Upper Colorado River Basin Information

January 2007

COLORADO'S DECISION SUPPORT SYSTEMS

COLORADO WATER CONSERVATION BOARD STATE OF COLORADO 1876 1937

COLORADO DIVISION OF WATER RESOURCES

Table of Contents

Figures and Tables

1. The Upper Colorado River Basin

The Upper Colorado River basin lies in west-central Colorado, with the headwaters originating at the Continental Divide in Rocky Mountain National Park. The Upper Colorado River flows in a westerly direction through forested mountains and irrigated valleys before it leaves the state in Mesa County downstream of the City of Grand Junction. The basin encompasses all or a large majority of Grand, Summit, Eagle, Garfield and Pitkin counties, and portions of Mesa, Routt, and Gunnison counties in Colorado. **Figure 1.1** is a map of the basin.

1.1. Physical Geography

The Upper Colorado River basin is approximately 9,916 square miles in size (excluding the Gunnison River basin). It ranges in elevation from 12,800 feet at its headwaters to 4,325 feet near the Colorado-Utah state line. The Upper Colorado River is the primary stream in the basin, with major tributaries including the Fraser River, Williams Fork River, Muddy Creek, Blue River, Eagle River, Roaring Fork River, Rifle Creek, and Plateau Creek. The Gunnison River enters the Colorado River downstream of the major projects and users on the Colorado River. Average annual streamflow in the upper drainage (USGS gage near Grand Lake, Colorado) is approximately 57,000 acre-feet, which increases to an annual average of 4.9 million acre-feet below Grand Junction, Colorado (USGS gage near the state line), including the Gunnison River inflows, for water years 1975 to 2005. The water rights of the Gunnison River basin are not included in the Upper Colorado River Model; rather the Gunnison River is treated as a gaged inflow in the Upper Colorado River Model at USGS gage 09152500.

1.2. Human and Economic Factors

The area remains moderately populated, with the 2000 census estimates placing the combined populations of Eagle, Garfield, Grand, Mesa, Pitkin, and Summit Counties at 252,567. Grand Junction and Glenwood Springs are the major population centers in the basin, with approximately 42,000 and 7,700 residents in 2000 and growth rates of 45 percent and 18 percent, respectively, from 1990 to 2000. Summit and Eagle Counties grew over 83 percent and 90 percent, respectively, from 1990 to 2000. Modest population growth was experienced in Pitkin and Mesa Counties at 17 percent and 25 percent, respectively, over the 1990 to 2000 period. The towns of Aspen and Vail experienced 25 and 28 percent growth, respectively, over the 1990 to 2000 time period. Population growth was generally concentrated in the lower portions of the basin at the existing major population centers. Growth was seen in the upper portions of the basin at a more modest pace. This attests to the continued importance of recreation-based activities, as the ski areas and other outdoor recreation opportunities draw people and increase tourism within the basin.

The major water use in the basin is irrigation, with several thousand irrigation ditches diverting from the mainstem and the numerous tributary streams throughout the basin. Diversions from many of the small irrigation ditches average one or two thousand acre-feet per year. There are also several larger irrigation ditches, such as the Government Highline Canal which diverts approximately 770,000

acre-feet per year. According to the State's geographical information system (GIS) records, total irrigated acreage in the basin (based on 1993 imagery) was approximately 271,000 acres. Irrigated acreage dropped slightly to about 230,000 acres in 2000.

Another major water use in the Upper Colorado River is transmountain diversions. These diversions serve water supply needs for irrigation and municipal uses along the Front Range and eastern plains of Colorado. Major transmountain diversions and the average amount diverted over the model calibration period 1975-2005 are as follows:

- Colorado-Big Thompson (CBT) Project exported approximately 232,000 acre-feet per year via the Alva B. Adams Tunnel for irrigation and municipal use in northern and eastern Colorado,
- City of Denver's Moffat Tunnel System diverted over 57,000 acre-feet per year,
- City of Denver's Roberts Tunnel System diverted approximately 58,600 acre-feet per year,
- Fryingpan-Arkansas Project exported approximately 51,000 acre-feet per year for irrigation and municipal use in southeastern Colorado,
- Independence Pass Transmountain Diversion System diverted approximately 38,500 acre-feet per year for municipal, industrial, and irrigation uses primarily in the Arkansas River basin,
- Homestake Diversion Project diverted approximately 24,000 acre-feet per year from the Upper Eagle River tributaries for municipal use in Colorado Springs and Aurora.

Other major water uses in the Upper Colorado River basin include power generation, industrial, municipal, and transbasin diversions within the basin. Principal power generation diverters include Shoshone Power Station, Grand Valley Power Plant, and Molina Power Plant, with collective historical diversions of approximately 1,064,000 acre-feet per year. Mining operations and snowmaking constitute the remaining major industrial uses in this basin. Diversions for municipal use include large population centers, municipal districts (i.e. Ute Water Conservancy District), and numerous small towns.

In addition to direct ditch diversions, there are 20 operational reservoirs in the model, including three that represent aggregations of numerous small facilities on Grand Mesa. Four reservoirs, including Rifle Gap Reservoir, Harvey Gap Reservoir, Vega Reservoir, and Leon Creek Aggregated Reservoir, are used primarily for irrigation. Six reservoirs, including Shadow Mountain/Grand Lake (modeled as one storage facility), Granby Reservoir, Willow Creek Reservoir, Meadow Creek Reservoir, Homestake Reservoir, and Upper Blue Reservoir, are predominantly used to store water for transmountain diversions. Bonham Aggregated Reservoir and Cottonwood Aggregated Reservoir serve industrial uses. The remaining reservoirs, including Williams Fork Reservoir, Green Mountain Reservoir, Dillon Reservoir, Clinton Gulch Reservoir, Ruedi Reservoir, and Wolford Mountain Reservoir, serve multiple uses, including municipal, industrial, irrigation, recreation, and endangered fish instream flows. With the exceptions of Meadow Creek Reservoir (1975), Clinton Gulch Reservoir (1977) and Wolford Mountain Reservoir (1995), all the above reservoirs were constructed prior to the 1975-2005 water year calibration period. Wolcott Reservoir and Eagle Park Reservoir are included in the model but only as placeholders for additional future scenarios. Three of these reservoirs are below the 4,000 acre-feet cutoff for inclusion in the model. However, Upper Blue

Reservoir (2,113 acre-feet capacity) was added in Phase IIIa to better represent Continental Hoosier system operations; Cottonwood Aggregated Reservoir (3,812 acre-feet capacity) was included to better model the Molina Power Plant in the Collbran Project; and Eagle Park Reservoir was included for future modeling of augmentation operations in the Eagle River Basin.

There are also ten non-operational aggregated reservoirs and one aggregated stock pond in the model. These were added in Phase IIIa to represent an additional 89,833 acre-feet of decreed storage.

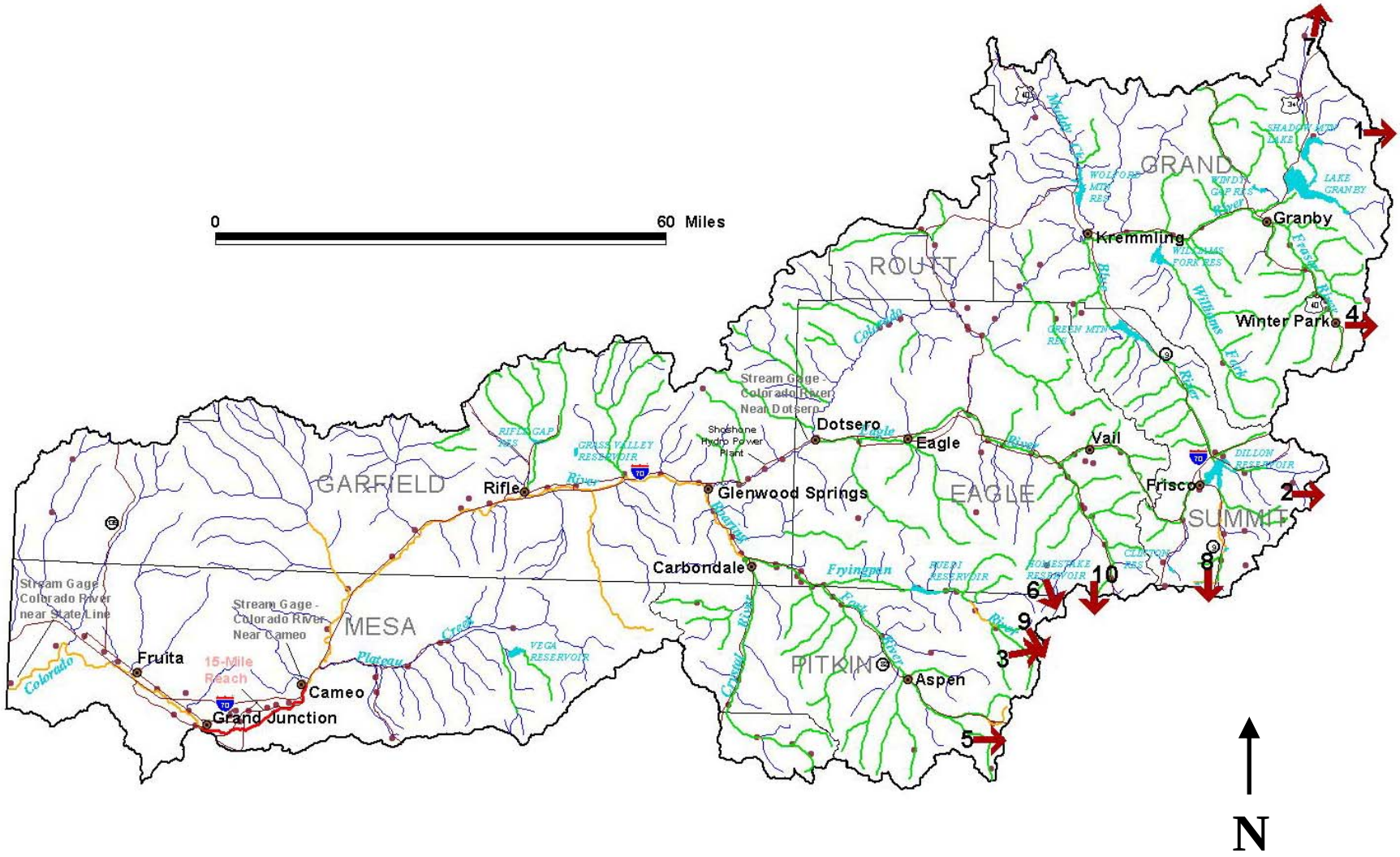

Figure 1.1 – Upper Colorado River Basins

1.3. Water Resources Development

The Upper Colorado River basin has had substantial water resources developments in the form of storage projects and pipelines developed by private groups and federal agencies. **Table 1.1** presents a timeline of key developments within the basin.

Table 1.1
Key Water Resources Developments

Date	Project (West Slope Reservoirs)	Agency
1882	Grand Valley Irrigation Canal	Grand Valley Irrigation Company
1890	Grand River Ditch	Water Supply and Storage Company
1915	Grand Valley Project	United States Bureau of Reclamation
1919	Orchard Mesa Irrigation District	Orchard Mesa Irrigation District
1935	Independence Pass Transmountain Diversion System (Grizzly Reservoir)	Twin Lakes Reservoir and Canal Company
1936	Fraser River Collection System (Meadow Creek Reservoir, Williams Fork Reservoir)	Denver Water Board
1938	Colorado-Big Thompson Project (Grand Lake and Shadow Mountain Reservoir, Granby Reservoir, Willow Creek Reservoir, Green Mountain Reservoir, Windy Gap Reservoir)	United States Bureau of Reclamation
1940	Williams Fork Diversion Project (Williams Fork Reservoir)	Denver Water Board
1948	Continental-Hoosier Diversion System (Upper Blue Lakes, Wolford Mountain Reservoir, Homestake Reservoir)	City of Colorado Springs
1959	Williams Fork Reservoir	Denver Water Board
1961	Homestake Diversion Project (Homestake Reservoir)	City of Colorado Springs - City of Aurora
1963	Collbran Project (Vega Reservoir, Bonham Reservoir, Big Creek Reservoirs, Leon Creek Reservoirs, Cottonwood Creek Reservoirs)	United States Bureau of Reclamation
1964	Blue River Diversion System (Dillon Reservoir, Williams Fork Reservoir, Wolford Reservoir)	Denver Water Board
1968	Silt Project (Rifle Gap Reservoir, Harvey Gap Reservoir)	United States Bureau of Reclamation
1972	Fryingpan-Arkansas Project (Ruedi Reservoir	United States Bureau of Reclamation
1995	Wolford Mountain Reservoir	Colorado River Water Conservation District
TBA	Wolcott Reservoir	Colorado River Water Conservation District

Section 2 provides a detailed description of all the modeled water resources developments within the basin.

1.4. Water Rights Administration and Operations

The primary call on the river during the irrigation season, the Cameo call, is located in the Grand Valley Area where some of the most senior water rights in the basin exist. This call is activated if the combined flows at the Cameo gage (USGS gage 09095500) and the Plateau Creek gage (USGS gage 09105000) fall below 2,260 cubic feet per second (cfs). The other significant call that affects the entire basin is at Shoshone Power Plant, located eight miles downstream of the Dotsero gage (USGS gage 09070500). Senate Document 80 stipulates how water should be administered to satisfy demands at this location.

Two distinct periods revolving around Green Mountain Reservoir operations with respect to the Shoshone call define the historical water rights administration in the Upper Colorado River basin. Prior to 1985, the division engineer administered the river according to a strict interpretation of Senate Document 80. If flows fell below the 1,250 cfs minimum at the Dotsero gage, all transmountain diversions were curtailed or replaced. If streamflow in the Upper Colorado River did not satisfy the Shoshone call, Green Mountain Reservoir would release water to satisfy the shortage. Following the publication of a new operating policy at Green Mountain and a restructuring of its reservoir accounts in 1984, the administration policy described above was revised. From 1985 forward, the division engineer began operating Green Mountain Reservoir as a true replacement facility to Western Slope beneficiaries. In addition, transmountain diversions senior to the Shoshone call were able to divert in priority. This change in policy triggered earlier releases than previously observed from Green Mountain Reservoir.

2. Upper Colorado River Projects and Special Operations

This section contains information that was gathered during initial data collection efforts for the CDSS project. This section discusses the administration and operation of a number of special water rights situations in the Upper Colorado River basin and is intended to provide a general understanding of the operations necessary to incorporate those water rights situations in the CRDSS Upper Colorado River Model.

2.1 Colorado-Big Thompson Project

The Colorado-Big Thompson Project (CBT Project) is a large transmountain diversion project that is operated to divert surplus water from the headwaters of the Upper Colorado River for delivery to irrigated lands in northeastern Colorado, in the South Platte River basin. The water diverted by the CBT Project provides a much needed, supplemental source of water to a service area containing approximately 750,000 irrigated acres. The project was constructed during the period 1938 through 1956 by the U. S. Bureau of Reclamation (USBR) and is jointly operated and managed by the USBR and the Northern Colorado Water Conservancy District (NCWCD). The NCWCD was formed to contract with the United States for construction of the project and is responsible for repayment of the project costs and the administration and operation of the project facilities to deliver the water throughout the service area.

The project was authorized for construction pursuant to Senate Document 80 legislation, which describes the project facilities and the manner of operations to divert the water from the Western Slope without causing injury to other water users in the Upper Colorado River basin. The major Western Slope facilities include: (a) The Alva B. Adams Tunnel, the structure used to convey the water under the Continental Divide for use in the South Platte River drainage; (b) Shadow Mountain Dam and Reservoir, a diversion structure used in conjunction with the natural Grand Lake to provide forebay storage and regulation for diversions into the tunnel; (c) Granby Dam and Reservoir, used to

provide regulation of the peak runoff volumes for delivery to the Adams Tunnel; (d) The Granby Pumping Plant and Pump Canal, used to deliver water from storage in Granby Reservoir to Shadow Mountain Reservoir; (e) Willow Creek Reservoir and the Willow Creek Pump Canal, used to import additional waters from the adjacent Willow Creek drainage; and (f) Green Mountain Reservoir, constructed on the Blue River for purposes of protecting Western Slope water users from injury as a result of the CBT operations. Each of these facilities will be discussed in more detail in the following documentation.

