

**COLORADO GEOLOGICAL SURVEY**  
**Open-file Report OF-02-14**  
**Evaluation of Mineral and Mineral Fuel Potential of**  
**Washington County**  
**State Mineral Lands Administered by the Colorado State Land Board**  
**18 June 2002**

The Colorado Geological Survey (CGS) is releasing an evaluation of the mineral and mineral fuel resource potential of the nearly 138,560 acres of state mineral lands located in Washington County as part of its long-term evaluation of approximately 4,000,000 acres of state lands administered by the State Land Board. The CGS divided the lands, for evaluation purposes, into 138 individual tracts that range from 160 acres to 16,160 acres in size. David May, geologist, and James Cappa, geologist, prepared this open file report.

This open file report includes an introduction to the geology and mineral resources of the county. The main body of the report includes evaluations of each individual tract, involving descriptive text as well as corresponding topographic and geologic maps. A summary of the tract locations and commodity ratings is included, as well as maps of oil and gas test wells with oil field locations, coal resources, and industrial mineral prospects.

Four general categories of resources are included in this inventory:

- oil and gas
- coal
- metallic minerals
- industrial minerals and construction materials.

Each individual tract evaluation includes:

- A bar graph which ranks each tract's resource potential for each of the four mineral categories. An explanation of the categories may be found with the tract summaries.
- Tract identifier number, county name, and county location map.
- Tract location on a 7-1/2-minute United States Geologic Survey topographic map.
- Tract location on a United States Geologic Survey surface outcrop map.
- Location as to section, township, and range and approximate acreage.
- Overview of tract geology.
- Specific assessment of the resource potential for the four resource categories.
- References used in assessing tract potential.

The abbreviations used in the tract documentation, with their definitions, are as follows:

MCF – thousand cubic feet  
MMCF – million cubic feet  
BCF – billion cubic feet  
TCF – trillion cubic feet  
BBL barrels  
BO – barrels of oil  
BW – barrels of water  
MBO – thousand barrels of oil  
MMBO – millions of barrels of oil  
DST – drill stem test

The maps were assembled by overlying the boundaries provided on a State Land Board computerized base map onto the United States Geologic Survey map bases in a Geographic Information System environment. Tract boundaries were not checked against the State Land Board's detailed land records because of time constraints.

## Geological Overview

Washington County, located in northeastern Colorado, has common borders with Yuma county to the east, Kit Carson and Lincoln counties to the south, Arapahoe and Adams counties to the west, Morgan County to the northwest, and Logan county to the north. The South Platte River valley cuts the northwest corner of the county. Washington County covers an area of 1,619,000 acres or 2,530 square miles. The county consists primarily of nearly level plains to gently rolling hills. The surface has been moderately affected by deposition of windblown sand and stream erosion. Elevation ranges from 4,000 feet along the South Platte River to about 5,400 feet in the southwestern portion of the county.

A total of 138 tracts have been evaluated for this report. Some of the tracts are composed of more than one individual land parcel. The State of Colorado owns the mineral estates for all tracts, totaling approximately 138,560 acres or about 8.6% of the county total.

Washington County lies within the Denver Basin. The Denver Basin encompasses portions of northeast Colorado, southeast Wyoming, southwest Nebraska and northwest Kansas. The basin is a structural depression developed in response to compressional forces of the Laramide Orogeny. Washington County is located in the south-central portion of the Sterling 1° x 2° Quadrangle and the north-central portion of the Limon 1° x 2° Quadrangle. Surface mapping in these Quadrangles in Washington County has identified 6 unconsolidated surficial units of Quaternary age, 3 semi-consolidated Tertiary age deposits, and 1 consolidated bedrock unit of Cretaceous age.

## Oil and Gas Resources

### County Production Statistics

As calculated from IHS Energy Group's production totals, Washington County produced 679,772 barrels of oil (BO) and 1,516,399 thousand cubic feet of gas (MCF) in 2000 from approximately 374 wells in 115 producing oil and gas reservoirs. The Colorado Oil and Gas Conservation Commission's website lists slightly different oil and gas production numbers for Washington County in 2000 at 682,037 BO and 1,518,047 MCF. This production placed Washington County 4th in annual oil and 16th in annual gas production in 2000 among Colorado's 30 oil-producing and 35 gas-producing counties.

The cumulative production from 226 oil and gas reservoirs in Washington County, as shown in the table in the following pages, reached 153,807,936 BO and 102,805,345 MCF of gas at the end of 2000. At year end 2000, Washington County was ranked 3rd for cumulative oil production and 16th for cumulative gas production among Colorado's producing counties.

### Producing Horizons

<b>Pay Zone</b>	<b>Lithology</b>	<b>Age</b>
Niobrara	Limestone (Chalk)	Upper Cretaceous
D Sand	Sandstone	Upper Cretaceous
J Sand	Sandstone	Lower Cretaceous

### Summary of Production by Fields

The following list contains the Washington County oil and gas fields, their general locations, current status

(producing, shut-in, or abandoned), producing formation(s), and cumulative oil and gas production at the end of 2000. Fields that had significant production (> 250 MBO and/or >2 BCF) are shown in bold print.

