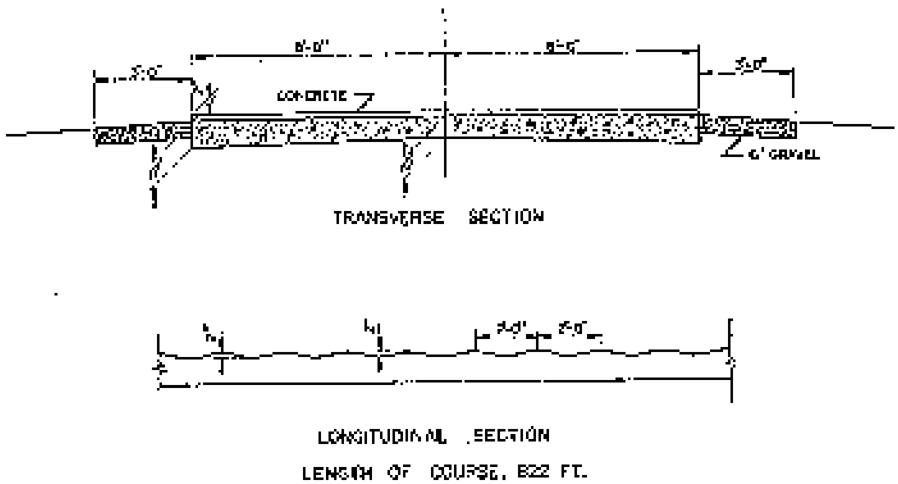


Figure 41. Sections of 2-inch washboard course.

Figure 42. Vehicle on 2-inch washboard course.

7.18 2- to 4-Inch Radial Washboard. This is laid out on reverse curves in such a manner that the wheels of a test vehicle are subjected to impacts at varied frequencies for any given speed. The course is useful for evaluating "wheel fight" and tendencies toward front-wheel "shimmy" (see Figures 43 and 44).

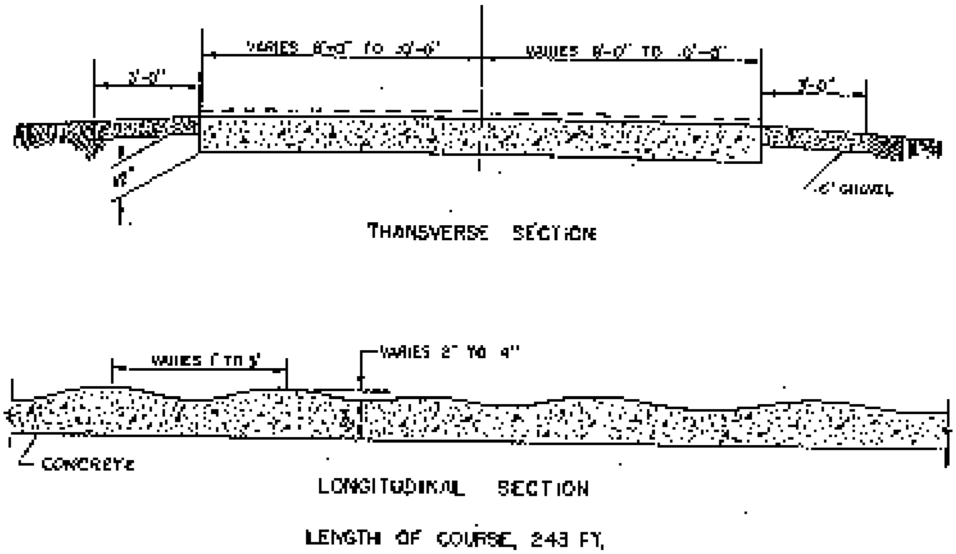


Figure 43. Sections of radial washboard.

Figure 44. Radial washboard course.

7.19 3-Inch Spaced Bump. This gives a vehicle an irregular jolt by means of 7.6-cm (3-inch) rounded sections that cross the road surface at various angles (see Figures 45 and 46). The spacing allows the suspension to "settle down" be tween jolts. This course is used mainly to impose shook and vibration stress on wheeled vehicle suspensions.

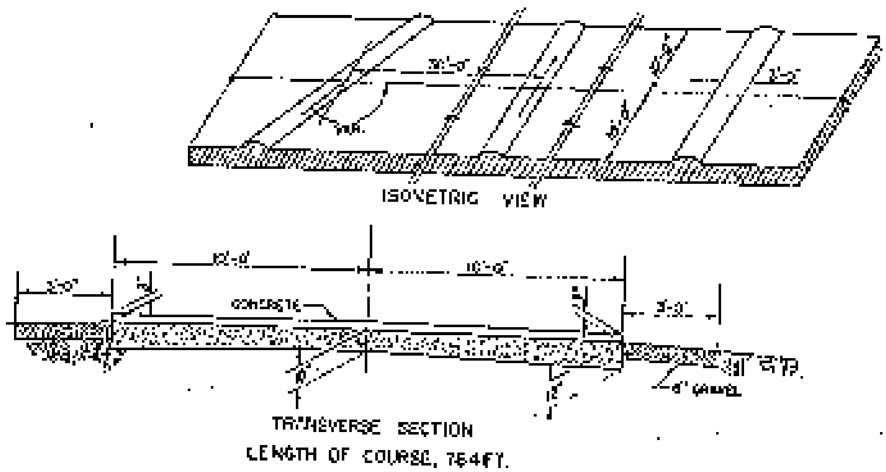


Figure 45. Isometric view and section of 3-inch spaced bump course.

Figure 46. Three-inch spaced bump course.

7.20 6-Inch Washboard. This is the most severe of the regular washboard courses, and was designed to evaluate vehicle pitching characteristics (see Figures 47 and 48). The pitching is induced at various speeds. The relatively large radius of the wave configuration and the 1.8-m intervals ensure that the larger wheels and track pitches ordinarily do not bridge the depressions.

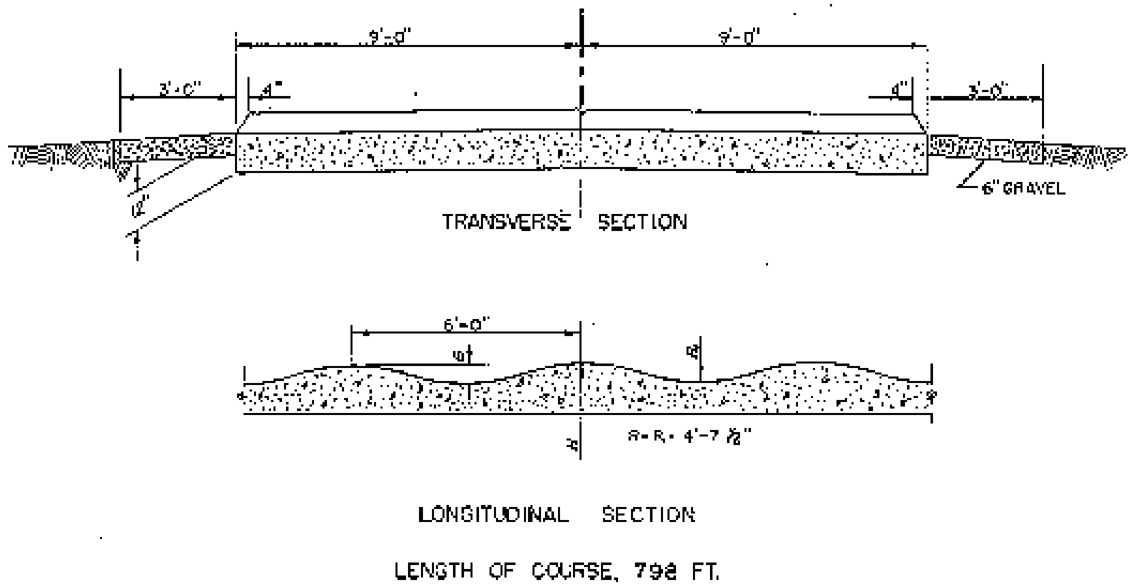


Figure 47. Sections of 6-inch washboard course.

Figure 48. US Roland on 6-inch washboard course.

7.21 Wave Course. Also known as the "frame twister", this course (see Figures 49 and 50) was designed to deflect the opposite wheels of a vehicle in alternately contrary directions. Articulation of the suspension increases with tread width. The course provides a severe test of differentials and universal joints, as well as suspensions. Distortion of vehicle bodies is checked by operating doors, dump bodies, engine hoods, etc., after stopping the vehicle with the suspension at extremes of vertical travel.