Water from the CBT Project is initially delivered on an allocation basis only to owners of allotment contracts with the NCWCD. A total of 310,000 shares, or units are outstanding. The Board of Directors of the NCWCD annually declares a quota, setting the amount of water to be delivered to each unit. A quota of 100 percent would entitle each unit to delivery of one acre-foot of supplemental water delivered from the project. Similarly, a 50 percent quota would entitle each unit to delivery of 0.5 acre-foot. Historically, the project deliveries have averaged about 230,000 acre-feet per year, representing an average quota of about 75 percent. Water rights for the CBT Project are summarized in Table 2.1.

Table 2.1
Colorado - Big Thompson Project Water Rights[1]

Name	WDID	Decreed Amount Absolute	Conditional
NORTH FORK COLORADO RIVER			
Alva B. Adams Tunnel	514634	550 cfs	
Shadow Mountain Reservoir /Grand Lake	513695	19,669 ac-ft	
Granby Reservoir	514620	543,758 ac-ft	
Granby Pump Canal	510678	1,100 cfs	
WILLOW CREEK			
Willow Creek Reservoir	513710	10,553 ac-ft	
Willow Creek Pump Canal	510958	400 cfs	
BLUE RIVER			
Green Mountain Reservoir[2]	363543	154,645 ac-ft	154,645 ac-ft
Green Mountain Reservoir[3]	363543	6,316 ac-ft	
Green Mountain Direct Flow Hydro-Electric	363543	1,726 cfs	

[1] All rights: Adjudication date October 12, 1955
Appropriation date August 1, 1935
Administration number 31258.00000

[2] Green Mountain Reservoir also holds a junior conditional refill right for 154,645 acre-feet.

[3] Second fill.

2.1.1 Description of Physical Facilities

The following discussion provides a brief description of the physical facilities pertinent to the West Slope operations of the CBT Project.

Alva B. Adams Tunnel (WDID 514634). The Adams Tunnel extends approximately 13 miles under the Continental Divide and conveys Project water from the Upper Colorado River drainage to the South Platte River drainage. The tunnel diverts directly out of Grand Lake, a natural lake located at the junction of Tonahutu Creek, North Inlet Creek and East Inlet Creek. The tunnel has a rated capacity of about 550 cfs. Transmountain diversions through the tunnel are measured and recorded at the east portal of the tunnel.

Shadow Mountain Dam and Reservoir (WDID 513695). This dam and reservoir serves as a diversion structure to intercept the natural flows of the North Fork (mainstem) of the Upper Colorado River for diversion through the Adams Tunnel. The reservoir commands a drainage area of about 187 square miles. Shadow Mountain Reservoir is physically connected to Grand Lake by an open channel and the water surface of the former is maintained at the same elevation of Grand Lake and therefore provides additional forebay storage for diversions into the tunnel. The reservoir also receives water pumped from the downstream storage in Granby Reservoir and serves as a transfer reservoir for routing water into the tunnel.

The specified operation of Shadow Mountain Reservoir limits the fluctuation of the water surface to one foot between the elevations of 8366 ft and 8367 ft above mean sea level (incremental capacity = 1,839 acre-feet). The storage elevation is regulated by releases through the tunnel and pumping from Granby Reservoir. It is not operated to provide regulation or carryover storage. The water surface area at an elevation of 8367 ft is about 1,852 acres.

The 30-inch outlet works for Shadow Mountain Dam has a rated capacity of 100 cfs. Through agreements with the U. S. Forest Service and the Colorado Division of Wildlife, releases are made to ensure a minimum streamflow below the dam. The minimum release is normally 20 cfs (January 1 through May 31); 50 cfs (June 1 through July 31); 40 cfs (August 1 through August 31); 35 cfs (September 1 through October 31) and 45 cfs (November 1 through December 31). This release may be reduced if the inflow to the reservoir is less than these amounts.

Granby Reservoir (WDID 514620). This reservoir provides the majority of the Western Slope regulatory storage for the project and collects water from the intervening drainages downstream of Shadow Mountain Reservoir, including Arapahoe Creek, Cascade Creek, Stillwater Creek and Willow Creek. The reservoir commands an incremental drainage area of about 124 square miles (downstream of Shadow Mountain Dam). Water in Granby Reservoir is pumped up to Shadow Mountain Reservoir, where it is conveyed to the Adams Tunnel for delivery to the Eastern Slope.

Granby Reservoir has a total capacity of about 539,758 acre-feet of which 74,190 acre-feet is dead storage and 465,568 acre-feet is active storage. At this time, all of the active storage is reserved for the sole purpose of supporting the transmountain diversions through the Adams Tunnel. At its normal high water line elevation (Elev. 8280), the reservoir has a surface area of about 7,260 acres.

The reservoir is normally operated to draw down storage during the winter months by the diversion of water through the Adams Tunnel to storage in the East Slope reservoirs of the CBT Project (Horsetooth and Carter Reservoirs). The reservoir is then filled during the following spring runoff. Historic EOM storage contents for the reservoir were obtained from the USBR and are incorporated into HydroBase. Pursuant to the requirements of Senate Document 80, releases are made from Granby Reservoir to ensure a minimum streamflow in the Upper Colorado River below the dam. During the non-irrigation season, October 1 through April 30, the required release is 20 cfs, measured at the stream gage below Granby Dam (Gage ID 09019500). During the irrigation season, the minimum release is measured below the headgate of the Coffee-McQuery Ditch (about two miles downstream of the dam) and is 75 cfs from May 1 through July 31, 40 cfs during August, and 20 cfs during September.

Granby Pumping Plant and Pump Canal (WDID 510678). This facility is used to transfer water from Granby Reservoir to Shadow Mountain Reservoir for delivery to the Adams Tunnel. The plant has three pump units but normally only uses two. The pumping capacity is a function of the number of pumps being used and the water levels in Granby Reservoir and is estimated to range from 340 cfs to 620 cfs.

Willow Creek Reservoir (WDID 513710). This reservoir is used to collect and store surplus water in the Willow Creek drainage and transfer that water to Granby Reservoir via the Willow Creek Pump Canal and Willow Creek Pumping Plant. The reservoir commands a drainage area of about 134 square miles. Inflows to the reservoir are calculated by the USBR using storage content and release data. These calculated inflows were obtained from the USBR and are incorporated into HydroBase. Average annual inflow is approximately 33,700 acre-feet.

Willow Creek Reservoir has a total storage capacity of 10,553 acre-feet of which 1,486 acre-feet is dead storage and 9,067 acre-feet comprises the live storage (inactive storage of 5,738 acre-feet and active storage of 3,329 acre-feet). Operation of the reservoir is normally only within the active capacity of 3,329 acre-feet (above elevation 8,117). In general the reservoir is operated to draw down storage to elevation 8,116 (equivalent to a total capacity of about 7,015 acre-feet) by late October or early November by pumping to Granby Reservoir. This provides capacity for storage of the winter inflows and the following spring runoff. In the spring, the available inflows are pumped to Granby Reservoir and the water in the active storage capacity above elevation 8,117 (equivalent to a total capacity of 7,224 acre-feet) is pumped to Granby as soon as possible. After pumping commences, when the active capacity is drawn back down to elevation 8,117, pumping is curtailed. After this drawdown in the spring, the pumps are operated as necessary to maintain the minimum elevation at 8,117.

When inflows (minus required releases) exceed pumping capacity, the active pool is filled to elevation 8,129, at which time the outlet gates are opened to release excess flows to Willow Creek.

Willow Creek Reservoir is designed to store that portion of the Willow Creek streamflow above the quantity required for downstream fishery flows and to meet the vested water rights of downstream water users. Criteria for the fishery flows require that during the non-irrigation

season (October 1 through April 30), 7 cfs or the reservoir inflow, whichever is less, will be bypassed through the Willow Creek Dam outlet works. No fishery flows are required during the rest of the year. During the irrigation season, water is bypassed in quantities sufficient to satisfy the demands of the downstream water rights that are senior to the CBT project, in particular the Bunte Highline Ditch (WDID 510546). It is noted that this ditch also benefits from the availability of surface tailwater from the Redtop Valley Ditch (WDID 510848 and 511315). The maximum capacity of the Willow Creek outlet works is in excess of 2,000 cfs.

Willow Creek Pump Canal and Willow Creek Pumping Plant (WDID 510958). Water from Willow Creek Reservoir is released into the Willow Creek Pump Canal where it is carried by gravity about 2.3 miles to the Willow Creek Pumping Plant for pumping up into Granby Reservoir. The rated capacity of both the canal and pumping plant is 400 cfs.

When the inflow is being directly pumped to Granby Reservoir, the diversions are credited against the direct flow right.

Green Mountain Reservoir (WDID 363543). This reservoir was constructed as an integral part of the CBT Project with the primary objective of providing replacement water to Western Slope water users of the water that would otherwise be usable if said water was not withheld or diverted by the CBT Project (out-of-priority diversions/storage). A secondary purpose of the reservoir is to store water for hydroelectric power generation and to supply existing irrigation and domestic water users in the Upper Colorado River basin. Green Mountain Reservoir is constructed on the mainstem of the Blue River and commands a drainage area of about 559 square miles, including the area above Denver's Dillon Reservoir. In addition to the mainstem of the Blue River, the reservoir is also filled using diversions from Elliott Creek via the Elliott Creek Feeder Canal (WDID 360606) with a capacity of 90 cfs. In the CRDSS Upper Colorado River Model, the Elliott Creek Feeder Canal is modeled as a carrier ditch which supplies water for the Green Mountain storage right.

Green Mountain Reservoir has a total capacity of about 154,645 acre-feet of which 6,860 acre-feet is dead storage and 147,785 acre-feet is live storage (4,785 acre-feet of inactive storage and 143,000 acre-feet of active storage). Pursuant to the provisions of Senate Document 80, 52,000 acre-feet in the reservoir (the Replacement Pool) is reserved for replacement of the out-of-priority depletions of the CBT Project (diversions through the Adams Tunnel and storage in Shadow Mountain, Granby and Willow Creek reservoirs). The remaining capacity of approximately 100,000 acre-feet (the 100,000 Acre-foot Power Pool) is used for the generation of hydroelectric power generation and the water that is released for power is available to supply existing irrigation and domestic uses on the Western Slope, at no charge.

In 1984, the USBR promulgated a new operating policy for Green Mountain Reservoir that limited use of water from the 100,000 acre-foot power pool for existing Western Slope uses. The policy states that water stored in the reservoir for all existing uses, whose water rights were perfected by use prior to October 15, 1977, would be limited to 66,000 acre-feet. This modified storage pool is referred to as the historic user pool. Subsequent to the implementation of the new operating policy, the remainder of the 100,000 acre-foot pool (34,000 acre-feet) was set aside and made available for contract purchase by industrial water users (entities that were not entitled

to the original benefits of Green Mountain Reservoir operations under the authorizing legislation of Senate Document 80) and by other users with water rights that were perfected by use after October 15, 1977 (The Contract Pool). This pool was later limited to 20,000 acre-feet.

Since the initiation of the new operating policy, the division engineer has administered the releases from the historic user pool to benefit all uses that had been perfected by use prior to January 24, 1984, the effective date of the new operating policy, as published in the Federal Register. However, for future operations, the beneficiaries of the historic user pool will be limited to those uses perfected prior to the specified October 15, 1977 date. These respective inclusion dates will be recognized in the historical versus baseline model scenarios in the CRDSS Upper Colorado River Model.

Storage releases from Green Mountain Reservoir are released through the hydroelectric power plant at rates of flow up to 1,726 cfs (WDID 360881). Although it carries its own direct flow water right, the power right has not been exercised historically to place an administrative call against upstream junior water rights. The USBR has historically operated the reservoir to maintain a minimum streamflow below the dam at 60 cfs. The Colorado Water Conservation Board has appropriated instream flow rights for the reach of the Blue River from Green Mountain Dam to its confluence with the Upper Colorado River. These instream flow rights are 60 cfs for the period May 1 through July 15 and 85 cfs for the remainder of the year. It is the current policy of the USBR to honor these instream flow rights. There is also a general agreement that a bypass/release to maintain these minimum flows will not count against the allowable fill in Green Mountain Reservoir; therefore in the CRDSS Upper Colorado River Model, the bypass should be reflected as an operational right with a priority just senior to the 1935 storage rights for the reservoir.

2.1.2 Historical Operation of Green Mountain Reservoir

From the time construction of Green Mountain Reservoir was completed (1948) until 1984, the reservoir was operated in strict accordance with the following provisions of Senate Document 80.

1. *Whenever the flow in the Upper Colorado River at the present site of said Shoshone Diversion Dam is less than 1,250 cfs, there shall, upon demand of the authorized irrigation division engineer or other State authority having charge of the distribution of waters of this stream, be released from said reservoir* [Green Mountain] *as part of said 52,000 acre-feet, the amount necessary with other waters available, to fill the vested appropriations of water up to the amount concurrently being diverted or withheld from such vested appropriations by the project for diversion to the eastern slope.*

2. *Said 100,000 acre-feet shall be stored primarily for the power purposes, and the water released shall be available, without charge, to supply existing irrigation and domestic appropriations of water, including the Grand Valley reclamation project, to supply all losses chargeable in the delivery of said 52,000 acre0feet of water, and for future use for domestic purposes and in the irrigation of lands thereafter to be brought under cultivation in western Colorado. It shall be released within the period from April 15 to October 15 of each year as required to supply a sufficient quality to maintain the specified flow of 1,250 cubic feet per second of water at the present site of said Shoshone diversion dam, provided this amount is not supplied from the 52,000 acre-feet heretofore specified. Water not required for the above purposes shall also be available for disposal to agencies for the development of the shale oil or other industries.*

During this time period, if the flow at the Shoshone Diversion Dam (WDID 530584), as measured at the Dotsero stream gage (Gage 09070500), was less than 1,250 cfs, the division engineer would first curtail all transmountain diversions (other than CBT) before making a release from Green Mountain Reservoir. As a result of this method of administration, Green Mountain typically remained reasonably full during the summer irrigation season and was drawn down beginning in September and reaching its low point in storage by the end of April of the following year. A significant portion of the water was being released for power generation without the additional benefit of supplementing existing Western Slope irrigation uses.

In 1985, the division engineer began to administer the river in accordance with the priority system, with the result that many of the transmountain diversions that historically had been curtailed by the division engineer (Denver and Colorado Springs) were actually in priority and entitled to divert. The junior rights that would be called out by the Shoshone Call and/or the Cameo Call were more likely to be junior Western Slope water users. This method of administration has tended to trigger an earlier release of water from the 100,000 acre-foot power pool in Green Mountain Reservoir.

Current Operations of Historic User Pool. In addition to Shoshone, the primary call on the Upper Colorado River is associated with a number of senior water rights that divert for irrigation and power purposes in the Grand Valley area near Grand Junction. Collectively, the demands for these rights are referred to as the Cameo Call (See separate documentation regarding these rights). As described in the accompanying documentation, the magnitude of the Cameo call is dependent upon operation of the Orchard Mesa Check, a facility that can be operated in a manner that could reduce the call. Issues related to the operation of the Check structure are currently the subject of litigation in Case No. 91CW247, the Orchard Mesa Check Case. Resolution of these issues will have a significant impact on the future operations of Green Mountain Reservoir, in particular, the historic user pool.

As part of settlement discussions in the referenced case, the USBR, in conjunction with the division engineer, is to develop criteria for the operation of the historic user pool with the objectives of: (1) Ensuring that sufficient water is available in Green Mountain Reservoir to meet the replacement needs of the historic user pool beneficiaries; (2) Ensuring that sufficient quantities of water are available in the historic user pool to meet direct delivery needs at Cameo;

(3) Ensuring that sufficient water remains in the historic user pool at the end of each irrigation season to meet winter demands of historic user pool beneficiaries; and (4) Providing a methodology to determine the amount of the historic user pool that is surplus to the anticipated needs of the historic user pool beneficiaries and would therefore be available for delivery for other beneficial uses in the Upper Colorado River basin, including augmentation of flows in the critical 15-Mile Reach for protection and recovery of endangered fish species. As of March 1996, the studies performed by the USBR have indicated that amount of water that needs to be reserved for historic user pool beneficiaries upstream of the Shoshone power plant may be only about 15,000 acre-feet annually (out of the 66,000 acre-feet in the historic user pool). The reduction is largely a reflection of replacing only the consumptive use as opposed to headgate diversion requirements. The USBR and division engineer have developed a preliminary rule curve for the release of water from the historic user pool, consistent with the above objectives.

Consolidated Case Nos. 2782, 5016 and 5017 (the Blue River Decree). In this 1955 adjudication, the relative priorities of the storage rights and hydroelectric rights for Green Mountain Reservoir and the upstream rights at Dillon Reservoir and the Continental-Hoosier System (Colorado Springs) were specified.