Field			Year	Year	Producing	CUM OIL	CUM GAS
Name	Location	Status	Disc.	Aband	Formation	(BO)	(MCF)
Abarr	12, T. 3 S., R. 49 W.	Producing	1979		Niobrara	0	1,200,260
<b>Abbott</b>	<b>10, T. 2 S., R. 54 W.</b>	<b>Producing</b>	<b>1952</b>		<b>J Sand</b>	<b>528,920</b>	<b>93,863</b>
Abbott North	35, T. 1 S., R. 54 W.	Abandoned	1955	1955	J Sand	6,293	0
<b>Able</b>	<b>1, T. 3 S., R. 54 W.</b>	<b>Producing</b>	<b>1966</b>		<b>J Sand</b>	<b>374,214</b>	<b>0</b>
Acme	2, T. 2 N., R. 52 W.	Abandoned	1984	1989	D Sand	3,357	0
Agate	24, T. 1 S., R. 56 W.	Abandoned	1956	1986	D Sand	30,034	5,400
Akron	23, T. 3 N., R. 53 W.	Abandoned	1952	1959	J Sand	0	133,156
<b>Akron East</b>	<b>25, T. 3 N., R. 52 W.</b>	<b>Producing</b>	<b>1955</b>		<b>D Sand</b>	<b>3,282,414</b>	<b>1,868,488</b>
Anton	15, T. 4 S., R. 52 W.	Abandoned	1958	1985	J Sand	6,798	0
Apex	22, T. 3 S., R. 54 W.	Abandoned	1968	1985	J Sand	48,683	40
Apollo	30, T. 2 S., R. 56 W.	Producing	1964		J Sand	53,568	5
<b>Appaloosa</b>	<b>20, T. 2 S., R. 53 W.</b>	<b>Producing</b>	<b>1980</b>		<b>J Sand</b>	<b>360,484</b>	<b>0</b>
Arrow	33, T. 3 N., R. 54 W.	Abandoned	1959	1969	Dakota	0	731
Arrow	33, T. 3 N., R. 54 W.	Abandoned	1959	1969	J Sand	1,104	231,226
<b>Azure</b>	<b>14, T. 1 S., R. 55 W.</b>	<b>Producing</b>	<b>1957</b>		<b>D Sand</b>	<b>670,446</b>	<b>88,643</b>
Azure East	12, T. 1 S., R. 55 W.	Abandoned	1965	1986	D Sand	50,413	2,111
Baker	35, T. 2 S., R. 54 W.	Shut in	1985		J Sand	10,495	0
<b>Barefoot</b>	<b>19, T. 3 S., R. 52 W.</b>	<b>Producing</b>	<b>1963</b>		<b>J Sand</b>	<b>293,504</b>	<b>9,970</b>
Barrow	32, T. 3 N., R. 53 W.	Abandoned	1956	1960	D Sand	24,382	476,353
Bead	30, T. 1 N., R. 54 W.	Producing	1974		D Sand	75,839	4,719
Beaver Creek	32, T. 1 S., R. 55 W.	Shut in?	1985		D Sand	56,973	116,885
Bedroll	21, T. 2 S., R. 55 W.	Producing	1991		J Sand	16,409	0
Becker	10, T. 2 S., R. 55 W.	Abandoned	1957	1959	J Sand	24,349	11,822

<b>Belle</b>	<b>34, T. 1 N., R. 53 W.</b>	<b>Producing</b>	<b>1969</b>		<b>J Sand</b>	<b>1,082,904</b>	<b>246,306</b>
<b>Big Beaver</b>	<b>17, T. 3 S., R. 56 W.</b>	<b>Producing</b>	<b>1954</b>		<b>J Sand</b>	<b>13,046,126</b>	<b>1,713,663</b>
<b>Bison</b>	<b>7, T. 4 S., R. 53 W.</b>	<b>Producing</b>	<b>1960</b>		<b>J Sand</b>	<b>6,087,749</b>	<b>3,254</b>
<b>Blade</b>	<b>2, T. 4 S., R. 53 W.</b>	<b>Producing</b>	<b>1962</b>		<b>J Sand</b>	<b>2,960,220</b>	<b>6,921</b>
Bluejay	16, T. 2 N., R. 54 W.	Producing	1974		D Sand	41,369	18,833
<b>Bobcat</b>	<b>4, T. 1 S., R. 56 W.</b>	<b>Producing</b>	<b>1954</b>		<b>D Sand</b>	<b>7,440,264</b>	<b>5,634,102</b>
Bobcat	16, T. 1 S., R. 56 W.	Abandoned	1954	?	J Sand	2,664	2,043
Bobcat West	8, T. 1 S., R. 56 W.	Abandoned	1956	1962	J Sand	31,133	33,545
Boom	12, T. 2 S., R. 55 W.	Producing	1985		J Sand	49,787	22,618
Braid	28, T. 3 S., R. 50 W.	Producing	1977		J Sand	42,029	0
Broken Fork	28, T. 3 S., R. 54 W.	Producing	1983		J Sand	215,477	0
<b>Buckaroo</b>	<b>27, T. 3 S., R. 52 W.</b>	<b>Shut in?</b>	<b>1964</b>		<b>J Sand</b>	<b>335,938</b>	<b>0</b>
Buffalo	9, T. 2 N., R. 54 W.	Abandoned	1954	1958	J Sand	5,148	151
Buffalo Slough	14, T. 2 N., R. 54 W.	Abandoned	1957	1977	D Sand	37,139	42,641
Buffalo Slough	14, T. 2 N., R. 54 W.	Abandoned	1957	1977	J Sand	28,016	20,026
Bullseye	28, T. 3 N., R. 51 W.	Abandoned	1973	1976	D Sand	0	25,207
Bullwacker	23, T. 2 N., R. 54 W.	Abandoned	1977	1978	J Sand	4,780	5,002
Caballero	25, T. 2 N., R. 54 W.	Producing	1971		D Sand	44,185	32,558
<b>Calhoun</b>	<b>21, T. 2 N., R. 49 W.</b>	<b>Producing</b>	<b>1964</b>		<b>J Sand</b>	<b>345,313</b>	<b>4,563</b>
<b>Camp Creek</b>	<b>4, T. 1 N., R. 53 W.</b>	<b>Producing</b>	<b>1955</b>		<b>J Sand</b>	<b>309,626</b>	<b>12,743</b>
Camp Creek West	5, T. 1 N., R. 53 W.	Abandoned	1985	1996	J Sand	40,698	0
Cantina	6, T. 2 N., R. 53 W.	Abandoned	1969	1988	D Sand	95,406	211,908
Cantina	6, T. 2 N., R. 53 W.	Abandoned	1969	1985	J Sand	15	10,369
<b>Caribou</b>	<b>30, T. 3 S., R. 56 W.</b>	<b>Producing</b>	<b>1968</b>		<b>J Sand</b>	<b>768,448</b>	<b>0</b>
<b>Casino</b>	<b>18, T. 2 S., R. 55 W.</b>	<b>Shut in?</b>	<b>1968</b>		<b>J Sand</b>	<b>690,884</b>	<b>32,296</b>
Centennial	9, T. 2 S., R. 55 W.	Abandoned	1959	1961	J Sand	17,270	4,768
Chance	31, T. 1 S., R. 51 W.	Shut in	1983		J Sand	2,498	0
Chileno	23, T. 2 N., R. 52 W.	Abandoned	1971	1975	D Sand	659	513,007
<b>Cimarron</b>	<b>11, T. 3 S., R. 52 W.</b>	<b>Shut in?</b>	<b>1967</b>		<b>J Sand</b>	<b>2,283,050</b>	<b>0</b>
<b>Cody</b>	<b>31, T. 3 S., R. 51 W.</b>	<b>Producing</b>	<b>1963</b>		<b>J Sand</b>	<b>1,366,164</b>	<b>146,206</b>
<b>Concho</b>	<b>11, T. 3 S., R. 51 W.</b>	<b>Producing</b>	<b>1966</b>		<b>J Sand</b>	<b>413,707</b>	<b>0</b>
Cone	34, T. 2 S., R. 56 W.	Abandoned	1958	1972	J Sand	154,330	38,551
Cope	33, T. 3 S., R. 49 W.	Abandoned	1962	1996	J Sand	208,343	100
Coral	16, T. 1 S., R. 55 W.	Abandoned	1959	1960	D Sand	2,530	595
Dapper	34, T. 2 S., R. 50 W.	Producing	1978		Niobrara	0	1,576,586
<b>Dart</b>	<b>23, T. 1 N., R. 53 W.</b>	<b>Shut in?</b>	<b>1969</b>		<b>J Sand</b>	<b>322,587</b>	<b>22,633</b>
Dealer	34, T. 2 S., R. 52 W.	Producing	1980		J Sand	72,546	0
Denova	16, T. 2 S., R. 49 W.	Shut in	1956		J Sand	135,978	3,347
<b>Denova</b>	<b>8, T. 2 S., R. 49 W.</b>	<b>Producing</b>	<b>1956</b>		<b>Niobrara</b>	<b>0</b>	<b>19,331,819</b>
Dorado	20, T. 3 S., R. 50 W.	Shut in	1964		D Sand	28,371	0
Dorado	20, T. 3 S., R. 50 W.	Abandoned	1964	1985	J Sand	159,125	0

