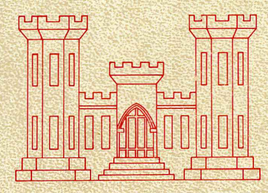
FORT CARSON, COLORADO

TERRAIN ANALYSIS



PREPARED BY

DAMES AND MOORE, WASHINGTON, DC

UNDER THE DIRECTION OF

THE TERRAIN ANALYSIS CENTER

US ARMY ENGINEER TOPOGRAPHIC LABORATORIES

FORT BELVOIR, VIRGINIA 22060

JANUARY 1978

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FORT CARSON, COLORADO

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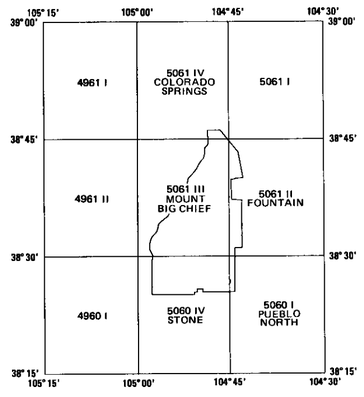

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CONTRACT NUMBER DACA 87-77-C-0059

JANUARY 1978

I. INTRODUCTION

BACKGROUND

The requirement for this terrain analysis of Fort Carson was stated in message P241854Z, October 1975, from the Commander, FORSCOM to the Office Chief of Engineers (OCE), Department of Army, subject: "Terrain Analysis of Selected FORSCOM Installations". The FORSCOM requirement identified 13 installations (later amended to include a total of 17) including Fort Carson, and cited topical coverage to be included in the studies. Responsibility for management and supervision of the program developed in response to the FORSCOM requirement was assigned by OCE to the Terrain Analysis Center (TAC), U.S. Army Engineer Topographic Laboratories. At FORSCOM request, TAC responsibility also includes technical supervision and direction of FORSCOM troop units assigned to the program.

Scope and content of the topical coverage included in the FORSCOM requirement were developed jointly between representatives of TAC and FORSCOM Headquarters. Analytical and cartographic specifications for the studies were developed by TAC, coordinated with OCE and concurred in by FORSCOM Headquarters.

This study was prepared by Dames & Moore, Washington, DC (Contract No. DACA 87-77-C-0059) under the direction of TAC.

PURPOSE

In stating the requirement for terrain analyses of selected installations FORSCOM indicated that the purpose of the program is to assist military planners in future stationing decisions. To achieve this purpose, planners must obtain an appreciation of the on-post terrain that includes among other things, knowledge of the suitability for conducting field training exercises involving maneuverability of troops and military vehicles. The degree of maneuverability that can be achieved is a function of several terrain factors including slope, surface configuration, soils, vegetative cover, and surface drainage, all of which are treated in the studies.

Planners concerned with troop stationing also need certain off-post information such as statistics on housing, schools, hospitals, and public utilities in urban areas near installations, as well as pertinent data on airfields and ports in the vicinity. These items are also treated in the studies.

Because the program under which this study was prepared is intended to serve troop stationing requirements, the support provided by the program to environmental requirements is only incidental. Some of the information contained in the studies may be useful as environmental baseline data, but the studies are by no means complete environmental inventories of the kind required in support of environmental impact assessments.

SCOPE

In scope, the terrain analysis is a compendium of available data on the pertinent natural and manmade features of the reservation and an evaluation of their effects on tactical military operations. The program does not include basic research to fill gaps in these data although some short-term field investigations were performed to obtain ground truth and a general overall appreciation of terrain elements. Therefore, the scope of the analysis is limited primarily to those factors which have been documented by other authorities and to the results of analysis and evaluation of those factors by senior terrain analysts for topics such as cross-country movement, cover and concealment, and water resources.

The terrain analysis preparation process has necessarily involved analytical judgment in the selection of pertinent source data, resolution of data conflicts, recognition of interrelationships not previously made explicit, and the application of remote sensing to update certain critical, time-variant data such as vegetative cover and manmade features including roads, airfields, and facilities constructed outside of the cantonment areas.

LIMITATIONS

The study naturally reflects limitations in the quality, amount, and currency of the source data on which it is based. Numerous field interviews and selective use of remote sensing were employed in an effort to assure presentation of the latest and best information. Within the relatively complex topical scope of the analysis, however, there are a number of aspects on which source data have not been generated with the focus or recency desired to meet objectives fully. As noted under Scope, the study effort was not designed to include basic research as a means of filling gaps in data.

By design, the presentation is cast at a level of data coverage consistent with stated objectives. Users interested in deeper pursuit of data are referenced to the List of Sources in the back of the study.

PRESENTATION

Maximum use of graphic presentation has been made throughout the terrain analysis. Supporting text is, as far as practicable, in tabular format keyed to the related graphics which follow. The primary map is 1:50,000. For Urban Area (Cantonment Area), the scale of the map is 1:9600 and for Off-Post Features the map scale is 1:1,000,000.

STUDY AREA

The Fort Carson military reservation is in semiarid south-central Colorado, approximately 13 kilometers (8 miles) south of Colorado Springs and 120 kilometers (75 miles) south of Denver. The reservation extends about 38.6 kilometers (24 miles) north-south and 24 kilometers (15 miles) east-west at its widest point, and covers an area of approximatey 570 square kilometers (140,000 acres). It includes parts of three counties--El Paso in the north and central portions, Pueblo in the south, and Fremont County on the western edge. The reservation lies between two major highways, Colorado State 115 on the west and Interstate 25 on the east.

The eastern portion of the Fort Carson military reservation lies within the Colorado Piedmont section of the Great Plains Province, a gently sloping surface of generally low relief. The western portion of the reservation is in the foothills of the Rampart Range, a part of the Southern Rocky Mountains Province. This area is characterized by higher relief and the occurrence of steeper slopes. The highest elevation is 2121 meters (6960 feet) on a ridge near the western edge of the reservation in the vicinity of State Highway 115. The lowest elevation is 1560 meters (5120 feet) in the valley of Beaver Creek in the extreme southwest corner of the reservation. The streams in this semiarid area generally flow from the northwest to the southeast and provide watershed drainage to the two major drainage systems which bound the reservation, the Arkansas River to the south and Fountain Creek to the east. All streams on the reservation are intermittent and contain water primarily during periods of substantial snowmelt or prolonged precipitation.

The temperature in the area is typical of a high elevation region having cool summers and relatively cold winters. Most of the precipitation occurs in the form of localized thunderstorms between April and September. Snowfall, with below-average moisture content, occurs October to April. Vegetation varies from short steppe, grass-covered lowlands on the east to pine forests in the western hilly upland. Cottonwood trees are found along the drainageways.

II. DESCRIPTION AND MILITARY ASPECTS OF TERRAIN

A. SURFACE CONFIGURATION

The eastern portion of Fort Carson is within the Colorado Piedmont section of the Great Plains Province; the western portion is in the foothills of the Rampart Range, a part of the Southern Rocky Mountains Province. The boundary between these two physiographic provinces is marked by a northerly trending ridge front which extends from the vicinity of State Highway 115 and Deadman Canyon on the north to the confluence of Booth Gulch and Turkey Creek on the south.

The extreme eastern portion of the reservation is characterized by low plains, consisting of flat to gently rolling alluvial surfaces drained by southeasterly flowing tributaries of Fountain Creek. The southeastern, west-central, and western portions of the reservation are characterized primarily by gently to strongly rolling, and intensely dissected high plains whose surfaces are interrupted by scattered rocky escarpments. An isolated group of rounded to sharp-crested low hills, characterized by rocky escarpments and moderate to steeply sloping terrain with narrow stream valleys, extends in a northerly direction across the west-central portion of the reservation. These low hills exhibit the highest relief in the area and form two prominent topographic features known locally as Booth Mountain and Timber Mountain.

LANDFORM TYPE	LANDFORM DESCRIPTION AND DISTRIBUTION	ELEVATIONS
1. LOW PLAINS	Flat to gently rolling alluvial surfaces of low relief predominate in the extreme eastern and in scattered areas in the east-central, west-central, and southern portions of the reservation. Slopes are largely between 0 and 3 percent, with slopes of 3 to 15 percent occurring locally in moderately dissected stream valleys in the extreme eastern portion of the reservation. Local relief is largely between 30 and 50 m (100 and 164 ft) throughout the low plains. The cantonment area, in the northeast portion of the reservation, is situated on a smooth alluvial surface with slopes predominantly between 0 and 3 percent; scattered areas of slope in the extreme northeast range between 3 and 8 percent. A major exception is the isolated hillock at grid reference 193863, where slopes are between 15 and 30 percent. Local relief within the cantonment area is largely between 30 and 36 m (100 and 120 ft). The eastern portion of the reservation contains the largest area of low plains. This area, which is drained by east-southeasterly flowing tributaries of Fountain Creek, including Rock Creek, Little Fountain Creek, and Sand Creek, occupies a smooth alluvial surface with average relief approximately 43 m (140 ft). Slopes are largely between 0 and 3 percent, with steeper slopes in the moderately dissected bluffs adjacent to Rock and Sand Creeks ranging from 3 to 15 percent. A major exception is the stream valley at grid reference 241711, where slopes locally exceed 30 percent. The valley of Turkey Creek and scattered portions of the upland surface immediately to the east consist of low plains; in the valley, gently to moderately rolling surfaces predominate, with slopes largely between 3 and 8 percent; the upland surfaces are flat to gently rolling with slopes predominantly between 0 and 3 percent. The low plains surface in the west-central portion of the reservation, known as Sullivan Park, is a broad, flat to gently rolling area surrounded by a series of moderate to intensely dissected high plains and, in part, by sharp-crested low hills. Slopes in the central portion of Sullivan Park are largely between 0 and 3 percent; on the valley periphery they range from 3 to 8 percent. The southwest portion of the reservation between Booth Gulch and Pierce Gulch is in a gently rolling plain containing slopes largely between 0 and 3 percent. Local relief is approximately 49 m (160 ft); the surface slopes generally to the south.	Elevations in the low plains range largely between 1646 and 1890 m (5400 and 6200 ft) above sea level. The lowest elevation, approximately 1630 m (5340 ft), occurs south of Young Hollow (grid reference 235635). The highest elevation is approximately 1970 m (6460 ft); this point is near the northwest boundary of a nearly flat area between Timber Mountain and State Highway 115 (grid reference 092721).
2. HIGH PLAINS	Gently to strongly rolling plains predominate in the southeast, west-central, and western portions of the reservation. This unit also occupies scattered areas northeast and southwest of the cantonment, and the valley of Young Hollow on the eastern boundary of the reservation. Slopes in this unit are largely between 3 and 15 percent; however, slopes greater than 30 percent occur locally in deeply dissected stream valleys and in scattered areas of hummocky landslide terrain. Slopes exceeding 100 percent occur along scattered rocky escarpments in the southeast and southwest portions of the reservation. Local relief is largely between 75 and 125 m (246 and 410 ft); maximum local relief is approximately 150 m (492 ft) near Wild Mountain. The terrain in the vicinity of the cantonment area and in the valley of Young Hollow is moderately rolling and has slopes largely between 3 and 8 percent. Slopes often exceed 15 percent in bluffs adjacent to stream valleys, exposing occasional rock ledges. Local relief is largely between 61 and 76 m (200 and 250 ft). In the southeast portion of the reservation the terrain is gently to moderately rolling with slopes of 3 to 8 percent. The surface is broken by three north-south trending, steep escarpments (hogbacks) capped by resistant limestone. Local relief is between 75 and 106 m (246 and 300 ft). The west-central and western portions of the reservation, surrounding Sullivan Park and including Wild Mountain, are moderately to steeply rolling, and, locally, hillocky and intensely dissected. The surface is more rocky than the high plains areas in the east and slopes generally range between 8 and 30 percent. A major exception is the area of Red Creek and State Highway 115, where slopes are between 3 and 8 percent. Slopes exceed 30 percent in Sand and Crooked Canyons and in hummocky landslide terrain at the extreme western boundary (Salt Canyon), including scattered, long, rocky escarpments peripheral to Timber and Wild Mountains. Hummocky landslide terrain also characterizes the slopes of Timber Mountain and Buck Hill. Local relief is largely between 106 and 125 m (350 and 410 ft); maximum local relief is 150 m (492 ft) in the vicinity of Wild Mountain. **The southwest portion of the reservation, including Booth Gulch, Pierce Gulch, Green Gulch, and lower Red Creek, is gently to moderately rolling. Slopes between 3 and 8 percent predominate; however, they exceed 15 percent on rocky dip-slope surfaces. The terrain is broken by a set of continuous rocky escarpments (hogbacks) which are eastward-facing at Booth Gulch and westward-facing at Pierce and Green Gulch. These escarpments, with slopes generally greater than 100 percent, reflect a general northwest to southeast geologic structure. Local relief is between 91 and 106 m (300 and 350 ft).**	Elevations range largely between 1645 and 1951 m (5400 and 6400 ft) above sea level. The lowest elevation is 1560 m (5120 ft) in the valley of Beaver Creek, in the southwest corner of the reservation (grid reference 037521). The highest elevation is 2101 m (6890 ft) at a point immediately to the west of the crest of an escarpment on Timber Mountain (grid reference 106686).
3. LOW HILLS	Rounded to sharp-crested hills, characterized by rocky surfaces, occasional gently rolling uplands, and shallow canyons with nearly vertical walls, occur in the west-central portion of the reservation. Slopes are largely between 15 and 45 percent; they often exceed 60 percent along steep-sided canyon walls and 100 percent along rocky escarpments. Local relief is largely between 150 and 220 m (492 and 720 ft); maximum local relief is 232 m (760 ft) on the easterly sloping surface immediately north of Timber Mountain. The most prominent landform features are Booth Mountain, the easterly sloping area north of Timber Mountain, and the intricately dissected, steeply rolling bluffs immediately east of State Highway 115 and Deadman Canyon. Booth Mountain is characterized by a moderate to strongly dissected rocky upland surface with numerous gulches and canyons. Scattered rocky escarpments are conspicuous, particularly the escarpment on the north end which extends continuously over a distance of 4.8 km (3 mi). Slopes are largely between 15 and 45 percent, with scattered gently rolling upland areas in the southern portion having slopes of 3 to 8 percent. Maximum local relief is 219 m (720 ft) along the axial crest. The easterly sloping terrain north of Timber Mountain varies from gently to steeply rolling. The center of the area has gentle slopes that range largely between 3 and 8 percent. This unit is bounded by steep westward- and southwestward-facing escarpments whose upper slopes are in hummocky landslide terrain. Maximum local relief is 232 m (760 ft). The area immediately east of State Highway 115 and Deadman Canyon is intricately dissected, steeply rolling terrain with slopes largely between 30 and 45 percent; slopes exceed 60 percent locally. The area exhibits the most rugged terrain on the reservation and is characterized by "badlands" topography, extremely rough, narrowly and steeply gullied topography carved in shale. Hummocky landslide terrain is also prominent on the northern and western slopes. Maximum local relief is between 207 m (680 ft) and 219 m (720 ft).	Elevations are largely between 1830 and 2075 m (6000 and 6800 ft) above sea level. The lowest elevation is approximately 1646 m (5400 ft), near Teller Reservoir, south of Booth Mountain (grid reference 143537); the highest elevation is 2121 m (6960 ft) on a ridge at grid reference 122779.

B. SURFACE DRAINAGE

Fort Carson is in the drainage basin of the Arkansas River. Principal streams that drain the reservation are Little Fountain Creek, Turkey Creek, and Red Creek. These and other streams originate in the mountains to the west and flow through Fort Carson, eventually reaching the Arkansas River, about 13 kilometers (8 miles) south of the reservation. Stream channels draining the southern and southwestern portions of the reservation empty directly into the Arkansas River or its tributaries, Beaver and Dry Creeks. Stream channels in the eastern and southeastern portions discharge southeast into the Fountain Creek drainage basin, which joins the Arkansas River near Pueblo, Colorado.

All streams on Fort Carson are intermittent and contain water primarily during periods of substantial snowmelt, or intense or extended rainfall. Snowmelt, occurring from April to June, creates fluctuating water levels varying from almost no flow to a fairly steady flow of short duration. Most of the precipitation falls in the form of localized thunderstorms between April and September; however, continuous streamflow rarely occurs. Stream channels are largely dry the remainder of the year.

Flash flooding occurs during rapid melting of the winter snowpack, when rain falls on frozen soil, during short rainfalls of high intensity, and when extended rainfall exceeds the infiltration capacity of the soil. Characteristic flooding is the result of localized high intensity storms of short duration. When these flash floods occur, excess surface water flows quickly into stream channels, creating rapid and often deep surges. Most storms producing floods occur between May and September.

On the reservation, flooding by streams south of the cantonment area could adversely affect cross-country movement at a large number of at-grade stream crossings (unimproved fords). These crossings are cuts in the streambanks with a graded roadway across the streambed. During shallow, high velocity floodflows, streambed undercutting could make fording difficult. Fountain Creek, just east of the reservation, has experienced serious flooding in the past and could restrict access to the reservation of personnel living off base.

No surface water records are available for streamflow on Fort Carson. Estimates of mean annual discharge, shown in the table below, were obtained from the U.S. Geological Survey. Drainage areas of selected streams were measured and estimated discharges were calculated using information developed by McCain and Jarrett. Discharge values used in the Drainage Characteristics table below are based on estimates for the two-year flood.

There are approximately 120 small earth dams used for erosion control on Fort Carson, primarily in the southern portion of the reservation. These contain water only during periods of high storm runoff.

No specific data are available on streambank slopes, materials, or heights. Generally, the banks are steep and deeply incised; however, they vary widely along the lengths of individual channels. In the eastern portion of the reservation, bank materials are mainly silt and clay of variable height. Bank materials in the western portion are predominantly coarse-grained; many stream channels expose bedrock.

B. SURFACE DRAINAGE (Continued)

DRAINAGE CHARACTERISTICS

DRAINAGE CATEGORIES	GENERAL	REGIME	WIDTH	BOTTOMS	DEPTH	VELOCITY AND DISCHARGE
WATERCOURSES						
Upper Arkansas drainage basin						
Red Creek	Wide intermittent stream flowing southwest through gently to strongly rolling plains in variable channels. Drains into Beaver Creek outside the reservation.	Streamflow occurs during spring snowmelt (April to June) and intermittently due to intense or extended rainfall (primarily from April to September).	Varies from 8 m (26.2 ft) to 20 m (65.6 ft) in normal flow. Channel subject to scour and siltation.	Mostly sandy with some silt and locally exposed bedrock. High infiltration rates. Basin slopes range from 5.1% in the north to 2.5% in the south.	Estimated average depth of 10-year flood 1.6 m (5.4 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 47.7 m^3/sec (1687 ft^3/sec).
Pierce Gulch	Narrow, gently meandering, intermittent stream flowing southwest through strongly rolling terrain in variable channels. Drains into Beaver Creek outside the reservation.	Same as above.	Varies from 2 m (6.6 ft) to 4 m (13 ft) in normal flow. Channel subject to scour and siltation.	Generally sandy with some silt and locally exposed bedrock. High infiltration rates. Average basin slope 1.4%.	Estimated average depth of 10-year flood 1.8 m (6.0 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 12.5 m^3/sec (443 ft^3/sec).
Booth Gulch	Intermittent stream flowing southeast through a shallow canyon with steep sides. Unstable channel bottom. Drains into Turkey Creek outside the reservation.	Same as above.	Varies from 4 m (13.1 ft) to 18 m (59.0 ft) in normal flow. Channel subject to scour and siltation.	Generally sandy with some silt and locally exposed bedrock. High infiltration rates. Average basin slope 1.9%.	Estimated average depth of 10-year flood 1.7 m (5.6 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 10.9 m^3/sec (385 ft^3/sec).
Little Turkey Creek	Major intermittent tributary of Turkey Creek flowing southeast through sharp-crested hills with localized rock outcrops. Drains into Turkey Creek.	Same as above.	Varies from 8 m (26.2 ft) to 10 m (32.8 ft) in normal flow. Channel subject to scour and siltation.	Generally sandy with some silt and locally exposed bedrock. Average basin slope 9.7%.	Estimated average depth of 10-year flood 1.3 m (4.1 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 45.4 m^3/sec (1606 ft^3/sec).
Turkey Creek	Intermittent stream flowing south through center of area. Meanders through flat to gently sloping valley to Teller Reservoir. Channel bottom variable.	Same as above.	Varies from 6 m (19.7 ft) to 14 m (45.9 ft) in normal flow. Channel subject to scour and siltation.	Generally sandy with some silt and locally exposed bedrock. High infiltration rates. Average basin slope 2.2%.	Estimated average depth of 10-year flood 1.8 m (6.0 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 57.6 m^3/sec (2036 ft^3/sec).
Wild Horse Creek	Intermittent stream originates in strongly rolling plains and continues south through flat to gently sloping plains below elevation 1676.4 m (5500 ft). Variable channel bottom. Drains into Dry Creek outside the reservation.	Same as above.	Varies from 4 m (13.1 ft) to 8 m (26.2 ft) in normal flow. Channel subject to scour and siltation.	Generally sandy with some silt and locally exposed bedrock. High infiltration rates. Average basin slope 1.4%.	Estimated average depth of 10-year flood 1.9 m (6.3 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 13.2 m^3/sec (468 ft^3/sec).
Other Streams	Narrow intermittent streams meandering through steep, deeply incised gullies in variable channels.	Same as above.	Generally less than 3 m (9.8 ft) in normal flow. Channels subject to scour.	Generally sandy with some silt and locally exposed bedrock. Very steep slopes with high gradients.	Depth of flooding will be generally low.	Most streams have high velocities when flowing.
Fountain drainage basin						
Young Hollow	Intermittent stream flowing southeast to Fountain Creek. Western two-thirds of stream flows through gently sloping plains; eastern third contained in highly incised erosional plains.	Streamflow occurs during spring snowmelt (April to June) and intermittently due to intense or extended rainfall (primarily from April to September).	Varies from 6 m (19.7 ft) to 16 m (52.5 ft) in normal flow. Channel subject to scour and siltation.	Mostly fine-grained silt and sand. Low infiltration rates. Average basin slope 2.2%.	Estimated average depth of 10-year flood 1.6 m (5.4 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 18.9 m^3/sec (667 ft^3/sec).
Sand Creek	Intermittent stream flowing southeast to Fountain Creek through flat to gently sloping plains. Variable channel bottom.	Same as above.	Varies from 10 m (32.8 ft) to 12 m (39.4 ft) in normal flow. Channel subject to scour and siltation.	Mostly fine-grained silt and sand. Low infiltration rates. Average basin slope 1.9%.	Estimated average depth of 10-year flood 1.6 m (5.1 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 15.3 m^3/sec (539 ft^3/sec).
Little Fountain Creek	Intermittent stream flowing southeast to Fountain Creek. Western half of channel flows through moderately rolling plains; eastern half flows through gently sloping plains. Channel bottom variable.	Same as above.	Varies from 6 m (19.7 ft) to 8 m (26.2 ft) in normal flow. Channel subject to scour and siltation.	Mostly fine-grained silt and sand. Low infiltration rates. Average basin slope 5.3%. For the portion of the stream on the base, the the average slope is 2.0%.	Estimated average depth of 10-year flood 1.4 m (4.5 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 39.1 m^3/sec (1382 ft^3/sec).
Rock Creek	Intermittent stream flowing southeast to Fountain Creek through flat to gently sloping plains. Variable channel bottom.	Same as above.	Varies from 4 m (13.1 ft) to 6 m (19.7 ft) in normal flow. Channel subject to scour and siltation.	Mostly fine-grained silt and sand. Low infiltration rates. Average basin slope 6.6%. For the portion of the stream on the base, the average slope is 1.9%.	Estimated average depth of 10-year flood 1.4 m (4.4 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 48.3 m^3/sec (1705 ft^3/sec).
Unnamed stream (grid reference 244810)	Intermittent stream flowing southeast to Fountain Creek through gently to strongly rolling terrain. Channel bottom unstable.	Same as above.	Varies from 4 m (13.1 ft) to 10 m (32.8 ft) in normal flow. Channel subject to scour and siltation.	Mostly fine-grained silt and sand. Average basin slope 2.3%.	Estimated average depth of 10-year flood 1.6 m (5.3 ft).	Very high velocity at high flows. Typical intermittent flood discharge less than 21.7 m^3/sec (766 ft^3/sec).
Other Streams	Intermittent streams flowing through gently to strongly rolling plains and draining into Fountain Creek or its tributaries. Variable channel bottom.	Same as above.	Generally narrow channels in normal flow. Channels subject to scour and siltation.	Mostly fine-grained silt and sand. Average basin slopes less than 2.0%.	Depth of flooding will be generally low.	Most streams have high velocities when flowing.
STANDING BODIES OF WATER						
Reservoirs (see table below)						

RESERVOIRS

MAP NUMBER	NAME	GRID REFERENCE	APPROXIMATE WATER SURFACE AREA AT CAPACITY hectares	(acres)	CONSTRUCTION* AND USE
1	Teller Reservoir	151548	37.5	(92.7)	Recreation and wildlife management.
2		210786	1.3	(3.2)	Intermittent—irrigation supply.
3		213782	0.9	(2.2)	Intermittent—irrigation supply.
4	Haymes Expansion	189791	0.7	(1.6)	Recreation and wildlife management.
5	Haymes Reservoir	191791	3.4	(8.4)	Recreation and wildlife management.
6	Northside Reservoir	209796	4.0	(10.0)	Recreation and wildlife management.
7	Fountain Reservoir	223806	1.0	(2.6)	Abandoned water supply reservoirs presently used by City of Fountain for ground water and surface water replacement. Discharge through 20.3 cm (8 in) pipeline into Fountain Creek.
8	Fountain Reservoir	225806	1.0	(2.4)	Same as above.
9	Fountain Reservoir	226806	0.2	(0.6)	Same as above.
10	Birdfarm 2 Reservoir	145816	1.4	(3.4)	Recreation and wildlife management.
11	Birdfarm 1 Reservoir	144814	3.0	(7.4)	Recreation and wildlife management. Overflow discharge and 25.4 cm (10 in) steel suction pipe.
12	Townsend Reservoir	171812	4.1	(10.2)	Recreation and wildlife management.
13	Gail Ditch Head Stabilization Dam	145820	0.8	(2.0)	Head stabilization.
14	Ames Reservoir	231821	--	--	Abandoned—may be reconstructed for fish and wildlife management.
15	Lonetree Reservoir	154813	0.8	(2.0)	Recreation and wildlife management. Overflow discharge and 15.2 cm (6 in) steel suction pipe.

*All dams are earth fill and have overflow discharges except where noted.

B. SURFACE DRAINAGE (Continued)

ESTIMATED FLOOD DISCHARGES

MAP NUMBER	STREAM NAME	DRAINAGE AREA $km^2(mi^2)$	DISCHARGE AT 10-YR FLOOD m^3/sec (ft^3/sec)	DISCHARGE AT 100-YR FLOOD m^3/sec (ft^3/sec)
1	Red Creek	20.7 (8.0)	80.3 (2836)	212.3 (7500)
2	Red Creek	65.8 (25.4)	136.2 (4813)	355.4 (12,558)
3	Red Creek	112.4 (43.4)	154.6 (5464)	437.4 (15,456)
4	Pierce Gulch	10.9 (4.2)	39.0 (1377)	142.9 (5050)
5	Pierce Gulch	21.5 (8.3)	52.4 (1853)	193.1 (6823)
6	Booth Gulch	6.0 (2.3)	35.5 (1253)	114.8 (4058)
7	Booth Gulch	11.9 (4.6)	43.1 (1522)	151.5 (5353)
8	Little Turkey Creek	19.4 (7.5)	88.0 (3110)	247.7 (8751)
9	Turkey Creek	32.4 (12.5)	103.9 (3672)	279.0 (9861)
10	Turkey Creek	27.5 (10.6)	117.1 (4139)	357.9 (12,646)
11	Turkey Creek	52.1 (20.1)	149.2 (5273)	534.6 (18,890)
12	Wild Horse Creek	7.3 (2.8)	29.9 (1055)	116.2 (4105)
13	Wild Horse Creek	20.1 (8.1)	53.8 (1900)	192.0 (6786)
14	Young Hollow	6.0 (2.3)	30.1 (1063)	100.6 (3554)
15	Young Hollow	30.0 (11.6)	70.5 (2491)	273.3 (9623)
16	Sand Creek	13.2 (5.1)	37.7 (1333)	160.0 (5652)
17	Sand Creek	21.0 (8.1)	46.0 (1628)	196.7 (6949)
18	Little Fountain Creek	28.5 (11.0)	87.2 (3081)	255.7 (9034)
19	Little Fountain Creek	57.0 (22.0)	143.8 (5082)	343.7 (12,144)
20	Little Fountain Creek	74.1 (28.6)	126.3 (4464)	384.7 (13,594)
21	Rock Creek	18.6 (7.2)	74.5 (2634)	213.2 (7535)
22	Rock Creek	30.0 (11.6)	87.4 (3087)	260.3 (9197)
23	Rock Creek	42.0 (16.2)	100.6 (3554)	301.0 (10,636)
24	Unnamed Stream at 244810	8.0 (3.1)	35.1 (1241)	133.0 (4700)
25	Unnamed Stream at 244810	5.7 (2.2)	22.4 (787)	119.3 (4216)
26	Unnamed Stream at 244810	32.4 (12.5)	61.2 (2162)	243.4 (8602)

ESTIMATED MEAN ANNUAL DISCHARGE OF UNGAGED STREAMS

MAP NUMBER	NAME OF STREAM SITE	GRID REFERENCE	DRAINAGE AREA $km^2(mi^2)$	MEAN ANNUAL DISCHARGE m^3/day (ft^3/sec)
1	Little Fountain Creek at State Highway 115	131809	31.1 (12.0)	3430 (1.4)
2*	Little Fountain Creek near mouth, near Fountain	282739	141.4 (54.6)	123 (0.05)
3	Little Turkey Creek at State Highway 115	115766	19.9 (7.7)	25 (0.01)
4	Turkey Creek at State Highway 115	091736	33.4 (12.9)	196 (0.08)
5	Turkey Creek at El Paso County Line	152633	102.0 (39.4)	539 (0.22)

*Not shown on base map.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

SURFACE CONFIGURATION

1. **LOW PLAINS** — Flat to gently rolling plains; local relief less than 50 m (164 ft); slopes predominantly between 0 and 3%.

2. **HIGH PLAINS** — Gently to strongly rolling and locally intensely dissected plains; local relief is largely between 75 and 125 m (246 and 410 ft); slopes predominantly between 3 and 15%. Scattered rocky escarpments with slopes commonly >100%.

3. **LOW HILLS** — Rounded to sharp-crested hills characterized locally by rocky surfaces; local relief largely between 150 and 220 m (492 and 720 ft); slopes predominantly between 15 and 45%. Scattered rocky escarpments with slopes commonly >100%.

Escarpment (slope>100%)

Through cut (>2m)

Side hill cut (>2m)

Note: Barbs and hachures point downslope.

SURFACE DRAINAGE

Watercourse (bank to bank gap width)*

15-25m

10-15m

3-10m

< 3m

2 — Estimated flood discharge

5 — Estimated mean annual discharge

Earth Dam

W4 — Reservoir

NOTE: Numbers refer to entries in tables.

* All streams intermittent; only major intermittent streams measured.

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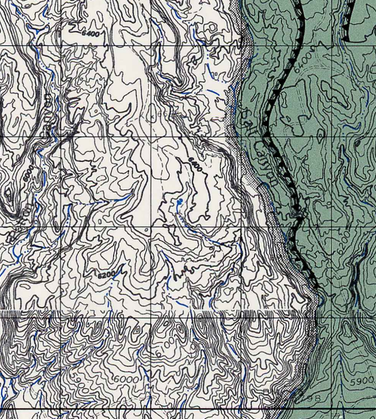
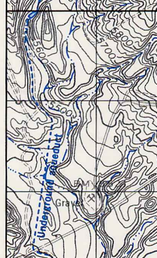


CONTOUR INTERVALS



Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters

1 ½ 0 1 2 3 Statute Miles

4250 000m N.

500 000m E.

C. WATER RESOURCES

1. SURFACE WATER

Surface water is scarce in the Fort Carson area. All streamflow on the base is intermittent and stream channels are dry most of the year. Brief periods of sustained flow occur during the spring snowmelt from April to June, and during intense or extended rainfall. Water volumes during periods of flow vary considerably and few data are available. Peak discharges of foothill streams typically range from 0.03 to 0.06 cubic meters per second (1 to 2 cubic feet per second) for a few days during the snowmelt season.

Recent enforcement of Colorado state water rights also has impacted surface water availability; prior upstream and/or downstream water rights limit use of available water in all major streams flowing through the base.

Available streamflow in the northern part of the reservation is used to manage the small recreation and wildlife reservoirs. Teller Reservoir in the south is not a managed reservoir; its depth fluctuates depending on discharge from Turkey Creek. For additional information on reservoirs see Section B, Surface Drainage.

Water quality for foothill streams flowing into Fort Carson is shown below. Also shown are data for Clover Ditch which carries sewage treatment plant effluent, some vehicle washrack effluent, and storm discharge from the cantonment area to Fountain Creek.

ANALYSIS OF SURFACE WATER ENTERING FORT CARSON
1973-1974

MAP NUMBER	SOURCE	GRID REFERENCE	DATE	DISCHARGE m^3/sec	DISCHARGE ft^3/sec	TEMPERATURE °C	TEMPERATURE °F	pH (Units)	SPECIFIC CONDUCTANCE (μmhos/cm at 25°C)
1	Rock Creek	133843	7 Sep 73	368	0.15	16.5	61.7	7.9	156
			24 Jan 74	2450	1.0	0.5	32.9	7.5	141
2	Little Fountain Creek	112822	7 Sep 73	3185	1.3	16.5	61.7	7.9	151
			24 Jan 74	2450	1.0	0.05	32.1	7.8	112
3	Little Turkey Creek	114766	7 Sep 73	123	0.05	14.0	57.2	7.6	318
†	Turkey Creek	057770	24 Jan 74	2450	1.0	0.05	32.1	8.0	243

CONSTITUENTS IN MILLIGRAMS PER LITER (mg/l)*

MAP NUMBER	SOURCE	GRID REFERENCE	DATE	DISSOLVED SOLIDS	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CHLORIDE	FLUORIDE	SULFATE	NITRATE
1	Rock Creek	133843	7 Sep 73	98	17	3.9	7.7	0	73	1.2	1.7	15	0
			24 Jan 74	88	15	3	8	1.4	53	2.1	1.9	18	0.09
2	Little Fountain Creek	112822	7 Sep 73	69	12	2.6	5.8	0	46	0.9	2.5	9.8	0
			24 Jan 74	70	11	2.3	6.4	1.3	41	1.8	2.9	12	0.4
3	Little Turkey Creek	114766	7 Sep 73	189	37	11	12	0	166	3	0.5	25	0.03
†	Turkey Creek	057770	24 Jan 74	148	23	8.3	15	1.3	110	2.5	0.7	28	0.04

MAP NUMBER	SOURCE	GRID REFERENCE	DATE	ALUMINUM	LEAD	MANGANESE	ZINC	SELENIUM	BERYLLIUM	CHROMIUM	COPPER	IRON	SILICA	HARDNESS ($CaCO_3$)
1	Rock Creek	133843	7 Sep 73	--	0.004	0.02	0	0.007	0	0	0.006	0.04	15	59
			24 Jan 74	0.03	0.004	0.04	0.02	0	--	--	0.003	0	12	50
2	Little Fountain Creek	112822	7 Sep 73	--	0.005	0.01	0	0.004	0	0	0.003	0.05	13	41
			24 Jan 74	0.02	0.002	0	0.01	0	--	--	0.004	0	12	37
3	Little Turkey Creek	114766	7 Sep 73	--	--	0.03	0.01	0.005	0	0	--	0.2	18	140
†	Turkey Creek	057770	24 Jan 74	--	0.004	0.04	0.02	0.002	--	--	0.004	0	15	92

* For purposes of this study mg/l may be taken to be roughly equivalent to parts per million (ppm).
† Sampling station not on map; outside reservation but pertinent.

WATER QUALITY - CLOVER DITCH

MAP NUMBER	GRID REFERENCE	DATE	TEMPERATURE RANGE* °C	TEMPERATURE RANGE* °F	pH RANGE*	DISSOLVED OXYGEN RANGE* (mg/l)†	CONDUCTIVITY RANGE* (μmhos/cm)
5	222858	Feb 76 - Jan 77	0 to 27	32 to 80	7.3 to 8.6	3.0 to 11.0	341 to 1880
6	225858	Feb 76 - Jan 77	0 to 27	32 to 80	7.3 to 8.6	3.0 to 11.0	341 to 1880

* Ranges given are based on total number of hourly records in the test period.
† For purposes of this study mg/l may be taken to be roughly equivalent to parts per million (ppm).

2. GROUND WATER

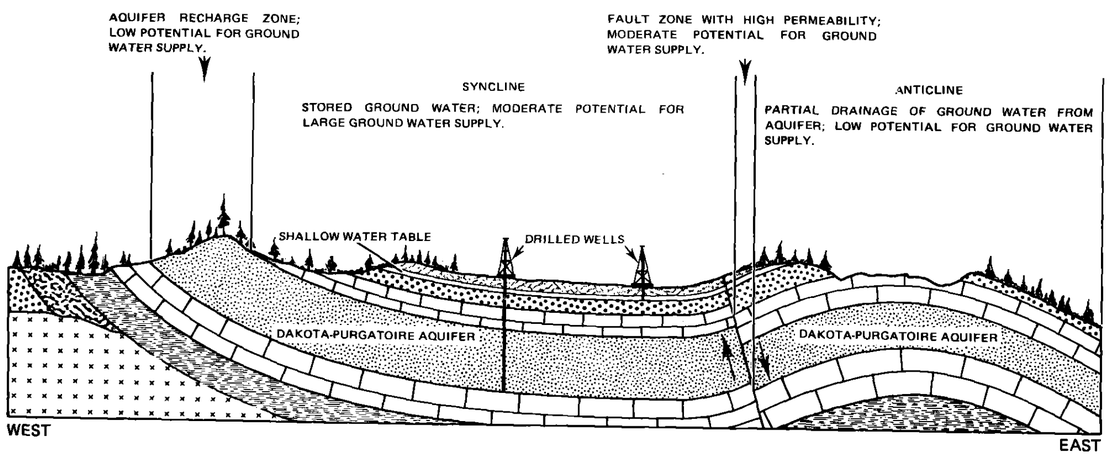
Fresh ground water is scarce at Fort Carson, where the semiarid climatic conditions result in insufficient aquifer recharge. The Dakota-Purgatoire unit is the only major aquifer in the area capable of supplying large quantities of fresh ground water. Minor quantities of ground water are available from alluvial deposits, but such supplies are subject to large seasonal fluctuations.

Ground water availability is determined largely by geologic structure; ground water is generally more abundant along fault planes and trough portions of synclines, rather than along anticlines and areas where the aquifer outcrops as a prominent ridge. Fractures, open joints, and bedding planes serve as conduits which enable water to flow through the aquifer.

Successful development of ground water supplies requires knowledge of the local geologic structure and stratigraphy. Maximum yields can be obtained by locating wells along faults and in areas where dense fracturing occurs. In both consolidated and unconsolidated deposits, maximum yields can be obtained by fully penetrating the saturated thickness of the aquifer. Well-stimulation techniques may increase well yields.

Ground water in the Fort Carson area is suitable for most uses including human consumption. Due to the carbonate nature of the rock units, the ground water is hard to very hard. Iron and fluoride concentrations commonly are high. In most cases, minor pretreatment is sufficient for potability.