Continental Hoosier System	77 cfs	August 5, 1929
Green Mountain Reservoir	154,645 acre-feet	August 1, 1935
Green Mountain Hydro	1,726 cfs	August 1, 1935
Green Mountain Senior Refill	6,315 acre-feet	August 1, 1935
Montezuma Tunnel (Roberts Tunnel)	788 cfs	June 24, 1946
Dillon Reservoir	252,678 acre-feet	June 24, 1946
Continental-Hoosier System	400 cfs	May 13, 1948
Continental-Hoosier Storage	5,306 acre-feet	May 13, 1948

In this decree, Colorado Springs and Denver obtained the right to divert and store water at their upstream facilities on an out-of-priority basis, if it can be determined that Green Mountain Reservoir will likely fill. Because the cities have storage in the upper Blue River basin, they are in a position to repay Green Mountain in the event the latter did not fill. This agreement to allow out-of-priority upstream diversions is assessed only against the senior storage decree at Green Mountain and does not apply to an administrative call placed by the Green Mountain direct flow hydroelectric right because the cities agreed to pay power interference charges to offset the potential impacts of upstream diversions as against the hydroelectric right.

When Denver incurs a liability to repay Green Mountain Reservoir for water stored out-of-priority at Dillon Reservoir, provisions of the Blue River Decree, as more specifically described in a 1964 Stipulation and Agreement, allow Denver to replace the water owed by substituting releases from its Williams Fork Reservoir. In 1991, the agreements were again modified to allow use of the proposed Wolford Mountain Reservoir as an additional source of substitution supply for waters owed to Green Mountain Reservoir by Denver. Theses agreements also make reference to a requirement for Denver to maintain a pool of 1,000 acre-feet in Dillon Reservoir, which must be released to Green Mountain Reservoir, to the extent necessary to maintain the flow in the Blue River below Dillon Dam at 50 cfs.

Definition of Green Mountain Fill has been a debated topic over time. There are different legal interpretations of when Green Mountain has reached its fill and when the senior August 1, 1935 first fill right is satisfied.

The Division 5 administration is outlined in the Interim Policy and was adopted by the State Engineer "to give water users certainty about administrative and accounting principles concerning Green Mountain Reservoir" and is, at the time of this update, the current administration of the Blue River Decree. The Interim Policy specifically outlines the components to the Paper Fill of Green Mountain Reservoir under its August 1, 1935, first fill right. The Paper Fill is defined to be met when 154,645 acre-feet is equal to the sum of:

1. Initial storage in Green Mountain Reservoir at the beginning of the administration year,
2. Stored water in Green Mountain Reservoir after the administration date,
3. Bypassed water in excess of 60 cfs or the demand of a downstream call senior to August 1, 1935,
4. Out-of-priority depletions from HUP and Contract beneficiaries upstream of Green Mountain Reservoir, and
5. Out-of-priority diversions and storage made by Denver and Colorado Springs.

After a paper fill has been met Green Mountain Reservoir stores under the October 10, 1955, "exchange" right up to the amount of water stored and diverted out-of-priority to its 1935 storage right by Denver and Colorado Springs. According to Alan Martellaro, Division 5 Engineer, this interpretation is based on the reservoir fill right being administered senior to the hydroelectric right, even though they have the same administration number. Alan Mrtellaro has administered the Blue River Decree under the Interim Policy from 2003 to the time of this update (2006).

The Denver Water Board and the USBR have alternate legal interpretations of the Blue River Decree. According to Denver Water planning staff, for planning purposes, they currently attempt to model the Blue River Decree according to the 2006 Interim Policy and the "Division 5 interpretation."

Green Mountain Reservoir has a senior re-fill storage right in the amount of 6,316 acre-feet, with an appropriation date of August 1, 1935. It can only be exercised after completion of the first fill right. Releases for replacement of depletions of Senate Document 80 beneficiaries and replacement of evaporation losses can be credited to the re-fill account. If any re-fill water remains in storage at the start-of-fill, it is considered as part of the contents of the reservoir for the next year's fill.

There is a conditional junior re-fill storage right for Green Mountain Reservoir (Case No. 88CW22) for 154,645 acre-feet, which can be exercised only after the senior re-fill right is satisfied. For purposes of accounting, the junior re-fill right has the same administration date as the conditional re-fill right for Dillon, pending in Case No. 87CW376. When in priority, the available flow shall be divided in a manner which essentially allows Green Mountain to store its share of the inflow originating below Dillon and allows Denver to store its share of inflow originating above Dillon Reservoir. Denver will observe the 50 cfs bypass and Green Mountain will observe the 60 cfs/85 cfs bypass requirements. These bypasses are not considered storable inflow for the junior re-fill right.

Contract User Pool. In the CRDSS Upper Colorado River Model, those water right structures that are currently entitled to contract water from Green Mountain Reservoir are attached to the Contract Pool via an operational right. For the CRDSS baseline scenario, all other structures with Green Mountain contracts that are not now in the model are aggregated as a single demand node just below Green Mountain Reservoir. This demand node is assumed to be 100 percent consumptive, since these contracts are primarily for augmentation uses. Table 2.2 summarizes all of the contractors who are entitled to water in this pool.

Table 2.2
Green Mountain Reservoir Water Service Contracts
(as of January 1, 1996)

Contractor Name	Amount (ac-ft)	Use*
Above Green Mountain		
BRECKENRIDGE, TOWN OF	800	M
COLOROW AT SQUAW CREEK	9	M
COPPER MTN. WATER & SANITATION	96	M
DONLON, JAMES D. AND SANDRA K.	98	IR
FOX, CHARLES B.	24	IR
HAMILTON CREEK METROPOLITAN	16	M
HILLYARD, JERRY & JULIE	100	IR
JOHNSON FAMILY TRUST II	5	M
KENSINGTON PARTNERS	490	M
KEYSTONE RESORTS MGMT., INC.	26	M
KEYSTONE RESORTS MGMT., INC.	43	M/I
L.G. EVERIST, INC.	39	I
NORTH BARTON CREEK LTD. LIAB. CORP.	24	M
ROLFES, GEORGE A.	3	M
S.G. COMPANY	66	IR
SILVERTHORNE, TOWN OF	250	M
SPLIT CREEK ASSOCIATES	10	M
Subtotal	2099	
Below Green Mountain		
ANDERSON, B.B. & BRUNKHARDT, J	2	M
B & B EXCAVATING, INC.	37	I
BARTLETT, D.M. & S.L.	1	M
BERNKLAU, CARL H. & NORA RUTH	40	M/IR
COLLET, J. FRED	12	M
CORDILLERA PROPERTY OWNERS	73	M
COUNIHAN CORPORATION	21	M
CRAGHEAD, JERRY & ALICE	47	IR
DANIELS, GEORGE H., III	22	M
EAGLE COUNTY, COLORADO	50	M
EAGLE GYPSUM PRODUCTS	270	I
EAGLE, TOWN OF	125	M
ELK TROUT, INC.	10	M/IR
ENCLAVE AT TRAVIS CREEK PARTNER.	4	M
FAITH PARTNERS	65	I

Contractor Name	Amount (ac-ft)	Use*
GALLEGOS MASONRY, INC.	6	IR/I
GYPSUM, TOWN OF	25	M
LANG-BURCHFIELD, DIANE	20	M/IR
MOORE, JAMES J. & MICHAEL D.	1	M
NIELSEN, R.A. CONSTRUCTION CO.	8	I
PITTEL, S. & CARETTO, G.	15	M
RANCHO DEL RIO	1	M
RED CANYON ACRES HOMEOWNERS ASSOC.	1	M
RED CANYON ESTATES HOME ASSOC.	13	M
SCHULTZ, ELBERT, DAVID, JAMES	10	IR
SHEPARD, SUZANNE	1	M
SPRING CREEK HOMEOWNERS ASSOC.	15	M
STODDARD, CHARLES M.	14	M
TELLER SPRINGS HOMEOWNERS ASSOC.	83	M
UPPER EAGLE REGIONAL WATER AUTHORITY	220	M
VAIL ASSOCIATES, INC.	300	I
VAIL ASSOCIATES, INC.	359	M/I
VAIL VALLEY CONSOLIDATED WATER	934	M/I
WESTERN MOBILE NORTHERN, INC.	50	I
Subtotal	2855	
Total for All Current Contracts	4954	

* Use Codes: IR = Irrigation, M = Municipal, I = Industrial

2.1.3 Windy Gap Project

The Windy Gap Project was constructed by the Municipal Subdistrict of the Northern Colorado Water Conservancy District to provide an additional, independent water supply of about 48,000 acre-feet per year for use by municipal and industrial users on Colorado's Eastern Slope. The project is designed to divert surplus flows from the Upper Colorado River during the spring runoff and deliver the water to the Eastern Slope, using excess carriage capacity in the CBT project facilities. The Windy Gap water is diverted from a small regulating storage pond (Windy Gap Reservoir) at the confluence of the Upper Colorado and Fraser rivers (WDID 514700) and is pumped into Granby Reservoir. The rated capacity of the pump station is 600 cfs. The structure has three absolute water rights, which cumulatively total 600 cfs and a storage right for the reservoir in the amount of 1,546.14 acre-feet (approximately 320 acre-feet of active storage). The Windy Gap water rights are summarized below.

Windy Gap Project Water Rights

Name	WDID	Admin. Number	Adjud. Date	Approp. Date	Decreed Amount
Windy Gap Reservoir	513742	43621.42906	5/31/1972	6/22/1967	445 ac-ft
Windy Gap Pump PL Canal	514700	43621.42906	5/31/1972	6/22/1967	300 cfs
Windy Gap Pump PL	514700	46751.46211	12/31/1978	7/9/1976	100 cfs

Canal Windy Gap Pump PL Canal	514700	47602.00000	12/31/1980	4/30/1980	200 cfs

As a term of settlement with various Western Slope water users, diversions by the project are limited to not more than 90,000 acre-feet in any single year and not more than an average of 65,000 acre-feet per year in any consecutive 10 year period. The Windy Gap diversions are also subordinated, by agreement, to all existing and future junior direct flow diversions for municipal, domestic and irrigation uses in the Fraser River basin. The effect of this subordination is expected to be minimal since these junior uses are relatively small and have minimal consumptive use.

As a further condition of settlement, the Municipal Subdistrict agreed to certain minimum streamflow values downstream of the Windy Gap Diversion Dam. Windy Gap diversions cannot occur unless the following minimum flows requirements on the Upper Colorado River are satisfied:

- Windy Gap Diversion Dam to Confluence with Williams Fork River: 90 cfs
- Williams Fork Confluence to Confluence with Troublesome Creek: 135 cfs
- Troublesome Creek Confluence to Confluence with Blue River: 150 cfs

In case numbers 80CW446, 447 and 448, the CWCB appropriated instream flow rights in these same amounts and river reaches. The CWCB rights are slightly junior to the Windy Gap water rights. The Windy Gap project was completed in 1985 and the first diversions occurred in 1986. These historical diversions can be used for purposes of calibrating the model.

2.2 Denver Water

The Denver Board of Water Commissioners (Denver) operates two extensive water collection systems in the Colorado River Basin. The first located in the Williams Fork and Fraser River basins diverts water through a system of open canals, closed conduits and tunnels to the West Portal of the Moffat Tunnel. The tunnel conveys the water to the headwaters of South Boulder Creek on Colorado's Eastern Slope. Delivery of the transmountain water is regulated using the storage in Gross Reservoir and Ralston Reservoir. The following discussion summarizes the key components of the Moffat Tunnel System.

Denver's second system is located on the Blue River consisting of Dillon Reservoir and Harold D. Roberts Tunnel, discussion of this system is located in section 2.2.6.

2.2.1 Williams Fork Diversion Project

The Williams Fork Diversion Project collects water from a number of small tributary streams at the headwaters of the Williams Fork River and diverts it into the Gumlick Tunnel a.k.a. the Jones Pass Tunnel (WDID 514603). The major streams from which water has historically been diverted include: (1) McQuery Creek; (2) Jones Creek; (3) Bobtail Creek; and (4) Steelman

Creek. The decreed amounts that have been made absolute are summarized in the following table. These water rights were all adjudicated on November 5, 1937 and granted an appropriation date of July 4, 1921 (administration no. 30870.26117).

Source	Total Decreed Amount (cfs)	Amount Absolute (cfs)
McQuery Creek	70	48.6
Jones Creek	25	21.5
McQuery - Jones Creek	115	70.0
Bobtail Creek	195	115.0
Steelman Creek	150	90.0
Middle Fork - Williams Fork	350	0
Allen Creek	250	0
South Fork - Williams Fork	200	0
Middle Fork Feeder	50	0

Denver has also adjudicated a number of conditional water rights for a future extension and enlargement of the Williams Fork collection system, including rights on Darling Creek. These rights carry a 1953 priority date.

The Gumlick Tunnel has a decreed capacity of 620 cfs under the 1921 priority date, of which 214 cfs has been made absolute. The maximum physical capacity is limited to approximately 500 cfs. The Tunnel conveys the water into the headwaters of the West Fork of Clear Creek. Here, the water can be delivered directly into the Clear Creek drainage; however, the flow is normally re-diverted back to the West Slope through another tunnel, the Vasquez Tunnel, for ultimate delivery to Gross Reservoir via the Moffat Tunnel.

According to Denver personnel, the primary operational objective for the Williams Fork Collection System is to achieve a fill of Gross Reservoir. As such, the collection system has a higher operational priority than storage in Williams Fork Reservoir. Once it is determined that Gross Reservoir will fill, the general practice has been to cease diversions at the collection system in favor of storage at Williams Fork Reservoir.

CRDSS Considerations - For the CRDSS, the entire Williams Fork Collection System is modeled as a single node at the west portal of the Gumlick Tunnel (WDID 514603), with a tributary drainage area based on the total area above Denver's collection facilities (13.9 square miles).

2.2.2 Williams Fork Reservoir

Williams Fork Reservoir is located in the lower reaches of the Williams Fork River, about two miles upstream of its confluence with the Upper Colorado River. According to information obtained from Denver, the reservoir has a total storage capacity of 96,822 acre-feet, measured to the top of the spillway gates. All of this storage is considered as active storage therefore there is no dead storage. The reservoir has a storage decree for 93,637 acre-feet, adjudicated in November 5, 1937 with a priority date of November 10, 1935. The reservoir is also an integral part of a number of Denver's exchange operations, including: (1) an exchange for direct flow

diversions at the Williams Fork Collection System and the Fraser River Diversion Project (Moffat Tunnel) and (2) an exchange for diversions at other units of Denver's system, including Dillon Reservoir and the Roberts Tunnel. Denver also obtained a more junior storage right for Williams Fork Reservoir, which added power generation as a beneficial use of the water. This right, which carries an appropriation date of October 9, 1956, can also be considered as a re-fill right for the reservoir.

Denver operates a small hydroelectric generating facility, installed on a secondary outlet from the reservoir and which is rated at three megawatts. Depending upon the available pressure head in the reservoir and the number of turbines in operation, the flow required for hydroelectric generation ranges from about 100 cfs (one megawatt) to 280 cfs (three megawatts). Denver obtained a decree for this facility, the Williams Fork Power Conduit (WDID 511237) for 295 cfs with an appropriation date of October 9, 1956.

In general, Williams Fork Reservoir is operated to provide replacement water to downstream senior water rights on the Upper Colorado River so that Denver's junior water rights at the Williams Fork, Fraser River and Blue River diversion projects can continue to divert water, by exchange. The water is diverted transbasin through the Moffat and Roberts tunnels, at times when the water rights for these facilities would otherwise be out-of-priority. According to Denver personnel, there is not a formal operating plan (rule curve) for the reservoir. However, the reservoir is typically operated in the following manner:

1. Storage and releases are managed to allow the reservoir to fill without spilling by the end of July (if the water is physically and legally available)

2. Spills are minimized by controlled releases through the hydroelectric plant on the reservoir outlet (see discussion below)

3. Once the reservoir has achieved its maximum storage for the year, it is held at that level until an administrative call is initiated from the mainstem (usually the call from the Shoshone Power Right)

4. When the call comes on, releases are made from the reservoir to replace on-going, out-of-priority diversions at the Williams Fork, Fraser and Dillon/Roberts Tunnel diversions

5. When replacement releases are being made, the release rate typically ranges from 240 cfs to 280 cfs, the flow rate necessary to generate maximum power from the Williams Fork Hydroelectric Plant (3 megawatts). As the demand for replacement water tapers off, the flow rate is reduced down to about 100 cfs, the minimum flow rate required for minimum generation of hydroelectric power (1 megawatt). In a dry year, Denver will reduce the release rate to 50-60 cfs, turning off the hydroelectric diversions and using only the normal reservoir outlet works.