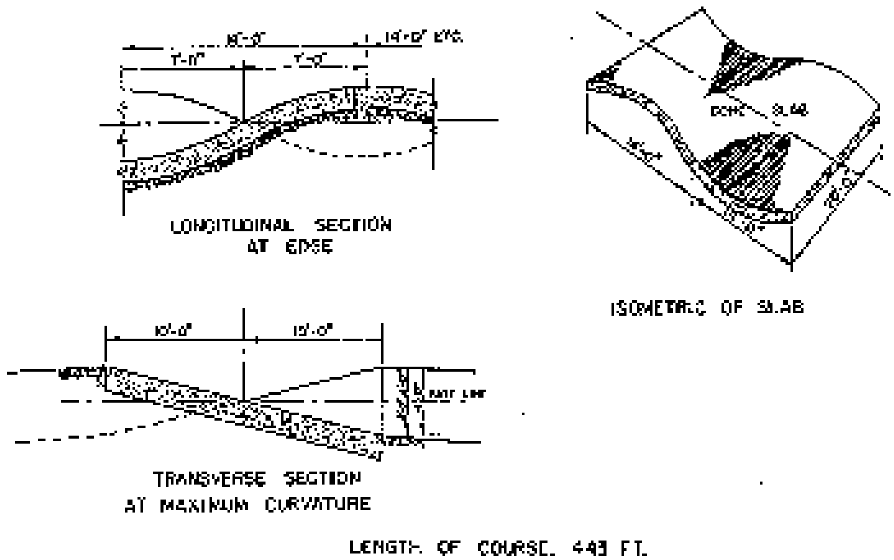


Figure 49. Sections of wave course.

Figure 50. Vehicle on wave course.

7.22 5- to 12-Inch Staggered Bump. This provides a means of inducing vehicle pitch and roll through cast concrete humps that alternately exercise opposite suspension members (see Figures 51 and 52). As with most washboard configurations, the effect on the vehicle varies with vehicle speed and suspension design.

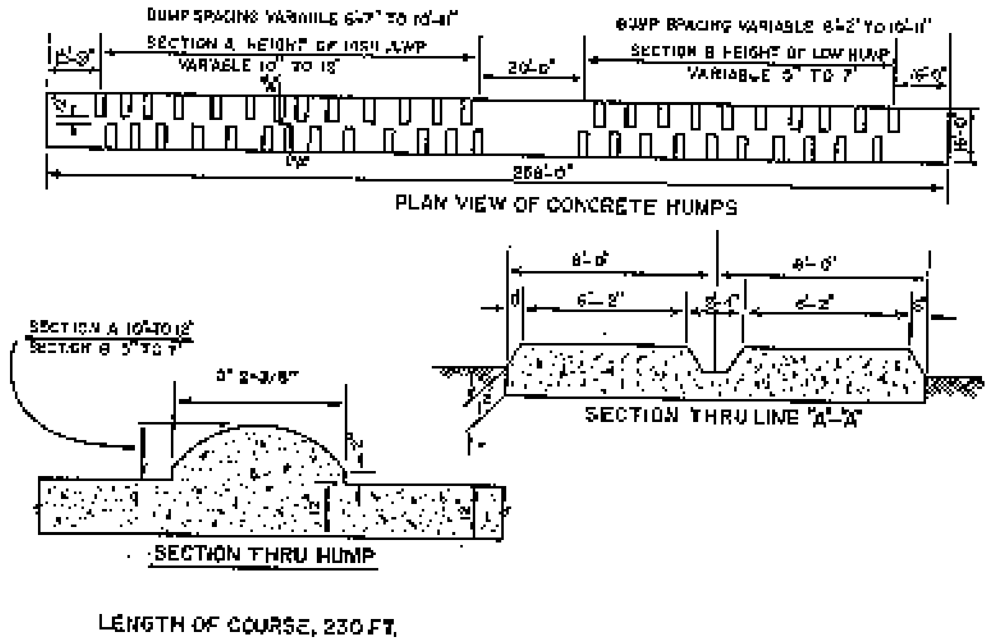


Figure 51. Plan view and sections of staggered bump course.

Figure 52. Staggered bump course.

7.23 Vertical Walls. Wall-climbing ability is a characteristic that is measured for all tactical vehicles. Maximum capability may be limited by projections from the vehicle that extend beyond the wheels or tracks. The Munson walls (see Figures 53 and 54) are equipped with replaceable timbers at the top so that the wall may be maintained in a standard condition following damage from tests.

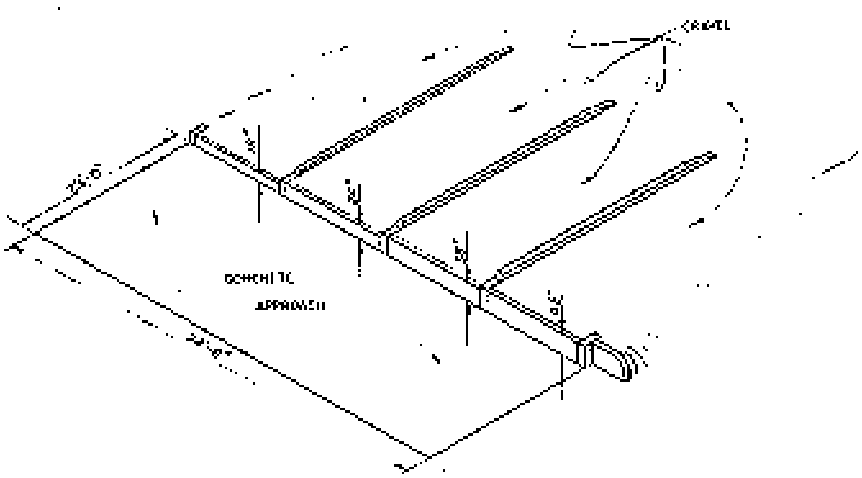


Figure 53. Isometric view of vertical walls.

Figure 54. Tracked vehicle negotiating vertical wall.

7.24 Bridging Device. The bridging requirement for various types of tracked vehicles is usually specified in the technical characteristics or design specifications. The bridging device provides an adjustable gap for measuring the maximum opening that the vehicle can cross unsupported (see Figures 55 and 56).

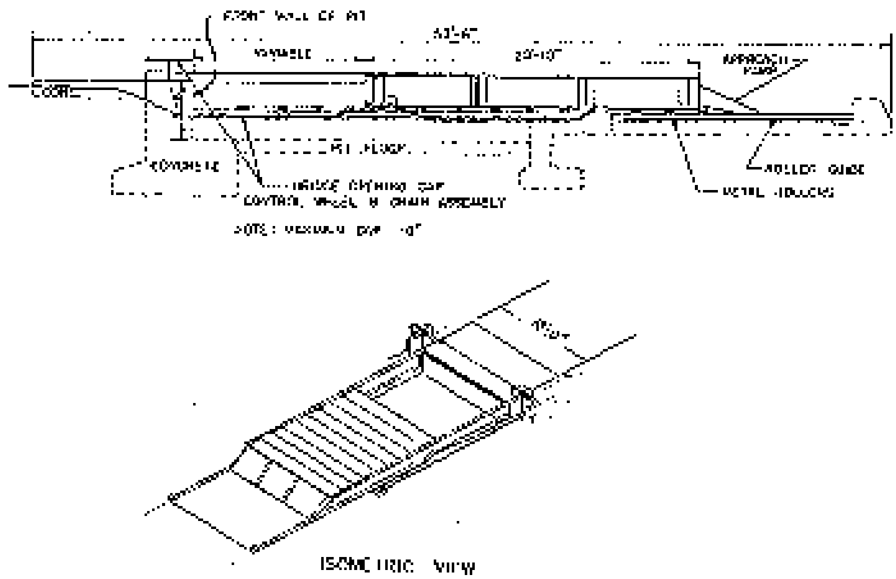


Figure 55. Plan and isometric view of bridging device.

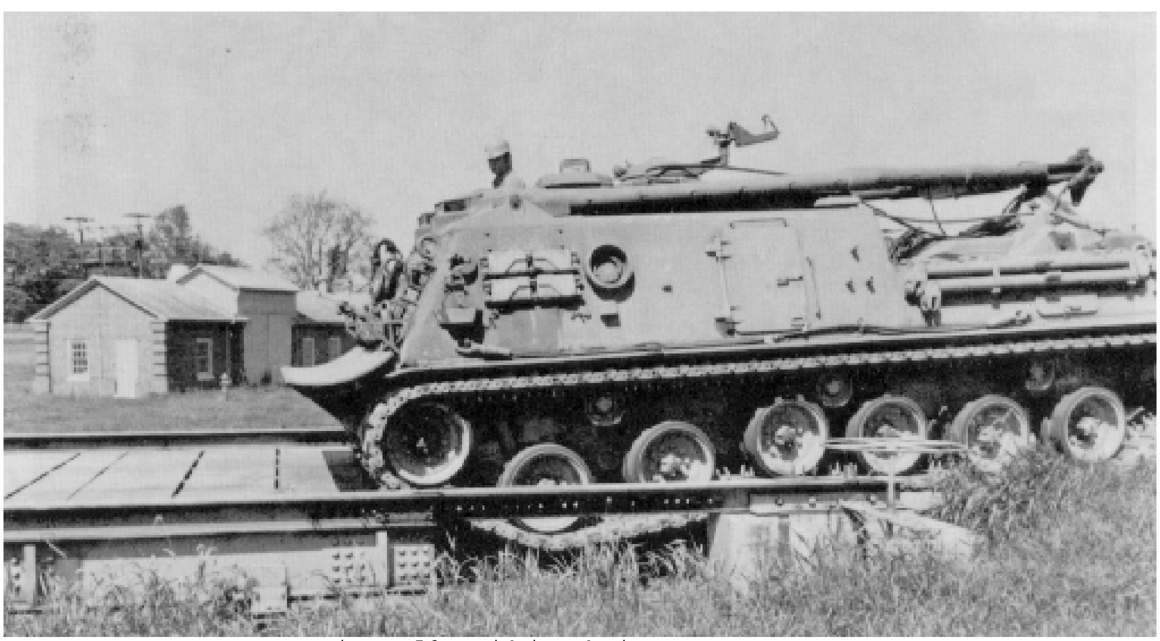


Figure 56. Bridging device

7.25 Ditch Profile. The standard ditch is used to check the adequacy of the angles of approach and departure of tactical vehicles. Tracklayers usually require rubber tracks for sufficient traction for pulling out of the trench (see Figures 57 and 58).