EFFECTS OF GEOLOGIC STRUCTURE ON AVAILABILITY OF GROUND WATER



MAP UNIT	QUANTITY AND SOURCE	DEPTH	QUALITY	DEVELOPMENT OF SOURCES
1	Moderate* to large quantities of fresh ground water are locally available from the Dakota-Purgatoire aquifer. The aquifer is principally artesian except in outcrop areas; its maximum thickness is 91 m (300 ft). Permeability is primarily due to fractures, open jointing, and bedding planes. Recharge is from precipitation in areas where the Dakota-Purgatoire unit is exposed at the surface. Structural variations affecting the availability of ground water in the aquifer are depicted in the schematic diagram above. Although recharge is controlled by climatic conditions, the amount of water stored in the aquifer allows sustained yields with limited fluctuations in water levels. Wells penetrating the aquifer on Fort Carson have recorded sustained yields ranging from 114 lpm (43,200 gpd) to 757 lpm (288,000 gpd); specific capacities ranged from 1.12 l/m (0.09 g/ft) to 52.78 l/m (4.25 g/ft).	For maximum water production, fully penetrating wells can range in depth from 91 m (300 ft) in outcrop areas to 762 m (2500 ft) at the bottom of the deeply buried Dakota-Purgatoire aquifer, near the cantonment area. In the northern two-thirds of Fort Carson, the top of the aquifer slopes eastward from its outcrop area (recharge zone) in the west to a depth of 670 m (2200 ft) immediately east of the cantonment area in the valley of Fountain Creek. In the southern third of the reservation, a sequence of anticlines and synclines results in a wide variation in depths to the aquifer. At the surface, the aquifer is unconfined, and the water table depth varies widely depending on topography. At depth, the aquifer is confined, which results in artesian water level conditions. The elevation of the piezometric water surface also varies widely and is controlled by geologic structure. A test well at Camp Devil (grid reference 078610) had a static water level of 25.6 m (84 ft), while test wells at Tank Tables VII (grid reference 168568) and VIII (grid reference 209544) had static water levels of 44.8 m (147 ft) and 74.7 m (245 ft), respectively. The wide variations in water levels are largely due to the positions of the wells in relation to the specific geologic structure encountered.	The ground water in the Dakota-Purgatoire unit is generally suitable for human consumption. No systematic studies of water quality have been performed to date. However, random water quality sampling indicates that total dissolved solids may range from 162 to 725 mg/lt. The very hard water is probably the result of percolation through shales and calcareous sediments. Locally, sulfates, iron, and naturally occurring radioactive nuclides have been observed in objectionable amounts. The results of chemical analyses of ground water from three wells in the Dakota-Purgatoire aquifer are presented in a subsequent table. No biological contaminants have been observed.	The most favorable well locations are along faults, intersecting fracture traces, and synclines in the Dakota-Purgatoire sequence. Well yields may be enhanced at these locations due to increased secondary permeability. In areas where the Dakota-Purgatoire outcrops in prominent hogback ridges, well yields will be minimal due to gravity drainage of the aquifer. All wells should penetrate the full thickness of the Dakota-Purgatoire to obtain maximum yields. Well-stimulation techniques such as hydraulic fracturing, shooting, and surging may increase well yields. Well casings should be set to prevent the entrance of ground water from formations above the producing zones; the undesirable waters may contain high concentrations of dissolved solids and reduce the quality of the Dakota-Purgatoire ground water. Access to well drilling sites is highly variable and is dependent on local terrain conditions.
2	Moderate quantities of fresh ground water are locally available from the Piney Creek and Nussbaum alluvial deposits, which are composed of poorly sorted sand, gravel, and cobbles with silt and clay. The Piney Creek and Nussbaum deposits are 6 m (20 ft) and 24 m (80 ft) thick, respectively. Permeabilities range from 0.45 m/d (1.5 ft/d) to 6.09 x 10^{-5} m/d (0.0002 ft/d). Recharge occurs as infiltration from precipitation and percolation of surface waters. In the semiarid climate of Fort Carson, there are large seasonal fluctuations in water availability. Well yields vary from 3.8 lpm (1440 gpd) to 380 lpm (144,000 gpd); higher yields correspond to increased thicknesses of saturated sediment. There are no known wells presently producing from the Piney Creek or Nussbaum alluviums.	The aquifers are unconfined and depths to the water table may range from 0.3 m (1 ft) in stream valleys to 12 m (40 ft) on the uplands. These depths are subject to large variations depending upon seasonal conditions. The ground water gradients may range from 0.036 to 0.005 and are typically 0.013 in the Piney Creek alluvium.	Water from these alluvial aquifers is generally suitable for human consumption. Although no systematic water quality studies have been made, random sampling of water quality in El Paso County indicates that concentrations of dissolved solids may range from 115 mg/l to 307 mg/l. Fluoride concentrations are expected to range from 0.1 mg/l to 5.8 mg/l, with the higher concentrations resulting from movement of ground water over fluoride-bearing rock units. As interpolated from similar alluvial aquifers in the area, the water will be moderately hard to hard and may contain objectionable amounts of iron.	Wells in the Piney Creek and Nussbaum alluvial deposits will obtain maximum yields when they are located near stream valleys and where the saturated thickness of the aquifer is fully penetrated. Numerous intermittent streams serve as ground water discharge conduits from the aquifer. Placement of wells in the stream valleys will greatly increase well yields. Upland well locations are less desirable because of the seasonal fluctuations in water levels. During spring, high water flows may hamper drilling efforts in floodplain locations. Wells should be gravel-packed and the production zone should be thoroughly screened and sealed to prevent surface water from entering the casing. Surging may be necessary to remove fine material and increase well production. Access to most drilling sites is good due to the flat to gently sloping surface occupied by the alluvial deposits.
3	Small quantities of fresh ground water may be available from the combined geologic formations which make up this map unit, including: loess, landslide deposits, the Pierre shale, the Fort Hays limestone member, the Greenhorn limestone, the Morrison and Ralston Creek formations, the Lykins formation, the Lyons sandstone, and the Fountain formation. Permeability of these formations is derived mainly from fractures, joints, and bedding planes. Recharge is generally from infiltration of precipitation and percolation of surface water in outcrop areas. Minor amounts of recharge into the subsurface may also occur as seepage from the overlying strata. Yields from these formations range largely from 3.8 lpm (1440 gpd) to 40 lpm (15,000 gpd), with the Greenhorn limestone providing up to 57 lpm (21,600 gpd) from fracture zones.	Due to the diverse geologic nature of the units, the depths of wells required to obtain maximum water yields vary considerably. Existing wells in this unit such as at grid references 099717 and 095648 range in depth from 4.2 m (14 ft) to over 100 m (331 ft). Water levels also vary widely depending upon geologic conditions. The aquifer is both confined and unconfined; water levels can be under artesian or water table conditions. Water levels measured in existing wells range from 7 m (23 ft) to 45 m (149 ft) below ground surface.	The water is generally fresh and suitable for human consumption. A major exception is the ground water in the Pierre shale where concentrations of dissolved solids can reach as high as 4000 mg/l. Elsewhere, concentrations of dissolved solids may range from 179 mg/l to 1570 mg/l. The Fountain formation has fluoride concentrations as high as 7.1 mg/l. High concentrations of dissolved solids and fluoride result from the chemical characteristics of the rock; lower chemical concentrations can be expected in recharge areas since the water is in contact with the rock for a shorter period of time. Hard water, with high iron and magnesium concentrations, generally can be expected throughout the unit.	Maximum yields can be obtained by locating wells on faults, fractures, intersecting fracture traces, and synclines. Wells should penetrate the full saturated thickness of each geologic formation. In areas of low fracture density, or where the strata occupy prominent ridges such as hogbacks, well yields will be extremely low. Wells completed in rock may be cased above the desired production zone and open to the aquifer. Where wells are completed in unconsolidated sediments such as loess or landslide deposits, the production zone should be screened with gravel-packing. Well-stimulation techniques will vary according to the geologic conditions and can include hydraulic fracturing, shooting, surging, and pressure acidizing. Due to the diversity of lithologies within this unit, a thorough subsurface investigation will be required to obtain maximum yields. Access to well drilling sites is highly variable, depending on local terrain.
4	Meager quantities of fresh ground water are available from the combined formations which compose this map unit, including: the Louviers alluvium, the Slocum alluvium, the Verdos alluvium, the Rocky Flats alluvium, the Smoky Hill shale member, the Carlile shale, and the Graneros shale. The alluvium is well-drained; permeability of the shale is due solely to fractures, joints, and bedding planes. Maximum yields range from 1.9 lpm (720 gpd) to 3.8 lpm (1440 gpd). In most areas, fresh ground water may be lacking.	Wells in alluvium could reach depths as great as 43 m (140 ft) to obtain yields of 1.9 lpm (720 gpd). Well depths in shale vary widely because water levels are dependent upon the local structure of the shale and the presence of water. In most areas, water may be absent.	Ground water from the alluvial deposits is generally fresh and potable; concentrations of dissolved solids range from 96 mg/l to 755 mg/l. Nitrate concentrations can be as high as 18 mg/l near Fountain Creek. The water in the shale units may not be suitable for human consumption. High concentrations of dissolved solids in the shales result in brackish ground water.	Wells located in the alluvial deposits near drainageways can provide minor amounts of fresh water during the spring recharge; such sources, however, would be seasonally unreliable. Wells located in areas of highly fractured or faulted shale may supply minor amounts of brackish water. In either case, water may be absent during most of the year. Excessive pumping of ground water may cause dewatering, which would further reduce the already low ground water yields from this unit.

*Definitions of underlined terms are as follows:

Quantity Terms	Liters Per Minute (lpm)	Gallons Per Day (gpd)
Large	400-4000	150,000-1,500,000
Moderate	40-400	15,000-150,000
Small	4-40	1500-15,000
Meager	<4	<1500

Quality Term
Brackish-Total dissolved solids 1500 mg/l to 15,000 mg/l

† For purposes of this study mg/l may be taken to be roughly equivalent to parts per million (ppm).

SUMMARY OF DATA FROM SELECTED WELLS

WELL NUMBER	GRID REFERENCE	PROBABLE AQUIFER	DEPTH m (ft)	ESTIMATED SUSTAINED YIELD lpm (gpd)
1	078611	Dakota-Purgatoire	31 (102)	568 (216,072)
2	168568	Dakota-Purgatoire	75 (246)	101 (38,421)
3	208544	Dakota-Purgatoire	50 (164)	15 (5706)
4	037602	Dakota-Purgatoire	53 (174)	--
5	072609	Dakota-Purgatoire	93 (305)	--
6	057619	Dakota-Purgatoire	96 (315)	--
7	106607	Lykins formation	58 (190)	--
8	095648	Lykins formation	22 (72)	23 (8749)
9	099717	Fountain formation	18 (59)	45 (17,118)
10	081525	Smoky Hill shale	51 (167)	--
11	165545	Smoky Hill shale	43 (141)	--
12	059563	Carlile shale	103 (338)	--
13	217565	Carlile shale	85 (279)	--

GROUND WATER QUALITY ANALYSIS IN THE FORT CARSON AREA
(In milligrams per liter except for color and pH)

WATER QUALITY PARAMETER	SPRING	WELL NUMBER 1	WELL NUMBER 2	WELL NUMBER 3
Alkalinity (as $CaCO_3$)	268.0	178.0	280.0	230.0
pH (pH units)	7.7	7.9	6.5	8.0
Hardness (total as $CaCO_3$)	305.0	331.0	440.0	307.0
Calcium	73.0	103.0	121.0	78.0
Potassium	3.9	4.7	3.9	4.4
Silica	17.8	15.5	5.0	12.1
Total Dissolved Solids	N/A	725.0	612.0	450.0
Color (color units)	<5.0	<5.0	0.0	<5.0
Copper	0.03	0.05	<0.01	0.22
Zinc	0.66	2.4	0.87	2.0
Iron	0.08	0.14	0.48	1.93
Magnesium	29.0	13.0	40.4	26.3
Manganese	0.01	0.01	0.009	0.04
Chlorides	37.1	13.1	16.0	17.0
Sulfates	63.0	370.0	96.0	128.0
Arsenic	<0.01	<0.01	<0.01	<0.01
Barium	<0.30	<0.30	N/A	N/A
Boron	0.15	0.13	0.16	0.12
Cadmium	<0.001	<0.001	<0.001	<0.001
Chromium	<0.01	<0.01	0.01	<0.01
Fluorides	0.72	0.62	0.82	0.89
Lead	<0.01	<0.01	<0.01	0.018
Mercury	0.0016	0.0002	0.0005	0.0005
Nitrates (as nitrogen)	0.1	3.0	0.1	0.27
Silver	<0.01	0.01	<0.01	<0.01
Sodium	40.0	110.0	35.0	41.6

Analyses provided by Sanitation Branch Utilities Division, Facilities Engineering, Fort Carson, Colorado.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

WATER RESOURCES

SURFACE WATER

All streams on Fort Carson are intermittent. Surface water is scarce or lacking most of the year, therefore, streams have not been delineated individually with regard to availability of surface water (see text for details).

W4 — Reservoirs, see Section B. SURFACE DRAINAGE for data.

2 — Water quality sampling location.

GROUND WATER

FRESH WATER LOCALLY PLENTIFUL

1. Moderate to large* quantities of fresh water available from fractured portions of thick sandstone.
2. Moderate quantities of fresh water available from alluvial deposits.

FRESH WATER SCARCE OR LACKING

3. Small quantities of fresh water available in unconsolidated deposits and fractured consolidated rocks.
4. Locally meager quantities of fresh water available from alluvium; meager quantities of brackish water in fractured shale.

2 — Well

Spring-340 lpm (129,600 gpd) sustained yield

Fault Trace

Anticlinal Axis

Synclinal Axis

*Definitions of underlined terms are as follows:

Quantity Terms	Liters Per Minute (lpm)	Gallons Per Day (gpd)
Large	400 - 4000	150,000 - 1,500,000
Moderate	40 - 400	15,000 - 150,000
Small	4 - 40	1500 - 15,000
Meager	< 4	< 1500

Quality Term

Brackish-Total dissolved solids 1500 mg/l to 15,000 mg/l

Note: Numbers refer to entries in tables.

USER NOTE: For permissible concentrations of impurities in military water supplies, see Field Water Supply, TM 5-700, July 1967, paragraph 19; or other applicable manuals or regulations.

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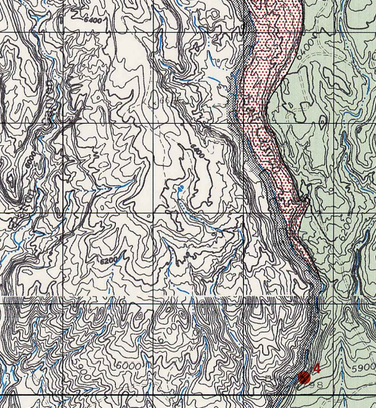
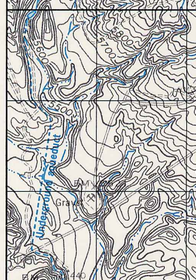


CONTOUR INTERVALS



Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters

1 ½ 0 1 2 3 Statute Miles

4250 000m N.

500 000m E.

D. ENGINEERING SOILS

The generalized pattern of soils on Fort Carson is outlined in the table and accompanying map, which define the prevalent physical, hydrologic, and engineering characteristics of the soils, particularly as these relate to general planning. This information provides the means for comparison of the key physical characteristics of various soil units on the reservation and gives a preliminary indication of their suitability and/or limitations with regard to development. It is intended to guide, not to supplant, detailed site investigations in specific areas.

The map is based on information contained in soil surveys prepared by the U.S. Department of Agriculture, Soil Conservation Service, supplemented by the stereoscopic interpretation of aerial photographs in areas where access restrictions make mapping in the field impossible, such as the large Impact Area south of Butts Army Airfield.

Soils have been grouped into eight map units. Each unit consists of soils that share certain characteristics, such as grain size distribution and depth or total thickness to bedrock. In certain cases, soils are also combined on the basis of key landform associations (floodplain, upland) and/or on subsoil permeability characteristics (extremely rapid or slow percolation rates). The soil profiles summarized in the table are highly generalized and represent "average" typical profiles that can be expected for each major unit; actual conditions may vary to some extent, especially the thickness of the individual layers. Each of the eight soil units is evaluated in terms of its limitations (slight, moderate, severe) for six common engineering applications, including the identification of major constraints such as shallow rock, excessive permeability, etc., which would limit its use for development.

The soils on Fort Carson consist of relatively young deposits that have developed on unconsolidated stream-deposited parent material, and residual soils formed on older sandstone and shale. The alluvial materials, composed of clay, silt, sand, and gravel, lie primarily in the eastern and east-central portions of the reservation, on broad, flat to gently sloping terraces parallel to streams or on flat upland pediment surfaces. The residual soils in the east, east-central, and southeast are chiefly clay, silt, and sandy soils derived from shales, interbedded sandstones, and clays of the Pierre and Niobrara formations. These soils are relatively shallow and easily erodible, severely limiting their use for major development.

The soils in the west-central and western portions of the reservation are derived from older sandstone and shale formations. Except where otherwise shown on the Engineering Soils map, the soils in these predominantly high plains and low hills areas are variably coarse- and fine-grained, shallow, and occupy moderate to steep slopes which generally limit their utilization for large scale engineering projects.

Floodplain deposits, Unit 6 on the accompanying map, are scattered throughout most stream valleys. These soils, which are particularly prominent in Rock, Little Fountain, Sand, Turkey, and Red Creeks, are coarse- and fine-grained, excessively drained, and occasionally flooded; consequently, their use for engineering development is limited.

MAP UNIT	AREA MAPPED ON RESERVATION km^2 (acres)	LANDFORM AND SLOPE	TYPICAL SOIL PROFILE*- LAYERS, THICKNESS OF LAYERS, DEPTH TO ROCK UNIFIED ENGINEERING CLASSIFICATION (PROFILES NOT TO SCALE)	HIGH WATER TABLE DEPTH	PERMEABILITY	SHRINK-SWELL POTENTIAL	RATING AND MAJOR LIMITING SOIL CHARACTERISTICS FOR: SEWAGE LAGOONS	SANITARY LANDFILL	FOUNDATIONS FOR SMALL BUILDINGS	ROAD LOCATION	SHALLOW EXCAVATIONS	TRAFFICABILITY	MAJOR SOIL SERIES† AND REMARKS
1	4 (988)	Gentle to moderately rolling plains, some stream dissected terraces. Slopes largely between 3 and 15 percent.	cm GM — Gravel-sand-silt mixture 122 Rock — Shale	Greater than 2 m (6 ft)	12.7 to 25.4 cm/hr (5.0 to 10.0 in/hr)	Low	Severe p, s	Slight	Slight	Moderate s	Severe u	Slight	Major soil series - Otero gravelly sandy loam.
2	167 (41,266)	Moderate to strongly rolling high plains and low hills with numerous near-vertical escarpments. Terrain is strongly dissected and rocky, slopes largely between 15 and 45 percent.	cm SM-GC — Sand with 15 to 20% rock fragments 20 Rock — Sandstone	Greater than 2 m (6 ft)	5.1 to 15.2 cm/hr (2.0 to 6.0 in/hr)	Low	Severe r, s	Severe p	Severe r	Severe r	Severe r	Moderate to Severe s, r	Major soil series - Schamber-Razor complex and the Travessilla series.
3	172 (42,501)	Flat to gently rolling plains, slopes generally between 0 and 8 percent.	cm CL — Sandy silty clays of low to medium plasticity Rock — Depth to shale greater than 6 m (20 ft)	Greater than 2 m (6 ft)	0.5 to 5.1 cm/hr (0.2 to 2.0 in/hr) At depth of 20 to 76 cm (8 to 30 in) 0.2 to 1.5 cm/hr (0.06 to 0.6 in/hr)	Moderate	Moderate s	Moderate c	Severe x	Severe x, c	Moderate c,s	Dry-Slight Wet-Moderate w	Major soil series- Mazanola series. Also includes several clay and clayey loam types. Subject to very high to severe erosion.
4	84 (20,756)	Flat to moderately rolling plains, some gullies. Most slopes range between 0 and 15 percent.	cm CL — Sandy silty clays of low to medium plasticity 71 Rock — Platy shale	Greater than 2 m (6 ft)	0.2 to 0.5 cm/hr (0.06 to 0.2 in/hr)	Moderate	Severe r, s	Moderate c	Slight to Moderate s	Moderate x, s	Moderate u, c	Dry-Slight Wet-Moderate w	Major soils series - Razor-Midway complex. Contains some highly eroded areas.
5	9 (2224)	Strongly rolling and intensely dissected plains containing severely eroded "badlands" areas. Slopes largely between 30 and 45 percent.	cm CL — Sandy silty clays of low to medium plasticity 30 Rock — Shale, siltstone	Greater than 2 m (6 ft)	0.2 to 0.5 cm/hr (0.06 to 0.2 in/hr)	High	Severe r, s	Severe r, s	Severe r, s	Severe r, s	Moderate r	Severe s, r, w	Major soil series - Shingle series. Map unit area contains extensive badlands.
6	7 (1730)	Flat to gently rolling floodplains and adjacent low terraces. Low-lying areas subject to infrequent and/or seasonal flooding. Slopes largely between 0 and 3 percent.	cm SP — Coarse sands with trace silt and gravel 15 SP-SM — Layers of coarse sand and silt (ML) — (In some areas this layer is primarily dark brown sandy silt with some clay) Rock — Depth to inter-bedded sandstone and shale 6 m (20 ft) or more	Greater than 2 m (6 ft)	1.5 to 50.8 cm/hr (0.6 to 20.0 in/hr)	Low	Severe p, u, f	Severe u, f	Severe u, f	Severe u, f	Severe u, f	Dry-Slight Wet-Severe u, f	Major soil series - Haverson and Ellicott. Floodplain soils; stream channels could expose rock locally.
7	48 (11,860)	Gently to strongly rolling high plains, some intensely dissected slopes. Slopes variable; most range between 8 and 30 percent.	cm SM — Dark gray-brown silty sand 25 SC — Dark brown clayey sand 45 SM — Brown silty sand 73 SP-SM — Brown silty coarse sand Rock — Depth to sandstone greater than 3 m (10 ft)	Greater than 2 m (6 ft)	1.5 to 50.8 cm/hr (0.6 to 20.0 in/hr)	Low	Moderate p	Slight to Moderate u, s	Slight to Moderate s	Slight to Moderate s	Slight to Moderate s	Slight to Moderate s	Major soil series - Bresser sandy loams.
8	71 (17,544)	Moderate to strongly rolling rocky plains with near-vertical escarpments. Slopes largely between 8 and 45 percent.	cm ML — Stony and clayey silt 30 Rock — Hard limestone	Greater than 2 m (6 ft)	1.5 to 5.1 cm/hr (0.6 to 2.0 in/hr)	Low	Severe r	Severe r	Severe r	Severe r	Severe r	Severe r, s	Major soil series - Penrose-Minnequa complex and Penrose-rock outcrop complex. Soils contain rock fragments.

* These are typical average layers based on the major soil series; thicknesses and composition may vary considerably from those shown.

† Soils that have profiles almost alike make up a soil series. Each series is given a common name after the town or geographic feature near its initial observation. Many other minor soils are included in the map unit.

SOIL CHACTERISTICS AFFECTING RATINGS

- c - clayey subsoils - poor workability
- f - flooding
- p - rapid percolation
- r - shallow to bedrock
- s - slope
- u - unstable soils
- w - slick when wet
- x - high shrink-swell potential

DEFINITIONS OF RATING TERMS

Slight - relatively free of limitations or limitations are easily overcome.
Moderate - limitations can be overcome with good planning and/or careful design.
Severe - limitations are serious and are difficult to overcome.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

ENGINEERING SOILS

COARSE-GRAINED SOILS

1. Poorly graded gravelly sands, some silt; moderately deep to deep*.
2. Gravelly sands, some inorganic silts and clays; shallow.

FINE-GRAINED SOILS

3. Silts and clays of low to medium plasticity, some fine sands; deep to very deep.
4. Silts and clays of low to medium plasticity, some fine sand; moderately deep.
5. Silts and clays of low to high plasticity; shallow.

COARSE-GRAINED AND FINE-GRAINED SOILS

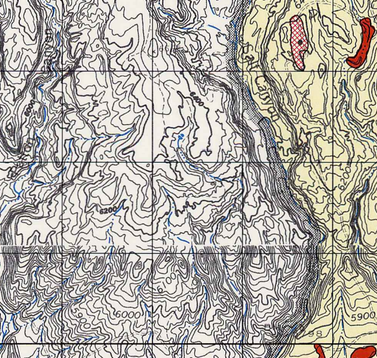
6. Poorly graded sands and silts; floodplain soils; deep to very deep.
7. Sand-silt-clay soils; moderately deep to deep.
8. Stony and clayey silts; shallow to moderately deep.

Note: Numbers refer to entries in table.

*Definitions of underlined terms are as follows:

Depth Terms	Meters	Feet
Very deep	>6	>20
Deep	2-6	7-20
Moderately deep	0.6-2	2-7
Shallow	<0.6	<2

INDEX TO SHEETS
SERIES V777
1:50,000
SCALE



CONTOUR INTERVALS

40 FEET

20 FEET

01

Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters

1 ½ 0 1 2 3 Statute Miles

4250000mN.

5000000mE.

E. ENGINEERING GEOLOGY

The table below and the accompanying Engineering Geology map indicate the engineering characteristics and distribution of the eleven geologic units on the reservation. These units are evaluated as to their engineering suitability for construction sites and route alinements, foundation stability for supporting light and heavy structures, cut-slope stability for road and bridge construction, and potential as sources of natural materials for construction and maintenance. Key physical properties of the individual units are also evaluated to determine additional impacts or constraints on engineering development, such as the presence of swelling clays and bentonite, relative resistance to erosion, and suitability for excavation and compaction. The units are placed into two major suitability categories, those having some and those having few engineering uses.

The geologic units on Fort Carson range in age from Quaternary to Pennsylvanian. Unconsolidated sediments deposited during the Quaternary are entirely Holocene and Pleistocene and consist of fluvial and alluvial sands, silts, and gravels, and wind-deposited (eolian) silts and sands. These unconsolidated materials are grouped into five map units. The consolidated units include Cretaceous shale, limestone, and hard sandstone; Jurassic siltstone, claystone, and thin beds of sandstone; Permo-Triassic shale and sandstone; and Permian-Pennsylvanian conglomerate, sandstone, and shale. These strata are combined into six map units based on their engineering properties.

The youngest sediments, occurring in the eastern portion of Fort Carson, are unconsolidated and form incised alluvial terraces and gently sloping upland erosion surfaces carved in bedrock; they consist of moderately to firmly compacted gravels and occupy flat to gently sloping plains adjacent to the easterly flowing tributaries of Fountain Creek. These sediments, Units 2, 3, and 4 on the Engineering Geology map, exhibit good foundation stability for supporting small and medium structures, are relatively resistant to erosion, and possess fair to good slope stability when cuts are less than 25 degrees. They are also good to excellent sources of sand and gravel. The broad floodplains in the eastern portion of the reservation are underlain by clayey silt and sand. These recent stream deposits (Unit 10) exhibit rather poor engineering capabilities and are susceptible to flooding. Unit 10 is, however, a source of sand and gravel, particularly along some of the larger stream channels. Wind-blown deposits consisting of loosely compacted silt and sand are scattered in the northeastern and extreme southwestern portions of the reservation (Unit 9). This unit is suitable for light structures; however, it tends to compress under heavy loads, and walls of trenches may collapse if not supported by shoring.

The unconsolidated sediments are underlain in the eastern and east-central portions of the reservation by a sequence of older rocks consisting principally of shale with thin to moderate beds of hard limestone. These sedimentary rocks also crop out in the extreme southwestern portion of the reservation between Booth Gulch and Red Creek. The predominant formation in the east and northeast is the Upper Cretaceous Pierre shale. This formation, Unit 11, occupies gently to strongly rolling plains with local fine-textured drainage patterns and intensely dissected slopes. This unit contains highly swelling clays and bentonite which severely limit its suitability for foundations. Slope stability is poor and slopes exceeding 5 degrees are susceptible to sliding.

The formations which underlie the Pierre shale in the southeastern and southwestern portions of the reservation are chiefly shale with hard beds of limestone. Although the shale contains thin beds of swelling clay and bentonite, foundation stability, particularly in Unit 6, is fairly good. Cut-slope stability ranges from fair to good and excavation and compaction are moderately easy with small power equipment. The limestone beds in Units 6 and 7 are dense and hard. They are extremely resistant to erosion and form sharp-crested escarpments termed "hogbacks," which are particularly prominent in the southwestern portion of the reservation. The limestone has excellent foundation and slope stability characteristics, except where dip slopes are undercut. Principal limitations to engineering development include steep slopes, rocky terrain, and difficulty in excavation and compaction.

The predominant formation underlying the west-central and western portions of Fort Carson is the combined unit consisting of the Lower Cretaceous Dakota sandstone and Purgatoire shale and claystone (Unit 8). This older unit occupies the most rugged terrain on the reservation and forms a series of prominent rocky escarpments (hogbacks). Foundation and slope stability are excellent; however, rocks on dip slopes may slide when undercut. This unit is an excellent source of building stone and clay, and is the principal artesian aquifier at Fort Carson (see C.2 Ground Water). Principal limitations to engineering development are steep slopes, rocky terrain, and difficulty in excavation and compaction.

Unit 5 underlies Unit 8 in the west-central (Sullivan Park) and northwest portions of the reservation, where it forms a partially concentric outcrop pattern peripheral to the older strata underlying Sullivan Park, and is characterized by variable terrain ranging from gently rolling plains to steeply sloping low hills. It comprises the Upper Jurassic Morrison and Ralston Creek formations and the older Permo-Triassic Lykins formation, and consists of interbedded siltstone and claystone, and beds of limestone and hard sandstone. Foundation stability is fair to good and slope stability is good. The siltstone and claystone members exhibit excellent compaction capabilities; however, excavation and compaction is extremely difficult in the resistant sandstone member.

The oldest strata outcropping on the reservation are those of Unit 1, which consists of the combined Permo-Pennsylvanian Lyons sandstone and Fountain conglomerate. This unit occupies the crestal portion of the Red Creek anticline, a prong-like north-northwesterly-trending breached anticline whose axial plane extends in a south-southeasterly direction through Sullivan Park and Booth Mountain. Camp Devil and the western part of Sullivan Park are within this unit; associated terrain is gently to strongly rolling. Unit 1 has excellent foundation stability, slope stability, and resistance to erosion. The chief limitation to engineering development is its hardness, which renders excavation and compaction very difficult for small power equipment.

MAP UNIT	TOPOGRAPHY	ROCK DESCRIPTION	PHYSICAL CONSTANTS	ENGINEERING EVALUATION	EXCAVATION FACTORS	PITS AND QUARRIES
1. Hard conglomerate, sandstone, some shale and siltstone.	The entire unit is within the Southern Rocky Mountains Province. It crops out in the west-central part of the reservation and occupies gently to strongly rolling terrain. Most of the unit is mantled by a variable thickness of residual soil, with major outcrops in the stream valleys and on steep slopes. The northern half of the unit is moderately dissected; the interstream areas are nearly flat to gently sloping, offering favorable terrain for construction sites. Numerous minor streams draining the northern half flow into East Fork Red Creek, which along with West Fork Red Creek and Red Creek, traverse the southern half of the unit. Slopes in the southern half are steeper; however, portions of the terrain, such as Sullivan Park, are suitable for construction. Local relief is largely between 60 and 90 m (197 and 295 ft). The highest elevation is approximately 2012 m (6600 ft) on the slopes of an alluvium-mantled hill in the northern part of the unit (grid reference 091728); the lowest elevation is approximately 1793 m (5880 ft), in a stream valley immediately south of the Pueblo-El Paso County line (grid reference 085629). Drainage is dendritic, with moderate to coarse texture prevailing; streams are generally curving to sinuous.	Contains the oldest strata outcropping on the reservation and consists of the combined Fountain and Lyons formations. The Fountain formation, of Pennsylvanian and Permian age, is overlain by the Permian Lyons sandstone, which forms a narrow band that borders the Fountain formation on the east and west; the eastern band continues northward to the vicinity of Turkey Creek Ranch and State Highway 115. The Fountain formation occupies the crestal portion of the Red Creek anticline, a north-northwesterly-trending structure whose axis roughly parallels the valley of Red Creek. The formation consists of reddish-brown arkosic conglomerate, coarse sandstone, and thin layers of pale-green and dark-reddish-brown shale. The Glen Eyrie shale member, at the base of the formation, is about 30 m (100 ft) thick and consists of gray sandstone, sandy shale, and black shale. The most common minerals are quartz, feldspar, and muscovite. The cementing materials are predominantly silica and, locally, calcium carbonate. The formation is stained with iron oxides which also act as cementing agents. Beds range in thickness from a few centimeters to several meters and are dense, hard, well graded, and crudely sorted. Sandstone and conglomerate beds are crossbedded; the fine fraction is made up of subangular to subrounded, quartz and feldspar sand grains; the coarse fraction contains stones as large as 18 cm (7 in) in diameter. Fractures are spaced a few centimeters to a few meters apart; they are extensive and somewhat open near the surface, but heal with depth. The contact with the Lyons formation is well defined. Total thickness of the Fountain formation is approximately 1340 m (4400 ft). The Lyons formation unconformably overlies the Fountain formation and consists of red and yellowish-gray, fine-grained, friable sandstone and conglomerate. The beds, ranging from a few centimeters to several meters thick, are laterally discontinuous, with uneven surfaces and distinct to abrupt boundaries. The unit is dense and hard, commonly massive and locally crossbedded. The sandstone is composed principally of clean, fine- to medium-grained, well-sorted, and well-rounded quartz grains which are cemented with silica, calcium carbonate, and iron oxides. Locally, the sandstone contains concretions and thin beds of siltstone. The conglomerate is similar in lithology to the sandstone; it contains cobbles as large as 10 cm (4 in) in diameter. Conspicuous fractures are spaced several centimeters to several meters apart; they are generally open at the surface, and close at a depth of a few hundred meters; total thickness of the Lyons formation ranges from 213 to 244 m (700 to 800 ft).	Permeability: low to high Swelling potential: noncritical Frost susceptibility: very slight	Suitable for several engineering uses, including potential construction sites. A large section of an open, flat to gently sloping valley within this unit, known as Sullivan Park, is suitable for multi-structures emplacement and is the site of an operating landing strip (Camp Devil). The northern section of this unit is also suitable for construction and installation sites, although it is gently rolling and more intensely dissected than Sullivan Park. The entire unit is capable of supporting roads, airfields, and other major structures. Grading or cut-and-fill operations would not be required on a large scale in this area. Stability of cut slopes is excellent, but debris and blocks may slide when bedding surfaces dip into the cut. Possible disruption to access routes is minimum. The unit is highly resistant to erosion and solution weathering. Foundation stability is excellent. The Lyons sandstone has been used as a source of building stone and riprap, and the Fountain formation is a possible source of decorative rock. The unit is unsuitable for disposal of solid or liquid wastes because excavation and compaction are difficult, and the hazard of polluting potential ground water supplies is high.	Excavation of sandstone and conglomerate is difficult. Blasting may be required. In places, it may be worked with heavy, tractor-drawn rippers. Slow drilling rates can be expected. Compaction is difficult and generally requires prior crushing and mixing with binder material. Hauling equipment and steel-wheeled rollers are suggested. State Highway 115 and existing roads on the reservation provide easy access for excavating equipment to most of the area within this unit. Overburden consists of residual loam, formed as a result of the leaching of the cementing material and disintegration of the bedrock. Overburden is generally loose and less than 3 m (9.8 ft) thick. It can be excavated by hand or power tools. Vegetation is concentrated mainly in the valleys of Red Creek and its tributaries, and consists of low grass and scrub. Slope stability is good to excellent. Fresh cuts will remain vertical; rockslides may occur, however, if the bedding planes dip into the cut.	None within this unit. The limited thickness of the overburden, stability of cuts, absence of seepage, and its overall accessibility make this unit favorable as a source of aggregate and building stone, particularly along some of the steeper slopes adjacent to the East and West Forks of Red Creek.
2. Coarse sand, some pebbles.	This unit is within the Colorado Piedmont section of the Great Plains Province. It constitutes a pediment, a gently inclined planar erosion surface carved in bedrock and veneered with fluvial gravels. Outcropping in the eastern portion of the reservation, it occupies nearly flat to steeply sloping upland surfaces, often bounded by steep escarpments with intensely dissected slopes exposing the underlying shale formations. The unit's gently sloping upland surfaces and rolling plains are suitable for construction sites. Intensely dissected terrain and scattered hills are unsuited for construction, particularly where the unit is bounded by steep slopes and escarpments. Maximum local relief is approximately 76 m (250 ft). The lowest elevation is 1701 m (5580 ft) in the valley of a small unnamed stream near the southern boundary of the reservation (grid reference 173529). The highest elevation is 2052 m (6730 ft) on a gently sloping upland (grid reference 130790). The drainage pattern is dendritic. Few streams drain the unit; these are curving to sinuous. The upland surface between Turkey Creek Ranch and the Rod and Gun Club is bounded on its eastern, northern, and western slopes by extensive landslide areas.	Pleistocene Nussbaum alluvium, consisting of brownish-gray, firmly compacted, stratified, coarse sand with pebbles. Generally poorly-sorted, cross-stratified, slightly cemented, and nonplastic. Grains are subrounded to subangular. Large boulders are abundant near the mountain front. Stones are altered by weathering and coated with calcium carbonate. Granite, porphyry, and gneiss are the main components of the alluvium. A 0.6 to 1 m (2 to 3 ft) thick conglomerate is at the base of the unit. The unit is approximately 24 m (80 ft) thick.	Permeability: good Swelling potential: noncritical Frost susceptibility: slight to moderate Plasticity: nonplastic	The gently sloping, upland surface is favorable for construction and the unit has several engineering uses, including multi-structures emplacement, and alinements for roads, railroads, and airfields. Minor grading and cut-and-fill are required at larger stream crossings. Slope stability is good; vertical cuts stand for a long time before slumping to a slope of 25 degrees or less. The unit is nonplastic and frost susceptibility is slight to moderate, depending on the amount of fine material present. Foundation stability is good when shallow spread footings are used. Excavated material is poor for use as base material beneath pavement or other surfaces. It dusts badly when used as road metal and is of poor quality for concrete aggregate because of many unsorted stones. The unit is, however, an excellent potential source of sand and gravel. The unit is not suitable for the disposal of liquid or solid waste because of the risk of polluting ground water supplies.	Excavation and drilling are generally easy with power equipment and moderately easy where cobbles are abundant. Access for excavating equipment is easy through existing road networks. Additional light-duty or unimproved roads may be required in areas designated as potential sources of sand and gravel. The overburden is a deep, well-drained residual sandy loam; its thickness exceeds 1.5 m (5 ft). Vegetation consists chiefly of low grass. Slope stability is good; vertical cuts stand for a long time, then slump to a slope of 25 degrees or less. Seepage is common.	The unit has been the source of only minor quantities of sand and gravel; however, the U.S. Army Corps of Engineers District, Omaha, NE, has tested and approved several areas as potential sources of sand and gravel; additional areas have been designated as potential sites, but no tests have been performed. These areas, which are shown on the Engineering Geology map, are easily accessible through existing roads; additional roads may be required in inaccessible areas.