6. Since approximately 1988, the reservoir releases are currently controlled in a manner to draw down the reservoir during the fall and winter months to a capacity of approximately 60,000 acre-feet, as carry-over for the following year. Prior to 1988, because Denver's

municipal demand was less, the reservoir was typically drawn down to an even greater extent with the objective of maximizing power generation. Denver uses an internal flow forecast model to project inflows to the reservoir and to plan for storage levels and power generation. It is noted that the generation of hydroelectric power is not a primary function or goal of the reservoir operation but rather a byproduct benefit realized from operation for the primary purpose of replacing out-of-priority diversions.

Denver - Henderson Mill Exchange. During the CRDSS study period, Denver maintained a separate account in Williams Fork Reservoir as part of the Denver-Henderson Mill Exchange, which also involves a portion of the yield from the City of Englewood's Cabin-Meadow Creek Project and Meadow Creek Reservoir (see subsequent discussion) and the diversions at the Henderson Mill (WDID 511070) in the upper reaches of the Williams Fork River. During times when Henderson is diverting water out-of-priority with respect to Denver's Williams Fork Collection system, Denver would forego diversions at its collection system in quantities necessary to protect the diversions at the Henderson Mill. Denver would receive, as replacement, water from Henderson's 3,000 acre-foot account in Meadow Creek Reservoir. At times when there is an administrative call from the Upper Colorado River (e.g. Shoshone), Denver would provide replacement for Henderson's out-of-priority diversions using releases from a 2,200 acre-foot account reserved in Williams Fork Reservoir. This account is used when necessary to allow Henderson to continue to divert water when the Henderson water rights would otherwise be out-of-priority with respect to the Upper Colorado River.

Williams Fork Exchanges. The interaction of Williams Fork Reservoir with the operation of the Roberts Tunnel and Dillon Reservoir is discussed in more detail in a separate sections of this documentation.

2.2.3 Fraser River Diversion Project

The Fraser River Diversion Project (numerous WDIDs) diverts water from the Fraser River and a number of its tributaries and delivers it into the Moffat Tunnel (WDID 514655) for conveyance to Gross Reservoir on the East Slope. The major drainages from which the diversions are made include: (1) the St. Louis Creek Drainage, (2) the Vasquez Creek Drainage (including water imported from the Williams Fork basin via the Gumlick and Vasquez tunnels), (3) the Fraser/Jim Creek Drainage, and (4) the Ranch Creek Drainage (South, Middle and North). There are multiple headgate structures in each of these drainages and the absolute water rights at each location are summarized below. All of these water rights were adjudicated on November 5, 1937 and have an appropriation date of July 4, 1921 (administration number 30870.26117).

Source	Total Decree Amount (cfs)	Amount Absolute (cfs)
West St. Louis Creek	112	42
St. Louis Creek	700	214
Vasquez Creek	275	70
Little Vasquez Creek	75	0
Fraser River	275	275
Jim Creek	75	75
Buck Creek	75	0
Cooper Creek	10	0
South Ranch Creek	280	50
Middle Ranch Creek	180	114
Ranch Creek	112	63
North Ranch Creek	112	79

The Fraser Diversion System is operated as the primary source of supply to the Moffat Tunnel and to Gross Reservoir. Historically, except for dry runoff years, there has been more water physically and legally available to the Fraser River collection system than has been diverted through the tunnel, largely because of the available storage capacity in Gross Reservoir and the magnitude of the demand at Denver's North side (Moffat) Water Treatment Plant. Denver anticipates that future operations of Gross Reservoir will include a larger reserve of carry-over storage to accommodate dry year demands and as such, the Fraser River system could be exercised to a greater degree.

For the CRDSS, the Fraser River Diversion Project is subdivided into four sub-basins: (1) the St. Louis Creek sub-basin (WDID 511309), (including West St. Louis, St. Louis, East St. Louis, Fool, King, East King, West Elk and Elk creek drainages), (2) the Vasquez/Little Vasquez sub-basin (WDID 511310), (3) the Fraser River/Jim Creek sub-basin (WDID 510639), and (4) the Denver Ranch Creek Project (WDID 511269). Denver maintains a number of flow measurement stations on the Fraser River system and records of the historical diversions for each of the sub-basins were obtained from Denver for the CRDSS study period, 1974 through 1991. For future reference, the historical diversions from the St. Louis sub-basin are estimated as the measured flow at Vasquez Gage No. 2 minus the flow at Vasquez Gage No. 3. The historical diversions from the Vasquez/Little Vasquez sub-basin are estimated as the measured flow at Vasquez Gage No. 1 minus the inflow from the St. Louis sub-basin minus the imported water from the Williams Fork River basin, via the Gumlick and Vasquez tunnels. The diversions from Jim Creek and the Fraser River are measured directly. The diversions from the Denver Ranch Creek system are estimated as the measured flow at the Ranch Canal Gage minus the deliveries from the Englewood Ranch Creek Project (see the following discussion).

Pursuant to agreements with the U.S. Forest Service, Denver has agreed to maintain a minimum flow below its primary diversion structures in the Fraser Collection System. These minimum bypass flows are as follows:

Creek Name	May 15 - September 15	September 15 - May 14
St. Louis Creek	10 cfs	3 cfs
Vasquez Creek	8 cfs	3 cfs
Fraser/Jim Creek	10 cfs	4 cfs
Ranch Creek Canal	4 cfs	2 cfs

There are also a number of other bypass agreements with local water users on Vasquez Creek but they are of minimal magnitude and are not reflected in the CRDSS Upper Colorado River Model.

2.2.5 Englewood Cabin – Meadow Creek Project (Meadow Creek Res.)

In the early 1970s, the City of Englewood, in conjunction with American Metals Climax (Climax), constructed a collection system to divert waters from other tributaries of the Fraser River, specifically, Meadow Creek (25 cfs), Trail Creek (25 cfs), Hurd Creek (25 cfs), Hamilton Creek (70 cfs), Cabin Creek (70 cfs), and Little Cabin Creek (70 cfs). The reported capacity of the pipeline is 25 cfs from Meadow Creek to Hurd Creek, 40 cfs from Hurd Creek to Hamilton Creek and 60 cfs from Hamilton Creek to the Denver system. There are stipulated minimum bypass flows at each of the diversion structures, all of which are relatively minor and are not included in the CRDSS Upper Colorado River Model.

All of the water rights were adjudicated in 1937 and granted an appropriation date of July 2, 1932 (administration no. 31259.30133). The water rights are slightly junior to Denver's Fraser River Diversion Project water rights, although they are not located on the same tributary streams. The Englewood Cabin-Meadow Creek system is physically connected to Denver's Ranch Creek Collection system, where it is subsequently conveyed through the Moffat Tunnel for use on the East Slope. On the Eastern Slope, Englewood historically received delivery of its Cabin-Meadow Creek water pursuant to an exchange agreement with Denver in which the transmountain delivery of water to Denver's North Side system was exchanged for delivery to Englewood from Denver's South Platte River sources.

A major component of the Englewood Cabin-Meadow Creek System is Meadow Creek Reservoir (WDID 513686), constructed on Meadow Creek at the northern end of the collection system. The reservoir has a total capacity of 5,700 acre-feet, of which approximately 5,370 acre-feet is active. The reservoir has an absolute storage decree is for 5,100 acre-feet (July, 1932 priority date) and a conditional decree for 294 acre-feet (May 29, 1923 priority date, - administration no. 34241.26811). Meadow Creek Reservoir is used to provide regulating and carryover storage for the project.

Historically (prior to 1995), the first 3,000 acre-feet in Meadow Creek Reservoir were reserved for Climax as a source of replacement water for the operation of the Henderson Mill (WDID 511070) in the Williams Fork River basin. The Henderson Mill water rights are junior to the water rights used by Denver at its Williams Fork Collection System in the headwaters of the Williams Fork basin. Pursuant to the exchange agreements between the three parties (Denver, Climax and Englewood), Climax (Henderson) had the right to use up to 3,000 acre-feet of its

water in Meadow Creek Reservoir as replacement to Denver for diversions at the Henderson Mill that would have otherwise been out-of-priority with respect to Denver's water rights. The exchange agreements also provided for Henderson to maintain a separate replacement account (2,200 acre-feet) in Denver's Williams Fork Reservoir to replace Henderson's out-of-priority depletions when the administrative call originates downstream of the Williams Fork.

A separate storage account is reserved in Meadow Creek Reservoir for the benefit of the Vail Ditch (Grand County Irrigation Company). This ditch historically diverted from Meadow Creek (WDID 511231) at a point just below the reservoir and from the adjacent Strawberry Creek drainage (WDID 510941). These diversions are made pursuant to its own direct flow rights (65.94 cfs at WDID 511231 and 63.5 cfs at WDID 510941). To supplement these direct flow diversions, the Vail Ditch is entitled to 850 acre-feet of storage capacity in the reservoir, together with 30 percent of the storable Meadow Creek inflows through June 30 of each year and all of the inflow after July 1. Direct flow diversions from Meadow Creek by the Vail Ditch are only allowed after the ditch has fully utilized its water right out of Strawberry Creek. The storage water is released upon request of the Vail Ditch and delivered through its system for irrigation in the Strawberry Creek area near the town of Granby. Records obtained from Denver indicate that the total diversions from Meadow Creek by the Vail Ditch (both direct flow and storage) averaged about 2,460 acre-feet during the CRDSS study period.

Delivery of direct flow water and storage water from the Englewood Cabin-Meadow Creek system is measured through a flume at the point of connection to Denver's Ranch Creek system (Measured flow at Cabin Gage No. 1 minus the flow through a spill gage - Cabin Gage No. 2). Records of the historic delivery into Denver's system were obtained from Denver for inclusion in the CRDSS. For the CRDSS time period of 1975 through 1991, the average annual delivery of the Cabin-Meadow Creek systems was about 5,583 acre-feet. Historically, about 61 percent of the system yield derives from storage releases from Meadow Creek Reservoir and 39 percent of the yield is attributable to the direct flow rights on the tributary streams.

Records maintained by Denver indicate that during the 1975 through 1992 period, the Henderson Mill replacement account yielded an average of about 2,600 acre-feet (about 47 percent of the total yield of the Cabin-Meadow Creek system). However, only about 1,200 acre-feet were actually needed by Henderson to support out-of-priority diversions at the Henderson Mill. The remaining portion of the Henderson yield was diverted by Denver through the Moffat Tunnel, pursuant to the agreements.

In 1995, the operation of the Cabin-Meadow Creek project was modified, with the result that the Henderson exchange account is no longer operated. In the future, the entire system yield is now diverted by Denver and Englewood through the Moffat Tunnel. Out-of-priority diversions at the Henderson Mill will now be replaced using water in Denver's Williams Fork Reservoir, pursuant to a new agreement.

2.2.6 Denver Water – Dillon Reservoir/Roberts Tunnel System

The Denver Board of Water Commissioners (Denver) operates Dillon Reservoir and the Harold D. Roberts Tunnel as primary features of its raw water collection and transmountain diversion system. Waters diverted pursuant to the direct flow decree of the Roberts Tunnel, together with releases from storage in Dillon Reservoir are conveyed under the Continental Divide to the headwaters of the North Fork of the South Platte River on Colorado's Eastern Slope. The following discussion summarizes the key elements of the system operation.

The Harold D. Roberts Tunnel (a.k.a. Montezuma Tunnel). The Harold D. Roberts Tunnel (WDID 364684) diverts directly from Dillon Reservoir at a submerged inlet on the east side of the lake and extends about 23 miles to its point of delivery in the North Fork of the South Platte River. The tunnel has an estimated capacity of 788 cfs. In a March 10, 1952 adjudication, Denver obtained a direct flow water right for the tunnel in the amount of 788 cfs and an appropriation date of June 24, 1946 (administration no. 35238.00000). Of this decreed amount, 520 cfs have been made absolute. On the Blue River, the Roberts Tunnel water right is junior to the storage rights of Green Mountain Reservoir and the direct flow rights of the senior portion (1929) of the Continental-Hoosier diversion project. Diversions through the tunnel are influenced by the downstream water rights for Green Mountain Reservoir, downstream calls from either the Shoshone Power Plant or the Cameo area water rights and the availability of water in other parts of Denver's system to replace out-of-priority diversions (Williams Fork Reservoir).

Dillon Reservoir. Dillon Reservoir (WDID 364512) is located on the mainstem of the Blue River and commands a drainage area of about 335 square miles, including the major tributaries of Ten Mile Creek and the Snake River. With the Roberts Tunnel, Dillon Reservoir is the major source of future raw water supplies for the City of Denver. According to information obtained from Denver, the reservoir has a total storage capacity at its normal high water line of 257,305 acre-feet of which 3,269 acre-feet represent dead storage. The active capacity is therefore 254,036 acre-feet. The reservoir has an absolute storage water right for 252,678 acre-feet, adjudicated in 1952 with a priority date of June 24, 1946 (administration no. 35238.00000). The outlet works from the reservoir is equipped with a hydroelectric generating facility, with a capacity of about 100 cfs. However, it generates power using only the releases that are made from the reservoir for other purposes. There is no direct flow right for the hydroelectric operation.

In regards to historical operations of Denver's Western Slope diversion projects, the Dillon/Roberts Tunnel system is the last supply used and is generally used to top off Denver's storage reservoirs in the South Platte River basin (Antero, Elevenmile and Cheesman reservoirs). For this reason, relatively little water has been diverted through the Roberts Tunnel in wet runoff years (in the South Platte basin) and significant quantities have been diverted in dry years.

According to Denver personnel, there is not a formal operating plan (rule curve) for the reservoir. However, the reservoir is typically operated in the following manner:

1. During the winter months, the reservoir is operated to draw its storage down by approximately 50,000 acre-feet, with the lowest point of storage generally occurring in

April. This drawdown is accomplished by a release (bypass) to maintain a minimum flow in the Blue River below the dam at 50 cfs and by winter diversions through the Roberts Tunnel at a rate of about 100 cfs. The tunnel diversion is used to help minimize icing problems in the North Fork of the South Platte.

2. Beginning in May, Dillon Reservoir begins to fill. (Note that there is generally sufficient inflow to physically fill Dillon Reservoir in most years; the inflow exceeds 100,000 acre-feet even in dry runoff years). Denver monitors the filling of its Eastern Slope reservoirs (using the Eastern Slope storage rights) and evaluates the potential need to divert water from the Blue River to ensure a fill of the South Platte reservoirs. If it is projected that the Eastern Slope reservoirs will need additional water, diversions through the Roberts Tunnel are initiated. The majority of these diversions occur in June and July.

3. The water rights for Dillon Reservoir and the Roberts Tunnel are junior to the downstream Green Mountain Reservoir and technically would not be allowed to store/divert until Green Mountain fills. However, in accordance with a number of decrees and agreements (see following discussion), Denver is allowed to temporarily store water in Dillon Reservoir, out-of-priority with respect to storage in Green Mountain, if there is a reasonable likelihood that the latter will fill using inflows between Dillon and Green Mountain (including all required bypasses at Dillon). Denver accounts for this Green Mountain Account in its operation of Dillon Reservoir. If Green Mountain fails to achieve a Blue River Decree Fill, Denver must release the water it stored and/or diverted out-of-priority.

   In determining the Blue River fill entitlement, all water diverted pursuant to the United States' direct flow water right at Green Mountain for power generation (1,726 cfs) is not included. Denver has separately negotiated to repay out-of-priority storage with respect to these hydroelectric diversions on the basis of power interference using other sources of power.

   In accordance with the provisions of the Blue River Decree and agreements with the USBR, Denver can also repay Green Mountain by substituting water from Williams Fork Reservoir and/or Wolford Mountain Reservoir. In fact, this is the normal method of replacement.

4. According to Denver, Dillon Reservoir generally fills by June 30. If and when it is determined that Green Mountain and Dillon will fill and spill, it is Denver's policy to divert as much water as possible through the Roberts Tunnel, providing that there is an Eastern Slope need: (a) to complete the fill of Denver's Eastern Slope reservoirs; or (b) the Roberts Tunnel water can be used directly to meet municipal demands.

5. When Dillon stops filling because of decreasing inflows or because of a senior downstream call, Denver stops direct flow diversions through the Roberts Tunnel and begins to deliver storage water from the reservoir through the tunnel, as required. In accordance with the terms of the Blue River Decree and other operating policies of Denver, the Blue River supply is generally the last source of water used by Denver to meet its municipal demands (after use of native South Platte sources and transmountain diversions through the Moffat system).