Dugout	31, T. 3 N., R. 50 W.	Shut in?	1976		D Sand	5,784	0
East Prong	21, T. 1 S., R. 55 W.	Abandoned	1957	1965	D Sand	31,558	10,842
Ember	2, T. 4 S., R. 52 W.	Producing	1979		J Sand	45,891	0
<b>Epiphany</b>	<b>31, T. 2 S., R. 53 W.</b>	<b>Producing</b>	<b>1966</b>		<b>J Sand</b>	<b>408,732</b>	<b>332</b>
<b>Faro</b>	<b>24, T. 3 S., R. 52 W.</b>	<b>Producing</b>	<b>1965</b>		<b>J Sand</b>	<b>309,561</b>	<b>0</b>
Feather	35, T. 3 S., R. 54 W.	Abandoned	1973	1996	J Sand	28,710	0
Feral	27, T. 1 S., R. 49 W.	Producing	1979		Niobrara	0	451,250
Fiesta	32, T. 2 S., R. 53 W.	Abandoned	1967	1998	J Sand	175,491	0
First-One	27, T. 2 N., R. 53 W.	Producing	1985		D Sand	125,310	8,582
First-One	27, T. 2 N., R. 53 W.	Producing	1985		J Sand	69,077	0
Fremont Butte	12, T. 3 N., R. 53 W.	Abandoned	1957	1958	D Sand	8,538	44,450
Gall	28, T. 2 N., R. 53 W.	Abandoned	1988	1992	D Sand	5,068	7,432
Gingham	2, T. 1 S., R. 55 W.	Abandoned	1977	1990	D Sand	20,961	0
Gullible	28, T. 2 S., R. 53 W.	Producing	1981		J Sand	141,499	0
Hammer Head	18, T. 2 S., R. 51 W.	Producing	1998		J Sand	59276	0
<b>Hardway</b>	<b>17, T. 3 N., R. 51 W.</b>	<b>Producing</b>	<b>1955</b>		<b>D Sand</b>	<b>1,000,974</b>	<b>545,696</b>
<b>Harrisburg</b>	<b>5, T. 3 S., R. 52 W.</b>	<b>Abandoned</b>	<b>1961</b>	<b>1996</b>	<b>J Sand</b>	<b>477,919</b>	<b>0</b>
Hector	18 T. 1 S., R. 56 W.	Abandoned	1956	1962	J Sand	112,354	78,643
<b>High Pockets</b>	<b>15, T. 2 N., R. 49 W.</b>	<b>Producing</b>	<b>1983</b>		<b>J Sand</b>	<b>685,270</b>	<b>0</b>
<b>Hinge</b>	<b>17, T 1 S., R. 56 W.</b>	<b>Abandoned</b>	<b>1954</b>	<b>?</b>	<b>D Sand</b>	<b>506,943</b>	<b>500,032</b>
Hirst	15, T. 3 S., R. 55 W.	Abandoned	1958	1968	J Sand	40,599	6,104
<b>Hone</b>	<b>16, T. 2 S., R. 55 W.</b>	<b>Abandoned</b>	<b>1958</b>	<b>1993</b>	<b>J Sand</b>	<b>519,626</b>	<b>81,403</b>
Hoolahan	10, T. 2 N., R. 51 W.	Producing	1979		D Sand	56,771	0
Hotspur	19, T. 2 S., R. 54 W.	Producing	1984		J Sand	165,696	0
Hurry Up	9, T. 3 S., R. 52 W.	Shut in?	1977		J Sand	17,527	0
<b>Hyde</b>	<b>10, T. 2 N., R. 49 W.</b>	<b>Producing</b>	<b>1955</b>		<b>D Sand</b>	<b>2,376,017</b>	<b>542,330</b>
Incline	6, T. 3 S., R. 55 W.	Producing	1982		J Sand	231,887	0
Jack Rabbit	29, T. 2 S., R. 56 W.	Abandoned	1961	1977	J Sand	113,679	28,601
Jeeper	20, T. 2 N., R. 51 W.	Producing	1974		D Sand	109,200	5,753
Jesse	1, T. 4 S., R. 53 W.	Producing	1978		J Sand	79,553	0
Jitter	1, T. 1 S., R. 54 W.	Abandoned	1963	1995	D Sand	181,115	300
<b>Justice</b>	<b>27, T. 3 S., R. 51 W.</b>	<b>Producing</b>	<b>1966</b>		<b>J Sand</b>	<b>448,220</b>	<b>0</b>
<b>Kachina</b>	<b>23, T. 3 S., R. 52 W.</b>	<b>Producing</b>	<b>1974</b>		<b>J Sand</b>	<b>1,484,335</b>	<b>553</b>
<b>Kejr</b>	<b>2, T. 2 S., R. 56 W.</b>	<b>Producing</b>	<b>1955</b>		<b>D Sand</b>	<b>2,242,914</b>	<b>579,631</b>
<b>Kejr</b>	<b>11, T. 2 S., R. 56 W.</b>	<b>Producing</b>	<b>1955</b>		<b>J Sand</b>	<b>795,781</b>	<b>169,949</b>
Kejr South	12, T. 2 S., R. 56 W.	Shut in	1955		D Sand	4,203	0
<b>Kejr South</b>	<b>12, T. 2 S., R. 56 W.</b>	<b>Shut in?</b>	<b>1955</b>		<b>J Sand</b>	<b>273,360</b>	<b>115,967</b>
<b>Keno</b>	<b>27, T. 1 S., R. 55 W.</b>	<b>Producing</b>	<b>1982</b>		<b>D Sand</b>	<b>256,501</b>	<b>0</b>
Lance	23, T. 3 S., R. 56 W.	Abandoned	1956	1986	J Sand	56,120	13,229
<b>Lariat</b>	<b>1, T. 2 S., R. 56 W.</b>	<b>Producing</b>	<b>1960</b>		<b>D Sand</b>	<b>782,315</b>	<b>256,554</b>
<b>Last Chance</b>	<b>25, T. 3 S., R. 56 W.</b>	<b>Abandoned</b>	<b>1955</b>	<b>1988</b>	<b>J Sand</b>	<b>697,209</b>	<b>33,050</b>

