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Mechanized Trail Equipment



Mechanized Trail Equipment

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PREFACE

This report documents an effort by the San Dimas Technology and Development Center (SDTDC) to catalog mechanized trail maintenance and construction equipment. The objective of this publication is to provide information on mechanized trail equipment, specifically earthmoving and hauling machinery. Earthmoving equipment includes excavators, dozer, and trail machines with a width not exceeding 72 inches (1.8m). Hauling equipment includes motorized wheelbarrows, totters, and all terrain vehicles (ATV).

Specifications and line drawings or pictures are provided to give the user information about the machinery. Metric equivalents are provided for reference only, unless English inch-pound units are in parenthesis. The dealers should be consulted for updates to these specifications. Purchase or rental costs are not included in this report due to the variability of this data. Some of the equipment presented in this report is no longer available for purchase through the manufacturer. However, they can be obtained through rental companies or used equipment dealers.

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Note: The summary Table included on pages 2, 3, 4, 5, and 6 has been provided as a convenient Table of Contents for the Specification Data for the various models of trail equipment included in this handbook. The location of the Specification Data page is shown in the right hand column of the Summary Table. Other information in this “quick reference” table includes data on the equipment type, equipment width, rated output, and comments.

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Abstract

Land managers are looking for ways to appropriately mechanize their trail work. The USDA Forest Service Washington Office is participating in this effort through its Technology and Development program. About thirty years ago, there was considerable interest in the Forest Service in mechanizing trail maintenance and reconstruction. Trail plows, rotor graders, gravel carriers, trailer backhoes, etc., were evaluated. Much of this equipment was too heavy, too unreliable, and too dangerous to gain wide acceptance. In the intervening 30 years, progress has been made in machine design and performance. Recently, the public's interest in using trails on National Forest system lands has increased. Our trail program has been funded to meet that need.

The objective of this document is to provide information on the mechanized trail equipment currently available to the land managers. The equipment cataloged in this report includes excavators, dozers, trail machines, loaders, haulers and powered handtools.

HOW TO USE THIS HANDBOOK

This handbook lists equipment available for purchase or rent. Some of the models discussed in the following sections may have been discontinued or replaced by other models. The dealer is the best source of information for the newer models. Discontinued models may be available for purchase or rental through equipment rental companies.

Table 1 provides an overview of equipment included in this document. The table is broken down by types of equipment, excavators, dozers, and haulers and the report *specifications page number* is provided. The overall width of the machinery is provided to illustrate the type of trail suited for the equipment. The rated power output of the machinery is provided for quick comparison between similar types of equipment.

Each equipment type is discussed separately; including configuration, general discussion, advantages and disadvantages, and equipment specifications. The configuration outlines the basic equipment type. There may be some deviation from the basic configuration, nevertheless the basic equipment function is the same. The discussion section provides a summary, in generic terms, covering all the equipment in the section. An advantages/ disadvantages section lists strong and weak points of each equipment type. These lists compare the use of the type of equipment to the manual method and/or to other equipment listed in this document. The final section lists the equipment specifications. The equipment is listed in alphabetical order. A short discussion precedes each specifications table. Trails 2000, Appendix C, is provided to illustrate some maintenance and construction techniques and furnish case histories and field observations.

PLANNING CONSIDERATIONS

Type of Trail

The trail type determines the equipment needed. Several small excavators have a track width of 24 inches (0.6 m) or less. For wider trails, larger excavators or dozers can be used. The width of the trail dictates what size and type of equipment to be used. However, as a rule of thumb, wider equipment may be used for "rough cut" on narrower trails; the actual trail tread will be narrower when the outside berm is removed and material "sloughs off". The presence of, or need for, waterbars, culverts, dips and switchbacks on a trail should also be considered when making a decision on which type of equipment to use. Some equipment is more versatile and can perform the various tasks necessary to construct or maintain these items but performance may be compromised.

Terrain

Rocky terrain and loose or plastic soils require more power to traverse. Steep terrain, with significant side slope, may require more stable platforms and operator experience. Soil type and distance to travel dictates whether a tracked or wheeled vehicle is more suitable. The machinery undercarriage is a major factor in determining stability, traction, and speed of travel. A tracked undercarriage, in most cases, provides greater traction, a more stable platform, but a lower travel speed when compared to a wheeled undercarriage. Tracked vehicles have slower travel speeds because of the greater rolling resistance. The rolling resistance is due to the greater contact area provided by a tracked undercarriage.

Rental or Purchase Cost

The cost to rent or purchase the equipment should be compared to the cost of using labor (hand crews). Once it is established that the cost to rent or purchase trail equipment is more economical than using labor, then determine whether it is more feasible to purchase or rent the equipment. The availability of funds as well as the anticipated frequency of equipment use are major factors to consider in deciding whether to purchase or rent. Other costs, including ancillary equipment associated with the piece of trail equipment needed and the use of a small crew (three people minimum) to work with the trail equipment should also be considered.

Safety

Operator training and certification to operate the machinery should be considered. An inexperienced operator may be a safety risk in areas with significant side slope and narrow trails. Most of the equipment listed was not designed specifically by the manufacturer for trail building or maintenance; however,

these machines perform the tasks well. In some cases, these machines may need to operate on narrow trails with steep side slopes; caution and common sense must be exercised in these situations. All operators of Forest Service owned or leased specialized equipment must be trained and authorized to operate such equipment. See Forest Service Handbook FSH 7109.11 (f) and FSH 6709.11.

Maintenance Cost

Maintenance must also be considered when purchasing equipment. A local equipment rental company may be a good source for this information.

Job Site

The cost and effort to move equipment to the site is also a concern. In remote areas where moving equipment in and out of the work site is not economical, consider leaving the equipment in place until the project is complete. In cases like this, investigate the need for vandal protection accessories.

Summary Table

Make / Model	Equipment Type	Width in (mm)	Rated output HP (kW)	Comments	Page
Bobcat X320	Excavator	38.6 (980)	13.5 (10.1)	Operating weight 3180 lbs. Steel track diesel, liquid cooled	9
Bobcat X325	Excavator	55.1 (1400)	23 (17)	Operating weight 5660 lbs. Steel track diesel, liquid cooled	9
Bobcat X331	Excavator	60.7 (1542)	34 (25.4)	Operating weight 7125 lbs. Steel track diesel, liquid cooled	9
John Deere 15	Excavator	38 (956)	14.5 (10.8)	rental only operating weight 2930 lbs. diesel, liquid cooled	10-11
John Deere 25	Excavator	57 (1447)	23 (17)	rental only operating weight 6426 lbs. diesel, liquid cooled	10-11
Kobelco SS60	Excavator	19 (483)	3.5 (2.6)	bicycle type seat rubber tracks operating weight 600 lbs.	12-14
Kobelco SK015	Excavator	38 (965)	16 (11.9)	expandable track & blade rubber tracks operating weight 3450 lbs.	12-14
Kobelco SK025	Excavator	57 (1447)	21 (15.7)	expandable track & blade rubber tracks operating weight 6250 lbs.	12-14
Kobelco SK035	Excavator	64 (1625)	27 (20.1)	rubber tracks constant blade & track width.	12-14

Make / Model	Equipment Type	Width in (mm)	Rated output HP (kW)	Comments	Page
Kubota KH-007	Excavator	32.3 (820)	8.5 (6.3)	rental only rubber track operating weight 1951 lbs.	19-20
Kubota KX-41	Excavator	40.9 (1039)	22.2 (16.5)	available in rubber or steel track operating weight 3485 lbs.	17-18
Kubota KX-71	Excavator	61.4 (1560)	32.2 (24.1)	available in rubber or steel track, ROPS/FOPS canopy or cab operating weight 6605 lbs.	17-18
Kubota KX-101	Excavator	63.4 (1610)	36.6 (27.3)	available in rubber or steel track, ROPS/FOPS canopy or cab. operating weight 8100 lbs.	17-18
Morrison Trailblazer	trail machine	24 (610)	25 (18.6)	steel, expandable (manual) track dry weight 2150 lbs. Gasoline	22
Takeuchi TB007	Excavator	29 (739)	8.0 (5.9)	Steel or rubber tracks. Hydraulically expandable track frame width operating weight 1667 lbs.	24-25
Takeuchi TB015	Excavator	38 (965)	16 (11.9)	Steel or rubber tracks. Hydraulically expandable track frame width operating weight 3418 lbs. Simultaneous digging functions.	24-25
Takeuchi TB020	Excavator	51 (1295)	21 (15.6)	Operating weight 4544 lbs. Steel or rubber tracks Simultaneous digging functions	24-25
Takeuchi TB025	Excavator	57 (1447)	26 (19.4)	Operating weight 5958 lbs. Steel or rubber tracks Simultaneous digging functions	27-28
Takeuchi TB035	Excavator	66 (1676)	33 (24.6)	Operating weight 7625 lbs. Steel or rubber tracks Simultaneous digging functions	27-28

Make / Model	Equipment Type	Width in (mm)	Rated output HP (kW)	Comments	Page
Takeuchi TB045	Excavator	72 (1828)	43.4 (32.4)	Operating weight 10092 lbs. Steel or rubber tracks Simultaneous digging functions	27-28
SWECO Dozer	Dozer	48 (1219)	56 (41.7)	70 HP (52.2 kW) with turbo gross weight 7800 lbs. 3 shank rippers available	21-32
Accutrak AC-30	Dozer	48" (1219)	28.5 (21)	rental only	33
Pacific Crawler	Dozer	47" (1194)	44 (33)	rental only	34
Bobcat 450	Loader	35.5 (901.2)	16.5 (12.3)	Rated capacity 600 lbs. Tipping load 1217 lbs. Gas engine / air cooled	36-37
Bobcat 453	Loader	35.5 (901.2)	15 (11.2)	Rated capacity 600 lbs. Tipping load 1470 lbs. Diesel / liquid cooled	36-37
Bobcat 553	Loader	49.5 (1257)	21.5 (16.1)	Rated capacity 850 lbs. Tipping load 1700 lbs. Diesel / liquid cooled	36-37
Bobcat 753	Loader	55 (1397)	40 (29.8)	Rated capacity 850 lbs. Tipping load 1700 lbs. Diesel / liquid cooled	41
Bobcat 753H	Loader	55 (1397)	40 (29.8)	Rated capacity 1300 lbs. Tipping load 2600 lbs. Diesel / liquid cooled	41
Bobcat 763	Loader	68.1 (1730)	40 (29.8)	Rated capacity 1400 lbs. Tipping load 2900 lbs. Diesel / liquid cooled	41
Bobcat 773	Loader	68.1 (1730)	40 (29.8)	Rated capacity 1700 lbs. Tipping load 3800 lbs. Diesel / liquid cooled	41
Bobcat 853	Loader	61.5 (1562)	40 (29.8)	Rated capacity 1700 lbs. Tipping load 3420 lbs. Diesel / liquid cooled	42
Bobcat 853H	Loader	61.5 (1562)	40 (29.8)	Rated capacity 1700 lbs. Tipping load 3420 lbs. Diesel / liquid cooled	42

Make / Model	Equipment Type	Width in (mm)	Rated output HP (kW)	Comments	Page
Bobcat 873	Loader	74.1 (1882)	40 (29.8)	Rated capacity 2300 lbs. Tipping load 4600 lbs. Diesel / liquid cooled	42
Takeuchi TL26	Loader	60.2 (1529)	61.5 (45.9)	Rated capacity 1310 lbs. Tipping load 3750 lbs. Diesel / liquid cooled Rubber crawler belt	44-45
Chikusui GC-640R Series	Hauler	42.7 (1085)	10 (7.5)	Rental only Chassis weight 1342 lbs. (610 kg) Max. load capacity 1760 lbs. (800 kg) Gasoline	46-47
Chikusui GC-640K Series	Hauler	42.7 (1085)	8 (6.0)	Rental only Chassis weight 1410 lbs. (640 kg) Max. load capacity 1760 lbs. (800 kg) Diesel	46-47
PowerWagon	Hauler	35 (889)	6 (4.5)	800 lbs. rated capacity ft ³ vol. Capacity wheeled undercarriage	47-48
PowerWagon II	Hauler	27.5 (698.5)	4 (3)	500 lbs. rated capacity 2.0 ft ³ vol. capacity	47-48
PowerWagon Battery-Electric	Hauler	27.5 (698.5)	0.4 (0.3)	400 lbs. rated capacity ft ³ vol. Capacity electric motor	47-48
Honda HP250	Hauler	24 (610)	2.4 (1790)	Adjustable carrier bed 400 level load capacity tracked undercarriage	52
Honda HP400	Hauler	24 (610)	4.0 (2983)	Adjustable carrier bed 770 level load capacity	52
PeCo Tracker 1000	Hauler	40 (1016)	12 -14 (8.9 - 10.4)	1000 lbs. load capacity 40"x60"x12 bed dimensions tracked undercarriage hydraulic dump bed	53
Whiteman Power Buggy WBH-12	Hauler	32 (81)	8 (6.0)	1800 lbs. load capacity 12 ft ³ tub capacity hydraulic dump & return	54

Make / Model	Equipment Type	Width in (mm)	Rated output HP (kW)	Comments	Page
Whiteman Power Buggy WBH-16/16E	Hauler	44 (118)	11 (8.2)	2600 lbs. load capacity 16 ft ³ tub capacity hydraulic dump & return	54
Kawasaki Mule 1000	Hauler	51.8 (1316)	454 cc	1030 lbs. load capacity ft ³ bed capacity 4-stroke liquid cooled DOHC Dual-mode differential Tilting cargo bed 25 MPH max. travel speed	55-56
Kawasaki Mule 2510	Hauler	57.5 (1460)	617cc	4-stroke liquid cooled 90° V-Twin OHC 4-wheel drive 800 load capacity 13.3 ft ³ 25 MPH max. travel speed	55-56

EXCAVATORS

Configuration

The most common excavator configuration is a boom and shovel with a dozer blade mounted below the boom. See figure 1. A tracked undercarriage is usually used. The primary earthworking implement is the bucket used to dig and move earth. If the excavator is equipped with a small blade, the blade is useful in grading off excess material, leveling and back filling. Most excavator manufacturers have grubhoes or different size buckets available as attachments.

The smallest excavator evaluated has a track width of 19 inches (0.48m) and the largest has an overall width of 63 inches (1.6 m). On some models the track width is variable and can be adjusted depending on trail conditions and operator experience. Horse power rating varies between 3.5 hp and 43.4 hp.

Discussion

The stability of the excavator is dependent on the center of gravity relative to the working surface and the overall width of the platform. The closer the center of gravity is to the ground and the wider the platform, the more stable the vehicle becomes. If equipped with a blade, the blade can act as an outrigger when excavation is performed. The boom and shovel also serve as a counter weight when using the blade.

Trail work with an excavator is most effectively accomplished with three person crews. One person operates the machine. A second person works forward of the excavator performing grubbing, clearing, and/or splitting. The third person works behind the machine finishing the trail. Depending on power output, the excavator could grub out stumps or move large boulders. The excavators also build a "platform" from which to work. The travel speeds of an excavator are from 0.9 to 3.1 mph (1.4 to 5 kph); lower speeds as compared to a skid loader or dozer.

The excavators evaluated for this project can easily be transported on the bed of a full size pick-up truck or on a trailer.

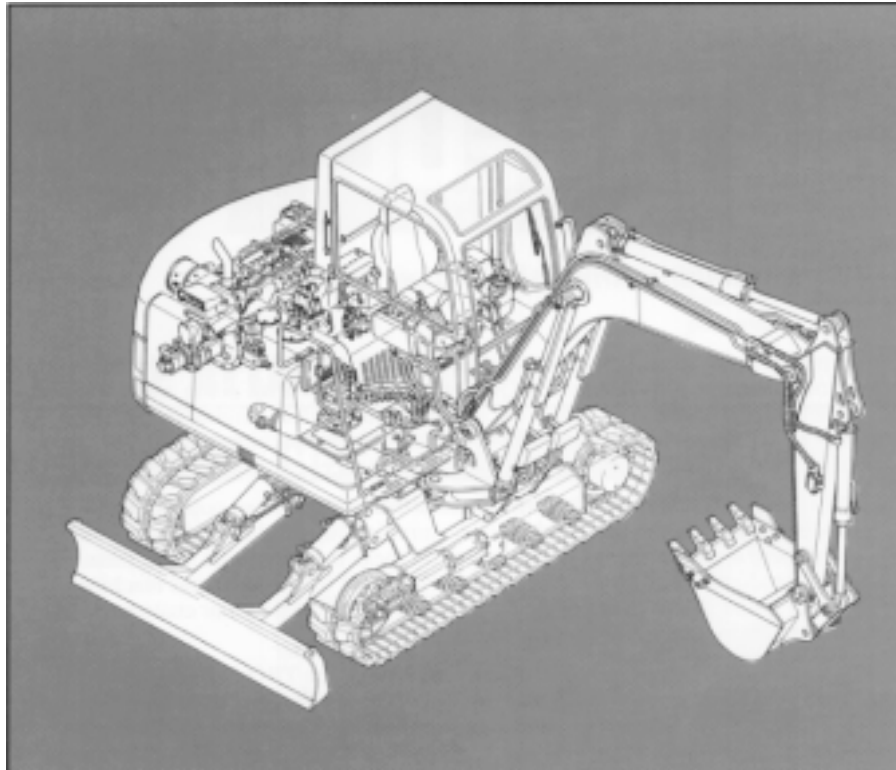


Figure 1.—Takeuchi excavator.

Advantages/Disadvantages

Advantages/disadvantages of excavators when compared to dozers and loaders are listed below. The loader is assumed to be equipped with a backhoe.

Excavator Advantages

Available in smaller width. The smallest excavator evaluated has an overall track width of 19 inches (0.48 m).

Able to build narrower trails.

Ideal for trenching and digging tasks.

Extensive attachments available.

Able to dig out large boulders or tree stumps that a dozer or a loader would not be able to move out.

Easily transported to-and-from job site.

Excavator Disadvantages

Stability is compromised with the narrower width especially when swinging the boom over large angles.

Slower than available dozers and dozer-type trail machines. Cutting a trail tread with a shovel and leveling with a smaller blade takes more time than cutting a trail with a dozer blade.

Requires an experienced operator.

Equipment Specifications

A. Bobcat X320, X325, X331

Bobcat X320, X325, and X331 mini-excavators are new entries in the mini-excavator market. The older model, Bobcat 220, has similar specifications as the Bobcat 320. The Melroe Company manufactures Bobcat Skid Loaders with backhoe attachments; these machines are discussed in the section on loaders.

Like most small excavators, these machines do not have outriggers for stability. The overall width varies from 38.6 inches (0.98 m) to 60.7 inches (1.5 m). The wider track increases stability, but requires a wider operating surface. Stability while operating the blade is gained by using the bucket as a counterweight. Positioning the bucket on the uphill side of the slope shifts more weight upslope and reduces the likelihood of rollover. Conversely, the blade could be used as an “anchor” by lowering the blade to ground level when using the bucket and boom. These excavators are mounted on top of a tracked undercarriage making them more stable than wheeled machines. The larger ground contact area of the tracks provides a stable platform and more traction than wheeled vehicles. These excavators could be equipped with steel tracks for additional traction, or rubber tracks to minimize damage on finished surfaces.

These machines are equipped with Roll-Over Protection/Falling Object Protection (ROP/FOP) and an enclosed cab is available. (Heaters are available in the X325 and X331 models.). A seatbelt is the primary operator restraint.

The ergonomics of these machines are good. Three levers operate the bucket, the blade, and the travel, making them easy to operate. Hydraulic lines on the machinery are routed to avoid being damaged during operation and transport. These new models are a significant improvement from older models. Access to the engine is through the tailgate.



Figure 2.—Bobcat compact excavators construct trails throughout the Rio Grande National Forest.

Specifications:	Bobcat	320 Excavator	325 Excavator	331 Excavator
Overall Length: in (mm)		144.8 (3678)	166 (4217)	192.7 (4895)
Overall Width: in. (mm)		38.6 (980)	55.1 (1400)	60.7 (1542)
Height: in. (mm)		88.8 (2243)	95.9 (2437)	96.4 (2448)
Operating Weight: lb. (kg.)		3180 l (1442)	5660. (2566 kg)	7125. (3231)
Maximum Speed: MPH (KPH)		1.1 (1.73)	1.4 (2.2)	Lo: 1.3 (2.0) High: 2.3 (3.7)
Engine:				
Make:		Kubota D-750-B	Kubota D1402B	Kubota V1902-B
Fuel:		Diesel	Diesel	Diesel
Fuel Tank Capacity gal. (L)		6.5 (24.6)		14 (54.5)
Cooling:		Liquid	Liquid	Liquid
Displacement: cu. In. (L)		46.5	85.1 (1.4)	116 (1.9)
Horsepower: HP (kW)		(10.1)	23 (17)	34 (25.4)
@ RPM		@ 2500	@ 2500	@ 2500
Hydraulics			:	
Pump type:		Gear	Gear	Gear (3)
Pump Total Capacity: GPM (L/Min.)		12 (45.4.)	21.4 (81.1.)	27.3 (103.5.)
Pump Auxiliary		8.0 (30.3.)	14.3 (51.4.)	18.2 (69.0.)
Hydraulic Flow: GPM (L/Min.)				
Hydraulic Tank Capacity: Gal (L)		3.75 (14.2)	6.8 (26)	10.5 (40)
Track				
Type:		steel	steel	steel
Length:		58.3 (1480)	70.9 (1800)	78.2 (19878)
Width: in (mm)		9.84 (250)	12.6 (320)	12.6 (320)
Ground pressure: PSI (KPa)		3.38 (23.3)	4.2 (26.9)	4.63 (31.9)
Maneuverability				
Swing Speed: RPM		9	9.5	9.5
Minimum Swing Radius: in (mm)		52.7 (1338)	80.8 (2052)	82 (2088)
Boom Swing		Left: 50 Right: 90	Left: 40 Right: 77.5	Left: 50 Right: 90
Blade: in (mm)		Width x Height: 38.6 (980)		
Maximum lift (above ground): in (mm)		6.6 (167)	13.6 (346)	14 (357)
Minimum lift (below grade): in (mm)		5.6 (142)	9.5 (241)	11 (280)
Working Range				
Arm Length: in (mm)		40 (1023)	45 (1150)	55 (1400)
Max. Digging Height: in (mm)		129.5 (3288)	148.1 (3761)	182 (4725)
Max. Dumping Height: in (mm)		90.2 (2291)	101.3 (2572)	126 (3200)
Max. Digging Depth: in (mm)		80.0 (2038)	97.3 (2472)	120 (3050)
Max. Vertical Wall		61.8 (1571)	62.7 (1594)	82.5 (2097)
Digging Depth: in (mm)				
Max. Digging Reach at Ground Level: in (mm)		144 (3657)	165.9 (4213)	190.5 (4840)
Bucket Digging Force: lb. (kg)		3272. (1484)	3863. (1752)	5170. (2350)

B. John Deere 15 and 25 Mini Excavator

The John Deere 15 and 25 excavators have widths of 38 inches (0.96 m) and 53 inches (1.3 m) respectively and must be operated on trails at least this wide. The finished trail may be slightly smaller when loose material sloughs off after the first season. Like the other excavators evaluated in these handbook, John Deere excavators do not have outriggers. Both models have a rated gradeability of 30 degrees or 50% slope. These excavators are able to negotiate the rated slope independent of surface conditions. Traversing in steeper terrain depends upon the skill of the operator. Inexperienced operators should first gain experience on flatter terrain.

These excavators are equipped with Tip-Over Protective Structure and are available with a cab. Like the other excavators, a seat belt is the primary operator restraint. Control lever lockouts and swing locks are standard equipment.

The operator has ample room in the canopy and has good visibility while operating the boom and blade. The blade is controlled with a single lever. Instrumentation and warning lights provide the operator with information on the status of the machinery.

Availability:

John Deere Models 15 and 25 are no longer manufactured; they are available through equipment rental yards.