E. ENGINEERING GEOLOGY (Continued)

MAP UNIT	TOPOGRAPHY	ROCK DESCRIPTION	PHYSICAL CONSTANTS	ENGINEERING EVALUATION	EXCAVATION FACTORS	PITS AND QUARRIES
3. Gravel, some clay, silt, and sand.	The unit, with the exception of some small isolated exposures in the western portion of the reservation, is within the Colorado Piedmont section of the Great Plains Province. Several exposures are scattered throughout the northern half of the reservation, occupying nearly flat to gently rolling terraces sloping to the east. Bedrock outcrops are absent. Extensive useable terrain is limited to three large exposures in the eastern portion of the reservation. The remaining exposures are generally less than 2 km (1.2 mi) long and less than 0.5 km (0.3 mi) wide. The unit exhibits a northwest to southeast topographic "grain"; local relief is generally less than 50 m (164 ft). The lowest elevation is approximately 1646 m (5400 ft) at grid reference 245674 and the highest elevation is 1963 m (6440 ft) at an isolated exposure within Turkey Creek Ranch (grid reference 096735). Few streams drain the unit; these are curving to sinuous.	Pleistocene Slocum alluvium and Louviers alluvium, generally less than 8 m (25 ft) thick. Loosely consolidated alluvium in the upper part is cemented by calcium carbonate to a hard conglomerate in the lower 0.3 to 0.6 m (1 to 2 ft). Beds range in thickness from 0.3 to 1.5 m (1 to 5 ft) and are laterally discontinuous, with uneven surfaces and distinct boundaries. The material is poorly sorted, weakly to moderately compacted, and well stratified. It contains yellowish-brown gravel with layers of clay, silt, and sand. An average size distribution curve shows 23 percent clay, 15 percent silt, 49 percent sand, 9 percent granules, and 4 percent pebbles. The sand and gravel size fraction consists mostly of rounded to subangular sandstone, ironstone, chert, and limestone fragments.	Slocum alluvium, local facies Permeability: poor to excellent Swelling pressure, kg/m^2 (lb/ft^2) (1 test): 7567 (1550) Frost susceptibility: slight to high Plasticity index (11 tests): Average, 11; Range, 5 to 17 Liquid limit (11 tests): Average, 32; Range, 28 to 36 Specific gravity, g/cm^3 (4 tests): Average, 2.68; Range, 2.66 to 2.71 Maximum density, AASHO modified compaction, kg/m^3 (lb/ft^3) (4 tests): Average, 1855.1 (115.8); Range, 1743.0 (108.8) to 1981.7 (123.7) Optimum moisture, percent (4 tests): Average, 14.8; Range, 12.0 to 17.7 Laboratory CBR, 90% maximum density (19 tests): Average, 5.4; Range, 3.2 to 8.6 pH: Average, 7.52 AASHO classification: Average, A-4; Range, A-2, A-4, A-6 Unified Soil Classification: Average, SC, CL	Exposures in the northern portion of the reservation do not permit long and straight alinements; however, they can be utilized in conjunction with adjacent units. The major portion of the unit, in the eastern part of the reservation, consists of nearly flat to gently rolling plains suitable for multi-structure emplacements; long, straight alinements are available for airfields. Minor grades and cut-and-fill would be required. Vertical cuts generally slump after a short period to a slope of 25 degrees or less. Bridging required over major stream crossings and some shoring may be necessary in trenches. Foundation stability of the fine-grained alluvium is fair to good, depending on the amount of clay. The coarser the alluvium, the better its foundation stability. Clayey alluvium has low bearing capacity and is unsuited for supporting heavy structures. Potential foundation problems can result from frost susceptibility of the fine-grained material, from sulfate reaction between the concrete and the foundation material, and from seeps at the base of the alluvium. Coarse-grained alluvium is suitable for concrete and bituminous aggregate when not too weathered or coated with calcium carbonate. It is also suitable for road metal, subbase, and base course material. The fine-grained alluvium is suitable for road metal and possibly for subbase or soil cement. The conglomerate layer at the base of the unit has been used for dimension stone with excellent results. The unit is generally satisfactory for the disposal of liquid waste if percolation is not too slow due to high clay content. Danger of polluting adjacent water supplies is high in the granular alluvium. The unit is moderately satisfactory for the disposal of solid waste.	Excavation, compaction, and drilling are generally easy with power equipment, becoming moderately difficult toward the mountains where cobbles and large boulders are abundant. Existing roads provide easy access for excavating equipment. Vibratory compactors and smooth-tired rollers are recommended for compaction. Overburden consists of residual soil approximately 2 m (6 ft) thick, characterized by a high accumulation of clay minerals. A high concentration of calcium carbonate marks the upper part of the parent material. The vegetative cover consists mostly of prairie grass. Material in vertical cuts generally slumps after a short period to a slope of 25 degrees or less. Numerous seeps occur at the base of the unit.	There are no sand or gravel pits in this unit on the reservation. Potential future sites include all unit exposures, particularly the deposits near the cantonment area, which are easily accessible.
4. Coarse sand and gravel, some clay.	Most of the unit is within the Colorado Piedmont section of the Great Plains Province. Exposures are scattered throughout the northern, eastern, and west-central portions of the reservation. Two isolated exposures, near the west-central boundary of the reservation, are in the Southern Rocky Mountains Province. Most of the unit is on gently to strongly rolling upland surfaces; one extensive exposure underlies a nearly flat terrace north of Rock Creek. Useable terrain within this unit includes two extensive areas bordering Rock Creek. Other exposures are of limited areal extent; they generally cap intensely dissected upland erosional surfaces. Mean local relief in the two areas bordering Rock Creek is approximately 36 m (120 ft) and 85 m (280 ft). Maximum local relief is approximately 90 m (295 ft). The lowest elevation is 1689 m (5540 ft) near the eastern boundary of the reservation (grid reference 244712). The highest elevation is approximately 1960 m (6430 ft) near the west-central boundary of the reservation (grid reference 057691).	Dark-yellowish brown to reddish-brown calcareous coarse sand and small pebbles in a clayey silt matrix. The predominant geologic formation is the Pleistocene Verdos alluvium; the Rocky Flats alluvium, also of Pleistocene age, composes a small portion of the unit. The material is poorly sorted, moderately to firmly compacted and stratified. Pebbles and cobbles are subrounded to subangular, some as large as 10 cm (4 in). A size distribution curve showing an average of all the material sampled shows 8 percent clay and silt, 52 percent sand, 26 percent granules, and 14 percent pebbles. Concretionary limestone, pegmatite, and quartz constitute 85 percent of the alluvium. Beds are laterally discontinuous, with uneven surfaces and distinct boundaries. The unit is approximately 6 m (20 ft) thick.	Permeability: Average, medium; Range, low to high Swelling potential: Average, noncritical Unified Soil Classification: Average, SM; Range, SC, SM Verdos alluvium Plasticity index (5 tests): Average, 3; Range, 0 to 13 Liquid limit (5 tests): Average, 23; Range, 19 to 35 Rocky Flats alluvium Plasticity index (5 tests): Average, 25; Range, 10 to 37 Liquid limit (5 tests): Average, 54; Range, 33 to 70	The areas bordering Rock Creek are in flat to gently rolling terrain suitable for multi-structures emplacement. The terrace north of Rock Creek has favorable alinements for roads, railroads, and airfields. Minor grading and cut-and-fill is generally required. Bridging required over major streams. Stable slopes average approximately 10 degrees, but can be as steep as 25 degrees. Frost susceptibility of the unit slight to high. The unit erodes readily; erosion control is required. Drains may be required where a highway crosses the base of the alluvium, because of seeps. Foundation stability is satisfactory; clay between grains, however, may result in poor bearing capacities when heavy loads are exerted on the material. Caissons into the underlying material may be required for larger structures. The excavated alluvium should not be applied as base material directly beneath pavement or other wearing courses. Locally, clay-rich soil may swell and cause heaving of shallow foundations. It is recommended that foundations extend below this soil zone, which is approximately 1 m (3 ft) thick. Material from this unit can be used as road metal and embankment fill of good to moderate quality; it also can be used as dumped fill and probably as subbase. The unit is generally satisfactory for the disposal of liquid wastes; in clay-enriched zones, however, percolation may be too slow. The potential of polluting adjacent water supplies is high in granular materials. The unit is moderately satisfactory for solid waste disposal.	Drilling and excavation with power equipment are generally easy, except in areas where cobbles and large boulders are abundant. Excavating equipment has easy access for most of the unit through existing roads. Compaction of the material is moderately easy; vibratory compactors and smooth-tired rollers are recommended. Residual overburden within the unit occurs on exposures of the Rocky Flats alluvium. This material is characterized by a slightly sticky, slightly plastic B horizon, with a thickness of 0.3 m (1 ft), and a calcium carbonate zone in the upper part of the parent material. Cuts stand vertical for several months; they eventually slump to a stable slope generally less than 25 degrees.	Most of the sand and gravel pits on the reservation are in this unit; it generally caps remnants of formerly extensive upland surfaces near the cantonment area. Potential future sites are northwest of Butts AAF and southeast of the Rod and Gun Club. Additional sites are north and east of the Impact Area at grid reference 196764 and within the Artillery and Small Arms Impact Area. All sites are readily accessible using existing roads.
5. Interbedded siltstone and claystone, some limestone and hard sandstone.	This unit, which is entirely within the Southern Rocky Mountains Province, underlies variable terrain ranging from nearly flat to strongly rolling and locally intensely dissected plains to low hills bounded by steep escarpments. It overlies Unit 1, forming a partially concentric outcrop pattern trending north-northwest, and occupies the inner flank portion of the Red Creek anticline. Most of the unit is covered by alluvium and residual soil approximately 5 m (16.4 ft) thick. Outcrops occur along steep escarpments, on the slopes of Booth and Timber Mountains, in stream valleys, and in scattered locations throughout the area. Sullivan Park, consisting of a flat to gently sloping plain covering approximately 12 km^2 (4.6 mi^2), is suitable for multi-structures emplacement and transportation routing, whereas Timber Mountain, with steep slopes and almost vertical escarpments, is not suitable for construction. The remainder of the unit is in terrain that is strongly rolling and locally intensely dissected, and is generally unfavorable for large-scale construction. Local relief is largely between 60 and 90 m (200 and 300 ft), with the exception of Timber Mountain, where local relief ranges from 150 to 215 m (500 and 705 ft). The highest elevation is approximately 2073 m (6800 ft) on Timber Mountain; the lowest elevation is approximately 1730 m (5680 ft) in Sullivan Canyon, at the easternmost border of the unit. The drainage pattern is dendritic and partially concentric, with moderate to coarse texture; streams are curving to sinuous, and locally incised. Several escarpments with nearly vertical slopes occur within the unit. Rockslides and rockfalls are likely where bedding surfaces dip into deep cuts and scarps.	Interbedded siltstone, claystone, sandstone, and limestone of the Permo-Triassic Lykins formation and the overlying Upper Jurassic Ralston Creek and Morrison formations. The Lykins formation is composed of reddish, thinly stratified siltstone, interbedded with thinly laminated or massive, porous limestone, light-brown sandstone, and finely-laminated, chert-bearing, sandy limestone. The beds are generally 2.5 to 90 cm (1 in to 3 ft) thick and laterally persistent, with uneven surfaces and distinct boundaries. The formation is dense, firm to hard, and locally exhibits a degree of overconsolidation. Clay is the predominant cementing agent, illite the most abundant clay mineral. Hematite (iron oxide) may also act as a cementing agent. The chert-bearing, sandy limestone is intricately folded and faulted. The beds dip regionally eastward at angles ranging from 25 to 40 degrees. Fractures are short, irregular, and partially open. The thickness of the formation in the Fort Carson area is approximately 55 m (180 ft). The Ralston Creek formation overlies the Lykins formation and consists of interbedded siltstone, sandstone, gypsum, and beds of limestone containing red jasper grains. The beds are laterally persistent to discontinuous, with uneven surfaces and indistinct boundaries. The siltstone is light-gray to grayish-red, massive, firm to hard, and cemented with calcium carbonate and silica. The beds dip regionally eastward at 25 to 40 degrees. Fractures are numerous, short, irregular, and partially open. The thickness of the Ralston Creek formation near Fort Carson is approximately 6 m (20 ft). The Morrison formation overlies the Ralston Creek formation and consists of varicolored gray, maroon, and green siltstone and claystone, and thin beds of sandstone, limestone, and conglomerate. The siltstone has characteristics similar to those of the Ralston Creek siltstone. The claystone is light-gray to pale-green, firm, massive, and contains thin beds of calcareous shale, fine-grained calcareous clayey sandstone and hard light-gray to moderate-red limestone. Clay minerals, chiefly mixed layers of illite-montmorillonite, illite, and kaolinite are abundant. The sandstone beds are firm, thin-bedded to massive, and locally crossbedded. Fractures are numerous, short, irregular, and nearly closed. The thickness of the Morrison formation is 68 m (225 ft).	Permeability: low to moderate Swelling potential: noncritical Frost susceptibility: slight	There are extensive areas suitable for construction; sources of construction material are limited. The large, gently rolling area, locally known as Sullivan Park, is partially located within this unit, and partially within Unit 1. This area is devoid of any major natural obstructions, which renders it favorable for multi-structures emplacement. The total flat to gently rolling area of Sullivan Park, comprising Units 1 and 5, is approximately 12 km^2 (4.6 mi^2). Another alinement exists along the southwestern section of the unit, bordering Wild Mountain; this narrow gently rolling area is presently the site of the western part of Route 8. The portion of this unit within Sullivan Park is suitable for straight transport route alinements; only minor cut-and-fill or grading would be required for roads and railroads. Minor bridging may be required; streams draining the area are small suggesting that culverts would be sufficient. Only minor surface solutioning is expected where the limestone is exposed. Erodibility of sandstone is low, whereas the resistance of the claystone is only fair; check structures may be needed. The interbedded siltstones, claystones, and limestones, with numerous fractures, and the occasional presence of gypsum beds reduce the overall foundation stability of the unit to low to moderate. Geotechnical investigations are suggested prior to large-scale construction. Where siltstone and sandstone beds are exposed, their surfaces are hardened; the limestone surface is craggy and solution-pitted. Generally, the claystone is altered to silty sandy clay and weathered to irregular fragments to a depth of 1 to 2 m (3 to 6 ft). The siltstone and claystone are possible sources of poor quality fill and a poor source of clay for brick and tile. The limestone yields good-quality crushed aggregate. The unit is unsuitable for the disposal of both solid and liquid wastes because it is difficult to excavate, the percolation rate is very slow, and there is danger of polluting potential ground water supplies.	Siltstone, claystone, sandstone, and hard limestone are not easily excavated with hand or small power equipment. The siltstone of the Lykins formation is easily excavated with most power equipment, including tractor-drawn scrapers and backhoes, to a depth of approximately 2 m (6 ft). Excavation becomes increasingly difficult with depth. Excavation of the siltstone of the Morrison and Ralston Creek formations is moderately difficult with heavy rippers and scrapers. The claystone can be excavated with most power equipment to the base of fractures and weathered material. Heavy equipment is needed for greater depths. The claystone adheres to the equipment when wet. The sandstone and limestone require heavy equipment; locally, blasting may be necessary since these members are fairly resistant to erosion. Access of excavating equipment is easy through several existing roads. Overburden consists mostly of residual loam, developed as a result of the leaching of the cementing material and disintegration of the bedrock. The overburden is generally loose, and its thickness is variable. It can be easily excavated by hand or power tools. Vegetation varies from pine forest on Timber Mountain and adjacent high plains areas to prairie grass on the gently sloping plains. Drilling is easy to moderately easy in claystone and siltstone, becoming moderately difficult in sandstone and limestone. No major drilling problems are anticipated. Compaction is moderately difficult for sandstone, limestone, and siltstone, and generally easy for claystone and the siltstone of the Lykins formation. Sheepsfoot, rubber-tired rollers or smooth-tired rollers are suggested. Slope stability of the unit is moderately good. Slopes on most beds of the Lykins formation stand vertically for a long time. Rockslides and rockfalls may occur where beds dip into deep cuts. Rockfalls may also occur where joint planes dip into the cut slope.	No development. No sites recommended.

E. ENGINEERING GEOLOGY (Continued)

MAP UNIT	TOPOGRAPHY	ROCK DESCRIPTION	PHYSICAL CONSTANTS	ENGINEERING EVALUATION	EXCAVATION FACTORS	PITS AND QUARRIES
6. Thin-bedded calcareous shale, interbedded hard limestone, and slightly swelling clay.	This unit, which is within the Colorado Piedmont section of the Great Plains Province, occupies variable terrain ranging from gently sloping plains along the eastern and southern boundaries of the reservation to gently to strongly rolling, locally intensely dissected high plains in the east-central and southwestern portions of the reservation. It is characterized by a series of conspicuous escarpments with nearly vertical walls. These escarpments, or hogbacks, exhibit a northwest to southeast topographic grain, and break the rolling plains surface in the southeastern and southwestern parts of the reservation. Much of this terrain is suitable for construction. Mean local relief is approximately 85 m (279 ft); the maximum local relief is approximately 146 m (480 ft). Elevations range from a low of approximately 1628 m (5340 ft) in a stream channel at grid reference 122522 to a high of 1939 m (6360 ft) on an upland surface at grid reference 130726. Bedrock outcrops occur along the crests of hogbacks and along the banks of incised streams. The drainage pattern is rectangular dendritic with generally straight stream segments.	Predominantly thin-bedded calcareous shale, interbedded hard limestone, and slightly swelling clays of the Upper Cretaceous Niobrara formation. This formation includes the Fort Hays limestone member and the overlying Smoky Hill shale member. The Fort Hays limestone contains gray, hard limestone beds, 2.5 to 66 cm (1 to 26 in) thick, separated by thin calcareous shale partings; the latter are yellowish-gray, soft, and fissile to platy or blocky. The limestone is predominantly composed of fossiliferous calcareous oolites and calcite. It is locally folded and faulted; total thickness is approximately 9 to 12 m (30 to 40 ft). The Smoky Hill shale consists of the following distinct lithologic units: basal gray shale and limestone; dark-gray, fissile to platy lower shale; gray, ridge-forming, lower limestone; dark-gray middle shale; yellowish-gray, ridge-forming middle limestone; yellowish-orange upper chalky shale; and a yellowish-orange, ridge-forming upper chalk unit. The Smoky Hill member is highly fossiliferous and the shale contains some swelling clay and bentonite beds. Beds are laterally persistent, with even surfaces and indistinct boundaries. The member is locally folded and faulted. Total thickness of the Smoky Hill shale member is approximately 162 m (530 ft).	Fort Hays limestone member only Permeability: poor Swelling potential: noncritical Frost susceptibility: slight Specific gravity, g/cm^3: 2.57 24-hour absorption, percent: 2.9 Los Angeles abrasion loss (A grading) after 500 revolutions, percent: 25 Soundness, percent loss after 50 cycles of freezing and thawing: 90 Soundness, percent loss after 5 cycles of immersion in sodium sulfate: 18 Smoky Hill shale member only Permeability: very poor to good Swelling potential: noncritical to critical Frost susceptibility: slight to high Plasticity index Middle shale unit (2 tests): Average, 12; Range, 7 to 16 Lower shale unit (1 test): 6 Liquid limit Middle shale unit (2 tests): Average, 37; Range, 34 to 39 Lower shale unit (1 test): 28 Upper chalky shale unit only Plasticity index (3 tests): Average, 5; Range, 4 to 7 Liquid limit (3 tests): Average, 33; Range, 29 to 37 Maximum density, kg/m^3 (lb/ft^3): 1832.7 (114.4) Optimum moisture, percent: 14.7 Laboratory CBR, at 90% maximum density: 5.2	Occupies gently to strongly rolling terrain that is suitable for construction. Flat to gently rolling terrain suitable for multi-structures emplacement is rather extensive along the extreme southeastern and southwestern portions of the reservation. The generally low relief allows straight alinements for roads, railroads, and airfields, with varying degrees of grading and cut-and-fill required. Cut-and-fill could be minimized if road alinements followed the contour of the terrain. Stability of cut slopes in the Fort Hays limestone is excellent, except on undercut dip slopes. The stability of cut slopes in the Smoky Hill shale is generally good but erosion resistance is poor. Cut slopes will stand vertical for a long time, but will gradually erode to a more stable angle approaching 25 degrees. Bridging will be required over major stream crossings. The limestone is not subject to rapid weathering, since its erosion resistance is good. Rockslides and rockfalls are common along escarpments capped by limestone, if the underlying limestone is undercut by streams. Foundation stability of the unit ranges from fair to excellent. Thin beds of swelling clay in the shale partings and bentonite may cause foundation problems. Therefore, allowance for a potential swelling pressure must be made in the foundation design. Shallow foundations and spread footings would be suitable under most buildings. Bearing strength tests on the shale partings are recommended. Frost susceptibility in the shale partings is medium to high; in the limestone, it is very slight. To avoid differential settlement in a unit containing alternating hard and soft beds, all foundation piers should be founded on the same bed, preferably hard chalk. Where surficial shale is weathered, deep foundations are required. Permeability is very poor in the shale and poor in the limestone with water flowing between limestone beds. Seeps issue from channelways at the base of the Fort Hays limestone and along joint planes; solution of the limestone occurs along the channelways. Water also may seep from shale bedding planes. Hard calcareous shale drains rapidly and does not require check drains, except where weathered. The Fort Hays limestone is a fairly good source of construction material. It has been used for smelter and foundry limestone, mineral filler, agricultural limestone, cement, structural and dimension stone, and road metal, although it dusts badly. Limestone from the Smoky Hill shale member has been used for smelter limestone and for the manufacture of cement. Some of the shale can be used as fill and for the manufacture of cement. The unit is generally unsatisfactory for the disposal of liquid waste; however, the Smoky Hill shale may be used for dump sites since excavation of the weathered shale is easy and the risk of polluting the ground water supply is negligible.	Excavation of the limestone below 1 m (3 ft) is difficult and may require blasting. Dropping a steel ball or a chisel may shatter the limestone and allow removal to a depth of approximately 2.4 m (8 ft). Drilling varies from easy to moderately difficult depending upon the resistance of the strata. Compaction is difficult and may require crushing and mixing with binder material. The shale can be excavated to a depth of approximately 3 m (10 ft). Excavating equipment has relatively easy access to most of the unit through existing roads.	Presently, there are no pits or quarries within the unit. Potential sites include the flat-topped rocky escarpments near the southwestern corner of the reservation and local areas within some of the incised stream valleys. The unit is a potential source of cement rock and smelter limestone.
7. Hard limestone, interbedded slighty to moderately swelling shale, calcareous shale, sandstone, and siltstone.	This unit, which is within the Colorado Piedmont section of the Great Plains Province, underlies flat stream valleys and gently to strongly rolling plains. It is often bounded by long rocky escarpments with nearly vertical walls. Bedrock outcrops on the slopes of sharp-crested ridges (hogbacks) and in the narrow stream valleys. The upper valley of Wild Horse Creek is in moderately rolling and deeply dissected terrain, locally bounded by steep rocky escarpments. The gently rolling high plains bordering Red Creek in the southwestern portion of the reservation exhibit a northeast to southwest topographic trend, whereas the narrow valleys of Booth Gulch and upper Turkey Creek exhibit a northwest to southeast topographic trend, which roughly parallels the physiographic boundary between the Southern Rocky Mountains Province on the west and the Colorado Piedmont section of the Great Plains Province on the east. The upper Turkey Creek valley, including the adjacent alluvial terraces on the east, and the gently sloping plains southeast of Red Creek offer terrain suitable for construction and road alinements. White Butte, in the valley of Turkey Creek, is the major topographic obstruction associated with this unit. Mean local relief is approximately 65 m (213 ft); maximum local relief is 116 m (380 ft). Elevations range from 1560 m (5120 ft), the lowest elevation on the reservation, in the valley of Beaver Creek, to a high of approximately 1939 m (6360 ft) at the northernmost exposure of the unit, in the valley of Turkey Creek (grid reference 133730). Drainage is moderate- to coarse-textured, with linear dendritic patterns predominating. Stream alinements are curving to sinuous.	Comprises the upper Cretaceous Carlile shale, Greenhorn limestone, and Graneros shale. Strata are generally laterally persistent, with even surfaces and indistinct boundaries. The total thickness is approximately 91 m (300 ft). The Carlile shale consists of four members: Fairport chalky shale, a yellowish-gray, soft, calcareous shale; Blue Hill shale, a dark-gray, noncalcareous shale containing large septarian concretions and thin bentonite beds; Codell sandstone, a yellowish-gray, massive to thin-bedded sandstone; and Juana Lopez member, a grayish-brown, hard calcarenite (sandy limestone composed of shell fragments). This formation and the Greenhorn formation are fossiliferous. The Greenhorn limestone consists of the following units: Lincoln limestone, a grayish-brown, thin-bedded hard calcarenite, and shaly calcarenite containing a 0.6 m (2 ft) thick marker bentonite layer at the base; Hartland shale, a gray, shaly calcarenite; and Bridge Creek limestone, a gray, dense limestone interbedded with hard calcareous shale. The Graneros shale is a dark-gray, fissile, soft to medium-hard, calcareous shale and shaly siltstone, containing bentonite beds and some disseminated gypsum.	Swelling potential: noncritical to very critical Frost susceptibility: slight to high Fairport chalky shale member Plasticity index: 17 Liquid limit: 47 Blue Hill shale member Plasticity index: 13 Liquid limit: 35 Lincoln limestone member Plasticity index: 8 Liquid limit: 39 Hartland shale member Plasticity index: 11 Liquid limit: 40 Graneros shale Plasticity index: 13 Liquid limit: 38 Bridge Creek limestone member only Specific gravity, g/cm^3: 2.59 24-hour absorption, percent: 2.7 Los Angeles abrasion test (A grading), percent loss after 500 revolutions: 25 Soundness, percent loss after 50 cycles of freezing and thawing: 75 to 100 Soundness, percent loss after 5 cycles of immersion in sodium sulfate: 20	Potential construction sites are limited to the Turkey Creek valley and adjacent terraces, and the high plains paralleling Red Creek on the southeast. Nearly straight alinements suitable for road and railroad construction are limited to the upper Turkey Creek valley and the low terraces adjacent to the lower Turkey Creek valley. Route 9 follows this alinement. Route 11 follows a curving alinement formed by Booth Gulch. Minor to moderate grading and cut-and-fill operations required. Cut-slope stability is generally poor except in the resistant Juana Lopez, Bridge Creek, and Codell members. Bridging required over major stream crossings. Generally, the shale erodes readily; check dams are needed. On vertical slopes, limestone blocks loosen and fall due to undercutting of the shale beds. Artificial drains are necessary in some depressions to reduce water absorption by shale. Rockslides have occurred locally. Frost susceptibility at the unit varies from slight to very high. Foundation stability of the unit varies from poor to excellent depending upon the specific member encountered. The shale members have fair to poor stability and have some slight to moderate swelling properties because of bentonite beds. The limestone and sandstone members are highly resistant and have excellent foundation stability. Swelling clay and bentonite layers should be avoided. Foundation borings should be probed beyond the depth drilled to assure the absence of bentonite beds immediately below the foundation. Foundations should be placed below the weathered surface, which extends to a depth ranging from 1 to 3 m (3 to 10 ft). Expansive clays shrink upon drying,causing differential settlement. Because water flowing through the shale is charged with sulfate, sulfate-resistant cement should be used. The Codell sandstone has been widely used for dimension stone, in retaining walls, foundations, buildings, stone arch bridges, and aprons with excellent results. The shale could be used for the manufacture of lightweight aggregate. The unit is unsatisfactory for disposal of liquid wastes due to slow percolation; however, the ease of excavation of the surficial weathered material and the low risk of polluting ground water supplies make this unit suitable for the disposal of solid wastes.	Excavation and compaction of the unit are moderately easy except in the Juana Lopez, Codell, and Bridge Creek members which are highly resistant to erosion. Excavating equipment has easy access to the unit through several post roads. Overburden consists of a residual loamy soil with a maximum thickness of approximately 3 m (10 ft). Excavation is moderately easy to the base of the weathered material with most power equipment, including tractor-drawn scrapers and backhoes; excavation becomes increasingly difficult with depth. Blasting or quarrying is necessary for the removal of sandstone. Cut slopes in the sandstone stand vertical unless undercut by erosion or by slides in the underlying material. Cut slopes in the shale are stable only in slopes of 5 to 10 degrees and erode readily.	No pits or quarries exist in this unit. Potential sites include two exposures near the southeastern corner of the reservation. Access to these areas is easy through existing roads.
8. Hard sandstone, shale, claystone and some gypsum.	The unit is within the Southern Rocky Mountains Province. It crops out on Booth and Wild Mountains, parts of Timber Mountain, and the high plains west of the Turkey Creek valley. Outcrops are abundant and scattered throughout the unit. Steep-walled canyons and gulches predominate on Booth and Timber Mountains although several small, gently sloping upland surfaces are present. Since the unit is characterized by sharp-crested ridges, escarpments with nearly vertical walls, gulches, steep-walled canyons, and rock outcrops, terrain suitable for large-scale construction is lacking. Mean local relief is approximately 190 m (625 ft); maximum local relief is approximately 225 m (740 ft). The highest elevation is 2130 m (6897 ft) on Timber Mountain; the lowest elevation is approximately 1646 m (5400 ft) near the southern border of the reservation at Turkey Creek. The unit is intensely dissected; streams occupy narrow, rocky valleys. The drainage pattern varies from radial on Booth Mountain to linear dendritic for the remainder of the unit.	Contains the combined Lower Cretaceous Dakota and Purgatoire formations. The Dakota formation is yellowish-brown to yellowish-gray, hard, slabby to massive, partly cross-bedded, fine- to medium-grained, moderately graded sandstone containing some shale. The sandstone also contains augite, biotite, chalcedony, and feldspar; the interstices between the grains contain clay minerals. Thickness of the Dakota is approximately 52 m (160 ft). The underlying Purgatoire formation consists of the Glencairn shale member, which contains shale, clay, and some gypsum; and the Lytle sandstone member, which contains fine-to coarse-grained sandstone, with pebbly beds and lenses of claystone. Thickness of the Purgatoire formation ranges from 52 to 66 m (160 to 200 ft). Beds in this unit vary in thickness from less than 0.3 m (1 ft) to several meters. They are laterally discontinuous with even to uneven surfaces and distinct to abrupt boundaries. Ripple marks are occasionally present. Fractures are conspicuous; they are generally spaced 15 cm to 3.6 m (6 in to 12 ft), and strike in perpendicular and parallel directions to the bedding planes.	Permeability: good Swelling potential: noncritical Frost susceptibility: very slight Specific gravity, g/cm^3: 2.37 24-hour absorption, percent: 2.7 Los Angeles abrasion test (A grading), percent loss after 500 revolutions: 97 Soundness, percent loss after 50 cycles of freezing and thawing: 0.01 Soundness, percent loss after 5 cycles of immersion in sodium sulfate: 35	Flat to gently rolling terrain is lacking in this unit, rendering it unsuitable for multi-structure emplacements, roads, railroads, or airfields. No roads cross the unit, with the exception of Routes 9 and 11, which traverse the unit for very short distances through stream valleys. Unimproved dirt roads and trails provide access to most of the area. Rockfalls are potential causes of disruption. The construction of roads within this unit requires substantial grading, cut-and-fill, and bridging; the stability of cut slopes is poor where the bedding planes dip into the cut; debris and sandstone blocks may slide on dip slopes, particularly if undercut. Foundation stability is excellent and bearing capacity is generally very high. Dams constructed over forty years ago in geologically and geotechnically similar lithologic units outside the reservation remain in excellent condition. The possibility of disruption or displacement of foundations by erosion, freeze-and-thaw, solution, piping, and earthquakes is very low. Tests indicate the sandstone to be of poor quality for use as riprap; however, it could be used if placed above the highest water level. The sandstone has been used for building and ornamental stone; it also could be used as a dimension stone. The shale members of the unit are important sources of clay for manufacture of brick, firebrick, and tile. The unit is not suitable for disposal of solid or liquid wastes because it is difficult to excavate, the claystone is impermeable, and there is a moderate risk of polluting the ground water supply.	Excavation of the unit is generally difficult; in places it has been excavated with heavy tractor-drawn rippers; commonly, blasting is required. Access for excavating equipment is primarily through unimproved dirt roads. Overburden is fairly thin and consists chiefly of residual loam formed from the leaching of the cementing material and subsequent disintegration of the bedrock. Overburden material is generally compact. It is easily excavated by hand or small power equipment. Vegetative cover consists of trees and scrub. Blasting is required for the sandstone; the claystone could possibly be excavated with heavy tractor-drawn rippers. Drilling is moderately difficult to difficult. Compaction is moderately difficult and mixing with binder material is generally required before compaction. Hauling equipment and smooth-tired rollers are recommended. Cut slopes stand vertical for a long time; rockslides may occur if bedding planes dip into cut faces.	Possible quarry sites in sandstone are abundant along scarps in Booth Mountain. Accessibility is poor. Clay from mines near Stone City is used for manufacture of brick, firebrick, and tile.

E. ENGINEERING GEOLOGY (Continued)

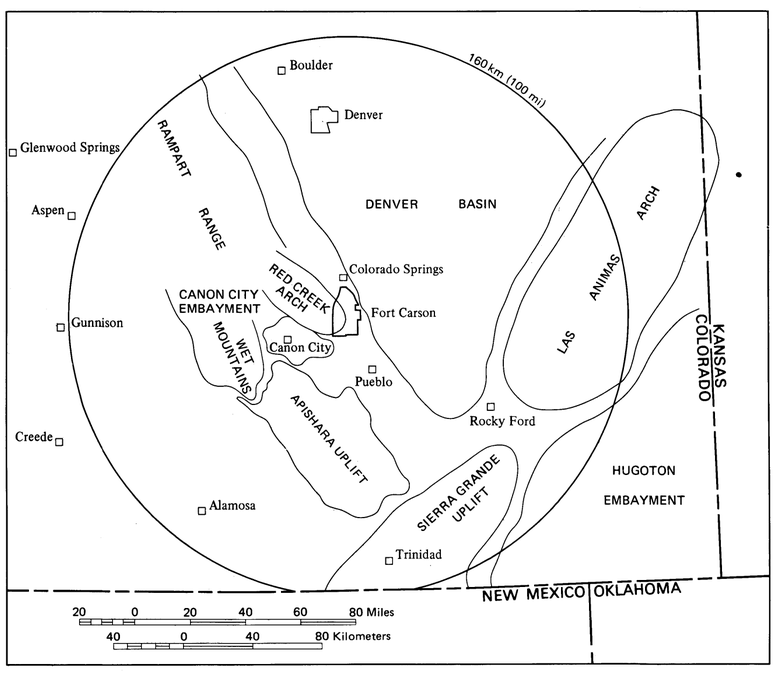
MAP UNIT	TOPOGRAPHY	ROCK DESCRIPTION	PHYSICAL CONSTANTS	ENGINEERING EVALUATION	EXCAVATION FACTORS	PITS AND QUARRIES
9. Wind-deposited silt and sand.	The unit is within the Colorado Piedmont section of the Great Plains Province; it is limited in areal extent. It occurs in one relatively large, northwest to southeast trending area southeast of Butts AAF and in three smaller, isolated areas. One of these areas borders the eastern part of the reservation, approximately 2.5 km (1.6 mi) north of Sand Creek. The other areas are in the extreme southwestern corner of the reservation. The unit occupies flat to gently sloping terrain. Mean local relief within the unit is approximately 35 m (115 ft); maximum local relief is approximately 48 m (160 ft). The lowest elevation is 1591 m (5220 ft) in a small area at the extreme southwestern corner of the reservation. The highest elevation is approximately 1780 m (5840 ft) in the vicinity of Butts AAF. Drainage within this unit is sparse.	**Wind-deposited (eolian) fine-to-coarse sand and clayey sandy silt of Holocene-Pleistocene age.** The sand is yellowish-gray or yellowish-brown, fine- to coarse-grained, slightly compacted, and weakly cemented. Cross-stratification is present but not readily apparent. An average size-distribution curve of the sand shows 40 percent combined silt-and-clay-sized material, 57 percent sand, 2 percent granules, and 1 percent pebbles. Sand grains are well graded and frosted. The isolated areas in the southwestern portion of the reservation consist primarily of wind-deposited clayey sandy silt (loess). Bedding is commonly absent. The material is firm, moderately dense, and moderately graded. The unit is generally less than 6 m (20 ft) thick.	Permeability: moderate to very good Swelling potential: slight to none Frost susceptibility: slight to very high Infiltration: moderate to very rapid Plasticity index (14 tests): Average, 4.4; Range, 0 to 11 Liquid limit (14 tests): Average, 22; Range, 18 to 26 Specific gravity, g/cm^3 (2 tests): Average, 2.66; Range, 2.66 to 2.67 Maximum density, AASHO modified compaction, kg/m^3 (lb/ft^3) (11 tests): Average, 1864.7 (116.4); Range, 1821.5 (113.7) to 1972.1 (123.1) Optimum moisture, percent (11 tests): Average, 13.1; Range, 10.6 to 14.4 Laboratory CBR, 90% maximum density (19 tests): Average, 8.2; Range, 2.8 to 12.5 AASHO classification: Average, A-4; Range, A-2, A-3, A-4, A-6 Unified Soil Classification: SC, SM, CL, ML	Occupies nearly flat to gently sloping plains; limited in areal extent and does not allow for continuous alinements, with the exception of the area at Butts AAF, which has already undergone extensive development. The remaining areas within the unit can only be used in conjunction with adjacent units for local multi-structures emplacement. Minor grading and cut-and-fill is required within the unit; however, bridging is not required. Walls of trenches may collapse if not supported by shoring. The uppermost few centimeters to few meters of the silt (loess) may be subject to creep, the rate of movement increasing with steepness of the slope. The unit is subject to both wind and water erosion if not covered by vegetation. Drains will be needed at the base of the sand to counteract potentially high-velocity runoff. Foundation stability is good where it is not subject to frost action; saturation may result in differential settlement of the silt-size materials. Dry sand generally compacts under the pressure of static load. Heavy loads may cause settlement, especially if original consolidation is poor. Material from this unit should not be applied as base material directly under pavement or other wearing courses because its bearing capacity decreases drastically when saturated. The sand has slight or no swelling potential; its frost susceptibility ranges from slight to very high depending on the amount of fine-grained material. The sand is used in combination with shale for the manufacture of bricks and is a potential source of plaster sand. Material from the unit can also supply topsoil or binder material in road construction. The unit is generally satisfactory for the disposal of liquid wastes; if the unit is thin, the lithologic characteristics of the underlying material must be thoroughly investigated. Settlement may result if excessive liquids are introduced into or withdrawn from the material. Because of its limited thickness, the unit is considered unsatisfactory for solid waste disposal sites.	Easily excavated with small power equipment and hand tools. High drilling rates can be expected. The unit is easily accessible by post roads with the exception of the small area in the southwest which is only accessible through unimproved dirt roads. Overburden consists of residual brown soil approximately 0.6 m (2 ft) thick, characterized by slight accumulations of clay minerals showing weak prismatic structure. Vegetative cover is predominantly prairie grass. Dry sand is stable in vertical exposures when freshly cut; as rainwater dissolves the cementing material, the sand slumps to a stable 10 degree slope. Walls of trenches may collapse if not supported by shoring.	There are no existing pits or quarries within the unit. Potential sites are abundant and easily accessible through existing roads. The unit is a source of commercial sand.
10. Organic clayey silt and sand, some gravel.	The unit lies within the Colorado Piedmont section of the Great Plains Province. It underlies the flat to gently sloping floodplains in the northeastern portion of the reservation and forms low terraces adjacent to stream channels. Mean local relief is 35 m (115 ft); maximum local relief is 50 m (164 ft). The lowest elevation within the unit is 1628 m (5340 ft), at the eastern boundary of the reservation near Young Hollow. The highest elevation is approximately 1854 m (6080 ft), near the golf course. Drainage is predominantly parallel dendritic. The degree of dissection is generally fine; occasionally, streams occupy arroyos with nearly vertical walls in excess of 3 m (10 ft). Streams within the unit are closely spaced and straight to curving. The unit is susceptible to local flooding.	Holocene Piney Creek alluvium, mostly gray to brown, organic clayey silt and sand. The average material contains 23 percent clay, 49 percent silt, 25 percent sand, 1 percent granules, and 2 percent pebbles. The material is igneous and metamorphic in origin; pebbles are generally well-rounded, sound, and roughly equidimensional. The gravel contains small amounts of interstitial lime ($CaCO_3$). The coarse-grained material is moderately dense; cohesive soils are firmly compacted. Beds are laterally discontinuous, with even to uneven surfaces and indistinct boundaries; their thickness ranges up to 0.6 m (2 ft). Maximum thickness of the alluvium is approximately 6 m (20 ft).	Permeability: low to high Swelling potential (4 tests): Range, 2000 to 3000 (marginal) Frost susceptibility: slight to high Infiltration: moderate Plasiticity index (15 tests): Average, 12; Range, 5 to 18 Liquid limit (15 tests): Average, 33; Range, 22 to 45 Specific gravity (1 test): 2.69 Maximum density, AASHO modified compaction, kg/m^3 (lb/ft^3) (1 test): 1872.3 (116.9) Optimum moisture, percent (1 test): 13.7 Laboratory CBR, 90% maximum density (8 tests): Average, 5.4; Range, 2.0 to 11.3 pH (5 tests): Average, 7.67; Range, 7.58 to 7.81 AASHO classification: Average, A-4; Range, A-4, A-6, A-7 Unified Soil Classification: CL, OL, SM	The entire unit occupies flat to gently sloping floodplains and low-lying areas, and is scattered throughout the northern and eastern portions of the reservation. A major portion of the cantonment area lies within this unit. The curvilinear northwest-southeast orientation of the cantonment area parallels the surface trend of this unit, thus minimizing grades and cut-and-fill. Straight alinements, with minor cut-and-fill and grading are available for roads, railroads, and airfields. Slope stability is poor to fair; cut slopes stand vertically along deep arroyos when dry, but slump when the base is water-saturated. Check dams are necessary to prevent erosion. Dams must have adequate spillways to prevent possible damage during flash flooding. Bridging may be required across some of the larger streams. Flooding will be the most likely cause of traffic disruption. Foundation stability is generally fair below the organic-rich layer and the zone of potential frost and heave action, which extends to a depth of approximately 1 m (3 ft). The organic-rich layer may compress under load when water is added; it also may cause heaving of foundation slabs. The unit appears to be best suited for small structures, however, the clayey portions may have low to medium swelling properties when wetted. Placement of foundations near arroyos should be avoided because of the lack of lateral confinement, continuance of subsurface drainage even after filling, and possible flood damage. Detailed geotechnical investigations are strongly recommended in specific areas where foundations are to be located. The unit is an excellent source of sand and gravel for concrete aggregate and road metal. Pebbles are generally well-rounded and sound. The gravel contains little interstitial lime ($CaCO_3$) and little or no reactive constitutents. The material has been used as fill and has a potential use as soil binder. The unit is generally poor for the disposal of liquid wastes; limitation results from slow percolation and the potential for flooding. Disposal of solid wastes also may result in pollution of the ground water supply.	Easily excavated by power equipment and hand tools. Access to the various areas composing the unit is easy via existing roads. Compaction is moderately easy. Rollers and vibratory compactors are suggested. If organic material constitutes more than 10 percent by volume of a layer, the layer should be removed before excavation and emplacement. Drilling through the unit is easy. Overburden is approximately 1.5 m (4.9 ft) thick and consists of an organic-rich loam. The predominant vegetative cover is prairie grass. Cut slopes as high as 3 m (10 ft) can stand vertical for a long time when dry; however, they slump or gradually erode to less than 20 degrees when their bases are water-saturated. Seeps are common at the base of the unit where it overlies impermeable bedrock.	The unit is an excellent source of high-quality gravel for concrete aggregate and road metal. All areas within the unit are potential sites which are easily accessible. Gravel deposits in areas adjacent to the reservation range in thickness from 4 to 18 m (13 to 60 ft).
11. Slightly to highly swelling shale and siltstone, some sandstone and limestone.	This unit, in the Colorado Piedmont section of the Great Plains Province, is characterized by numerous exposures extending through the northern and eastern portions of the reservation. The unit occupies variable terrain ranging from nearly flat low plains to strongly rolling, intensely dissected bluffs mantled by fluvial deposits. Bedrock outcrops occur mostly in stream cuts, steep bluffs, and freshly exposed surfaces. Mean local relief is generally less than 50 m (164 ft); maximum local relief is approximately 61 m (200 ft). Elevations range from a low of approximately 1634 m (5360 ft) south of Young Hollow (grid reference 245637) to a high of approximately 1890 m (6200 ft) in the valley of Rock Creek, immediately downstream from State Highway 115. The drainage pattern is fine-textured dendritic in areas where the shale crops out; a moderately- to coarsely-textured dendritic pattern predominates where limestone and sandstone crop out. Stream alinements curving to sinuous.	Upper Cretaceous Pierre shale, a slightly to highly swelling "bentonitic" shale with some limestone, siltstone, and sandstone. Upper part is a clayey shale containing fibrous aragonite and concretionary structures underlain by dark-gray shaly sandstone, a clayey shale containing large irregular limestone masses that weather into conical mounds called tepee buttes, soft shaly yellowish-brown sandstone, silty noncalcareous shale containing ironstone nodules, thin ridge-forming siltstone, and an olive-gray clayey calcareous shale. Beds range in thickness from a few centimeters to a few tens of meters; they are laterally persistent, with even surfaces and indistinct boundaries. The material is often clayey, dense, and poorly graded. The clay beds are firm and impermeable. Siltstone and sandstone beds are soft to firm, and partly cemented with calcium carbonate and clay. The shale is composed chiefly of clay minerals with layers of illite-montmorillonite being the most abundant. Numerous swelling bentonite beds range in thickness from 1.5 cm (0.6 in) to 15 cm (6 in). The formation is highly fossiliferous. Fractures are numerous, short, irregular, and nearly closed. The sandstone generally contains more fractures than the shale. The thickness of the unit varies from 960 m (3150 ft) to 1463 m (4800 ft).	Permeability: Average, poor; Range, poor to very poor Swelling potential, kg/m^2 (lb/ft^2): Range, 6344 (1300) to 34,500 (7070) Frost susceptibility: medium to very high Plasticity index (19 tests): Average, 14; Range, 1 to 26 Liquid limit (19 tests): Average, 39; Range, 25 to 57 Unit weight, kg/m^3 (lb/ft^3): 2146.7 (134) Natural moisture content (intact), percent: 18 Porosity (rock mass), percent: 33 Young's modulus, MPa (lb/in^2): 9.65×10^5 (140,000) Bulk modulus, MPa (lb/in^2): 5.36×10^5 (77,800) Shear modulus, MPa (lb/in^2): 4.02×10^5 (58,300) Poisson's ratio: 0.2 Cohesion: 200 Friction angle, degrees: 5 Dilation angle, degrees: -5 Uniaxial compressive strength, MPa (lb/in^2): 9.65×10^3 (1400) Tensile strength, MPa (lb/in^2): 3.44×10^2 (50) AASHO classification: A-4, A-6, A-7 Unified Soil Classification: CH, CL, ML, MH, Apache Creek sandstone member only Plasticity index (7 tests): Average, 15; Range, 8 to 19 Liquid limit (7 tests): Average, 37; Range, 25 to 43 Specific gravity, g/cm^3 (3 tests): Average, 2.75; Range, 2.74 to 2.76 Maximum density, AASHO modified compaction, kg/m^3 (lb/ft^3) (3 tests): Average, 1778.2 (111.0); Range, 1701.3 (106.2) to 1859.9 (116.1) Optimum moisture, percent (3 tests): Average, 16.5; Range, 13.9 to 18.9 Laboratory CBR, 90% maximum density (4 tests): Average, 3.8; Range, 3.0 to 6.7 pH (2 tests): Average, 7.65; Range, 7.4 to 7.9 AASHO classification: Average, A-6; Range, A-4, A-6, A-7 Unified Soil Classification: CL Transition member only Plasticity index (5 tests): Average, 17; Range, 13 to 21 Liquid limit (5 tests): Average, 43; Range, 38 to 46 Maximum density, AASHO modified compaction test, kg/m^3 (lb/ft^3): Average, 1821.5 (113.7) Optimum moisture, percent: Average, 14.9 Laboratory CBR, 90% maximum density: Average, 4.7 pH: Range, 7.88 to 8.02 AASHO classification: Average, A-6 Unified Soil Classification: CL, ML	Occupies moderately rolling, dissected terrain which forms generally broad belts in the northern and narrower belts in the eastern portions of the reservation. Alinements within the unit have a northwest to southeast topographic grain, with highly irregular shape. Grades and cut-and-fill requirements minor in most of the low plain areas; however, in the highly dissected bluffs of upland surfaces, considerable grades and cut-and-fill are necessary. Slope stability is generally poor. Natural slopes range from 5 to 10 degrees. Mass movements are not anticipated unless large areas of shale are excavated at steep slopes, or if the toe of the slope is removed. Excessive loads also may result in slope instability. Plasticity is generally low to medium. Frost susceptibility varies from medium to very high, depending on moisture content and degree of weathering. Control structures are required along roadside ditches because erosion resistance is poor and the shale weathers rapidy. Bridging required over major streams. Foundation stability is generally poor. Slightly to highly swelling bentonite layers cause foundation heaving. Foundations should not be placed immediately above bentonite beds. Stability is best for deep foundations where water level can be kept constant. For large structures, caisson or pier foundations should be used, extending into the more competent, unweathered material, which is generally at a depth of less than 6 m (20 ft). Sulfate-resistant cement should be used due to the high sulfate content in the water. All depressions at construction sites should be artificially drained to avoid collection of water and prevent cyclic moistening of clay minerals. Seepage is generally not expected in open canals. Excavated shale is not suitable for base material under pavement or other wearing course. The unit is a source of clay for brick or tile production and of bloated clay for the manufacture of lightweight aggregate. The unit is generally unsatisfactory for the disposal of liquid waste due to poor percolation. It is, however, favorable for the disposal of solid waste since excavation is easy and the risk of polluting ground water is negligible.	Excavation and compaction are easy in shale, and moderately easy in the sandstone, siltstone, and scattered concretionary beds, where ripping or blasting may be required locally. Drilling is moderately easy; however, drill bits tend to clog due to the stickiness of the clayey materials when wetted. Access for excavating equipment is easy through existing roads. Overburden consists of residual clayey soil generally 3 to 5 m (10 to 16 ft) thick. Vegetation consists mostly of prairie grass. The overburden material is easily excavated with small power equipment, including tractor-drawn scrapers and backhoes; when wet, the material adheres to the equipment.	The intensely dissected remnants of upland surfaces in the northern and eastern portions of the reservation are potential borrow sites for clay. Access to potential sites is easy through existing roads. Overburden thickness is generally less than 5 m (16 ft); support will be required for cut slopes. Seepage problems can be anticipated.