<b>Lindon</b>	<b>31, T. 3 S., R. 53 W.</b>	<b>Producing</b>	<b>1959</b>		<b>J Sand</b>	<b>4,172,822</b>	<b>10,462</b>
<b>Little Beaver</b>	<b>32, T. 1 S., R. 56 W.</b>	<b>Producing</b>	<b>1951</b>		<b>D Sand</b>	<b>14,155,374</b>	<b>8,364,392</b>
<b>Little Beaver</b>	<b>30, T. 1 S., R. 56 W.</b>	<b>Producing</b>	<b>1951</b>		<b>J Sand</b>	<b>3,308,276</b>	<b>11,162,158</b>
<b>Little Beaver East</b>	<b>34, T. 1 S., R. 56 W.</b>	<b>Temp Abdn</b>	<b>1954</b>		<b>D Sand</b>	<b>3,671,942</b>	<b>2,375,114</b>
<b>Little Beaver East</b>	<b>26, T. 1 S., R. 56 W.</b>	<b>Abandoned</b>	<b>1954</b>	<b>1973</b>	<b>J Sand</b>	<b>598,333</b>	<b>218,655</b>
Lobo	26, T. 3 N., R. 54 W.	Producing	1963		D & J Sand	71,807	128,817
<b>Lobo</b>	<b>23, T. 3 N., R. 54 W.</b>	<b>Producing</b>	<b>1963</b>		<b>J Sand</b>	<b>356,382</b>	<b>854,468</b>
<b>Lone Valley</b>	<b>28, T. 1 N., R. 54 W.</b>	<b>Producing</b>	<b>1957</b>		<b>J Sand</b>	<b>915,740</b>	<b>383,442</b>
Lone Star	13, T. 3 S., R. 52 W.	Producing	1977		J Sand	99,559	0
Longknife	31, T. 2 S., R. 50 W.	Producing	1978		Niobrara	0	510,412
Mandan	23, T. 1 N., R. 53 W.	Producing	1987		J Sand	70,380	26,817
Mescalero	14, T. 3 S., R. 55 W.	Shut in?	1983		J Sand	17,190	109
Midnight	26, T. 2 S., R. 53 W.	Abandoned	1984	1994	J Sand	44,810	0
Mirage	7, T. 4 S., R. 55 W.	Producing	1989		J Sand	56,256	0
<b>Monte</b>	<b>25, T. 3 S., R. 52 W.</b>	<b>Producing</b>	<b>1964</b>		<b>J Sand</b>	<b>1,733,531</b>	<b>0</b>
<b>Nugget</b>	<b>20, T. 1 S., R. 56 W.</b>	<b>Producing</b>	<b>1955</b>		<b>D Sand</b>	<b>2,489,216</b>	<b>1,207,542</b>
Old Road	18, T. 2 N., R. 54 W.	Abandoned	1989	1993	D Sand	438	54,056
Otis	25, T. 3 N., R. 50 W.	Abandoned	1954	1984	D Sand	0	1,216,193
Overlook	30, T. 2 S., R. 53 W.	Producing	1985		J Sand	34,965	0
Oxbow	9, T. 2 S., R. 56 W.	Producing	1962		J Sand	135,640	0
Pack	19, T. 3 N., R. 53 W.	Abandoned	1979	1989	D & J Sand	0	211,216
Patrol	2, T. 1 N., R. 54 W.	Producing	1964		J Sand	176,850	691
Patrol North	35, T. 2 N., R. 54 W.	Abandoned	1984	1994	D Sand	10,199	36,039
<b>Phegley</b>	<b>30, T. 1 S., R. 55 W.</b>	<b>Producing</b>	<b>1955</b>		<b>D Sand</b>	<b>2,576,611</b>	<b>457,147</b>
Ping	17, T. 2 S., R. 54 W.	Producing	1994		J Sand	47,180	6,037
Pinto	28, T. 3 N., R. 52 W.	Producing	1963		D Sand	81,669	191,928
Pinto	28, T. 3 N., R. 52 W.	Producing	1963		J Sand	170,408	9
Pinto North	16, T. 3 N., R. 52 W.	Abandoned	1979	1987	D Sand	4,246	9,061
Pinto North	16, T. 3 N., R. 52 W.	Abandoned	1979	1984	J Sand	6,262	49,312
Pitch	20, T. 3 S., R. 53 W.	Abandoned	1961	1962	J Sand	5,182	213
<b>Plains</b>	<b>6, T. 3 S., R. 53 W.</b>	<b>Producing</b>	<b>1975</b>		<b>J Sand</b>	<b>434,169</b>	<b>496</b>
Platner	18, T. 2 N., R. 51 W.	Abandoned	1955	1996	D Sand	14,435	78,012
Pleasant Valley	34, T. 3 N., R. 53 W.	Abandoned	1955	1964	J Sand	59,774	20,846
<b>Plum Bush Creek</b>	<b>25, T. 2 S., R. 56 W.</b>	<b>Shut in</b>	<b>1954</b>		<b>J Sand</b>	<b>18,864,859</b>	<b>2,168,463</b>
Poco	13, T. 3 S., R. 53 W.	Abandoned	1967	1967	J Sand	281	0
<b>Pod</b>	<b>27, T. 3 S., R. 50 W.</b>	<b>Producing</b>	<b>1961</b>		<b>J Sand</b>	<b>1,188,831</b>	<b>882</b>
Point Bar	17, T. 3 N., R. 50 W.	Producing	1970		D Sand	82,226	1,670
Purdy	1, T. 2 N., R. 52 W.	Abandoned	1955	1958	D Sand	5,026	2,306
Quest	19, T. 2 S., R. 52 W.	Producing	1993		J Sand	141,232	0
Rago	1, T. 1 S., R. 55 W.	Producing	1953		D Sand	43,174	0