Specifications: John Deere	15	25
Engine Make & Model	YANMAR 3TNA72-UJB	YANMAR 3TN78-RJB
Horsepower (Mfg. Rating @ rpm)	14.5 (10.8 kW) @ 2250	23 (17 kW) @ 2500
Bore & Stroke	2.83x2.83 in. (72x72mm)	3.07x3.39 in. (78x86 mm)
Displacement	53.6 cu. In. (879 cc)	75.2 cu. In. (1232 cc)
Hydraulic Pumps/System		
Quantity	3-section	3-section
Type	Gear	Gear
Systems	open center/constant flow	open center/constant flow
Total pump capacity	10.7 GPM (0.68 L/s)	25 GPM (1.58 L/s)
Max. System operating pressure	2204 psi (15.197 KPa)	2133 psi (14,707 KPa)
Performance Ratings		
Arm Digging Force	1565 lb. (7 kN)	2910 lb. (13 kN)
Bucket Digging Force	2315 lb. (10 kN)	4519 lb. (20kN)
Max. Reach @ Ground Level	11 ft. 3 in. (3.44 m)	15 ft. 1 in. (4.60m)
Max. Digging Depth W/ Blade	83 in. (2.12 m)	111 in. (2.84 m)
Max. Dump Height	87 in. (2.20 m)	110 in. (2.83 m)
Boom		
Swing Angle	45° left / 90° right	50° left / 90° right
Arm length	37 in. (0.95 m)	47 in. (1.2 m)
Offset distance L/R	18.5/15.4 in. (470/390 mm)	27.6/21.1 in. (700/535 m)
Track		
Track Gauge	29 in. (0.73 m)	44 in. (1.13 m)
Track Length	54 in. (1.37 m)	76 in. (1.94 m)
Track Shoe Width	9 in. (230 mm)	13 in. (320 mm)
Std. Ground Contact Area	842 in. ² (5432 cm ²)	1635 in. ² (10,548 cm ²)
Std. Ground Pressure	3.48 psi (24 kPa)	3.93 psi (27.10 kPa)
Track Rollers (each side)	3	4
Track Carriers (each side)	0	1
Max. Travel Speed	1.24 mph (2.0 km/h)	1.24 mph (2.0 km/h)
Track width	38 in. (0.96 m)	57 in. (1.45 m)
Gradeability	50% 30°	50% 30°
Swing Speed	9 rpm	10 rpm

Specifications: John Deere	15	25
Engine Make & Model	YANMAR 3TNA72-UJB	YANMAR 3TN78-RJB
Tailswing	44 in. (1.11 m)	55 in. (1.40 m)
Operating Weight	2930 lb. (1328 kg.)	6426 lb. (2915 kg.)
Std. Bucket Capacity	0.05 cu. yd. (0.04 m ³)	0.10 cu. yd. (0.08 m ³)
Ground Clearance	8.3 in. (210 mm)	11.8 in. (300 mm)
Capacities		
Cooling System	0.66 gal. (2.5 L)	1.45 gal. (5.5 L)
Fuel Tank	5.8 gal. (22 L)	12.9 gal. (49 L)
Crankcase	0.5 gal. (1.9 L)	1.05 gal. (4.0 L)
Hydraulic System	11.1 gal. (42 L)	22.5 gal. (85 L)
Hydraulic Reservoir	9.0 gal. (34 L)	17.2 gal. (65 L)
Propel drive gear case (each side)	0.09 gal. (0.35 L)	0.13 gal. (0.5 L)
Dimensions		
Std. Transport width	39 in. (1.00 m)	57 in. (1.45 m)
Std. Transport length	138 in. (3.50 m)	185 in. (4.69 m)
Std. Transport height	83 in. (2.10 m)	94 in. (2.38 m)

C. Kobelco SS 60 Super Shovel , SK015, and SK025 Compact Excavator

The SS 60 Super shovel is the smallest earthmoving machine evaluated in this handbook and has an overall width of 19 inches (0.48 m) and weighs only 600 lbs (272 kg). The operator rides behind the excavator and balances the action of the bucket. The operator has the option of sitting on a bicycle type seat or standing on a platform while operating the machine. The bicycle seat can be folded up when the platform is in use. The platform can be lowered two-inches (51 mm) below ground level to act as an anchor and stabilize the machine. The excavator does not have a blade; all trail work is done with the bucket.

The machine is not equipped with ROP/FOP or a restraint system. In case of a roll-over, the operator steps off the machine.

The machine is operated entirely with levers. Two levers control the boom and bucket; another two levers provide directional control of the tracks, and two other levers are used to shift from high to low travel speeds and raising and lowering the platform.

The SS 60 Super Shovel can be transported using a medium-size pickup truck. Mobility on the trail is limited by its maximum speed of 0.87 mph (1.4 kph). The tracks and low ground pressure provide good traction. The rubber tracks minimize damage to finished surfaces such as grass or concrete, but are not as durable as steel tracks.

The SK015 track and dozer blade can be expanded from 38 inches (0.97 m) to 52 inches (1.3 m) and can be used to build or maintain trails of this trail tread width. The dozer blade extends and retracts to match the crawler width. Extending the track provides a wider stance and makes the machine more stable. Inexperienced operators should use a wider stance and avoid rough uneven terrain. The SK015 has a greater travel speed, 2.6 mph (4.3 kph), as compared to the SS60. This improves mobility at the job site. The SK015 is available with a rubber or steel track.

Standard safety equipment includes an operator protective structure and seat belt. Swing flashers which warn workers when the machine is swinging, are a standard feature. An enclosed cab is being developed to provide the operator with ROP/FOP, and comfort controls are also being considered.

The SK025 is larger than the SK015 and has a larger bucket and dozer blade. Unlike the SK015, the rubber tracks and dozer blade are a fixed width. This excavator has a width of 57 inches (1.4 m) with

each track 12 inches (0.3 m) wide yielding a ground pressure of 3.9 psi (26.9 kPa) which is lower than the SK015. Travel speed ranges from 1.8 to 3.1 mph (2.9 to 5.0 kph). The safety equipment on the SK025 is similar to the SK015.

Special Features

Kobelco SK015

- Pilot control levers provide smooth and easy operation reducing operator fatigue.
- Swing flashers.
- Spanner undercarriage adds to the stability.
- Cushioned swing cylinders provides shockless stops and starts reducing operator fatigue.
- Dozer blade can be extended and retracted to match crawler width.
- Control panels on both sides of the seat tilt up to allow easier access and prevent accidental lever operation when mounting or dismounting the machine.
- Auxiliary hydraulics add versatility for operating attachments.
- Quick change buckets saves time when changing buckets.

Kobelco SK025

- Pilot control levers provide smooth and easy operation reducing operator fatigue
- Swing flashers.
- Slow Swing mode provides precise control when working in tight quarters.
- Swing shockless valve minimizes rebound motion at the end of the swing cycle making starts and stops very smooth and limits spillage.
- Straight propel system keeps travel on a straight course even during simultaneous attachment operations.
- One-touch deceleration puts engine in low idle to reduce fuel consumption during inactive periods.
- Parking brakes for both swing and travel automatically engage when controls are in idle position.
- Auxiliary hydraulics add versatility for operating attachments.

Specifications:	Super Shovel			
	SS60	SK015	SK025	SK035
General:				
Overall Length:	7'1"	12'1"	14'9"	16'3"
Overall Width:	1'7"	3'2" / 4'4"	4'9"	5'4"
Height:	3'7"	7'5"	8'1"	7'9"
Bucket capacity:	0.25 cu ft	1.4 cu ft	2.4 cu. ft.	3.5 cu. ft.
Bucket width:	9 inches	16 inches	18 inches	24 inches
Fuel Tank:	2.2 US gal	6.3 US gal	10.5 US gal	10.5 US gal
Performance				
Travel Speed:	0.87 high, 0.50 low	2.6 mph	1.8 / 3.1 mph	2.9 mph
Boom swing speed:	3.7 sec (90°)	8.8 rpm	9.0 / 4.5 rpm	9.0 / 4.5 rpm
Gradeability:	47% (25°)	30 °	30 °	30 °
Stick digging force		1830 lb.	3020 lb.	3860 lb.
Bucket digging force	750 lb.	2450 lb.	4013 lb.	5300 lb.
Operating weight:	600 lb.	3450 lb.	6250 lb.	7400 lb.
Ground Pressure	~	4.4 psi	3.9 psi	4.4 psi
Engine:				
Type:	4-cycle, air-cooled	YANMAR	YANMAR	YANMAR
		3TNA72L	3TNC78	3TN84 I
	gasoline	Diesel	Diesel	Diesel

Specifications:	Super Shovel SS60	SK015	SK025	SK035
Rated output: (HP @ rpm)	3.5 @ 1600	16 @ 2,550	21 @ 2,500	27 @ 2,560
Displacement		53.6 cu. in.	59.9 cu. in.	87.2 cu. in.
Hydraulic System				
Pumps:	2 gear pumps	see note	see note	see note
Max. discharge pressure:	2,130 psi	see note	see note	see note
Hydraulic tank capacity:	1.85 US gal	7.6 US gal	15.8 US gal	15.8 US gal
Track				
Type	Rubber	Rubber	Rubber	Rubber
Overall Length:		4' 6.5"	6'3.9"	6' 11"
Overall Width:		3' 2" / 4' 4"	4'9"	5'4"
Shoe Width:			9.0"	12.0" 13.7"
Maneuverability				
Boom Swing Angle		90°L / 90°R	90°L / 90 ° R	90°L / 90 ° R
Boom Offset:		Left 1'11" / Right 1'8"	Left 2'3" / Right 1'10"	Left 2'5" / Right 2'1"
Front Swing Radius:		4'4"	4'10"	5'7"
Tail Swing Radius:		3'6"	4'2"	4'7"
Travel Speed:		1.3 / 2.6 mph		1.7 / 2.9 mph
Draw Bar Pull:		1917 lb.	2976 lb.	3968 lb.
Ground Clearance:		6.8"	11.4"	11.4"



Figure 3.—Kobelco Super Shovel SS60.

Hydraulic System	SK015	SK025	SK035
Main Pumps			
Type:	Fixed Gear	Variable Piston	Variable Piston
Pressure:	2845 psi	2987 psi	2987 psi
Delivery:	4.12 gpm	8.0 gpm	10.0 gpm
No. Of Pumps:	2	2	2
Swing Pump			
Type:	Fixed Gear	Fixed Gear	Fixed Gear
Pressure:	1635 psi	2204 psi	2631 psi
Delivery:	2.9 gpm	5.0 gpm	5.7 gpm
No. Of Pumps:	1	1	1
Pilot Pump			
Type:	Fixed Gear	Fixed Gear	Fixed Gear
Pressure:	682 psi	497 psi	497 psi
Delivery:	1.6 gpm	2.3 gpm	2.4 gpm
No. Of Pumps:	1	1	1
Auxiliary Port			
Pressure:	2845 psi	2987 psi	2987 psi
Delivery:	8.24 gpm	12.6 gpm	15.6 gpm
Travel Motors			
Type:	Orbit Motor	Orbit Motor	Orbit Motor
No. Of Pumps:	2	2	2

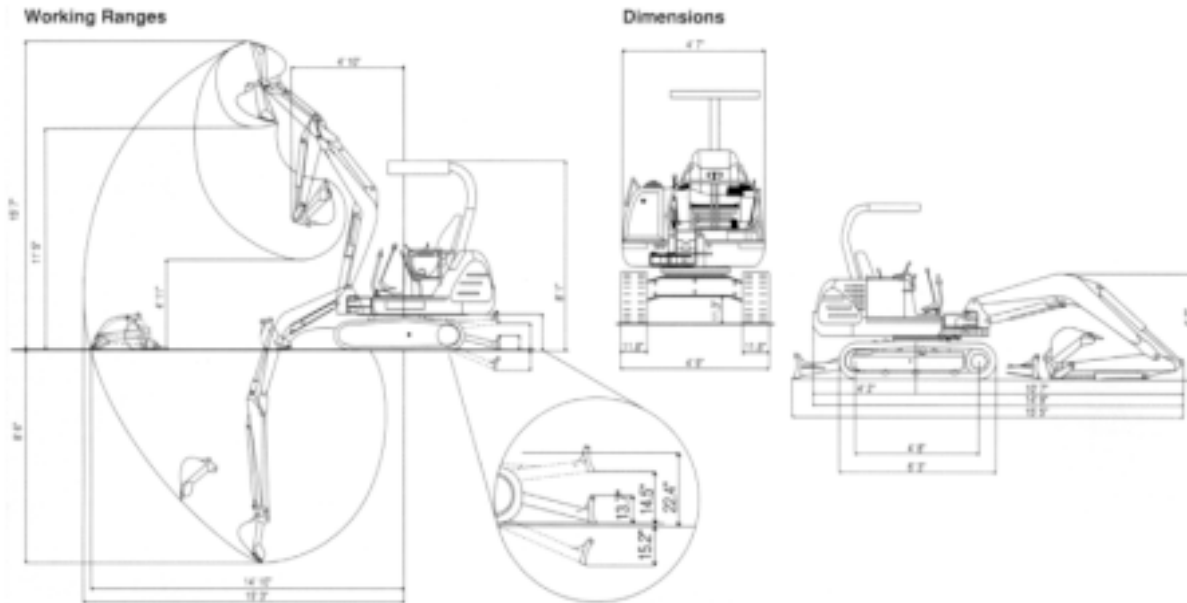


Figure 4.—Kobelco SK025.



Figure 5.— Kobelco SK015.

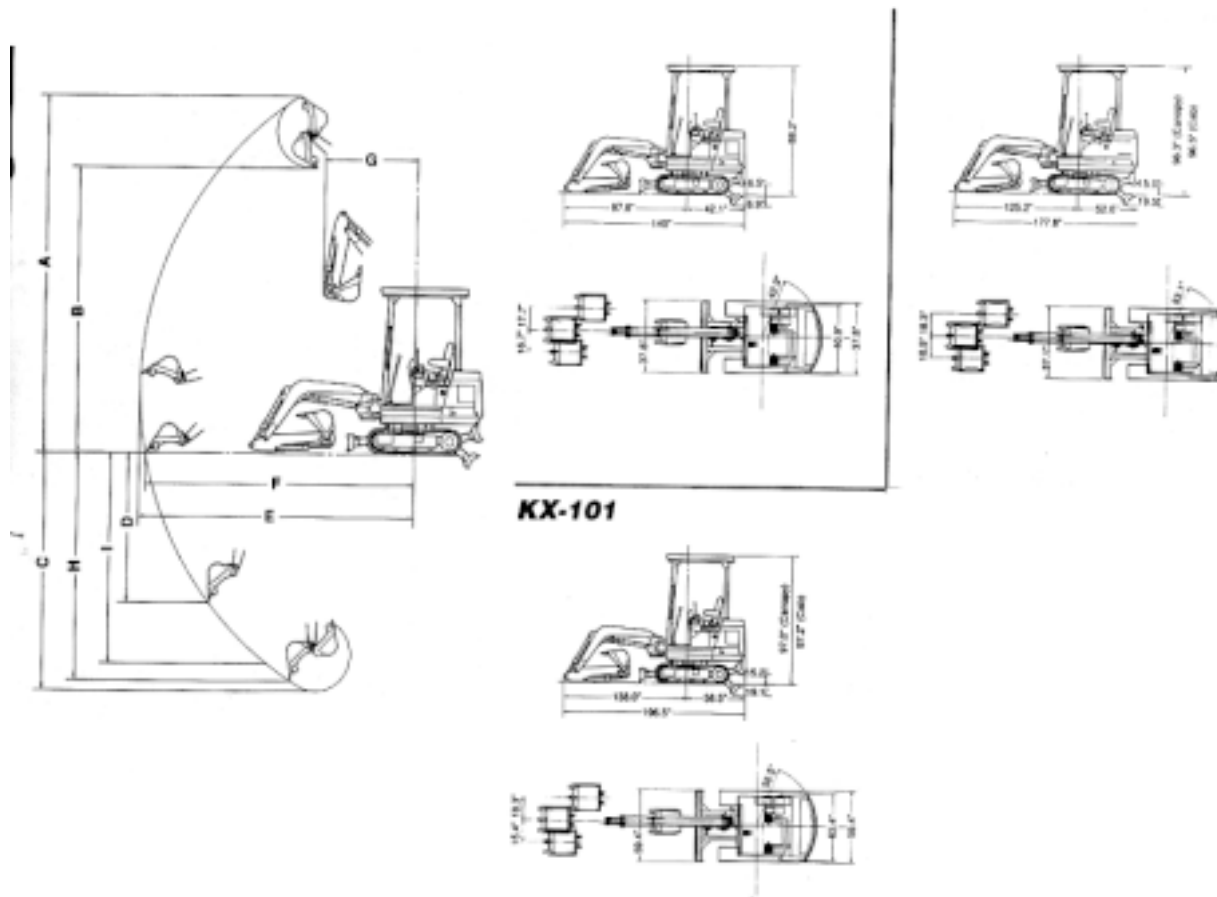


Figure 6.—Kubota KX-41.

D. Kubota KX-41, KX-71, KX-101, and KH007

Kubota makes several mini-excavators. The models reviewed are KX-41, KX-71, and KX-101. The KX-41 is an improved version of the KH-007. These mini-excavators are equipped with a small blade that can be raised and lowered but not tilted or angled. Each excavator comes equipped with a short arm, and there are three dipper arm length options for each model. Each model is also equipped with either a 4-post ROPS/FOPS or a ROPS/FOPS cab. The ROPS/FOPS are designed so the operator enters or exits the excavator from either side. This feature helps when working in confined areas. These new models have more foot space than the previous model.

Operation is controlled by foot pedals and four levers. The bucket control levers are mounted on 5-way adjustable towers on either side of the operator. The levers to control each track are located in front of the operator. All levers are easily accessible and intuitive.

The hydraulic system on these excavators is designed to produce up to 15% more power when the turntable swing or dozer blade is not being used. A booster valve automatically increases the pressure of the first and second hydraulic pumps when the third pump (used for slewing, boom swing, and dozer blade operation) is not used.

The Kubota KX-41 and KX-71 is designed with a two-speed swing system. With a flip of a lever, the operator can reduce the swing speed up to 50%. This feature increases safety and adaptability. An inexperienced operator should operate the machinery at the lower swing speed to reduce the probability of significant and sudden changes in center of gravity caused by rapid movement of the cab.

Feature	KX-41	KX-71	KX-101
ROPS/FOPS Type	ROPS/FOPS Canopy	Canopy	Canopy
Track Type	Steel / Rubber	Steel/ Rubber	Steel/ Rubber
Engine			
Model	Kubota D1105-BH	Kubota V1505-BH	Kubota-V1902-BH5
Cylinders	3-cyl, overhead valve	4-cyl, overhead valve	4-cyl, overhead valve
Cooling	liquid	liquid	liquid
Fuel	diesel	diesel	diesel
Flywheel HP (SAEJ1349 gross)	22.2 @ 2400 rpm	32.2 @ 2600 rpm	36.6 @ 2450 rpm
Displacement	68.5 in ³	91.4 in ³	113.6 in ³
Dimensions			
Overall Length	140.0 in.	177.8 in.	196.5 in.
Overall Height	88.2 in.	96.3 in.	97.0 in.
Overall Width	40.9 in.	61.4 in.	63.4 in.
Min. Ground Clearance	6.7 in.	11.6 in.	11.6 in.
Hydraulic System			
No. of Pumps	3	3	3
Pump Capacity	3.5 gal (P1,P2) 2.6 gal (P3)	7.7 gal. (P1, P2) 4.8 gal. (P3)	8.5 gal. (P1, P2) 5.6 gal. (P3)
Relief Valve Setting (@ power up)	2985 psi (P1, P2) 2775 psi (P3)	2845 psi (P1, P2) 2275 psi (P3)	2985 psi (P1, P2) 2775 psi (P3)
Auxiliary Hydraulic Flow Rate	7.0 gpm	15.4 gpm	17.1 gpm
Drive System			
Max. Travel Speed	1.25 mph	1.31 mph	low: 1.19 mph high: 2.25 mph
Max. Drawbar Pull	3600 lb.	7125 lb.	9460 lb.
Swing System			
Unit Swing Speed	8.3 rpm	8.7 rpm	9.4 rpm
Boom Swing Angle (Left/Right)	90° / 50°	90° / 50°	80° / 43°
Blade			
Blade Width x Height	37.8" x 9.8"	57.1" x 15.2"	59.4" x 15.2"
Max. Lift above Ground	6.5 in.	15.0 in.	15.2 in.
Max. Drop Below Ground	6.9 in.	19.5 in.	19.1 in.
Undercarriage Shoe Width	9.1 in.	11.8 in.	13.8" /11.8"
Ground Contact	4.47 4.37	4.46 ^{1&3} -4.31 ^{2&3} 4.59 ^{1&4} -4.44 ^{2&4}	4.06 ^{1&3} - 4.59 ^{2&3} 4.15 ^{1&4} -4.70 ^{2&4}
Pressure psi			
Maximum Bucket Breakout Force (@ powerup)	2810 lb.	5455 lb.	5940 lb.
Coolant & Lubricant			
Fuel Reservoir gal	6.34	15.06	15.06
Coolant gal	1.06	1.32	2.11
Engine Oil	1.19	1.53	2.19
Final Drive (each side) gal	0.07	0.13	0.16
Swing Drive (each drive) gal		0.34	0.34

¹Steel ²Rubber ³Canopy ⁴Cab

Feature	KX-41	KX-71		KX-101					
ROPS/FOPS Type	ROPS/FOPS Canopy	Canopy	Cab	Canopy	Cab				
Track Type	Steel / Rubber	Steel/ Rubber	Steel/ Rubber	Steel/ Rubber	Steel/ Rubber				
Hydraulic Reservoir gal	3.17	11.36		15.58					
Operating Weight (lb.)	3615 ¹ -3485 ²	6415 ^{1&3} 6605 ^{1&4}	6260 ^{2&3} 6450 ^{2&4}	8115 ^{1&3} 8300 ^{1&4}	7915 ^{2&3} 8100 ^{2&4}				
Standard Bucket Capacity (SAE J296)	1.34 ft ³	2.30 ft ³		3.73 ft ³					
Performance	Short-Long-Extend		Short-Long-Extend		Short-Long-Extend				
	Arm	Arm	Arm	Arm	Arm	Arm			
Arm Length (in.)	35.4	45.3	31.7 - 49.4	47.2	55.1	40.7- 64.4	51.2	63.0	47.2- 78.7
Max. Arm Digging Force lb.(@ power up)	1995	1635	1540	3330	2900	2635	4330	3740	3320
Max. Digging Height(in.)	121.5-126.-123.2			165.7-169.3-164.4			179.5-184.8- 182.1		
Max. Dumping Height (inches)	80.1- 84.6- 83.9			116.3-119.9-118.9			125.4-130.7- 139.7		
Max. Digging Depth (in.)	81.1-90.9-95.3			105.1-113.0-122.0			121.3-133.1- 149.0		
Max. Vertical Digging Depth (in.)	64.0-73.4-68.9			76.8 84.4 71.1			88 99.4 104.9		
Max. Digging Radius (inches)	142.1-151.4-154.7			182.5-189.6-196.1			199.4-210.7- 222.6		
Min. Swing Radius w/o Boom Swing (in.)	64.8- 63.8 -			76.2- 76.2 -			85.8- 85 -		
Min. Swing Radius w/ Boom Swing (in.)	46.1- 46.2 -			55.9- 57.3 -			68.7- 68.9 -		
2 ft. Flat Bottom (in)	79.7-89.8-94.3			104.1-112.2-131.3			120.5-132.3- 146.4		
8 ft. Flat Bottom (in)	55.1-68.9-75.4			84.1 -95.9- 105.5			102.2-116.1- 135.4		

¹Steel ²Rubber ³Canopy ⁴Cab

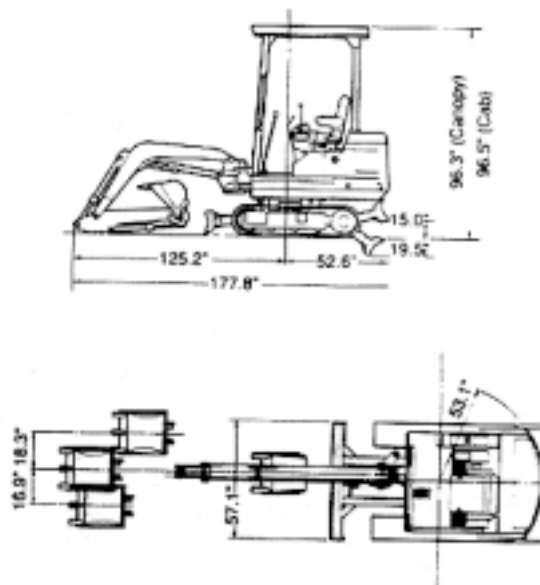


Figure 7.—Kubota KX-71.