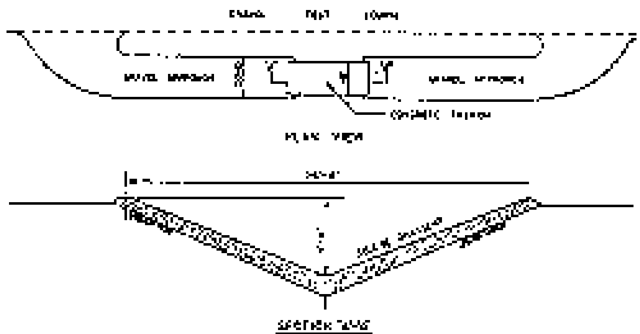


Figure 57. Plan view and section of ditch profile.

Figure 58. Ditch profile

7.26 Turning Circle. This is used for measuring turning diameters on a hard surface. It is large enough to permit figure-8 turns by the largest vehicles and for plotting limits of vision (see Figures 59 and 60). It is also used for other activities requiring a large and essentially flat concrete surface. An overhead platform is available at the edge for taking photographs from high angles. The platform floor is at a height 7 m 20 cm (24 feet 8 inches) above the circle; the camera mount, 8 m 23 cm (25 feet 9 inches).

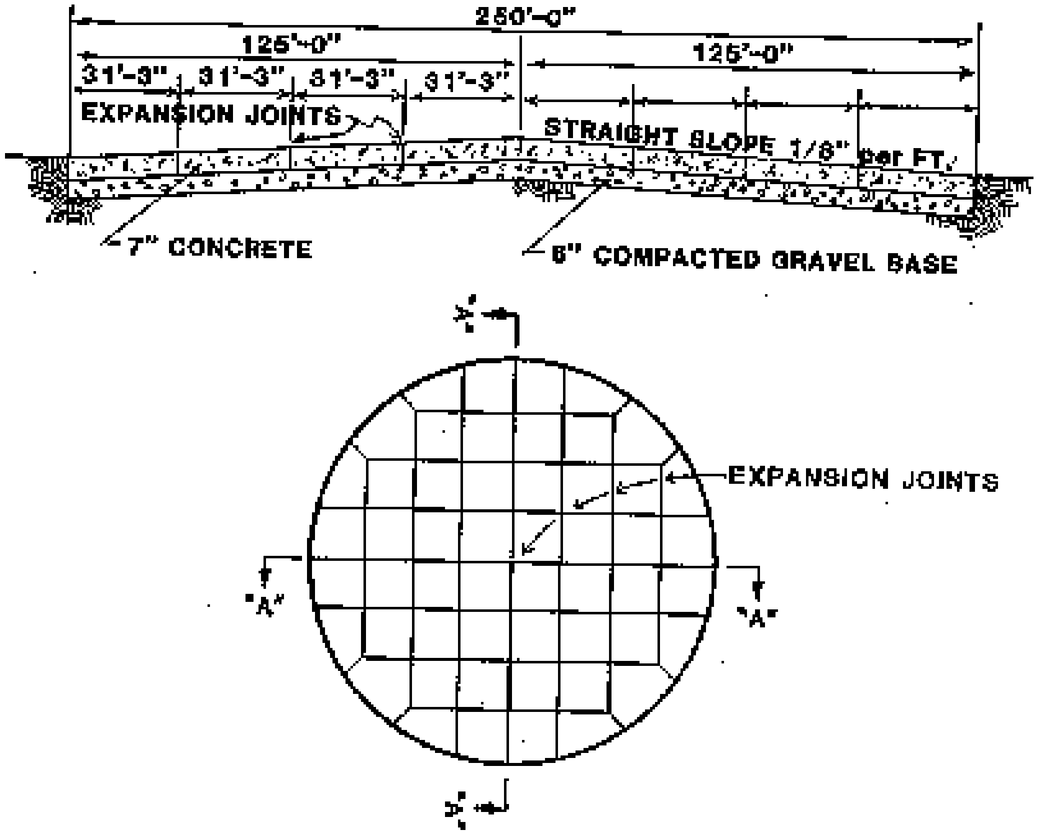


Figure 59. Section and plan view of turning circle.

Figure 60. Turning circle.

7.27 Winch Test Facility. This is used to perform functional tests, e.g., winch-holding capability. By means of a cable And pulley arrangement, selected weights can be lifted vertically while the winch being tested is pulling on a cable parallel to the ground.

7.28 Load Vibration Course. This comprises nearly 3.2 km (2 miles) of Munson courses (see Figure 61) selected to subject electronic equipment and other sensitive loads in wheeled vehicles to various vehicle reactions. The course was arranged to accommodate the standard load vibration test developed in cooperation with the former Signal Corps Laboratories at Fort Monmouth as a means for determining the ability of electronic units to withstand shock and vibration in specified vehicles. All road shock and vibration tests now use the automatic data-acquisition and processing techniques (ADAPT) system. The data are digitized directly from the test item and transmitted in pulse-coded modulation (PCM) form to a central control station where they are converted by analog-to-digital computer to desired form (tabular and/or graph).

The course is also used for evaluating the portability of other special military loads, including those of the Navy and Air Force. The individual courses are parallel with smooth roads for the.operation of instrument vehicles.

A ramp-type bump course is employed to impact tracked vehicle pitch in order to test turret fire-control components.

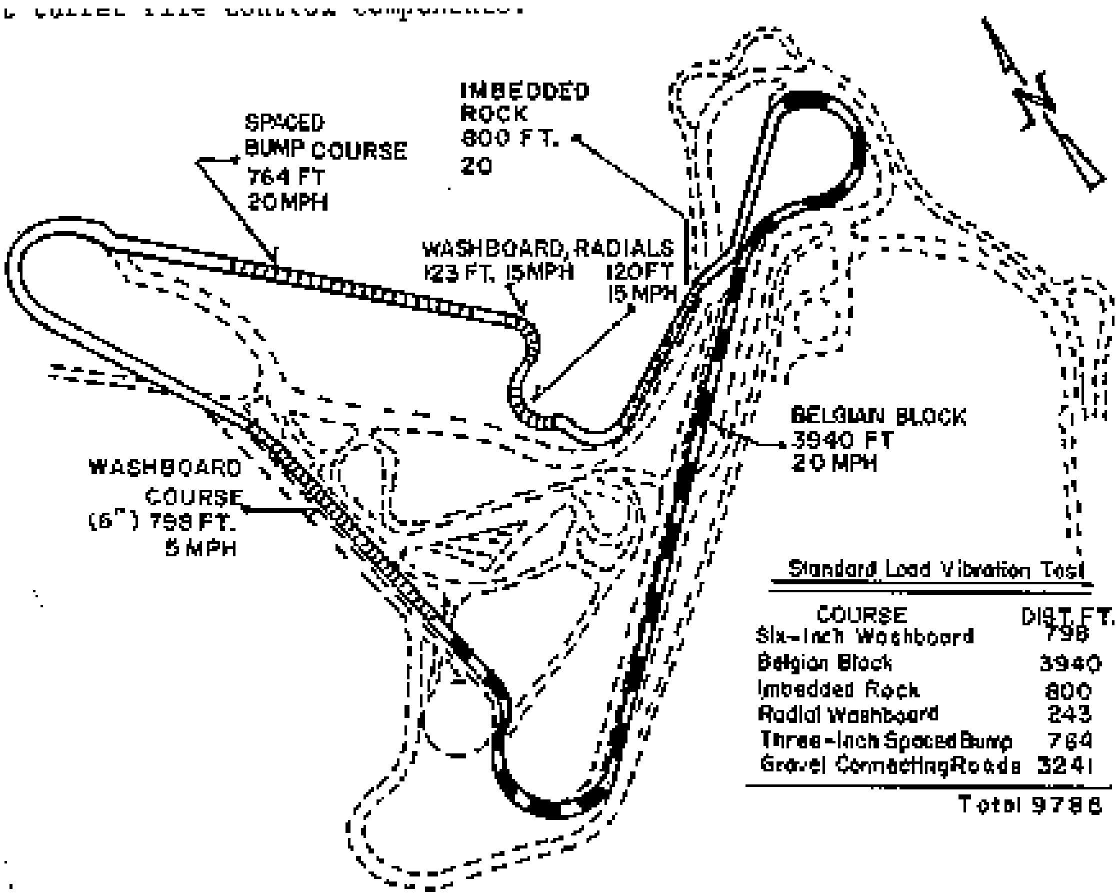


Figure 61. Load vibration test course.

7.29 Fuel Consumption Course. This is a loop of graded Munson roads, gravel and paved, totalling, 2439 m (8,003 feet) and used for a specific standard test (TOP/MTP 2-2-603 6) in which the vehicle is operated in clockwise and counterclockwise directions on each grade and surface (see Figure 62). Fuel consumption data are used for evaluating vehicle design, comparing with other vehicles, and determining fuel consumption rate that might be expected under field conditions

Figure 62. Fuel consumption course.