F. SPECIAL PHYSICAL PHENOMENA

1. EARTHQUAKES

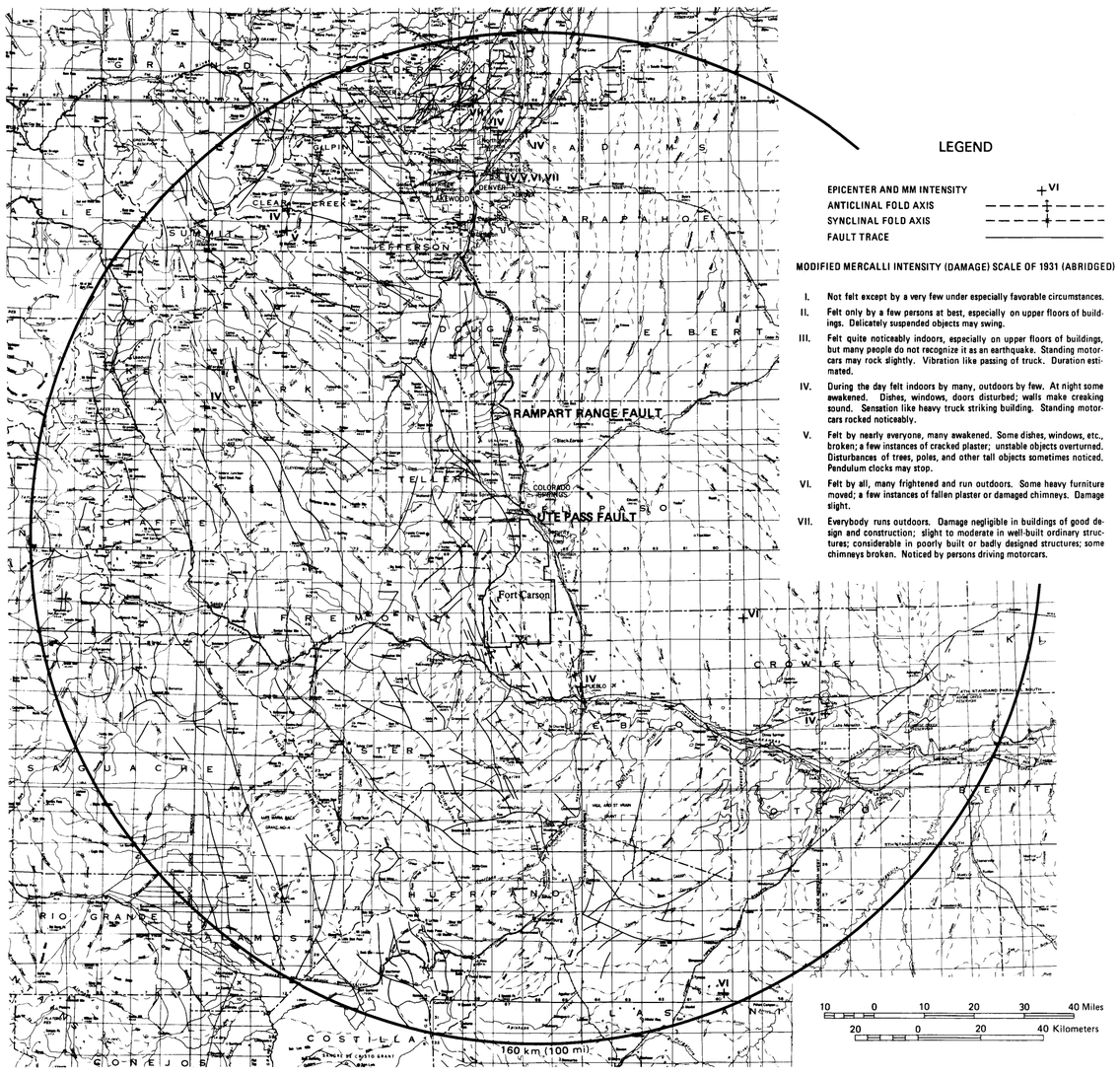
The generalized seismic risk map of the United States indicates that the area around Fort Carson is a Zone 1 region. This is a zone of minor damage where earthquakes have maximum intensities corresponding to V and VI on the Modified Mercalli Scale, shown below. Based on the known distribution of damaging earthquakes and the Modified Mercalli Intensities associated with these earthquakes, including evidence of strain release and consideration of major geologic structures and provinces, the reservation is in a region of minor seismic significance.

REGIONAL TECTONIC MAP



Fort Carson is bordered on the east by the southwestern flank of the Denver Basin, an elongated, asymmetrical structural trough whose axis trends in a north-south direction through Denver. The eastern and central portions of the reservation are in the transition zone between the Denver Basin on the east and the Rampart Range Uplift on the west. The rocks within this zone are sandstones and shales which strike north-northwest and dip east into the Denver Basin. The Red Creek Arch, a shallow prong-like uplift, trends north-northwest through the west-central and western portions of the reservation. Along the axis of this arch, as defined by the valley of Red Creek, older sandstone formations are either exposed or lie at shallow depth below a thin residual soil cover. The southeastern boundary of the Rampart Range Uplift, a broad north-northwesterly trending regional dome consisting of older granitic-type rocks, is immediately adjacent to the northwest border of the reservation.

REGIONAL FAULT AND EARTHQUAKE EPICENTER MAP



LEGEND

EPICENTER AND MM INTENSITY +VI
ANTICLINAL FOLD AXIS
SYNCLINAL FOLD AXIS
FAULT TRACE

MODIFIED MERCALLI INTENSITY (DAMAGE) SCALE OF 1931 (ABRIDGED)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at best, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably.

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars.

No earthquake epicenters have ever been recorded at Fort Carson. Within a 160-kilometer (100-mile) radius of the cantonment area, thirty-three earth tremors of Intensity IV or greater have been reported during the period 1870-1972. Two earthquakes of Intensity VII have occurred, one near Boulder in 1882; the other near Commerce City, a northern suburb of Denver, in 1967. The closest recorded epicenters during the last 100 years were Intensity IV and VI earthquakes near Pueblo , some 67.6 kilometers (42 miles) south-southeast of the cantonment area.

The most recent earthquake investigation by Presgrave indicates that Colorado Springs has a statistical probability of an earthquake with a magnitude of 3.7 occurring once in 30 years. This investigation also reveals that southwest-central and northwest-central Colorado are most susceptible to severe earthquakes, while the Colorado Springs-Pueblo area (including Fort Carson) is relatively less prone to serious earthquake damage.

The most prominent structural features in the vicinity of Fort Carson are the Rampart Range fault and the Ute Pass fault. The Rampart Range fault trends in a general north-south direction along the mountain front from Fountain Creek west of Colorado Springs northward to the South Platte River, a distance of approximately 80 kilometers (50 miles). This fault is characterized by a large displacement which locally has brought older granitic rocks on the west in contact with much younger sandstones and shales on the east. The Ute Pass fault trends in a northwesterly direction from the vicinity of Little Fountain Creek and State Highway 115 (adjacent to Fort Carson) for a distance of approximately 72 kilometers (45 miles) to the town of Deckers in the Rampart Range. These faults apparently have long been inactive; no movement has been recorded on or related to them in recent geologic time.

SUMMARY OF INTENSITY IV OR GREATER EARTHQUAKES WITHIN 160-KILOMETER (100-MILE) RADIUS OF FORT CARSON (1870-1972)

Year	Date	Local Time	Locality	N. Lat.	W. Long.	Circular Felt Area Thousands of km² (mi²)	M. M. Intensity	Richter Magnitude
1870	4 Dec	05:00	Pueblo	38.5	104	160.6? (62?)	VI	
1871	9 Nov	10:15	Georgetown	39.7	105.7		IV	
1882	7 Nov	18:30	Denver-Boulder?	40?	105?	1191? (460?)	VII	
1894	5 Aug	05:00	Georgetown	39.6	105.7		V	
1955	27 Nov	22:25	Rocky Ford	38.2	103.7	1.0 (0.4)	IV	
1962	17 June	17:46	Commerce City	39.8	104.9	1.5 (0.6)	V	3.1
1962	4 Dec	10:50	Commerce City	39.8	104.9	19.4 (7.5)	V	3.6
1962	5 Dec	06:48	Commerce City	39.8	104.9	25.9 (10)	V	3.8
1963	30 Jan	16:05	Commerce City	39.8	104.9	15.5 (6)	IV	3.2
1963	7 Apr	17:04	Commerce City	39.8	104.9	15.5 (6)	V	3.2
1963	24 Apr	15:30	Commerce City	39.8	104.9	7.7 (3)	IV	3.2
1963	25 May	03:45	Commerce City	39.8	104.9		IV	3.5
1963	2 July	01:03	Commerce City	39.8	104.9	38.8 (15)	V	3.7
1963	13 Nov	14:34	Pueblo	38.3	104.6		IV	2.8
1965	16 Feb	15:22	Commerce City	39.8	104.9	1.5 (0.6)	V	3.2
1965	16 Apr	10:25	Commerce City	39.8	104.9	0.5 (0.2)	V	3.4
1965	14 June	03:25	Commerce City	39.8	104.9	0.1 (0.05)	IV	3.1
1965	13 Sept	03:58	Commerce City	39.8	104.9	1.8 (0.7)	V	3.8
1965	14 Sept	16:47	Commerce City	39.8	104.9	4.6 (1.8)	V	4.1
1966	4 Jan	17:37	Commerce City	39.8	104.9	2.0 (0.8)	V	3.5
1966	2 Oct	19:26	Trinidad	37.4	104.1	150 (60)	VI	4.6
1966	14 Nov.	13:02	Commerce City	39.8	104.9	25.9 (10)	VI	4.2
1967	10 Apr	12:00	Commerce City	39.8	104.9	31.1 (12)	VI	4.7
1967	27 Apr	10:24	Commerce City	39.8	104.9	10.3 (4)	V	3.8
1967	9 Aug	06:25	Commerce City	39.8	104.9	116.5 (45)	VII	5.3
1971	8 Aug	05:22	Northglenn	39.9	104.8	1.5 (0.6)	IV	4.4
1971	8 Dec	22:28	Commerce City	39.8	104.9	0.2 (0.06)	IV	
1972	29 Nov	15:15	Brighton-Broomfield	39.9	104.9	0.1 (0.05)	IV	

2. LANDSLIDES

Landslides, found in the central and western portions of the reservation, are shown on the Engineering Geology map. One group of slides occurs along the steeply sloping northeastern and western rim of the upland surface area between the Rod and Gun Club and Turkey Creek Ranch. The two largest slides in this group are centered at grid references 124770 and 159767; the first is approximately 3.5 kilometers (2.2 miles) long, and 150 meters (492 feet) to 600 meters (1968 feet) wide; the second is approximately 2 kilometers (1.2 miles) long and 150 meters (492 feet) to 700 meters (2296 feet) wide. Also within this area are five small slides centered at grid references 134791, 139786, 144782, 154780, and 161755; the combined areal extent of these slides is less than 1 square kilometer (0.4 square miles). Three large landslides occur along the steep slopes of Timber Mountain. The largest of these, centered at grid reference 115675, is approximately 2.5 kilometers (1.6 miles) long and 1 kilometer (0.6 miles) wide. The other slides, centered at grid references 109703 and 117651, cover a total area of approximately 2 square kilometers (0.8 square miles). Two other landslides are shown on the map. One, centered at grid reference 186837, is approximately 1 kilometer (0.6 miles) long and 0.5 kilometers (0.3 miles) wide; the other, centered at grid reference 034643, parallel to State Highway 115 along the western boundary of the reservation, is rather large and well defined, approximately 5 kilometers (3 miles) long and 0.5 kilometers (0.3 miles) wide.

The landslides are primarily debris-slides, slumps, and earthflows. All deposits are sandy and contain many boulders; clay and silt content varies from abundant, where slides involve shaly bedrock, to low, where slides are derived from the sandy materials of Unit 8. The upper surface of these deposits is hummocky; their thickness can be as much as 9 meters (30 feet).

Steep slopes and boulders make excavation moderately difficult for small power equipment. Compaction is also moderately difficult because of the presence of boulders. As the clay content of the deposits increases, the permeability decreases. Foundation stability varies from poor to fair. Factors which may cause further sliding of the deposits are increased moisture content, steep slopes, and the applied load. Detailed geotechnical investigations should be undertaken prior to excavation or construction. Earthquake stability for existing slides and potentially unstable slopes is very poor. Resistance to erosion is good if covered by boulders and vegetation, and fair if vegetation is lacking.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

ENGINEERING GEOLOGY

SOME ENGINEERING USES

1. Hard conglomerate, sandstone, some shale and siltstone.
2. Coarse sand, some pebbles.
3. Gravel, some clay, silt,and sand.
4. Coarse sand and gravel, some clay.
5. Interbedded siltstone and claystone, some limestone and hard sandstone.
6. Thin-bedded calcareous shale, interbedded hard limestone,and slightly swelling clay.
7. Hard limestone, interbedded slightly to moderately swelling shale, calcareous shale, sandstone,and siltstone.
8. Hard sandstone, shale, claystone, and some gypsum.
9. Wind-deposited silt and sand.

FEW ENGINEERING USES

10. Organic clayey silt and sand, some gravel.
11. Slightly to highly swelling shale and siltstone, some sandstone and limestone.

Note: Numbers refer to entries in table.

CONSTRUCTION MATERIALS

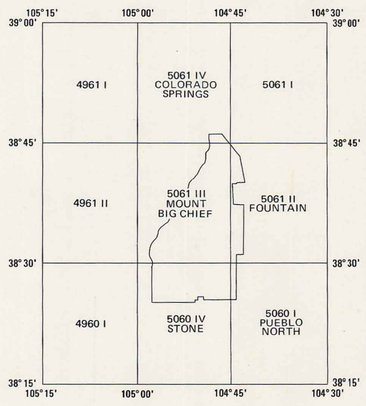
- Borrow pit (S:Sand; G:Gravel; C:Clay)
- Rock quarry (Sandstone)
- S-G — Known or tested sand and gravel deposit*

*Information provided by U.S. Army Corps of Engineers District, Omaha, NE

SPECIAL PHYSICAL PHENOMENA

- Landslide deposit, unsuited for all engineering uses.

INDEX TO SHEETS
SERIES V777
1:50,000
SCALE



CONTOUR INTERVALS

40 FEET

20 FEET

01

Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters

1 ½ 0 1 2 3 Statute Miles

4250000m N.

5000000m E.

G. VEGETATION

Three major vegetative types, grasslands, scrub, and forests, are significant to military training and operations at Fort Carson.

Grasslands compose 70 percent of the vegetation on the reservation, principally in the east, east-central, and southwest portions. The grasses are short, seldom exceeding heights of 1 meter (3 feet). Major species include blue grama, western wheat grass, little bluestem, and needle-and-thread. Grazing has occurred on the reservation in the past; however, under current policy, this practice has been eliminated.

Scrub vegetation composes 25 percent of the vegetative cover, with 24 percent being coniferous scrub and the remainder deciduous scrub. Of the total coniferous scrub, 10 percent is dense and nearly closed canopy scrub, while 14 percent consists of more widely spaced trees. Major species within this type are pinyon pine and one-seed juniper. Coniferous scrub is extremely fragile and is slow to recover if severely disturbed. Deciduous scrub vegetation consists principally of moderately spaced Gambel oak.

Forests, consisting of coniferous and deciduous trees, compose approximately 5 percent of the vegetative cover. Coniferous trees include ponderosa pine forest, with some pinyon pine and one-seed juniper. Deciduous species include primarily plains cottonwood, which occurs in scattered locations along major drainageways, and Gambel oak.

Vegetative types affording the best cover and concealment possibilities for foot troops and vehicles are the dense stands of forest and scrub. Coniferous forest and scrub compose approximately 28 percent of the vegetation on the reservation and afford year-round cover and concealment possibilities. Deciduous forest and scrub, 2 percent of the total vegetation, provide fair cover and concealment potential from late May through early October when the trees are in leaf. Vegetative types which afford least cover and concealment are deciduous forest and scrub, during the leafless period (early October to late May), and grasslands.

The location and extent of vegetative types on Fort Carson are shown on the accompanying Vegetation map. Descriptive details of each map unit are included in the table below.

MAP UNIT	DESCRIPTION	DISTRIBUTION	REMARKS	COVER	CONCEALMENT
1. Coniferous trees; medium to dense spacing.	Coniferous species, composing 75 percent or more of each stand, consist of widely spaced ponderosa pine with closely spaced pinyon pine and one-seed juniper, occasionally interspersed with Gambel oak. Spacing between trees averages 5 to 7 m (16 to 23 ft). Crown cover density is 50 to 100 percent. Ponderosa pine stem heights range from 8 to 10 m (25 to 33 ft); stem heights of pinyon pine, one-seed juniper, and Gambel oak average 2.5 to 3.5 m (8 to 12 ft). Stem diameters of ponderosa pine range from 30 to 40 cm (12 to 14 in); those of pinyon pine, one-seed juniper, and Gambel oak are 10 to 20 cm (4 to 8 in). Undergrowth occupies 25 to 35 percent, with mountain mahogany, snowberry, Oregon grape, prickly pear cactus, and cholla cactus as principal shrubs. Wheat grasses, brome, bluegrasses, yarrow, hairy goldaster, and milk vetch are major herbaceous species. Undergrowth height averages 1 m (3 ft) or less.	Occurs primarily on Booth Mountain. Smaller parcels also occur in the vicinity of Turkey Creek Ranch (Deadman Canyon) and the area immediately south of Sand Canyon. It occupies steeply sloping terrain, all of which is in high plains and low hills.	Ponderosa pine seedlings from a small nursery immediately north of Haymes Reservoir are used for landscaping purposes.	Cover for foot troops from flat-trajectory fire of small arms is good to excellent.	Concealment for foot troops from both aerial and ground observation is excellent year-round. Concealment for vehicles from aerial and ground observation is good to excellent year-round.
2. Deciduous trees; nearly open to medium spacing.	Deciduous species compose 75 percent or more of each stand. Dominant trees include plains cottonwood, box elder, and peachleaf willow. Spacing between trees is greater than 7 m (23 ft). Crown cover density averages 25 to 50 percent. Plains cottonwood stem heights range from 9 to 18 m (30 to 60 ft); stem heights of box elder and peachleaf willow average 3 to 6 m (10 to 20 ft). Stem diameters range from 7.5 125 cm (3 to 50 in). Undergrowth consists mainly of herbaceous plants (bluegrass and wheat grass) with a few stubby plants such as snowberry, chokecherry, golden currant, and wild plum.	Scattered along major drainageways. The most extensive stands occur along Little Fountain Creek and the lower portion of Rock Creek. Smaller stands occur along Turkey Creek.	Cottonwoods have been planted around many recreation areas to provide shade. Some cottonwoods still persist around abandoned farmsteads where they serve as windbreaks.	Cover for foot troops from flat-trajectory fire of small arms is poor.	Concealment for foot troops is fair from aerial and ground observation when trees are in leaf (late May through early October); during the leafless season, concealment for foot troops is poor. Concealment for vehicles from aerial observation during the period when the trees are in leaf is poor and almost nonexistent during the leafless season. Concealment for vehicles from ground observation is poor at all times.
3. Coniferous scrub; medium to dense spacing.	Coniferous species, composing 75 percent or more of each stand, are mainly pinyon pine and one-seed juniper; Gambel oak is occasionally interspersed. Tree spacing is 5 to 7 m (16 to 23 ft). Crown cover density is 50 to 100 percent. Stem heights range to 6 m (20 ft), but average less than 4.5 m (15 ft). Stem diameters are as large as 25 cm (10 in), but average 10 to 15 cm (4 to 6 in). Undergrowth consists of shrubs such as mountain mahogany, snowberry, Oregon grape, four-wing saltbush, prickly pear cactus, and cholla cactus. Grasses such as Indian ricegrass, blue grama, needle-and-thread, galleta, and squirrel-tail predominate with numerous forb species. Ground cover ranges from 20 to 30 percent. Undergrowth height averages 1 m (3 ft) or less.	Common throughout the west-central and western portions of the reservation; occurs primarily on steeply sloping high plains and low hills, with shallow soils.	Most of this vegetation is fragile; if severely disturbed, it would require considerable time to recover. The presence of Gambel oak, a deciduous tree, is minor, and does not significantly alter concealment possibilities.	Cover for foot troops from flat-trajectory small arms fire is fair.	Concealment for foot troops from aerial and ground observation is excellent year-round. Concealment for vehicles from aerial and ground observation is good.
4. Coniferous scrub; nearly open to medium spacing.	Coniferous species, composing 75 percent or more of each stand, include pinyon pine and one-seed juniper, occasionally interspersed with Gambel oak. Tree spacing is greater than 7 m (23 ft). Crown cover density is 25 to 50 percent. Stem heights are as great as 6 m (20 ft), but average less than 4.5 m (15 ft). Stem diameters are as large as 25 cm (10 in), but average 10 to 15 cm (4 to 6 in). Undergrowth consists of mountain mahogany, snowberry, Oregon grape, four-wing saltbush, prickly pear cactus, cholla cactus, Indian ricegrass, blue grama, needle-and-thread, galleta, squirrel-tail, and numerous forbs. Ground cover ranges from 20 to 30 percent. Undergrowth height averages 1 m (3 ft) or less.	Common throughout the western and southwestern portions of the reservation, occupying gently to steeply sloping high plains.	Consists of extremely fragile vegetation; if disturbed, it would require considerable time to recover. The presence of Gambel oak does not significantly alter cover and concealment.	Cover for foot troops from flat-trajectory small arms fire is poor.	Concealment for foot troops from aerial and ground observation is fair year-round, while concealment for vehicles from aerial and ground observation is poor to almost nonexistent.
5. Deciduous scrub; nearly open to medium spacing.	Gambel oak composes 75 percent or more of each stand; relatively few pinyon pines and one-seed junipers are interspersed. Tree spacing averages 7 to 12 m (23 to 40 ft). Crown cover density is 25 to 50 percent. Stem height ranges from 1.5 to 3 m (5 to 10 ft). Stem diameters range from 2.5 to 12 cm (1 to 5 in). Undergrowth is sparse; wheat grass, needle-and-thread, aster, and Oregon grape are dominant. Ground cover is 20 to 30 percent. Undergrowth height averages less than 0.5 m (1.5 ft).	Occurs in two locations, one along Turkey Creek north of Teller Reservoir, and the second, in the southeast portion of the reservation, near Tank Table VII.	Gambel oak is common throughout the reservation, except in the grasslands (Unit 6). Gambel oak grows in clumps or clones consisting of many stems, which form parabolic patterns. Stem density within the clones can be extremely dense, consequently, local mobility can be severely limited.	Cover for foot troops from flat-trajectory small arms fire is poor to nonexistent.	When the trees are in leaf, concealment for foot troops from aerial and ground observation is fair. During the leafless season, concealment for foot troops from ground observation is poor and almost nonexistent from aerial observation. Concealment for vehicles from aerial observation is almost nonexistent year-round. Concealment for vehicles from ground observation is poor during the period when the trees are in leaf and poor to almost nonexistent during the leafless season.
6. Short grasses.	Short grasslands consist of blue grama, buffalo grass, needle-and-thread, galleta, western wheat grass, little bluestem, and alkali sacaton. Heights rarely exceed 1 m (3 ft), with the average being 0.5 m (1.5 ft). Shrubs scattered throughout the grasslands unit include prickly pear cactus, cholla cactus, yucca, four-wing saltbush, rabbit brush, and skunkbrush. Shrub height is less than 1.5 m (4.5 ft).	Dominant vegetation on Fort Carson; most prevalent in the eastern and east-central portions. Sullivan Park and the area between Pierce Gulch and Booth Gulch in the southwest also contain extensive grasslands.	Severely disturbed areas are being seeded to grassland. These areas include parts of Booth Gulch, Sullivan Canyon, and Young Hollow. A ranch within the Rod and Gun Club cultivates native hay and alfalfa to supplement feed for the horses quartered at Turkey Creek Ranch.	Cover for foot troops from flat-trajectory small arms fire is nonexistent.	Concealment for foot troops from aerial and ground observation is poor. Concealment for vehicles from aerial and ground observation is nonexistent.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

VEGETATION

FORESTS

1. Coniferous trees; medium to dense spacing.

2. Deciduous trees; nearly open to medium spacing.

SCRUB

3. Coniferous scrub; medium to dense spacing.

4. Coniferous scrub; nearly open to medium spacing.

5. Deciduous scrub; nearly open to medium spacing.

GRASSLANDS

6. Short grasses.

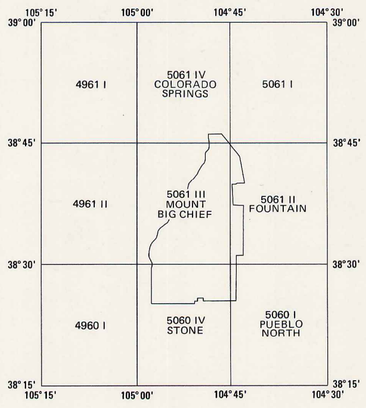
OPEN

OPEN

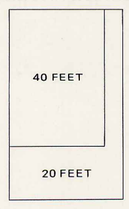
7. Built-up and heavily used areas. Vegetation is not a significant factor.

Note: Numbers refer to entries in table.

INDEX TO SHEETS
SERIES V777
1:50,000
SCALE



CONTOUR INTERVALS



Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters

1 ½ 0 1 2 3 Statute Miles

4250 000m N.

500 000m E.

25

H. CLIMATE

The climate at Fort Carson is that of semiarid south-central Colorado, a high elevation region having cool summers and relatively cold winters. Predominant climatic factors are its continental location, its elevation of 1789.5 meters (5871 feet) above mean sea level (at Butts Army Airfield), and its proximity to the Rocky Mountains to the west.

The annual temperature range is somewhat narrow, from a mean daily temperature of 21.6°C (71°F) in July to -1.4°C (29.5°F) in January. The mean daily maximum temperature in the hottest month, July, is 29.1°C (84.4°F); and the mean daily minimum temperature in the coldest month, January, is -8.8°C (16.1°F). Over a 28-year period, from 1941 to 1970, the highest temperature recorded was 37.8°C (100°F) in June and again in July, 1954; the lowest temperature recorded was -32.8°C (-27°F) in February 1951.

When a cold air temperature is combined with a high wind speed, the temperature stress on the human body is equivalent to the effects of a much lower temperature with no wind. This "equivalent wind-chill" temperature, at Fort Carson, can drop on occasion to as low as -34.4°C (-30°F) when winds associated with winter storms combine with normal cold temperatures. Temperatures below -17.8°C (0°F) are rare, however, only occurring about 10 days a year.

Prevailing winds are from the north, with moderately high speeds averaging 13 kilometers per hour (7 knots). The fast-moving, winter "chinook" winds, for example, result when air rapidly descends the eastern slopes of the Rocky Mountains. Their characteristic wind speeds of 96.6 to 112.7 kilometers per hour (60 to 70 miles per hour) and temperatures -2.5° to -1.1°C (25° to 30°F) warmer than the surrounding air, make them an important factor in moderating temperatures and preventing snow from remaining on the ground for long periods of time. Highest winds at Fort Carson occur in the spring.

Prevailing upper air currents generally come from the west. Storms moving in from the Pacific Ocean lose much of their moisture crossing the mountains. Hence, areas on the eastern slopes, such as Fort Carson, receive relatively little precipitation. In the past 40 years the wettest year (1965) at nearby Colorado Springs measured 646 millimeters (25.4 inches), while in the driest year (1939) there were only 154 millimeters (6.1 inches). Most of the average annual precipitation of 400 millimeters (15.7 inches) falls during localized summer thunderstorms. The maximum monthly rainfall recorded over a 28-year period was 203 millimeters (8.0 inches) in June 1965. Snowfall averages 1016 millimeters (40 inches) a year; heaviest snow occurs during the spring months of March and April as a result of warm, moist air from the south meeting cold, dry air from the north. The maximum monthly snowfall recorded was 1085 millimeters (42.7 inches) in April 1957.

The comparatively dry air, average annual humidity of 54 percent, in combination with the elevation and general lack of pollution, increase the hazards of severe sunburn, heatstroke, loss of body fluids, etc.

Since complete and long-record climatological observations do not exist for Fort Carson/Butts AAF, the data presented below are derived from records at Colorado Springs Municipal Airport (prior to December 1975 known as Peterson Field), which is approximately 8 kilometers (5 miles) northeast of the cantonment area. There are only slight variations in climate between the two sites, and these derive less from Fort Carson's lower elevation than from its greater proximity to the mountains. Orographic effects produce slightly less precipitation at Fort Carson than at Colorado Springs. Also, lower ceilings prevail for somewhat longer periods of time on the reservation.

See the following table for climatic and ephemeral data.

CLIMATIC SUMMARY*

COLORADO SPRINGS MUNICIPAL AIRPORT LATITUDE 38°49' N LONGITUDE 104°43' W ELEVATION 1873 m (6145 ft)