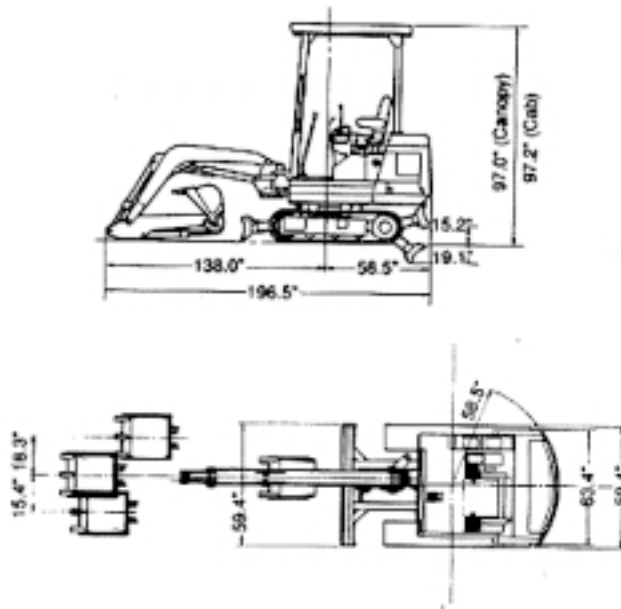


Figure 8.—Kubota KX-101.

Kubota KH007

The Kubota KH007 was replaced by the KX-41, however, the model is still available through used or rental equipment dealers. This model has a rated flywheel horsepower of 8.5 hp (6.3 kw) which is lower than the KX41 (22.2 hp/16.5 kw). A double-section gear pump is used in the hydraulic system to power all the front attachments, dozer, and swing. The boom, in this model, is cushioned by a boom cylinder. The cylinder absorbs the shock and minimizes spillage. Auxiliary hydraulic outlets are also available as standard equipment. The swing system is driven by an orbit motor which brakes automatically when the swing control lever is in neutral. A counterbalance valve is used in the swing hydraulic circuitry to make starts and stops smoother. The counter balance valve also minimizes body motion.

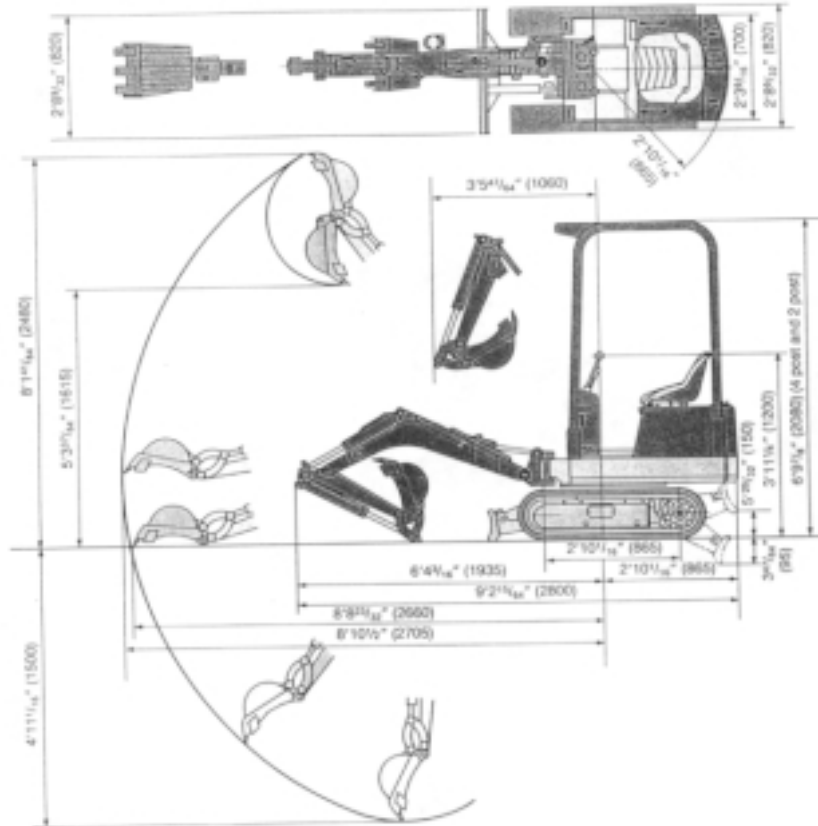


Figure 9.—Kubota KH007.

Specifications: Kubota KH007

Operating Weight	1797 lbs. (815 kg) w/ 2 post ROPS
1951 lbs. (885 kg) w/4 post ROPS	
Noise level at operators ear	79 dB (A)
Maximum travel speed	1.03 mph (1.65 km/h)
Engine	
Model	Kubota Z430-K
Type	4-cycle, water-cooled, vertical diesel engine
Flywheel horsepower	8.5 hp (6.3 kW) @ 2500 rpm
Number of cylinders	2
Displacement	25.9 cu. In. (425 cc)
Hydraulic System	
Capacity (@ 2500 rpm)	gpm x 2 @ 2062 psi (10.0l/min x 2 @ 145 kgf/cm ²)
Auxiliary hydraulic outlet: flow rate	gpm (20l/min)
Main relief pressure	2062 psi (145 kgf/cm ²)
Swing System	
Swing Speed	9 rpm
Boom swing angle (L/R)	125 degrees (80°/45°)
Undercarriage	
Blade width x height	32.3 inches (820 mm)
Max. lift height above ground	5.9 inches (150 mm)

Specifications: Kubota KH007

Max. depth below ground	3.75 inches (95 mm)
Track Type	Rubber
Track Pad Width	7.1 inches (180 mm)
Ground Pressure	
with 2 post ROPS	psi
with 4 post ROPS	3.78 psi
Tension System	Screw bolt
Capacities	
Fuel Reservoir	2.11 gal. (8.0l)
Coolant	0.37 gal (1.4l)
Engine Oil	0.40 gal. (1.5l)
Hydraulic Reservoir	
Tank	2.91 gal. (11l) (tank)
System	3.96 gal. (15 l) (system)

E. Morrison Trailblazer

The Morrison Trailblazer was one of the first machines designed specifically for trail maintenance and construction. The machine has undergone several improvements since its introduction. Several trail contractors use this piece of equipment, and it is still available for purchase and rent.

The Trailblazer is equipped with a small blade that can be raised and lowered hydraulically and tilted manually, 15 degrees on either side. The small blade is useful for leveling and building a platform from which the Trailblazer sits while building a trail. The blade also provides stability while operating the backhoe.

The tracks on the Trailblazer are expandable from 24 inches (0.6 m) to 30 inches(0.76 m). The wider track provides added stability on steeper side slopes. The narrower tracks, however, make it unstable on steep and irregular terrain. The Trailblazer is not equipped with ROP and several trail contractors have modified their equipment by adding a roll bar. Other contractors believe that ROP on the Trailblazer is not necessary because the operator could simply “walk off” before the machinery rolls over. Two opposing opinions exist on the stability of the Trailblazer. The first is the machinery is unstable on irregular and steep side slopes due to the narrow track and the shifting center of gravity associated with the movement of the boom. The second is the stability of the machinery is dependent upon the operator. The operator can use the blade as an anchor while using the backhoe adding to the stability of the Trailblazer. Inversely, the backhoe can be placed on the uphill side of the slope while using the blade.

The overall consensus is that the Trailblazer, like any other piece of machinery, should only be operated by an experienced operator. A new operator can gain experience with the equipment by expanding the track and working in flatter areas.

The Trailblazer lacks the ergonomic features now available on newer excavators. Six levers operate the blade, boom, and bucket. The location of the hydraulic lines also makes the Trailblazer more susceptible to breakdown because the line is exposed and could easily shear off. Some of the routing problems have been corrected in the newer Trailblazer models, however, the problem still exists.

Two attachments are available, a grubhoe and a bucket. The grubhoe may be used to speed trail construction in light and medium soil with brushy cover. The bucket is used for digging. When used for trenching, the Trailblazer is capable of digging a 12-inch (305 mm) wide trench 42-inches (1.1 m) deep. The hoe and the bucket are capable of moving large rocks or digging out stumps.



Figure 10.— Morrison Trailblazer (old) at San Bernardino National Forest.



Figure 11.—Morrison Trailblazer at San Juan-Rio Grande National Forest.

Specifications: Morrison Trailblazer

General

Overall Length 9 foot 3 inches
Overall Width 24 inches
Height 45 inches
Weight 2150 lb.(dry)
Maximum Speed

Engine

Make ONAN
Fuel Gasoline
Cooling

Displacement

Horsepower 25 hp @3000 rpm
Drives 2 DP Charlynn Motors
Steering Hydraulic ...independent motors

Hydraulics

Pump Type Gear
Pump Total Capacity @ 3000 rpm
Backhoe 6 gpm
Track Drives 12 gpm

Relief Valve Settings

Backhoe 1500 psi
Track Drives 1500 psi

Cylinders

Swing 2" x 12" Single Acting — 2 cylinders
Bucket 3" x 10" Double Acting — 1 cylinder
Stick 3" x 10" Double Acting —1 cylinder
Boom 3" x 10" Double Acting —1 cylinder
Blade 3" x 6" Double Acting — 1 cylinder
Boom Swing arc 180°
Turning Clearance within its own length
Working Range
Arm Length 6' 3"
Max. Digging Height 5'
Max. Dumping Height
Max. Digging Depth 4' 6"
Max. Vertical Digging Depth
Max. Digging Reach at Ground Level
Bucket Digging Force
Bucket Capacity 2.7 ft³ (Approximately)
Bucket Weight 87 lb.
Grubhoe Attachment
Blade Height 13 inches
Blade Width 16 inches
Grubhoe Weight 120 lb.

F. Takeuchi TB007, TB015, TB020, TB025, TB035, TB045

Takeuchi makes several excavator models. The six models discussed below have an overall width of 72-inches (1.8 m) or less. Features common to all Takeuchi excavators are discussed first and special features are discussed separately. Like other excavators included in this document, Takeuchi models have a dozer blade. However, Takeuchi models have the unique feature of a hydraulically adjustable track frame width. In the narrow frame position the excavator can pass through narrow openings and operate in confined areas. In the wide frame position the excavator gains greater stability for heavy digging, operation of attachments, and work on uneven terrain. All excavators have two-speed track drive motors for high torque grading and backfilling and high speed job site mobility. Takeuchi excavators also have feathered action main control valve spools to eliminate abrupt machine response. Smoother start/stop hydraulic functions provide for precise, safe operation and minimal operator fatigue. These excavators use auxiliary hydraulics which allow the operator to run different implements without halting operation on the primary hydraulics. The auxiliary hydraulics are fully installed to the dipstick with stop valves. The attachment hoses are routed through the boom yoke improving operator visibility and offering additional protection from external hose damage.

Special Features:

TB 007

Hydraulically adjustable track frame from 26.8 inches (0.7 m) for narrow areas to 35.4 inches (0.9 m) for greater operating stability.

Boom swings 180° for maximum digging offset.

Auxiliary circuit routed to the end of the arm permits quick hook-up of hydraulic attachments.

Two-speed travel.

Dozer blade for light grading and backfilling.

Rubberized tracks.

Tilt-back engine cover provides quick access to engine, battery, and filters.

Wraparound counterweight protects the engine compartment.

Wide angle independent boom swing.

TB015

Hydraulically adjustable track frame from 26.8 inches (0.7 m) for narrow areas to 35.4 inches (0.9 m) for greater operating stability.

Electronic monitoring system apprises operator of vital engine conditions.

Automatic fuel bleed system eliminates the need for fuel bleeding and priming.

Synchronized bucket and arm cylinder speeds for flat bottom trenching.

Two-way auxiliary circuit routed to the end of the arm for quick hook-up of hydraulic attachments.

Simultaneous digging functions for fast cycle times.

Wrap around counterweight protects the engine compartment.

Available with steel or rubber tracks.

Automatic arm acceleration.

TB020

Electronic monitoring system apprises operator of engine conditions.

Automatic fuel bleed system.

Synchronized bucket and arm cylinder speeds.

Two-speed travel.

Available steel and rubber tracks.

Simultaneous digging functions.

Variable displacement pressure compensated axial piston main hydraulic pumps. System flows and pressure vary according to the load demand placed on the hydraulic system.

TB025 , TB035 and TB045

Electronic monitoring system notifies operator of engine conditions.

Automatic fuel bleed system.

Synchronized bucket and arm cylinder speeds.

Two-speed travel.

Available steel and rubber tracks.
 Simultaneous digging functions.
 Emergency shutdown system. Engine shuts down during low oil pressure or overheating conditions.
 Straight travel while operating other functions.
 Variable displacement pressure compensated axial piston main hydraulic pumps. System flows and pressures vary according to the load demand placed on the hydraulic system.

	TB007	TB015	TB020		
Dimensions & Weight					
Operating Weight	1667 lb.	Steel track 3418 lb.	Rubber track 3197 lb.	Steel Track 4672	Rubber track 4278
Overall Length(Transport)	9'0"	12'2"		13'4"	
Overall Width	29.1" / 35.4"	3'2" / 4'3"		4'3"	
Overall Height	6'8"	7'7"		7'9"	
Min. Ground Clearance	6.3"	7"		12"	
Min. Front Swing Radius				4'0" (80° Boom Swing)	
Tail Swing Radius	31.5"	43"		4'0"	
Engine					
Manufacturer	Yanmar	Yanmar		Kubota D11053	
Horsepower @ rpm	8.0 @ 2550	16 @ 2550		21 hp @ 2500	
Cylinders	2	3		3	
Displacement (CID)	26.8	53.7		68.5 CID	
Fuel Tank Capacity	2.1 US gal	6.1 US gal		6.2 US gal	
Fuel Consumption				1.2 gal/hr	
Performance					
Max. Digging Depth	61 inches	87 inches		7'7"	
Max. Dump Height	79 inches	102 inches		9'3"	
Max. Reach	107 inches	145 inches		13'3"	
@ Ground Level					
Max. Digging Depth w/ 2 ft. Flat Bottom	59 inches	84 inches		7'6"	
Max. Digging Depth w/ 8 ft. Flat Bottom		4'11"		5'7"	
Max. Bucket Digging Force	1874 lb.	2415 lb.		3308 lb.	
Max. Stick Digging Force	1323 lb.	1830 lb.		2426 lb.	
Travel Speed mph	1.2 / 2.3	1.4 / 2.6		steel track 1.4/2.5	rubber track .5/2.6
Gradeability	25°	30°		30°	
Bucket					
Width	14 inches	18 inches		4feet 3 inches	
Capacity SAE Heaped	.81 ft ³	1.3 ft ³		2.0 cu. ft (1.5 SAE Struck)	
Dozer Blade					
Width	26.8" / 35.4"	3'2" / 4'3"		4'3"	
Height	7.9"	10"		13"	
Max. Raise	6.1"	7.8"		15.1"	
Max. Lower	4.7"	8.7"		10.3"	
Swing System					
Boom Swing Angle (L/R)	90°/90°	90°/50°		80°/50°	
Slew Speed	9.1 rpm			10 rpm	
Slew Reduction				Bullgear	
Slew Brake				Main Control Check valve	
Slew Motor				Gerotor	
Swing Speed		9.1 rpm		10 rpm	

	TB007	TB015	TB020
Undercarriage			
Traction Motor Type	Gerotor	Gerotor	Gerotor
Traction Drive Type	Planetary	Planetary	Planetary
Traction Brake Type	Counter Balance Valve	Friction	Friction
Track Rollers Per Side	2	3	3
Shoe Type	Rubber Belt	Double Semi-Grouser	Crawler Type Double Semi Grouser
Shoe Width	7 inches	9.1 inches	10 inches
Ground Contact Length	35.5 inches	40 inches	51 inches
Ground Pressure	3.1 psi	4.1 psi	Steel Track 4.2 psi Rubber Track 3.8 psi
			Cab Canopy Cab Canopy 4.2 psi 4.0 psi 3.8 psi 3.5 psi
Hydraulic System			
System Capacity	4.1 US gal	7.9 US gal	16.6 US gals
System Operating Pres.	2133 psi	2774 psi	2698 psi
Pump Type	Tandem Gear	Triple Gear	Triple Gear
Hydraulic Flow	2.8 x 2 gpm	4.1 x 2/2.7 x1 gpm	5.3 x 3 gpm
Auxiliary Hydraulic Flow	5.6 gpm	8.2 gpm	10.6 gpm

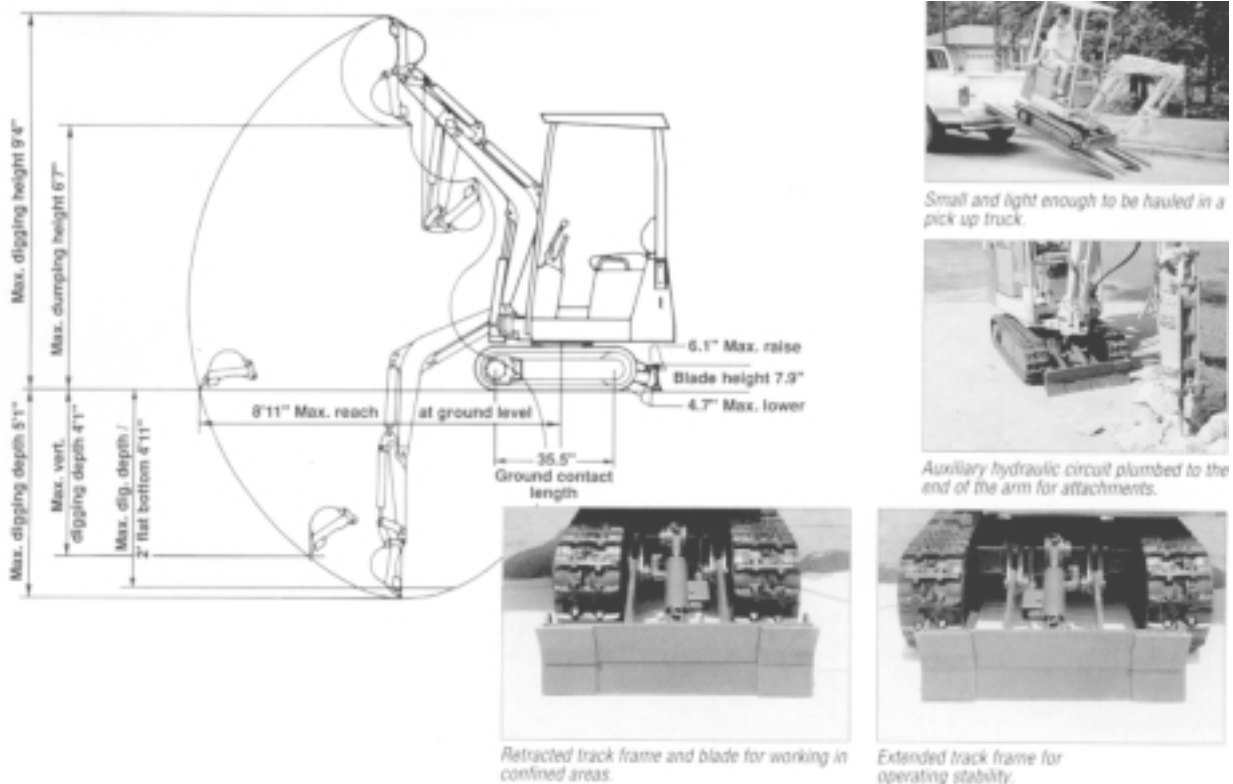


Figure 12.—Takeuchi TB007 compact excavator.

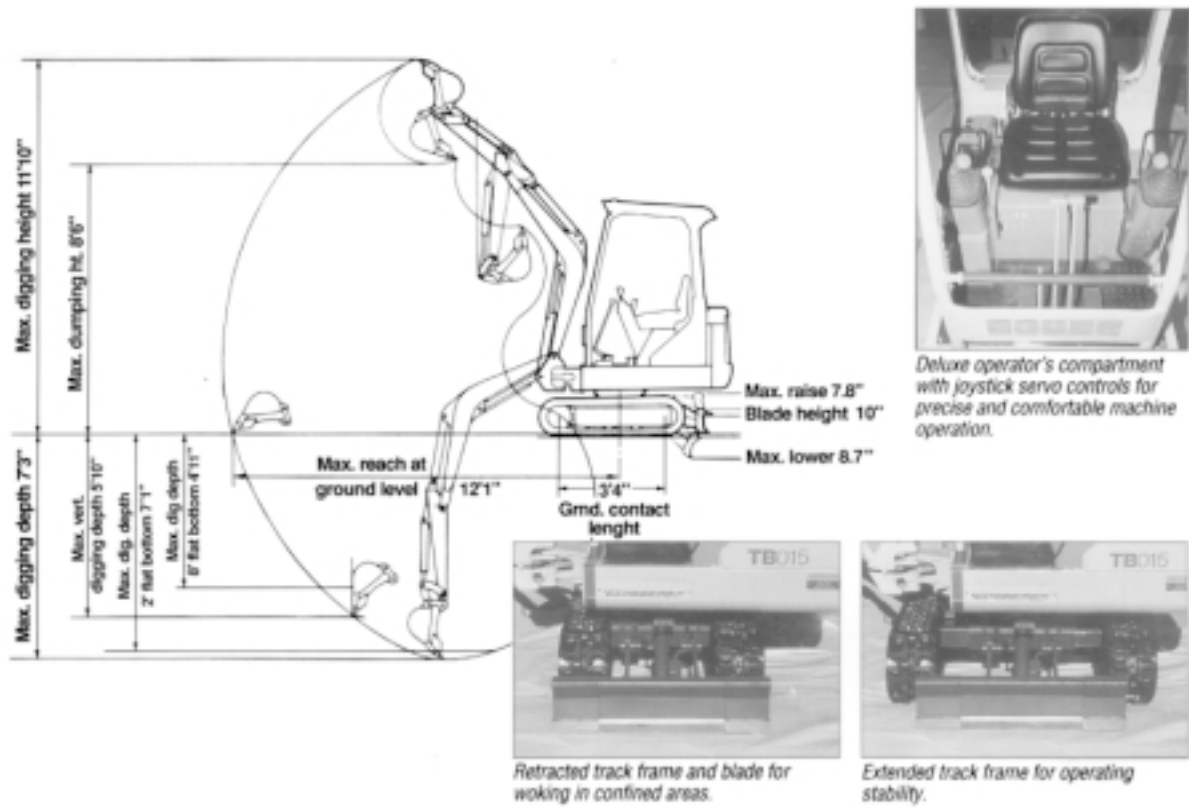
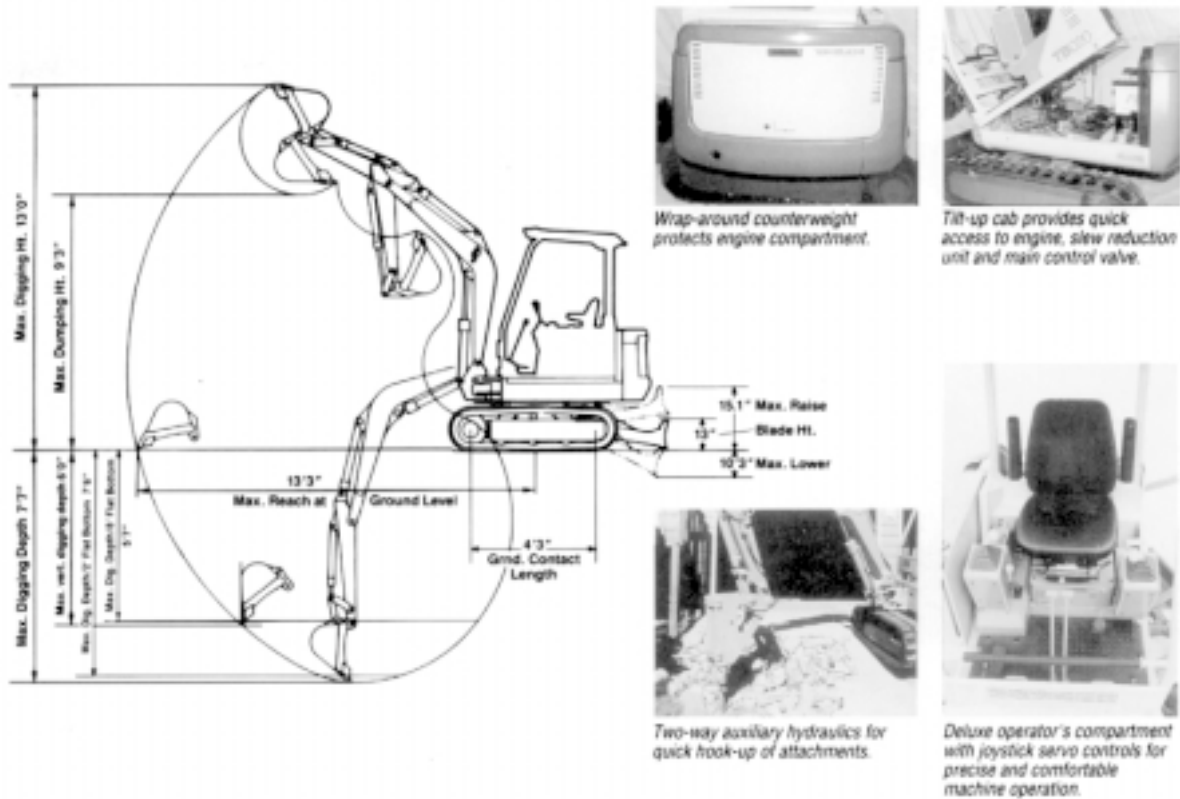


Figure 13.—Takeuchi TB015 compact excavator.
 Figure 14.—Takeuchi TB020 compact excavator.