TABLE 3

		Operating Distance*			
		Clockwise		Counterclockwise	
Surface	Grade	Ft.	M.	Ft.	M.
Gravel	Less than 1%	2718	828	2718	828
Bituminous	Less than 1%	3930	1198	3930	1198
concrete	1 to 5%	467 up	142 up	467 down	142 down
	5%	483 down	147 down	483 up	147 up
	15%	256 down	78 down	256 up	78 up
Concrete	30%	149 up	45 up	149 down	45 down
	Total	8003	2439	8003	2439

*Included are short lengths of approach roads in addition to the centerline dimensions of individual test courses.

8. PERRYMAN TEST AREA. Perryman adjoins the northwestern boundary of APG, and includes about 800 hectares (2,000 acres) about 8 km (5 miles) from post headquarters (see Figure 63). originally devoted to farming, the area is now used mainly for cross-country testing of vehicles for durability and reliability. Facilities for other tests are also in the area.

Although surface variations due to weather are a desirable feature of most Perryman courses, changes in course geometry are assessed periodically by a test course committee that recommends appropriate maintenance as necessary to restore the courses to the same severity. Details of the procedure are contained in TOP 1-1-010. Test course area supervisors also make daily inspections and maintain an on-site log of climatic and course conditions.

8.1 Cross-Country Courses. Four important cross-country loop courses graduated in severity are within Perryman. Course 1 is a moderate one with a substantial roadbed composed primarily of quarry spall and bank gravel (see Figure 64). The loop includes sharp and sweeping curves, and the surface ranges from smooth to rough (roughness being due to potholes, washboard, and rutting). Potholes and other sharp depressions are usually limited to a depth of 15 cm by filling with crushed stone. During wet weather, the whole course is characterized by light mud which affects wheeled vehicles mainly be splash.

Course 2 is laid out in a loop of moderately irregular terrain. The native soil includes Sassafras loam, a silty loam with 17.3 percent clay content, and Sassafras silt loam, a silty loam with less than 15 percent clay. Surfaces range from smooth to rough, and there are sweeping turns. Under wet conditions, the course is extremely muddy (see Figure 65); when dry, it is extremely dusty (see Figure 66). One area of the course used for testing earthmoving equipment includes earthen side slopes, a "cut-and-fill" area, and a figure-8 course.

Course 3 is a rough one of native soil similar to that of course 2. Mud ranges from light (with free water) to cohesive. Although dust is severe when the course is dry, there is always mud in some areas (see Figure 67). Much of the course is rough due to many years of tests of tank-type vehicles.

Course 4 is a tract of extremely rough terrain including marshy areas with swamp-type vegetation (see Figure 68). The drier areas are characterized by a succession of depressions that develop after intensive operation of heavy track-laying vehicles. A typical profile is shown in Figure 69 in which it can be seen that the main repetitive humps are spaced in a pattern, the horizontal distance from high to low averaging about 4 m (13.75 ft) and the vertical distance from low to high averaging about 3.7 m (12.5 ft). The difference in the slopes is attributed to the fact that vehicles have generally been run in one direction. The soil of the course is native soil as described under course 2.

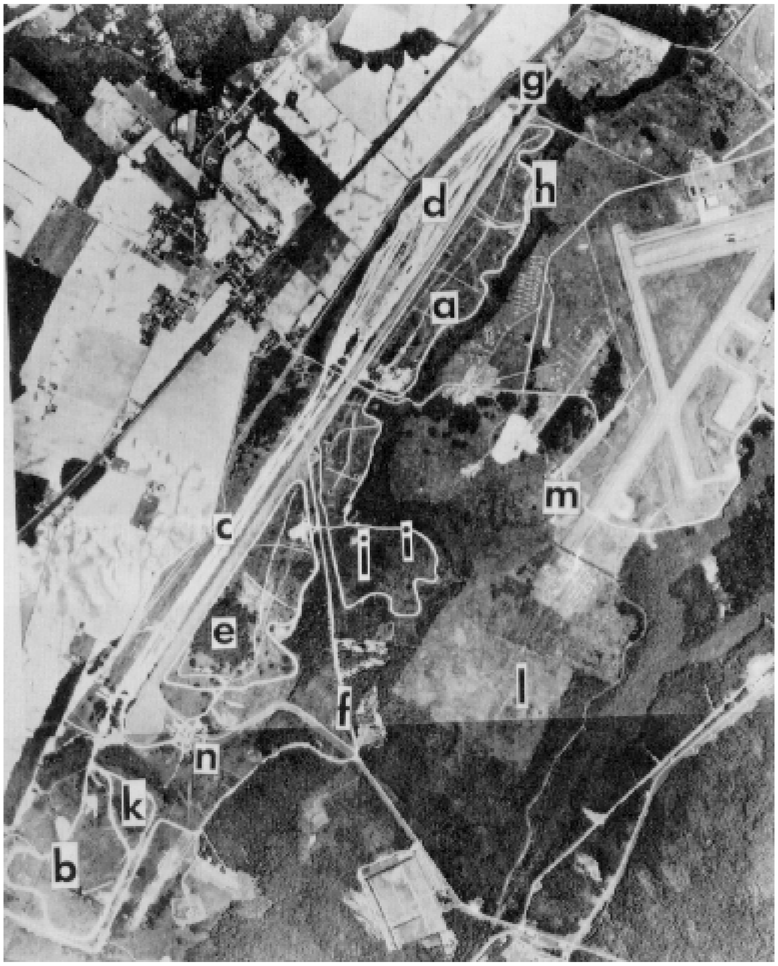


Figure 63. Aerial view of Perryman Test Area.

a. No. 1 cross-country course
b. No. 2 cross-country course
c. No. 3 cross-country course
d. No. 4 cross-country course
e. Secondary road A
f. Secondary road B
g. 3-mile high speed road
h. Mud bypass course
i. Mud mobility course
j. Mobile bridge test facility
k. Deep water fording facility
l. Swamp quarter mobility area
m. Crash barrier
n. Shop area

Figure 64. View of roadbed characteristics, cross-country course No.1.

Figure 65. Vehicle in mud on cross-country course No. 2.

Figure 66. Cross-country course No. 2 under dusty conditions.

Figure 67. Vehicle on cross-country course No. 3.

Figure 68. Example of rough terrain of course No. 4.

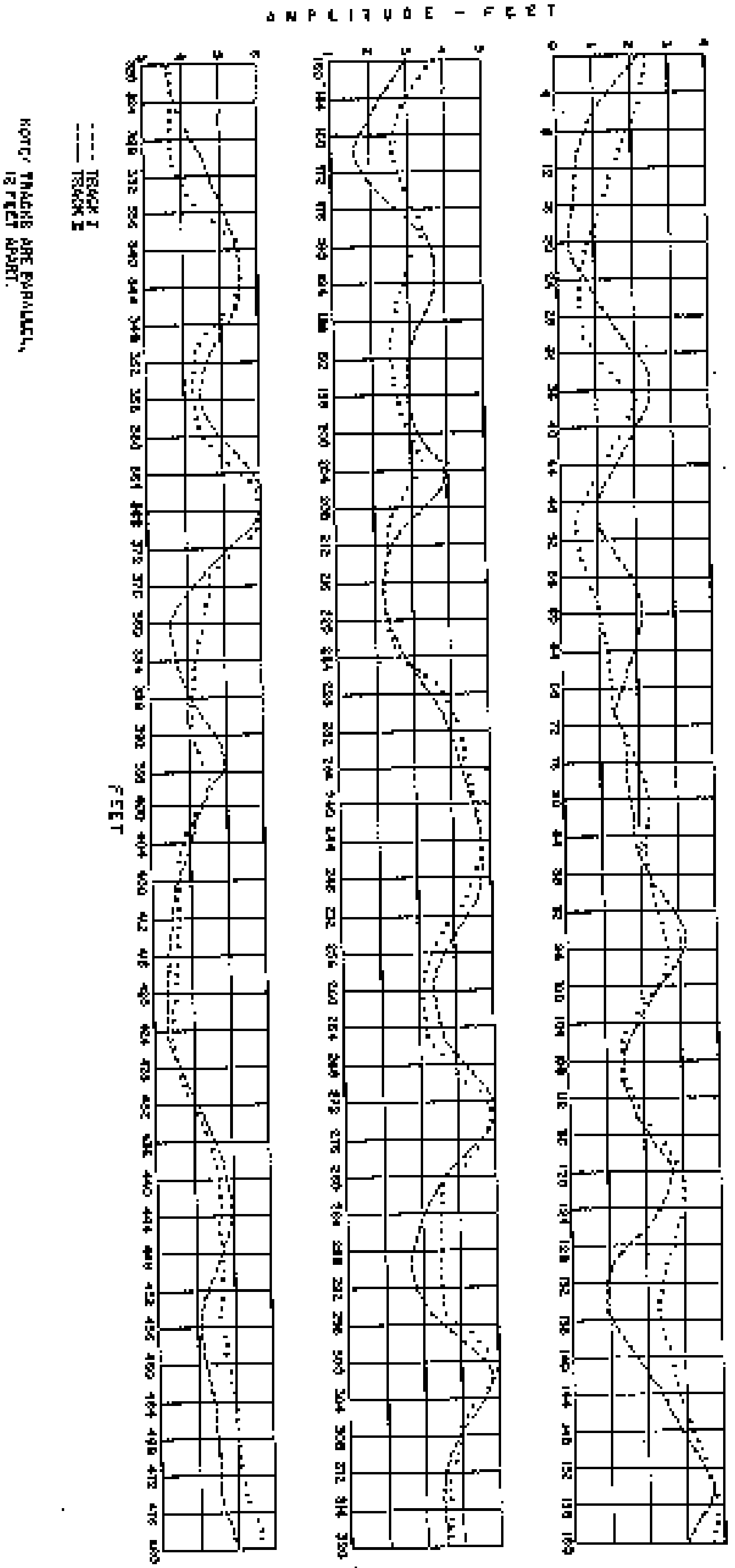

AMPLITUDE - FEET
FEET
TRACK I ——
TRACK II ----
NOTE: TRACKS ARE PARALLEL, 12 FEET APART.