PARAMETER DESCRIPTION	UNIT OF MEASURE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	YEARS OF RECORD
Absolute maximum temperature	°C	22.2	24.4	27.2	27.2	33.3	37.7	37.7	37.2	35.0	30.0	25.0	25.0	37.7	28
	°F	72	76	81	81	92	100	100	99	95	86	77	77	100	28
Mean daily maximum temperature	°C	5.0	6.4	8.7	15.1	20.2	25.6	29.1	28.0	23.8	17.9	9.9	6.2	16.3	30
	°F	41.0	43.6	47.7	59.2	68.4	78.1	84.4	82.4	74.9	64.2	49.8	43.1	61.4	30
Mean daily minimum temperature	°C	-8.8	-7.3	-5.1	0.6	5.9	10.6	13.9	13.2	8.3	2.7	-3.8	-7.3	1.9	30
	°F	16.1	18.9	22.8	33.1	42.6	51.1	57.0	55.8	46.9	36.8	25.1	18.9	35.4	30
Absolute minimum temperature	°C	-32.2	-32.8	-23.9	-19.4	-6.1	0.0	5.5	6.1	-3.9	-15.0	-22.2	-26.7	-32.8	30
	°F	-26	-27	-11	-3	21	32	42	43	25	5	-8	-16	-27	30
Mean number days with maximum temperature ≥ 32.2°C (90°F)		0	0	0	0	#	4	8	3	#	0	0	0	15	16
Mean number days with minimum temperature ≤ 0.0°C (32°F)		30	27	27	14	2	0	0	0	1	8	24	29	162	16
Normal heating degree-days (base 18.3°C/65°F)		1128	944	921	564	301	103	9	13	155	456	825	1054	6473	30
Normal cooling degree-days (base 18.3°C/65°F)		0	0	0	0	6	91	186	140	32	6	0	0	461	30
Mean dew point temperature	°C	-11.7	-10.0	-8.9	-4.4	0.5	4.4	8.9	8.3	3.3	-2.8	-7.8	-10.5	-2.8	29
	°F	11	14	16	24	33	40	48	47	38	27	18	13	27	29
Mean percent relative humidity		57	59	53	56	57	49	53	54	48	53	55	58	54	7
Mean monthly precipitation	mm	7.8	8.6	19.5	36.8	53.8	58.7	78.7	65.5	28.2	23.4	11.4	6.8	399.5	30
	in	0.31	0.34	0.77	1.45	2.12	2.31	3.10	2.58	1.11	0.92	0.45	0.27	15.73	30
Mean number days with precipitation ≥ 2.54 mm (0.1 in)		4	4	7	4	1	T	0	0	T	2	3	3	28	26
Absolute maximum monthly precipitation	mm	28.4	22.4	65.8	149.9	144.0	203.2	148.6	150.9	108.7	72.6	56.1	27.9	645.9	40
	in	1.12	0.88	2.59	5.90	5.67	8.00	5.85	5.94	4.28	2.86	2.21	1.10	25.43	40
Absolute minimum monthly precipitation	mm	T	0.51	T	0.25	8.38	3.81	14.0	3.81	T	0.25	T	T	154.2	40
	in	T	0.02	T	0.01	0.33	0.15	0.55	0.15	T	0.01	T	T	6.07	40
Mean number days with thunderstorms		0	0	0	2	9	11	17	13	5	1	0	0	58	28
Mean monthly snowfall	mm	111.8	114.3	215.9	182.9	27.9	T	0.0	0.0	40.6	83.8	124.5	104.1	1005.84	28
	in	4.4	4.5	8.5	7.2	1.1	T	0.0	0.0	1.6	3.3	4.9	4.1	39.6	28
Mean number days with snowfall ≥ 38.1 mm (1.5 in)		1	1	2	1	#	0	0	0	#	1	1	1	8	26
Absolute maximum monthly snowfall	mm	322.6	292.1	520.7	1084.6	378.5	27.9	0.0	0.0	708.7	551.2	464.8	297.2	2270.8	28
	in	12.7	11.5	20.5	42.7	14.9	1.1	0.0	0.0	27.9	21.7	18.3	11.7	89.4	28
Percent frequency of surface wind speed ≥ 28 knots (51.9 kmph or 32.2 mph)		0.7	0.9	1.0	0.9	0.7	0.4	0.2	0.1	0.6	0.2	1.2	0.2	0.6	7
Percent frequency of surface wind speed ≥ 17 knots (31.5 kmph or 19.6 mph)		8.0	10.6	14.4	14.6	11.2	11.9	5.9	4.3	7.8	5.9	11.2	5.7	9.3	7
Mean number days with surface wind ≥ 17 knots (31.5 kmph or 19.6 mph) and no precipitation	(at 1700 LST)	1.7	2.7	6.1	6.9	6.1	5.4	1.6	2.7	2.5	2.0	1.9	1.3	40.9	7
	(at 2300 LST)	2.0	2.0	2.9	2.2	1.9	1.8	0.6	0.2	1.0	0.3	2.7	1.4	19.0	7
	(at 0500 LST)	2.1	1.2	2.8	3.0	2.1	1.2	0.8	0.6	1.5	0.7	2.2	1.0	19.2	7
	(at 1100 LST)	3.5	4.7	5.7	5.7	3.8	5.4	0.8	1.4	3.0	2.9	4.6	3.6	45.1	7
Mean number days with surface wind 4 to 10 knots (7.4 to 18.5 kmph or 4.61 to 11.52 mph) and temperature 0.6° to 31.7°C (33° to 89°F) and no precipitation.	(at 1700 LST)	12.2	12.5	11.4	14.9	15.6	12.7	20.7	20.1	20.1	22.9	16.6	14.1	193.8	7
	(at 2300 LST)	4.9	7.3	11.5	20.8	23.0	23.7	27.0	27.5	25.3	25.0	10.2	6.4	212.6	7
	(at 0500 LST)	3.3	5.8	7.8	17.5	23.3	25.6	25.8	26.5	22.8	23.4	9.2	6.7	197.7	7
	(at 1100 LST)	14.1	12.5	14.9	17.5	18.8	15.2	21.8	23.5	18.9	19.9	16.6	15.8	209.5	7
Fastest one-minute wind speed	knots	47.8	45.2	52.1	41.7	45.2	47.8	40.8	34.8	34.8	35.6	43.4	52.1	52.1	26
	kmph	88.5	83.7	96.6	77.2	83.7	88.5	75.6	64.4	64.4	66.0	80.5	96.6	96.6	26
	mph	142.4	134.7	155.5	124.2	134.7	142.4	121.7	103.6	103.6	106.2	129.5	155.5	155.5	26
Mean number days with an occurrence of visibility ≤ 0.8 km (0.5 mi)		3.5	5.1	5.0	5.0	3.6	2.4	0.4	1.6	0.7	2.1	3.7	3.8	36.9	7
Percent frequency ceiling ≤ 1524 m (5000 ft) or visibility ≤ 8.05 km (5 mi)		13.3	21.5	18.4	24.4	25.7	18.2	8.6	11.1	8.3	13.1	12.8	12.8	15.7	7
Percent frequency ceiling ≤ 457.2 m (1500 ft) or visibility ≤ 4.83 km (3 mi)	(for 0000-0200 LST)	8.6	17.8	12.1	17.8	14.7	10.9	1.9	4.3	3.7	8.5	7.6	9.5	9.8	7
	(for 0300-0500 LST)	7.0	17.2	11.9	17.3	15.9	12.7	4.1	8.4	5.6	9.5	7.6	9.5	10.6	7
	(for 0600-0800 LST)	8.9	17.6	12.4	16.5	18.6	9.2	3.4	7.1	6.9	11.1	8.0	10.2	10.8	7
	(for 0900-1100 LST)	9.9	13.4	8.8	12.5	14.7	4.5	1.9	5.4	3.5	8.6	8.1	8.1	8.3	7
	(for 1200-1400 LST)	7.7	10.8	8.7	7.6	9.0	2.0	1.3	3.4	1.7	5.2	6.7	5.3	5.8	7
	(for 1500-1700 LST)	7.0	12.0	10.1	8.7	11.9	2.0	1.9	2.8	1.5	4.7	7.2	5.0	6.2	7
	(for 1800-2000 LST)	7.5	13.8	9.2	10.9	11.4	2.2	1.3	4.3	1.9	3.8	6.7	6.1	6.6	7
	(for 2100-2300 LST)	10.0	16.5	11.3	14.0	14.3	5.8	1.5	4.1	2.6	5.6	7.2	7.9	8.4	7
Percent frequency ceiling ≤ 91.4 m (300 ft) or visibility ≤ 1.61 km (1 mi)	(for 0000-0200 LST)	4.7	9.1	6.2	7.8	5.6	4.4	0.4	2.6	0.7	2.9	4.8	4.3	4.5	7
	(for 0300-0500 LST)	3.6	8.6	4.6	9.6	5.8	4.9	0.6	4.5	0.9	2.7	5.0	3.8	4.5	7
	(for 0600-0800 LST)	3.6	10.6	5.9	6.9	4.8	2.9	0.0	1.9	0.4	3.6	2.6	5.7	4.1	7
	(for 0900-1100 LST)	4.2	4.5	2.3	2.7	1.9	0.9	0.0	1.1	0.0	1.8	3.3	3.2	2.2	7
	(for 1200-1400 LST)	1.6	3.5	1.6	2.0	0.6	0.2	0.0	0.2	0.2	0.9	2.6	0.2	1.1	7
	(for 1500-1700 LST)	3.1	4.7	4.0	1.6	0.9	0.2	0.6	0.0	0.0	1.1	3.0	0.7	1.7	7
	(for 1800-2000 LST)	3.6	3.7	3.8	2.7	1.1	0.0	0.2	0.4	0.4	1.4	3.2	3.0	2.0	7
	(for 2100-2300 LST)	5.4	7.1	5.4	6.2	2.4	0.7	0.4	1.9	0.6	1.6	3.5	4.7	3.3	7
Mean number days with sky cover ≤ 30 percent and visibility ≥ 4.83 km (3 mi)	(at 1700 LST)	11.0	9.2	8.4	2.5	1.0	4.5	3.0	3.5	11.5	14.0	12.5	12.0	93.1	3
	(at 2300 LST)	19.0	14.9	16.8	17.0	15.5	15.5	13.5	14.5	19.0	21.5	17.5	14.3	199.0	4
	(at 0500 LST)	19.0	15.8	16.5	14.5	10.5	14.0	14.0	13.5	17.0	17.5	16.5	18.5	187.3	3
	(at 1100 LST)	14.7	10.2	10.1	7.0	4.5	13.0	12.0	11.5	13.5	11.5	10.5	9.0	127.5	3
Mean number days with ceiling ≥ 304.8 m (1000 ft) and visibility ≥ 4.83 km (3 mi)	(at 1700 LST)	29.1	24.9	28.1	28.2	28.8	29.6	30.8	30.4	29.6	30.5	27.8	29.8	347.6	7
	(at 2300 LST)	28.0	23.2	27.8	26.6	27.4	28.4	30.4	30.0	29.6	29.5	28.3	28.5	337.7	7
	(at 0500 LST)	28.8	23.5	27.5	25.2	27.0	27.0	30.4	28.8	28.8	28.5	28.0	28.5	332.0	7
	(at 1100 LST)	28.1	25.5	28.8	27.6	28.2	29.4	30.8	30.4	29.5	29.3	28.3	28.8	344.7	7
Mean number days with ceiling ≥ 609.6 m (2000 ft) and visibility ≥ 4.83 km (3 mi) and surface wind ≤ 10 knots (18.5 kmph or 11.5 mph)	(at 1700 LST)	22.3	15.0	11.5	11.6	11.8	9.6	18.0	17.8	15.3	16.8	20.2	22.2	192.1	7
	(at 2300 LST)	19.8	15.9	17.8	20.2	19.8	21.8	27.0	25.4	24.7	23.7	21.5	24.0	261.6	7
	(at 0500 LST)	20.2	17.8	19.4	16.6	18.4	20.6	25.8	23.8	22.0	21.8	20.8	23.8	251.0	7
	(at 1100 LST)	20.0	16.0	17.2	15.2	14.4	15.4	23.6	22.2	19.3	19.3	18.7	19.7	221.0	7
Mean number days with ceiling ≥ 762.0 m (2500 ft) and visibility ≥ 4.83 km (3 mi)	(at 1700 LST)	29.1	23.7	27.3	25.8	26.4	27.4	29.8	29.8	29.3	29.5	27.3	28.5	333.9	7
	(at 2300 LST)	26.8	22.2	26.4	25.0	25.4	27.0	30.4	29.0	28.5	28.6	27.3	28.0	324.6	7
	(at 0500 LST)	28.0	23.0	25.6	23.4	24.6	25.2	29.0	28.0	27.3	27.2	27.0	27.2	315.5	7
	(at 1100 LST)	27.3	23.7	27.8	25.8	25.2	28.0	29.8	28.8	28.7	27.7	27.0	28.3	328.1	7
Mean number days with ceiling ≥ 1828.8 m (6000 ft) and visibility ≥ 4.83 km (3 mi)	(at 1700 LST)	27.7	22.5	24.3	22.0	20.2	22.8	24.2	24.6	27.7	27.2	26.5	26.8	296.5	7
	(at 2300 LST)	26.2	21.0	24.7	22.6	22.2	23.8	29.0	27.8	27.2	27.0	25.8	27.0	304.3	7
	(at 0500 LST)	26.8	22.2	24.3	22.4	23.0	23.2	28.2	27.4	26.0	26.3	25.5	26.7	302.0	7
	(at 1100 LST)	25.8	22.4	25.8	22.6	21.6	24.6	28.6	27.0	26.6	26.5	25.8	27.2	304.5	7
Mean number days with ceiling ≥ 3048.0 m (10,000 ft) and visibility ≥ 4.83 km (3 mi)	(at 1700 LST)	26.5	21.7	21.9	17.8	11.0	16.6	16.2	14.6	22.7	24.5	25.1	25.8	244.4	7
	(at 2300 LST)	25.8	20.6	23.7	21.6	21.0	23.0	27.0	26.6	25.8	26.3	25.7	26.5	293.6	7
	(at 0500 LST)	26.7	21.6	24.1	21.8	20.8	21.8	27.0	26.4	24.7	25.5	25.0	26.3	291.7	7
	(at 1100 LST)	25.5	21.4	23.8	19.4	18.8	21.8	26.6	25.4	24.8	25.0	24.8	26.2	283.5	7

* Note: # = Less than 0.5 day; T = Trace; LST = Local Standard Time

EPHEMERIS FOR FORT CARSON, COLORADO

(MOUNTAIN STANDARD TIME)

DATE	NAUTICAL TWILIGHT BEGINNING	NAUTICAL TWILIGHT END	SUNRISE	SUNSET	DATE	NAUTICAL TWILIGHT BEGINNING	NAUTICAL TWILIGHT END	SUNRISE	SUNSET	DATE	NAUTICAL TWILIGHT BEGINNING	NAUTICAL TWILIGHT END	SUNRISE	SUNSET	DATE	NAUTICAL TWILIGHT BEGINNING	NAUTICAL TWILIGHT END	SUNRISE	SUNSET
January 1	0614	1751	0717	1648	April 1	0446	1921	0544	1822	July 1	0326	2040	0438	1928	October 1	0457	1840	0555	1742
January 11	0615	1800	0717	1657	April 11	0430	1932	0529	1832	July 11	0333	2036	0443	1925	October 11	0507	1824	0604	1727
January 21	0612	1809	0713	1708	April 21	0414	1943	0515	1841	July 21	0342	2028	0451	1920	October 21	0516	1811	0614	1713
February 1	0606	1821	0705	1721	May 1	0359	1955	0502	1851	August 1	0354	2016	0500	1910	November 1	0527	1758	0626	1659
February 11	0557	1831	0655	1732	May 11	0345	2006	0451	1901	August 11	0405	2002	0509	1859	November 11	0537	1749	0637	1649
February 21	0545	1841	0643	1743	May 21	0334	2018	0442	1909	August 21	0416	1947	0518	1846	November 21	0547	1743	0648	1642
March 1	0534	1849	0632	1752	June 1	0326	2028	0436	1918	September 1	0428	1929	0528	1830	December 1	0556	1740	0658	1638
March 11	0520	1859	0617	1802	June 11	0322	2036	0434	1924	September 11	0438	1913	0537	1814	December 11	0604	1741	0707	1638
March 21	0504	1909	0602	1812	June 21	0322	2040	0434	1927	September 21	0448	1856	0546	1758	December 21	0610	1744	0714	1641

I. CROSS-COUNTRY MOVEMENT

MAP UNIT	GENERAL TERRAIN CONDITIONS	MOVEMENT OF TRACKED VEHICLES*	MOVEMENT OF WHEELED VEHICLES†	MOVEMENT OF FOOT TROOPS
1. Smooth, nearly flat to gently rolling grasslands.	Extensive tracts of nearly flat to gently rolling terrain are scattered throughout the reservation. Most slopes range between 0 and 8 percent. A few short, widely separated drainageways, which are nearly always dry, traverse the unit. Soils are mainly fine grained with good bearing strength throughout the year, except after significant precipitation when they become soft and slippery.‡ Dominant short grass vegetation may grade to scattered shrubs in local areas; vegetation height rarely exceeds 1 m (3 ft).	Generally easy in any direction for both tank and APC when soils are dry. Local obstructions easily bypassed. Movement on clayey-silty soils in eastern and northeastern portions could be somewhat slowed after heavy rains. Dust problems can be anticipated during maneuvers in dry weather, particularly in areas where grass cover is thin and soils have been loosened by previous vehicular traffic.	Generally easy in any direction. Slowed after heavy rains by slippery soil conditions, particularly in areas with steeper slopes. Dust problems can be anticipated during maneuvers in dry weather, in areas where grass cover is thin, and where soils have been loosened by previous vehicular traffic. Cloudbursts in spring and summer months could temporarily hinder mobility at stream crossings.	Unhindered in any direction. Cloudbursts during spring and summer could temporarily hinder mobility at stream crossings.
2. Gently sloping grass-covered floodplains and low terraces.	Gently sloping floodplains and adjacent low alluvial terraces, of variable length and width, are scattered throughout the reservation. Most slopes range between 3 and 8 percent. Numerous sub-parallel to parallel shallow drainageways and arroyos, nearly always dry, cross the unit. Many channels are active and susceptible to flooding after significant precipitation. In the western part of the reservation, many channels are cut in bedrock and bounded by steep valley walls. Alluvial soils vary from deep, fine-grained silts and clays to shallow, coarse-grained sands. Vegetation is mainly short grasses; scattered clusters of moderately spaced deciduous trees occur in some stream valleys.	Unrestricted throughout the year when soils are firm and dry. Tank movement may be difficult or halted for brief periods after heavy rains, due to soft clayey soils or high water conditions at stream crossings during spring and summer months. Movement of APC relatively easy except during high water flow at stream crossings. Movement in narrow floodplains in western and southwestern portions of the reservation limited by steep valley walls and incised channels.	Hindered at stream crossings for brief periods after heavy rains. When soils are wet and soft, movement is greatly restricted. Movement in trace to be avoided if possible. Grass assists in vehicle traction and weight support. Deciduous vegetation moderately hinders mobility in valleys of Little Fountain and Turkey Creeks. Movement in narrow floodplains severely hindered.	Easy most of the year except after heavy rains, when alluvial soils are relatively soft. Movement hindered briefly at stream crossings after periods of heavy rains, due to possible flooding.
3. Moderately sloping upland plains with areas of short, steep slopes and deep gullies.	Moderately sloping upland plains, with areas of short, steep slopes and deep gullies, are scattered throughout the reservation, particularly in the extreme east and southeast. Most slopes range between 8 and 30 percent; some exceed 45 percent in deeply eroded gullies adjacent to stream valleys. Drainageways are generally short and cut in bedrock. Soils are predominantly thin and composed of variable coarse- and fine-grained materials with relatively good bearing strength. Dominant short grass vegetation may grade to scattered shrubs in local areas; vegetation height rarely exceeds 1 m (3 ft).	Moderately slowed by steep slopes and gullying. Short, steep slopes, such as those associated with rock ledges, are deterrents to mobility and should be bypassed if possible. Dust problems can be anticipated during maneuvers in dry weather. Tank and APC movements severely hindered during periods of heavy rain.	Severely slowed by steep slopes, local gullying and rock outcrop. Very cautious driving required. During wet periods, slope and soil conditions could preclude all but local movement.	Generally easy most of the year. Slightly to moderately slowed in areas of locally steep slopes and near-vertical rock ledges.
4. Thinly wooded uplands; most slopes moderate.	Moderately sloping uplands occur in large tracts, principally in the southern part of the reservation. Most slopes range from 8 to 30 percent; slopes of steep rock ledges exceed 45 percent. Drainageways are generally cut in bedrock; widths vary. Predominantly thin soils, composed of coarse- and fine-grained sands and silts, have variable plasticity. Principal vegetation is coniferous scrub with trunk spacing generally greater than 7 m (23 ft) and stem diameters ranging from 10 to 15 cm (4 to 6 in).	Moderately slowed by wooded vegetation; severely slowed in areas of dense vegetation and steep slopes. Twisting and turning required to avoid large trees. Movement easy in open areas. Slippery soil conditions prevail after heavy rains in clayey areas, but only for short periods. Vertical rock ledges impede movement and alternate routes should be selected.	Severely hindered by wooded vegetation, steep slopes, and rock outcrops. Mobility precluded in dense vegetation. Movement is fairly easy for short distances in areas of more gentle slope and in scattered grass or brush-covered openings. Visibility moderately impaired in wooded areas.	Slightly to moderately slowed by combined effects of trees, steep slopes, and rock ledges. Easy in grass-covered openings.
5. Moderately to steeply sloping wooded uplands.	Moderate to steeply sloping uplands are particularly prominent on Booth Mountain and in the vicinity of Wild Mountain and Timber Mountain. Most slopes range from 15 to 45 percent in wooded terrain, and exceed 100 percent along rocky escarpments. Scattered grass-covered upland areas are characterized by slopes ranging between 3 and 15 percent. Stream channels are numerous; many are deeply cut in bedrock. Thin soils are composed of sandy loam and rock fragments. Dominant vegetation is coniferous forest and scrub; trunk spacing ranges from 5 to 7 m (16 to 23 ft) and stem diameters vary from 10 to 40 cm (4 to 14 in).	Tank movement severely slowed by randomly spaced trees, steep slopes, and rock ledges. APC slowed, but not as severely as tanks. Mobility precluded at insurmountable barriers formed by escarpments. Local movement relatively easy in gently to moderately sloping grassland areas. Visibility moderately to severely impaired in densely wooded areas.	Not practical for long distances due to randomly spaced trees too large to push over, steep slopes, and rock outcrops. Limited movement in openings, but only for short distances. Risk of damage to vehicles unacceptably high.	Slow, but not difficult. Movement moderately slowed by combined effects of trees and steep slopes. Escarpments can severely hinder progress; however, cliff faces can be scaled by troops experienced in rock climbing techniques. Movement in gently sloping grasslands unhindered in any direction.
6. Highly dissected, mostly steep terrain.	Highly dissected, mostly steeply sloping uplands characterized by badlands, hillocky landslide terrain, and shallow rock. Tracts vary in length and width, and occupy scattered portions of the west-central and western reservation. Most slopes range from 15 to 45 percent; slopes greater than 60 percent occur in numerous short and deeply incised stream channels in badlands areas. Soils are thin throughout, and vary from highly plastic clays and soft shales in badlands, to cobbles and boulders in unstable landslide terrain. Vegetation is highly variable, ranging from short grasses in badlands to moderately wooded coniferous trees and scrub in hillocky landslide terrain.	Movement of tanks generally prohibited in most of map unit area due primarily to steep slopes and highly dissected terrain and, secondarily, to closely spaced trees and rocky surfaces. Some movement possible in areas where slope is gentle and vegetation is relatively thin. Movement of APC severely slowed when soils are dry, and precluded after heavy rains.	Not practical except locally.	Slow, but not difficult. Movement slowed by steep slopes and hillocky and rocky terrain in landslide areas. In badlands, movement additionally slowed during and after rains by slippery, sticky ground conditions in clayey soil areas.
7. Very steep terrain associated with rocky escarpments.	Dominantly very steeply sloping rocky escarpments associated with prominent hogbacks in the southeast and southwest portions of the reservation. Escarpments exceed 10 m (33 ft) in height and have slopes greater than 100 percent. Most slopes in areas adjacent to escarpments exceed 30 percent. Stream channels are short, deeply incised, and occasionally form narrow water gaps, or openings in the escarpment face. Soils are extremely shallow and predominantly stony; numerous hard sandstone and limestone rock ledges outcrop on steep slopes, and the potential for rockfalls is high. Vegetation is chiefly coniferous scrub with highly variable trunk spacing.	Mobility precluded at all times by extremely steep slopes and rocky escarpments which form insurmountable barriers. Movement possible only through gaps in escarpments.	Mobility precluded at all times by steep slopes and rocky escarpments which form insurmountable barriers.	Steep slopes invariably hinder troop movement. Mobility at escarpments is extremely difficult, but not impossible. Sheer cliffs can only be scaled by troops experienced in rock climbing techniques.

*Comments apply to the M-60 tank and the M-113 armored personnel carrier.

†Comments apply to the M-35, 2½-ton truck and the M-151, ¼-ton truck.

‡Movement conditions will be degraded for a day or two following heavy rains, due to soft or slippery soils. Soils dry quickly after a rain due to rapid runoff and fairly high evapotranspiration rate. Most rains come in thunderstorms during late spring and summer months. Precipitation during autumn and winter months is sparse and the bearing strength of the soil generally remains high. Snow at Fort Carson is seldom a limiting factor in cross-country movement.

FORT CARSON, COLORADO
TERRAIN ANALYSIS
CROSS-COUNTRY MOVEMENT

This map deals with cross-country movement, or movement away from roads, and is primarily intended for use in planning operations. For determining exact driving routes, reconnaissance on the ground is required. Data on the terrain factors and the evaluations are generalized to suit the scale of the map. Many areas of minor areal extent, such as small tracts of forest, cleared areas, and depressions, are too small to portray.

The predicted movement ratings are those believed to prevail in most years. Variations in these evaluations may occur from year to year and even within a season due to abnormal variations in the weather. The evaluations are based on terrain conditions as they are known at present. Future alterations of the terrain, such as timber clearing operations, artificial drainage, and road construction, would obviously change cross-country movement conditions.

EVALUATION OF TERRAIN FOR CROSS-COUNTRY MOVEMENT

		PREDICTED MOVEMENT RATINGS FOR:				
		TANK (M-60)	APC (M-113)	2½-TON TRUCK (M-35)	¼-TON TRUCK (M-151)	FOOT TROOPS
	1. Smooth, nearly flat to gently rolling grasslands.	Good	Good	Good	Good	Good
	2. Gently sloping grass-covered floodplains and low terraces.	Good	Good	Fair	Fair	Good
	3. Moderately sloping upland plains with areas of short, steep slopes and deep gullies.	Fair	Fair	Poor	Poor	Good
	4. Thinly wooded uplands; most slopes moderate.	Fair	Fair	Poor	Poor	Fair
	5. Moderately to steeply sloping wooded uplands.	Poor	Fair	Poor	Poor	Fair
	6. Highly dissected, mostly steep terrain.	Unsuited	Unsuited	Unsuited	Unsuited	Poor
	7. Very steep terrain associated with rocky escarpments.	Unsuited	Unsuited	Unsuited	Unsuited	Poor

Note: Numbers refer to entries in table.

Impact area; off-limits to vehicles and foot troops due to the danger of unexploded munitions.

Escarpment (slope > 100%). Barbs point downslope.

Note: Movement conditions will be degraded for a day or two following heavy rains, due to soft or slippery soils. Soils dry quickly after a rain due to rapid runoff and fairly high evapotranspiration rate. Most rains come in thunderstorms during late spring and summer months. Precipitation during autumn and winter months is sparse and the bearing strength of the soil generally remains high. Snow at Fort Carson is seldom a limiting factor in cross-country movement.

EXPLANATION OF RATING TERMS

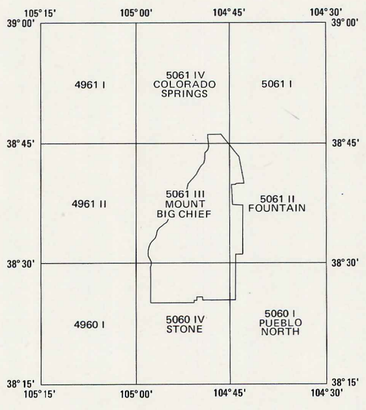
Good — Conditions permit free movement in any direction. Terrain will permit 12 or more passes in trace of an M-60 tank or permit at least one maneuver (starts, stops, sharp turns, or crossing of tracks) at one location.

Fair — Conditions moderately hinder progress or moderately restrict choices of direction for movement. Terrain will permit 3 to 12 passes in trace of an M-60 but maneuvering will be difficult.

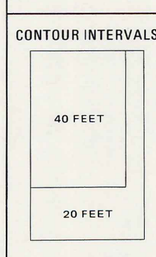
Poor — Conditions severely hinder progress or greatly restrict choice of movement routes. Terrain will probably permit up to 3 passes in trace of an M-60. Very cautious driving required. Movement in trace should be avoided.

Unsuited — Conditions preclude all but local movement. Engineer work required for vehicular movement.

INDEX TO SHEETS
SERIES V777
1:50,000
SCALE



CONTOUR INTERVALS



CANTONMENT AREA

IMPACT AREA

FORT CARSON MILITARY RESERVATION

EL PAS... PUEBLO MORATO...

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters

1 ½ 0 1 2 3 Statute Miles

Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

4250 000m N.

500 000m E.

J. LINES OF COMMUNICATION

1. ROADS

Few hard-surfaced roads exist on Fort Carson except in the cantonment area. South of the cantonment there are approximately 56 kilometers (35 miles) of hard-surfaced roads, including those with double bituminous seal treatment and asphalt coated gravel surfaces. In most cases the shoulder is considered part of the road width; the shoulder is demarcated only on roads with painted lane markers. Many roads are being resurfaced with gravel to reduce repair problems; only the steep grades on these roads, at grid references 179565 to 181562 and 150777 to 165772, will be hard-surfaced.

Conventional vehicles are largely restricted to the cantonment area, Route 5, and the paved segment of Route 2. The depicted dirt roads, totalling approximately 112 kilometers (70 miles), are used by both four-wheel-drive vehicles and tracked vehicles.

The reservation south of the cantonment area is a maze of tank trails. Of these, only four are designated tank trails; these are graded, have some culverts, and are maintained on a regular basis. Because of their similar characteristics, the designated tank trails have been treated as a group in the table below.

There are 24 bridges on the Fort Carson reservation; box culverts greater than 6.1 meters (20 feet) are treated in this study as bridges. Excluding two box culverts, all bridges in the cantonment area are timber. South of the cantonment area, there are five old timber bridges, three new concrete slab bridges, four large box culverts and one temporary, Bailey-type bridge which spans Red Creek. The U.S. Army Corps of Engineers District,Omaha, NE, is currently evaluating the condition of bridges on the reservation.

Although few bridges occur south of the cantonment, there are many small culverts and at-grade stream crossings (unimproved fords). The crossings are cuts in the streambanks with a graded roadway across the streambed; streambed undercutting during high velocity floodflows could make fording difficult.

ROADS

ROUTE NUMBER/NAME	ROUTE LOCATION (GRID REFERENCE) FROM	TO	LENGTH OF SEGMENT	MILITARY LOAD CLASSIFICATION	ROUTE TYPE	SURFACE CONSTRUCTION MATERIALS	SURFACE WIDTH/CONDITION	SHOULDER CONSTRUCTION MATERIALS	SHOULDER WIDTH/CONDITION	REMARKS
Primary roads in the cantonment area										
Barkeley Avenue	179903	213861	3.9 km (2.4 mi)	No data	All weather	Bituminous	7.3 m (24 ft)/ excellent	Bituminous	1 m (3 ft)/excellent	2 lanes; one way; snow removal: priorities 1 and 2.*
Chiles Avenue	183873	173890	1.9 km (1.2 mi)	No data	All weather	Bituminous	7.3 to 13.7 m (24 to 45 ft)/excellent	Bituminous	No data	2 to 3 lanes; one way; snow removal: priorities 1 and 4.
Magrath Avenue	178905	231860	7.6 km (4.7 mi)	No data	All weather	Bituminous	6.7 to 15.8 m (22 to 52 ft)/good	No data	No data	2 to 3 lanes; one way; snow removal: priority 1.
Nelson Boulevard	168875	193896	3.2 km (2.0 mi)	No data	All weather	Bituminous	6.7 to 13.1 m (22 to 43 ft)/excellent	Dirt; bituminous	0 to 1.2 m (0 to 4 ft)/poor to good	2 lanes except near gate and Hdqs; snow removal: priorities 1 and 2.
O'Connell Boulevard	165887	199894	3.5 km (2.2 mi)	No data	All weather	Bituminous	6.7 to 11.0 m (22 to 36 ft)/excellent	No data	No data	2 to 3 lanes; snow removal: priority 1.
Prussman Boulevard	172870	194882	2.6 km (1.6 mi)	No data	All weather	Bituminous	9.1 to 16.8 m (30 to 55 ft)/good	Bituminous	1 m (3 ft)/good	2 to 4 lanes; snow removal: priorities 1 and 4.
Specker Avenue	175901	214864	7.1 km (4.4 mi)	No data	All weather	Bituminous	6.7 to 10.0 m (22 to 33 ft)/ excellent	No data	No data	2 lanes; one way; snow removal: priorities 1, 2, and 3.
Secondary roads in the cantonment area										
Barger Street	174892	184895	1.0 km (0.6 mi)	No data	All weather	Bituminous	7.3 m (24 ft)/good	No shoulder	No shoulder	2 lanes; snow removal: priority 2.
Ellis Street	177885	187890	1.3 km (0.8 mi)	No data	All weather	Bituminous	8.8 to 10.4 m (29 to 34 ft)/good	No data	No data	2 lanes; snow removal: priority 2.
Minick Street	186893	214864	4.0 km (2.5 mi)	No data	All weather	Bituminous	7.3 m (24 ft)/good	No data	No data	2 lanes; snow removal: priority 4.
Sheridan Avenue	172873	182860	2.1 km (1.3 mi)	No data	All weather	Bituminous	6.7 to 12.2 m (22 to 40 ft)/good	No data	No data	2 lanes,widens near hospital; snow removal: priorities 1 and 2.
Titus Boulevard	158855	204872	5.2 km (3.2 mi)	No data	All weather	Bituminous	7.9 to 9.1 m (26 to 30 ft)/excellent	Grass and bituminous	0.3 to 1 m (1 to 3 ft)/fair	2 lanes; snow removal: priorities 1,2, and 4.
Wetzel Avenue	174892	195866	3.2 km (2.0 mi)	No data	All weather	Bituminous	6.7 to 12.2 m (22 to 40 ft)/good	No data	No data	2 lanes; snow removal: priority 1.
Wickersham Boulevard	164905	181900	1.1 km (0.7 mi)	No data	All weather	Bituminous	7.3 m (24 ft)/good	No data	No data	2 lanes; snow removal: priority 1.
Downrange roads										
Route 1	231860	162568	45.9 km (28.5 mi)							
segment a/ Pete's Road	231860	221773	10.3 km (6.4 mi)	No data	Fair weather	Gravel	4.2 m (13.7 ft)/fair	Dirt	1.2 m (4 ft)/poor	Not used.
segment b/ Butts Road	221773	238650	14.5 km (9.0 mi)	No data	All weather	Asphalt	7.3 m (23.8 ft)/poor	Asphalt	0.3 m (1 ft)/fair	Plans to pave.
segment c/ Butts Road	238650	220555	10.3 km (6.4 mi)	No data	All weather	Double bituminous seal treatment	5.5 m (18 ft)/poor	Dirt	1.2 m (4 ft)/fair	Low cost pavement; to be replaced with gravel.
segment d/Butts Road	220555	162568	10.8 km (6.7 mi)	No data	Fair weather	Dirt and gravel	5.5 m (18 ft)/fair	Sand	Undefined	Hill will be stabilized hard surface.
Route 2	151835	232798	9.0 km (5.6 mi)							
segment a/ Wilderness Road	151835	196818	4.5 km (2.8 mi)	No data	All weather	Asphalt	6.6 m (21.8 ft)/excellent	Asphalt	0.6 m (2 ft)/good	2 lanes.
segment b/ Wilderness Road	196818	232798	4.5 km (2.8 mi)	No data	Fair weather	Loose gravel	7.5 m (24.5 ft)/fair	No shoulder	No shoulder	
Route 3	133810	154806	1.8 km (1.1 mi)	No data	Fair weather	Dirt and gravel	5.9 m (19.3 ft)/good	Sand and gravel	Undefined	Soft shoulder.
Route 4	129772	196794	10.9 km (6.8 mi)							
segment a/ Dead Mans Canyon Road	129772	154806	6.4 km (4.0 mi)	No data	Fair weather	Dirt	8.5 m (28 ft)/fair	Dirt	Undefined	
segment b/ Frick's Road	154806	196794	4.5 km (2.8 mi)	No data	Fair weather	Dirt and gravel	5.9 m (19.3 ft)/good	Sand and gravel	Undefined	Soft shoulder.
Route 5/ Butts Road	199864	221773	9.2 km (5.7 mi)	No data	All weather	Asphalt	6.7 m (22.1 ft)/good	Asphalt and grass	0.3 m (1 ft) paved/good	Partially torn up for repaving; snow removal: priorities 2 and 4.
Route 5A/ Sargent Road	178858	194841	2.7 km (1.7 mi)	No data	Fair weather	Dirt	5.0 m (16.3 ft)/fair	No data	No data	
Route 6/ Diamond Express	119773	198778	7.9 km (4.9 mi)	No data	Fair weather	Dirt and gravel	7.3 m (24 ft)/ good	Dirt	0.8 m(2.5 ft)/fair	Hill at 151777 is stabilized hard surface.
Route 7/ Artillery Road	124771	178610	18.4 km (11.4 mi)	No data	Fair weather	Dirt	6.7 m (22 ft)/fair	No data	No data	
Route 7A	143775	160737	3.7 km (2.3 mi)	No data	All weather	Double bituminous seal treatment	7.2 m (23.7 ft)/poor	Dirt	1.2 m (4 ft)/fair	Low cost pavement.
Route 8/ Devil Road	047674	237650	22.8 km (14.2 mi)	No data	Fair weather	Dirt and gravel	6.1 m (20 ft)/good	Dirt	1.1 m (3.5 ft)/fair	Small section near Devil Bridge is bituminous.
Route 8A/ Sonnie Road	114622	119627	0.6 km (0.4 mi)	No data	Fair weather	Dirt	5.0 m (16.3 ft)/fair	No data	No data	
Route 9/ Lytle Road	108747	159536	22.8 km (14.2 mi)	No data	Fair weather	Dirt	5.5 m (18 ft)/good	No data	No data	
Route 9A	142700	150700	1.0 km (0.6 mi)	No data	Fair weather	Dirt	5.0 m (16.3 ft)/fair	No data	No data	
Route 10/ Sullivan Canyon Road	097613	226610	14.6 km (9.1 mi)	No data	Fair weather	Dirt	8.4 m (27.5 ft)/fair	No data	No data	Fire road and tank trail.
Route 10A	181611	220582	5.5 km (3.4 mi)	No data	Fair weather	Dirt	6.1 m (20 ft)/good	No data	No data	
Route 11	121772	117520	27.4 km (17.0 mi)							
segment a/ Diamond Express	121772	078633	14.6 km (9.1 mi)	No data	All weather	Asphalt coated gravel	8.3 m (27.3 ft)/good	Dirt	1 m (3 ft)/fair	
segment b/ Booth Road	078633	123549	9.7 km (6.0 mi)	No data	Fair weather	Dirt	7.3 m (24 ft)/fair	No shoulder	No shoulder	Merges with Route 8 for short distance.
segment c/ Stone City Road	123549	117520	3.1 km (1.9 mi)	No data	Fair weather	Dirt	5.5 m (18.2 ft)/good	No shoulder	No shoulder	
Route 12/ South Border	037559	122541	10.9 km (6.8 mi)	No data	Fair weather	Dirt	5.5 m (18.2 ft)/good	No shoulder	No shoulder	
Route 13/ Pierce Gulch Road	096596	086552	4.8 km (3.0 mi)	No data	Fair weather	Dirt	6.6 m (21.7 ft)/poor	No shoulder	No shoulder	
Route 14	123549	205529	9.2 km (5.7 mi)	No data	Fair weather	Dirt and gravel	7.3 m (24 ft)/poor	No shoulder	No shoulder	

ROUTE NUMBER/NAME	ROUTE LOCATION (GRID REFERENCE) FROM	TO	LENGTH OF SEGMENT	MILITARY LOAD CLASSIFICATION	ROUTE TYPE	SURFACE CONSTRUCTION MATERIALS	SURFACE WIDTH/CONDITION	SHOULDER CONSTRUCTION MATERIALS	SHOULDER WIDTH/CONDITION	REMARKS
Downrange roads										
Route 14A/ Packard Road	172535	198547	2.7 km (1.7 mi)	No data	Fair weather	Dirt	5.6 m (18.5 ft)/fair	No shoulder	No shoulder	
Route 15	093603	064571	4.8 km (3.0 mi)	No data	Fair weather	Dirt	8.1m (26.7 ft)/poor	No shoulder	No shoulder	
Route 15A/ Swiicircle	073598	058574	3.7 km (2.3 mi)	No data	Fair weather	Dirt	7.1 m (23.2 ft)/poor	No shoulder	No shoulder	
Designated Tank Trails			222 km (138 mi)	No data	Fair weather	Dirt	5.8 to 8.2 (19 to 27 ft)/poor to good	Dirt	Undefined	Graded periodically; improved with some culverts.

*Priority 1 roads are cleared of snow first; priority 4 roads are the last to be cleared.

ROAD BRIDGES

BRIDGE NUMBER/NAME	ROUTE DESIGNATION	GRID REFERENCE	FEATURE CROSSED	MILITARY LOAD CLASSIFICATION	DIMENSIONS	CLEARANCE*	TYPE/CONSTRUCTION MATERIALS	CONDITION	REMARKS
1/T85123†	Tevis Street	178896	Clover Ditch	No data	23.6 m (77.6 ft)long 12.8 m (41.8 ft) wide Roadway width 7.3 m (24 ft)	Unlimited vertical 9.1 m (30 ft) horizontal	Timber trestle bridge/wood	Fair	
2/T85124	Nelson Boulevard	178879	Intermittent stream	No data	27.9 m (91.5 ft) long 12.2 m (40 ft) wide Roadway width 7.3 m (24 ft)	Unlimited vertical 9.1 m (30 ft) horizontal	Timber trestle bridge/wood	Fair	
3/T85125	Sheridan Avenue	180872	Intermittent stream	No data	27.9 m (91.4 ft) long 12.2 m (40 ft) wide Roadway width 6.7 m (22 ft)	Unlimited vertical 8.5 m (28 ft) horizontal	Timber trestle bridge/wood	Fair	
4/T85126	Prussman Boulevard	189879	Clover Ditch	No data	14.1 m (46.3 ft) long 12.8 m (42 ft) wide Roadway width 9.1 m (30 ft)	Unlimited vertical 11.0 m (36 ft) horizontal	Timber trestle bridge/wood	Fair	
5/T85127	Prussman Boulevard	181872	Intermittent stream	No data	27.9 m (91.7 ft) long 12.1 m (39.8 ft) wide Roadway width 11.0 m (36 ft)	Unlimited vertical 11.0 m (36 ft) horizontal	Timber trestle bridge/wood	Fair	
6/P85129	Titus Boulevard	200868	Clover Ditch	20 Ton‡	16.6 m (54.5 ft) long 7.3 m (24 ft) wide Roadway width 7.0 m (23 ft)	Unlimited vertical Unlimited horizontal	Concrete box culvert§ /concrete	Good	
7/P85130	Titus Boulevard	187860	Intermittent stream	20 Ton	27.4 m (90 ft) long 6.7 m (22 ft) wide Roadway width 6.7 m (22 ft)	Unlimited vertical 6.7 m (22 ft) horizontal	Concrete box culvert /concrete	Good	Has guard rails.
8/T85131	Specker Avenue	212861	Clover Ditch	No data	18.6 m (61 ft) long 12.2 m (40 ft) wide Roadway width 6.7 m (22 ft)	Unlimited vertical 9.1 m (30 ft) horizontal	Timber trestle bridge/wood	Fair	
9/T85133	Magrath Avenue	220862	Intermittent tributary to Clover Ditch	No data	14.2 m (46.7 ft) long 9.8 m (32 ft) wide Roadway width 6.7 m (22 ft)	Unlimited vertical 9.1 m (30 ft) horizontal	Timber trestle bridge/wood	Fair	
10/T85139	Wickersham Boulevard	172903	Clover Ditch	No data	18.8 m (61.6 ft) long 10.1 m (33.2 ft) wide Roadway width 7.3 m (24 ft)	Unlimited vertical 9.1 m (30 ft) horizontal	Timber trestle bridge/wood	Fair	
11/T85140	O'Connell Boulevard	173887	Intermittent stream	No data	23.3 m (76.4 ft) long 16.3 m (53.4 ft) wide Roadway width 11.0 m (36 ft)	Unlimited vertical 14.6 m (48 ft) horizontal	Timber trestle bridge/wood	Fair	
12/T85115	Route 1	243810	Intermittent stream	No data	24.7 m (81 ft) long 7.5 m (24.5 ft) wide Roadway width 7.1 m (23.2 ft)	Unlimited vertical 7.0 m (23 ft) horizontal	Timber trestle bridge/wood	Fair	
13/P85145	Route 1	239652	Young Hollow	20 Ton	41.4 m (136 ft) long 8.0 m (26.1 ft) wide Roadway width 7.3 m (23.8 ft)	Unlimited vertical 7.3 m (23.8 ft) horizontal 5.5 m (18 ft) clearance beneath	Two span concrete slab/ reinforced concrete	Good	
14/P85110	Route 1	231638	Intermittent stream	20 Ton	10.1 m (33 ft) long 9.8 m (32 ft) wide Roadway width 5.5 m (18 ft)	Unlimited vertical Unlimited horizontal	Concrete box culvert /concrete	Good	
15/P85111	Route 1	229636	Intermittent stream	20 Ton	10.1 m (33 ft) long 9.8 m (32 ft) wide Roadway width 5.5 m (18 ft)	Unlimited vertical Unlimited horizontal	Concrete box culvert /concrete	Good	
16/P85112	Route 1	226630	Intermittent stream	20 Ton	10.1 m (33 ft) long 9.8 m (32 ft) wide Roadway width 5.5 m (18 ft)	Unlimited vertical Unlimited horizontal	Concrete box culvert /concrete	Good	
17/P85113	Route 1	226619	Intermittent stream	20 Ton	16.5 m (54 ft) long 5.5 m (18 ft) wide Roadway width 5.5 m (18 ft)	Unlimited vertical Unlimited horizontal	Concrete box culvert /concrete	Good	
18/T85114	Route 14	169537	Intermittent stream	No data	17.7 (58 ft) long 5.2 m (17 ft) wide Roadway width 4.0 m (13 ft)	Unlimited vertical 4.0 m (13 ft) horizontal	Timber trestle bridge/wood	Poor	Abandoned.
19	Route 11	118523	Intermittent tributary to Turkey Creek	No data	10 m (32.8 ft) long 6 m (19.7 ft) wide Roadway width 5.5 m (18.2 ft)	Unlimited vertical 5.5 m (18.2 ft) horizontal	Timber trestle bridge/wood	No data	Formerly maintained by Pueblo County.
20	Route 8	071635	Devil Creek (intermittent stream)	No data	57.9 m (190 ft) long 4.5 m (14.7 ft) wide Roadway width 3.9 m (12.7 ft)	Unlimited vertical 3.9 m (12.7 ft) horizontal	Single span steel truss (Bailey bridge)/wood deck, steel truss	Fair	
21/T85137	Route 9	114727	Turkey Creek (intermittent stream)	No data	11.9 m (39 ft) long 6.4 m (21 ft) wide Roadway width 4.6 m (15 ft)	Unlimited vertical 4.6 m (15 ft) horizontal	Timber trestle bridge/wood with steel stringers	Fair	
22/T85135	Route 9	133713	Little Turkey Creek (intermittent stream)	5 Ton	14.0 m (46 ft) long 6.1 m (20 ft) wide Roadway width 4.3 m (14.2 ft)	Unlimited vertical 4.3 m (14.2 ft) horizontal	Timber trestle bridge/wood with steel stringers	Fair	
23/P85143	Route 11	119724	Turkey Creek (intermittent stream)	20 Ton	37.1 m (121.8 ft) long 7.8 m (25.7 ft) wide Roadway width 7.2 m (23.7 ft)	Unlimited vertical 7.2 m (23.7 ft) horizontal 3.5 m (11.7 ft) clearance beneath	Two span concrete slab/ reinforced concrete	Good	
24/P85144	Route 11	118751	Little Turkey Creek (intermittent stream)	20 Ton	37.3 m (122.2 ft) long 7.9 m (26 ft) wide Roadway width 7.3 m (24 ft)	Unlimited vertical 7.3 m (24 ft) horizontal 3.2 m (10.6 ft) clearance beneath	Two span concrete slab/ reinforced concrete	Good	Guard rail needs repair.