Takeuchi	TB025	TB035	TB045
Dimensions & Weight			
Operating Weight (lbs.)	5958	7625	10,092
Overall Length(Transport)	14'6"	16'6"	18'4"
Overall Width	4'9"	5'4"	6'0"
Overall Height	7'11"	7'11"/ 8'1"	8'6"
Min. Ground Clearance	12"	12"	13"
Min. Front Swing Radius (80° Boom Swing)	4'11"	4'11"	4'11"
Tail Swing Radius	4'3"	4'8"	4'11"
Engine			
Manufacturer	Yanmar	Yanmar	Yanmar
Horsepower @ rpm	26 @ 2450	33 @ 2600	43.4 @ 2000
Cylinders	3	3	3
Displacement (CID)	87.2	87.0	158
Fuel Tank Capacity	7.6	8.9	15.3
Fuel Consumption (gals/hr.)	1.4	1.9	2.4
Performance			
Max. Digging Depth	8'6"	10'2"	11'6"
Max. Dump Height	9'5"	11'2"	12'5"
Max. Reach	14'7"	16'6"	18'9"
@ Ground Level			
Max. Digging Depth w/ 2 ft. Flat Bottom	8'5"	10'1"	11'4"
Max. Digging Depth w/ 8 ft. Flat Bottom	6'8"	8'7"	10'0"
Max. Bucket Digging Force	3968	5138	6967
Max. Stick Digging Force	3020	3870	5270
Travel Speed mph	1.3/2.5	1.4/2.7	1.7/2.9
Gradeability	30°	30°	30°
Bucket			
Width	18"	22"	22"
Capacity SAE Heaped (cu. ft.)	2.5	3.5	5.0
Dozer Blade			
Width	4'9"	5'4"	6'0"
Height	13.8"	15"	16.2"
Max. Raise	15.4"	16.5"	17.3"
Max. Lower	11.8"	14.9"	13.6"
Swing System			
Boom Swing Angle (L/R)	80°/50°	80°/50°	80°/50°
Slew Speed	10	10.7	11.3
Slew Reduction		Planetary	
Slew Brake		Main Control Check Valve	
Slew Motor		Piston	
Undercarriage			
Traction Motor Type		Piston	
Traction Drive Type		Planetary	
Traction Brake Type		Friction	
Track Rollers Per Side	3	4	5
Shoe Type	Crawler Type Double Semi-Grouser		Double Semi-Grouser
Ground Contact Length	4'7"	5'3"	6'3"
Ground Pressure (psi)	4.0	4.0	3.8
Steel Track Canopy Ground Pressure (psi)	4.2	4.1	3.9
Steel Track Cab			

	TB025	TB035	TB045
Ground Pressure (psi)	3.8	3.7	3.8
Rubber Track Canopy			
Ground Pressure (psi)	4.0	3.8	3.8
Rubber Track Cab			
Hydraulic System			
System Capacity (gallons)	21.7	26.4	31.7
System Operating Pres.	2845	2845	2845
Pump Type	Triple Gear	2 x Variable Displacement Piston/ 1 x gear	
Hydraulic Flow (gpm)	x 2	x 2	x 2
	5.2 x 1	5.8 x 1	9.1 x 1
Auxiliary Hydraulic Flow	12.6	15.0	14.8

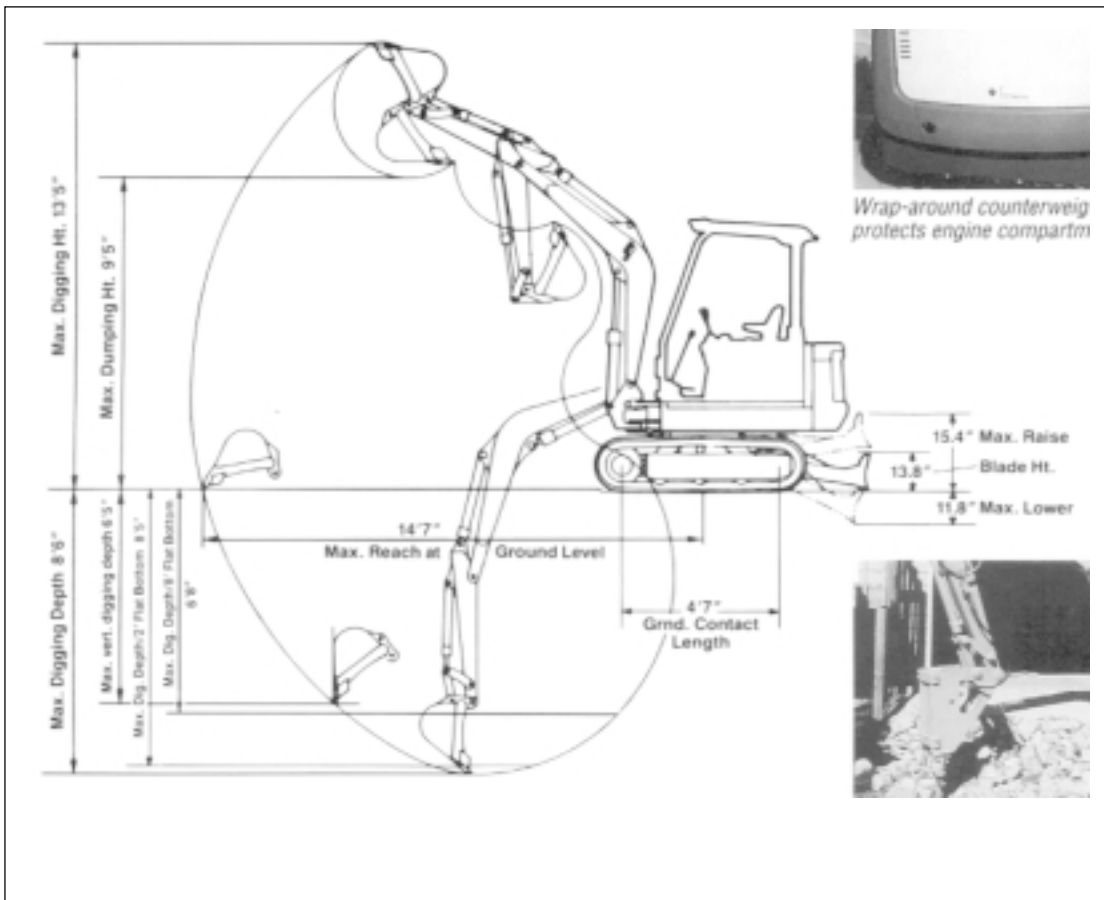


Figure 15.—Takeuchi TB025 compact excavator.

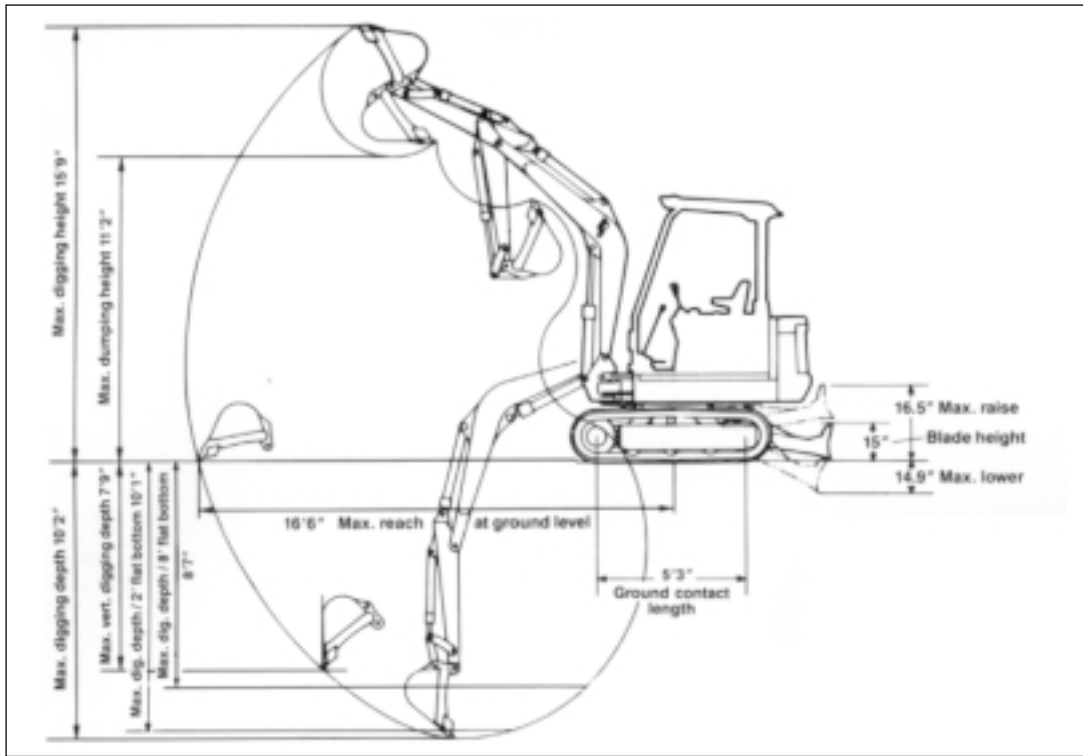
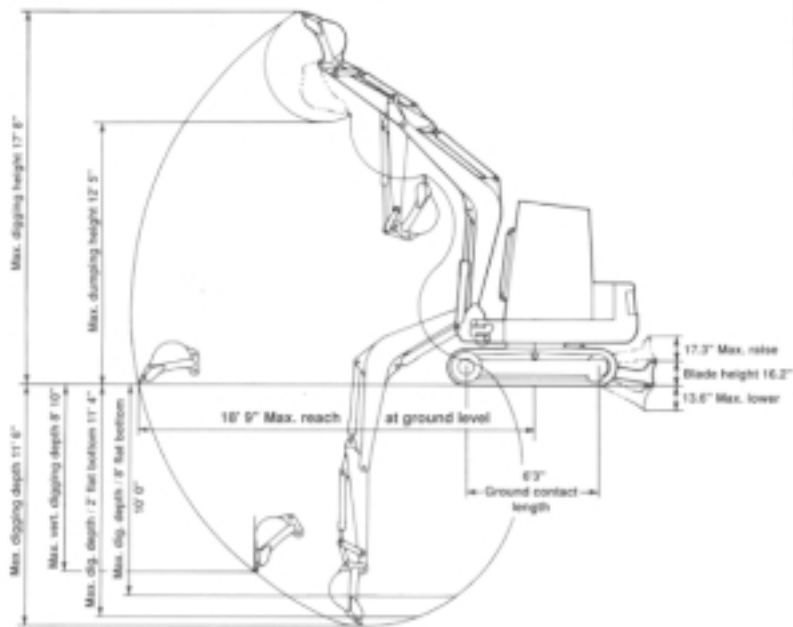


Figure 16.—Takeuchi TB035 compact excavator.



Tilt-up platform provides quick access to engine, slew reduction unit and main control valve.



Feature packed operator's compartment with fully adjustable suspension seat, roll back front window, tinted glass, heater, defroster, windshield wiper/washer, AM/FM cassette radio, hand and foot operated travel levers and joystick servo controls.

Figure 17.—Takeuchi TB045 compact excavator.

DOZER

Configuration

Dozers are self-propelled machines mounted on either a wheeled or crawler tractor to exert a push/pull force through a blade, drawbar, or ripper and are used to move objects or materials. The primary trail building implement is the dozer blade.

Discussion

Dozers considered for this section are machines with a width under 72-inches (1.8 m), not including the width of the implement. The three trail building dozers discussed below, the SWECO Dozer, the Accutrak AC-30, and the Pacific Crawler Dozer are all mounted on crawler tractors. The SWECO dozer is the only one currently being manufactured. Information for the other two are provided because they may still be available through used equipment or rental equipment dealers.

All machines considered have quick attachments to an auxiliary hydraulic system to power the dozer blade, drawbar, ripper, loader bucket, and backhoe attachments. There are two primary earthworking implements that are used for trail building or maintenance; the dozer blade and a backhoe attachment. All of the equipment in this section have a 6-way dozer blade.

The dozers evaluated all have engines mounted on the rear of the frame, making the tractor more stable when lifting or moving earth with the implements mounted in the front. The rear mounted engine also gives the operator better visibility.

Advantages/Disadvantages

The advantages/disadvantages of dozers compared to excavators are listed below. Other advantages/disadvantages may be observed depending on use, terrain, and local.

Advantages

- Large dozer blade is faster cutting a rough trail tread than using a backhoe bucket.
- More stable than the backhoe because the center of gravity remains constant. These machines are usually wider than the compact backhoe thus making them more stable.
- Moving large boulders or tree stumps is easier with a dozer. The larger engine available in these machines makes pushing obstacles out of the way faster than digging them out.
- The auxiliary hydraulics available makes the dozer an excellent platform to power other hydraulic implements.

Disadvantages

- Larger than most compact backhoes; and cuts a wider trail.
- Larger trailers and towing vehicles are required for transport to the job site.

Equipment Specifications

A. SWECO Dozer

The SWECO Trail Dozer is well designed and built for trail use. The dozer is equipped with full ROP, 1 1/4- inch (32 mm) steel plates, oversize hydraulic cylinders with triple filtration in both the hydraulic and air filters adding to the durability of the trail dozer. The dozer sits on top of a Berco carriage with the engine mounted in the rear. Two 24-gallon (91 liter) hydraulic and diesel tanks are mounted on each side of the dozer. The hydraulic pumps are easily accessible through a rear panel. The operator sits forward of the engine and operates the dozer with six levers. Two levers control the tracks and four levers operate the blade, rippers, and other attachments connected to the auxiliary hydraulics.

Unlike excavators, the SWECO dozer is able to cut a rough trail in one pass and has enough power to “plow” through brush and large rocks, thus reducing the need to blast. The dozer builds trail faster than an excavator due to the larger blade and more power. The overall width of the tractor dictates the width of the trail built. Although the dozer blade is wider than the tractor, the blade could be tilted or angled to reduce the effective width. The actual trail tread is smaller than the 48 inches (1.2 m) width of the

tractor when the outside berm is removed and when material starts to slough off the cut slope onto the tread. The dozer blade can be raised and lowered two feet, angled and tilted, making it ideal for building waterbars and dips.

The SWECO dozer is available with an air compressor and auxiliary hydraulic connectors. The air compressor can be used to run pneumatic hand tools including pruners and chain saws. Auxiliary hydraulics can power a backhoe or small hydraulic devices (rock drills).

Like the excavator, the dozer needs an experienced operator especially in areas with steep side slopes. Since the dozer must operate on a platform, the operator must ensure that the platform is stable. The optional winch can aid in getting the dozer out of trouble or stabilizing the dozer for safer operation.

The optimum number of people working with the dozer is three; the operator, one person ahead of the dozer for safety, and one behind to clean up the trail. The length of trail built or maintained is dependent upon the terrain, the type of work required, and the skill of the operator. For new trail construction the SWECO dozer has a range of 500 ft (152 m) per hour for rocky terrain to 1000 ft (305 m) per hour for softer areas.

The dozer is most efficient when used in conjunction with other equipment; an ATV dragging a harrow (see ancillary equipment section) could be used to remove the outside berm. The weight of the trail dozer also helps in compacting the soil.

Specifications: SWECO TRAIL DOZER

Width	48 inches
Length (with blade & rippers)	128 inches
Height	76 inches
Ground Clearance	6.5 inches
Gross weight (w/ blade & rippers)	7800 lb.
Travel Speed	0 - 5 mph
Max. Blade Lift	24 inches
Max. Blade Drop	24 inches
Max. Blade Angle	30 degrees
Max. Blade Tilt	25 degrees

Engine:

Make	Isuzu Diesel
Horse Power	56 hp @ 3000 rpm, 70hp w/ Turbo
Type	4 cylinder
Cooling Medium	water
Electrical System	12 volts
Max. Inclination, all angles	35 degrees
Fuel consumption (Avg.)	1.0 gal/Hr

Transmission	Sunstrand twin hydrostatic pumps & Fairfield torque hubs
--------------	--

Steering	Dual controls, full hydrostatic, counter rotating
Hydraulics	Gear pump 10-30 gpm, triple filtration

Undercarriage

Make	Berco
Track Frame	Rigid Frame
Track Rollers	1 Top, 4 Bottom
Shoes per Track	30
Track Width	11 in.
Ground Pressure	5.7 psi

Available Attachments

Dozer 6-way, 50 inches (1.2 m) or 60 inches (1.5 m)
Rippers, 3 shank
Backhoe, 8 ft (203 mm) or 9 ft 229 mm) reach
Auger, 4"(101 mm) to 24"(610 mm) diameter
Logging Arch/Winch
Air Compressor

Standard Features

Seat Belt
ROPs
Tach/Hourmeter
Warning lights
Vandal Protection Kit
Fuel & Hydraulic Gauges
Cold Weather Starting Kit

Heavy Duty Engine Cooling System
Side Brush Screens
Rock Guards
Safety Brake
Limb Risers
Auxiliary Hydraulics

Options

Rock Points
Spark Arrester
Front & Rear Lights
Draw Bar (on rippers)
Trailer (Standard or custom)

Hand Tool Holders
Float Action on Tilt
Backup Alarm
Fire Extinguisher



Figures 18A & 18B.—SWECO trail dozers working in Angeles National Forest.



B. Accutrac AC-30

At the time of publication, the manufacturer could not be contacted. It is believed this machine is no longer available for purchase; however, it may be available for rent. The machine is included in this publication for reference only. The specifications used are based on data issued in 1988.

Specifications: Accutrac AC-30

Tractor Length	85 in. (2159 mm)
Tractor Width	48 in. (1219 mm)
Height (w/ ROP)	84 in. (2134 mm)
Weight	4500 lb.
Engine	
Make	Deuts F2L511-2 cyl
Horsepower	Continuous: 28.5 hp (21 kW) Intermittent: 34 hp (25 kW)
Displacement	
Cooling	100 cu. in. (1625 cc) Forced Air
Electrical System	12 Volt 33 Amp
Undercarriage	
Track Rollers	Full Floating Track & Sprockets 4 (each side)
Length of track on ground	51.5 in. (1308 mm)
Shoes per Track	331
Track Shoe Width	9.85 in. (250 mm)
Track on Ground	1015 sq. in. (6548 sq. cm)
Ground Pressure	4.35 psi (30KPa)
Capacities	
Fuel	19 US gal (72 L)
Hydraulic	27 US gal (103 L)
Steering	
Hydrostatic 3-way	Full power on turns Lock one track Counter rotate
Attachments	
Front end Loader	
Bucket width	54 inches
Lift height	96 inches
Loader Capacity	1/3 cu. yd w/ tilt 1200 lb. lift 1/2 cu. yd. straight 1500 lb. lift
Six way blade	
Max. Blade Lift	20 inches
Max. Blade Drop	12 inches
Max. Blade Angle	30 degrees
Max. Blade Tilt	30 degrees
3-Point Hitch Frame	Will accept category one 3 point attachments

Standard Equipment

ROP Canopy
Full instrumentation & gauges
Full belly pan
Seat belt
Remote mount oil filter
Six-way hydraulic power front & rear
Power take off connections, front & rear
Heavy duty under carriage w/ 4 sealed
and prelubricated rollers each side
Forced air hydraulic oil cooler
Cold weather starting aid

Optional Equipment

Three shank ripper
3-point hitch adapter, front & rear
6-way dozer blade
12-inch street pads
Lights
Drawbar
Bolt on pads
PTO hydraulic drive motor w/ 1-inch dia.
keyed shaft and all connection hoses

C. Pacific Crawler Dozer

At the time of publication, the manufacturer could not be contacted. Although the equipment is not available for purchase, it may be available for rent. The equipment is presented for reference. The specifications are as of 1988.

Specifications: Pacific Crawler Dozer

Width	47 inches (1193.8 mm)
Length (including rippers)	126 inches (3200.4 mm)
Height	40 inches (1016 mm)
Ground Clearance	36.5 inches (927.1 mm)
Gross Weight	5000 lb. (2269 kg)
Blade Width	47.5 in. (1206.5 mm)
Blade Lift	21 in. (533.4 mm)
Below Grade	14 in. (355 mm)
Blade Tilt	15°
Blade Angle	25°
Travel Speed	0-5 mph
Engine	
Make	Hatz 2L or Deutz F2L-511D Diesel
Horsepower @ rpm	44 hp (33 kW) @ 2800 rpm
Type	2 cylinders
Cooling	Air Cooled
Electrical System	12 volts
Max., inclination, all angles (gradeability)	35° (97%)
Transmission	
Type	Sundstrand w/ twin hydrostatic pumps & Fairfield torque hubs with independent track, hydrostatic propulsion fully reversible to control speed and direction of travel. Wobble stick, full hydrostatic, counter rotating
Steering	
Hydraulics	
Pump Type	Gear
Number of Pumps	3
Pump Capacity	12 gpm (20 gpm available)
Hydraulic Tank Capacity	20 gallons (75.7L)
Undercarriage	
Make	Berco
Track Frame	Rigid Frame
Track Rollers	4 bottom rollers
Carrier Roller	1 carrier roller
Length of Track on Ground	48 inches (1219 mm)
Shoe per Track	30
Track Shoe Width	10 in (254 mm) / 12 in (304 mm)
Ground Pressure	10 in. track width = 5 psi (34.5 kPa) 12 in. track width = 4 psi (27.6 kPa)
Capacities	
Fuel Tank	10 gal (37.8 L)
Hydraulic System	20 gal (75.7 L)
Crankcase	5 qt.
Frame	Unitized with full belly pan

Attachments

Loader with 1/2-cubic yard capacity
4 post ROP
6-way hydraulic dozer with wobble stick control
3-shank parallelogram rippers
Backhoe

LOADERS

Configuration

Loaders are mounted on either a wheeled or tracked undercarriage. These machines have loader buckets up front with engines mounted in the rear. Loaders are ideal for moving rocks, soil, or other trail building material to the job site. They are not designed to cut trail tread, however an angled blade and a york rake attachment are available for that purpose.

The smallest loader in this section is the Bobcat 453 with a width of 35.5 inches (0.9 m). The largest of the loaders is the Bobcat 873 with a width of 74.1 inches (1.9 m). Bobcat loaders come standard with wheels, but a track to fit over the wheels is available. The Takeuchi TL26 is the only tracked loader reviewed.

Discussion

The size of the machine dictates the width of the trail on which the machine can operate. Tracks on the vehicle provide more traction because of a large contact area with the ground. The larger contact area also provides better resistance to inadvertent slipping, making it more stable. The larger contact area also provides more "float" over plastic soil conditions. The damping action provided by the pneumatic tires gives the wheeled vehicle a smoother ride.

The vast assortment of available attachments for these loaders makes them versatile trail machines. The loaders can be used to haul or move trail materials closer to the job site. The number of people working with the machinery varies with the task. For example, when building a trail tread with a backhoe attachment, a crew of three is needed. The crews placement is the same as previously discussed for excavators. The power output and safety considerations define the amount of material or the size of boulders the loader can move. Never exceed the maximum operating capacity of the equipment.