Rago	1, T. 1 S., R. 55 W.	Abandoned	1953	1988	J Sand	86,299	25,207
<b>Rago</b>	<b>1, T. 1 S., R. 55 W.</b>	<b>Abandoned</b>	<b>1953</b>	<b>1988</b>	<b>D &amp; J Sand</b>	<b>281,096</b>	<b>114,320</b>
<b>Rago North</b>	<b>23, T. 1 N., R. 54 W.</b>	<b>Producing</b>	<b>1954</b>		<b>D Sand</b>	<b>791,513</b>	<b>110,481</b>
<b>Rago North</b>	<b>25, T. 1 N., R. 54 W.</b>	<b>Producing</b>	<b>1954</b>		<b>J Sand</b>	<b>2,197,286</b>	<b>395,287</b>
<b>Rainbow</b>	<b>22, T. 2 S., R. 53 W.</b>	<b>Producing</b>	<b>1974</b>		<b>J Sand</b>	<b>462,504</b>	<b>290,927</b>
Ram	3, T. 3 S., R. 56 W.	Abandoned	1977	1981	J Sand	4,051	0
<b>Ramp</b>	<b>8, T. 3 S., R. 55 W.</b>	<b>Producing</b>	<b>1958</b>		<b>J Sand</b>	<b>1,108,891</b>	<b>72,836</b>
Ranchero	29, T. 2 N., R. 53 W.	Producing	1963		D Sand	58,377	624,532
<b>Ranchero</b>	<b>33, T. 2 N., R. 53 W.</b>	<b>Producing</b>	<b>1963</b>		<b>J Sand</b>	<b>1,053,279</b>	<b>714,686</b>
<b>Ranger</b>	<b>30, T. 3 S., R. 51 W.</b>	<b>Producing</b>	<b>1963</b>		<b>J Sand</b>	<b>1,287,726</b>	<b>0</b>
Red Cloud	29, T. 1 N., R. 53 W.	Producing	1969		D Sand	35,634	2,135
<b>Red Cloud</b>	<b>29, T. 1 N., R. 53 W.</b>	<b>Producing</b>	<b>1969</b>		<b>J Sand</b>	<b>281,499</b>	<b>50,614</b>
<b>Redwing</b>	<b>3, T. 2 N., R. 52 W.</b>	<b>Producing</b>	<b>1968</b>		<b>D Sand</b>	<b>1,533,322</b>	<b>2,648,548</b>
Rill	8, T. 4 S., R. 56 W.	Producing	1958		J Sand	138,398	12,036
<b>Ring</b>	<b>2, T. 3 S., R. 56 W.</b>	<b>Producing</b>	<b>1960</b>		<b>J Sand</b>	<b>531,898</b>	<b>103,527</b>
Rockies	12, T. 1 N., R. 53 W.	Shut in?	1994		D Sand	1,123	0
<b>Roderick</b>	<b>15, T. 3 S., R. 54 W.</b>	<b>Producing</b>	<b>1956</b>		<b>J Sand</b>	<b>2,106,481</b>	<b>140,567</b>
Rolling Hills	4, T. 3 S., R. 55 W.	Abandoned	1979	1986	J Sand	16,202	1,197
Rowel	13, T. 3 S., R. 54 W.	Producing	1975		J Sand	137,731	0
<b>Ruby</b>	<b>28, T. 2 N., R. 54 W.</b>	<b>Abandoned</b>	<b>1959</b>	<b>1997</b>	<b>D Sand</b>	<b>584,887</b>	<b>3,664,160</b>
Rush Willadel	26, T. 3 S., R. 51 W.	Producing	1952		Niobrara	0	722,304
<b>Rush Willadel</b>	<b>25, T. 3 S., R. 51 W.</b>	<b>Producing</b>	<b>1952</b>		<b>D Sand</b>	<b>667,171</b>	<b>12,464</b>
<b>Rush Willadel</b>	<b>26, T. 3 S., R. 51 W.</b>	<b>Producing</b>	<b>1952</b>		<b>J Sand</b>	<b>6,111,518</b>	<b>0</b>
Saddle	3, T. 2 S., R. 55 W.	Abandoned	1960	1988	J Sand	125,764	18,823
Sandia Peak	32, T. 2 S., R. 54 W.	Shut in?	1985		J Sand	10,819	0
Sandy	4, T. 1 N., R. 54 W.	Abandoned	1984	1987	J Sand	7,481	0
Santo	12, T. 4 S., R. 55 W.	Producing	1980		J Sand	8,769	0
Sapphire	26, T. 2 S., R. 55 W.	Abandoned	1960	1971	J Sand	115,380	59,450
Santana	35, T. 2 N., R. 53 W.	Abandoned	1989	1995	D Sand	700	109,374
Scottie	33, T. 2 S., R. 49 W.	Producing	1981		Niobrara	0	99,027
Scout	27, T. 3 N., R. 52 W.	Abandoned	1970	1983	D Sand	32,314	0
Shears Draw	11, T. 1 N., R. 54 W.	Abandoned	1955	1959	D Sand	14,687	0
<b>Shears Draw</b>	<b>15, T. 1 N., R. 54 W.</b>	<b>Producing</b>	<b>1955</b>		<b>J Sand</b>	<b>413,214</b>	<b>14,940</b>
Shoal	28, T. 3 N., R. 50 W.	Abandoned	1982	1997	D Sand	17,275	0
<b>Sioux</b>	<b>6, T. 2 N., R. 51 W.</b>	<b>Producing</b>	<b>1967</b>		<b>D Sand</b>	<b>355,692</b>	<b>134,724</b>
Smiley	8, T. 3 N., R. 51 W.	Abandoned	1990	1996	D Sand	12,559	0
Snowflake	36, T. 3 N., R. 54 W.	Abandoned	1972	1984	J Sand	23,483	1,306,610
Sombrero	20, T. 3 S., R. 49 W.	Shut in	1993		Niobrara	0	16,839
<b>Spar</b>	<b>34, T. 1 N., R. 54 W.</b>	<b>Producing</b>	<b>1958</b>		<b>J Sand</b>	<b>878,821</b>	<b>79,836</b>
<b>Spear</b>	<b>25, T. 2 S., R. 50 W.</b>	<b>Producing</b>	<b>1977</b>		<b>Niobrara</b>	<b>0</b>	<b>5,715,884</b>
Stallion	22, T. 3 S., R. 50 W.	Producing	1966		J Sand	89,634	0