6. Denver has agreed to maintain a minimum flow in the Blue River below Dillon Dam of 50 cfs or the reservoir inflow; whichever is less. In 1987, Denver constructed a hydroelectric power plant on the outlet from the reservoir. Since that time, there has been adequate water available to operate the power plant at rates of about 100 cfs (rather than the minimum of 50 cfs). For future scenarios in the CRDSS, the required release should be 50 cfs.

7. When water is stored in Dillon Reservoir, out-of-priority with respect to Green Mountain Reservoir, the first 1,000 acre-feet of this storage is allocated to a temporary storage account (the 1,000 acre-foot pool), which is essentially Green Mountain water stored in Dillon. Water in this account is to be released from Dillon Reservoir as necessary to maintain flows at 50 cfs, immediately downstream of the Dillon Dam. If Green Mountain Reservoir fails to fill, Denver repays Green Mountain first with any water remaining in this temporary 1,000 acre-foot storage account (if necessary to increase the flow below Dillon Dam to 50 cfs) and then by an exchange from Williams Fork Reservoir and/or Wolford Mountain Reservoir. On April 15 of each year, if it is determined that Green Mountain will fill, any water remaining in the 1,000 acre-foot pool will be booked over into Denver's storage in Dillon.

Summit County Agreement. Pursuant to negotiations for the anticipated construction of Denver's Two Forks Reservoir, Denver entered into a September 1985 agreement with Summit County in which the County agreed to support the Two Forks Project and Denver agreed to subordinate a portion of its Blue River water rights (Dillon Reservoir and Roberts Tunnel) to provide water for new uses in the County. The agreement gave Summit County the right to divert and consume up to 3,100 acre-feet of water annually at locations upstream of Green Mountain Reservoir. Of this amount, 1,750 acre-feet were to be used for domestic, municipal, commercial and irrigation (M & I water) and 1,350 acre-feet were to be used for snowmaking purposes.

In order to compensate Denver for the loss of water resulting from the subordination, the County agreed to provide Denver with 1,211 acre-feet of contract water from Green Mountain Reservoir or from some other acceptable source, including: (a) water from Granby Reservoir pursuant to the Middle Park Water Conservancy District's contract and (b) irrigation water rights owned by the town of Breckenridge. The required amount of replacement is computed as: (1) 0.58 acre-foot of replacement water to Denver for each consumptive acre-foot of water used for M & I uses; and (2) 0.145 acre-foot for each acre-foot diverted for snowmaking.

Through its own studies, Denver determined that the total consumptive use upstream of Dillon that could potentially result from implementation of the Summit County Agreement would be about 2,088 acre-feet, assuming 100 percent of the M & I water (1,750 acre-feet) and 25 percent of the snowmaking water would be consumed.

The Summit County Agreement also contains a number of other provisions, including: (a) an agreement to release up to 100 acre-feet of water per year from Dillon Reservoir, which water would be used by the County for augmentation when junior rights in the County would otherwise be called out by senior rights downstream of Dillon Reservoir (in this situation, the County agreed to pay back Denver 1.4 acre-feet for each acre-foot of water released from the reservoir), (b) an agreement to release up to 300 acre-feet for augmentation purposes by the town of Silverthorne, and (c) an agreement to maintain desirable lake levels in Dillon Reservoir to enhance recreational and aesthetic benefits to the County (these desirable lake levels are conditioned upon construction of a South Platte Reservoir and only to the extent they do not restrain Denver's ability to meet its municipal water delivery obligations).

The 3,100 acre-feet of yield from the original Summit County Agreement was allocated to the various users as follows:

- Breckenridge Ski 233 acre-feet
- Copper Mountain 331 acre-feet
- Keystone 1,500 acre-feet
- Snake River WD 100 acre-feet
- Summit County 108 acre-feet
- Town of Breckenridge 602 acre-feet
- Town of Dillon 84 acre-feet
- Town of Frisco 100 acre -feet
- Blue River WD 42 acre-feet

As will be discussed in the following discussion of the Clinton Gulch Reservoir Agreement, the original Summit County Agreement has been downsized as several of the parties have surrendered all or significant portions of their original entitlement. Currently, the remaining water under the Summit County Agreement is 1,020.5 acre-feet (out of the original 3,100 acre-feet), allocated as follows:

- Breckenridge Ski 8.0 acre-feet
- Copper Mountain 61 acre-feet
- Keystone 15.5 acre-feet
- Blue River WD 42 acre-feet
- Town of Breckenridge 602 acre-feet
- Town of Dillon 84 acre-feet
- Snake River WD 100 acre-feet
- Summit County & Misc. 108 acre-feet

As can be seen, most of the water originally contemplated for snowmaking purposes at the

Summit County ski areas is no longer covered by the Summit County Agreement, but rather has been supplanted by the Clinton Gulch Reservoir Agreement (see following discussion). Of the remainder, only the 602 acre-foot entitlement of the town of Breckenridge is of major significance to the CRDSS effort.

Clinton Gulch Reservoir Agreement. The Summit County Agreement contemplated the use of contract water in Green Mountain Reservoir as the primary means of compensating Denver for the subordination of its water rights for the benefit of the County. Subsequently, a number of the Summit County entities sought to modify the Summit County Agreement with the intent of securing a more reliable source of supply other than the Green Mountain contracts. This effort was driven, in part, by the acquisition of Clinton Gulch Reservoir (WDID 363575) from the Climax Molybdenum Co. This reservoir has an absolute decree for 4,250 acre-feet of storage with an appropriation date of June 25, 1946 (junior to Denver's decrees for Dillon Reservoir and the Roberts Tunnel).

In July 1992, Denver and these parties (including Summit County, the Summit County Ski Areas, the Summit County towns, the Grand County towns and the Winter Park Ski Area) entered into the Clinton Gulch Reservoir - Fraser River - Water Agreement (Clinton Gulch Reservoir Agreement) to further provide additional water supplies for Summit and Grand Counties. One of the effects of this new agreement was the downsizing of the original Summit County Agreement, as will be discussed below. Although the agreement was not in effect during the CRDSS study period it has a significant role in the future operations of the upper Blue River and upper Fraser River basins. As such, additional discussion of the Clinton Gulch Reservoir Agreement is warranted.

Pursuant to the Clinton Gulch Reservoir Agreement, Denver agreed to operate its Dillon Reservoir and Roberts Tunnel water rights so as to allow Clinton Gulch Reservoir to store up to 3,650 acre-feet each year, during the period August 1 through July 31. Engineering studies indicate that the maximum fill of 3,650 acre-feet will produce a reliable, firm annual yield of about 1,200 acre-feet. This reservoir yield is then used to repay Denver for the consumptive use attributable to snowmaking at the ski areas and other beneficial uses, including augmentation. Denver will allow the Summit County Ski areas (Breckenridge, Keystone and Copper Mountain) to divert water for snowmaking and will correspondingly release water from Williams Fork Reservoir in amounts and at times required to augment the snowmaking diversions, by exchange. The amount of snowmaking diversions cannot exceed five times the amount of reservoir yield in Clinton Gulch Reservoir to which the ski areas are entitled. Denver reserved the right and claim to all return flows from snowmaking. The snowmaking consumptive use is estimated at 20 percent of the total diversion and is credited to Denver's account in Clinton Gulch Reservoir as the exchange occurs.

The Agreement also provides water for snowmaking at the Winter Park Ski Area in Grand County under a similar repayment scheme. Here, Denver agreed to diversions by Winter Park from its Fraser River Collection System and Winter Park agreed to credit Denver's account in Clinton Gulch Reservoir in an amount equal to the consumptive use of snowmaking (20 percent of the snowmaking diversions). To the extent that return flows from snowmaking at Winter Park do not return above Denver's collection system, Winter Park is obligated to credit Denver's Clinton account at a rate of one acre-foot for each acre-foot which cannot be recaptured.

Denver cannot exchange water from Williams Fork Reservoir to the Summit County Ski Areas at any time when the computed natural inflow to Dillon Reservoir is less than 50 cfs. In years when Denver has water in the 1,000 acre-foot pool (see above), water in this pool can be released from Dillon Reservoir and used to supplement the computed natural inflow and accordingly, allow upstream municipal diversions and exchanges for snowmaking to occur. If insufficient water is available in the pool, Denver will not make the exchanges. Sufficient water is considered to be available only to the extent that storage in the 1,000 acre-foot pool exceeds the following minimum values:

October 1 - January 31	188 acre-feet
February 1 - February 28	135 acre-feet
March 1 - March 7	113 acre-feet

Key to the Clinton Gulch Reservoir Agreement were amendments to the Summit County Agreement such that: (1) the M & I consumptive use limitation was reduced from 1,750 acre-feet to 1,151.6 acre-feet and (2) the total diversion was reduced from 3,100 acre-feet to 1,217.8 acre-feet. Breckenridge, Copper Mountain and Keystone agreeing to reduce their entitlements under the original agreement by 1,882.2 acre-feet accomplished this downsizing. This downsizing left 1,168 acre-feet of consumptive use water available to the beneficiaries of the Summit County Agreement and created a surplus of 920 acre-feet, the rights to which were then conveyed to the Grand County users, including Winter Park.

The 920 acre-feet of water is delivered to Grand County users in the form of a bypass at Denver's collection systems in the Fraser and Williams Fork basins. The bypass water is in addition to all other minimum flows that Denver had previously been required to bypass at the headgates of its Fraser River Collection system. To the extent that the entire 920 acre-feet obligation is not bypassed and used by users in Grand County, Denver will release water from Williams Fork Reservoir to make up any shortage. In exchange for the 920 acre-feet, the Grand County water users must provide replacement water to Denver on the basis of 0.67 acre-foot for every acre-foot of bypass water released by Denver between September 15 and May 15 of the year and 1.33 acre-feet for every acre-foot released between May 16 and September 14. The source of this replacement water is contract water in Wolford Mountain Reservoir purchased by Grand County water users and assigned to Denver.

The Clinton Gulch Reservoir Agreement also contains provisions for Summit County, the town of Dillon, the town of Frisco and Copper Mountain to reduce their respective entitlements to water from the original Summit County Agreement in exchange for water stored in Dillon Reservoir (future Dillon Reservoir water) on the basis of one acre-foot in the reservoir for every acre-foot of reduction. Any Summit or Grand County water user can then use the future Dillon

Reservoir water as a source of year-round augmentation. In order to use this future Dillon Reservoir water, the user must provide replacement water to Denver on the basis of 1.58 acre-feet for every acre-foot of future water. The primary sources of this replacement water would be Green Mountain Reservoir, Wolford Mountain Reservoir or other sources acceptable to Denver, including Clinton Gulch Reservoir water itself. As of January 1996, the town of Frisco had exercised this option and converted 100 acre-feet of its original Summit County Agreement water to future Dillon Reservoir water (December 1994) and Copper Mountain had converted 97.3 acre-feet (November 1995).

The Clinton Gulch Reservoir Agreement provides that up to 343 acre-feet of water in Clinton Gulch Reservoir can be released for subsequent diversion by the Copper Mountain Ski Area (WDID 361016). All return flows from this use (reservoir release less 20 percent consumptive use for snowmaking) is treated as a new supply to Denver and is credited against any consumptive use repayment water owed to Denver by any other snowmaking user.

The Keystone Ski Area (WDID 360908) can use its Summit County Agreement water or its Clinton water by an exchange on the Snake River providing that the instream flows on the Snake River are not adversely impacted. Otherwise, Keystone has the rights to divert directly from Denver's Roberts Tunnel (via the Montezuma Shaft) up to 1,500 acre-feet per year. To repay Denver, Keystone causes a release from Clinton Gulch Reservoir in an amount equal to 20 percent of its total diversion used for snowmaking (if the water is used for other purposes, the consumptive use is computed using factors referenced in the Agreement).

The town of Breckenridge may use its reservoir yield from Clinton Gulch Reservoir to exchange against out-of-priority storage in Goose Pasture Tarn. This exchange is made on an acre-foot for acre-foot basis and can only occur when the computed natural inflow is greater than 50 cfs. The Breckenridge Ski Area can also exchange its reservoir yield from Clinton Gulch Reservoir to storage in Goose Pasture Tarn for subsequent snowmaking uses. Because of return flows from snowmaking, the ski area is obligated to release (or credit to Denver's account in Clinton Gulch Reservoir) only 0.2 acre-foot for each acre-foot stored in the Tarn for snowmaking uses.

The ownership interests for the Clinton Ditch and Reservoir Company were obtained from the current shareholders list and are shown below:

Participant	Percent	Firm Yield	Avg. Yield
Town of Breckenridge	10.83	130 ac-ft	390 ac-ft
Town of Dillon	1.67	20 ac-ft	60 ac-ft
Town of Silverthorne	4.58	55 ac-ft	165 ac-ft
Breckenridge Ski Area	12.63	152 ac-ft	455 ac-ft
Copper Mountain Resort	13.63	163 ac-ft	490 ac-ft
Keystone (all)	36.25	434 ac-ft	1,305 ac-ft
Winter Park Rec. Assoc.	7.50	90 ac-ft	270 ac-ft
Summit County	12.92	155 ac-ft	465 ac-ft
Total	100.00	1,200 ac-ft	3,600 ac-ft

The accounting required for proper operation of the Clinton Gulch Reservoir Agreement is relatively complex and is based upon a number of exchanges, different consumptive use factors,

return flow accounting, etc. For the initial set-up of the CRDSS Upper Colorado River Model, it is recommended that these storage allotments be connected through a special operations file to each of the respective diversion nodes for the town of Breckenridge (WDID 361008), Breckenridge Ski Area (WDID 360989), Copper Mountain (WDID 361016), Keystone Snowmaking (WDID 360908), Keystone municipal (WDID 365002), and the town of Dillon (WDID 360829). The remaining entities are not presently included in the CRDSS Upper Colorado River Model.

2.3 Fryingpan – Arkansas Project

The Fryingpan - Arkansas Project (Fry-Ark) is a large, multipurpose transmountain diversion project water development constructed by the USBR during the years 1963 through 1980. The purpose of the project is to divert surplus, unappropriated water from the headwaters of the Roaring Fork River basin on Colorado's Western Slope, for use in the more populated and water short Arkansas River basin on the Eastern Slope. The water diverted by the Fry-Ark Project provides a much-needed source of supplemental water supplies for municipal use in the Arkansas River basin (Colorado Springs, Pueblo and the smaller municipalities along the river) and supplemental irrigation supplies for about 280,000 acres of land. The Southeastern Colorado Water Conservancy District (SECWCD) was created for the purpose of developing and administering the Project and is the legal agency responsible for repayment to the USA for the reimbursable part of the project. The District boundary extends along the Arkansas River from Buena Vista to Lamar and along Fountain Creek from Colorado Springs to Pueblo.

Features of the Fry-Ark Project in the upper reaches of the Arkansas River basin include: Turquoise Lake; Mount Elbert conduit; Mount Elbert forebay; Mount Elbert pumped-storage power plant; Twin Lakes Reservoir; Pueblo Reservoir and the Fountain Valley Pipeline. Project features on the Western Slope, the primary concern of this CRDSS documentation, include: the North Side collection system; the South Side collection system, including Hunter Creek; the Charles H. Boustead Tunnel under the Continental Divide; and Ruedi Reservoir. Each of the Western Slope features is described in more detail below.

Using a 1928 through 1965 study period, the USBR performed operation studies to estimate the yield of the Fry-Ark Project. The average annual yield was estimated to be about 80,400 acre-feet for the combined operations of both Western Slope and Eastern Slope operations. The amount of water that is potentially divertible from the Western Slope is estimated to be about 72,000 acre-feet per year. Operating principles negotiated by the SECWCD provide the following additional limitations on the transmountain diversions: (1) a maximum annual diversion through the Boustead Tunnel in any one year of 120,000 acre-feet and (2) aggregate diversions not to exceed 2,352,800 acre-feet in any consecutive 34-year period (equivalent to an average annual diversion of 69,200 acre-feet). These values are exclusive of waters diverted pursuant to the exchange with the Twin Lakes Reservoir & Canal Company. The yield of the Project was initially allocated on the basis of 51 percent to municipal and domestic uses and 49 percent to irrigation uses.

2.3.1 Description of Physical Facilities

The following discussion provides a brief description of the physical facilities pertinent to the Western Slope operations of the Fry-Ark Project.

Charles H. Boustead Tunnel (WDID 384625). The Boustead Tunnel extends approximately 5.4 miles under the Continental Divide and is used to convey all water collected at the project facilities in the headwaters of the Fryingpan River and Hunter Creek to Turquoise Lake in the Arkansas River drainage. The rated capacity of the 10.5 foot diameter tunnel is 945 cfs. Transmountain diversions through the Boustead Tunnel are measured and recorded at the east portal of the tunnel. Records of the historical diversions were obtained from the Division of Water Resources database, supplemented by USGS records.