These machines are compact and maneuverable which allows operation in confined areas. The small size of the loaders allows for easy transport via trailer or on a truck bed. The higher travel speed compared to excavators and dozers allows for greater mobility in and around the job site and also reduces cycle time.

Advantages/Disadvantages

The following are the advantages/disadvantages of the loader compared to the excavator, dozer, and hauler.

Advantages

- Versatile with the available attachments the loader performs many other functions. Able to move large volume of material.
- Higher travel speeds reduce cycle time.
- Parts and service are widely available.

Disadvantages

- Performance is compromised when used as other than a loader or hauler.
- Additional cost to procure attachments.

Equipment Specification

A. Bobcat 400, 500, 700, and 800 Series Skid-Steer Loaders

This document evaluates the 400, 500, 700, and 800 series loaders. The skid-steer loaders are wheeled vehicles and have less traction in loose, plastic soil types than tract mounted loaders. Wheeled vehicles, in general, are not as stable on terrain with large side slopes due to smaller ground contact area thus providing less resistance to slippage. These loaders are compact and very maneuverable making them ideal for working in small areas. Their small size also makes them easy to transport to and from the job site. The Bobcat 453 Skid-Steer is the narrowest (35.5 inches/0.9 m) Bobcat loader evaluated.

The operator compartment and controls are ergonomically designed. The operator seat is cushioned and can be adjusted fore and aft. The seat bar doubles as a cushioned arm rest when two control levers are being used. The operator cab has ample room; entering and exiting the cab is easy. The two levers control the steering and drive. A thumb switch on one of the levers allows the operator to control auxiliary hydraulic functions. Two foot pedals control the hydraulics. Hydraulic hand controls are also available.

Maintenance of the loaders is aided by easy access to the engine and hydraulic/hydrostatic components. The engine is accessed through a swing out tailgate. Fluid levels, battery, and oil drain are also easily accessed. Access to the radiator requires the removal of the oil cleaner. Hydraulics/hydrostatics are serviced by unbolting two nuts and lifting the cab back. The Bobcat Skid-steers also are manufactured with self lubricating axle bearings that do not need greasing.

Safety devices in the Bobcat loaders include ROP/FOP cabs with a rear egress port which allows the operator to exit the loader if the front exit is obstructed. All loaders are also equipped with the Bobcat Interlock Control System (BICSô). The BICSô locks the hydraulic lift and tilt functions and the traction drive when the seat bar is raised and the engine is running. Also, if the operator moves off the seat for more than one second the seat sensor relays information to the controller which locks the hydraulic lift and tilt functions. Auxiliary hydraulics are not affected. The seat bar adds additional restraint and also serves as an arm rest. As a safety option, the Bobcat loaders are available with a sound cab which reduces the noise level (at the operators ear) to 85 dBA. Spark arrester mufflers are standard equipment on skid loaders.

Additional attachments for these loaders are available and are listed in the specifications section below. Each model may not be equipped with the same attachments. In general, smaller loaders have fewer available attachments. Changing attachments are facilitated by the Bob-Tach System. The operator moves the frame into the attachment flange, pushes the two handle pins down and presses the wedge through the frame and attachment hole making a solid connection.

The 400 and 500 series Bobcat Skid-Steer Loaders are steered and driven with two levers on each side of the operator. The levers also control attachments which require auxiliary hydraulics (backhoes, grapples & forks). Hydraulics are controlled using two foot pedals. Applying pressure on the top or bottom of the pedal raises/lowers, dumps, and rolls back the bucket. This combination makes the skid-steer easy to control.

Specifications:	450	453	553
Capacity			
Rated Operating Capacity lb. (kg)	600 (272)	600 (272)	850 (408)
Tipping Load lb. (kg)	1217 (552)	1470 (667)	1700 (771)
Hydraulic Pump Capacity GPM (LPM)	6.8 (25.7)	6.8 (25.7)	8 (30.3)
Dimensions			
Length (w/ bucket) in. (mm)	97 (2464)	97 (2464)	106.6 (2708)
Width (w/ bucket) in. (mm)	35.5 (901.2)	35.5 (901.2)	49.5 (1257)

Specifications:	450	453	553
Height in. (mm)	72 (1829)	72 (1829)	72.8 (1849)
	450	453	553
Height to Bucket Pin in. (mm)	92 (2337)	92 (2337)	102.5 (2604)
Engine			
Make/Model	Kohler M18QS	Kubota D750-B	Kubota D950-B
Fuel/Cooling	Gas/Air	Diesel/Liquid	Diesel/Liquid
Cylinders	2	3	3
HP/Displacement in ³ (L)	16.5/42.19 (0.69)	15/46.5 (0.76)	21.5/56.6 (0.93)
Fuel Tank Capacity gal (L)	6.5 (24.6)	6.5 (24.6)	10 (38)
Operating Weight lb. (kg)	2195 (996)	2513 (1140)	3622 (1643)
Operation			
Steering & Drive	Forward, Reverse, Travel Speed & Steering controlled by 2 levers		
Hydraulics	2 foot pedals raise/lower lift arms & dump/rollback bucket		
Transmission	Hydrostatic, four wheel drive		



Figure 19A.—Bobcat 763 Skid-Steer loader with a modified blade.

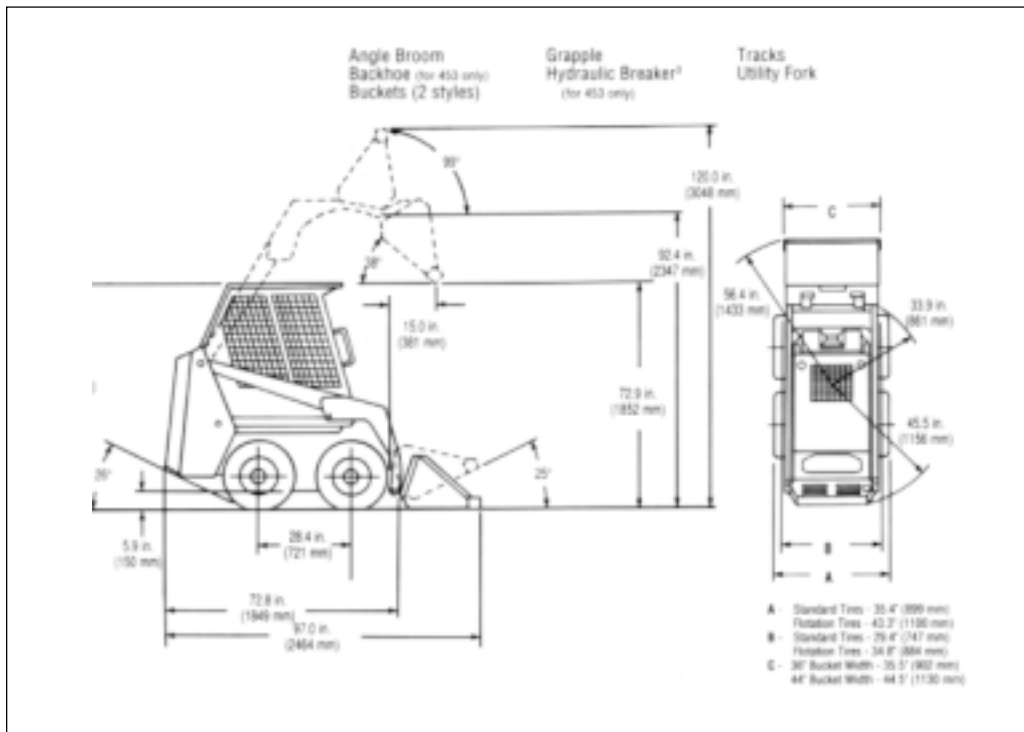


Figure 19B.—Bobcat 400 C-Series Skid-Steer loader.

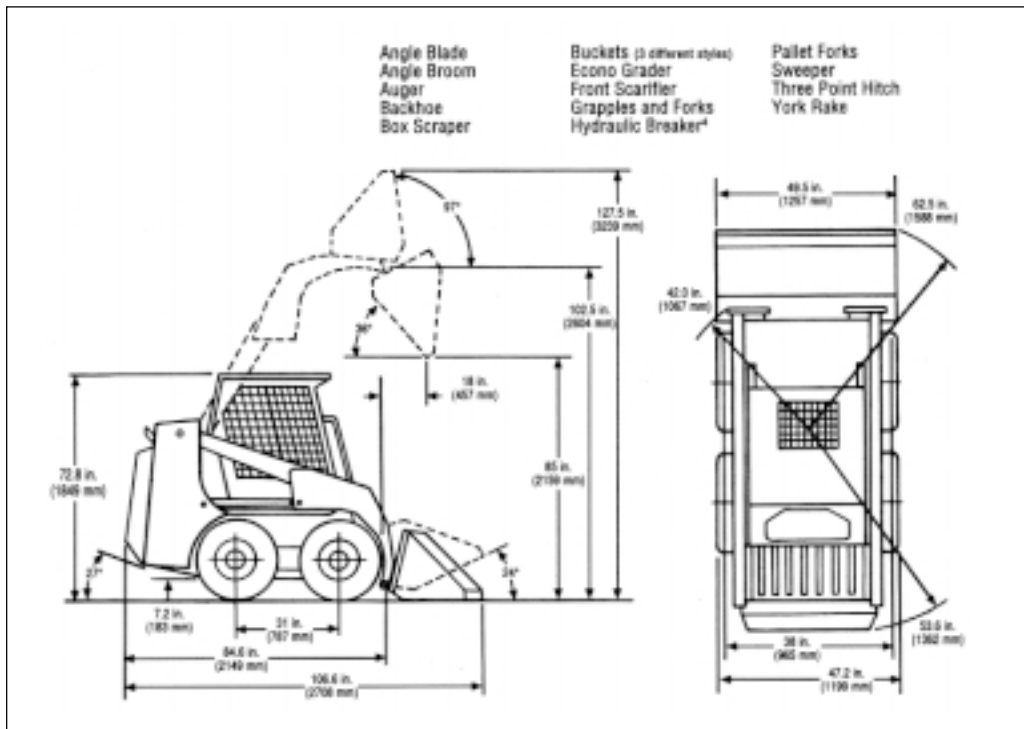


Figure 20.—Bobcat 553 C-Series Skid-Steer loader.

Standard Features

Adjustable Cushioned Seat
 Bobcat Interlock Control System
 Bob-Tach
 Flotation Tires
 Lift Arm Support
 Meters/Gauges/Warning Lights

Operator Cab
 Parking Brake
 Seat Bar
 Seat Belt
 Spark Arrester Muffler

Available Attachments

Angle Blade
 Angle Broom
 Auger
 Backhoe
 Box Scraper
 Buckets (3 styles available)
 Econo Grader

Grapples and Forks
 Hydraulic Breaker
 Pallet Forks
 Sweeper
 Three Point Hitch
 York Rake

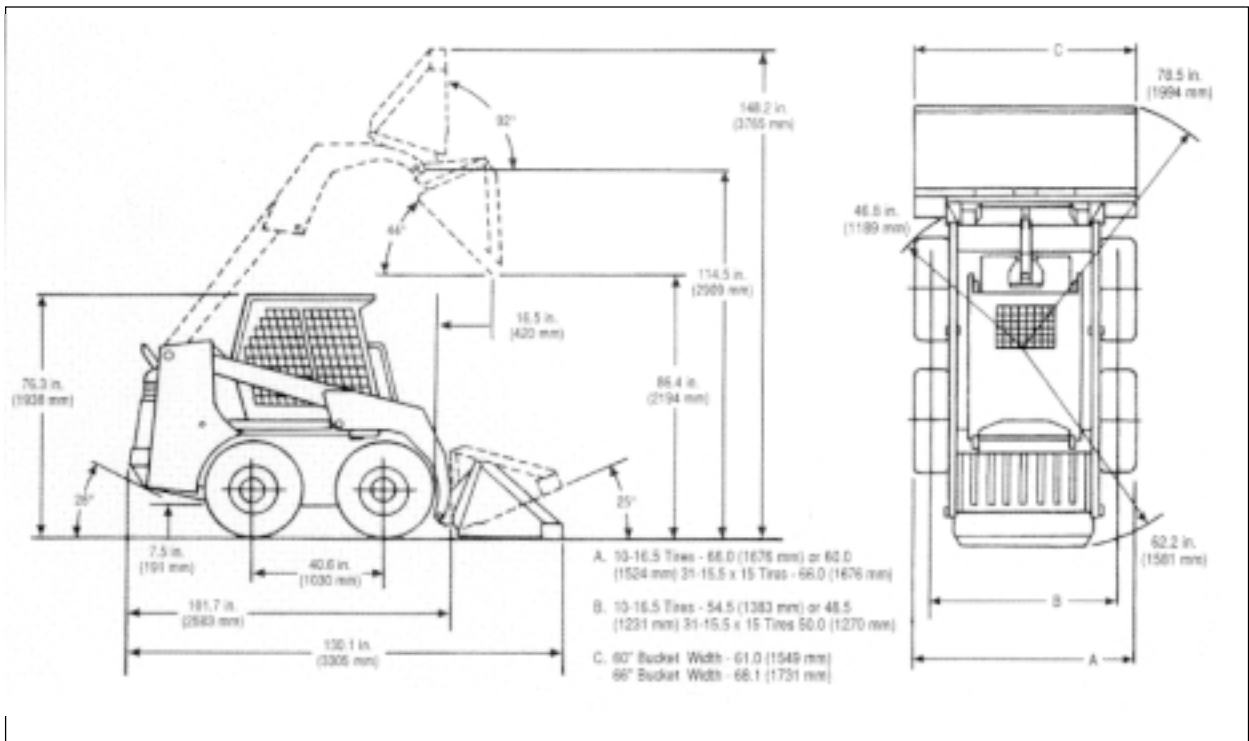


Figure 21.—Bobcat 763 Skid-Steer loader.

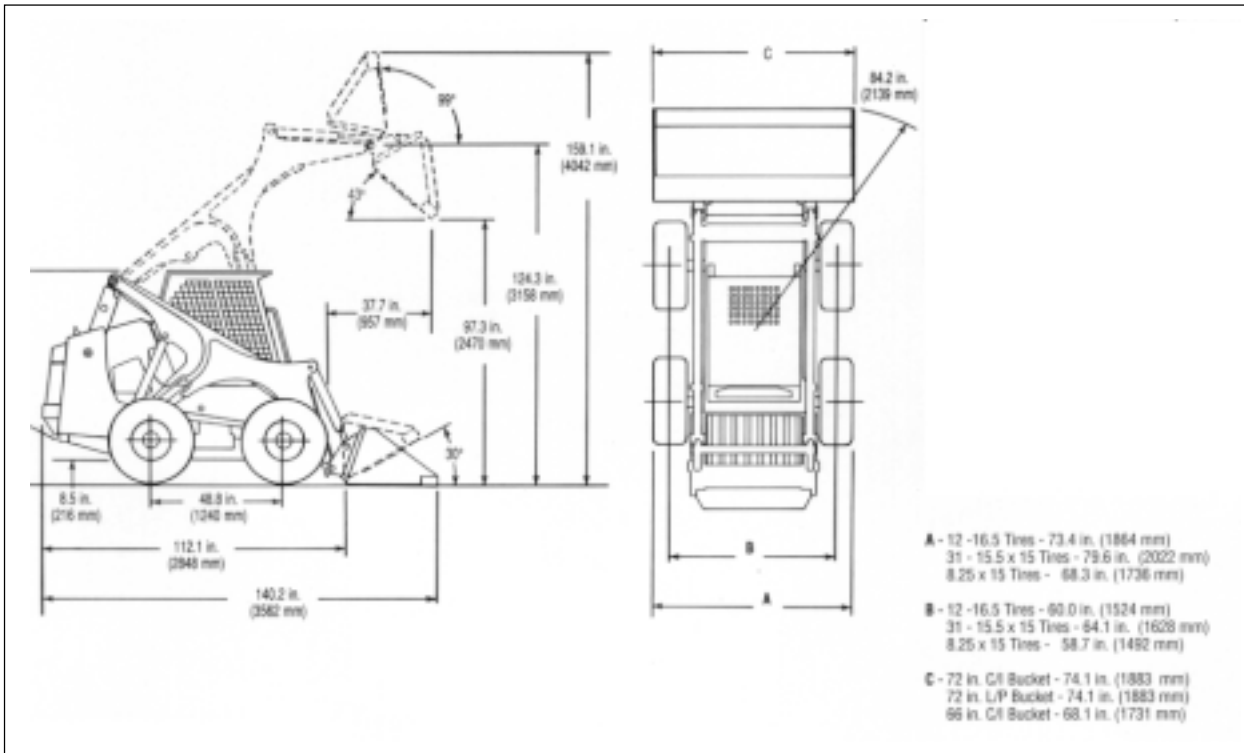


Figure 22.—Bobcat 873 Skid-Steer loader.

Bobcat® 700 C-Series Skid-Steer Loaders

	753	753H Optional Package	763	773
Capacity				
Rated Operating Capacity lb. (kg.)	1300 (590) 1400 (635) optional counterweight	1400 (680)	1500 (680) 1600 (706) optional counterweight	1700 (771) 1800 (816) optional counterweight
Tipping Load lb. (kg.)	2600 (1179)	2900 (1315)	3000 (1361)	3800 (1724)
Hydraulic Pump Capacity gpm (lpm)	13 (49)	21 (79)	15 (57)	15 (57)
Dimensions				
Length w/ bucket in. (mm)	120.5 (3059)	120.5 (3059)	130.1 (3305)	130.1 (3305)
Width w/ bucket in. (mm)	55 (1397)	55 (1397)	68.1 (1731)	68.1 (1731)
Height in. (mm)	76.0 (1930)	76.0 (1930)	76.3 (1938)	76.3 (1938)
Height to Bucket Pin in. (mm)	109.1 (2771)	109.1 (2771)	114.5 (2909)	115.0 (2921)
Engine				
Make/Model	Kubota/V2203-B	Kubota/V2203-B	Kubota/V2203-B	Kubota/V2203-B
Fuel/Cooling	Diesel/Liquid	Diesel/Liquid	Diesel/Liquid	Diesel/Liquid
Cylinders	4	4	4	4
HP/Displacement hp/in ³ (L)	40 / 134 (2.2)	40 / 134 (2.2)	40 / 134 (2.2)	40 / 134 (2.2)
Fuel Tank Capacity gal (L)	14 (53)	14 (53)	14 (53)	14 (53)
Operating Weight lb. (kg.)	4730 (2146)	5187 (2353)	5368 (2435)	5457 (2475)
Operation				
Steering & Drive	Forward, Reverse, Travel Speed & Steering controlled by 2 levers			
Hydraulics	2 foot pedals raise/lower lift arms & dump/rollback bucket			
Transmission	Hydrostatic, four wheel drive			
Standard Features	Adjustable Cushion Seat...Heavy Duty Tires (763 & 773 only)...Bobcat Interlock Control System (BICS)...Bob-tach..Dual path Cooling System... Lift Arm Support...Meters/gauges/Warning Lights...Operator Cab... Parking Brake...Push Button Activated Glow Plugs...Seat Bar... Seat Belt...Spark Arrestor Muffler			

Attachment Available

Angle Blade... Angle Broom... Auger... Backhoe... Bale Handler...Box Scraper...Buckets...Combination Bucket...Front Scarifier...Grader...Grapples & Forks...Hydraulic Breaker...Landscape Rake...Longwood Grapple...Pallet Forks...Planer...Rear Stabilizer...Snow Blower...Stump Grinder...Sweeper...Three Point Hitch...Tiller...Tracks...Tree Transplanter...Vibratory Roller...Wheel Saw... York Rake.

Specifications: Bobcat® 800 C-Series Skid-Steer Loaders

	853	853H Optional Package	873
Capacity			
Rated Operating Capacity lb. (kg.)	1700 (771)	1700 (771)	2300(1043)
Tipping Load lb. (kg.)	3420 (1551)	3420 (1551)	4600 (2086)
Hydraulic Pump Capacity gpm (lpm)	18 (68)	24 (91)	18 (68)
Dimensions			
Length w/ bucket in. (mm)	128.5 (3264)	128.5 (3264)	140.3 (3562)
Width w/ bucket in. (mm)	61.5 (1562)	61.5 (1562)	74.1 (1883)
Height in. (mm)	80.9 (2055)	80.9 (2055)	78 (1981)
Height to Bucket Pin in. (mm)	119.6 (3038)	119.6 (3038)	124.3 (3158)
Engine			
Make/Model	Isuzu/4JB1PK-03	Isuzu/4JB1PK-03	DeutzBF4M1011
Fuel/Cooling	Diesel / Liquid	Diesel / Liquid	Diesel/Oil
Cylinders	4	4	4
HP/Displacement hp/in ³ (L)	58/169 (2.77)	58/169 (2.77)	73.5/167 (2.73)
Fuel Tank Capacity gal (L)	25 (95)	25 (95)	25 (95)
Operating Weight lb. (kg.)	6500 (2948)	6550 (2971)	6885 (3123)
Operation			
Steering & Drive	Forward, Reverse, Travel Speed & Steering controlled by 2 levers		
Hydraulics	2 foot pedals raise/lower lift arms & dump/rollback bucket		
Transmission	Hydrostatic, four-wheel drive		
Standard Features	Adjustable Cushion Seat...Heavy Duty Tires (763 & 773 only)...Bobcat Interlock Control System (BICS)...Bob-tach..Dual path Cooling System... Lift Arm Support...Meters/gauges/ Warning Lights...Operator Cab... Parking Brake...Push Button Activated Glow Plugs...Seat Bar... Seat Belt...Spark Arrester Muffler		
Attachment Available	Angle Blade... Angle Broom... Auger... Backhoe... Bale Handler... Box Scraper... Buckets... Combination Bucket... Front Scarifier... Grader... Grapples & Forks... Hydraulic Breaker... Landscape Rake... Longwood Grapple... Pallet Forks... Planer... Rear Stabilizer... Snow Blower... Stump Grinder... Sweeper... Three Point Hitch... Tiller... Tracks... Tree Transplanter... Vibratory Roller... Wheel Saw... York Rake.		

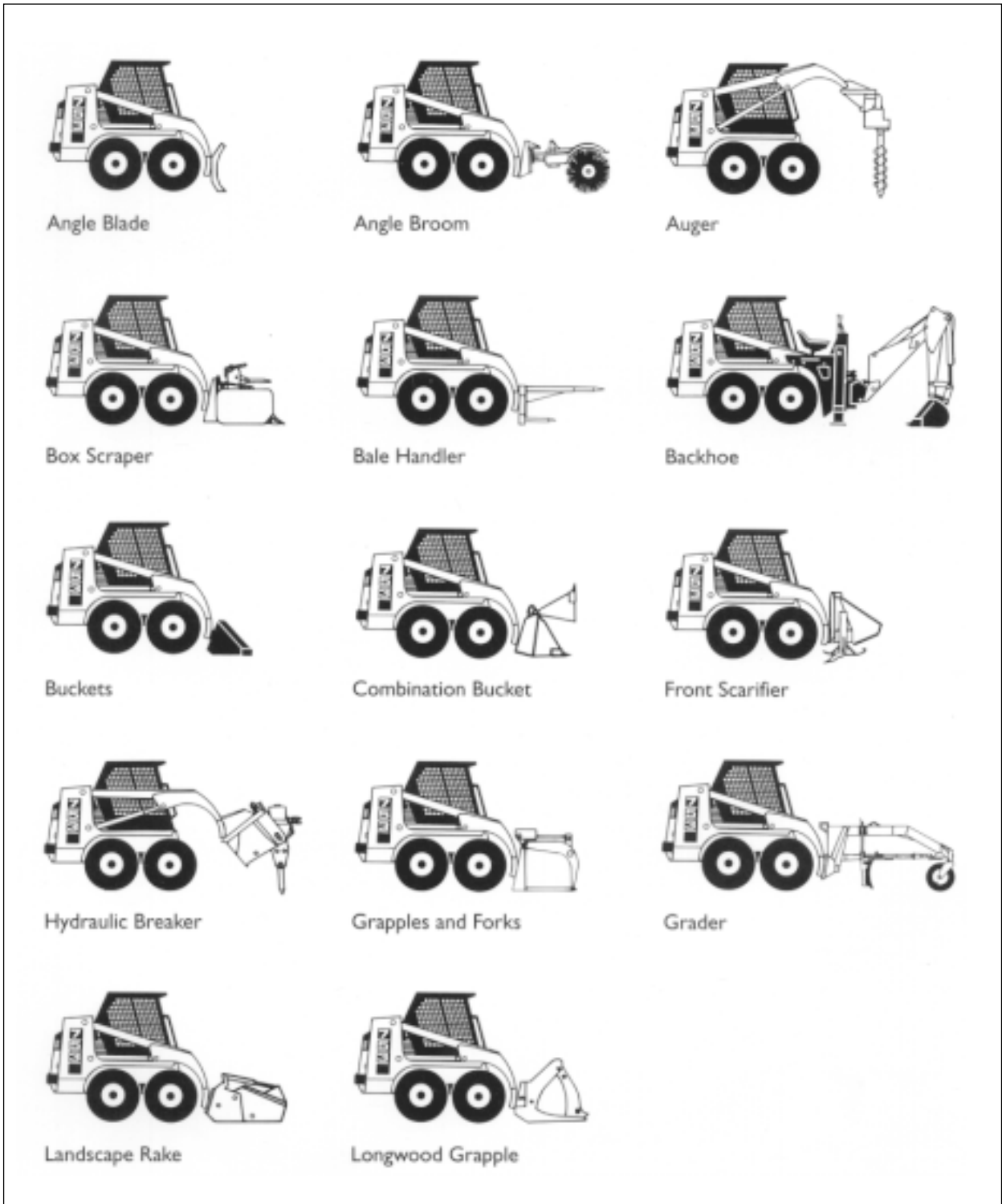


Figure 23.—Attachments available for the Bobcat Skid-Steer loaders.