* Horizontal clearance approximate.

† On-post computer code.

‡ All tonnage designations are civilian load classification.

§ Concrete box culverts greater than 6.1 m (20 ft) long are considered to be bridges.

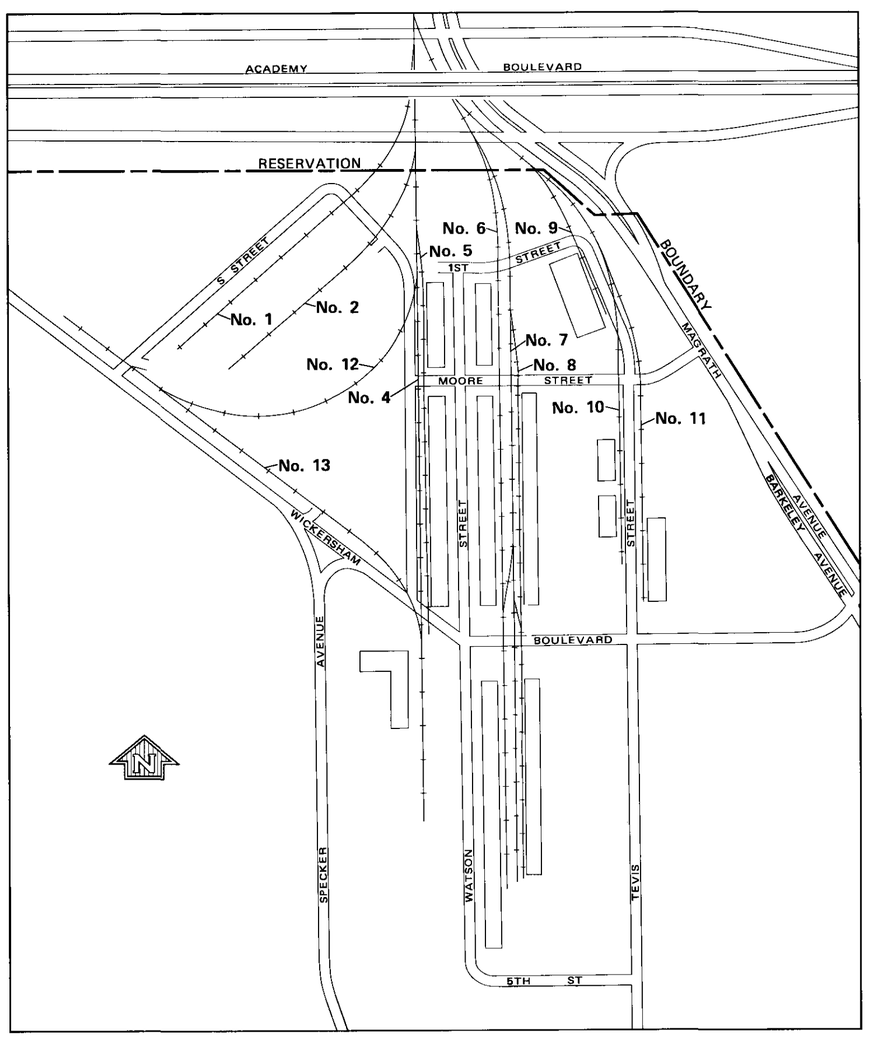
2. RAILROADS

Railroads on Fort Carson consist solely of freight and storage yard track; total trackage is 6.6 kilometers (4.1 miles). The rail yard handles an average of 68 cars per month.

There are no main line railroads on the reservation. A U.S. Government owned and maintained, single track, standard gage line continues outside the reservation for 3.4 kilometers (2.1 miles) to connect with the Denver and Rio Grande Western Railroad. The volume of traffic to and from the reservation averages 121 cars per month. It is used primarily for supply, but could be used to load and ship troops by rail in the event they are deployed.

There are no railroad bridges within the Fort Carson reservation boundaries.

IDENTIFICATION	SEGMENT OF TRACK (GRID REFERENCE) FROM TO	LENGTH OF SEGMENT	OWNERSHIP OF LINE AND CONDITION OF TRACK	TRACK AND BED CHARACTERISTICS	CROSSOVERS (GRID REFERENCE)	SIDINGS	VOLUME OF TRAFFIC	REMARKS
Rail yard; (refer to individual tracks by number in the inset figure below).	Track 1: 176907 - 173903 Track 2: 176905 - 174902 There is no track 3. Track 4: 176907 - 176898 Track 5: 176903 - 176900 Track 6: 176907 - 177897 Track 7: 177903 - 177897 Track 8: 177905 - 177897 Track 9: 178904 - 178903 Track 10: 176907 - 178900 Track 11: 178903 - 178900 Track 12: 176903 - 174902 Track 13: 173903 - 176900	402.3 m (1320 ft) 323.1 m (1060 ft) 609.6 m (2000 ft) 691.9 m (2270 ft) 1036.3 m (3400 ft) 850.4 m (2790 ft) 637.0 m (2090 ft) 313.9 m (1030 ft) 463.3 m (1520 ft) 359.7 m (1180 ft) 374.9 m (1230 ft) 530.4 m (1740 ft)	U.S. Government owned and maintained freight yard and storage yard; good condition.	Single track, standard gage (1.44 m or 4 ft 8½ in); maximum grade less than 3%; minimum radius of curvature 237.7 m (780 ft); ballast material (unless otherwise noted): crushed stone; weight of rails (unless otherwise noted): 39.7 kg/m (80 lb/yd). Track 6 ballast material: limestone. Track 7 ballast material: limestone. Track 8 ballast material: limestone; weight of rails: 44.6 kg/m (90 lb/yd).	At 176900, length: 47.5 m (156 ft). At 177900, length: 15.8 m (52 ft).	All track segments are sidings.	68 cars per month average.	No main lines on the reservation.



LEGEND

Single Track, Standard Gage

Numbers refer to entries in table.

Scale 1:4800

1000 0 1000 Meters

500 0 500 Feet

3. AIRFIELDS/AIRSTRIPS

Fort Carson has one airfield and one operational airstrip. Butts Army Airfield, 4.5 kilometers (2.8 miles) south of the cantonment area, is used by both small fixed-wing and rotary-wing aircraft. The airfield is also utilized by U.S. Air Force and National Guard aircraft, including high performance jets. There are two runways in good condition; weight restrictions vary on access and apron areas. The airfield operates seven days a week: 0600 to 2200 Local Standard Time (LST) Monday through Friday, 0700 to 1500 LST weekends and holidays. The communications facility of the City of Colorado Springs Municipal Airport (Peterson Field) controls approach and departure to Butts AAF. Traffic records from 1969 to 1971 show operations averaged 125,000 movements yearly by fixed-wing and 45,000 movements yearly by rotary-wing aircraft. Records since 1971 are not available.

The buildings at Butts AAF dating from the late 1950's are temporary. Permanent facilities have been built since 1964; however, growth in the area has stabilized. Permanent facilities include the relatively new operations building and control tower, a fire station, messhall, and two very large hangars which provide online aircraft maintenance for both fixed-wing and rotary-wing aircraft. The older aircraft compound, northwest of the crosswind runway, is used predominantly as a motor pool and for the post flying club (presently inactive).

Devil landing strip, in the west-central portion of the reservation, is the only operational airstrip. Prior to 1975 it was used infrequently; since 1975 it has been used to support maneuvers approximately four times a year.

In addition, 5 abandoned landing strips are shown in Section L, Non-Urban Culture Features.

MAP NUMBER AND NAME; LOCATION; TYPE; AND CLASSIFICATION	ELEVATION AND STATUS	RUNWAY DESCRIPTION	TAXIWAY, PARKING, APRON, AND HARDSTAND AREA DESCRIPTION	BUILDING DESCRIPTION	POL FACILITIES	NAVIGATIONAL AIDS	REMARKS
1. Butts Army Airfield; 205811; Airfield; Army.	1789.48 m (5871 ft); Operational.	Primary runway: 1389.9 x 22.9 m (4560 x 75 ft); azimuth, 130° - 310°; maximum weight bearing capacity, S 50, T 60*; asphaltic concrete surface. Crosswind runway: 701.0 x 22.9 m (2300 x 75 ft); azimuth, 40° - 220°; maximum weight bearing capacity, S 30, T 40; asphaltic concrete surface.	Taxiway: 15.2 m (50 ft) wide; maximum weight bearing capacity, S20, T30; 2.5 cm (1 in) thick bituminous surface treatment over gravel base. Overruns: 22.9 m (75 ft) wide; maximum weight bearing capacity and surface material same as taxiway. Engine run-up aprons: 14,134.7 m^2 (152,150 ft^2) total area; maximum weight bearing capacity, S 40, T 45; asphaltic concrete surface. Parking and Hangar aprons: 82,156.1 m^2 (884,350 ft^2) total area; maximum weight bearing capacity, S 45, T 50; portland cement concrete surface. Rotary-Wing hover lane: 25,666.9 m^2 (276,285 ft^2) total area; maximum weight bearing capacity, S 30, T40; asphaltic concrete. Crosswind hangar apron: 3158.6 m^2 (34,000 ft^2) total area; maximum weight bearing capacity, S 25, T 35; portland cement concrete.	Five hangars: Two permanent buildings, numbers 9604 and 9620; cinder block with corrugated metal facing, cantilevered facilities; 196.3 m long x 49.1 m wide x 18.7 m high (644 x 161 x 61.5 ft) and 79.2 m long x 48.8 m wide x 21.0 m high (260 x 160 x 69 ft). Two equipment-in-place buildings, numbers 9635 and 9636; Quonset huts; 30.5 m long x 18.3 m wide x 9.1 m high (100 x 60 x 30 ft) each. Flying Club hangar, building number 9648 (inactive); Quonset hut; 51.8 m long x 42.7 m wide x 9.1 m high (170 x 140 x 30 ft). Administration and Terminal buildings: Control tower, building number 9602; concrete block, 260.1 m^2 (2800 ft^2). Fire station, building number 9600; concrete block, 330.7 m^2 (3560 ft^2). Operations building, number 9601; concrete block, 723 m^2 (7782 ft^2). Other administration and terminal buildings, numbers 9642, 9611, 9612, concrete block; number 9644 is Quonset hut; combined gross area 1104.9 m^2 (11,893 ft^2). Maintenance facilities: (Including hangars), buildings number 9620, 9604, 9645, concrete block; numbers 9648, 9630, 9641, sheet metal; combined gross area 18,549 m^2 (199,666 ft^2). Other buildings: (Including lighting equipment vault, heating plant, etc.), buildings number 9606, 9610, 9649, 9609, 9613, concrete; number 9647, sheet metal; combined gross area 445 m^2 (4790 ft^2).	8 tanks totalling 537,400 liters (142,000 gal), bulk delivery, 1 pump per tank: 4 tanks—378,500 liters (100,000 gal), underground, U.S. aviation fuel (MIL-SPECS) 115/145, JP-4; 4 tanks—two 37,800 liters (10,000 gal) and two 45,400 liters (12,000 gal), underground, aviation gasoline, diesel fuel, and motor pool gasoline.	Control tower: 1789.5 m (5871 ft) above mean sea level, 18.8 m (61.8 ft) high; temporary Ground Control Approach system; radar control Colorado Springs. Lights: Rotating beacon; lighted windsock; mid-intensity runway lights 35.6 cm (14 in) high; flush mounted lights on taxiway and parking ramps.	High plains approximately 4.8 km (3 mi) west of airfield.
2. Devil Landing — Extraction Zone; 079637; Airstrip; Army.	1811.1 to 1834.9 m (5940 to 6020 ft); Operational.	1280.2 x 18.3 m (4200 x 60 ft) azimuth, 170° - 350°; maximum weight bearing capacity 67,950 kg (150,000 lb); clay surface, poor condition.	Overruns: 91.4 m (300 ft) long x 18.3 m (60 ft) wide at each end. Turnaround: 45.7 m (150 ft) diameter circle at each end.	No buildings	No facilities	Portable lighting for night operations.	Reworked surface August 1977; 3.0 m (10 ft) shoulder each side of runway; 2048.3 m (6720 ft) and 2011.7 m (6600 ft) high hills (parts of Timber Mountain) approximately 2500 m (8200 ft) to the north-northeast, 1976.6 m (6485 ft) high hill approximately 3000 m (9840 ft) to the north-northwest, and 1865.4 m (6120 ft) high northwest-southeast-trending ridge approximately 1600 m (5248 ft) to the south of the airstrip.

*Runway weight bearing capacity in pounds (gross weight of aircraft) is determined by adding 000 to figure following S, T, ST, TT, TDT. Runway weight bearing capacity given is for unlimited operations. Aircraft weight higher than given requires prior permission from aerodrome controlling authority.

S - Runway weight bearing capacity for aircraft with single-wheel type landing gear (C-47, F100).
T - Runway weight bearing capacity for aircraft with twin-wheel type landing gear (C-9A).
ST - Runway weight bearing capacity for aircraft with single-tandem landing gear (C-130).
TT - Runway weight bearing capacity for aircraft with twin-tandem type (includes quadricycle) landing gear (B-52, C-135).
TDT - Runway weight bearing capacity for aircraft with twin-delta tandem landing gear (C-5).

For further information, see DOD Flight Information Publication (enroute IFR-Supplement United States).

4. PIPELINES

Four underground pipelines cross the reservation. A gravity flow water line to the City of Fountain roughly follows an east-west right-of-way at latitude 38°40'N; an unused tap at the Rod and Gun Club is the only connection on the base. One water and two gas lines share a second right-of-way in the extreme northeast corner of the reservation, which was leased to the City of Colorado Springs in 1954 for the operation and maintenance of a 40.6 centimeter (16 inch) water line; the two gas lines were later additions. There are no connections to these lines on the base.

A third right-of-way, lying roughly north-south along the east-northeast reservation boundary, will house the proposed Fountain Valley conduit. This 106.7 centimeter (42 inch) pipeline is part of the Fryingpan-Arkansas Project, a multiple-purpose water resource management project involving the transmountain diversion of water to the Arkansas River Basin; the project has been approved by the U.S. Congress and is the responsibility of the U.S. Bureau of Reclamation.

In addition, one gas pipeline and one water pipeline, used for internal distribution on Fort Carson, are shown in Section L, Non-Urban Culture Features.

MAP NUMBER AND/OR NAME	GRID REFERENCE FROM	GRID REFERENCE TO	STATUS	OWNERSHIP	PIPELINE CHARACTERISTICS	TANK CROSSING SITES (GRID REFERENCE)	REMARKS
1	133809	245809	Operative	City of Fountain	25.4 cm (10 in) diameter pipe; 11.9 km (7.4 mi) across the reservation; water line; design capacity 0.14 m^3/sec (5 ft^3/sec); depth underground approximately 1.5 m (5 ft).	156810; 163811; 192809; 243809	Gravity flow; collects surface water runoff in the mountains; tap at the Rod and Gun Club is not used, needs there are met by a spring; no other connections are made on the base.
2a	188900	204896	Operative	City of Colorado Springs	40.6 cm (16 in) diameter pipe; 1.8 km (1.1 mi) across the reservation; water line; design capacity maximum flow under 7 kg/cm^2 (100 lb/in^2) pressure.	No crossings	Three underground pipelines within the same right-of-way; no pumping stations on the reservation; no throughput data available. No data on burial depth.
2b	188900	204896	Operative	City of Colorado Springs	20.3 cm (8 in) diameter pipe; 1.8 km (1.1 mi) across the reservation; gas line; design capacity maximum flow under 3.5 to 3.9 kg/cm^2 (50 to 55 lb/in^2) pressure.	No crossings	Throughput figured on "as required" basis—no data available. No data on burial depth.

4. PIPELINES (Continued)

MAP NUMBER AND/OR NAME	GRID REFERENCE FROM	GRID REFERENCE TO	STATUS	OWNERSHIP	PIPELINE CHARACTERISTICS	TANK CROSSING SITES (GRID REFERENCE)	REMARKS
2c	188900	204896	Operative	City of Colorado Springs	12.7 cm (5 in) diameter pipe; 1.8 km (1.1 mi) across the reservation; gas line; design capacity maximum flow under 3.5 to 3.9 kg/cm^2 (50 to 55 lb/in^2) pressure.	No crossings	Throughput figured on "as required" basis—no data available. No data on burial depth.
3	200899	244821	Proposed	U.S. Bureau of Reclamation project	106.7 cm (42 in) diameter pipe; 9.4 km (5.8 mi) across the reservation; water line; maximum diversion 86.1 x 10^6 m^3/yr (70,000 acre ft/yr); approximate location of proposed pumping station #4 grid reference 237845.	233857; 242830	Fountain Valley conduit of Fryingpan-Arkansas Project, Colorado. No data on burial depth.

5. HELICOPTER LANDING ZONES

Nine helicopter landing zones are designated in the cantonment area, three of which are hard surface helipads; the others are open areas. The hospital helipad complex, consisting of one primary helipad and three smaller pads, is the only helicopter landing zone in the cantonment area that is maintained. An additional eight helicopter landing zones serve firing ranges in the east and central portions of the reservation.

Butts Army Airfield employs and maintains a large contingent of rotary-wing aircraft. More than three-fourths of its total parking apron, approximately 60,682 square meters (653,200 square feet), is designated for rotary-wing use. The hover lane is 25,667 square meters (276,285 square feet) in total area. Butts AAF has two hover points: one with the approach zone parallel to the main runway and one with the approach zone parallel to the crosswind runway.

MAP NUMBER AND/OR NAME	LOCATION (GRID REFERENCE)	DIMENSIONS	AZIMUTH	ELEVATION	SURFACE MATERIAL	RESTRAINTS	REMARKS
1. Commanding General's Quarters	188867	No data	No data	1789.2 m (5870 ft)	Sod	Hill southeast.	Wind indicator; best approach from the south; special instructions: PPO.
2. Division Headquarters	180879	45 x 30 m (147.6 x 98.4 ft)	No data	1786.1 m (5860 ft)	Sod	Wires on four sides; smoke stack to south.	Wind indicator; best approach from the south; special instructions: VIP traffic only.
3. Hospital Helipad Complex (4 pads)	177871	14 x 12 m (45.9 x 39.4 ft) 6 x 6 m (19.7 x 19.7 ft) 8 x 6 m (26.2 x 19.7 ft) 8 x 6 m (26.2 x 19.7 ft)	90 - 270° 90 - 270° 90 - 270° 97 - 277°	1786.1 m (5860 ft)	Bituminous	Trees north; wires north and west; chimney north.	Wind indicator; best approach from the west; restricted: notify Butts AAF tower of Medevac and ETA at hospital.
4.	185880	No data	No data	1775.5 m (5825 ft)	Bare	Abandoned.	Torn up by construction work.
5. 3rd Brigade Pad	205864	16 x 14 m (52.5 x 45.9 ft)	No data	1751.1 m (5745 ft)	Prairie grass	Baseball diamond north.	Best approach from the west.
6. DISCOM Headquarters Pad	182886	No data	No data	1775.5 m (5825 ft)	Sod	Nearby buildings.	Best approach from southeast; can handle CH-47.
7. 1st Brigade Pad	193893	8 x 6 m (26.2 x 19.7 ft)	No data	1775.5 m (5825 ft)	Pierced steel planking	Wires west.	Wind indicator; best approach from the southeast.
8. DIVARTY	180892	91.4 x 45.7 m (300 x 150 ft) overall landing area, includes actual planking	No data	1784.6 m (5855 ft)	Pierced steel planking	Wires west and east.	Wind indicator; best approach from the west.
9. 2nd Brigade Pad	190876	No data	No data	1767.8 m (5800 ft)	Bare	Wires east and north; buildings west.	Best approach northwest-southeast.
10. Butts AAF (2 hover points)	204814 211809	Not applicable	40 - 220° 120 - 300°	1783.1 m (5850 ft) 1775.5 m (5825 ft)	Bare Concrete	No restraints.	
11. 43rd GSG Pad	191872	No data	No data	1773.9 m (5820 ft)	Bare	No restraints.	Best approach from the southeast.
12. Range 105	213764	6.1 x 6.1 m (20 x 20 ft)	No data	1725.2 m (5660 ft)	Perforated steel plates	No data	Semipermanent.
13. Range 109	221745	6.1 x 6.1 m (20 x 20 ft)	No data	1725.2 m (5660 ft)	Perforated steel plates	Permanent control tower for the firing range.	Semipermanent.
14. Range 119	240693	6.1 x 6.1 m (20 x 20 ft)	No data	1713.0 m (5620 ft)	Perforated steel plates	No data	Semipermanent.
15. Range 141	184761	6.1 x 6.1 m (20 x 20 ft)	No data	1780.0 m (5840 ft)	Perforated steel plates	No data	Semipermanent.
16. Range 143	172572	6.1 x 6.1 m (20 x 20 ft)	No data	1713.0 m (5620 ft)	Perforated steel plates	No data	Semipermanent.
17. Range 145	208546	6.1 x 6.1 m (20 x 20 ft)	No data	1770.9 m (5810 ft)	Perforated steel plates	No data	Semipermanent.
18. Range 147	201535	6.1 x 6.1 m (20 x 20 ft)	No data	1664.2 m (5460 ft)	Perforated steel plates	No data	Semipermanent.
19. Range 155	183562	6.1 x 6.1 m (20 x 20 ft)	No data	1761.7 m (5780 ft)	Perforated steel plates	No data	Semipermanent.

6. DROP ZONES

Sullivan Park, in the west-central portion of the reservation, is a flat to gently sloping low plain covering approximately 12 square kilometers (4.6 square miles) and surrounded on the east, south, and west by steeply sloping high plains and a series of rounded to sharp-crested low hills. The drop zone in Sullivan Park is oriented northeast-southwest; it is 2537.5 meters (2775 yards) long and 786.4 meters (860 yards) wide. The highest elevation within the drop zone is 1844 meters (6050 feet).

Airdrop operations require that aircraft approach the drop zone from the southwest after obtaining entry clearance into the restricted area from Butts Tower and the Combat Control Team. Point of impact is 274.3 meters (300 yards) from the leading edge, on drop zone centerline, at grid reference 090637; point of impact elevation is 1822.7 meters (5980 feet).

Sullivan Park drop zone is accessible by Devil landing strip, Routes 8 and 11, Tank Trail D, and various unimproved dirt roads and trails.

NUMBER AND NAME	LOCATION (GRID REFERENCE)	DIMENSIONS	AZIMUTH	ELEVATION	SURFACE DESCRIPTION	AIRCRAFT OBSTRUCTIONS	REMARKS
1. Sullivan Park	103656 109650 085638 091632	2537.5 x 786.4 m (8325 x 2580 ft)	45° - 225°	1822.7 m (5980 ft)	Barren ground with some scrub.	Two hills approximately 1700 m (5576 ft) south, elevations 1868.4 m (6130 ft) and 1877.6 m (6160 ft); hill 1868.4 m (6130 ft) high 550 m (1804 ft) east; ridge line north, highest point 2051.3 m (6730 ft).	Hard-surfaced road and nearby Devil landing strip provide access. Dirt roads cross drop zone.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

LINES OF COMMUNICATION

ROADS

- Hard surface, 4 or more lanes
- Hard surface, 2 or 3 lanes
- Loose surface, 2 or more lanes
- Hard surface, 1 lane
- Loose surface, 1 lane
- Improved dirt
- Unimproved dirt
- Tank trail
- (15) Military Reservation Route Number

150m / 7% — Grade (percentage, direction and length. Given only if ≧ 7%)

Bridge Data (measurements in meters)

∞ A B C D E

- **A** Bridge number
- **B** One-way military load classification
- **C** Two-way military load classification
- **D** Roadway width
- **E** Length
- ∞ Unlimited vertical clearance

RAILROADS

(see inset figure following Table 2, Railroads)

AIRFIELDS/AIRSTRIPS

1 Airfield

2 Airstrip

PIPELINES

(3) Pipeline

P Pumping Station (water)

Tank Crossing

HELICOPTER LANDING ZONES

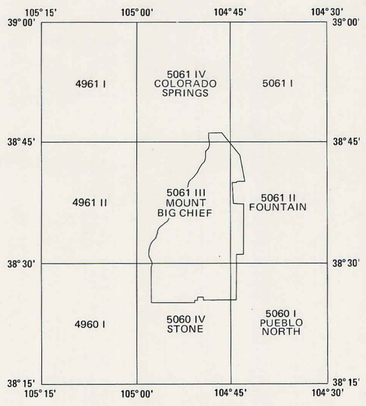
H 19 Landing Zone

DROP ZONES

DZ 1 Drop Zone

Note: Numbers refer to entries in tables.

INDEX TO SHEETS
SERIES V777
1:50,000
SCALE



CONTOUR INTERVALS

40 FEET
20 FEET

Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters
1 ½ 0 1 2 3 Statute Miles

4250 000m N.
500 000m E.

K. URBAN AREA (CANTONMENT AREA)

TROOP BILLETS

TYPE	NUMBER OF BUILDINGS	CAPACITY	CURRENT LOAD	CONDITION	REMARKS
Permanent	61	10,236 MN*	6250 MN	Excellent to Good	Permanent construction has taken the place of many World War II mobilization-type structures. It consists of clusters of consolidated barracks, messhalls, admin/classroom, and dayroom facilities. These permanent barracks and support buildings are grouped together, with space for expansion, on the east side of the cantonment lying north-south between Barkeley and Magrath Avenues. They are presently filled to 61% of their authorized occupancy. An additional four permanent barracks with 121 MN capacity each are planned.
Temporary	92	3680 MN	2001 MN	Fair to Poor	Temporary barracks consisting of World War II mobilization-type structures are classified by the Department of Defense as substandard, but may be made adequate through renovation. They are slated for five years retention, with incremental demolition as replacement structures are approved. Their present 54% occupancy, with some buildings sparsely occupied or vacant, is based on a peacetime downrated capacity of 34 to 40 MN per building; the WWII mobilization capacity is 72 MN per building. Occupied temporary barracks are concentrated in two areas of the cantonment. The "mulebarn" area, east of the consolidated maintenance shop, will be converted to maintenance and Reserve Army facilities with relocation of troop housing to new permanent barracks. The second concentration of temporary barracks in the southeast corner of the cantonment occupies the land where the last group of permanent replacement barracks is slated to be built.

*8.4 m^2/individual (90 ft^2/individual)

QUARTERS

TYPE	NUMBER OF BUILDINGS	CAPACITY	CURRENT LOAD	YEAR OF CONSTRUCTION	CONDITION	REMARKS
BOQ						Five permanent buildings, originally designed for use as BOQ, are situated just east of the Officers' Club and south of the existing hospital complex. Most bachelor officers live off base; therefore, present use of these quarters is mixed. The BEQ was formerly a BOQ. Bachelor officers occupy 65 spaces in one building, with the remaining 13 spaces used for temporary duty assignments (TDY). In another, only 7 spaces are designated BOQ, with the remaining 17 spaces TDY. A third building accommodates incoming families awaiting housing assignment and TDY. The fourth permanent BOQ and the semi-permanent BOQ are assigned entirely to TDY.
Permanent	4	30	--			
		78	65			
		24	--			
		24	7	1970	Good	
Semi-Perm	1	10	--	1948	Fair	
BEQ						
Permanent	1	78	78	1970	Good	
Guest Houses	2	56	56	1942	Fair	Guest houses are in the existing hospital complex and house TDY assignments. Plans call for two new, permanent guest houses to be built in the future, one to accommodate 20 and another which will house 46.

--Indicates load other than use intended as explained in remarks.

FAMILY HOUSING

TYPE	NUMBER OF BUILDINGS	NUMBER OF FAMILY UNITS	CURRENT LOAD	YEAR OF CONSTRUCTION	CONDITION	REMARKS
General						The temporary structure modified and classified as General's quarters is in good condition. The other three structures are permanent Capehart construction with basements and garages.
Temporary	1	1	1	1942	Good	
Permanent	3	3	3	1958	Good	
Colonel						Senior officers' family housing occupies an area known as Ute Hill. The average occupancy rate is 99+%, as compared to an obliged rate of 98.6%. Corley House, a temporary structure, was originally a farm house; it was completely renovated in 1974 and is now generally assigned to the Post Command Sgt-Major.
Temporary	1	1	1	1948	Good	
Permanent	8	8	8	1958	Good	
	16	16	16	1957	Good	
Lt. Col-Major	20	20	20	1957	Good	The area known as Cheyenne Village contains single, duplex, and a group of fourplex buildings which house families of field grade, company grade, and warrant officers. All of these structures are permanent. Family units have two or three bedrooms; many have basements. In August 1977, only two family units were vacant.
Lt. Col-Major	9	9	9	1958	Good	
CGO/WO	52	104	103	1957	Excellent	
CGO/WO	8	30	30	1965	Excellent	
CGO/WO	19	38	37	1958	Excellent	
NCO	72	200	200	1973-1974	Excellent	Apache Village has NCO family housing of duplex and fourplex construction, with a few six-family buildings. Those built in 1972 have carports.
NCO	49	240	240	1972	Excellent	
NCO	75	150	148	1971	Excellent	
NCO	45	250	250	1965	Excellent	Arapahoe Village has NCO family housing of fourplex and six-family buildings. A few have detached garages, and 100 buildings have basements.
NCO	65	279	279	1958	Good	
NCO	109	480	480	1958	Good	
Totals	552	1829	1825	(99.78% occupancy)		All of the buildings in Apache and Arapahoe Villages are permanent structures. NCO family housing occupies 289 acres in a north-south belt on the west side of the cantonment. As of September, 1977, family housing was occupied to 99.78% of possible capacity with vacant units either being repaired, or in transition between families. No alterations or additions are considered for the future, since nearby Colorado Springs has a relatively high vacancy rate and can provide off-post housing. Total population for family housing units is calculated by allowing one military sponsor plus 2.5 dependents for each unit. (3.5 x 1825 = 6388 population as of September 1977).

NATURAL GAS

CAPACITY	CURRENT LOAD	REMARKS
As required (2 to 3 times present load, if needed, provided proper adjustments in pressure and temperature)	398.2 x 10^3 m^3 (14,061 x 10^3 ft^3) maximum daily draw*	Natural gas is supplied to Fort Carson by Colorado Springs on a "firm basis," that is, the city is required by the State of Colorado, Public Utilities Commission, to supply existing facilities connected to the "firm supply" at Fort Carson under all circumstances. The gas is purchased from the City Department of Public Utilities, which is in turn supplied by the Colorado Interstate Gas Company. Basis of purchase is 3.54 x 10^7 J/m^3 at 0.9 kg/cm^2 absolute at 15.6°C (950 BTU/ft^3 at 12.65 lb/in^2 absolute at 60°F). Two facilities within the cantonment (the post laundry and the central heating plant for troop housing) are on interruptible gas status: supply may be denied by the city, for any reason, with less than one hour's notice. The only point at which natural gas is introduced onto the reservation is at a metering station east of gate 4; it is delivered at approximately 63,279 kg/m^2 (90 lb/in^2) through a 25.4 cm (10 in) line. During FY 1976 Fort Carson consumed a total of 46,964 x 10^6 m^3 (1,658,340 x 10^6 ft^3) of natural gas, of which 10,887 x 10^6 m^3 (384,427 x 10^6 ft^3) were supplied on an interruptible basis and 36,077 x 10^6 m^3 (1,273,913 x 10^6 ft^3) on a firm basis. No new facility at Fort Carson requiring an excess of 99.1 m^3/hr (3500 ft^3/hr) per device (boiler, etc) can receive a gas permit. New permits are authorized for a replacement structure only if it is built within one year after demolition of an existing temporary building. The demand for natural gas is based on supplying facilities that have gas permits rather than on the number of persons. Demands for the foreseeable future, to FY 1980, appear to be stable. There are no expectations for expansion; further expansion capabilities could be limited by availability and supply of natural gas. Colorado Springs can continue to meet the presently anticipated demands. Piping in the distribution system consists of wrapped steel and uncoated black iron, with some plastic pipe in newer construction. It is in generally good condition. Localized segments which have deteriorated due to age are being replaced in an ongoing maintenance program. The system is adequate to meet present and foreseeable demands. In compliance with Department of the Army directives, issued in 1974 and 1975, Fort Carson is augmenting natural gas fuel supplies to its central heating plant with fuel oil standby capability. Subsequent proposed military projects will provide the appropriate facility with a 90 day supply of fuel oil.

* Current load, calculated on FY 1976 "worst case" basis: 248,158 x 10^3 ft^3 (heaviest actual month of use, FY 1976) divided by 30 days x 1.7 (estimated peak load factor) = 14,061 x 10^3 ft^3 maximum daily draw.

WATER SUPPLY

TYPE	CAPACITY	CURRENT LOAD	REMARKS
Supply	32.2 x 10^6 lpd (8.5 x 10^6 gpd)*	14 x 10^6 lpd (3.7 x 10^6 gpd) 617 lpd/person (163 gpd/person) average daily consumption 28.8 x 10^6 lpd (7.6 x 10^6 gpd) peak daily consumption 40.5 x 10^6 lpd (10.7 x 10^6 gpd) peak hourly rate 43.1 x 10^6 lpd (11.4 x 10^6 gpd) design† peak & fire daily demand	Water supplied to the cantonment at Fort Carson is purchased from Colorado Springs and is supplied through two 50.8 cm (20 in) pipes. Some water purchased by Fort Carson is supplied to the NORAD Cheyenne Mountain Complex located to the west. With newly installed recirculating power equipment, it is estimated that the Complex will account for 4% of Fort Carson's water needs. Usage is metered and recorded at the Complex and Fort Carson is reimbursed for the amount used based on these records. Inadequacy of supply water pressure occurs in summer months at times of peak demand. Potential increase in water supply depends upon the amount of water that can reliably be supplied under contract with Colorado Springs.
Treatment			Colorado Springs pretreats water as follows: 1. Flocculation and coagulation; 2. Sedimentation; 3. Filtration (rapid sand & dual method); and 4. Disinfection. Residual chlorine is held between 0.50 and 0.75 ppm. No fluorides are added by the city nor is further treatment provided by the installation. No future requirements are planned as there are no limitations to the treatment capacity or efficiency.
Storage Reservoirs	Three 3,785,000 liter (1,000,000 gal)	Two at 75% to 100% capacity One at 25% to 50% capacity (usual condition)	Based on average daily demands, existing water storage is adequate. However, at the consumption rate of 616.9 lpd (163 gpd) per capita, the summer minimum storage capacity of 2,523,330 liters (666,666 gal) would only support a design population of 4090 with no reserve for fire demands. Based on peak demands†, inadequate pressures in the Colorado Springs supply line compounded with low supply line pressure on the post, do not allow the complete filling of the reservoirs. A shortage of approximately 9,841,757 liters (2,600,200 gal) may result in summer (as calculated for required water storage at peak demand cited in TM5-813-4). An Army project to be completed FY 1978 and proposed improvements in the city system will alleviate this pressure and storage problem in the future. The water distribution system consists of an extensive network of mains ranging in size from 7.6 cm (3 in) up to 50.8 cm (20 in) in diameter. Most of the pipe, much of which was laid in 1942, is cast iron, with some sections of asbestos cement and cement coated steel. There is little or no effective cathodic protection on the lines to counteract existing highly corrosive soil conditions. The general layout of the system provides many loop networks and thus good control for isolating certain runs of pipe without disrupting pipe in other areas. With ongoing replacement of old lines and hydrants and redesign of the supply/storage system, the existing distribution system will be adequate for the design population.

* liters per day; gallons per day

† Based on a FY 1976 effective population at Fort Carson of 22,684 with calculated 617 lpd (163 gpd) per capita consumption.

SCHOOLS AND MEDICAL FACILITIES

TYPE	CAPACITY	CURRENT LOAD	REMARKS
Schools			
Elementary - Total	1650 pupils	1425	Two elementary and one junior high school, under the jurisdiction of Fountain School District #8, serve the dependents of Fort Carson. Located in and adjacent to family housing areas, they are considered adequate to meet the present post-dependent population. Senior high school-aged dependents are bused off post to a nearby community. No new facilities are reflected on the current Master Plan.
Freedom Trails	800	760	35 classrooms, library, multi-purpose room; built 1957: 4666.8 m^2 (50,235 ft^2); grades K-6.
Gen. Craighton Abrams	750 regular 850 w/special programs	665	25 classrooms, two music rooms, multi-purpose room, media center; built 1976: 4527.8 m^2 (48,738 ft^2); grades K-6.
Middle School Carson Jr. High	400	362	24 classrooms, gym, library; built 1958: 3715.1 m^2 (39,990 ft^2); grades 7-9.
Medical Facilities			
Hospital Semi-permanent	176 beds authorized		A World War II mobilization-type hospital complex of 34 buildings serves Fort Carson. Although only 176 beds are authorized, additional wards may be used in emergency situations. The hospital is served by an adjacent helipad complex. Emphasis is on out-patient clinics. A new consolidated hospital is planned after FY 1980.
Medical Laboratory	3/4 of 1 building		
Dispensaries	6 units		Troop medical clinics are located throughout the cantonment area. They are for minimal care and do not contain beds or in-patient facilities.
Dental Clinics	4 units		One existing dental clinic contains 28 dental treatment rooms (DTR). Two are planned with 21 DTR and 51 DTR for the new enlisted men's barracks area, expected for completion by FY 1980. In the interim, two clinics occupy buildings in the hospital complex and one is under construction in the area of Post Headquarters.

RECREATION FACILITIES

TYPE	CAPACITY	REMARKS
Outdoor Facilities		
Golf Course (1)		An 18-hole regulation golf course with clubhouse and starter building was built in 1972.
Golf Driving Range (1)		
Mini-Golf Course (1)		External lighting for night use.
Multi-Courts (44)		Eleven are tennis courts only, three of which have night-lighting. Others have concrete-asphalt surface with two basketball goals and a volleyball court and are distributed in troop housing areas throughout the cantonment.
Handball Courts (2)		Three are within the housing area and three are near it.
General Purpose Playgrounds (6)		
Softball Fields (13)		Two are new as of September 1977.
Baseball Field (1)		
Running Tracks (2)		Located around football fields.
Outdoor Swimming Pool (1)		Has locker rooms, etc., in adjacent bath house.
Football Fields (4)	3500 seats (1) 500 seats (3)	Temporary bleachers provide seating at each football field.
Soccer Fields (2)		One soccer field is superimposed on the football field near the #1500 block of buildings and has seating for 3500 in temporary bleachers. The second soccer field is south of the #1700 block of buildings and was converted from the old driving range.
Youth Baseball and Softball Field		For dependent-youth activities.
Motocross Court	bikes up to 250 cm^3	Dirt motor-bike riding track near gate 20.
Indoor Facilities		
Fieldhouse	4500 seats	Temporary structure built in 1942; slated for renovation by 1980.
Gymnasiums (5)	50 seats 250 seats 3300 seats 2151.5 m^2 (23,159 ft^2) 2729.5 m^2 (29,381 ft^2) (under construction)	One small gym is devoted to dependent-youth activities. It and another 250 seat capacity gym are slated for renovation by 1980. The other three are permanent structures; one built in 1966, one in 1975, and the last under construction in the area of the new permanent troop barracks.
Theaters (3)	580 seats 1080 seats 288 seats	Movie theater; scheduled renovation of this temporary structure by 1980. Permanent theater with stage suitable for live or filmed entertainment. Live theater in a temporary building with stage; scheduled for demolition by 1980 with future replacement by a proposed Drama Center.
Bowling Center	36 lanes	Permanent structure in the Community Center was built in 1966.
Libraries (2)		One main library and one branch library serve the base. The main library was built in 1974 as a permanent structure. The branch is in an old hospital building which is scheduled for demolition by 1980.
Indoor Swimming Pool		The first permanent structure at Fort Carson, built in 1951; this small indoor swimming pool is 22.9 m (25 yd) long.