North Side Collection System. The North Side Collection System is designed to divert, collect and transport an average of about 18,400 acre-feet of water annually through facilities at Mormon, Carter, Ivanhoe, Granite, Lily Pad, North Cunningham, Middle Cunningham and South Cunningham Creeks. This collection system consists of diversion structures on each of these major tributaries of the North Fork of the Fryingpan River and a series of tunnels (Carter Tunnel, Mormon Tunnel, Cunningham Tunnel and Nast Tunnel) to deliver the water to the west portal of the Boustead Tunnel. The diversions at each of these tributaries are measured and recorded by the division engineer in cooperation with the USBR and the SECWCD.

The operating principles for the Fry-Ark Project prescribe minimum bypass requirements at each of the tributary diversion structures. The CWCB has appropriated instream flow water rights for all of these tributaries. The CWCB instream flow rights are junior to the project water rights and are typically decreed in amounts less than or equal to the required bypasses. In addition, the following minimum flow requirements must be satisfied with respect to the Fryingpan River as measured at the Thomasville gaging station (USGS Gage No. 09078600):

- April 100 cfs
- May 150 cfs
- June 200 cfs
- July 100 cfs
- August 75 cfs
- September 70 cfs
- October through March 30 cfs

Records of the historical diversions at each of the diversion points in the North Side Collection System were obtained from the USBR, commencing on the date the facility was activated.

South Side Collection System. The South Side Collection System is designed to transport an average of 50,800 acre-feet of water annually from the Fryingpan and Roaring Fork river basins. Facilities located on No Name, Midway and Hunter Creeks are used to collect water in the headwaters of the Hunter Creek basin for delivery via the Hunter Tunnel to the Fryingpan River basin, which in turn is delivered to the Boustead Tunnel. Additional facilities on Sawyer Creek, Chapman Creek, the South Fork of the Fryingpan River, and the mainstem of the Fryingpan are

used to collect and transport water from these tributaries to the west portal of the Boustead Tunnel. The diversions at each of the tributaries are measured and recorded. The operating principles provide for minimum bypass requirements at each of the diversion structures on the South Side Collection System (except Sawyer Creek).

Ruedi Reservoir (WDID 383713). Ruedi Reservoir is located on the mainstem of the Fryingpan River about 15 miles east of Basalt and is used to provide replacement storage for out-of-priority diversions at the North Side and South Side collection systems. Additional storage is available for contract sale to meet irrigation, municipal, and industrial water needs in western Colorado and is a source of supply for instream flow benefits on the lower Upper Colorado River, including the 15-Mile Reach, critical to habitat for endangered fish species.

Ruedi Reservoir has a total capacity of about 102,373 acre-feet of which 1,095 acre-feet is dead storage and inactive storage. The remaining active storage capacity is 101,278 acre-feet. At its normal high water line (elevation 7,766), the water surface area of the reservoir is about 998 acres. The principal outlet works for the reservoir has a capacity of about 1,800 cfs.

The reservoir is normally operated to maximize control of spring runoff, accommodate recreational interests and provide for downstream fishery requirements. Through releases to downstream fishery requirements and sales of contract water, the reservoir is typically drawn down during the fall and winter months, reaching a low point in storage by March or April of the following spring. During the winter, release rates and drawdown targets are periodically adjusted as necessary to ensure a fill of the reservoir under anticipated runoff conditions. Inflows are projected using the snow survey data provided by the Soil Conservation Service. Through agreements to accommodate recreational interests, the reservoir is not normally drawn down to below elevation 7,706, corresponding to a storage volume of 53,000 acre-feet. This informal agreement will be honored only until long-term contract sales are developed for additional use of the stored waters.

Based on projections of the inflow to the reservoir, the release rates are managed to achieve a fill during the spring or early summer. Historically, the reservoir generally fills by late June or July. Following the fill, the reservoir is operated as long as possible to enhance recreational uses by maintaining the water level between elevations 7764 and 7766, corresponding to capacities of 100,390 acre-feet and 102,373 acre-feet. This mode of operation continues until it becomes necessary to draw down the reservoir for contract sales and/or demands for additional releases for downstream fisheries.

As part of the original operating principles, minimum fishery bypass requirements downstream of Ruedi Reservoir were established in the following amounts: (rates of flow or the actual reservoir inflow, whichever is less):

- November 1 through April 30 39 cfs
- May 1 through October 31 110 cfs

The USBR has provided records of the historical EOM storage contents for Ruedi Reservoir, as well as historical inflow-outflow data.

2.3.2 Water Rights

SECWCD obtained water right decrees for the project works of the Fryingpan-Arkansas Project. The majority of the project water rights were adjudicated on June 20, 1958 and were granted an appropriation date of July 29, 1957. All of the rights share an administration number 39291.00000. As can be observed, most of the water rights have been made absolute. These water rights are summarized in Table 2.3.a.

Table 2.3.a
Frying Pan-Arkansas Project Water Rights[1]
(Western Slope Features)

Name	WDID	Amount (cfs) Absolute	Conditional
NORTH SIDE COLLECTION SYSTEM			
Carter Creek	381585	83	17
Mormon Creek	381602	60	
North Cunningham Creek	381606	30	
Middle Cunningham Creek	381600	50	
South Cunningham Creek	381616	20	
Ivanhoe Creek	381592	143	7
Granite Creek	381592	45	5
Lily Pad Creek	381598	335	
Subtotals		466	29
SOUTHSIDE COLLECTION SYSTEM			
No Name Creek	381608	85	10
Midway Creek	381601	85	
Hunter Creek	381593	140	
Sawyer Creek	381613	40	
Chapman Creek	381588	300	
South Fork Fryingpan	381610	250	
Main Stem Fryingpan	381590	362	38
Subtotals		1,262	48
Boustead Tunnel	384625	900	
Boustead Tunnel [2]	384625	963	37
Ruedi Reservoir [3]	383713	102,368.7 ac-ft	
Ruedi Reservoir [4] (Refill)	383713		101,280 ac-ft
Ruedi Reservoir [5] (Power Plant)	381360		600

[1] All rights: Adjudication Date June 20, 1958; Appropriation Date July 29, 1957; Administration No. 39291.00000
[2] Unknown if total decree is absolute
[3] Unknown if total decree is absolute
[4] Conditional: Adjudication Date December 31, 1981; Appropriation Date January 22, 1981; Administration No. 47869.00000
[5] Conditional: Adjudication Date December 31, 1975; Appropriation Date October 22, 1975; Administration No. 45950.00000

SECWCD also appropriated a direct flow water right for the hydroelectric plant installed on the outlet of Ruedi Reservoir, in the amount of 600 cfs and a junior re-fill storage right for the reservoir in the amount of 101,280 acre-feet.

The hydroelectric plant operates as a run of the river facility, relying upon the normal releases being made through the reservoir outlet. This junior direct flow right is not operated in a manner that would call out upstream junior rights.

U. S. Fish and Wildlife Service Biological Opinion. In conjunction with the expected Round II Sales of contract water from the reservoir, the U. S. Fish and Wildlife Service (FWS) issued a Biological Opinion (1987) which addressed the possible needs for additional environmental commitments to support the Recovery Program for Endangered Fish Species in the Upper Colorado River basin (Recovery Program). As a required conservation measure, 5,000 acre-feet have been reserved in Ruedi Reservoir for fishery benefits in the 15-Mile Reach of the Upper Colorado River. The water is released upon call by the FWS.

The required conservation measure also requires that an additional 5,000 acre-feet be made available in four out of five years from Ruedi Reservoir during the months of July through October, through modified operation of the reservoir. The release pattern for this additional 5,000 acre-feet is determined by the FWS, in consultation with the USBR. The entire block of 10,000 acre-feet (5,000 + 5,000) was leased from the FWS to the CWCB, which is now the contract owner of record. The lease agreements were executed in 1990.

In 1991, the FWS requested another block of water from the regulatory pool in Ruedi Reservoir, in an amount of an additional 10,000 acre-feet. This lease was also assigned from the FWS to the CWCB. This second lease had an initial term of only one year and the water was to be used on a temporary basis to study and evaluate the effects of such additional water on the fishery habitat in the 15-Mile Reach. At the end of this original lease, the lease agreement was renewed and extended for a second year. The lease has since been renewed annually and currently runs through 1996.

2.3.3 Twin Lakes Exchange

The Twin Lakes Reservoir and Canal Company (TLRCC) operates the Independence Pass Transmountain Diversion project in the headwaters of the Roaring Fork River. The water is delivered through Twin Lakes Tunnel No. 1 (WDID 384617) to storage in Twin Lakes Reservoir on the Eastern Slope. In accordance with the original operating principles for the Fry-Ark Project, the TLRCC agreed to forego transmountain diversions into Tunnel No. 1 at times when the natural flow of the Roaring Fork River above its confluence with Difficult Creek is less than the following minimum monthly flow values.

Month	Average Flow	Month	Average Flow
October	2,700 acre-feet	April	3,800 acre-feet
November	2,100 acre-feet	May	6,200 acre-feet
December	1,800 acre-feet	June	7,100 acre-feet
January	1,600 acre-feet	July	6,200 acre-feet
February	1,400 acre-feet	August	3,900 acre-feet
March	1,500 acre-feet	September	2,600 acre-feet

In order to compensate the TLRCC for this bypass of water that would ordinarily have been diverted through the TLRCC Tunnel No. 1, the Fry-Ark Project assumed an obligation to deliver up to 3,000 acre-feet from the Project water supplies to the TLRCC, deliverable to the TLRCC storage account in Twin Lakes.
TLRCC's obligation to forego diversions at its collection system is applicable up to 3,000 acre-feet delivered by exchange from the Fry-Ark Project and TLRCC is not required to forego diversions except to the extent that a like quantity of water is furnished to the TLRCC from the Project.

In practice, this exchange has been operated by the TLRCC bypassing divertible flow at Grizzly Reservoir on Lincoln Gulch and at the Roaring Fork diversion dam in the following amounts: At times when the TLRCC diversions are in priority, the bypasses are accumulated against the 3,000 acre-foot exchange obligation from the Fry-Ark Project.

Month	Bypass At Grizzly Reservoir	Bypass at Roaring Fork
January	3.0 cfs	-
February	3.0 cfs	-
March	3.0 cfs	-
April	3.0 cfs	-
May	3.0 cfs	1.0 cfs
June	2.0 cfs	1.5 cfs
July	2.0 cfs	1.5 cfs
August	3.0 cfs	4.0 cfs
September	3.0 cfs	4.0 cfs
October	3.0 cfs	4.0 cfs
November	3.0 cfs	-
December	3.0 cfs	-

2.3.4 Contract Sales from Ruedi Reservoir

As stated previously, the primary purpose of Ruedi Reservoir is to provide replacement, as needed, for out-of-priority diversions through the Boustead Tunnel. Storage for this purpose is accounted for in the replacement capacity of the reservoir and is released as called for by the division engineer to satisfy a senior call on the Upper Colorado River at times the Fry-Ark Project is diverting. Account structure and reservoir operating rules were changed in Phase IIIa to facilitate water deliveries to contract sales structures (953001, 953002, 953003, 953004) in future baseline applications of the Upper Colorado River Mode.

The operating principles also provide for regulatory capacity in the reservoir for water not needed for replacement purposes. Water stored in this pool can be sold or leased by the USA to water users for any purpose, in the Upper Colorado River basin. The USA has entered into a number of long-term (40 years) lease agreements for water in the regulatory capacity of Ruedi Reservoir. As of January 1996, the following contracts were in place (Round I Sales):

Name	Amount (acre-feet)
Basalt Water Conservancy District	500
Battlement Mesa, Inc.	1,250
Exxon Corporation	6,000
White Horse Springs WSD/Starwood	20
Subtotal (M & I)	7,770
Colorado Water Conservation Board (See previous discussion)	20,000
Total (All existing contracts)	27,770

After the initial sales of water, there were numerous requests for additional water from the reservoir. Accordingly, the USBR initiated studies to determine the impacts of additional sales (Round II Sales). This action led to a Section 7 Consultation, resulting in the 1987 Biological Opinion from the FWS that is discussed above. As of January 1996, there were numerous pending Round II contracts for water from the regulatory capacity pool. These contracts cumulatively total about 16,851 acre-feet. If these proposed contracts are eventually executed, the total water committed by contract would be about 44,621 acre-feet per year.

The Colorado Water Conservation Board holds the large majority of the contract water in the regulatory capacity of the reservoir. As part of the Recovery Program, this water is to be released as necessary to provide supplemental flows to the mainstem of the Upper Colorado River in the 15-Mile Reach to enhance habitat for endangered fish species.

2.3.5 Busk-Ivanhoe Facility Sharing Agreement

The Busk-Ivanhoe transmountain diversion project, operated by the cities of Pueblo and Aurora, collects surplus water from the headwaters of Ivanhoe Creek (via the Lyle Ditch (WDID 381761) and the Hidden Lake Creek Ditch (WDID 381762) and historically has delivered it through the Busk-Ivanhoe Tunnel (WDID 384613), formerly the Carlton railroad tunnel. The water rights for the Busk-Ivanhoe project are slightly senior to those of the Fry-Ark Project and are decreed for 120 cfs, absolute.

In recent years, portions of the tunnel have failed and diversions are presently limited to a rate of only 50 cfs through a 30-inch steel pipe installed in the tunnel. In order to recover a portion of the yield lost, Pueblo and Aurora have contracted with the USBR/SECWCD to take delivery of a portion of the divertible yield through the Boustead Tunnel. Because the Busk-Ivanhoe system is physically upstream of the Fry-Ark diversion structures on Ivanhoe Creek, the use of the Boustead Tunnel for this purpose can be readily accomplished. Both the Busk-Ivanhoe and Boustead tunnels deliver to Turquoise Lake, on the Eastern Slope.

Table 2.3.b
Frying Pan-Arkansas Project
North Side and South Side Collection Systems

Tributary Source	Year Water First Diverted	Diversion Capacity (cfs)	Tunnel Capacity (cfs)	Minimum Bypass Requirement
NORTH SIDE COLLECTION SYSTEM				
Carter Creek	1981	100		2
North Fork (Carter Tunnel)	1980	30		1
Mormon Creek (Mormon Tunnel)	1979	60		2
North Cunningham Creek	1979	30		1
Middle Cunningham Creek	1979	50		1
South Cunningham Creek	1980	20		0
(Cunningham Tunnel)			270	
Ivanhoe Creek	1974	605		2
Granite Creek	1981	50		0
Lily Pad Creek	1974	20		0
(Nast Tunnel)			360	
SOUTHSIDE COLLECTION SYSTEM				
No Name Creek	1980	95		4
Midway Creek	1980	85		5
Hunter Creek	1980	140		12
(Hunter Tunnel)			270	
Sawyer Creek	1972	30		0
Chapman Creek	1972	300		3
(Chapman Tunnel)			300	
South Fork	1972	740		6
(South Fork Tunnel)			450	
Frying Pan	1972	1,100		12
BOUSTEAD TUNNEL			**945**	

The CRDSS Upper Colorado River Model should reflect the operation of four accounts in Ruedi Reservoir: (1) the replacement account for replacement of out-of-priority diversions by the Fry-Ark Project; (2) a portion of the regulatory capacity reserved for all existing and currently pending contracts used for municipal, domestic, and industrial uses (Round I and II Sales); (3) a portion of the regulatory capacity reserved for all contracts held by the CWCB for purposes of enhancing instream flows; and (4) an unregulated account, inclusive of dead storage and inactive storage.

Based on the current allocation of water in the reservoir, the four reservoir accounts should be initially established in the following amounts:

Replacement Account:	28,000 acre-feet
Existing & Future Contracts: (Municipal and Industrial)	31,500 acre-feet
CWCB Fishery Pool:	20,000 acre-feet
Unallocated (Incl. Dead/Inactive)	22,873 acre-feet
Total	102,373 acre-feet

For the initial set-up of the CRDSS Upper Colorado River Model, the agreement to use the Boustead Tunnel to deliver portions of the Busk-Ivanhoe yield is not modeled. This is justified given the small amounts of water that apparently were delivered historically and given that both diversions are transmountain by nature, with no return flow implications to the Upper Colorado River basin.

At this level of development for the CRDSS Upper Colorado River Model, it is believed that it is not necessary to model the exchange of Fry-Ark Project water to the Twin Lakes Reservoir and Canal Company. The repayment of water owed to TLRCC is typically made on the Eastern Slope in Twin Lakes Reservoir and the historic effects of the foregone diversions by TLRCC are reflected in the historical data of total diversions through the TLRCC Tunnel No. 1. Furthermore, the minimum bypasses described above for the TLRCC system should reasonably represent the effects of the exchange.