Figure 69. Typical contour of Perryman cross-country course No. 4 at 1-foot intervals. Amplitude plotted to nearest 01. foot (Ref.: McCafferty, James and Smith, Donald F., "Profile Data on Test Courses at Aberdeen Proving Ground", Ann Arbor, Michigan, Univ. of Michigan Engineering Institute, Report 2601-505-M, 2 October 1957).

8.2 Deep Water Fording Facility. Vehicle performance and safety and effectiveness of fording kits and snorkels are evaluated in this facility along Perryman course 2. This facility (see Figure 70) is about 61 m (200 ft) long, 4.6 m (15 ft) wide, and 2 m (7 ft) deep. It has an earthen bottom covered with metal screens.

8.3 High Speed Paved Road. This is a 6.1-km (3.8-mile) straight-away with banked turnaround loops at each end for, tests requiring uninterrupted operation such as cooling tests, operation at high speed, etc.

8.4 Mud Bypass Course. This is a 213-m (700-foot) bypass off of course 1. It is most useful in periods of dry weather for exposing vehicles to muddy conditions to evaluate seals, brakes, or other mud-sensitive components during endurance operations. The course is prepared by tilling and pumping water onto it from a nearby stream.

8.5 Mud Mobility Course. This is an area 36.6 m by 125 m (120 by 410 feet) within the southern loop of course 1 near the mobile bridge test facility (see 9.6). The soil can be tilled to a depth of 76 cm (30 inches). This course is especially useful for evaluating mobility in severe mud, particularly with respect to traction, flotation, and steering. There is adequate room for side by-side operation of vehicles for comparing performance.

8.6 Mobile Bridge Test Facility. Located within the southern loop of course 1, this is a man-made pond used for testing bridge-launching equipment and conducting bridge-crossing tests (see Figure 71). The pond is irregularly shaped roughly 48.8 m (160 feet) wide by 68.6 m (225 feet) long, and as deep as 2 m (7 feet). There are two approaches for vehicle entry and exit. A quarry pond in the Chelsea area of APG is also used to test floating bridges with spans as great as 260 feet

8.7 Secondary Roads. Road A is a closed loop course 3.9 km (2.4 miles) long with sharp sweeping turns typical of unimproved country roads. The course surface is about 10.7 m (35 feet) wide, maintained by grading and filling with native soil.

Road B is 5.2 km (3.2 miles) long with a maximum width of 6.1 m (20 feet). The course is characterized by long straight portions with sharp sweeping curves. A turnaround loop is provided at each end of the course. The surface is maintained with bank gravel and crushed stone.

8.8 Swamp Quarter Mobility Area. This is a .8-hectare (2-acre) swampy section of Perryman used for mobility testing in soft soil and natural vegetation environments (see Figure 72). A rectangular area of about 76.2 m by 91.4 m (250 by 300 feet) in this section includes terrain obstacles constructed to simulate rice fields. Various entry and exit slopes are provided, along with a simulated drainage canal.


Figure 70. Vehicle in deep water fording facility.


Figure 71. Ribbon bridge across pond in Chelsea area.


Figure 72. "Rice" field.

9. POOLE'S ISLAND. Located inside the southeast corner of APG, Poole's Island is in the Chesapeake Bay, south of the mouth of Bush River, near Gunpowder Neck (see Figures 73 and 74). It contains a sandy beach about 1.6 km long on the west and northwest shore suitable for sand mobility and amphibious testing. The firm smooth area that slopes to a 4.6-m (15-foot) water depth provides an excellent facility for deep-water fording tests.

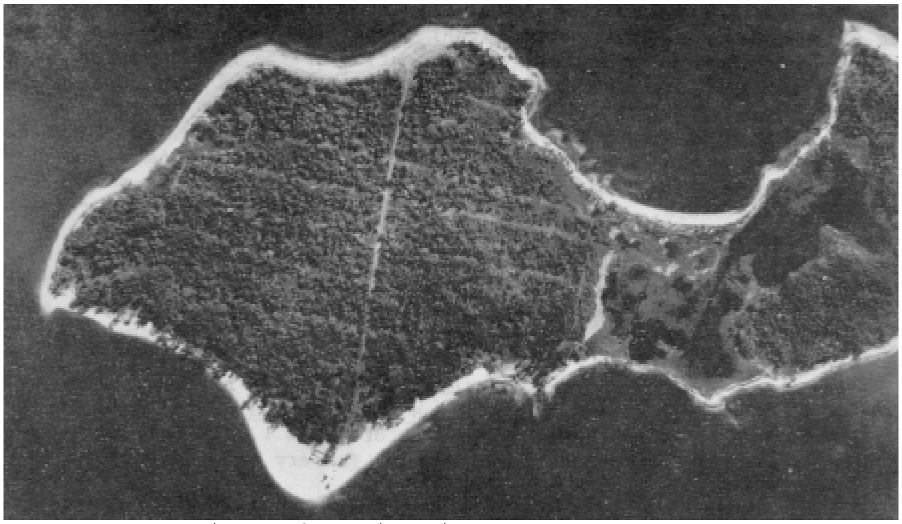


Figure 73. Aerial view of Poole's Island.

Figure 74. Beach sand course.

10. TANK GUNNERY RANGES. The testing and evaluation of tank armament is conducted on unique firing ranges on Gunpowder Neck (see Figure 75) and trench warfare. Tracking data are generated by two gated TV systems with input from a video camera boresighted with the tank gun (to collect lead angle and tracking data) and another video camera in the sight (to collect gunner tracking data). These systems are video digitizers that output constantly updated error signals equal to the target's azimuth and elevation deflections in the field of view of the video cameras. These systems essentially accomplish real-time automatic film reading with video input, and error signal output recorded directly on magnetic tape. Video recorders provide video documentation of the gated TV tracking data, and monitors allow the test director real time monitoring of the video data.

At the H-field area of Gunpowder Neck (see Figure 76), the direct-fire ranges are arranged with wide-angle "safety fans" with line-of-sight targets as far away as 3000 meters. For specialized long-range firing, a range of 5000 meters (partly over water) is available. Special firing slopes (15 percent up, 30 percent down, and various combination slopes up to 20%) permit firing at maximum gun elevation and depression, as well as over a variety of vehicle attitudes. Supporting facilities include a four-bay maintenance shop with adjoining offices and briefing room, range control/instrumentation shelters, ammunition magazines meteorological instrumentation, and communications and other equipment.

Standardized cross-country courses and test conditions (e.g., bump) are available for comparative performance testing of tank turret-stabilized fire control systems (see Figure 77). A cross-country course of about 1.6 km long is in the area for determining durability characteristics of gunnery systems during vehicle operation.

A 6- by 6-m (20- by 20-foot) moving target facility (see Figure 78) has speeds as great as 56 km (35 miles) per hour. With a vehicle at stationary position, traversing the gravel bump or the zig-zag course on range C, remote controls and a 2-km (1-1/4-mile) triangular railroad layout are used to alter the speed and orientation of the moving target to the line of fire. The moving target is used to measure accuracy of fire for tank turrets, including those equipped with hypervelocity guns or guided missiles.

In addition, the H-field ranges are equipped with video scoring instrumentation to remotely record target impacts (see Figure 80). Down-range wind speed and direction, as well as other meteorological data, are obtained by means of a fully automated meteorological station. Other telemetry and data-processing instrumentation are available to record and reduce data obtained from monitoring on-board vehicular equipment such as gun sight optics, ballistics computer output, rangefinder readings, and main gun aimpoint. These data are acquired on-site by a mini-computer data-acquisition system that is part of the Automated Data-Acquisition and Processing Techniques (ADAPT) distributed network. The data are then passed from the H-field test site to the central computer via a microwave link.

Testing capabilities at the principal ranges of H-field are summarized in Table 4.