B. Takeuchi TL26 Compact Track Loader

The Takeuchi TL26 Compact Track Loader has an overall width of 60.2 inches (1.5 m) (without bucket). The loader is mounted on rubberized crawler tracks which have internal steel cables and exposed mandrels. The internal steel track cables absorb the power generated by the high torque planetary final drives. The track rollers ride on the exposed steel mandrels to prevent inner track damage from rocks and other debris. A tracked undercarriage provides machine stability and the high ground surface contact makes a stable platform. This is important in rough terrain with significant side slope or with an inexperienced operator. The tracks have a rated ground pressure of 5.8 psi (40 kPa) which allows for flotation in slippery or muddy conditions and in loose materials. The track undercarriage delivers the traction required for excavating tough, heavy materials.

The TL26 Compact Loader is equipped with ROP/FOP as part of the cab enclosure. A seat belt is provided and a lap bar is also standard equipment for additional restraint. This loader uses a hydraulically released multi-disc type parking brake that engages whenever the engine stops, the lap bar raised, or the brake lever applied. Windows are provided to keep out the elements and noise. The noise level at the operators ear is 87 dBA. The rear and top windows are removable if the normal front exit is obstructed.

Travel and loader functions are controlled by two joysticks. Auxiliary hydraulics are controlled with a foot pedal that is lockable in the loose position for an attachment requiring continuous fluid flow. The operator compartment is spacious and is equipped with a six-way adjustable suspension seat. The lap bar doubles as an arm rest for the operator when using the joysticks. Like other rear mounted loaders, visibility is excellent. The instruments are grouped to provide information at a single glance. Audible and visual alarms alert the operator to potential engine problems.

Specifications:

TL26

Dimensions & Weight

Operating Weight	6813 lb.
Width w/o bucket	60.2 inches
Height	79.4 inches
Length w/ bucket	130.4 inches
Length w/o bucket	103.6 inches
Front Clearance Radius w/ Bucket	81 inches
Rear Clearance Radius	59.1 inches
Angle of Departure	26°
Maximum Lift Height to Bucket Pin	119.2 inches
Dump Height Fully Raised	93.8 inches
Maximum Dump Angle Fully Raised	38°
Maximum Bucket Rollback @ Ground Level	30°
Reach Fully Raised	27.8 inches

Engine

Make/Model	Isuzu 4JB1PA-20
Horsepower/rpm	61.5/2600
Cylinders	4
Displacement (CID)	169
Noise Level @ Operator's Ear	87 dBA

Performance

Tipping Load	3750 lb.
Operating Capacity	1310 lb.
Breakout Force	4930 lb.

Cycle Time

Raise - full Load	4.2 seconds
Lower - no load	2.5 seconds
Dump - full load	2.7 seconds
Curl - full load	2.1 seconds

Specifications:

TL26

Bucket

Width	66 inches
Capacity - SAE Heaped	12.9 ft ³

Hydraulic System

Drive System	
Hydrostatic Pump	Variable Displacement Piston x 2
Hydraulic Flow	23 gpm x 2
System Relief Valve Pressure	3980 psi
Charge Pump Pressure	200 psi

Implement System

Pumps	gear x 2
Hydraulic Flow	17.4 GPM / 11.0 gpm
System Relief Valve Pressure	2276 psi
Control Valve	3 spool sectional

Undercarriage

Traction Motor Type	Piston
Traction Drive Type	Planetary
Traction Brake Type	Multi-Disc
Traction Force	6514 lb.
Track Rollers (per side)	5
Shoe Type	Rubber Crawler Belt
Crawler Belt Width	12.6 inches
Track Ground Contact Length	46.5 inches
Ground Pressure	5.8 psi
Minimum Ground Clearance	10.8 inches
Maximum Travel Speed	5.3 mph

Capacities

Hydraulic Tank	13.2 gal
Fuel Tank	15.6 gal
Engine Oil	6.6 qt.
Engine Cooling System	3.3 gal
Planetary Drive Reduction Unit	1.9 qt.

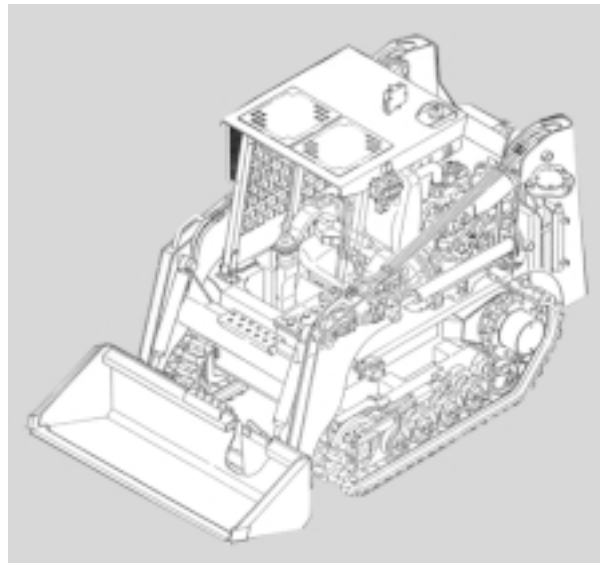


Figure 24.—Takeuchi TL compact track loader.

HAULERS

Configuration

The basic hauler has two components: cargo area and power unit. The cargo area of the haulers listed in this document range from a polyethylene tub to a hydraulically tilting dump bed. The power units range from an electric motor to a 4-stroke, liquid-cooled 90°V-Twin.

Discussion

Haulers are used to haul material to and from a job site. The hauling capacity and travel speed becomes important when hauling to and from a remote location. Although these machines were designed to traverse unimproved areas, in most cases the machines travel on trails being maintained or trails with a rough cut tread.

Advantages / Disadvantages

The advantages/disadvantages listed here are by no means complete. The advantages/ disadvantages differ with varying situations. The list compares mechanized and manual hauling.

Advantages

- Greater hauling capacity with shorter cycle.
- Reduced physical demand to the user.
- Reduced injury due to manual labor.
- Traverses rougher areas than a garden cart or wheelbarrow.

Disadvantages

- Requires more maintenance.
- Requires transport
- Need to carry gasoline or batteries
- High initial capital investment when compared to manual methods.

A. Chikusui

Chikusui makes a range of powered haulers. Four of the most common are listed here. These machines are tilting dump beds mounted on rubber tracked crawlers. The rubber tracks are reinforced with steel wires and a steel core. The tracks gives these machines excellent traction and can travel through rough areas. The models RD3 and KD3 are equipped with a three-way tilting bed. Dump beds are hydraulically operated and an automatically opening tail gate assists in the dumping process. The bed will tilt up 57° when dumping. The Chikusui are powered by either a gasoline or diesel engine.

Specifications:	Model	GC-640R, GC-640K	GC-640RD3, GC-640KD3
Chassis			
Length		100.4 (2550)	100.4 (2550)
Width		42.7 (1085)	43.9 (1115)
Height		50.4 (1280)	50.4 (1280)
Crawler			
Ground Contact		40.6 (1030)	40.6 (1030)
Width		9.8 (250)	9.8 (250)
Center Length		28.7 (730)	28.7 (730)
Inside Bed			
Length		63.6 (1615)	63.9 (1625)
Width		10.8 (275)	39.9 (1015)
Engine			
Type		Petrol (R Series) Diesel (K Series)	Petrol (RD3 Series) Diesel (KD3 Series)
Max. Power		10 hp (R), 8 hp (K)	10 hp (RD3), 8 hp (KD3)
Starter System		Recoil or Cell (R) Handle or Cell (K)	Recoil or Cell (RD3) Handle or Cell (KD3)

Specifications:	Model	GC-640R, GC-640K	GC-640RD3, GC-640KD3
Chassis Weight lbs. (kg.)		1342 (610)	1410 (640)
Max. Load Capacity		1760 (800)	1760 (800)
Min. Turn Radius		1760 (800)	1760 (800)
Ground Clearance		4.7 (120)	4.7 (120)
Forward Speed		4	4
Reverse Speed		3	3
Max. Speed		3.4 mph (5.4 kph)	3.4 mph (5.4 kph)
Dump System		Oil Pressure Reciprocating	Oil Pressure Reciprocating
Dump Angle		57°	55°
Clutch		Belt Tension	Belt Tension
Brake		Inner expansion	Inner expansion
Climb Capacity		25° (880 lbs.)	25° (880 lbs.)

B. DR® PowerWagon™

The DR PowerWagon is essentially a powered wheelbarrow; a stake bed mounted on a powered wheeled undercarriage. Three models are available and are discussed below. The rated load capacities range from 400 to 800 pounds (181.6 to 363 kg) depending on model. Since the PowerWagon is powered, the operator does not have to lift any load. These haulers are equipped with a tilting (forward) dump body which aids in unloading.

The wide tread tires selected for the PowerWagon are designed for carrying loads on uneven or soft soils distributing the load and reducing the impact and provide more traction with heavier loads. Wheel weights are available to increase traction and provide stability when operating the PowerWagon with the sulky (a trailer with a seat for the operator) without a load. Each wheel weight weighs 41 pounds (18.6 kg) and attaches to the drive wheels. The sulky attaches to a single ball hitch. Sulkies are good for relatively flat ground, however its use adds to the weight the engine has to pull. This could be a problem in steep, rough, or boggy areas where the added weight may be too much for the engine. If this is the case, the operator has to dismount until a more suitable terrain is reached. In general the PowerWagon can climb a 20° slope. This number would change depending on terrain conditions and load distribution. The downhill speed of the hauler is controlled by using a lower gear.

The controls are mounted on a panel between the handlebars. The PowerWagon is equipped with a “dead-man clutch” or a “dead-man grip” (for electric motors) which automatically stops the engine. Electric starters are available for the gasoline models.

The PowerWagon can be equipped with two body types, a stake body and molded body. Each body type comes in two sizes, small and large, to accommodate the different models. The frame is constructed with hand-welded 1-inch (25.4 mm) diameter 11 gauge cold-rolled steel tubing. The frame is powder coated.

Specifications:	PowerWagon™	PowerWagon II™	Battery-Electric Power Wagon™ Motor
Engine			
Type	Tecumseh Vector	Tecumseh Premier	
Displacement	207 cc. (12.6 cu.in.)	~	
Power	6 hp	4.0 hp	300 Watt, 1800 rpm, 24 volt, fully enclosed permanent magnet
Starter	Manual-recoil start Electric start key (optional)	Manual-recoil start Electric start key (optional)	

Specifications:	PowerWagon™	PowerWagon II™	Battery-Electric Power Wagon™ Motor
Fuel Capacity	1.5 qt. (1.43 liter)	1.5 qt. (1.43 liter)	
Max Speed	5.5 mph	3 mph	3 mph
Brake	Disc brake with parking brake latch and reverse gear stop.	Disc brake with parking brake latch and reverse gear stop.	External band brake mounted on the differential. With parking brake.
Rated Capacity	800 lbs.	500 lbs.	400 lbs.
Stake Body	Large	Small	Small
Flatbed Dimensions	40" x 31.5"	30.5" x 24"	30.5" x 24"
Inside Bed Dimensions	39" x 29.5" x 9"	31.5" x 24" x 6"	30.5" x 24"
Body Floor	5/8" dent-proof pressure treated plywood	5/8" dent-proof pressure treated plywood	5/8" dent-proof pressure treated plywood
Volumetric Capacity	5.9 cubic feet	2.0 cubic feet	2.0 cubic feet
Weight (w/o sulky)	230 lbs.	167 lbs.	167 lbs.
Height @ Handlebars	38.5"	33" - 37.5" adjustable	33" - 37.5" adjustable
Sides & Front Panel	1"x7" removable pressure treated wood.	1" x 5" removable pressure treated wood.	1" x 5" removable pressure treated wood.
Overall Length	76.5" w/o sulky	53"	53"
Overall Width	35"	27.5"	27.5"
Overall Height	41.5"		
	Large Molded Body	Large Molded Body	
Volumetric Capacity	5.6 cubic feet	5.6 cubic feet	
Weight (w/o sulky)	184 lbs.	184 lbs.	
Height @ Handlebars	38.5"	38.5"	
Overall Length	79"	79"	
Overall Width	35"	35"	
Floor Dimensions	30" x 27"	30" x 27"	
Inside Body Dimensions	Top: 40.5" x 30.5" x 9"	Top: 40.5" x 30.5" x 9"	
Outside Body Dimensions	Top: 43.5" x 33" x 9"	Top: 43.5" x 33" x 9"	
Body Material	Vacuum-formed, .25" polyethylene	Vacuum-formed, .25" polyethylene	
		Small Molded Body	Small Molded Body
Total Weight		137 lbs.	137 lbs.
Volumetric Capacity		2.75 cu. ft.	2.75 cu. ft.
Overall Length		54"	54"
Overall Width		27.5"	27.5"
Body Material		Vacuum-formed, .25 " polyethylene	
Front Tire	16/6.50 x 8 tubeless turf thread	13/5.00 x 6, 2 ply tubeless	13/5.00 x 6, 2 ply tubeless
Rear Tire	4.10/350 x 4, 4 ply, saw tooth thread tubeless	4.10/350 x 4, 4 ply saw tooth thread	4.10/350 x 4, 4 ply saw tooth thread
Sulky			
Weight	38 lbs.		
Length	49"		
Sulky Tire	410/350 x 6 2-ply stud thread, tubeless		
Wheels	pressed steel rims, ball bearings		

Special Features

DR® PowerWagon™

Multi-speed gear-drive transaxle mounted on outboard ball bearings for increased capacity and durability.

Interior components are immersed in an oil bath.

Four-forward speeds, 1 reverse

Built-in weight rack to increase traction when empty, and for pulling sulky.

Twin-belt drive train for smoother transfer of power from the engine to transaxle.

DR® PowerWagon II™

Adjustable handlebars. Height adjusts from 33 inches to 37.5 inches.

Multi-speed gear drive mounted on outboard ball bearings for increased capacity and durability.

Two-forward speeds, 1 reverse, and neutral

Transmission: Peerless Series 700 die cast aluminum housing. Oil impregnated bronze bushing and needle bearings on imprint shaft. Heat treated spur gears.

Differential: Sintered metal and steel cut automotive-type, hardened thrust washer. Die cast aluminum housing with oil impregnated bearings.

Battery-Electric DR® PowerWagon II™

Forward and reverse controls, turn knob and/or handle with autostop; brake with parking lock.

Battery charger: 24-volt with overcharge protection. Recharges overnight.

Battery: Two 12-volt, deep cycle, Genesis-sealed lead acid batteries; connected in series.

Motor controller: Electronic infinite speed controller, 50% reverse speed built-in motor protection.

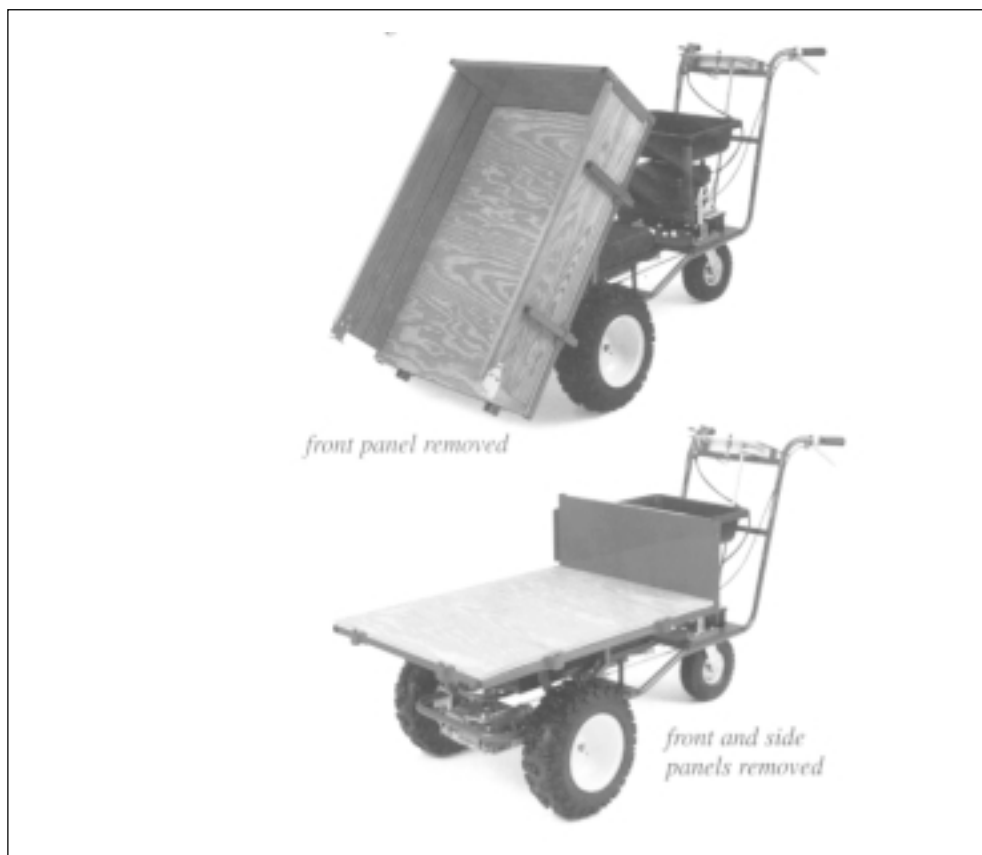


Figure 25A.—DR® PowerWagon™.



Figure 25B.—DR® PowerWagon™.



Figure 26.—DR® PowerWagon II™.



Figure 27.—DR® PowerWagon™ Battery Electric.

C. Honda Power Carriers

The Honda Power Carriers are walk-behind haulers with a stake bed mounted on a tracked undercarriage. The tracked undercarriage provides a stable platform that traverses rough and uneven terrain. Each track can be controlled independently giving the Power Carriers a tight turning radius. The tracked undercarriage gives the Power Carriers a low center of gravity, making it more stable.

The controls are mounted on and next to the handle bars. Stake beds on the carriers are sheet metal and the beds can be titled manually for dumping.

Specifications:	HP250	HP400
Engine:	4-stroke, single-cylinder, air-cooled	4-stroke, single-cylinder, air-cooled
Power	2.4 hp, single valve	4 hp, overhead valve
Transmission	2 forward speeds, 1 reverse	2 forward speeds, 1 reverse
Dimensions (LxWxH)	63" x 24" x 41"	74" x 25" x 41"
Dry Weight	262 lbs.	352 lbs.
Wheelbase	22.5 inches	32 inches
Fuel Capacity	0.25 gallons	0.42 gallons
Ground Speed	1st gear 76 ft/min 2nd gear 191 ft/min Reverse 71 ft/min	1st gear 76 ft/min 2nd gear 191 ft/min Reverse 71 ft/min
Carrier Dimensions (LxWxH)	Adjustable 32" x 20" - 31" x 5.3"	Adjustable 43.7" - 58" x 20" - 30" x 7"
Load Capacity	Level operation 440 lbs. Inclined operation 330 lbs.	Level operation 770 lbs. Inclined operation 550 lbs.

Special Features

- Track steering
- Manual-tilt cargo bed
- Adjustable side rails
- Tie-down hooks
- Low center of gravity
- Sealed transmission
- Transmission protector bar
- Easy view fuel check



Figure 28.—Honda Power Carrier.

D. PeCo Tracker 1000

The Tracker 1000 is a rideable hauler. The dump body is mounted on a tracked undercarriage that provides more traction and stability. This hauler has the largest rated capacity of the haulers reviewed. Like the other tracked hauler, the Tracker 1000 has rubber tracks which reduces damage on finish surfaces. The Tracker 1000 comes standard with a flat bed with fold down sides. The flat bed dimensions are increased when the sides are folded down. A bucket hopper with 1-yard capacity is available.

Specifications:

PeCo Tracker 1000

Load Capacity	1000 lbs.
Length	7' 8"
Width	40"
Weight	750 lbs.
Travel Speed	0 to 4 mph
Ground Pressure (unloaded)	1.4 psi
Ground Pressure (fully loaded)	4.5 psi
Bucket Hopper Capacity (optional)	1 yard
Flat Bed Dimensions	40" x 60" x 12" (fold down sides)
Length with sides folded down	72"
Width with sides folded down	64"
Engine Options	12 hp Kawasaki 12 hp Kohler 13 hp Kawasaki 13 hp Honda 14 hp Briggs & Stratton

Special Features

- Rubber tracks
- Hydrostatic drive
- Infinitely variable speed
- Easy to reach controls
- 5 micron supply and return filter
- Zero turn radius
- 70 degree dumping angle
- Hydraulic dumping
- Self adjusting tracks

E. Whiteman Power Buggy

The original Whiteman Power Buggy was designed over 30 years ago as a convenient way to carry concrete or any bulk material. The Power Buggy could be operated as a "ride-on" or a walk-behind hauler. All controls are conveniently located for easy use by the operator. The machine is compact and lightweight. The buggies are powered by Honda engines with recoil starters. An electric start is an option on the 16 cubic foot model. This hauler utilizes an infinitely variable, fully hydrostatic drive system which allows smooth, steady operation from start to stop. A polyethylene cowling covers the engine and other vital components. This cowling can be easily removed giving access to virtually every control, adjustment, and fluid reservoir. The polyethylene bucket makes clean up easy. Concrete does not stick on the bucket. The bucket is stable to -40°F. The bucket is molded with a splash-shield to prevent material spills during operation.

Specification: Whiteman Power Buggy

Model WBH-12

WBH-16/-16E

Dimensions	72" x 32" x 47"	90" x 44" x 46"
(LxWxH)	(183 x 81 x 119 cm)	(229 x 118 x 117cm)
Wheelbase	38" (97 cm)	38" (97 cm)
Capacity Weight	1800 lbs. (816 kg)	2600 lbs. (1179 kg)
Engine	Honda GX-240 (recoil start)	Honda GX-340 (recoil start)
Horsepower	8 hp	11 hp
Tub capacity	12 cu. ft.	16 cu. ft.
(cu. ft. water level)	(340 liter)	(453 liter)
Transmission	Infinitely variable hydrostatic drive	
Speed	Up to 7 mph forward & reverse	Up to 7 mph forward & reverse
Steering	Rear wheels	Rear wheels
Drive Wheel Brakes	Oversized hydraulic disk type	Oversized hydraulic disk type
Parking	Mechanical	Mechanical
Turning Radius	51" (130 cm)	51" (130 cm)
Dump Control	Fully hydraulic dump and return	Fully hydraulic dump and return
Operating Weight (lb.)	860 lbs. (390 kg)	900 lbs. (408 kg)
Drive tires	5.70 x 8 (4-ply)	5.70 x 8 (4-ply)
Steering Tires	4.80 x 8 (4-ply)	4.80 x 8 (4-ply)



Figure 29.—Whiteman Power Buggies.

F. Kawasaki Mule 1000/2510

The Mule utility vehicle is a cross between a power hauler and an All-Terrain Vehicle with a tilting pick-up style bed and a fold down tail gate to aid in unloading material and access the engine. The Mule 1000 has a load capacity of half a ton while the Mule 2510 is limited to 800 pounds (363 kg). Each of the vehicles is designed to tow up to 1000 pounds (454 kg). Safety features in these machines include: Rollover protection, seatbelts, headlights, tail lights, and stop lights.