Historical demands at the Boustead Tunnel and the Hunter Tunnel should be based on the diversion data provided by the USBR. These data reflect the timing of project components being brought on line.

Future Fry-Ark demands at the Boustead Tunnel, to be included in the CRDSS baseline scenario, should be estimated in accordance with the operating principles, which effectively limit the diversions to an average annual diversion of 69,200 acre-feet per year, exclusive of the water delivered to TLRCC pursuant to the exchange agreement.

Release schedules for water from the CWCB fishery pool in Ruedi Reservoir should be based on guidance from the CWCB. It is recommended that a new demand node be included in the CRDSS Upper Colorado River Model to represent demands for fishery enhancement in the 15-Mile Reach. This node should be placed immediately downstream of the node for WDID 720645, the Grand Valley Irrigation Canal and should have a priority that is slightly junior to an operational right to deliver water to the 15-Mile Reach from Green Mountain Reservoir on the mainstem. The demand at this node should be set up to easily modify the demands for fishery purposes. The delivery of water from Ruedi Reservoir to this new demand node should reflect a 5 percent transit loss.

For historical scenarios in the CRDSS, actual release data from the CWCB should be used based on the 10,000 acre-feet available in Ruedi Reservoir. For future baseline scenarios, CWCB and FWS personnel should be consulted in establishing these demands, based on a 20,000 acre-foot account in the reservoir.

Ruedi Reservoir should be operated with target storage levels to attempt to keep the reservoir full

from June 1 through Labor Day. During the winter and spring months, the targets should be periodically adjusted to provide storage capacity to accommodate anticipated spring snowmelt runoff.

2.4 Grand Valley Area Water Demand (Cameo Call)

The Grand Valley Area is situated adjacent to the Upper Colorado River near the City of Grand Junction, extending a distance of about 35 miles from the diversion dam for the Government Highline Canal to the end of the irrigated area near West Salt Creek. Two large systems, the Grand Valley Irrigation Company and the Grand Valley Project, provide the majority of the irrigation water for the Grand Valley. These two major systems provide irrigation water to an estimated 65,500 acres in the valley. Because of the seniority of the water rights in these systems and as a result of the operations of Green Mountain Reservoir, these systems generally receive a full supply of water. The amount of water available for diversion by these two systems is typically represented by the flow in the Colorado River at the Cameo stream gage (USGS Gage 09095500) and the flows of Plateau Creek; the cumulative demands are often referred to as the Cameo Demand.

2.4.1 Grand Valley Irrigation Company

The Grand Valley Irrigation Company (GVIC) owns and operates the **Grand Valley Irrigation Canal (WDID 720645)** which diverts from the Upper Colorado River near the town of Palisade. The Canal irrigates about 27,720 acres on the north side of the river. The main canal eventually splits into the Grand Valley Mainline Ditch, the Grand Valley Highline Ditch, the Independent Ranchmens Ditch and the Kiefer Extension. The main diversion canal has a capacity of approximately 650 cfs.

The GVIC owns two direct flow water rights for 520.81 cfs and 119.47 cfs. The larger right is one of the most senior water rights in the entire Upper Colorado River basin. The smaller right, although much more junior, is still senior to many upstream rights, including Denver's Blue River Diversion Project and the CBT Project. The GVIC water rights are summarized in Table 2.4.

2.4.2 Grand Valley Project

The Grand Valley Project was constructed by the USBR in 1915 and delivers water to a federally owned irrigation system operated by the Grand Valley Water Users Association (Association). The project also delivers water to several privately owned irrigation systems, including the Palisade, Mesa County and Orchard Mesa Irrigation Districts. Water is diverted for the Project at a diversion dam, known as the roller dam, just upstream of the confluence of the Upper Colorado River and Plateau Creek. From this point the water is carried in the **Government Highline Canal (WDID 720646)** for the irrigation of lands above and to the north of the lands served by the Grand Valley Irrigation Canal. The capacity of the initial reach of the Government Highline Canal is estimated to be about 1,620 cfs. Approximately 25,700 acres are served from the federal portion of the Project (Association lands). The Association owns a large senior water right in the amount of 730 cfs, described in Table 2.4.

Table 2.4
Grand Valley Area Water Rights

Name	Amount (cfs)	Cumulative (cfs)	Approp. Date	Admin. Number	Use	Comments
Grand Valley Canal (GVIC)	520.81	520.81	08/22/1882	22729.11922	Irrigation	
Palisade Irrigation District	80.0	600.81	10/01/1889	22729.14519	Irrigation	(1) (2)
E. Palisade Irrigation District (OMID)	10.2	611.01	10/01/1990	22729.18536	Irrigation	(1)
Mesa Co. Irrigation District	40.0	651.01	07/01/1903	22729.19544	Irrigation	(1) (2)
Orchard Mesa Irrigation District	450.0	1101.01	10/25/1907	22729.21116	Irrigation/ Power	(1) (2)
Grand Valley Project (Government Highline Canal)	730.0	1831.01	02/27/1908	22729.21241	Irrigation	
Grand Valley Project (Government Highline Canal)	400.0	2140.81	02/27/1908	30895.21241	Power/ Commercial	(3)
Grand Valley Canal (GVIC)	119.47	2260.28	04/26/1914	30895.23491	Irrigation	
Palisade Irrigation District	23.5	2283.78	06/01/1918	30895.24988	Irrigation	(1) (4)

Notes: (1) Diverted through Government Highline Canal.
(2) Of 460.2 cfs owned by OMID, approximately 272 cfs used at OMID Power Plant and 188.2 cfs used for irrigation.
(3) During irrigation season, the 400 cfs water right for the USA Power Plant is effectively limited to 309.8 cfs. This water right is decreed for 800 cfs during the non-irrigation season.
(4) This water right for 23.5 cfs can only be diverted when space is available in the Government Highline Canal. It is generally not considered part of the Cameo Demand.

The Government Highline Canal is used to deliver irrigation water to the Palisade Irrigation District via the Price Ditch and the Mesa County Irrigation District via the Stub Ditch. Total irrigated acreage under these two systems is estimated to be about 4,600 acres. The water rights owned by these districts are relatively senior in the Upper Colorado River basin. It is noted that Mesa County Irrigation District owns additional water rights but is not allowed to call for water on these rights, which are not included in the tabulation in Table 2.4.

At a point on the Government Highline Canal about 4.6 miles downstream from the roller dam, water is delivered to the Orchard Mesa Irrigation District (OMID). The water is conveyed through a siphon under the Upper Colorado River and delivered to the Orchard Mesa Power Canal on the south side of the river. A portion of this water (approximately 309.8 cfs) is delivered to the **Grand Valley Power Plant (USA Power Plant)**, a facility constructed to generate power revenues to assist the Association and others in the repayment of loan obligations to the federal government. Public Service Company operates the USA Power Plant. The power right owned by the United States is decreed for 800 cfs but by stipulation is limited to 400 cfs during the irrigation season. The USA power right is further limited to about 309.8 cfs at times when OMID is diverting its full decreed amount of 460.2 cfs and the Association is diverting its

full entitlement of 850 cfs. This limitation is attributable to the maximum conveyance capacity in the Government Highline Canal (1,620 cfs) above the siphon (1,620 cfs - 850 cfs (Association) - 460.2 cfs (OMID) = 309.8 cfs).

Of the remaining water in the Orchard Mesa Power Canal, 17.2 cfs is delivered by gravity to the Vinelands area of the OMID and the balance is delivered to the **Orchard Mesa Pumping Plant (OMID Pump)** where hydraulic pumps are used to lift irrigation water to higher lands in the OMID south of the Upper Colorado River. Typically, the OMID Pump requires 272 cfs to lift about 171 cfs to the irrigated lands. The water rights owned by the OMID total about 460 cfs and are summarized in Table 2.4.

2.4.3 Orchard Mesa Check

Through mutual agreements between the GVIC and the Grand Valley Project, the two irrigation systems can be operated in a manner to enhance the delivery of water at times when the total river flow (Upper Colorado River + Plateau Creek) is insufficient to meet the cumulative Cameo demand of approximately 2,260 cfs. To avoid a situation in which the senior water rights of the GVIC would call out the more junior water rights of the upstream Grand Valley Project, return flows from the power diversions at the USA Power Plant and the OMID Pump can be physically returned to the Upper Colorado River at a location upstream of the headgate of the Grand Valley Irrigation Canal, effectively reducing the GVIC call. This is accomplished by utilizing a structure known as the Orchard Mesa Check. The Check is a weir structure, equipped with three radial gates, constructed across the tailrace of the two power plants and a bypass channel extending about 1,200 feet upstream to the Upper Colorado River. Normally, water in the tailrace would return to the Upper Colorado River downstream of the headgate of the Grand Valley Irrigation Canal. When the gates are closed, however, water from the tailrace can be elevated and conveyed by gravity to a point on the river upstream of the GVIC headgate. Under full operation of the Check, the total Cameo demand could be reduced to about 1,700 cfs, assuming a maximum return of 309.8 cfs from the USA Power Plant and 272 cfs from the OMID Pump.

Operation of the Check by the OMID is not a condition of any water right decree or matter of law. It only serves to allow continued diversions by the junior water rights in the valley at times when the available flow at the Cameo gage is less than the amount necessary to satisfy all of the decreed rights. Furthermore, operation of the Check reduces the operating head on the power plant turbines and reduces the generation of power, which decreases revenues, and which correspondingly reduces the amount of water that can be lifted to the OMID lands. These reductions must be made up from other sources.

2.4.4 Administration of Cameo Call

Historically, during the period 1943 through 1984, the Grand Valley area water rights did not directly realize the benefits of the operations of Green Mountain, since the reservoir releases were being made only as necessary to keep 1,250 cfs at the Shoshone Power Plant, without additional regard for downstream demands at Cameo. During these years, the division engineer did not enforce a call from the Grand Valley against upstream junior rights but rather required that the Check be fully implemented and providing water to the GVIC prior to curtailing

upstream junior water rights and prior to making releases from Green Mountain. It was therefore necessary for the OMID to regularly operate the check to ensure full water supplies to Grand Valley water users. It is believed that during this period, the Check was operated to some extent in most years, with checked flows ranging from 10 cfs to 582 cfs. The effect of this method of operation was to benefit upstream junior water rights by reducing the Cameo call to approximately 1,700 cfs.

In December 1983, a revised operating policy for Green Mountain Reservoir was published. Under the new policy, 66,000 acre-feet of the 100,000 acre-foot Power Pool in the reservoir were reserved to meet the demands of historical agricultural and domestic water users on the Western Slope (historic user pool). When either Shoshone or Cameo places an administrative call, the division engineer requests that the USBR release water from Green Mountain to supplement natural streamflows. These releases are first made to offset the consumptive uses attributable to historical irrigation and domestic water rights that were perfected by use prior to October 15, 1977. Consistent with the provisions of Senate Document 80, this release is intended to allow junior users on the Western Slope to continue to divert water when they otherwise would have been out-of-priority with respect to either Shoshone or Cameo. If this release of water for junior Western Slope beneficiaries is insufficient to satisfy the Cameo demand, additional water is released from Green Mountain, as necessary to meet the demand.

In this same time frame (1984-85), the division engineer adopted a change in policy regarding the Cameo call and no longer requires operation of the Check prior to placing a call against upstream junior water rights. Rather, as the streamflows begin to drop off and the GVIC junior right for 119.47 cfs makes the initial call at Cameo, the division engineer begins to administer upstream junior water rights. As described above, junior water rights that are not beneficiaries of Senate Document 80, are curtailed and reservoir releases are made to replace depletions of junior rights that are beneficiaries. If the releases are insufficient to increase the flow at Cameo and accordingly, meet the calling demand of the 119.47 cfs GVIC right, additional water is released from Green Mountain Reservoir. Thus the administration regime changed from historical conditions in that a junior water right at Cameo that was formerly satisfied by operation of the Check, now can place an additional demand on the river.

The division engineer currently administers the Cameo call to provide a flow at the Grand Valley Project diversion dam of 1,950 cfs. This amount represents the full 2,260 cfs demand less the 310 cfs normally diverted for the USA Power Plant. The revised operating policy for Green Mountain Reservoir limits releases from the 66,000 acre-foot historic user pool to agricultural and domestic uses, not industrial uses. In purposes of determining the flow available for the Grand Valley water users, the division engineer uses the recorded flows at the Cameo Gage (USGS Gage No. 09095500) plus the inflow from Plateau Creek (USGS Gage No. 09105000).

2.4.5 Orchard Mesa Check Case (91CW247)

In Case No. 91CW247, the United States, the Association and the OMID are seeking to adjudicate a water right which recognizes the historical exchange that has occurred through operation of the Check. The application requests an April 1, 1926 appropriation date in the amount of 640 cfs, equal to the decreed rights of the GVIC. Numerous parties objected to the application and there have been extensive negotiations to resolve a number of issues surrounding the historical operation of the Check. As of March 1996, the issues in the case have not been completely resolved although there appears to be tentative consensus on the following:

1. The USA would agree not to exercise its 400 cfs power right during the irrigation season, April 1 through October 31 so as to place a call against upstream junior water rights, except as to the conditions described in items 2 and 3, below.

2. During the irrigation season, diversions at the headgate of the Government Highline Canal (Roller Dam) would be limited to no more than 1,310 cfs and the USA's Power right can be exercised as necessary to maintain a total call at the Roller Dam of 1,310 cfs. Note that 1,310 cfs at the Roller Dam + 640 cfs at the GVIC results in a total demand of 1,950 cfs.

3. If the irrigation season diversions by the GVIC are less than 400 cfs, the USA can exercise its power right up to the amount by which the GVIC diversions are less than 400 cfs.

4. The USA stipulates that the effective priority date of the power right is August 3, 1934.

The USBR, in conjunction with the division engineer, will develop criteria for the operation of the historic user pool in Green Mountain Reservoir. The criteria has the objectives of: (a) ensuring that sufficient water is available in Green Mountain Reservoir to meet the replacement needs of the historic user pool beneficiaries; (b) ensuring that sufficient quantities of water are available in the historic user pool to meet direct delivery needs at Cameo (as described above); (c) ensuring that sufficient water remains in the historic user pool at the end of the irrigation season to meet winter demands of historic user pool beneficiaries; and (d) providing a methodology to determine the amount of the historic user pool that is surplus to the needs of historic user pool beneficiaries and would therefore allow delivery to other beneficial purposes on the Upper Colorado River, including augmentation of flows in the 15-Mile Reach for the recovery of endangered fish species. The USBR and division engineer have developed preliminary rule curves for the release of water from the historic user pool, consistent with the above objectives.

2.4.6 15-Mile Reach Flows

The Colorado Water Conservation Board (CWCB) has instream flow rights for that reach of the Upper Colorado River between the headgate of the Grand Valley Irrigation Canal (GVIC) and the confluence of the Upper Colorado River and the Gunnison River. This is often referred to as the 15-Mile Reach and is considered a critical flow reach for the protection of endangered fish species because the river can be physically dried up at the GVIC headgate. In Case No. 92CW286, the CWCB received an instream flow right in the amount of 581 cfs (the amount of the maximum Check diversion), with a claimed appropriation date of March 5, 1992. The water right is effective from July 1 through September 30 of each year. As a stipulation in the Orchard Mesa Check Case, this instream flow right would be administered as being junior to the exchange right being requested by the USA, et al. In Case No. 94CW330, a second application was made to claim an additional 300 cfs, with an appropriation date of November 4, 1994. This water right affects only the downstream two miles of the 15-Mile Reach.

To ensure that the flows are satisfied, the Recovery Program for Endangered Fish Species in the Upper Colorado River basin (Recovery Program) has conducted studies on basin operations and project feasibility studies. Two particular studies that have been implemented are the Coordinated Reservoir Operations Study (CROS) and the Recovery Implementation Program – Recovery Action Plan (RIPRAP).

The Coordinated Reservoir Operations Study (CROS) was conducted to determine the flexibility of current federal and private reservoir fill operations to enhance the peak flows in the 15-Mile Reach. The goal of CROS is to enhance peak flows to improve the 15-Mile Reach habitat for endangered fish species while not reducing the reservoir project yields or increasing the cost of reservoir operations.