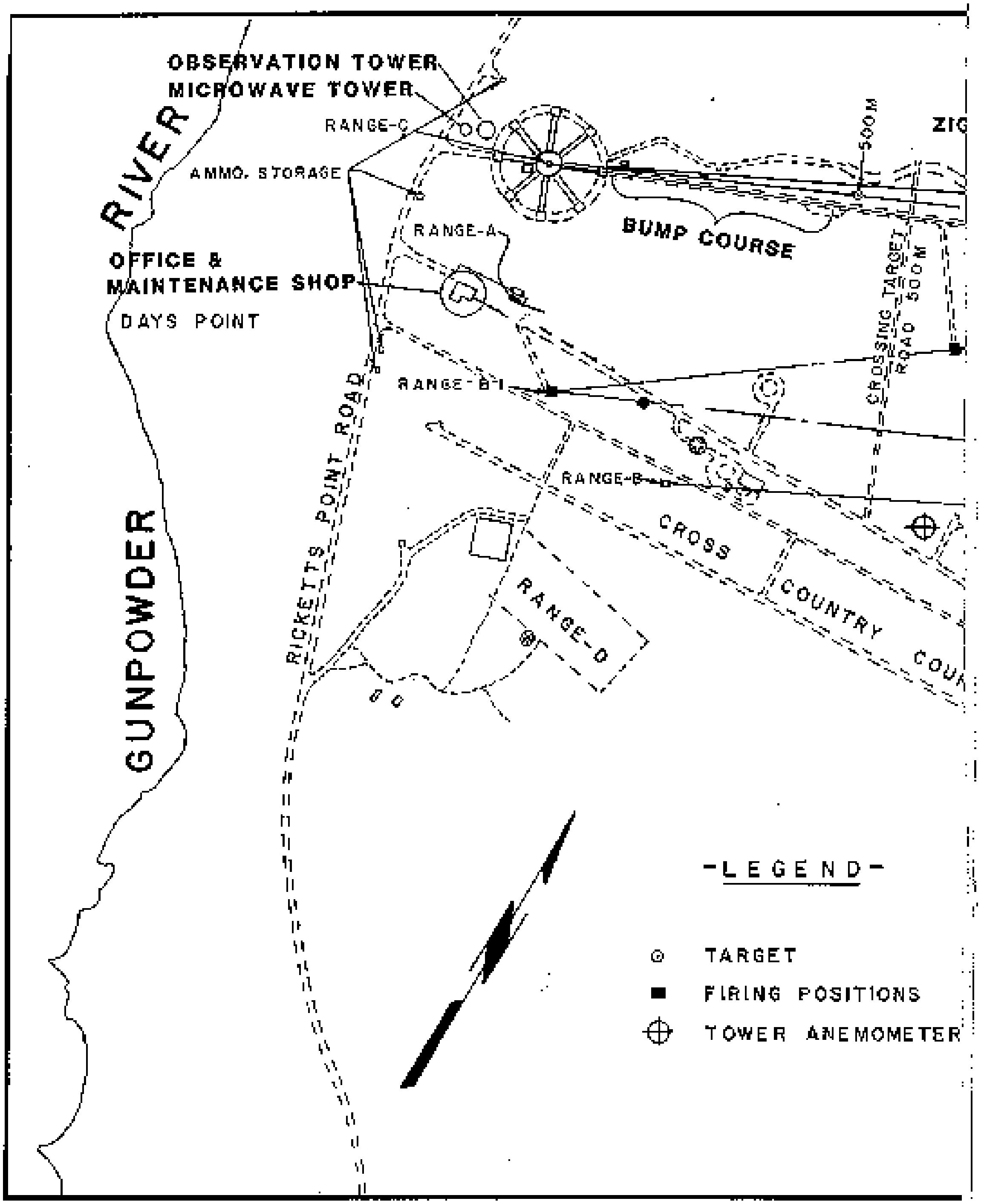


Figure 75. Tank gunnery range, Gunpowder Neck
part 1 of 3 page map

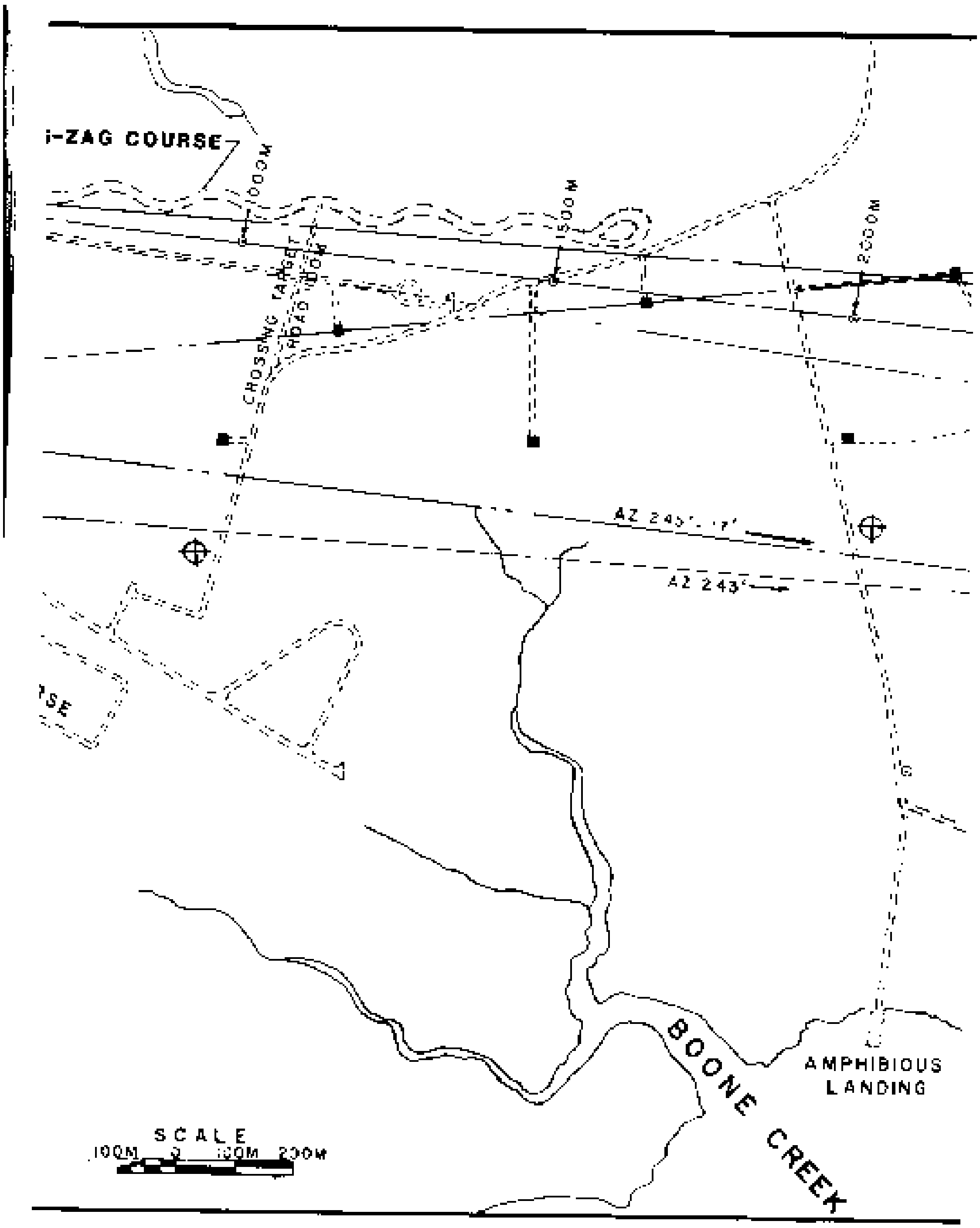


Figure 75. Tank gunnery range, Gunpowder Neck.