The Mule 1000 is a two wheel drive (rear wheel drive) with a Dual-Mode differential which allows the operator to lock the drive wheels for added traction or unlock the drive wheels when traveling on delicate surfaces. The Mule 2510 is equipped with selectable 4-wheel drive and a limited-slip differential allowing the vehicle to traverse unimproved surfaces. The short wheelbase aids in the vehicle's ability to maneuver in rough and close quarters.

Special Features

Mule 1000

Rack & pinion steering

Automatic clutch

Dual-mode differential locks the rear wheels together for added traction.

Tilting cargo bed. A hydraulic tilt-bed kit is available.

Spin-on automotive type oil filter, paper air cleaner, and no-points electronic ignition.

Sealed drivetrain.

Mule 2510

Rubber mounted 4-stroke, OHV, V-Twin engine to reduce noise and vibration.

Selectable 4-wheel drive and McPherson strut type front suspension.

Limited-slip front differential, balloon tires.

Tilting cargo bed rated up to 800 and 1200 pounds (363 and 545 kg). Rated trailer hitch.

Sealed, self-adjusting dual front drum brakes.

Air-intake snorkel built into cab frame with dual-element air filter. The air filter is located under the driver's seat.

5.3 gallon (20 L) fuel tank

External DC leads provide power for electrical accessories.

Specifications:	Model	Mule 1000 (KAF450-B1)	Mule 2510 (KAF620-A1)
Engine Type		4-stroke, liquid cooled In-Line Twin	4-stroke, liquid cooled 90° V-Twin
Displacement		454 cc	617 cc
Bore x Stroke		72.5 x 55.0 mm	76 x 68 mm
Compression Ratio		9.6:1	10.3:1
Valve System		DOHC, 8 valves	OHV
Carburetion		Keihin CVK30 x 2	Mikuni BV26-18
Air Filter		dry replaceable	twin element dry replaceable oil
Filter		Automotive-type spin on canister	Automotive-type spin on canister
Ignition		Maintenance free digital	Transistorized
Electrical		12-volt DC; 19 amp-hour battery, alternator	12-volt DC; 19 amp-hour battery, alternator
Drive Train		Automatic torque converter; forward, neutral, reverse	Automatic torque converter; forward, neutral, reverse
Final Drive		Dual-mode differential	Dual-mode differential, 4WD
Tires front/rear		Tubeless, 22 x 11-10	Tubeless, 22 x 11-10
Suspension, front		Independent McPherson-strut type	Independent McPherson-strut type
Suspension, rear		Independent semi-trailing arm type	Semi-independent, DeDion type

Specifications:	Model	Mule 1000 (KAF450-B1)	Mule 2510 (KAF620-A1)
Wheel travel, front/rear		4.0/4.0 inches	3.9 / 2.8 inches
Steering		Rack & pinion	Rack & pinion
Brakes		4-wheel hydraulic drum self adjusting	4-wheel hydraulic drum self adjusting
Fuel Capacity		4.5 gallons	5.3 gallons
Dry Weight		1065 lbs.	1184 lbs.
Overall Dimensions (LxWxH)		108.7 x 51.8 x 72 inches	112 x 57.5 x 75.6 inches
Wheelbase		70.3 inches	73.6 inches
Ground Clearance		8.1 inches	6.7 inches
Cargo Bed (LxWxH)		x 44.9 x 10.6 inches (11.3 cu. ft.)	x 51.6 x 9.6 inches (13.3 cu. ft.)
Track, front/rear		38 / 40.6 inches	45.7 / 46.5 inches
Vehicle Load Capacity		1030 lbs.	800 lbs.
Towing Capacity		1000 lbs.	1200 lbs.
Turning Radius		14.4 feet	11.2 feet
Top Speed		25 mph (governed)	25 mph (governed)
Lights		35 watt sealed beam headlights with (2) 8/27-watt tail/spotlight	35 watt sealed beam headlights with (2)5/21-watt tail/spotlight
Instrumentation		Speedometer, odometer, fuel gauge, warning lights for oil pressure, coolant temp., parking brake	



KAF450-B1



KAF620-A1

Figure 30.—Kawasaki Mules.

ALL-TERRAIN VEHICLES (ATV)

Configuration

There are numerous ATV models on the market. The basic configuration resembles a motorcycle with either three, four, or six wheels. The models come in either a two or four wheel drive. ATV's typically have a short wheel base with high ground clearance.

Discussion

ATV's are versatile trail machines used for hauling material and shuttling personnel to and from the job site. An ATV can tow a trailer to haul material and equipment to the job site. There are numerous attachments which can be purchased or fabricated to adapt the machine to all sorts of tasks. The ATV's are used with a drag/plow (figure 32) or a harrow to groom trails. The drag/plow, Trail Dawg, is a grooming tool requiring two people to operate; an ATV driver and one person to stand on the drag and free it from roots when necessary. The drag has a deep vee shape and a large tee handle for height adjustment. The Trail Dawg was designed and built by the Rampart Range Motorcycle Committee. A harrow, similar to the ones used on baseball fields, could be dragged behind the ATV to groom the trail or to remove the outside berm on a newly constructed trail.

After market kits are also available to improve the performance of the ATV. The II-Tracker, shown in Figure 32, bolts on to the Yamaha 350/400, the Honda 350/400, the Kawasaki 400, and the Polaris 350/400 4X4. The II-Tracker kit increases the footprint of the applicable 4X4 ATV by adding another set of wheels. The extra wheels increase the vehicle's stability, payload, and towing capacity.

Specifications for the typical ATV's are not covered in this document because information is readily available through dealers.



Figure 31A.—ATV dragging a harrow, Pacific Crest Trail, Angeles National Forest.



Figure 31B.—ATV Permazyme at Mark Twain National Forest.

Advantages/Disadvantages

The advantages and disadvantages listed here are not an all inclusive list. The list is generated by comparing the use of the machinery to the manual method of grooming and hauling materials.

Advantages

Versatile the ATV can be fitted with implements used for trail building.

Readily available.

Accessibility most ATV's are small and rugged and can travel over rough unimproved terrain or narrow trails.

Able to haul larger loads.

Higher travel speed thus covering a larger area. When used to haul tools and material, the higher travel speed reduces the cycle time.

Disadvantages

Need to transport.

Need to carry fuel.

Operator has to be trained to operate and handle the machine.

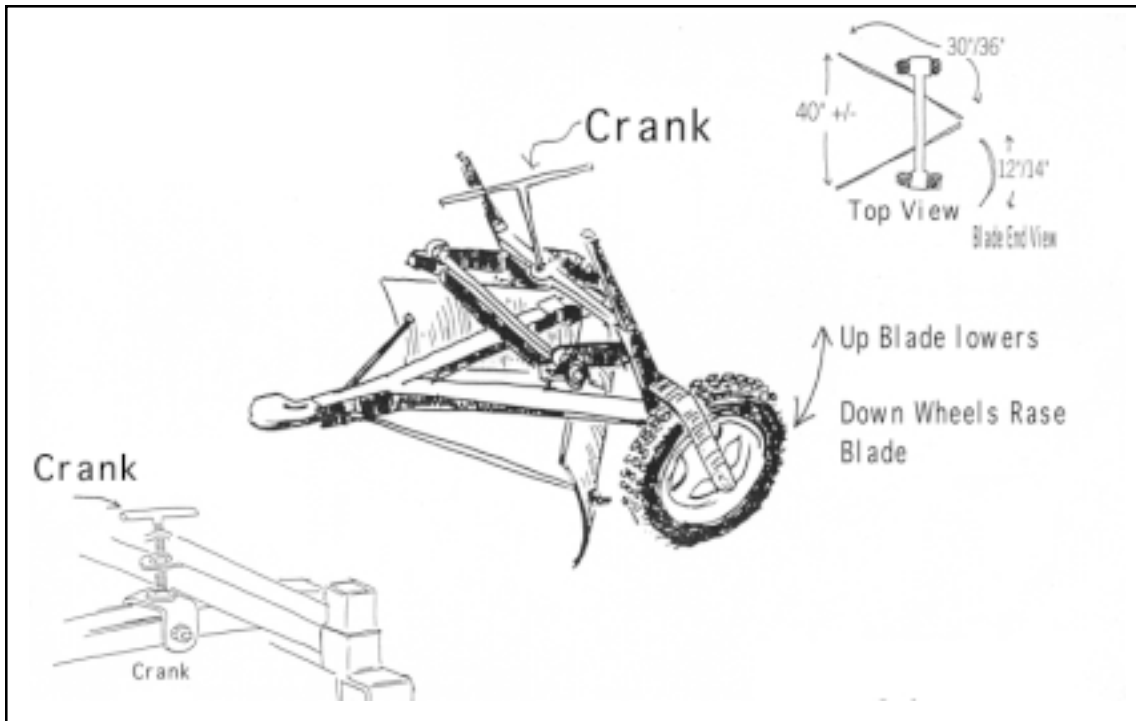


Figure 32.—Trail Dawg.



Figure 33.—II Tracker.

Appendix A

Definitions

Definitions:

Blade Height - The vertical distance from the lower edge, resting on the horizontal reference frame, to the top of the blade.

Boom Swing Angle - The angle between the longitudinal centerline and the boom when moved to the left and right. The angles may differ from left to right.

Bucket Digging Force - The digging force generated by the bucket cylinder(s).

Capacity SAE Heaped - The volume of material "heaped" over the stuck volume at a 1:1 angle of repose. This does not apply if the hoe must carry the bucket oriented in this attitude or if all the material has a 1:1 angle of repose.

Digging Depth, 2 ft. Flat bottom - The vertical distance from the ground line to a flat bottom trench 610 mm (24 inches) in length generated by the bucket teeth.

Digging Depth, 8 ft. Flat bottom - The vertical distance from the ground line to a flat bottom trench 2440 mm (96 inches) in length generated by the bucket teeth.

Drawbar Pull - Horizontal force use to accelerate the vehicle, climb the slope, or pull loads. Also called the tractive effort.

Excavator - A mobile machine which has an upper structure capable of continuous rotation and which digs, elevates, swings, and dumps material by action of the boom and the bucket. The upper carriage may be mounted on a tracked or wheeled undercarriage. The boom and bucket are hydraulically controlled.

Flywheel HP - Net engine power. Net flywheel power of a fully equipped engine.

Gradeability - The calculated tangent of the slope expressed in percent, independent of surface conditions, that the hydraulic excavator can negotiate based on rated draw bar pull (DBP) and operating weight (W).

Hydraulic Lift Capacity - The actual vertical load measured at hinge pin of bucket that can be lifted at a specified position under specific conditions.

Lift Capacity, Over End - The load that can be lifted anywhere within an angle of 45 degrees either side of a line through the swing pivot centerline and parallel to the prime mover.

Lift Capacity, Swing Arc - The load that can be lifted by actuating the boom cylinder(s).

Boom Lift Capacity - The load that can be lifted by actuating the boom cylinder(s) and can be held by the dipper stick cylinders.

Hydraulic Pump Delivery - Combined output flow with engine at "rated engine speed," of all pumps supplying oil to hydraulic travel motors and at the hydraulic pressure differential required to sustain travel motion on a level surface having a rolling resistance equal to that specified in the definition of rolling resistance.

Loading Height - The maximum vertical distance from the ground to the lowest point on the bucket. Bucket is to be positioned so that the line passing through the hinged pin center and passing through the farthest point forward point of the bucket cutting edge shall be 60 degrees maximum with respect to the horizontal. SAEJ1349.

Loading Reach - The horizontal distance from the intersection of swing pivot centerline and supporting surface to the bucket teeth with bucket positioned and located as describe in the loading height.

Maximum Blade Lift, Lower Edge - The maximum vertical height which the lower edge of the blade can be raised from the horizontal reference plane. Tire size should be specified.

Maximum Digging Depth - The vertical distance from the ground line to the tip of the bucket teeth.

Operating Mass - The mass of the base machine with all equipment specified by the manufacturer, 75 kg (165 lb) operator, full fuel tank, with full lubricating, hydraulic, cooling systems.

Operating Weight - The total weight of the unit as specified, fully serviced, and including a full fuel tank and an 80 kg (175 lb.) operator.

Rated Boom & Dipperstick Lift Capacity - The lift capacity is 87% of the hydraulic lift capacity; not to exceed 75% of the tipping load, measured at the hinge pin of the bucket.

ROPS/FOPS - Roll-Over Protection Structure / Falling Objects Protection Structure.

Rolling Resistance - The force required to sustain track rotation over a given level surface. It includes losses caused by soil deformation, track chain motion and drive sprocket. For the purpose of developing a uniform rating, a value of 6% of operating weight should be used.

Shipping Mass - The mass of the base machine without the operator, with full lubricating, cooling, and hydraulic systems, 10% of the fuel tank capacity and with the equipment as specified by the manufacturer.

Slew Speed - See swing speed.

Standard Bucket Capacity (SAE J296).

Stick Digging Force - The force generated by the arm/dipperstick cylinder.

Struck Volume - The volume bounded by the strike plane, side sheets, bottom sheets, and back sheet.

Swing Speed - Rotation of the cab about the vertical axis. Units in revolutions per minute (rpm).

Travel Speed - Speeds that can be obtained on a hard horizontal surface in each forward and reverse gear ratio with the engine at rated speed, machine empty of payload.

Appendix B

Manufacturers

Manufacturers:

Bobcat Excavators and Loaders
Melroe Company
P.O. Box 6019
Fargo, ND 58108-6019

Chikusui CO., LTD
Daiwa Building 8F, 39-3
Hashizume-cho, Uchihomachi,
Higashi-ku, Osaka, 540 Japan
Franksons, Inc.
Authorized Sales, Service, & Parts
1004 South Glendale Ave..
Glendale, CA 91205
(818) 247-0306

DR® PowerWagon
Country Home Products®
Ferry Road
P.O. Box 89
Charlotte, Vermont 05445

Honda Power Carriers
DBA May's Honda Sale
909 Hwy 2-Dover Highway
Sandpoint, ID 83864

John Deere
RDO Equipment Co.
P.O. Box 1069
Riverside, CA 92502-1069
(800) 494-4863

Kawasaki Motors Corp.
P.O. Box 25252
Santa Ana, CA 92799-5252

Kobelco America Inc.
10515 Harwin Drive
Houston, TX 77036
(713) 981-4050
Fax: (713) 981-0150

Kubota Tractor Corporation
550 W. Artesia Blvd.
Compton, CA 90220
(310) 370-3370

Morrison Trailblazer
5125 Griffin Lane
Medford, OR 97501
(503) 779-8690
Fax: (503) 779-3242

PeCo Inc.
P.O. Box 1197
Arden, NC 28704
Phone: (704) 684-1234
1-800-438-5823
Fax: (704) 684-0858

SWECO Dozer
Sutter Equipment Co.
Novato, CA 94947

Takeuchi Manufacturing Co.
2711 Peachtree Square
Atlanta, GA 30360-2634
Phone (401) 5500
Fax: (404) 451-4544

II-Tracker
P.O. Box 606
Portland, OR 97207
Phone: (503) 292-8682
Fax: (503) 292-8697

Western Trail Builders Association
President: Roger Bell
Bellfree Contractors, Inc.
505 W. Cypress Ave.
Redlands, CA 92373

Whiteman Buggies
Whiteman Industries
19810 Wilmington Ave.
P.O. Box 6254
Carson, CA 90749

Appendix C

Trails 2000

A Trail Construction and Maintenance Update

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Preface

I have been managing trail systems for over 20 years and have seen a steady decline in the ability to maintain and construct trails within the Forest Service and other government agencies that provide trail opportunities due to reduced staff and budgets. During those years, I have designed, laid out, constructed and maintained hundreds of miles of trails. In 1993 I completed my most valuable achievement by constructing the last major link in the Pacific Crest Trail. However the government continues business as usual; well, we can't continue to do business as usual. Making a career of swinging a Pulaski or other hand methods is just not good enough for the professional trail manager.

But we still have 100,000+ miles of trail in the Forest Service to keep open and safe for the public - they are demanding it! I am proposing a strategy to help the Trails Program survive today and in the future - I call it "TRAILS 2000". It may seem a major diversion from our normal policy, but if its to survive, that's what's needed. People who helped me make the strategy a reality, such as Mike Dolfey, Don Trammell, Jeff Applegate, Doug Pewitt, Max Larson and Ralph Rawlinson have seen the need and have tried this new approach with much success. I would also like to thank the people at Sutter Equipment Company who have worked with me over the years to develop a machine that can do what we needed it to do, that is, build and maintain multi-purpose trails faster and at less cost per mile than any other approach.

TRAILS 2000

An Approach to Survival

I. INTRODUCTION

A. The state-of-the-art, Trail Construction, 1968

In 1968, a report was prepared by the Missoula Equipment Development Center (MEDC) for ED&T 1831, revised in 1969, that recognized a major trend in trail construction, maintenance, the problems and a recommended solution. The problems identified were (and are even more applicable today):

1. Escalating trail construction costs
2. A growing demand for trails
3. Wilderness trail costs escalating at 10.5%/yr. as they are tied to labor costs.
4. A huge inventory (50,000 miles) of inadequate trails that need to be repaired.
5. Limited funds available, yet plans call for an additional 22,000 miles of new trails.
6. A desperate need to reduce construction and maintenance costs.

The extensive analysis of this report concluded that the area of highest potential savings is reducing labor associated with trail clearing and earthwork. In a trial project, mechanization of this component reduced overall trail costs significantly (25%) by using a backhoe machine to build 24" and 36" trails.

The report also concluded that wider treads (24" to 48") have the following advantages and characteristics:

1. Increased useful life
2. Decreased maintenance
3. Decreased overall construction costs
4. Initially lower aesthetics i.e. more soil exposed and vegetation disturbance
5. Increased capability to travel faster and safer.

A relationship of tread width to trail mileage became apparent.

1. Wider treads yielded more trail miles per dollar and shorter construction/maintenance time.
2. Costs per trail mile dropped due to indirect costs becoming a smaller percentage of total cost.

The conclusion and recommendations were:

Rather than have a mix of 18", 24", 36", and 48" trails each designated for a specific use, why not standardize on a size that fits all, is easier to build and maintain and thereby reduce the number of trail miles required to satisfy the public. The report published in 1968 by MEDIC for ED&T 1831 stated that 48" trails in 3 to 5 years had sloughing and vegetation growth that reduced the tread width to 3 feet and were aesthetically pleasing, requiring very little maintenance.

In Summary:

1. Wilderness demands are increasing rapidly and will compete even more for trail dollars.
2. The biggest factor in reducing costs is mechanization of clearing and earthwork.
3. A 48" trail tread may be the most economical, short and long term.

B. 1968 to 1994 Update

This report attempts to update the analysis, conclusion and recommendations of the 1968 report to current conditions.

Since 1968, there have been considerable changes and events that make the 1968 report even more significant and poignant.

1. Congress is cutting budgets and staff dramatically.
2. Public demand for trails is growing even more rapidly.
3. Multi-purpose trails are becoming the norm.
4. Wider and smoother trails are needed to accommodate the rapid growth in urban forests.
5. Wilderness demands for trail funds continue to compete at an escalating rate.
6. Trail construction and maintenance is falling even further behind plans and projections due to increased cost of personnel, shrinking funds and staff.
7. Public dissatisfaction with trail conditions may result in pressure on Congress to review or even cut the budgets even further.

These events underscore the need to dramatically improve the current methods of trail construction and maintenance, i.e., construct and maintain trails cheaper and faster without sacrificing the environment.

The 1968 report compared 18" trails constructed by hand with 24" and 36" trails using some mechanization and found mechanization reduced costs dramatically.

This report will review the next step in this progression taking the 24" and 36" trails to 48" wide using advanced methods and reviewing the costs and consequences.

II. TRAILS 2000 TRAIL CONSTRUCTION AND MAINTENANCE

Because of the time and funding constraints, it would be impossible to duplicate the 1968 report, but I feel comfortable in making observations and comparisons of how far we have come over the past quarter century. For the purposes of this report, I did not comment on 5 of the 11 components: blasting, sign installation, bridges, punchon and crew facilities. My only comment would be to say "all these activities would be greatly enhanced by the use of hydraulic and pneumatic tools. My discussion will be in the form of observations and actual construction and maintenance projects. I didn't do any controlled engineering analysis of the operations, just field observations and experience.

I have included the actual report to help refresh people's memories and give credit to LaMoure Besse who was the author and developer of the 48" wide trail standard. I never met LaMoure, but he sparked the idea that has become a reality today. Before we get into Trails 2000, let's look at costs. In 1968, they used \$3.00 per hour cost for labor; today it can be \$30.00 or more for the same labor, and overhead costs have risen from 5-10% to 30% or more while productive work periods have decreased from 6 hours to 4 hours or less if you incorporate all the new mandatory programs required today.

Another factor that has required a look at how we develop and maintain trails is the continuing efforts to manage for (OHV) motorcycle/ATV's and mountain bikes. Our continuing efforts to educate ourselves by developing new construction maintenance standards has shown us that we will need mechanized equipment to meet the maintenance needs for this significant segment of our recreating public; if you combine all these conditions, it is painfully evident we cannot keep up and have steadily fallen further behind in deferred maintenance and new construction. It's only my opinion, but from my observations and discussions with other trail managers nationwide, our biggest culprit is resistance to change, "This is the way we always do it."

What I am proposing won't work in wilderness areas or for trails that can't be developed to the 48" width; but for the vast majority, we can and must take advantage of new technology and products to provide the quality, lowest cost and resource-sensitive trail systems. That is why I propose Trails 2000.

A. Trails 2000

Utilizing a 48" wide trail tractor, mechanical toter, hydraulic/pneumatic tools, and ATV's with a crew of two or three, I have been able to construct and maintain trails at the ratio of 10:1 or more over conventional methods while maintaining the highest quality with much less long-term resource impacts and at a

lower cost per mile. In utilizing the two person crew, it is critical for the persons to be qualified to operate the trail machine and work in shifts to keep pace with the tractor. The key to this crew is mobility and mechanical advantage.

A typical day of trail maintenance (which is already 48") proceeds as follows: The two-person crew arrives with all equipment on one trailer (tractor, toter, hydraulic and pneumatic tools) on site, unloads and begins working. The trail tractor can move large amounts of material and compact it with only one person while the other crew member utilizes the toter to carry all tools necessary and pulls a trail groomer. The crew, working in heavy brush and steep side hill, can move along at 500 to 1,500 feet per hour. The main deciding factor will be the ability of the crew person(s) to keep pace with the tractor.

The majority of my trail system needs to be reconstructed to replace the water bars with rolling and drain dips. To make such a change requires moving large amounts of soil and compacting the base to prevent loss of water control. In addition to the water control, I have found the need to redesign switch backs into climbing turns where areas are being managed for mountain bikes or OHV'S. The long-term resource impacts on switch backs warrant the redesign. Using the trail machine requires very little time and effort, 1/2 to 1 hour compared to all day or longer and still not have the ability to compact the soil in the turn to lessen erosion. The other design factor found with OHV's and mountain bikes is the need to have berm banked or super-elevated areas where the vehicles tend to ride toward the outside of a turn. These areas need a machine to mechanically place and compact the material to prevent the vehicle from riding off the trail and promotes the direction of travel without barriers or signs.

There is a continuous flow of improved equipment and methods for the building of trails and trail maintenance being developed. Some of these will be highlighted below:

B. Method

Trail design, planning and construction has advanced significantly in the last few years. Considerable effort has been made to observe and document causes of trail deterioration and misuse and then develop corrective methods.

Water Bars vs. Rolling Dips

Not too many years ago, water bars were about the only solution to trail water diversion. However, they experienced considerable erosion which necessitated high maintenance.

Rolling dips have been tried as an alternative which have proven quite successful. They are constructed over a length of 20' to 40' with a smooth 1' to 2' dip in the trail. The cross berm is just slightly sloped to the downhill side and spaced perpendicular where water would naturally drain from the trail. It is imperative the berm be compacted to retain its shape. In severe situations, soil stabilization is often used. These are described below.

Switch Backs vs. Climbing Turns

1. Switchbacks

In the past, switchbacks have tended to be flat turns which resulted in trail bikes kicking out tread as they power around the turn. This, in turn, accelerated trail erosion and failure.