Stem	5, T. 1 N., R. 52 W.	Abandoned	1964	1969	D Sand	0	373,293
<b>Stirrup</b>	<b>36, T. 3 S., R. 51 W.</b>	<b>Producing</b>	<b>1968</b>		<b>D Sand</b>	<b>466,411</b>	<b>0</b>
Stony Point	20, T. 2 N., R. 54 W.	Abandoned	1954	1980	D Sand	10,006	9,270
Strand	17, T. 2 S., R. 56 W.	Abandoned	1959	1961	J Sand	4,248	1,274
Sundown	35, T. 2 N., R. 53 W.	Producing	1970		D Sand	100,995	622,648
<b>Sunup</b>	<b>16, T. 3 S., R. 52 W.</b>	<b>Producing</b>	<b>1973</b>		<b>J Sand</b>	<b>252,909</b>	<b>0</b>
<b>Surveyor Creek</b>	<b>15, T. 2 N., R. 52 W.</b>	<b>Producing</b>	<b>1955</b>		<b>D Sand</b>	<b>675,241</b>	<b>4,101,270</b>
<b>Swan</b>	<b>15, T. 2 S., R. 56 W.</b>	<b>Abandoned</b>	<b>1955</b>	<b>1969</b>	<b>D Sand</b>	<b>1,716,466</b>	<b>310,172</b>
<b>Swan</b>	<b>22, T. 2 S., R. 56 W.</b>	<b>Abandoned</b>	<b>1955</b>	<b>1992</b>	<b>J Sand</b>	<b>1,623,013</b>	<b>402,516</b>
Taco	17, T. 1 N., R. 53 W.	Shut in?	1975		D Sand	9,941	120,448
Tap	24, T. 2 N., R. 49 W.	Producing	1975		D Sand	238,146	0
Tarn	31, T. 1 N., R. 53 W.	Abandoned	1961	1967	D Sand	12,273	18,150
Thistle	20, T. 2 S., R. 55 W.	Abandoned	1974	1978	J Sand	16,763	0
Topaz	22, T. 1 N., R. 54 W.	Producing	1957		J Sand	246,027	36,076
<b>Trader</b>	<b>3, T. 3 S., R. 52 W.</b>	<b>Producing</b>	<b>1962</b>		<b>J Sand</b>	<b>788,463</b>	<b>7,739</b>
Trail	19, T. 1 N., R. 53 W.	Abandoned	1960	1964	D Sand	19,594	0
Trail South	30, T. 1 N., R. 53 W.	Abandoned	1973	1982	J Sand	44,132	3,267
Uranus	32, T. 2 N., R. 54 W.	Producing	1978		D & J Sand	170,165	182,509
<b>Vortex</b>	<b>5, T. 2 S., R. 55 W.</b>	<b>Producing</b>	<b>1981</b>		<b>J Sand</b>	<b>1,227,942</b>	<b>0</b>
Wampum	20, T. 3 S., R. 52 W.	Producing	1966		J Sand	234,895	0
Ward	35, T. 1 S., R. 54 W.	Abandoned	1966	1973	J Sand	32,247	0
Warpaint	13, T. 3 N., R. 52 W.	Abandoned	1973	1981	D Sand	5	89,957
<b>Westfork</b>	<b>19, T. 3 S., R. 55 W.</b>	<b>Producing</b>	<b>1956</b>		<b>J Sand</b>	<b>3,703,897</b>	<b>888,287</b>
<b>Wetzel Creek</b>	<b>19, T. 2 S., R. 56 W.</b>	<b>Abandoned</b>	<b>1955</b>	<b>1966</b>	<b>J Sand</b>	<b>399,313</b>	<b>88,185</b>
Whirlpool	24, T. 4 S., R. 53 W.	Abandoned	1980	1997	J Sand	15,994	0
<b>White Eagle</b>	<b>14, T. 2 S., R. 50 W.</b>	<b>Producing</b>	<b>1977</b>		<b>Niobrara</b>	<b>0</b>	<b>6,402,726</b>
Woodlin	1, T. 3 S., R. 55 W.	Abandoned	1984	1995	J Sand	66,807	0
Woodrow East	22, T. 1 S., R. 55 W.	Producing	1952		D Sand	145,775	45,519
<b>Woodrow East</b>	<b>26, T. 1 S., R. 55 W.</b>	<b>Abandoned</b>	<b>1952</b>	<b>1981</b>	<b>J Sand</b>	<b>3,519</b>	<b>2,129,899</b>
<b>Woodrow South</b>	<b>19, T. 1 S., R. 55 W.</b>	<b>Producing</b>	<b>1954</b>		<b>D Sand</b>	<b>458,549</b>	<b>156,980</b>
Woodrow South	18, T. 1 S., R. 55 W.	Shut in	1954		J Sand	73,230	47,127
Xenia	13, T. 2 N., R. 54 W.	Abandoned	1954	1959	D Sand	0	72,659
Xenia	24, T. 2 N., R. 54 W.	Abandoned	1954	1988	J Sand	90,413	147,197
Xenia North	7, T. 2 N., R. 53 W.	Abandoned	1955	1958	D Sand	4,775	23,494
<b>Xenia North</b>	<b>7, T. 2 N., R. 53 W.</b>	<b>Producing</b>	<b>1955</b>		<b>J Sand</b>	<b>856,030</b>	<b>656,722</b>
Xenia West	11, T. 2 N., R. 54 W.	Abandoned	1954	1965	D Sand	49,520	17,025
<b>Xenia West</b>	<b>11, T. 2 N., R. 54 W.</b>	<b>Producing</b>	<b>1954</b>		<b>J Sand</b>	<b>2,649,453</b>	<b>1,318,688</b>
Zephyr	22, T. 3 N., R. 51 W.	Abandoned	1972	1984	D Sand	26,893	83,232
Unnamed	34, T. 3 S., R. 56 W.	Abandoned	1997	1998	J Sand	556	0
Unnamed	24, T. 3 N., R. 49 W.	Producing	1999		D Sand	1,878	0
					<b>County Totals:</b>	<b>153,807,936</b>	<b>102,805,345</b>



BO = barrels of oil, MCF = thousand cubic feet

### **Structural and stratigraphic controls on production**

Washington County is located in the Denver Basin. The Denver Basin was structurally formed by the Laramide Orogeny. The Laramide Orogeny involved Late Cretaceous/Early Tertiary compressional tectonics that caused the Front Range uplift and formation of the Denver Basin. Laramide forces created an asymmetrical structural depression with a steeply dipping western flank and broad, gently dipping eastern flank. The basin axis which separates the western and eastern flanks, parallels and lies about 20 miles east of the eastern edge of the Front Range uplift. Most of the Denver Basin, including Washington County, lies on the widespread, westward dipping eastern flank. Except for minor modifications, the Laramide Orogeny established the Denver Basin's present structural configuration. The basin is bounded on the west by the Rocky Mountain Front Range, on the northwest by the Hartville Uplift, on the northeast by the Chadron Arch, and the Apishapa Uplift and Las Animas Arch on the southwest and southeast, respectively.