Figure 75. Tank gunnery range, Gunpowder Neck.
part 2 of 3 page map

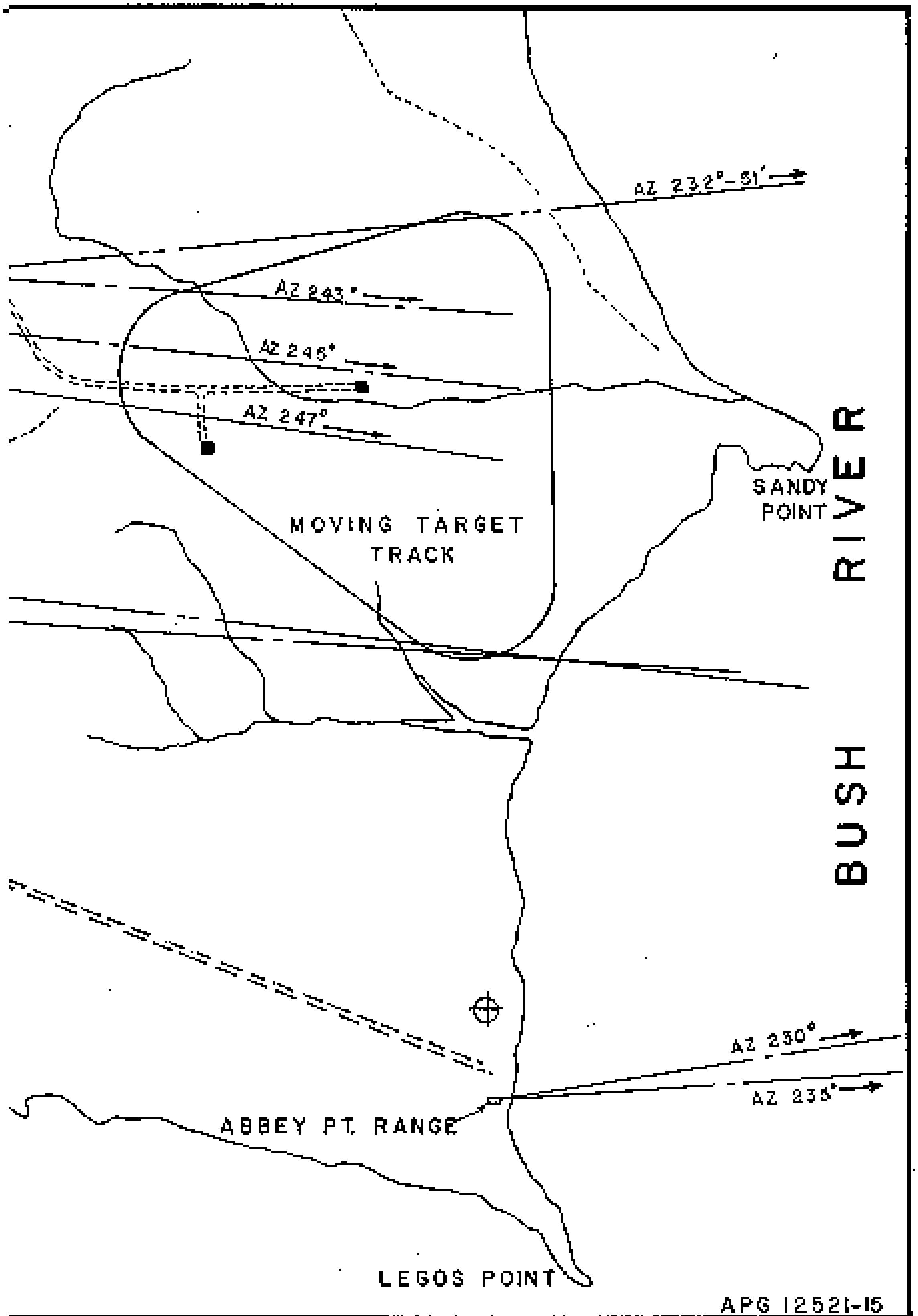

AZ 232°-51'
AZ 243°
AZ 245°
AZ 247°
MOVING TARGET
TRACK
SANDY
POINT
BUSH RIVER
AZ 230°
AZ 235°
ABBEY PT. RANGE
LEGOS POINT
APG 12521-15

Figure 75. Tank gunnery range, Gunpowder Neck. part 3 of 3 page map

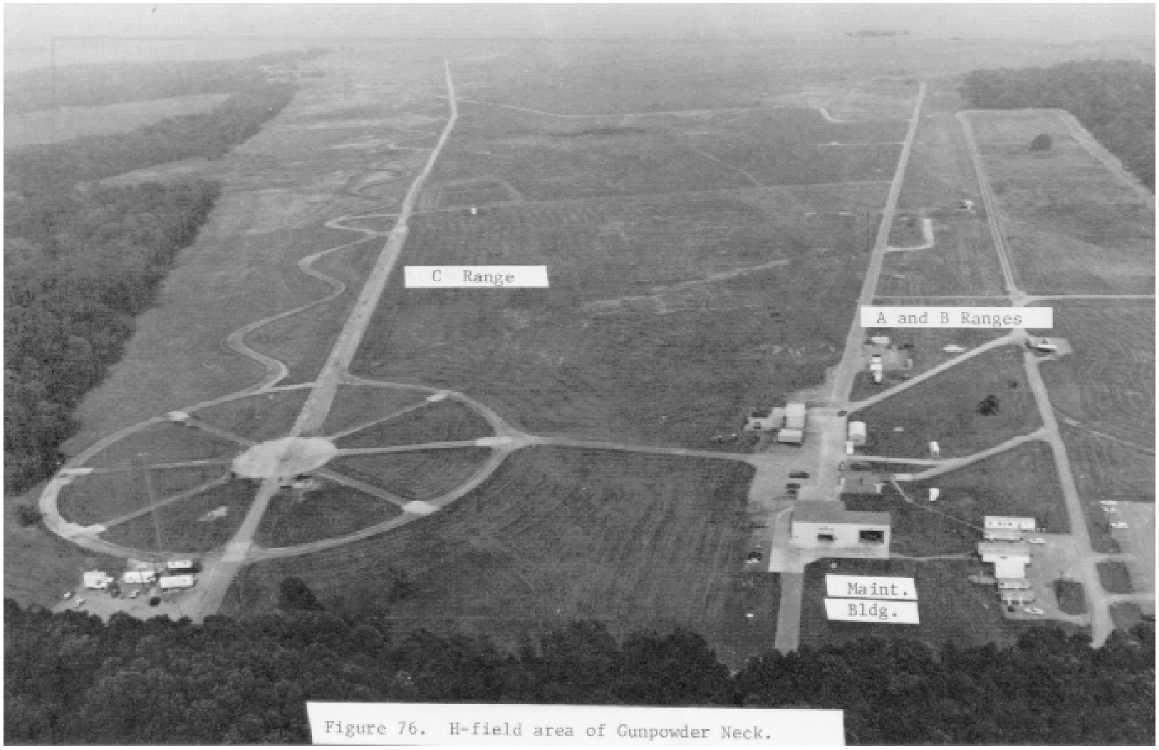


Figure 76. H-field area of Gunpowder Neck.

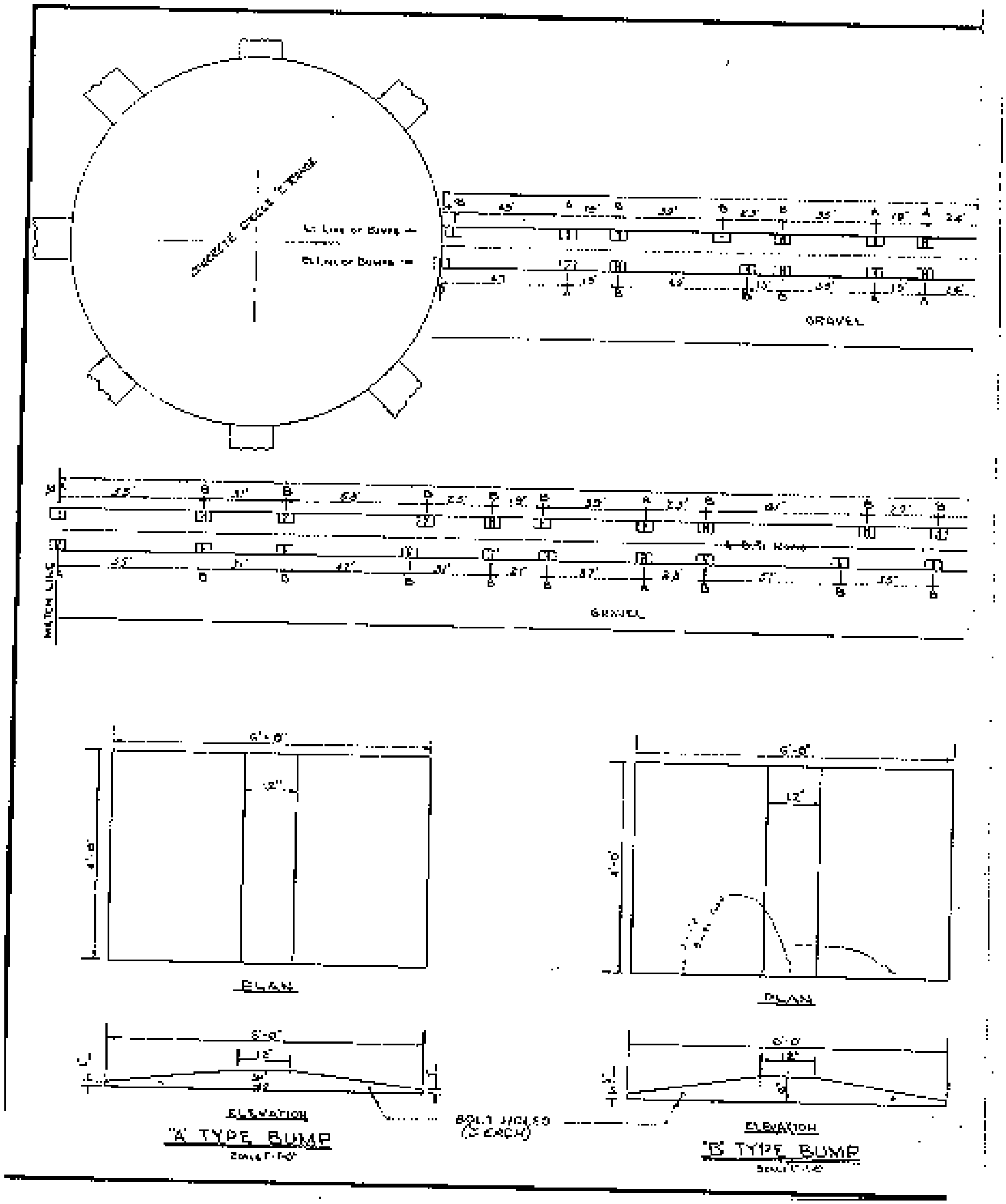
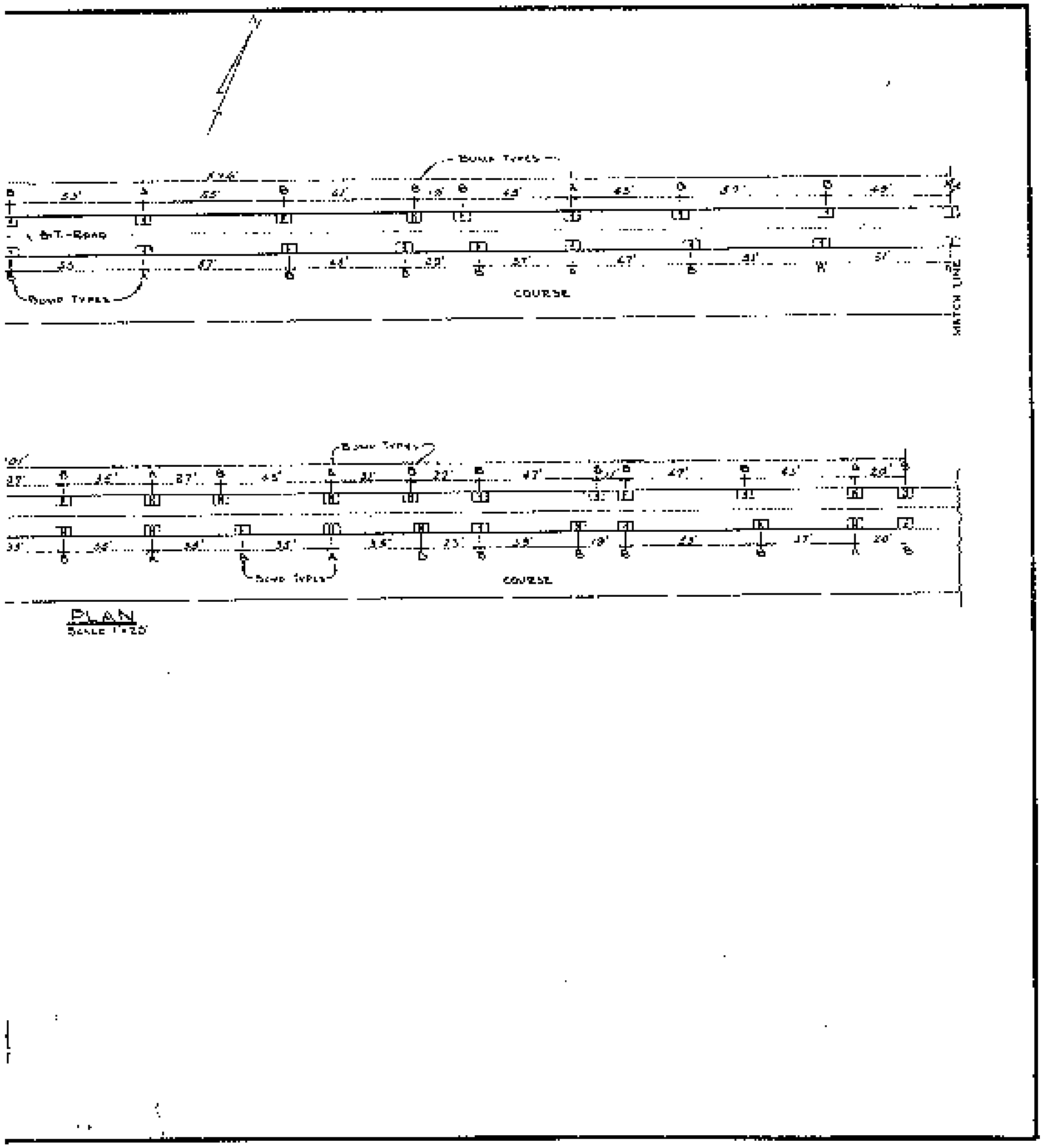