ELECTRICITY

SUBSTATIONS	TRANSFORMERS	CAPACITY	LOAD	REMARKS
#1	Two 5.0 MVA	7.0 MVA	Peak demand	Electricity is generated from a combination of interconnected sources which represent a capacity of 225 MW. The Colorado Springs system is connected to the Greenwood 115 kV line to Denver, and to the 115 kV west station line in Pueblo, with a capacity of 50 MVA. By October 1979 the new Nixon Power Plant, built by Colorado Springs, will be online with an additional 200 MW capacity.
#2	One 7.5 MVA	10.5 MVA	FY 1977: 12,840 kW	
Total	17.5 MVA	24.5 MVA		Electricity is supplied at Fort Carson in two 34.5 kV,3 phase aerial lines by Colorado Springs Department of Public Utilities. It is transformed down to 12.47/7.2 kV for distribution throughout the subsequent system at substations 1 and 2. Substation 1 has eight circuits which deliver 100% of the present transformer capacity. Substation 2 has one transformer with four circuits: one serving Ute Hill and Cheyenne Village, two (waiting use) for new enlisted men's barracks, and one serving Butts AAF, south of the cantonment. A tieline between the two substations is slated for FY 1978 and will enable a sharing of transformer potential for all of the cantonment. Standby generators are in strategic locations for emergency backup use. The present distribution system is very good; it is mostly less than 10 years old and uses aluminum wire.

TELECOMMUNICATIONS

TYPE	CAPACITY AND CURRENT LOAD	REMARKS
Official Telephone	2663 main centrex lines 19 Autovon network trunks 3 5-band Wats lines 7 operator positions approximately 5600 telephone instruments	The Mountain Bell Telephone Company operates all service in the cantonment area at Fort Carson. Service and lines are leased from Mountain Bell on a contract, renewable for the new FY each October 1. Most of the telephone service lines are overhead; lines to new construction since 1971 have been installed underground, generally whenever electrical service has been installed underground. Since 1974 many old lead-insulated cables have been removed and new polyethylene-insulated cables installed as part of the current new construction project. Since system revamping was completed in March 1976, the post no longer pays for cable maintenance. A relatively new telephone exchange facility north of the reservation in the Strathmoor Hills subdivision serves all the needs of the cantonment area. Service is provided to family housing units by separate, direct individual contracts with Mountain Bell. There is an ongoing problem with vehicle clearances under overhead telephone lines. The Telephone Company requires a 101.6 cm (40 in) separation from power lines on common poles and a 5.5 m (18 ft) clearance above road surfaces, requirements which often conflict with one another, usually with a compromise of overhead clearances. Severance of the telephone lines is usually caused by careless truck operations. The U.S. Army Communications Command provides a 20% expansion capability in establishing its communications systems. Because the proposed facilities do not represent an increase in actual number of units or personnel, this 20% reserve capacity will not be diminished by construction shown on the Master Plan. Further expansion capability, without additional construction of communication lines, would be limited to this approximate 20% expansion potential.

SEWERAGE

PLANT	CAPACITY	AVERAGE DAILY FLOW	PEAK RECORDED FLOW	REMARKS
Main Sewer Plant (Magrath Ave. near gate 20)	13.6 x 10^6 lpd (3.6 x 10^6 gpd) max daily flow hydraulic design capacity	6 x 10^6 lpd (1.6 x 10^6 gpd) 253.6 lpd/person (67.6 gpd/person) based on FY 1976 effective population	22.7 x 10^6 lpd (6 x 10^6 gpd) (after heavy rain)	Sanitary sewage treatment for the entire cantonment area, including effluent from several vehicle washrack facilities and sewage from the NORAD Complex in Cheyenne Mountain is provided by a plant in the southeast corner of the cantonment area on Magrath Avenue near gate 20. Effluent from this plant is discharged into Clover Ditch and into the irrigation system which serves the golf course. Built in 1942 and upgraded in 1963, during 1971-72 and 1976-77, the plant provides primary and secondary treatment. The collection system consists of gravity flow lines, except for one segment of forced main with a lift station. The pipelines vary in size from 15.2 to 76.2 cm (6 to 30 in) in diameter. Average depths of the predominantly reinforced concrete and vitrified clay pipe are from 1.1 to 2.3 m (3.5 to 7.5 ft). The cantonment collection system is composed of four subsystems which contain some 1071 manholes. Various studies of the collection system and treatment facilities, conducted since 1971, found excessive infiltration, inflow, and exfiltration in the system. In 1976, a TV inspection survey identified all portions of the system requiring maintenance. With a program instituted for proper maintenance, the system will remain adequate; future expansion must consider the size limitation of some lines, however. The treatment plant hydraulic capacity complies with EPA regulations; an investigation of compliance, based on two studies done between 1974 and 1976, found it sufficient to serve the existing effective and the design population. However, virtually none of the EPA effluent quality requirements were met. The resulting construction program to correct existing plant problems will be completed in early 1978. At that time the post sewage treatment plant will meet all EPA Pollution Discharge Limitation requirements.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

URBAN AREA (CANTONMENT AREA)

AREA FEATURES

- Family Housing, Officers
- Family Housing, NCO
- Barracks, Troop Quarters
- Bachelor Officer Quarters, Male
- Bachelor Enlisted Quarters
- Guest Houses, Temporary Quarters
- Parade Grounds
- Recreation Facilities

POINT FEATURES

1. Post Headquarters
2. Post Hospital
3. Officers' Open Mess
4. Post Exchange and Branch PXs
5. Commissary
6. Post Office
7. Elementary Schools
8. Chapel and Unit Chapels
9. Directorate of Facilities Engineering
10. Consolidated Field Maintenance Shop
11. Sewage Treatment Facility
12. Electrical Power Substation
13. Central Heating Plant
14. Cooling Plant
15. Cooling Towers
16. Water Storage Tank
17. Post Museum
18. Education Center
19. Radio Station
20. Corley House
21. MARS Station

Scale 1:9600

500 0 500 1000 Meters

1000 0 1000 2000 3000 Feet

INSET

FOR CONTINUATION SEE INSET AT UPPER RIGHT

L. NON-URBAN CULTURE FEATURES

On the Fort Carson reservation, there are over 125 manmade features outside the cantonment area which could either positively or negatively affect military training or operations. Most of these features, depicted on the accompanying map and described below, consist of various types of buildings, revetments, and towers, many of which are associated with the various ranges on the reservation. The manmade features included are those that existed as of December 1977.

MAP NUMBER	GRID REFERENCE	DESCRIPTION
1	196881	Gas chamber: 129.3 m^2 (1392 ft^2), concrete block, built-up, permanent.
2	206876	Sanitary landfill: capacity approximately 59 metric tons (65 short tons) per day for 25 years; closing 12/77; waiting shelter, 8.3 m^2 (89 ft^2), wood, frame, temporary.
3	198863	Radio tower, height 13.7 m (45 ft), 3 wooden poles, adjacent to Range Control; Range Control building, 157.9 m^2 (1700 ft^2), all buildings associated are concrete frame, temporary; two Facilities Engineers buildings, one 154 m^2 (1659 ft^2), one 141 m^2 (1527 ft^2); electronics maintenance building, 23.8 m^2 (256 ft^2); communications center, 125 m^2 (1350 ft^2); target storage shed, 74 m^2 (800 ft^2)(1) (see footnotes), concrete piers, frame, temporary.
4	190859	Power substation (see Urban Area-Cantonment Area).
5	200862	At Range 1 (excess propellant burning): Latrine, 16.8 m^2 (181.4 ft^2), prestressed concrete slab; inflammable materials storehouse, 20.8 m^2 (224 ft^2), concrete, metal, frame, temporary.
6	204859	At Range 3 (pistol familiarization): Latrine, 4.5 m^2 (48 ft^2), wood(2); target house, 37.2 m^2 (400 ft^2), concrete, frame, temporary.
7	205858	At Range 5 (night firing M16 rifle): Latrine(2); target storage building, 74.3 m^2 (800 ft^2)(3), concrete, concrete block, built-up, temporary.
8	207858	At Range 5A (combat pistol qualification course and quick target training device): To the west is target storage building, 107 m^2 (1152 ft^2)(4), concrete, concrete block, built-up, temporary.
9	208857	At Range 7 (mini-tank range): Latrine(2); five concrete firing pads, each 34.8 m^2 (375 ft^2), permanent; wind wall, length 137 m (450 ft), height 2.4 m (8 ft), wood.
10	210857	At Range 7A (known distance): Pit target house(4).
11	212858	At Range 9 (Tank Table I, II, or III and recoilless rifle, sub-caliber crew proficiency course): Latrine and target house in pit(4); latrine at rear of range(2); stationary and moving target, length 60 m (197 ft); tramway-cableway towing mechanism, gas engine, steel wire target tow(5), standard gage railroad track, protective revetment length of track.
12	215858	At Range 11 (M60 machine gun zero): Latrine(2); range storage shed(5), concrete, frame, temporary.
13	217858	At Range 13 (90 mm and 106 mm recoilless rifle sub-caliber): Moving target, length 200 m (656 ft); tramway-cableway towing mechanism, wooden ties, steel straps for carts, temporary.
14	221857	At Range 15 (M60 machine gun and automatic rifle): Latrine(2); range storage shed(3),concrete, frame, composition shingles, temporary.
15	227860	At Range 17 (NRA pistol range): Sheltered fire line, length 76 m (250 ft), depth 1.8 m (6 ft), wall and roof, wood, temporary; range storage shed(3); target storage building, northeast of Range 17(3).
16	233852	At Range 29 (shotgun range): Latrine(2); target shed(4).
17	236843	At Range 30 (bayonet assault course): Wall, length 100 m (328 ft), height 2.4 m (8 ft); trench with boardwalk, length 10 m (33 ft), width 71.7 cm (28 in), wood; steel and concrete mounted parrying targets; earth berm, length 100 m (328 ft), height 3.6 m (12 ft), width 3.6 m (12 ft) bottom, 1.2 m (4 ft) top, backed by another set of mounted targets.
18	235839	At Range 31 (unused): Range storage shed, 11.9 m^2 (128 ft^2)(6), wood, frame, temporary.
19	239830	At Range 35 (hand grenade): Latrine(2); control bunker, length 3.7 m (12 ft), depth 2.4 m (8 ft), concrete block with plexiglass viewing window; ten throwing bays, height 1.2 m (4 ft), 0.5 m^2 (6 ft^2) each, reinforced concrete.
20	240826	At Range 37 (81 mm and 107 mm mortar practice): Two moving targets, standard gage, length 9.1 m (30 ft) each track; tramway-cableway towing mechanism.
21	239819	At Range 41 (14.5 mm sub-caliber trainer artillery): Latrine(2).
22	235807	At Range 43 (rifle marksmanship record fire): Latrine(2); range storage shed, 22.3 m^2 (240 ft^2)(7), concrete, concrete block, composition shingles; control tower, height 4.9 m (16 ft), base 5.9 m^2 (64 ft^2)(8), wood, temporary.
23	222805	At Range 45 (known distance): Latrine(2); range storage shed(6).
24	200805	Two oxidation ponds-raw sewage lagoons: capacity 283,875 liters (75,000 gal), earth and concrete, permanent.
25	206809	Pumping station, potable water: 108.6 m^2 (1944 ft^2), concrete, concrete block, built-up, permanent.
26	205809	Elevated water tank: capacity 1,892,500 liters (500,000 gal), all concrete, permanent.
27	196823	At Range 49 (rifle marksmanship field firing): Latrine, 39.3 m^2 (423 ft^2)(9), concrete, concrete block, built-up; control tower(8).
28	192827	At Range 47 (NRA pistol range-competitive): Target storage shed, 8 m^2 (87 ft^2), wood, frame, temporary.
29	196827	At Range 51 (rifle marksmanship zero and night firing): Range storage shed(1); control tower(8).
30	193828	At storage area south of Range 54: Two igloo-style general storehouses, 171.87 m^2 (1850 ft^2) each, all concrete, permanent; one general storehouse, 253.4 m^2 (2728 ft^2), concrete, built-up, temporary.
31	197830	At Range 55 (rifle marksmanship zero and night firing): Latrine(2); range storage shed, 26.8 m^2 (288 ft^2)(10), concrete, concrete block, temporary; control tower(8).
32	197835	At Range 57 (rifle marksmanship field firing): Range storage shed, 22.3 m^2 (240 ft^2)(11), concrete, concrete block , built-up, temporary; control tower(8).
33	196837	At Range 59 (rifle marksmanship zero and night firing): Latrine(9); range storage shed(10); control tower(8).
34	196838	At Range 61 (rifle marksmanship field firing (M16 automatic rifle range superimposed)): Range storage shed(10); control tower(8).
35	194841	At Range 63 (rifle marksmanship field firing): Latrine(9); control tower(8).
36	195841	At Range 65 (rifle marksmanship zero and night firing): Range storage shed, 85.3 m^2 (918 ft^2), concrete, frame.
37	195846	At Range 67 (infiltration course): Latrine(2); control tower(8) with siren mounted on roof; floodlights on 10.6 m (35 ft) high wooden telephone poles; four machine gun mounts, in concrete pads, 0.37 m^2 (4 ft^2), 1 m (3 ft) deep.
38	199857	At Range 69 (rifle marksmanship record fire): Latrine(9); range storage shed(7); control tower(8).

MAP NUMBER	GRID REFERENCE	DESCRIPTION
39	177836	At Range 71 (chemical munitions): Latrine, skid mounted wooden, temporary; range storage shed(6); chemical mixing pad, 9.2 m^2 (100 ft^2), concrete slab with wooden shed over it, temporary.
40	169829	Abandoned airstrip: 1816.6 m (5960 ft) mean sea level, length 499.9 m (1610 ft), width 15.2 m (50 ft), azimuth 80°-265°, sod/gravel surface, no known obstructions.
41	178818	Wilderness ammunition storage area: Fourteen igloos, all permanent concrete, twelve of which are 229.6 m^2 (2471 ft^2), two of which are 197.6 m^2 (2127 ft^2); two ordinance administration buildings, one 94.1 m^2 (1013 ft^2), concrete, concrete block, composition shingles, permanent, one 29.7 m^2 (320 ft^2), concrete, frame, temporary; three flammable materials storage buildings, two 39.8 m^2 (428 ft^2), one 20.8 m^2 (224 ft^2), wood, frame and metal, metal, temporary; one small arms pyrotechnics magazine, 1114.8 m^2 (12,000 ft^2), concrete, metal, permanent; one sentry station, 5.9 m^2 (64 ft^2), wood, frame, composition shingles, temporary; one fuse detonator magazine, 109.4 m^2 (1177 ft^2), concrete, concrete block, built-up, permanent.
42	160822	At Range 36 (TOW trainer range (non-firing)): Range storage shed, 16.7 m^2 (180 ft^2), wood, temporary.
43	154812	Water pumphouse, potable: 9 m^2 (97 ft^2), concrete, concrete block, composition shingles, temporary structure.
44	144811	Water pumphouse: 13.4 m^2 (144 ft^2), concrete, concrete block, temporary.
45	141812	Rod and Gun Club: 567.4 m^2 (6107 ft^2), concrete, frame, recreational use, temporary.
46	137811	Two Girl Scout buildings: one 67 m^2 (722 ft^2), one 74.3 m^2 (800 ft^2).
47	208784	General storehouse: 188.6 m^2 (2030 ft^2), concrete, frame, composition shingles, temporary.
48	207784	Water pumphouse, potable: 9.3 m^2 (100 ft^2), concrete, frame, temporary.
49	135779	Abandoned airstrip "A": 2042.2 m (6700 ft) mean sea level, runway length 701 m (2300 ft), width 15.2 m (50 ft), azimuth 140°-320°, sod/gravel surface, no known obstructions.
50	198758	At Range 101 (combat in fortified and built-up areas): Mock village; single street, 150 m (492 ft) long, facade of plywood construction in poor condition.
51	207760	At Range 103 (recoilless rifle 90 mm and 106 mm): Latrine(2); ten concrete firing pads, each 4.2 m^2 (45 ft^2), 30.5 cm (12 in) thick.
52	210761	At Range 105 (tank crewman gunnery qualification, 165 mm gun CEV): Control building, 8.9 m^2 (96 ft^2), wooden shed, temporary; sight synchronization pad, length 13.4 m (44 ft) x width 4.5 m (15 ft), 30.5 cm (12 in) thick.
53	216752	At crew served weapons (overflow range): Latrine(2); gravelled firing berm, length 50 m (164 ft).
54	222741	At Range 109 (tank crewman gunnery qualification and direct fire (Tank Table V and VI)): Latrine, 34.6 m^2 (372 ft^2), concrete, concrete block, built-up, permanent; messhall, 155 m^2 (1668 ft^2)(12), concrete, concrete block, built-up, permanent; control tower, height 2.8 m (30 ft), base 1.2 m (13 ft) x 1.2 m (13 ft)(13), steel, wood, glass, permanent; ammunition loading dock, length 25 m (82 ft) x 3 m (10 ft) wide, approximately 30.5 cm (12 in) thick concrete slab; equipment storage building(11). Also see Map Number 110.
55	229742	At Range 111 (caliber 0.50 machine guns and under crew served weapons): Latrine(2). See Map Number 111.
56	243734	At Range 113 (caliber 0.50 machine guns and under crew served weapons): Latrine(2); moving target, (see Map Number 13), length 150 m (492.2 ft); target house, 37.2 m^2 (400 ft^2), concrete, frame, temporary.
57	244731	At Range 113A: Permanent bleachers, 2 sets, capacity 140 men, all concrete(14); target roadbed, gravel, length 120 m (393.7 ft), width 45.7 cm (18 in), mean thickness 30.5 cm (12 in).
58	244724	At Range 115A (M79 and M203, 40 mm grenade launcher): Latrine(9); earthblown bunkers for target protection.
59	244717	At Range 115 (transition firing (M60 machine gun and artillery)): Latrine(9); control tower(13); range storage shed(11); equipment drop shed, 147.6 m^2 (512 ft^2)(15), steel post, built-up, permanent; six ammunition storage points, made of concrete pipe sections, height 1.2 m (4 ft), concrete, permanent; bleachers, 3 sets(14), capacity 210 men; earth berm, length 50 m (164 ft), height 1.5 m (5 ft), width 3 m (9.8 ft) top, 4.5 m (14.8 ft) bottom.
60	235696	At Range 119A: Gravel firing berm, length 200 m (656.2 ft), width 3.7 m (12 ft), 15 cm (5.9 in) thick.
61	238694	At Range 117 (technique of fire): Latrine(2); three bunkers, 2.2 m^2 (24 ft^2) each, for target operation, wooden, earth reveted; range storage building(11).
62	238692	At Range 119 (tank crewman machine gun field firing): Control tower(8); moving and stationary targets. See Map Number 112.
63	241674	At Range 153 (35 mm sub-caliber LAW): Latrine(9); fire line, length 300 m (984.3 ft), width 2.4 m (8 ft), 30.5 cm (12 in) thick, gravel; scoring dock(18) with upright wall, length 6 m (20 ft), height 4.3 m (14 ft), walkway 0.9 m (3 ft) wide, concrete; concrete pad, 10.7 m (35 ft) long, 9.1 m (30 ft) wide; two moving target tracks, (grid references 230672 and 230674), each 100 m (328 ft) long, standard gage(5); two tramway-cableway towing mechanisms.
64	237665	At Range 121 (demolition, blasting, M18 Claymore, mines, fuses, and antipersonnel mine training): Latrine(2); viewing personnel bunker, concrete, temporary.
65	212661	At Range 123 (high performance aircraft live fire): Latrine(2) (grid reference 216653); control tower, height 25.9 m (85 ft), base 6.1 m (20 ft) x 6.1 m (20 ft), wood/steel, temporary.
66	162665	Abandoned airstrip "D": 1851.7 m (6075 ft) mean sea level, runway length 838.2 (2750 ft), width 15.2 m (50 ft), azimuth 140°-320°, sod surface, no obstructions.
67	157684	Abandoned airstrip "C": 1914 m (6280 ft) mean sea level, runway length 640.1 m (2100 ft), width 15.2 m (50 ft), azimuth 140°-320°, sod surface, obstructing wires north and south.
68	151705	At Range 127 (close combat): Range storage shed(3).
69	155726	At Range 129 (mechanized infantry rifle squad combat and scout squad proficiency course): Latrine(9); moving target track, length 100 m (328 ft), standard gage(5), earth reveted, (grid reference 163721).
70	160740	At Range 133 (squad defense and platoon defense): Latrine(9); control tower(13); equipment drop shed(15); range storage shed(11); four ammunition storage points made of concrete pipe sections, height 1.2 m (4 ft), concrete, permanent; six 2-man fire pits, 2.2 m^2 (24 ft^2), concrete; four moving silhouette targets, length 150 m (492 ft) each, chain-link driven.

L. NON-URBAN CULTURE FEATURES (Continued)

MAP NUMBER	GRID REFERENCE	DESCRIPTION
71	156739	At Range 131 (squad attack and platoon attack course): Latrine(9); messhall(12); control tower(13); sand table 4.8 m (16 ft) long, 3.7 m (12 ft) wide; four ammunition storage points made of concrete pipe sections, height 1.2 m (4 ft), concrete, permanent; bleachers, 4 sets, capacity 210 men each(14); equipment storage shed(15); range storage shed(11).
72	160742	At Range 135 (squad technique of fire): Latrine(9); messhall(12); control tower(8); bleachers, 1 set, capacity 210 men(14); equipment drop shed, 59.5 m^2 (640 ft^2), concrete, steel posts, metal, permanent; range storage shed(11); water storage tank under wooden shed, 28 m^3 (1000 ft^3) capacity.
73	161746	At Range 137 (squad battle drill): Latrine(9); control tower(13); bleachers, 2 locations, each capacity 210 men(14); equipment drop shed(15); range storage shed(11).
74	182762	At Range 139 (66 mm LAW rocket launcher and M202A1 multiple launch flamethrower): Latrine(2); firing berm, length 30 m (98.4 ft), width 2.4 m (8 ft), 30.5 cm (12 in) thick gravel.
75	185762	At Range 141 (firepower demonstration): Latrine (M&F)(9); storage shed 8.9 m^2 (96 ft^2), wood, temporary.
76	134738	Abandoned airstrip "B": 1987.3 m (6520 ft) mean sea level, runway length 502.9 m (1650 ft), width 15.2 m (50 ft), azimuth 140°-320°, sod surface, obstructing wires east side.
77	103733	At Turkey Creek Ranch (all buildings are temporary): Recreation building, 390.2 m^2 (4200 ft^2), concrete, frame and stucco, clay tile; detached garage, 62.7 m^2 (675 ft^2), concrete, frame and stucco, clay tile, built-up; youth center, 95.1 m^2 (1024 ft^2), concrete, logs, composition shingles; two detached latrines, each 18.9 m^2 (203 ft^2), concrete, concrete block, composition shingles; fire station, 233.4 m^2 (2512 ft^2), concrete, frame and stucco, wood; pumphouse, 18.6 m^2 (200 ft^2), all concrete; elevated water storage tank, semi-permanent, capacity 27,252 liters (7200 gal), concrete and wood.
78	103731	At Turkey Creek Ranch, continued: Three general storehouses, one 111.5 m^2 (1200 ft^2), one 459.9 m^2 (4950 ft^2), and one 178.4 m^2 (1920 ft^2), concrete, frame, composition shingles; two riding stables, one 186.2 m^2 (2004 ft^2), wood, frame, metal, and one 326.1 m^2 (3510 ft^2), concrete, frame, wood, composition shingles; corral with feed silo; Boy Scout building, 92.9 m^2 (1000 ft^2), concrete, concrete block, composition shingles; recreation area; mini-town: Fort Turkey.
79	099717	Windmill tower, 9.4 m (31 ft) high; fan, 2.4 m (8 ft) in diameter, steel; Aerometer; storage tank, 6.1 m (20 ft) long x 1.2 m (4 ft) wide; stock tank, 2.9 m (9.5 ft) long x 0.6 m (2 ft) wide; nonoperational.
80	132712	Windmill tower.
81	110690	Windmill tower, 7.8 m (25 ft) high; disconnected fan, bent blades; nonoperational.
82	057689	Windmill tower, 7.9 m (26 ft) high; fan, 2.4 m (8 ft) in diameter, steel; Dempster #12; storage tank, 6.1 m (20 ft) long x 1.4 m (4.5 ft) wide; stock tank, 2.1 m (7 ft) long x 0.6 m (2 ft) wide; operational.
83	105670	Windmill tower, 6.6 m (21.5 ft) high; fan, 2.4 m (8 ft) in diameter, steel; Aerometer; storage tank, 6.4 m (21 ft) long x 1.2 m (4 ft) wide; stock tank, 2.1 m (7 ft) long x 0.6 m (2 ft) wide; nonoperational.
84	095649	Windmill tower, 9 m (29.5 ft) high; fan, 3 m (10 ft) in diameter, steel; Aerometer; storage tank, 7.6 m (25 ft) long x 1.5 m (5 ft) wide; nonoperational.
85	073636	At Camp Devil (all buildings of temporary construction): Three general instruction buildings, one 423.5 m^2 (4558 ft^2), concrete, concrete block and frame, built-up, one 99.1 m^2 (1067 ft^2), one 124.5 m^2 (1340 ft^2), both concrete, wood; messhall, 371.6 m^2 (4000 ft^2), concrete, metal; two sheds, one 167.2 m^2 (1800 ft^2), wood posts, metal, and one 89.4 m^2 (962 ft^2), concrete, piers, wood posts, metal; two classroom buildings, each 142.5 m^2 (1440 ft^2), concrete, metal and frame; water storage with pump station, 12 m^2 (128 ft^2); water treatment pumphouse, 3.7 m^2 (40 ft^2), concrete, frame; detached lavatory, 46.5 m^2 (500 ft^2); lavatory (pit), 16.8 m^2 (181 ft^2), all concrete; rapelling tower, height 12.2 m (40 ft), wood; 142 concrete slabs for tent city, each 12.2 m (40 ft) long x 7.6 m (25 ft) wide x 30.5 cm (12 in) thick.
86	048638	Radio communications relay.
87	056637	Observation tower.
88	109626	Windmill tower, 9.1 m (30 ft) high with fan; storage tank, 11.6 m^2 (125 ft^2); operational.
89	118616	Observation tower.
90	072609	Windmill tower, 7.8 m (25.5 ft) high; fan, 3 m (10 ft) in diameter, steel; Aerometer; storage tank, 6.4 m (21 ft) long x 1.2 m (4 ft) wide; stock tank, 2.3 m (7 ft) long x 0.5 m (1.7 ft) wide; nonoperational.
91	037602	Windmill tower, 9.1 m (30 ft) high; fan, 3 m (10 ft) in diameter, steel; Aerometer; stock tank, 4.6 m (15 ft) long x 0.6 m (2 ft) wide; nonoperational.
92	089575	Windmill tower.
93	059563	Windmill tower, 7.9 m (26 ft) high; fan, 3 m (10 ft) in diameter, steel; Aerometer; storage tank, 7.6 m (25 ft) long x 1.5 m (5 ft) wide; stock tank, 3 m (10 ft) long x 0.6 (2 ft) wide; nonoperational.
94	085551	Windmill tower, 9.3 m (30.5 ft) high; fan, 3 m (10 ft) in diameter, steel; Aerometer; stock tank, 9.4 m (31 ft) long x 0.6 m (2 ft) wide; nonoperational.
95	057537	Observation tower.
96	081525	Windmill tower, 9.4 m (32 ft) high; fan, 2.4 m (8 ft) in diameter, steel and wood; Dempster #12; stock tank, 0.9 m (3 ft) long x 0.4 m (1.5 ft) wide; operational.
97	106545	Windmill tower, 9.4 m (31 ft) high; fan, 3 m (10 ft) in diameter, steel; Butler Co.; storage tank, 7.6 m (25 ft) long x 1.5 m (5 ft) wide; stock tank, 5.8 m (19 ft) long x 0.6 m (2 ft) wide; nonoperational.
98	124555	Rock crusher, abandoned.
99	142540	Calciner plant, abandoned.
100	From To 171905/200899	Fencing: 19,018 m (62,400 linear ft), chain-link, perimeter, north of cantonment area.
101	177612	Windmill tower, 9.8 m (32 ft) high; fan, 3.7 m (12 ft) in diameter, steel; Dempster #12; stock tank, 9.8 m (32 ft) long x 6.7 m (22 ft) wide; nonoperational.
102	185575	At Range 155, (Tank Table IX): Moving target track, length 60 m (196.9 ft), (grid reference 191588); 20 kg (45 lb) to 40.8 kg (90 lb) test cable; protective revetment length of track.
103	174571	At Range 143, (Tank Table VII): Latrine(9); messhall, 163.2 m^2 (1757 ft^2), concrete, concrete block, built-up, permanent; control building, 11.1 m^2 (120 ft^2), concrete, has downrange control and demonstration electrical control panel; pumphouse, 11.9 m^2 (128 ft^2), all concrete; ammunition loading dock, 53.5 m^2 (576 ft^2), all concrete, permanent; scoring dock(18); equipment storage building(11); site synchronization pad (grid reference 183567), length 13.4 m (44 ft), width 4.2 m (15 ft), 30.5 cm (12 in) thick; range house, 23.6 m^2 (254 ft^2), concrete, concrete block, built-up; two personnel bunkers, 9.2 m^2 (100 ft^2), concrete, concrete block; two equipment bunkers with underground cable, 1.5 m^2 (16 ft^2); two equipment bunkers, 18.5 m^2 (200 ft^2), with steel doors. See Map Number 113.
104	168546	Windmill tower.
105	207545	At Range 145, (Tank Table VIII): Latrine(9); messhall,163.2 m^2 (1757 ft^2), concrete, concrete block, built-up, permanent; target storage(11); pumphouse, 12 m^2 (128 ft^2), all concrete; ammunition loading dock, 53.5 m^2 (576 ft^2), all concrete, permanent; range house, 23.6 m^2 (245 ft^2), concrete, concrete block, built-up, permanent; scoring dock(18); two personnel bunkers, 9.2 m^2 (100 ft^2), concrete, concrete block; two equipment bunkers with underground cable, 1.5 m^2 (16 ft^2); two equipment bunkers, 18.5 m^2 (200 ft^2), with steel doors. See Map Number 114.
106	200533	At Range 147 (chaparral): Latrine (M&F)(9).
107	199529	Windmill tower, 5.6 m (18.5 ft) high; fan, 3 m (10 ft) in diameter, steel; David Bradley WD21/802-10; four stock tanks, each 3 m (10 ft) long x 0.6 m (2 ft) wide; nonoperational.
108	175533	Radio tower: 15.2 m (50 ft) high.
109	166530	Radio tower: 30.5 m (100 ft) high.
110	214727	At Range 109 (Tank Table V and VI): Converted jeep-towing mechanism moving target track, length 2700 m (8858.7 ft); protective revetment, (A) height 3.6 m (12 ft), width 4.3 m (14 ft); (B) height 3 m (10 ft), width 4.3 m (14 ft). Also see Map Number 54.
111	223724	Moving target track: Length 400 m (1232.4 ft), tramway-cableway towing mechanism, single direction railroad, standard gage mine rails, 8.2 kg (18 lb) test steel cable, gasoline Continental 4 cylinder engine; protective revetment 400 m (1232.4 ft) long; car shelter(16).
112	232694	At Range 119: Length 400 m (1232.4 ft), tramway-cableway cart-towing mechanism, single direction railroad, standard gage(5) rail, 8.2 kg (18 lb) test steel cable, gasoline Continental 4 cylinder engine; protective revetment length of track.
113	172585 (A) 179582 (B)	At Range 143 (Tank Table VII): Converted jeep-towing mechanism; moving target track, (A) length 1000 m (3281 ft), (B) length 1000 m (3281 ft); protective revetment (contour conforming), (A) height 2.4 m (8 ft), width 3.6 m (12 ft), (B) height 4.5 m (15 ft), width 3.6 m (12 ft); vehicle storage(17).
114	196577 (A) 204566 (B)	At Range 145 (Tank Table VIII): Converted jeep-towing mechanism; moving target track, (A) length 1000 m (3281 ft), (B) length 1000 m (3281 ft); protective revetment, (A) height 3 m (10 ft), width 3.6 m (12 ft), (B) height 3.6 m (12 ft), width 3.6 m (12 ft); vehicle storage(17).
115	From To 198863/205810	Cable, underground: Range communication line.
	198863/173668	Range communication line: Post distribution, mainly aluminum lines (with some copper lines) on wooden poles 7.6 to 9.1 m (25 to 30 ft) high, class 5 or 6.
	123747/170572	Range communication line: Post distribution, mainly aluminum lines (with some copper lines) on wooden poles 7.6 to 9.1 m (25 to 30 ft) high, class 5 or 6.
	094615/119620	Range communication line: Post distribution, mainly aluminum lines (with some copper lines) on wooden poles 7.6 to 9.1 m (25 to 30 ft) high, class 5 or 6.
	203665/238651	Range communication line: Direct underground burial.
	198863/220774	Range communication line: Post distribution, mainly aluminum lines (with some copper lines) on wooden poles 7.6 to 9.1 m (25 to 30 ft) high, class 5 or 6.
	220774/168568	Range communication line: On power poles, 9.1 m (30 ft) high.
	196810/162744	Range communication line: On power poles, 9.1 m (30 ft) high.
116	167872/233862	Simia underground telephone: AT and T owned,(abandoned).
117	159860/247798	Truckton underground telephone, (abandoned).
118	138818/247650	Lamar underground telephone, (abandoned).
119	190864/206810	Pipeline, underground: Post internal distribution, gas to Butts AAF.
	190863/205810	Pipeline, underground: Post internal distribution, water to Butts AAF.
120	195845/197787	Power line: Post distribution on wooden poles, 7.6 to 10.6 m (25 to 35 ft) high.
	196823/235806	Three #6 aerial copper wire conductors (ACWC).
	195818/180823	Two #4 aerial aluminum cable, steel reinforced (ACSR), 72kV.
	197787/160737	Four #2 ACSR, 7200/12470Y primary.
	220774/168568	Four #2 ACSR, 7200/12470Y primary.
121	100742/117721	Power line: Turkey Creek Ranch, Southern Colorado Power Company owned, 3 Ø, 4 wire-4-4# ACSR 7.6/13.2kV, poles 10.6 m (34 ft) high.
122	048680/071639 071635/074637	Power line: Camp Devil, Southern Colorado Power Company owned, 3 Ø, 4 wire-4-4# 1/10 ACSR 7.6/13.2kV, poles 10.6 m (35 ft) high, insulated for 23kV.
123	070633/081612	Power line: Government owned.
124	036540/231537	Power line: Bureau of Reclamation, three-1272 million circular mils (MCM) and ACSR, 230kV, 6.35 cm (2.5 in) steel overhead groundwire on 15.2 m (50 ft) steel towers.
125	203665/238651	Power line: Post distribution, single phase, underground direct burial.

Footnotes:

(1) Range storage shed: 74.3 m^2 (800 ft^2), concrete, concrete block, temporary.

(2) Latrine, small: 4.5 m^2 (48 ft^2), wood, temporary.

(3) Storage shed: 74.3 m^2 (800 ft^2), concrete, concrete block, built-up, temporary.

(4) Target storage building: 107 m^2 (1152 ft^2), concrete, concrete block, built-up, temporary.

(5) Moving target tracks: standard gage 144 cm (56.5 in), 20 kg (45 lb) test and 40.8 kg (90 lb) test steel rails; majority are standard railroad ties.

(6) Range storage shed: 11.9 m^2 (128 ft^2), wood, frame, temporary.

(7) Range storage shed: 22.3 m^2 (240 ft^2), concrete, concrete block, composition shingles, temporary.

(8) Control tower: height 4.9 m (16 ft), base 5.9 m^2 (64 ft^2), wood, temporary.

(9) Latrine, large: 39.3 m^2 (423 ft^2), concrete, concrete block, built-up, temporary.

(10) Range storage shed: 26.8 m^2 (228 ft^2), concrete, concrete block, temporary.

(11) Range storage shed: 28.2 m^2 (304 ft^2), concrete, concrete block, built-up, permanent.

(12) Messhall: 154.9 m^2 (1668 ft^2), concrete, concrete block, built-up, permanent.

(13) Control tower, type A: height 9.1 m (30 ft), base 15.7 m^2 (169 ft^2), steel, wood, glass, permanent.

(14) Permanent bleachers, 70 man capacity-1 set: 3.7 m (12 ft) wide, 4 m (13 ft) high, 5.9 m (19.3 ft) deep, concrete, steel, wooden seats; roof 22 gage corrugated zinc-coated steel.

(15) Equipment drop shed: 47.5 m^2 (512 ft^2), steel posts, built-up, permanent.

(16) Vehicle storage-car shelters (moving target tracks extend 60.9 to 91.4 m (200 to 300 ft) to car shelters): Tank Table V, type I, 5 m (16.5 ft) wide, 9.7 m (32 ft) deep, 2.1 m (7 ft) above grade, slab concrete, earth reveted, top grade 1:1, slope 45°.

(17) Vehicle storage-car shelters (moving target tracks extend 60.9 to 91.4 m (200 to 300 ft) to car shelters): Tank Table VII and VIII, type II, 4.3 m (14 ft) wide, 11.6 m (38 ft) deep, 2.1 m (7 ft) above grade, slab concrete, earth reveted, top grade 1:1, slope 45°.

(18) Scoring dock: Upright wall length 6 m (20 ft), height 4.3 m (14 ft); walkway 1 m (3 ft) wide, concrete; concrete pad length 10.7 m (35 ft) x width 9.1 m (30 ft).

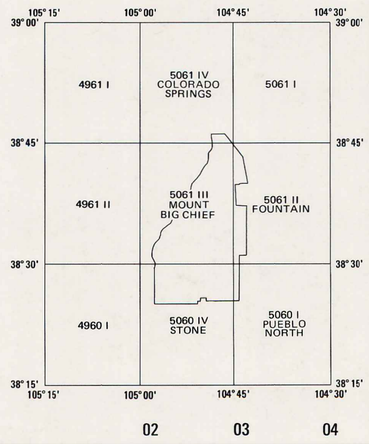
FORT CARSON, COLORADO
TERRAIN ANALYSIS

NON-URBAN CULTURE FEATURES

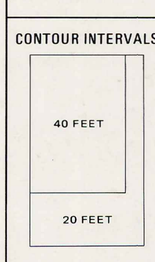
- Building
- Windmill/Windpump
- Tower (Observation, Guard, Range)
- Radio Tower
- Water Tower
- Recreation Area
- Abandoned Airstrip
- Permanent Bleachers
- Ammunition Dump
- Launcher Site
- Gas Chamber
- Sanitary Landfill
- Power Substation
- Mock Village
- Oxidation Pond
- Observation Bunker
- Pump Station
- Ruins
- Moving Target
- Telephone Line
- Underground Cable (telephone)
- Underground Cable (power)
- Pipeline (underground)
- Wall
- Fence
- Power Line (above ground)

Note: Symbol numbers on map refer to entries in table.

INDEX TO SHEETS
SERIES V777
1:50,000
SCALE



CONTOUR INTERVALS



01 02 03 04

Prepared by Dames & Moore, Washington, D.C., under the direction of the Terrain Analysis Center, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. January 1978.

Scale 1:50,000

1000 500 0 1000 2000 3000 4000 5000 Meters

1 ½ 0 1 2 3 Statute Miles

4250 000m N.

5 00 000m E.

III. OFF-POST FEATURES

A. AIRFIELDS

Two airfields within a 50-mile radius of Fort Carson will support aircraft as large as C-130A's. The City of Colorado Springs Municipal Airport (formerly Peterson Field) is approximately 8 kilometers (5 miles) northeast of Fort Carson; Pueblo Memorial Airport is approximately 68 kilometers (42 miles) southeast of the cantonment area.

The City of Colorado Springs Municipal Airport primarily accommodates private and commercial flight operations. In addition, the U.S. Air Force rents part of the airport from the City of Colorado Springs through a joint-use agreement. Civil aviation operated hangars, their associated parking aprons, maintenance facilities, and refueling operations are commercially owned. The terminal building and its parking apron are city owned and leased to the air carriers. These civilian facilities would be available for military use only during a declared National emergency. The U.S. Air Force (Peterson AFB) uses most of the buildings, ramps, and taxiways on the northeast side of the airport.

Pueblo Memorial Airport is a regional commercial airport serving the Spanish Peaks Region of Colorado. One air carrier offers limited intrastate and interstate service.

There are no military or commercial ports within a 100-mile radius of the reservation.