Sedimentary formations in the Denver Basin range in age from Mississippian to Recent. The thickest section of sedimentary units is found at the basin's deepest point near Denver, Colorado where 13,000 feet is present. Approximately 70% of this thickness is comprised of Cretaceous sediments (Hemborg, 1993a). Most of the Denver Basin's oil and gas production has been derived from Cretaceous-aged rocks, especially the D and J Sandstones. According to Clayton and Swetland (1980), these Cretaceous units were sourced from carbon-rich intervals in the Skull Creek Shale, Muddy (J) Sandstone, Mowry Shale, Graneros Shale, Carlile Shale and Niobrara Formation. Mature source rocks capable of oil and gas generation are limited to the deeper axial part of the basin (Clayton and Swetland, 1980). Long distance, lateral oil and gas migration of as much as 100 miles is inferred for the sourcing of D and J Sandstone reservoirs, including those in Washington County, on the eastern flank of the Denver Basin (Tainter, 1984).

In the Denver Basin, oil and gas production are derived primarily from Lower and Upper Cretaceous strata. Higley and others (1996) states that more than 90 percent of the Denver Basin's 800+ million barrels oil (MMBO) and 1.2+ trillion cubic feet of gas (TCFG) production has come from the J Sandstone. More than one-half of the province's 1.2 TCF gas has been produced from the Wattenberg Field (Higley and others, 1996).

Higley and others (1996) defined six conventional and five unconventional oil and gas plays in the Denver Basin. Two of the conventional plays, the Dakota Group (Combined J and D Sandstones) play, and Niobrara-Shallow Biogenic Gas play, are present in Washington County. Hemborg (1993) defined five gas plays in the Denver Basin. Three of these plays, D Sand (DB-4), Muddy (J) Sand (DB-5), and Niobrara Chalk Biogenic Gas (DB-3), occur in Washington County. In addition, one of the two Southeast Colorado plays defined by Hemborg (1993), the Morrow and Cherokee Sandstones play (EC-2), may extend into the southeastern corner of Washington County.

Through 2000, Washington County has produced 153.8 MBO and 102.8 BCF from 226 oil and/or gas reservoirs. One hundred thirty-four of these reservoirs are hosted by the Muddy (J) Sandstone, 77 by the D Sandstone, 5 by undifferentiated D and J reservoirs and 10 by the Niobrara. During 2000, 115 reservoirs were productive, 90 were abandoned and 21 were shut in or temporary abandoned. The Muddy (J) Sandstone has produced 66.6% of the county's oil and 26.5% of its gas. The D Sandstone has produced 33.0% of the county's oil and 37.8% of its gas. Average production in Washington County is 659 MBO for D Sandstone reservoirs and 765 MBO for Muddy (J) Sand reservoirs. The Niobrara has produced 36.0 BCF or 35.0% of Washington county's gas total. Average Niobrara reservoir production is 3.6 BCF.

The various play types present in Washington County are described below:

#### **D Sand Play**

The Upper Cretaceous D Sandstone is productive and/or prospective throughout northeast Colorado and southwest Nebraska in the Denver Basin. Gross D Sandstone thickness ranges from a zero depositional edge to

about 100 feet (Hemborg, 1993c). Depth ranges from about 3,800 to approximately 8,300 feet. The trapping mechanism consists of structural and stratigraphic elements with stratigraphy being the dominant control. Depositionally, the D Sandstone consists of older, near shore, fossil-rich marine sediments and younger channel or valley-fill deposits. Average porosity and permeability of reservoir-quality D sandstones in the Denver Basin is 15% and 187 md (Hemborg, 1993c). Although considered a mature play, significant discoveries such as the Lilli field in 1987 as well as the extension of the Woodrow East and Keno fields, Washington County, in the late 1990's points to untapped potential.

The D Sandstone is productive and/or prospective for oil and gas throughout most of Washington County. At the end of 2000, 77 D Sand reservoirs had produced 50,774,231 BO and 38,887,778 MCF or 33.0% and 37.8% of Washington County's total oil and gas production. Twenty-two D Sand reservoirs have exceeded 250 MBO and/or 2 BCF (shown in bold on field production chart) and 11 D Sand reservoirs have produced in excess of 1 million barrels oil. During 2000, 33 producing Washington County D Sandstone reservoirs produced 172,659 BO and 40,051 MCF for a yearly reservoir average of 5,232 BO and 1,214 MCF. The largest D Sand field in Washington County is Little Beaver. Through 2000, Little Beaver has produced 14,155,374 BO and 8,364,392 MCF since its discovery in 1951.

### **J Sand Play**

In the Denver Basin, the Lower Cretaceous Muddy (J) Sandstone is productive and/or prospective throughout portions of northeast Colorado, southeast Wyoming and southwest Nebraska. Gross Muddy (J) Sandstone thickness ranges from a few feet to a maximum of about 150 feet (Hemborg, 1993d). Productive depths range from about 3,700 to approximately 8,400 feet. The primary trapping mechanisms are stratigraphic, structural or a combination of structural/stratigraphic elements. In the southeastern portion of Washington County, trapping is also enhanced or affected by hydrodynamic conditions (Nylund, 1978). Depositionally, early delta front and nearshore marine deposits were followed by later sedimentation of channel origin. Average porosity and permeability of reservoir-quality Muddy J sands in the Denver Basin is highly variable and appears to be depth related. Porosity and permeability range from 7-10% and 0.1 millidarcies (md) at about 9,000 feet to 24% and 200 md at 4,000 feet (Hemborg, 1993d). Although considered a mature play, unexploited potential still exists for the Muddy (J) Sandstone in the Denver Basin. In Washington County two Muddy (J) Sandstone fields, Quest and Hammer Head, were discovered in 1993 and 1998, respectively.

The J Sandstone is productive and/or prospective for oil and gas throughout most of Washington County. At the end of 2000, 134 J Sand reservoirs had produced 102,510,637 BO and 27,253,598 MCF or 66.6% and 26.5% of Washington County's total oil and gas production. Fifty-six J Sand reservoirs have exceeded 250 MBO and/or 2 BCF (shown in bold on field production chart) and 22 J Sand reservoirs have produced in excess of 1 million barrels oil. During 2000, 71 producing Washington County Muddy (J) Sandstone reservoirs produced 502,100 BO and 41,012 MCF for a yearly average of 7,072 BO and 578 MCF per reservoir. The largest J Sand field in Washington County is Plum Bush Creek. Discovered in 1954, Plum Bush Creek has produced 18,864,859 BO and 2,168,463 MCF through 2000.