If the turn is banked with the outside edge being the high side, the trail bike doesn't slide when power is applied but instead puts pressure straight down on the tires which increases traction and reduces tread kick-out thereby eliminating displacing or shearing the soil. This will prevent erosion and prolong trail life.

2. Climbing Turns

The original design started with the standard switchbacks for foot transportation to gain elevation within a limited area by reversing direction (180 degrees) while maintaining an acceptable trail grade. A climbing turn utilizes a larger turning arc with a bermed outside edge and has a continuous smooth arc and grade utilizing existing side slope grade. For side slopes up to 30%, climbing

turns can be constructed without a large amount of disturbance by moving the existing tread material to the outside edge to create a berm. But for side slopes greater than 30%, rolling dips are required before and after the turn, trail grades into and out of the turn should be as level as possible and the actual turn is constructed by berming up the outside of the trail tread until a smooth arc has been achieved. Water is then channeled to the inside of the turn and drained at the rolling dip directly after the turn.

C. Products

The following products and equipment are all designed to reduce trail construction and maintenance costs, accelerate and simplify the methods and be as environmentally compatible as possible. There are a number of products available for tread construction to reduce or eliminate tread erosion and promote stabilization.

Construction Materials

There are a number of building block types of materials that are placed directly on the trail tread that form a foundation for the trail and hold the trail material in place. Some of these are Turfstone, and interlocking paving stone, Geoweb Cellular Confinement System, and expandable honeycomb structure, and Geoblock Porous Pavement System, a flexible pavement system that will support vehicular and pedestrian traffic.

Soil Stabilization Products

There currently are a number of products available which vary in cost and type of use, are non-toxic chemicals and bind clay structures to form materials that are resistant to moisture penetration. Some of these compounds are Bio Cat, EMC2, Permazyne and Road Bond These are applied in various concentrations, mixed into the soils and compacted by the use of a heavy roller. These all require the soil or trail tread have at least 5 to 10% clay content.

Another product that will bind aggregate containing little or no clay is Road Oyl. This is a pine tar derivative that acts as a cementing agent. The product is mixed in much higher concentrations than the above compounds and therefore is much more expensive.

Sutter Retaining Wall

Building retaining walls has always been a tedious and labor-intensive process of digging or drilling holes for the vertical support members and support anchors, hauling in cement and back filling with a porous material for drainage.

A new product that is a significant time and labor saver has recently been developed by Sutter Equipment Co., where the vertical member or post is a steel "H" beam that is either driven into the ground by a hydraulic hammer or slipped over a steel pin that has been drilled into the rock foundation. The horizontal members, either treated 2x6 or 2x12 wood or 2x6 or 2x10 recycled reinforced plastic members, are placed in the "H" beam web and fastened with metal screws. Either earth anchors (soil) or chemical (rock) anchors secure galvanized allthread to the vertical steel members. Finally, a steel cap is placed over the top horizontal members to protect against damage from falling rocks, which are fastened to the steel posts tying the total structure into one unit. The vertical posts also have a slot for hand rails to be installed on top of the retaining wall.

Mechanized Equipment

Hand Tools

A variety of pneumatic and hydraulic hand tools are currently available to perform any task imaginable. They include limb loppers, chain saws, jackhammers, rotary drills, cut off saws, post pullers, tampers and more.

Normally, limb loppers and chain saws are preferred pneumatic as the single air line is much easier to handle than two hydraulic hoses.

On the other hand, jack hammers and rock drills are usually recommended hydraulic as they have much more power and are quieter.

Trail Dozer

Sutter Equipment Co. realized in 1988 that 48" trails were becoming more popular due to the dramatic growth in the use of ATV's and the basic economics of multi-purpose trails. By 1990, Sutter Equipment Co. had redesigned and tested its 48" wide crawler tractor in the field, building trails of all kinds. Considerable input was received from the Forest Service, BLM, State and County Park and Recreation Departments. The resulting SWECO 450 has a number of features that allows the construction and maintenance of trails are considerable savings, with less staff and is much faster. The tractor was reviewed in detail from both an engineering standpoint for this report (see Appendix I) and then tested in the field by a number of agencies as described in the following section "Case Histories."

III. CASE HISTORIES

The following case histories are not intended to be a complete test of the Trails 2000 system trail dozer and its attachments but only to demonstrate what was experienced by different users.

In summary, the dozer cut and graded out a 48" tread in easy to extremely rocky ground at the rate of 1,500 ft. to over 8,000 ft./day. This is about ten times faster than the mechanized 24" and 36" wide treads discussed in 1968 report by MDEC. This translates into an 80% cost reconstruction for the clearing and earthwork portions of trail construction. Since this portion is 40% to 50% of total direct and indirect trail costs i.e. does not include bridges, signing, administrative, etc.; the net trail cost reduction will range form 30% to 90%. Other costs were reduced using the dozer which included:

1. Only one operator and one helper is normally required which reduces transportation, supply and facility requirements.
2. The dozer has hydraulic connections or "power beyond" as a standard feature both front and rear which means the use of hydraulic hand tools did not require a separate power source.
3. Dozers equipped with an air compressor can supply air to pneumatic tools which eliminates the need for a separate compressor.
4. Dozers equipped with the chipper eliminated the need for either stockpiling or hauling out brush and tree limbs.
5. Dozers equipped with the slope board save considerable time and manpower trimming off the high side of the cut bank which greatly reduce future sloughing onto the trail.
6. Dozers equipped with the winch were able to pull trees and boulders out of the way that would take considerable manpower and time otherwise.

Overall, the machine is expensive when compared to other currently available equipment. However, when the cost savings are taken into account, the machine can pay for itself in a short time. In the case of the Angeles National Forest, approximately \$67,000 and 2 months' time was saved in just one 10-day project.

A. History No. 1

Angeles National Forest

Pacific Crest Trail

In 1960, President Johnson signed into law the building of the Pacific Crest Trail from the Mexican to the Canadian Border.

By January of 1993, only 7.2 miles were left to complete the Pacific Crest Trail (PCT). This portion is in the Angeles National Forest on the Tejon Ranch at elevations of 4,000 to 6,000 feet. The trail needed to be laid out, flagged, roughed out and finished. The terrain included considerable brush, rock outcroppings and some very steep slopes, as much as 80%.

The Angeles National Forest was requested to complete this portion by June 5, 1993, the date of the PCT dedication ceremony.

A budget was established of \$75,000 and 3 months time for completion. Staff, however, could not start the work as planned due to required right-of-way documents on the Tejon Ranch. The project was delayed until May, 1993 when all approvals were finally obtained, leaving only 1 month time.

RESULTS

A. Case History No. 1 Angeles National Forest

NAME: Pacific Crest Trail, Tejon Ranch section

LOCATION: Angeles National Forest, Saugus Ranger District

LENGTH OF TRAIL: 38,016 feet

TYPE OF TRAIL: hiker/equestrian

TYPE OF TERRAIN: canyons with steep side hill mostly broken rock, shallow soils and bedrock.

TYPE OF VEGETATION: dense chemise chaparral with scrub oak/digger pine average 3-4 root wads per foot.

TYPICAL SIDE HILL: 40 to 80%

WIDTH: 48 inches

GRADE: average 8% with short pitches to 18%

CLEARING: 6 ft. wide, 10 ft. high

CREW SIZE: 2 persons

MACHINE: SWECO 450

RATE OF CONSTRUCTION: average 660 ft. per hour. TOTAL 10 working days.

FUEL CONSUMPTION: 67 gal. #2 diesel

COMMENTS

Construction consisted of side hill tread construction through heavy brush and scrub oak and pines. Clearing, tread construction, water control, back cutting and finish grading were accomplished with two passes. The two passes consisted of one for pioneering, the other for back cutting and finish grading. No breakdowns occurred with daily servicing consisting of air filter clean out, (6) grease fittings, engine/hyd. oil checks and fueling. The tractor didn't use any oil or lose any fluids.

COMPLAINTS

Engine cooling fan needed to be reversed to blow air away from operator.

COMPLIMENTS

Ease of operation and power to remove stumps and rocks the size of the machine with relative ease and no breakdowns.

COST: Move In/Out Cost: Vehicle Mileage and Employee Salary	\$ 800.00
Trail Construction Tractor Cost	100.00
Trail Construction ATV Cost	50.00
Trail Construction: Two Employees 10 hr. x 8 days	4,000.00
Travel and Daily Mileage, 2 Pickups 10 Days x 1250 Miles x \$0.30	900.00
Brushing/Clearing: 8-Person Fire Crew 5 Days	<u>2,560.00</u>
Total	\$8,460.00

ESTIMATED COST if done by crew:

Time: 12 weeks Cost: (12 man crew @ \$12.00/hr)	\$ 69,120.00
In/Out costs:	<u>5,880.00</u>
Total	\$75,000.00

B. Case History No. 2 Mendocino National Forest

NAME: Contour Trail

LOCATION: Mendocino National Forest, Stonyford Ranger District

LENGTH OF TRAIL: 4,800 feet

TYPE OF TRAIL: Dirt Bike, ATV, Mountain Bike

TYPE OF TERRAIN: Steep side hill, shallow soils, with some large rocks.

TYPE OF VEGETATION: Dense chemise/ceanothus chaparral. Average 1-2 root wads per foot.

TYPICAL SIDE HILL: 40 to 60%

WIDTH: 48 inches

GRADE: average 6% with short pitches to 10%

CLEARING: 6 ft. wide, 10 ft. high

CREW SIZE: 4-person brushing crew, plus equipment operator and swampier.

MACHINE: SWECO 450

RATE OF CONSTRUCTION: average 480 ft. per hour. TOTAL 2.5 working days.

FUEL CONSUMPTION: 10 gal. #2 diesel

COMMENTS

Construction consisted of light chain saw brushing and tractor side hill tread construction through heavy chaparral. Clearing, tread construction, water control, back cutting and finish grading were accomplished with two passes. The two passes consisted of one for pioneering and the other for back cutting of air filter blowout, (6) grease fittings, engine/hyd. oil checks and fueling. The tractor didn't burn or lose any fluids.

COMPLIMENTS

Ease of operation and power to remove large stumps and rocks. All water control features were tracked-packed. All work was completed with proper soil moisture present. This timing is critical for proper compacting of trail tread features.

COST: Includes:	1. Planning	\$1,950.00
	Location and Layout	
	BE/BA Wildlife/Sensitive Plants	
	Arch Survey ASR	
	NEPA Document - CE	
	2. Brushing/Clearing	500.00
	3. Tractor Construction	2,000.00
	4. Signing	500.00
	Total	\$4,950.00

ESTIMATED Cost if done by crew:

Time: 5 weeks	Cost: Labor (6 man crew at \$12.00/hr)	\$14,400.00
	In/Out costs:	<u>\$4,500.00</u>
	Total	\$18,900.00

C. Case History No. 3 California Parks & Rec.

Maintenance Report

NAME: Basalt Trail

LOCATION: San Luis Reservoir SRVA, Basalt Campground to Willow Point, CA.
Parks & Rec.

LENGTH OF TRAIL: 1.5 Miles

TYPE OF TRAIL: Hiker/Mountain/Equestrian

TYPE OF TERRAIN: Rolling Grass Covered Hills, Deep Soils.

TYPE OF VEGETATION: Grass

TYPICAL SIDE HILL: 40 to 80%

WIDTH: 48 inches

GRADE: Average 9% with short pitches to 15%

CLEARING: N/A

CREW SIZE: 2 person

MACHINE: SWECO 450

RATE OF CONSTRUCTION: Average 528 ft. per hour. TOTAL 2 Days.

FUEL CONSUMPTION: 22.5 gallons of #2 diesel.

COMMENTS

Construction consisted of widening an existing tread through rolling hills. Back cutting and grading were accomplished with two passes. The trail was finished with a hand crew. There were no breakdowns.

Daily servicing consisted of air filter blowouts, lube of grease fittings, engine/hydraulic oil checks and fueling. The tractor didn't burn or lose fluids. The crew consisted of one operator and one swampier and a six person hand crew.

COST: Includes	1. Move in/out cost. Vehicle mileage & salary	\$70.00
	2. Tractor cost: fuel, parts & maintenance	23.00
	3. ATV/Totter 1 cost: fuel, parts & maintenance	0.00
	4. Employees Salary: brushing crew/operator	943.00
	5. Vehicle Mileage: Pickups or Trucks	<u>20.00</u>
	Total	\$1,056.00
ESTIMATED Cost if done by crew:		
TIME: 3 weeks	Cost: Labor (8 man crew at \$12.00/hr)	\$11,520.00
	In/Out costs:	<u>650.00</u>
	Total	\$12,170.00

D. Case History No. 4 California Parks & Rec.

New Construction

NAME: Salt Spring Trail

LOCATION: San Luis Reservoir SRVA, Basalt Campground to Willow Point, CA.

Parks & Rec.

LENGTH OF TRAIL: 1 Mile

TYPE OF TRAIL: Hiker/Mountain/Equestrian

TYPE OF TERRAIN: Steep canyon wall with sandstone bedrock loosely consolidated. Shallow soils.

TYPICAL SIDE HILL: 60 to 90%

WIDTH: 48 inches

GRADE: 10% with pitches to 15%

CLEARING: N/A

CREW SIZE: Operator with one swampier. Six person hand crew.

MACHINE: SWECO 450

RATE OF CONSTRUCTION: Average 660 ft. per hour.(8 HOURS TOTAL)

FUEL CONSUMPTION: 12 gallons of #2 diesel.

COMMENTS

Construction consisted of widening an side hill tread across a steep grass covered slope. Underlying material was loosely consolidated sandstone. Cutting and grading were accomplished with 2 or 3 passes. There were no breakdowns. Normal servicing was performed daily. The tractor did not burn or lose fluids. The trail was finished with a hand crew.

COMPLAINTS

On occasion the trail edge, built of soft material, would give way and the tractor would slide downhill. On one portion of the trail, the tractor rolled onto its side and had to be jacked onto its tread.

There were no injuries or damage to the dozer.

COMPLIMENTS

The machine moved through the material with ease.

COST: Includes:	1. Move in/out cost. Vehicle mileage & salary	\$ 85.00
	2. Tractor cost: fuel, parts & maintenance	12.00
	3. ATV/Totter cost: fuel, parts & maintenance	0.00
	4. Employees Salary: brushing crew/operator	682.00
	5. Vehicle Mileage: Pickups or Trucks	<u>40.00</u>
	Total	\$819.00

ESTIMATED Cost if done by crew:

Time: 2 weeks	Costs: Labor (8 man crew at \$12.00/hr)	\$7,680.00
	In/out Costs:	<u>420.00</u>
	Total	\$8,100.00

E. Case History No. 5 Dixie National Forest

New Construction

NAME: Thunder Mountain Trail

LOCATION: Dixie National Forest, Powell Ranger District

LENGTH OF TRAIL: 22,176 feet

TYPE OF TRAIL: Hiker/Mountain Bike/Equestrian

TYPE OF TERRAIN: Canyon with steep side hill mostly broken rock, shallow soils and bedrock.

TYPE OF VEGETATION: Scattered conifer and mountain brush.

TYPICAL SIDE HILL: 40 to 80%

WIDTH: 48 inches

GRADE: 8% with pitches to 15%

CLEARING: 6 ft. wide, 10 ft. height

CREW SIZE: 3 person

MACHINE: SWECO 450

RATE OF CONSTRUCTION: Average 520 ft. per hour. Total 5.3 working days.

FUEL CONSUMPTION: 41 gallons of #2 diesel.

COMMENTS

Construction consisted of a side hill tread construction through brush and Pines. Clearing, tread construction water control, back cutting and finish grading were accomplished with two passes. The two passes consisted of one for pioneering the other for back cutting and finish grading. No breakdowns occurred with daily serving consisting of air filter blowout, (6) grease fittings, engine/hyd. oil checks and fueling. The tractor didn't burn or lose any fluids. Crew consisted of 1-tractor operator, 1 clearing crew, 1 ATV operator pulling a trail groomers.

COMPLAINTS

None.

COMPLIMENTS

It provided a base of operation and power to remove stumps and rocks the size of the machine with relative ease and no breakdowns.

COST: Includes:	1. Move in/out cost. Vehicle mileage & salary	\$ 260.00
	2. Tracer cost: fuel, parts & maintenance	160.00
	3. ATV/Totter cost: fuel, parts & maintenance	50.00
	4. Employees Salary: brushing crew/operator	1,500.00
	5. Vehicle Mileage: Pickups or Trucks	<u>5.00</u>
	Total	\$2,045.00

ESTIMATED Cost if done by crew: (Labor intensive due to extensive rock)

TIME: 8 weeks	Costs: Labor (6 man crew at \$12.00/hr)	\$23,040.00
	In/out Costs:	<u>3,200.00</u>
	Total	\$26,240.00

IV TRAIL DOZER OBSERVATIONS

The following is a brief summary of our observations of the SWECO 450 tractor construction and operation:

A. Trail Dozer

Undercarriage

The tracks, chain, sprockets, and rollers are made of hardened steel; the rollers are sealed for life and the track tensioners are a grease-filled piston with a pre-tensioned spring the same as Case, Cat & Deere crawlers. The life expectancy is ten years or more.

Frame

The tractor frame is a unitized structure made of 1/2" steel and has a full plate on the bottom to protect the drive components from projecting rocks, etc. There is a removable plate on the back to allow access to the engine drain and hydraulic motors.

Dozer Blade

The blade is 60" wide (50" at full angle), has extreme duty hardened steel corner rock bits and cutting edge. The 60" width is designed so that at full angle (30°), the blade is even with tracks on the uphill side and extends 2" past the tracks on the downhill or spillage side. This eliminates the problem of the tracks riding up on the spillage mound which would interfere with level grading.

The blade is constructed of 1/2" steel plate curved the right amount so the dozed material curls over as it's graded. The blade is backed by two 3/4 plates separated by a sheet of UHMW (Ultra High Molecular Weight) Teflon material to reduce friction and wear.

The blade is true 6-way blade tilting and angling 30° in all directions and drips 24" below the tractor tracks and raises 24" above. This allows the building of rolling dips and ditches. The cylinders are oversized to take the abuse from working in rocks and large roots/stumps.

The increased working angle and tilt of the blade facilitates cutting roots and prying out large rocks greatly reducing hand work and drilling/blasting.

Rippers/Draw Bar

Parallelogram rippers are hydraulically controlled and have 3 - 12" hardened steel shanks with replaceable cutting points. Utilizing the parallelogram mounted on a 3-point hitch arrangement allows for even soil penetration and lifting of material to maximize the efficiency of ripping. Utilizing the 3-point hitch allows

for even soil penetration and lifting of material to maximize the efficiency of ripping. Utilizing the three-point hitch allows adjusting the draw bar height for proper pulling of any implement and tucks away when raised up to the maximum.

Engine

Two engines are available, one with a turbo for high altitude applications, and one without. The non-turbo engine is a 56 hp. Isuzu, Model C240 water-cooled 4 cylinder diesel. The turbo engine, recommended over 5,000 feet elevation, is a 4JB 1T which produces 80 hp. The engines have been certified by Isuzu in a field test running the engines at full throttle for 6 hours at full load. The radiators are oversized and keeps the engines under 190° F at all times. The engines have three fuel filters and a triple air cleaner system.

Hydraulics

The tractor drive system is comprised of two series 48 Sundstrand variable displacement transmission pumps and drive motors rated at a maximum of 100 hp. The auxiliary pump is a positive displacement type and is rated at 20 gpm at 2,000 psi for the attachments.

The tractor has a manual safety brake that is released only by system hydraulic pressure. Thus, the tractor brakes will engage for any reason when the system loses pressure such as the engine stalling or a line breaks. The hydraulic tank has a 24-gallon capacity and has oversized, double filtration on the suction side and single on the return side. The dozer has hydraulic quick disconnects both front and rear for attachments and hydraulic hand tools.

ROPs

The roll-over protection system has been designed to support the weight of the tractor under dynamic conditions and also acts as a complete limb riser protecting the operator and exhaust stack. Side screens are standard to protect the operator.

Operation

The tractor was designed to produce a 36" trail or wider, be easy to operate for reliable and safe, and give the operator good visibility with a wide variety of attachments, eliminating the need for a number of other machines. The engine is in the rear, the operator sits in front, the same as a skid steer tractor. This allows excellent visibility of the dozer blade which is where most of the work is done. This does reduce the visibility in the rear, however, this did not seem to be a problem during the "case history" projects. All the controls for the attachments are on the right side of the operator, including the dozer blade, rippers, winch, backhoe, chipper, lights, air compressor and auxiliary hydraulic system for hydraulic hand tools.

On the left side are two steering controls side by side which operate each track separately. They are held in the left hand and movement forward or backwards moves the tractor in the same direction. If the hand is rotated slightly, one track slows down and the other speeds up which provides for full power turns. If the hand is rotated in the "dead center" or neutral position, the tracks counter rotate, which means the tractor will turn in its own length. The handles are spring loaded and return to the neutral position when released.

There are no foot pedals on the standard model, unlike the skid steer tractors, which makes learning to operate the dozer much easier and also makes it easier for the operator to brace himself on rough or steep terrain. However, in one case the tractor was modified for foot pedal operation to meet special needs of a one-armed operator.

The starting system includes a glow plug for cold weather starting. This is activated by turning the ignition key counterclockwise until the heater element (next to the ignition) glows, usually 20 to 25 seconds, then turning the key clockwise to start the engine.

The tractor comes with a safety belt and safety helmet and can be equipped with a shoulder harness for the fire operators. The owners manual contains safety precautions, operating tips, maintenance procedures and schedule. The instrument panel includes a tachometer/hour meter, engine temperature gauge, and fuel gauge. The warning lights include low engine oil pressure, alternator failure and high engine temperature. There is also a hydraulic oil level indicator.

B. Trail Dozer Attachments

The current SWECO 450 trail dozer has a variety of attachments in addition to the dozer and rippers that are designed to facilitate the full scope of trail building and maintenance. Sutter Equipment Co. continues to develop new attachments as demand dictates. Current attachments are:

Winch

This mounts in the rear on top of the ripper bar. It has a 9,000 pound pull and comes with 125 feet of 3/8" wide rope. It is controlled by the auxiliary valve at the operator's seat and has a free-wheeling feature.

Auger

The hydraulic auger mounts in place of the bucket on the backhoe. The auger bits are available in diameters ranging from 6" to 24" and are 48" long with extensions available.

Slope Board

The slope board mounts on the dozer, is hydraulically operated and is 4 feet long with hardened steel cutting edges. The slope board is reversible to either side of the blade and rotates from horizontal to vertical. It's used to trim the upper side of cuts made into the side slope and reduces the amount of long-term sloughing into a trail.

Air Compressor

The air compressor is mounted on top of the engine and comes with a 5 gallon air tank built into the dozer frame and a hose reel with 50 feet of 3/8 hose. This 12 cfm, 130 psi compressor allows the use of a variety of pneumatic tools such as chain saws, limb loppers and mechanics air tools.

Chipper

The chipper mounts on the 3-point hitch on the rear L of the dozer. It is powered by the hydraulic system and can chip up to 6" diameter material. It has a self-feeding system and emergency stop bar on the feed chute. The chipping blades are machined steel and reversible for longer life.

Roller Compactor

Two types are offered, smooth or with sheepsfoot. One is a pull behind 30 inch dia. x 4 feet wide. The other mounts on the ripper bar; is 12 inch dia x 4 feet wide, which can use the ripper cylinders for down pressure.

Tine Harrow

The pull behind tine harrow can be pulled by a NATV or tractor. It is used to smooth out trails once roughed in and comes in 4 feet wide sections. Several can be linked together to combine rough and smooth operations.

Flail Mower

A 41 inch wide, hydraulically powered flail mower is attached to the dozer blade. This allows adjustment to fit the side slope. It will mow material up to 1 1/2 inch diameter.

Trailer

Sutter Equipment Co. offers a tilt bed trailer specifically designed for use with the SWECO 450. It comes either with a straight tongue or fifth wheel, fir or hardwood decks and utility box for maintenance items and tools. The trailer is of sufficient length to also carry an ATV to facilitate transporting crew, materials, supplies and tools.

Options

The SWECO 450 has a number of options including:

- Back-up Alarm
- Front and Rear Lights
- Vandal Protection Kit
- Blade Extension
- Fire Extinguisher
- Spark Arrester
- High Altitude Package
- Extra High ROPs