MAP NUMBER AND/OR NAME; LOCATION; TYPE; AND CLASSIFICATION	ELEVATION; AND STATUS	RUNWAY DESCRIPTION	TAXIWAY, PARKING, APRON, AND HARDSTAND AREA DESCRIPTION	BUILDING DESCRIPTION	POL FACILITIES	NAVIGATIONAL AIDS	REMARKS
1. City of Colorado Springs Municipal Airport; 38°49'N, 104°43' W; Airfield; Civil airport, joint-use facility with U.S. Air Force, Peterson AFB, as tenant of the city.	1881m (6172 ft); operational.	North-south runway: 3356.8 x 45.7 m (11,013 x 150 ft); azimuth, 170°-350°; maximum weight bearing capacity S115, T175, ST175, TT345*; asphalt surface. Northwest-southeast runway: 2594.2 x 45.7 m (8511 x 150 ft); azimuth, 120°-300°; maximum weight bearing capacity S85, T110, TT180; asphalt surface. Northeast-southwest runway: 2552.4 x 45.7 m (8374 x 150 ft); azimuth, 30°-210°; maximum weight bearing capacity same as northwest-southeast runway; asphalt surface.	SHARED FACILITIES Taxiways: Approximately 10; 22.9 m (75 ft) wide; maximum weight bearing capacity TT350, except main runway (north-south) taxiway's weight bearing capacity is TDT775; asphalt surface. CIVILIAN FACILITIES Parking area, Apron, and Hardstand: 30,657 m^2 (330,000 ft^2) approximate total area; maximum weight bearing capacity same as north-south runway; asphalt surface. MILITARY FACILITIES Parking area, Apron, and Hardstand: 230,763.6 m^2 (2,484,000 ft^2) total area; of which 121,234.5 m^2 (1,305,000 ft^2) has weight bearing capacity TT350 and surface of 8.9 cm (3.5 in) coal tar over 15.2 cm (6 in) concrete, 36,370.4 m^2 (391,500 ft^2) has weight bearing capacity TT350 and 25.4 cm (10 in) concrete surface, 35,534.2 m^2 (382,500 ft^2) has weight bearing capacity TT350 and 7.6 cm (3 in) asphalt surface, 20,902.5 m^2 (225,000 ft^2) has weight bearing capacity S20 and 5.1 cm (2 in) asphalt surface, 4180.5 m^2 (45,000 ft^2) has weight bearing capacity TT660 (no data on surface material), 12,541.5 m^2 (135,000 ft^2) can handle C5's, but use is on an emergency basis only (no specific weight bearing capacity, no data on surface material).	CIVILIAN FACILITIES Hangars: All 5 hangars on the civilian side of the airport are commercially owned, few data available; one owned by State Game and Fish; one owned by Colorado Interstate Corporation; Maytag hangar, 1449 m^2 (15,600 ft^2) area; other owners names not available. Administration and Terminal building: City owned; old terminal stucco and stone faced, approximately 2322.5 m^2 (25,000 ft^2); new addition completed summer 1977, twin-T concrete, approximately 4645 m^2 (50,000 ft^2). MILITARY FACILITIES Hangars: 13 hangars, one 4552.1 m^2 (49,000 ft^2), one 1950.9 m^2 (21,000 ft^2), one 1765.1 m^2 (19,000 ft^2), one 1300.6 m^2 (14,000 ft^2), four 1291.3 m^2 (13,900 ft^2), one 1142.7 m^2 (12,300 ft^2), one 1068.4 m^2 (11,500 ft^2), one 808.2 m^2 (8700 ft^2), two 464.5 m^2 (5000 ft^2); all have concrete floors, seven have transite walls, five have corrugated sheet metal walls, one has concrete walls. Maintenance facilities: Total 14 facilities, 8 are in hangars. Administration and Terminal building: Base operations, building number 122, 1858 m^2 (20,000 ft^2) floor space, contains FAA tower and weather detachment.	SHARED FACILITIES The same fuel trucks are used by both civilian and military operations. Jet fuel: one 15,140 liter (4000 gal) truck, three 12,375 liter (3300 gal) trucks, one 7570 liter (2000 gal) truck. Low lead fuel: two 7570 liter (2000 gal) trucks, one 5866.8 liter (1550 gal) truck. CIVILIAN FACILITIES Jet fuel type A; underground storage 227,100 liters (60,000 gal). Low lead fuel grade 100; underground storage 90,840 liters (24,000 gal). Hedrick Beachcraft provides contract fuel services. MILITARY FACILITIES U.S. aviation fuel (MILSPECS) 115/145 JP-4; 11 underground tanks, total capacity 923,540 liters (244,000 gal); one aboveground tank, 757,000 liters (200,000 gal). MoGas (for motor pool); one underground tank at POL tank farm, 45,420 liters (12,000 gal); four underground tanks at motor pool, total capacity 105,980 liters (28,000 gal). Diesel fuel; one underground tank at POL tank farm, 45,420 liters (12,000 gal); one underground tank at motor pool, 37,850 liters, (10,000 gal). Pumps; most JP-4 dispensed by eight 473 lpm (125 gpm) pumps; some JP-4, MoGas, and diesel dispensed by five 1135.5 lpm (300 gpm) pumps; motor pool has three 94.6 lpm (25 gpm) pumps.	Control tower: 19.8 m (65 ft) high including antenna. VORTAC, unuseable 200°-300° beyond 42 km (26.1 mi) below 4754.9 m (15,600 ft) and 300°-040° beyond 28 km (17.4 mi) below 2895.6 m (9500 ft); ILS. Lights: Clear and green rotating beacon; north-south runway has high intensity runway lights; northwest-southeast runway has medium intensity lights; northeast-southwest runway unlighted; all taxiways reflector marked only; sequenced flashing lights; visual approach slope indicator system; runway end identifier lights.	Extensive construction in vicinity of civilian terminal building. New control tower, 41.1 m (135 ft) high, to be completed in 1979. Most civil aviation activities confined to west side of airport; most buildings, ramps, and taxiways on northeast side leased to U.S. Air Force. U.S. Air Force has use of all runways and taxiways. Peterson AFB flight service very limited. Landing of C5's is on "emergency only" basis. Caution: instrument T-41 aircraft student training surface to 3352.8 m (11,000 ft) within 42 km (26.1 mi); unmonitored light aircraft glide-tow plane activity 12.9 km (8 mi) north; do not mistake well lighted street parallel to north-south runway, nor Garden Valley Airport, for Colorado Springs; rising terrain approach end northwest-southeast runway; jet aircraft should require north-south runway for takeoff or landing if within crosswind limitations.
2. Pueblo Memorial Airport; 38°17'N, 104°30' W; Airfield; Civil.	1440 m (4726 ft); operational.	East-west runway: 3200 x 45.7 m (10,497 x 150 ft); azimuth, 70°-250°; maximum weight bearing capacity S130, T150, ST175, TT250*; asphalt surface. North-south runway: 2532.3 x 45.7 m (8308 x 150 ft); azimuth, 170°-350°; same weight bearing capacity as above; asphalt surface. Diagonal runway: 2520 x 45.7 m (8268 x 150 ft); azimuth, 120°-300°; same weight bearing capacity as above; asphalt surface.	Taxiways: 7; 22.9 m (75 ft) wide; maximum weight bearing capacity 113,400 kg (250,000 lb); asphalt surface. Parking area, Apron, and Hardstand: 3734.6 m^2 (40,200 ft^2) total area; maximum weight bearing capacity same as runways except in general aviation areas where it is 18,144 kg (40,000 lb); asphalt and/or concrete surface materials.	Three hangars: One large frame/stucco hangar, 37.2 x 24.4 m (122 x 80 ft), with 7.6 m (25 ft) door. Two metal T-hangars, 68.6 x 18.3 m (225 x 60 ft), with 6.4 m (21 ft) door and 10 stalls each. (See Remarks for additional hangar notes.) Administration and Terminal building: Building T99; concrete block; 1382.4 m^2 (14,880 ft^2) total area; includes 252.4 m^2 (2717 ft^2) restaurant, 306.6 m^2 (3300 ft^2) annex, 167.2 m^2 (1800 ft) weather bureau. Maintenance building: Building T93; approximately 557 m^2 (6000 ft^2) Other buildings: Fire station; concrete block and prestressed concrete; 25.9 x 22.6 m (85 x 74 ft); includes 158 m^2 (1700 ft^2) administration on upper level.	Jet fuel type A-50 with FSII (icing inhibitor); bulk plant 227,100 liter (60,000 gal) capacity; one 7570 liter (2000 gal) refueler; two 15,140 liter (4000 gal) refuelers. Low lead fuel grade 100/130; 68,130 liter (18,000 gal) capacity bulk storage with into-plane capability; two 5677.5 liter (1500 gal) refuelers. Flower Aviation provides contract fuel services.	Control tower: 25.6 m (84 ft) high; with antenna it is 28.2 m (92.7 ft) high. VORTAC; compass locator station at outer marker site; VHF/DF ILS-ILS unmonitored. Lights: Rotating beacon; all runways lighted except 7R-25L; high intensity runway lights; sequenced flashing lights; visual approach slope indicator system; airfield boundary not lighted.	Two additional hangars have been demolished and a third has been converted to industrial use.

*Note: Runway weight bearing capacity in pounds (gross weight of aircraft) is determined by adding 000 to figure following S, T, ST, TT, TDT. Runway weight bearing capacity given is for unlimited operations. Aircraft weight higher than given requires prior permission from aerodrome controlling authority.

S - Runway weight bearing capacity for aircraft with single-wheel type landing gear (C-47, F100).
T - Runway weight bearing capacity for aircraft with twin-wheel type landing gear (C-9A).
ST - Runway weight bearing capacity for aircraft with single-tandem landing gear (C-130).
TT - Runway weight bearing capacity for aircraft with twin-tandem type (includes quadricycle) landing gear (B-52, C-135).
TDT - Runway weight bearing capacity for aircraft with twin-delta tandem landing gear (C-5).

For further information, see DOD Flight Information Publication (enroute IFR-Supplement United States).

B. URBAN AREAS

Ten urban areas within 50 miles of the reservation had 1970 census populations greater than 2500. These areas are concentrated in three population centers, each in a different Colorado county.

The smallest population center includes Canon City, Lincoln Park, and Florence in Fremont County southwest of the reservation. The area is surrounded by mountains and parks which support a year-round tourist industry. Mining and agriculture are also economically important. Expansion, especially in Canon City, is limited by the mountainous topography.

Pueblo, in Pueblo County southeast of the reservation, is the second largest population center and the second largest urban area within 50 miles of Fort Carson. Pueblo is highly industrialized; its principal industry, steel, is supported by the sufficient water resources of the Arkansas River valley and coal from nearby coalfields. Possibilities still exist for industrial expansion.

Neighboring the cantonment area on the north and east is the third and largest population center, which includes Colorado Springs, Manitou Springs, Stratton Meadows, Security, Widefield, and Fountain in El Paso County. The tourist industry and winter sports, including sports centers such as the world famous Broadmoor, with its ski area and Olympic skating arena, are important economic factors in the area. Colorado Springs and Manitou Springs together form the tourist and recreation center of the region. Stratton Meadows, Security, Widefield, and Fountain are residential areas housing many military personnel. The military population also is important to the area's economy; it includes active duty military personnel and retired personnel who located in the area to take advantage of climate, open space, and the availability of Army medical service, commissary, and exchange facilities. This area is one of the most rapidly developing centers in the western United States. Limitations to continued expansion include a shortage of water and restraints on energy resources.

The most recent available data were used to compile the table below.

B. URBAN AREAS (Continued)

NAME AND LOCATION	POPULATION	HOUSING AVAILABILITY	EDUCATIONAL FACILITIES	MEDICAL FACILITIES	RECREATION FACILITIES	UTILITIES AND SERVICES
Canon City, CO 38°26.7'N 105°14.1'W	1970: 9206 1975 est.: 12,791 (1976 data)	Single and Multi-family Dwellings Total units: 3500 Rental units: 525 Vacancy rate: 1 to 2% Average sale price: $38,000 to $42,000 Average rent per month: $175 to $200 (1977 data)	Public Schools (Fremont County School District RE-1) 4 Elementary Schools Enrollment capacity: 2120 1976 enrollment: 1764 1980 projected enrollment: 1730 1 Junior High School Enrollment capacity: 900 1976 enrollment: 920 1980 projected enrollment: 870 1 High School Enrollment capacity: 900 1976 enrollment: 875 1980 projected enrollment: 870 2 sites have been acquired for future school construction. (1977 data) Private Schools 5 Elementary Schools 1975 enrollment: 270 4 Secondary Schools 1975 enrollment: 464 (1976 data) Colleges and Universities Fremont Education Center; extension service of the University of Southern Colorado, Pueblo, Colorado (2-year public university). 1975 enrollment: 180 (1976 data)	1 Hospital (St. Thomas More Hospital) 60 beds 4 bed ICU/CCU* Plans to remodel and to expand ICU. (1977 data) 6 Nursing homes 370 beds 1 Mental health clinic Doctors Total: 22 Doctor/population ratio: 1/581† Dentists Total: 9 Ratio: 1/1421† (1976 data)	11 Parks 1 Softball field 6 Tennis courts 2 Nine-hole golf courses (1 private, 1 public) 2 Swimming pools (1 private, 1 public) 1 Bowling alley 20 lanes 2 Movie theaters (1 outdoor, 1 indoor) 3 Museums 1 Art gallery (1976 data)	Electric Southern Colorado Power Company generating station in Canon City and 2 other stations in the region; adequate supply; no plans to expand. Heating Fuels Natural gas; propane; Greeley Gas Company supplier; adequate supply; customers are being added. (1977 data) Water Supply Arkansas River-source; Canon City treatment plant, 68.1 x 10^6 lpd (18 x 10^6 gpd) capacity; adequate supply, average daily consumption 18.9 x 10^6 liters (5 x 10^6 gal), peak consumption 37.8 x 10^6 liters (1 x 10^7 gal); present storage capacity 17 x 10^6 liters (4.5 x 10^6 gal), plan to add 15.1 x 10^6 liters (4 x 10^6 gal) storage tank and 2000 meters. (1976 data) Sewage Disposal 1 Main plant, (2 others nearby serve some residents); anaerobic digestor; flow capacity 8 x 10^6 lpd (2.1 x 10^6 gpd); actual flow 10.6 x 10^6 lpd (2.8 x 10^6 gpd) in summer, 6.8 x 10^6 lpd (1.8 x 10^6 gpd) in winter; serves 100 percent of community; Canon City, Florence, and Lincoln Park are in early planning stages developing a regional sewage treatment plant, operational in mid-1980's. (1976 and 1977 data) Solid Waste Disposal Private service; Fremont County sanitary landfill. (1976 data)
Colorado Springs, CO 38°50.0'N 104°49.2'W	1970: 135,060 1976 est.: 185,700 1980 projection: 218,800 (1976 data)	Single Family Dwellings (includes mobile homes) Total units: 69,205 Vacant units: 2638 Vacancy rate: 3.8% Average residential sale—new: $37,300 Average residential resale: $30,400 Apartments: Total units: 36,956 Vacant units: 5894 Vacancy rate: 13.8% Average rent per month: Efficiency: $126 1 bedroom: $147 2 bedroom: $181 3 bedroom: $202 (1976 data)	42 Preschools and Day Care Centers Public Schools (El Paso County School District #11) 37 Elementary Schools Enrollment capacity: 23,855 1976 enrollment: 17,596 10 Junior High Schools Enrollment capacity: 9745 1976 enrollment: 8069 5 Senior High Schools Enrollment capacity: 9046 1976 enrollment: 8347 Private Schools 8 Elementary Schools Enrollment capacity: 2283 1975 enrollment: 1832 1 Secondary School Enrollment capacity: 620 1975 enrollment: 532 1 K through 12 Enrollment capacity: 315 1975 enrollment: 310 Colleges and Universities University of Colorado at Colorado Springs 1976 enrollment: 3757 Expansion by 2000 A.D.: 17,000 U.S. Air Force Academy Enrollment capacity: 4417 1976 enrollment: 4017 Colorado College 1976 enrollment: 1849 El Paso Community College Enrollment capacity: 8000 1976 enrollment: 5325 New campus under construction in 1977. Nazarene Bible College 1976 enrollment: 850 Special Schools Colorado School for the Deaf and Blind (3 schools, grades K to 12) Enrollment capacity: 350 1975 enrollment: 268 Enrollment expected to remain stable. Colorado Technical College Enrollment capacity: 300 1975 enrollment: 300 10-yr projection is for new facility with hospital to accommodate 3000. Colorado Springs Montessori School (preschool to grade 6) Enrollment capacity: 120 1975 enrollment: 95 (1976 data)	6 Hospitals (1 psychiatric, 1 osteopathic, 1 specializes in cancer research) 1059 beds 52 beds ICU/CCU 20 Nursing homes 2 Mental health clinics Doctors Total: 300 Doctor/population ratio: 1/619 Dentists Total: 125 Ratio: 1/1486 (1976 data)	56 Public parks and playgrounds 49 Baseball/playfields 9 Public tennis court facilities (also 5 racquet clubs) 11 Golf courses 4 Swimming pools 2 Indoor ice rinks 8 Museums and galleries (1976 data)	Electric Colorado Springs Public Utilities (2 steam plants, 2 hydroelectric plants and purchase power from the CRSP-USBR); supply adequate; plans for 1 additional steam plant. Heating Fuels Natural gas, LPG, propane from Colorado Springs Dept. of Public Utilities; supply adequate; expands with the community needs. Water Supply Homestake Reservoir, Pikes Peak watershed, Blue River watershed, and Twin Lakes watershed; supply is very good; gravity system, peak flow maximum 435.3 x 10^6 lpd (115 x 10^6 gpd); expands with the community needs. Sewage Disposal 1 Sewage treatment facility (activated sludge and trickling filter plants); flow capacity 159 x 10^6 lpd (42 x 10^6 gpd); actual flow 94.6 x 10^6 lpd (25 x 10^6 gpd). (1976 data)

B. URBAN AREAS (Continued)

NAME AND LOCATION	POPULATION	HOUSING AVAILABILITY	EDUCATIONAL FACILITIES	MEDICAL FACILITIES	RECREATION FACILITIES	UTILITIES AND SERVICES
Florence, CO 38°23.4'N 105°07.5'W	1970: 2846 1975 est.: 3153 1980 projection: 5000 to 7000 (1976 data)	Single Family Dwellings Total units: approximately 320 Rental units: < 50 Vacancy rate: <1% Average sale price: $22,000 Average rent per month: $100 Apartments Total units: 40 Average rent per month: $90 (1976 data)	1 Elementary School Enrollment capacity: 970 1976 enrollment: 899 Overall system expected to grow at 2% annually. 1 Junior High School Enrollment capacity: 207 1976 enrollment: 207 2% annual growth expected. 1 Senior High School Enrollment capacity: 520 1976 enrollment: 520 2% annual growth expected; plan to build new high school in 1980. (1977 data)	1 Hospital (St. Joseph Hospital) 34 beds 2 rooms equipped for ICU/CCU. 40 bed nursing home is part of the hospital. Doctors Total: 9 Doctor/population ratio: 1/350 Dentists Total: 2 Ratio: 1/1576 (1976 data)	5 Parks 1 Public swimming pool 1 Community theater (1976 data)	Electric Southern Colorado Power (3 generating plants); supply adequate; no plans to expand. Heating Fuels Natural gas, coal, propane; supply adequate, however natural gas is limited; no plans to expand. Water Supply Arkansas River-source; supply adequate, however consumption is close to treatment plant capacity in summer; expanding service to outlying areas. Sewage Disposal 1 Secondary treatment plant (trickling filter); flow capacity 3.8×10^6 lpd (1×10^6 gpd); actual flow in summer 3.8×10^6 lpd (1×10^6 gpd), in winter 0.95×10^6 lpd (0.25×10^6 gpd); part of regional expansion plan, see Canon City above. (1977 data)
Fountain, CO 38°41.0'N 104°41.9'W	1970: 4426 1975 est.: 7401 1980 projection: 8660 (1977 data)	Single Family Dwellings Total units: 1500 Rental units: 375 Vacancy rate: 4% Average sale price: $30,000 to $35,000 Apartments Total units: 304 Average rent per month: Efficiency: $134 1 bedroom: $148 2 bedroom: $180 3 bedroom: $206 (1976, 1977 data)	Public Schools (El Paso County School District #8) 4 Elementary Schools (includes 2 on the Fort Carson reservation) Enrollment capacity: 2750 1976 enrollment: 2275 1980 projected enrollment: 2575 2 Junior High Schools (includes 1 on the Fort Carson reservation) Enrollment Capacity: 800 1976 enrollment: 725 1980 projected enrollment: 775 1 Senior High School Enrollment capacity: 650 1976 enrollment: 500 1980 projected enrollment: 550 (1977 data)	2 Dentists Ratio: 1/3700 Residents use Colorado Springs and Fort Carson facilities; 50% of the population is military related. No plans to provide other facilities. (1977 data)	3 Parks 2 Baseball fields 1 Tennis court (1977 data)	Electric Colorado Springs Public Utilities, 115 kVA transmission line; actual use 13 MW; maximum 30 MW. Heating Fuels Propane and natural gas; industrial and large commercial users restricted; residential use not restricted; residential customers added when there is sufficient supply. Water Supply Shallow wells in Fountain aquifer with Little Fountain Creek as a backup supply; supply adequate; future participation in the Fryingpan-Arkansas Water Resources Project. Sewage Disposal 1 Treatment facility (lagoon system-formerly "waste stabilization ponds"); flow capacity 2.1×10^6 lpd (0.55×10^6 gpd); actual flow 1.8×10^6 lpd (0.47×10^6 gpd). (1977 data)
Lincoln Park, CO (unincorporated) 38°25'N 105°12'W	1970: 2984 1976 est.: 3600 1980 projection: 4200 (1977 data)	Single Family Dwellings Total units: 1100 Rental units: 50 Average sale price: $35,000 Average rent per month: $150 Apartments none (1977 data)	Part of Canon City school district, see Canon City above.	Use Canon City facilities, see Canon City above.	1 Park 2 Ballfields (1977 data)	Electric Acquired through Canon City, see above. Heating Fuels Acquired through Canon City, see above. Water Supply Acquired through Canon City, see above. Sewage Disposal 1 Treatment facility (lagoon system); flow capacity 0.26×10^6 lpd (7×10^4 gpd); actual flow (exceeds capacity) 1.1×10^6 to 1.9×10^6 lpd (0.3×10^6 to 0.5×10^6 gpd); part of regional expansion plan, see Canon City above. (1977 data)
Manitou Springs, CO 38°51.8'N 104°54.8'W	1970: 4278 1975 est.: 4206 1980 projection: 4740 (1977 data)	Single Family Dwellings Total units: 1760 Vacancy rate: 2.5% Average sale price: $48,360 Average resale price: $33,412 (figures for Colorado Springs metro area) Apartments Vacancy rate: 12.9% Average rent per month: Efficiency: $83 1 bedroom: $140 2 bedroom: $160 (1976, 1977 data)	Public Schools (El Paso County School District #14) 2 Elementary Schools Enrollment capacity: 600 1977 enrollment: 481 Enrollment is expected to remain stable. 1 Junior High School Enrollment capacity: 300 1977 enrollment: 226 Enrollment is expected to remain stable. 1 Senior High School Enrollment capacity: 450 1977 enrollment: 408 Enrollment is expected to remain stable. (1977 data)	2 One-doctor clinics Doctor/population ratio: 1/2103 Dentists Total: 3 Ratio: 1/1402 (1975, 1977 data)	4 Parks 1 Tennis facility 3 Public golf courses 1 Swimming pool (1975 data)	Electric Supplied by Colorado Springs, see above. Heating Fuels Supplied by Colorado Springs, see above. Water Supply 1 Reservoir, supply is inadequate. Sewage Disposal No data (1976 data)

B. URBAN AREAS (Continued)

NAME AND LOCATION	POPULATION	HOUSING AVAILABILITY	EDUCATIONAL FACILITIES	MEDICAL FACILITIES	RECREATION FACILITIES	UTILITIES AND SERVICES
Pueblo, CO 38°14.4'N 104°36.3'W	1970: 97,453 1975 est.: 105,312 1980 projection: 109,901 (1976 data)	Single Family Dwellings Total units: approximately 41, 235 Owner-occupied: 26,800 Rental units: 12,250 Vacancy rate: 1 to 1.5% Average sale price—new: $45,000 to $50,000 Average resale price: $37,500 to $42,500 Monthly rental range: $175 to $300 (1975–1977 data) Apartments Total units: approximately 2000 Vacancy rate: 6 to 7% Average rent per month (plus utilities): 1 bedroom: $150 2 bedroom: $175 to $200 3 bedroom: $200 to $225 (1975–1977 data)	Public Schools 29 Elementary Schools 1976 enrollment: 10,287 8 Junior High Schools 1976 enrollment: 5724 4 Senior High Schools 1976 enrollment: 7980 Colleges and Universities University of Southern Colorado (public, 4-year) Enrollment: approximately 6000 (1976, 1977 data)	3 Hospitals (2 general care, 1 psychiatric) 1990 beds 17 beds ICU 12 beds CCU Doctors Total: 126 Doctor/population ratio: 1/836 Dentists Total: 56 Ratio: 1/1880 (1977 data)	56 Parks 38 Tennis courts 5 Golf courses 10 Swimming pools 1 Roller skating rink 1 Ice skating rink 3 Community theaters 1 Civic center 500-seat theater conference rooms 4 Museums (1977 data)	Electric 60% provided by Southern Colorado Power; 40% purchased from Public Service Company of Colorado under long-term contract (one internal combustion and 2 steam generating plants); supply adequate; no new construction until 1994. (1975, 1977 data) Heating Fuels Public Service Company furnishes gas and small suppliers for propane; residential supply adequate; commercial and industrial users of natural gas experience delays due to scarcity; restrictions limit any one natural gas user to 212.4 m^3/hr (7500 ft^3/hr) and 3500 hr maximum annual use; no expansion. Water Supply Arkansas River-source; distributed by Pueblo Board of Water Works; raw water rights for a population of 250,000; capacity of treatment plant 289.6 x 10^6 lpd (76.5 x 10^6 gpd); average daily consumption 90.8 x 10^6 lpd (24 x 10^6 gpd); peak consumption 170.3 x 10^6 lpd (45 x 10^6 gpd); new treatment facility under construction in 1977. Sewage Disposal 1 Treatment facility, both primary and secondary treatment (clarifiers, aerators, digestive sludge); flow capacity 113.6 x 10^6 lpd (30 x 10^6 gpd); actual flow 53 x 10^6 lpd (14 x 10^6 gpd); peak flow 83.3 x 10^6 lpd (22 x 10^6 gpd). (1977 data)
Security, CO 38°45.1'N 104°44.5'W	1970: Security-Widefield joint population: 15,297 1973 est.: 8900 1980 projection: 10,450 (1977 data)	Single Family Dwellings Total units: 2120 Rental units: 600 Average sale price: $40,000 No rental data Apartments Total units: 110 Vacancy rate: 14.3% Average rent per month: $150 (1976 data)	Part of Widefield School District, see below.	4 Doctors for Security and Widefield jointly. Dentists Total: 8 Ratio: 1/1112 Residents use Colorado Springs and Fort Carson (military related) facilities. (1977 data)	1 Park 2 Ballfields 1 Indoor swimming pool (1976 data)	Electric Part of Colorado Springs service area, see above. Heating Fuels Part of Colorado Springs service area, see above. Water Supply Security Water District uses Widefield aquifer and Black Squirrel Basin; supply adequate; future participation in the Fryingpan-Arkansas Water Resources Project. Sewage Disposal 1 Treatment facility (secondary treatment, trickling filter); flow capacity 5.7 x 10^6 lpd (1.5 x 10^6 gpd); actual flow 3.8 x 10^6 lpd (1 x 10^6 gpd). (1977 data)
Stratton Meadows, CO (unincorporated) 38°49.9'N 104°49.2'W	1970: 6223 1973 est.: 7600 1980 projection: 7530 (1977 data)	Single Family Dwellings Total units: 2280 Vacancy rate: 2.5% Average sale price: $48,360 Average resale price: $33,412 (figures for Colorado Springs metro area) Apartments Vacancy rate: 14.3% Average rent per month: Efficiency: $115 1 bedroom: $132 2 bedroom: $149 3 bedroom: $167 (1976 data)	Public Schools (El Paso School District #2–Harrison) 7 Elementary Schools Enrollment capacity: 5010 1977 enrollment: 3849 1980 projected enrollment: 4200 3 Junior High Schools Enrollment capacity: 2700 1977 enrollment: 1613 1 Senior High School Enrollment capacity: 1378 1977 enrollment: 1301 Plans for a combined junior-senior high with capacity 3200. (1976, 1977 data)	Residents use Colorado Springs and Fort Carson (military related) facilities.	1 Park within boundaries belongs to Colorado Springs. (1977 data)	Residents served through Colorado Springs, see above.
Widefield, CO 38°44'N 104°44'W	1970: Security-Widefield joint population: 15,297 1975 est.: 14,375 1980 projection: 17,740 (1976 data)	Single Family Dwellings Total units: 3503 Rental units: 150 Average sale price: $22,000 to $38,000 Average rent per month: $200 Apartments Total units: 256 Average rent per month: $140 to $200 (1976 data)	Public Schools (El Paso County School District #3) 7 Elementary Schools Enrollment capacity: 3900 1977 enrollment: 3400 Expected to remain stable. 3 Junior High Schools Enrollment capacity: 2400 1977 enrollment: 1925 1980 projected enrollment: 1750 Expected to decline. 1 Senior High School Enrollment capacity: 2000 1977 enrollment: 1975 1980 projected enrollment: 1750 Expected to decline. (1977 data)	Residents use Colorado Springs and Fort Carson (military related) facilities.	2 Parks (1976 data)	Electric Part of Colorado Springs service area, see above. Heating Fuels Part of Colorado Springs service area, see above. Water Supply Ground water from 3 aquifers including Black Squirrel Basin; supply adequate; more wells can be equipped if needed; will participate in the Fryingpan-Arkansas Water Resources Project. Sewage Disposal 1 Treatment facility (modified activated sludge); flow capacity 4.9 x 10^6 lpd (1.3 x 10^6 gpd); actual flow 4.5 x 10^6 lpd (1.2 x 10^6 gpd); future plans for a 8.1 x 10^6 lpd (2.15 x 10^6 gpd) facility. (1976, 1977 data)

* ICU/CCU = intensive care unit/coronary care unit.

† Ratios for each city derived using most recent population estimate.

FORT CARSON, COLORADO
TERRAIN ANALYSIS

100 STATUTE MILES
50 STATUTE MILES
Manitou Springs
COLORADO SPRINGS
City of Colorado Springs Municipal Airport
Stratton Meadows
Security
FORT CARSON
Widefield
Fountain
CANON CITY
Lincoln Park
Florence
PUEBLO
Pueblo Memorial Airport
DENVER
Stapleton International Airport
Buckley ANGB
Peterson Field
Falcon AFB
Schriever AFB
Lowry AFB
Aurora
Englewood
Littleton
Arapahoe
Castle Rock
Parker
Elizabeth
Kiowa
Limon
Hugo
Hoxtun
Holyoke
Sterling
Fort Morgan
Brighton
Greeley
Fort Collins
Loveland
Estes Park
Boulder
Longmont
Golden
Evergreen
Idaho Springs
Central City
Georgetown
Leadville
Aspen
Glenwood Springs
Eagle
Gypsum
Vail
Steamboat Springs
Craig
Meeker
Rangely
Grand Junction
Fruita
Delta
Montrose
Ouray
Telluride
Durango
Cortez
Dolores
Mesa Verde
Pagosa Springs
Chama
Dulce
Farmington
Gallup
Shiprock
Bloomfield
Aztec
Cuba
Bernalillo
Albuquerque
Kirtland AFB
Sandia
Los Alamos
Santa Fe
Española
Taos
Raton
Las Vegas
Tucumcari
Clayton
Springfield
Lamar
Wray
Yuma
Burlington
Stratton
Seibert
Flagler
Genoa
Simla
Matheson
Calhan
Falcon
Peyton
Ramah
Monument
Palmer Lake
Woodland Park
Divide
Florissant
Cripple Creek
Victor
Canon City
Penrose
Fremont
Pueblo
Pueblo Ordnance Depot
Avondale
Boone
Olney Springs
Ordway
Crowley
Fowler
Rocky Ford
La Junta
Las Animas
Lamar
Holly
Granada
Bristol
Wiley
Kornman
Eads
Haswell
Galatea
Arlington
Chivington
Sheridan Lake
Towner
Kit Carson
Cheyenne Wells
Firstview
Arapahoe
Wild Horse
Karval
Rush
Yoder
Bovero
Kutch
Ayer
Timpas
Ruxton
Springfield
Vilas
Walsh
Pritchett
Campo
Kim
Andrix
Edler
Tobe
Folsom
Des Moines
Capulin
Branson
Kenton
Mexhoma
Boise City
Keyes
Griggs
Seneca
Moses
Grenville
Dawson
Colfax
Raton
Trinidad
Segundo
Weston
Morley
Yaquina
Crews
Las Animas
Hoehne
Model
Tyrone
Ludlow
Aguilar
Pryor
La Veta
Walsenburg
Gardner
Badito
Johnson
Houghton
Delhi
Muddy Creek Res.
Cedarwood
Colorado City
Pueblo West

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AERIAL PHOTOGRAPHY

100. Black and white panoramic photography. Scale 1:16,000. 18 December 1976. Flown by U.S. Air Force, 91st Tactical Reconnaissance Squadron, Mission No. 670-901. Available at U.S. Army Engineer Topographic Laboratories, Terrain Analysis Center, Fort Belvoir, VA.

PERSONAL COMMUNICATIONS

101. Mr. Robert Jarrett. September 1977. U.S. Geological Survey, Denver, CO. Telephone conversation concerning surface drainage.

102. Mr. Stan Ness. August 1977. Buildings and Grounds, Land Management Officer, Directorate of Facilities Engineering, Fort Carson, CO. Interview and telephone conversations concerning surface drainage, water resources, and windmills.

103. Mr. Richard Brown. August-September 1977. Fountain City Manager, Fountain, CO. Telephone conversations concerning water resources and Fountain, CO.

104. Mr. Bob Ermal. September 1977. State Water Commissioner for the area, Fountain, CO. Telephone conversation concerning water resources.

105. Mr. Russell K. Livingston. August 1977. U.S. Geological Survey, Denver, CO. Telephone conversation concerning water resources.

106. Mr. Jack Wagar. August 1977. U.S. Geological Survey, Reston, VA. Telephone conversation concerning water resources.

107. CPT Peter J. Dalton. August-September 1977. Deputy Airfield Commander, Butts Army Airfield, Fort Carson, CO. Interview and telephone conversation concerning Butts Army Airfield.

108. CPT Donald K. Miller. August-September 1977. Airlift Liaison Officer, U.S. Air Force, 4th Infantry Division, Fort Carson, CO. Interview and telephone conversations concerning drop zones.

109. CWO Robert M. Neal. August-September 1977. Division Aviation Safety Officer, Butts Army Airfield, Fort Carson, CO. Interview and telephone conversation concerning helicopter landing zones.

110. Mr. Ron Skillings. August-September 1977. Buildings and Grounds, Roads and Railroads Officer, Directorate of Facilities Engineering, Fort Carson, CO. Interview and telephone conversations concerning roads, bridges, railroads, and gravel pits.

111. Mr. Craig Withee. September-October 1977. Sanitation Engineer, Chief Sanitation Branch, Utilities Division, Directorate of Facilities Engineering, Fort Carson, CO. Interview and telephone conversations concerning pipelines, cantonment water and sewerage, and non-urban culture features.

112. Mr. Ziegler. September 1976, August 1977. Operations Officer, Butts Army Airfield, Fort Carson, CO. Interview concerning Butts Army Airfield.

113. Mr. Robert Ahlfs. 22 September 1977. Housing Engineer, Directorate of Industrial Operations Housing Division, Fort Carson, CO. Telephone conversation concerning officer's and NCO housing.

114. Ms. Mary Bethel. 12 October 1977. Secretary, Real Property, Directorate of Facilities Engineering, Fort Carson, CO. Telephone conversation concerning the cantonment area.

115. Mr. D. Hair. 28 September 1977. Recreation Services Officer, Director of Personnel and Community Activities, Recreation Services Division, Fort Carson, CO. Telephone conversation concerning the cantonment area.

116. Ms. Kay James. 8 September 1977. Communications Systems Division, USACC Detachment, Fort Carson, CO. Telephone conversation concerning telecommunications on the reservation.

117. COL Moody. 29 September 1977. Director of Industrial Operations, Supply Division (Hospital), Fort Carson, CO. Telephone conversation concerning the hospital on the reservation.

118. SGT Mundy. 21 September 1977. Troop Billets and Quarters, Directorate of Industrial Operations Housing Division, Fort Carson, CO. Telephone conversation concerning the cantonment area.

119. Mr. Dave Nicholson. August-September 1977. Real Property Officer, Directorate of Facilities Engineering, Fort Carson, CO. Interviews and telephone conversations concerning the cantonment area.

120. Mr. Mickey Weatherman. 5 October 1977. Electrical Engineer, Utilities Division, Directorate of Facilities Engineering, Fort Carson, CO. Telephone conversation concerning the cantonment area.

121. Mr. Jack R. Weigel. 7 September 1977. Mechanical Engineer, Utilities Division, Directorate of Facilities Engineering, Fort Carson, CO. Interview concerning the cantonment area.

122. Office of the Superintendent. 8 September 1977. El Paso County School District 8, Fountain, CO. Telephone conversation concerning schools in the cantonment area.

123. COL Griffin. 26 October 1977. Chief of Range Control, Directorate of Plans and Training, Fort Carson, CO. Telephone conversation concerning non-urban culture features.

124. Mr. Hardy. October-November 1977. Assistant Chief of Staff, G3, in Charge of Range, Directorate of Plans and Training, Fort Carson, CO. Telephone conversations concerning non-urban culture features.

125. Mr. Dale Hill. 5 December 1977. Range Communications, USACC Detachment, Fort Carson, CO. Telephone conversation concerning non-urban culture features.

126. LT Doerr. December 1977. Environmental Engineer, Peterson AFB, Colorado Springs, CO. Telephone conversation concerning Peterson AFB.

127. Mr. Tom Lopez. November-December 1977. Director of Aviation, City of Pueblo, CO. Letter and telephone conversation concerning Pueblo Memorial Airport.

128. Mr. Edward L. Stricker. November-December 1977. Director of Aviation, City of Colorado Springs, CO. Letter and telephone conversation concerning City of Colorado Springs Municipal Airport.

129. Mr. Barickman. August-September 1977. Fremont County School District 8. Telephone conversation concerning schools in Fountain, CO.

130. Mr. Bartelle. August-September 1977. El Paso County School District 3. Telephone conversation concerning schools in Widefield, CO.

131. Mr. Paul Baschleben. 28 September 1976. Customer Consultant, Department of Public Utilities, City of Colorado Springs, CO. Letter concerning off-post utilities.

132. Mrs. Bradley. August-September 1977. El Paso County School District 14. Telephone conversation concerning schools in Manitou Springs, CO.

133. Ms. Kathleen Brennan. November 1977. Pikes Peak Area Council of Governments. Telephone conversations concerning Manitou Springs, Stratton Meadows, Security, Widefield, and Fountain, CO.

134. Ms. Ann Daugherty. November 1977. City Clerk, Fountain, CO. Telephone conversation concerning Fountain, CO.

135. Ms. Betty Evans. 28 September 1976. Administrative Assistant, Colorado Springs Public Schools, El Paso County School District 11. Letter concerning schools in Colorado Springs.

136. Mr. Dan Gonzales. August-September 1977. Florence City Manager, Florence, CO. Telephone conversation concerning Florence, CO.

137. Mr. Hank Hume. August-September 1977. Natural Gas Company, Canon City, CO. Telephone conversation concerning off-post utilities.

138. Mr. Vincent Isele. August-September 1977. Pueblo Office, Southern Colorado Power Company. Telephone conversation concerning off-post utilities.

139. Mr. Jackson. August-September 1977. Canon City Office, Southern Colorado Power Company. Telephone conversation concerning off-post utilities.

140. Ms. Jeannette Meyer. August-September 1977. Community Relations, St. Mary's Hospital, Pueblo, CO. Telephone conversation concerning medical facilities in Pueblo, CO.

141. Mrs. Meyers. August-September 1977. El Paso County School District 2, Harrison, CO. Telephone conversation concerning schools in Stratton Meadows, CO.

142. Mr. Hal Miller. August-September 1977. El Paso County School District 14. Telephone conversation concerning schools in Manitou Springs, CO.

143. Mr. Harold Miskel. August-September 1977. Resource Planning Department, City of Colorado Springs, CO. Telephone conversation concerning the City of Colorado Springs, CO.

144. Mr. Harvey Opfer. August-September 1977. Lincoln Park Sanitary District, Lincoln Park, CO. Telephone conversation concerning off-post utilities.

145. Mr. James C. Perry. September 1976, August 1977. Vice-President, Widefield Homes Water Company. Interview and telephone conversation concerning Widefield, CO.

146. Mr. Jim Pollo. August-September 1977. Fremont County School District RE-1. Telephone conversation concerning schools in Canon City, CO.

147. Mr. Freeman Rader. 27 September 1976. City Planner, Manitou Springs, CO. Interview concerning Manitou Springs, CO.

148. Mr. Thomas K. Remple. September 1976, August 1977. Manager-Secretary-Treasurer, Security Water and Sanitation District. Interview and telephone conversation concerning Security, CO.

149. Ms. Nancy J. Sanford. September 1976. Health Planner, Pikes Peak Area Council of Governments. Interview concerning medical facilities in Colorado Springs, CO.

150. Mr. Schlabach. August-September 1977. Parkview Episcopal Hospital, Pueblo, CO. Telephone conversation concerning medical facilities in Pueblo, CO.

151. Mr. Wayne Strickland. August-September 1977. Fremont County School District RE-2. Telephone conversation concerning schools in Florence, CO.

152. Mr. Richard Topielec. November 1977. Upper Arkansas Council of Governments. Telephone conversation concerning Canon City, Lincoln Park, and Florence, CO.

153. Mr. Clarence Weaver. August-September 1977. Canon City Metro Sewage District, Canon City, CO. Telephone conversation concerning off-post utilities.

154. Mr. Fred Weisbrod. August-September 1977. Pueblo City Manager, Pueblo, CO. Telephone conversation concerning Pueblo, CO.

155. Mr. Marion Willard. August-September 1977. Canon City Water Department, Canon City, CO. Telephone conversation concerning off-post utilities.

156. El Paso County Medical Society. August-September 1977. Telephone conversation concerning off-post medical facilities.

157. El Paso County Public Health Department. August-September 1977. Telephone conversation concerning off-post medical facilities.

158. Administrative Office. August-September 1977. St. Thomas More Hospital, Canon City, CO. Telephone conversation concerning medical facilities in Canon City, CO.