### **Niobrara Chalk – Shallow Biogenic Gas Play**

The Upper Cretaceous Niobrara Formation is productive and/or prospective in 4 separate geologic settings in the Denver Basin. Higley and others (1996) includes the Niobrara in the 1) Greater Wattenberg Codell/Niobrara, 2) Fractured Niobrara-Greater Silo/Dale Salt-Edge, 3) Fractured Niobrara-Greater Northern Denver Basin, and 4) Niobrara Chalk-Shallow Biogenic Oil and/or Gas Plays. All of these plays, except for the Niobrara Chalk-Shallow Biogenic Gas Play, are conventionally sourced from mature source rocks. The Niobrara Chalk-Shallow Biogenic Play involves reservoirs that are internally sourced. They provide not only the source but the trap for the gas. The gas is biogenically derived by decomposition of organic material at relatively low temperatures in an anaerobic environment (Abbott, 1993). The gas is very dry and methane-rich. All of the Niobrara Chalk-Shallow Biogenic gas fields are on low-relief structures with 50200 feet of closure (Hemborg, 1993b). Depths range from 1,000 feet to about 3,500 feet. The Niobrara Chalk-Shallow Biogenic gas play encompasses parts of eastern Colorado, northwestern Kansas and southwestern Nebraska (Abbott, 1993). The Niobrara is productive and prospective for

biogenically-derived gas in the eastern part of Washington County.

The Niobrara is productive and/or prospective for shallow biogenic gas throughout the eastern portion of Washington County. At the end of 2000, 10 Niobrara reservoirs had produced 36,027,107 MCF or 35.0% of Washington County's total gas production. During 2000, nine producing Washington County Niobrara reservoirs produced 1,433,187 MCF for an average of 159,243 MCF/reservoir. The largest accumulation of Niobrara gas in Washington County is found at the De Nova, Spear White Eagle field complex. Although it contains three field names, it appears to be one continuous reservoir. Through 2000, the De Nova/Spear/White Eagle complex has produced 31,450,429 MCF.

### **Morrow and Cherokee Sandstones Play**

Oil and gas production from Lower Pennsylvanian Morrow Group valley-fill sands and Middle Pennsylvanian Cherokee Group marine sands extends into southeastern Colorado. Average porosity for the Morrow reservoirs is about 16% with permeability ranging from 1 millidarcy to over a darcy (Hemborg, 1993f). The Cherokee sandstones contains porosity of 10% at the representative Bent's Fort Cherokee Sand reservoir in Bent County. The play area for these sands, as defined by Hemborg, 1993, encompasses much of southeastern Colorado and on the northern side includes parts of Lincoln, Elbert, Kit Carson, Yuma and Washington Counties. The southeast corner of Washington County is included in the Morrow and Cherokee Sandstones Play area. Due to the limited number of Morrow penetrations in the area, potential can not be determined.

## **Coal Resources**

There are no known coal resources in Washington County.

## **Metallic Mineral Resources**

There are no known metallic mineral resources in Washington County.

## **Industrial Mineral Resources**

Sand and gravel are the only industrial minerals and construction materials that occur in Washington County and include the following: Sand and gravel for industrial and construction use can be derived from the Quaternary alluvium and eolian sands and the Tertiary Ogallala Formation. Sand and gravel from the Ogallala Formation is used as road base and as an adequate source of aggregate. Most of the smaller drainages in the county have a low ratio of clasts to matrix, which makes them a poor source of construction material. However, the Ogallala Formation is prospective for sand and gravel throughout the county where it is not too deeply buried by Quaternary surficial deposits.

## **Stratigraphic Units Occurring on State Land Board Tracts**

Listed below are geologic descriptions of the Washington County map units.

### **Surface Geologic Units:**

- Qa - Alluvium (Holocene) – Dark yellowish gray to yellowish-tan, crossbedded, unconsolidated silt, sand and gravel alluvial deposits of modern flood plains and stream beds. (Qal on Sterling 1° x 2° Quadrangle)
- Qe – Eolian Sand (Holocene and Pleistocene) – Yellowish-brown to pale-brown to dark yellowish-brown very fine to medium-grained, locally silty, well-sorted loose wind-blown quartz sand. Forms sand sheets with widespread dunes up to 30 m (100 ft) high. (Qes on Sterling 1° x 2° Quadrangle)
- Qb - Broadway Alluvium (Pleistocene – Pinedale Glaciation) – Light olive-brown to yellowish-brown, silty, wellbedded medium sand. Confined to northwest corner of Washington County as terrace above South

Platte River.

- Qp – Peoria Loess (Pleistocene – Pinedale and Bull Lake Glaciations) – Brown to moderate yellowish-brown, slightly clayey to very fine sandy, non-stratified wind-blown, blocky, calcareous silt.
- Qg – Grand Island Formation (Pleistocene) – Reddish-brown, pebbly sand and gravel exposed along tributary of Arikaree River in southwestern Washington County.
- Qr - Rocky Flats Alluvium (Pleistocene – Aftonian Interglaciation or Nebraskan Glaciation) – Reddish-brown or yellowish brown, well-stratified, cobbly gravel and silty sand. Occurs as terrace deposits in southwestern Washington County along Beaver Creek and in the northwestern corner of Washington County along the South Platte River. (Qrf on Sterling 1° x 2° Quadrangle)
- Tou – Ogallala Formation (Upper Miocene) – Fluvial deposit consisting primarily of cobbly gravel that is well-cemented with sandy caliche. Unit contains grayishorange-pink calcite-cemented sand and silt beds which commonly form resistant ridges. Non-consolidated gravel with rounded multi-lithic clasts are abundant. Silt-bearing upper part contains silver-gray and biotite-rich volcanic ash beds with frequent vertebrate fossils. (To on Sterling 1° x 2° Quadrangle)
- Ta – Arikaree Formation (Lower Miocene) – Gray to brown moderately well-consolidated conglomerate, sandstone, siltstone, and claystone of fluvial origin. Some cross-stratified gravel and sand are present. Commonly unconformable with underlying beds. Contains vertebrate fossils. Exposure is limited to northwest Washington County in hills above Jones Flat.
- Tw – White River Group (Oligocene) – Gray to pale-brown silty clay with grayishwhite to gray, medium to coarse, crossbedded sandstone and fine gravel interbeds. Resistant sandstone units are commonly silica-cemented and contain silicified vertebrate bone fragments and teeth.
- Kp – Pierre Shale (Upper Cretaceous) – Dark-gray marine, calcareous silty shale, shaly sandstone, and sandy shale. Upper part contains buff to brown, fine to medium, soft sandstone interbeds. Sand content decreases downward. (Kpt or Upper Transition Member of Pierre Shale on Sterling 1° x 2° Quadrangle)

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