Figure 77. Bump types and



locations, gun stabilizer test course.

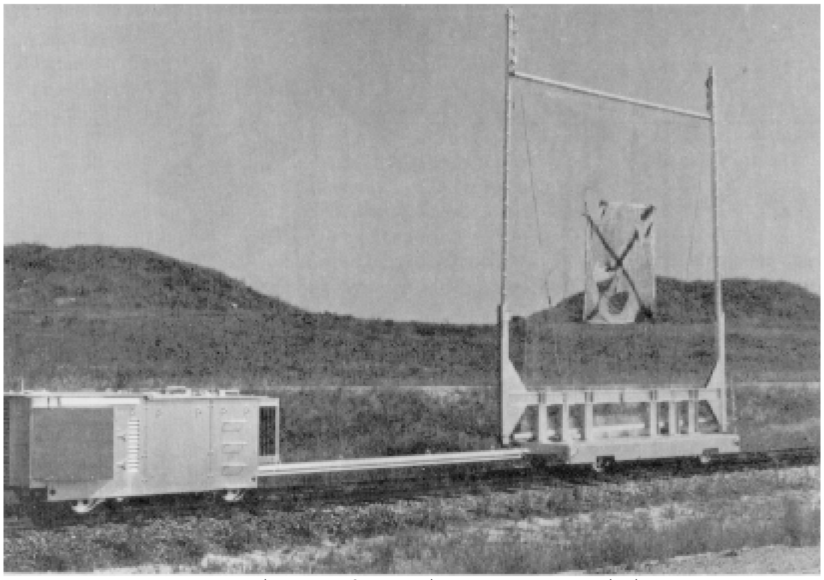


Figure 78. Moving target facility.

Figure 79. Test site terminal -interior view

Figure 80. Automated Video Target Scoring System.

This system automatically and remotely acquires down-range target impact coordinates. Video data from the down-range cameras are transmitted over a microwave link to the processing station.

1. Microwave antenna
2. TV camera
3. Microwave transmitter
4. TV monitor
5. Video digitizer
6. Controlling calculator
7. Remote pan and tilt electronics
8. Battery

TABLE 4
H-FIELD TANK GUNNERY RANGE TEST CAPABILITY

Range	Maximum Distance for Direct Fire (meters 0 to)	Facilities	Type of Test
A	3000	Targets and bombproofs; slopes for firing in 15% reverse, 30% forward position, or other vehicle attitudes to 20%	miscellaneous
B	2000	Moving (vehicle-mounted) target area	Tracking of vehicle-mounted targets
	5500	Targets partly across water	High velocity, long range
B1	3000	Remotely controlled moving target 0 to 56 km/hr (0 to 35 mph) controllable to +/- 3.2 km/hr (+2 mph)	Accuracy firing on moving targets, including light armor plate structures
C	3000	Stabilizer courses (zig-zag, gravel, straight, black-top, chronograph, jump targets, cant slopes, bump; automated meteorological station including down-range wind profile)	Effectiveness of stabilizers, functioning of traversing mechanisms
	500 and 1100	Crossing target roads	Tracking and laying tests
	3000	Targets and bombproofs	Wide-angle accuracy firing
D	457	Sand butts	Machine gun and mine tests, vulnerability of vehicles

At the trench warfare range, it is possible to fire Staballoy ammunition from tanks in hit probability exercises. This range has many of the features of the H-field facility, but on a less extensive scale. Maximum distance for stationary targets is 3000 meters. A laser beam-simulated moving target at 2400 meters maximum range is being developed for this range. Bump courses will be emplaced at three locations down range for fire-on-the-move exercises. A limited zigzag course is also available. Instrumentation capabilities rivaling H-field can be obtained using portable equipment with permanent installation planned for the future

The trench warfare range is also used for longer distance nonfiring target surveillance and observation exercises to evaluate combat vehicle night sights. Its large open area with undulating terrain can accommodate targets as far as 4000 meters from the viewing vehicle.

The target-simulation facility at the C-field area of Gunpowder Neck is used for gun laying, tracking, and fire control system accuracy/performance tests. It employs a computer-controlled laser beam on a large screen mounted inside a building. The motion of the maneuvering target (target simulation facility) is emulated by a moving image projected onto a screen in front of the tank. A small CW laser is used as the projection light source, and a scanning mirror is used to control the movement of the target image. A digital minicomputer is used to control mirror and target movement, calibration, fire commands sent to the gunner, and generation of documentation words to be recorded with the data. The computer requests input from the test director and then controls all testing automatically.

11. TILT TABLE. This is adjacent to a shop building near Mulberry Point. This steel table, 0.3 m (1 foot) high, is used to determine tipping angles of vehicles, most commonly small warehouse and rough terrain forklifts. Two 5-ton-capacity manual chain hoists at the rear of the table regulate its slope from 0 to 40 percent. The overall surface dimensions of the table are 3.8 m (12 feet 6 inches) wide by 3.7 m (12 feet) long (the 3.7-m edge being the tipping edge).

Recommended changes of this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, Md. 21005. Technical information may be obtained from the preparing activity: Commander, US Army Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, Md. 21005. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, Va. 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A
REFERENCES

1. Test Operations Procedure/MTP 2-1-002, Automotive Laboratory Instrumentations, 15 July 1968.

2. TOP/MTP 2-1-005, Automotive Field Test Equipment and Instrumentation, 27 July 1970.

3. TOP 1-1-010, Vehicle Test Course Severity, 12 April 1976.

4. MIL-T-21863D, Truck, Lift, Fork, Diesel, Pneumatic Tire, All-Purpose, 6000-Pound-Capacity at 24-Inch Load Center.

5. TOP/MTP 2-2-608, Braking, Wheeled Vehicles, 15 January 1971.

6. TOP 2-2-603, Vehicle Fuel Consumption, 1 November 1977.