Coordinated Reservoir Operations consist of bypassing water from the participating reservoirs during a 10 day period to enhance peak flows in the 15-Mile Reach when flows are between 12,900 and 26,000 cfs. In early April, after the National Weather Service has released runoff forecast information, entities involved will determine a preliminary operations strategy. Runoff will be monitored from May through July and preliminary operations will be adjusted as necessary to synchronize bypasses with the peak flows in the 15-Mile Reach. Operations are voluntary, coordinated between entities involved, and are designed to not affect yields or water rights of participating reservoirs. Bypassed water does not include any previously stored water and is only the release of inflows that would otherwise have spilled or been released at a later time due to the reservoir filling.

In general the entities and facilities involved in the project are:

1. Colorado River Water Conservation District
    a. Wolford Mountain Reservoir
2. Denver Water
    a. Williams Fork Reservoir
    b. Dillon Reservoir
3. Colorado Springs Utilities
    a. Homestake Reservoir

4. Northern Colorado Water Conservancy District (NCWCD)
    a. Windy Gap Project
5. U.S. Bureau of Reclamation (in consultation with NCWCD and SCWCD)
    a. Green Mountain Reservoir
    b. Ruedi Reservoir
    c. Granby Reservoir
    d. Willow Creek Reservoir
6. Recovery Program for the Endangered Colorado River Fishes
7. U.S. Fish and Wildlife Service
8. National Weather Service
9. Colorado Water Conservation Board
10. Colorado Division of Water Resources, Division 5 Office
11. Southeastern Colorado Water Conservancy District
12. Grand Valley Irrigators (GVIC, GVWUA, OMID, Palisade)

Coordinated Reservoir Operations have been in place since 1997 and have operated successfully in 1997 through 1999, and 2006. During the six years of drought from 2000 through 2005, bypasses were not possible due to low snow pack and subsequent low runoff. However, the coordination process was followed and allowed for successful operations following the drought.

The Recovery Implementation Program – Recovery Action Plan (RIPRAP) was created to supply flows to the 15-Mile Reach in the critically low flow months of July through October. The USFWS recommended flows for these months are 1630 cfs, 1240 cfs, and 810 cfs under wet, average, and dry hydrologic conditions. In 1997, reservoir pools throughout the basin were designated to release to the 15-Mile Reach during low flows, as follows:

Reservoir	Account Name	Capacity (acre-feet)
Ruedi	Unallocated / 5,000 acre-feet	5,000
	CWCB Fish	10,825
	USFWS 5,000 acre-feet 4/5	5,000
Williams Fork	Temporary Fish	5,413
Wolford Mountain	Temporary Fish	5,413
	Fish Account	6,000
Green Mountain	Historic Users Pool (excess)	66,000

Weekly phone conferences are held from July through October to determine the quantity and source of releases required to meet the fish demands. The entities involved in the phone conferences are generally the same entities involved in the CROS calls, see above. In general, fish flow releases from the HUP account in Green Mountain Reservoir are made when the account is operating above the operational zone, see **Figure 2.1**.

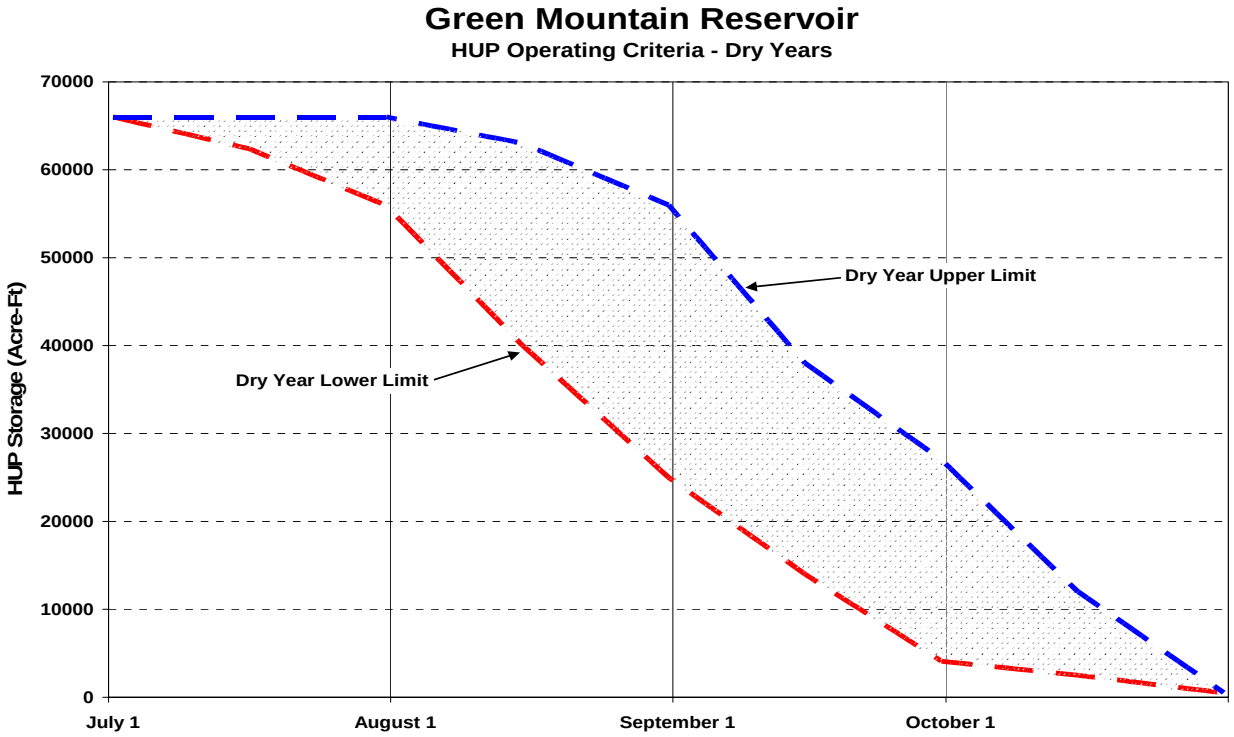

Figure 2.1 Green Mountain Reservoir – HUP Operating Criteria

2.5 Homestake Diversion Project

The Homestake Diversion Project is a municipally owned transmountain diversion project. The purpose of the project is to divert water from the headwaters of the Eagle River basin on Colorado's Western Slope for municipal use by the cities of Colorado Springs and Aurora in the Arkansas River basin (Division 2) and the South Platte River basin (Division 1), respectively.

The primary storage feature of the Homestake Diversion Project in the upper reaches of the Arkansas River basin is Turquoise Lake, constructed by the USBR as part of the Fryingpan-Arkansas Project. Project features in the Eagle River basin, which are the primary concern of the CRDSS Upper Colorado River Model, include: (a) the Missouri Tunnel, (b) Homestake Reservoir, and (c) the Homestake Tunnel. Each of these Project features is described in more detail below.

The Homestake Diversion Project diverts available streamflow pursuant to various direct flow water rights from the East Fork and Middle Fork of Homestake Creek. Water is also diverted from French Creek, Fancy Creek, Sopris Creek and Missouri Creek via pipeline and is delivered through the Missouri Tunnel (WDID 374643) to storage in Homestake Reservoir (WDID 373516), located on the Middle Fork of Homestake Creek. All flows diverted into the reservoir can also be stored under a storage water right. Homestake Reservoir storage water is conveyed via Homestake Tunnel (WDID 374614) to Turquoise Lake located in the Arkansas River Basin.

2.5.1 Description of Physical Facilities

The following discussion provides a brief description for the physical facilities pertinent to the Western Slope operations of the Homestake Diversion Project.

Missouri Tunnel (WDID 374643). The Missouri Tunnel is used to transport diversions from French, Fancy, Missouri and Sopris Creeks to Homestake Reservoir. The 8.0 foot diameter tunnel extends approximately 1.6 miles through a mountain and has a rated capacity of at least 600 cfs. The diversions at each of the individual tributaries are measured and recorded by the City of Colorado Springs.

Homestake Reservoir (WDID 374516). Homestake Reservoir is located on the Middle Fork of Homestake Creek, southeast of the Holy Cross Wilderness Area. The reservoir has a total capacity of about 43,600 acre-feet of which 211 acre-feet is dead and inactive storage. At its normal high water line, the water surface area of the reservoir is about 334 acres. Homestake Reservoir stores all water diverted at the collection facilities on French Creek, Fancy Creek, Sopris Creek, and Missouri Creek and which are conveyed through the Missouri Tunnel. Inflows from the Middle Fork Homestake Creek and diversions from the East Fork Homestake Creek are also stored in the reservoir.

In recent years, the reservoir has been operated in such a manner so as to create adequate space to capture the anticipated snowmelt runoff. In most cases, releases from Homestake Reservoir to the Homestake Tunnel are made during the months of March and April to create room for the runoff. Colorado Springs and Aurora have made additional water purchases to help supply growing water demands and, as a result, historical Homestake Reservoir operations may not be indicative of future operations.

Reservoir EOM storage contents and releases through the outlet works to Homestake Creek are measured and recorded by the City of Colorado Springs. Reservoir inflows are calculated and also recorded by Colorado Springs.

Homestake Tunnel (WDID 374614). The Homestake Tunnel extends approximately 5.6 miles under the Continental Divide and is used to convey all water collected at the project facilities and stored in Homestake Reservoir. The 66-inch-diameter Homestake Tunnel is capable of carrying at least 300 cfs. However, according to project operators, flows through Homestake Tunnel must be regulated such that the total inflows into Turquoise Reservoir (Homestake Tunnel imports plus the natural flows of Lake Fork Creek) do not exceed 300 cfs. Although this limitation is not decreed, it is part of an agreement with the U. S. Forest Service. During winter, streamflow in Lake Fork is basically frozen such that Colorado Springs will usually divert all of the 300 cfs through the tunnel.

2.5.2 Water Rights

All of the project water rights were adjudicated on June 8, 1962 and were granted an appropriation date of September 22, 1952. All of the rights share an administration number of 39650.37520. These water rights are summarized in Table 2.5. As can be observed, only portions of the water rights have been made absolute.

Table 2.5
Homestake Diversion Project Water Rights [1]
(Western Slope Features)

Name	WDID	Amount (cfs) Absolute	Conditional
COLLECTION SYSTEM			
French Creek	371253	60.1	119.9
Fancy Creek	371254	38.6	91.4
Missouri Creek	371255	39.8	80.2
Sopris Creek	371256	41.3	118.7
East Fork Homestake Creek	374644	70.8	189.2
Middle Fork Homestake Creek [2]	N/A	N/A	
SUBTOTALS		250.6	850.0
Homestake Project Conduit (Missouri Tunnel)	374643	179.8	1,530.0
Homestake Project Tunnel	374614	300.0	310.0
Homestake Reservoir	374516	43,504.7 ac-ft	126,844 ac-ft

[1] All rights: Adjudication Date June 8, 1962;
Appropriation Date September 22, 1952;
Administration No. 39650.37520

[2] Absolute decreed amount of 300 cfs for Homestake Project Tunnel (374614) may include storable inflows from Middle Fork Homestake Creek in addition to 250.6 cfs from collection system.

2.5.3 Bypass Requirements

Project operations are restricted by minimum bypass flow requirements, stipulated to as part of the environmental permitting process. The amounts listed must pass the diversion structures at all times:

Location of Bypass Measurement	Amount
French Creek Div. Dam	1.67 cfs
Fancy Creek Div. Dam	1.00 cfs
Missouri Creek Div. Dam	3.00 cfs
Sopris Creek Div. Dam	2.00 cfs
East Fork Homestake Creek Div. Dam	2.67 cfs
Middle Fork Homestake Creek Div. Dam	6.00 cfs
USGS Gage Homestake Creek at Gold Park	24.00 cfs

To ensure the project continues to operate, Colorado Springs will sometimes divert water at the various diversion locations on the tributary streams and release water from Homestake Reservoir

to satisfy the bypass requirement at the Gold Park Gage (USGS Gage No. 09064000).

According to Colorado Springs personnel, the Gold Park Gage tends to restrict diversions more frequently than a call from the mainstem of the Upper Colorado River. The effect of this bypass requirement at the Gold Park gage is to reduce diversions on both ends of the seasonal hydrograph, curtailing the normal diversion season by an average of two to three weeks each year.

2.6 Major Industrial Water Users

The CRDSS Upper Colorado River Model includes a number of structures that divert water for industrial purposes. The following documentation describes some of the more significant industrial water diversions in the Upper Colorado River basin.

2.6.1 Shoshone Power Plant (WDID 530584)

The Shoshone Power Plant (a.k.a. the Glenwood Power Canal) is a hydroelectric generation plant owned and operated by Public Service Company of Colorado. Water is diverted from the Upper Colorado River in Glenwood Canyon at a point located about eight miles upstream of Glenwood Springs and eight miles downstream of the Dotsero gaging station (USGS Gage No. 09070500). Water rights exercised at the power plant include the following:

Amount (cfs)	Appropriation Date	Adjudication Date	Administration Number
1,250	1-07-1902	12-09-1907	20427.18999
158	5-15-1929	02-07-1956	33023.28989

Water is diverted at Shoshone on a year-round basis, although the plant is often closed during January for maintenance. There is no consumptive use associated with the operation of the power plant and all diverted water is returned back to the river at a point located about three miles downstream of the diversion dam. There are no other water rights in the intervening reach of the river.

During times when the streamflow at the Dotsero gage is less than 1,408 cfs, the power plant diverts generally all of the river flow, leaving only a small amount of leakage through the diversion dam as the flow in the river throughout the three mile reach. At times when the flow is less than 1,250 or 1,408 cfs, the division engineer strictly enforces the call by the Shoshone Power Plant. The senior right for 1,250 cfs is senior in comparison with the majority of the larger upstream water rights, so the Shoshone Power Plant is generally the controlling call on the river during the late summer, winter and early spring. During unusually dry years, the Shoshone call can be enforced throughout the period of late June through mid-April of the following year. During unusually wet years, the call does not go into effect until November or December.

Prior to 1985, the flow required to satisfy the demand at the Shoshone Power Plant specifically governed the operations of the Colorado-Big Thompson Project pursuant to the provisions of Senate Document 80, in particular the operations of Green Mountain Reservoir (see separate discussion). The Shoshone demand also limited transmountain diversions by Denver and Colorado Springs. Subsequent to 1985, the Shoshone Call is still a major factor in administration of the Upper Colorado River but no longer is the sole factor influencing the operation of Green Mountain Reservoir.

2.6.3 Climax Mine and Mill (WDID 360841)

The Climax Mine and Mill, owned and operated by the Climax Molybdenum Company, is located at the headwaters of Tenmile Creek in the upper Blue River basin above Dillon Reservoir. The mine was opened in about 1918 and historically has been the world's largest producer of molybdenum. Mining production has been minimal since about 1982 because of reduced demand and the productions capabilities at the Henderson Mine (see following discussion). Because of its substantial ore reserves, it is anticipated that primary molybdenum production will resume at Climax.

The milling operations at the Climax Mine are based on flotation processes to recover the molybdenum concentrate. The waste rock, crushed to a consistency of fine sand, is transported as tailing slurry for deposition in large tailing ponds. Water is used and re-used in the milling process through an elaborate system of pumping stations, pipelines, reservoirs, tanks, and tailing ponds. Consumptive use of water is primarily associated with evaporation from the surfaces of the tailing ponds and water reservoirs, together with the consumption of water entrapped within the deposited tailing sands. From data supplied by Climax and its consultants, the historical consumptive uses of water at the Climax Mine and Mill are estimated to be about 5,600 acre-feet annually during peak production years, although it historically has been in excess of 7,300 acre-feet. For the CRDSS study period, 1975 through 1991, the average annual consumptive use has been about 3,300 acre-feet.

Most of the replacement (make-up) water used at Climax is diverted from the headwaters of Tenmile Creek and its tributaries on Climax property. Depletions to Tenmile Creek have averaged about 5,300 acre-feet during peak production years. Additional replacement water for the milling process is diverted from the upper reaches of the East Fork Eagle River and the East Fork Arkansas River. Water imported from the Eagle River basin (Water District 37) and from the Arkansas River basin (Division 2) have averaged about 250 and 300 acre-feet per year, respectively. The diversions from the Arkansas River basin represent a transbasin import into the Upper Colorado River basin. Very little of the water imported from the Arkansas River is consumed in the milling process.

Water in excess of the industrial requirements, including replacement, is intercepted and diverted around the mine complex and tailing ponds in a network of interceptor canals, for eventual discharge into Tenmile Creek and the East Fork Eagle River downstream of the industrial facilities. To the extent that process water within the industrial water system is unneeded, the excess water is treated and discharged into Tenmile Creek. This discharge occurs on a year-round basis, although most of the water is discharged during the spring snowmelt runoff period.

Climax owns and utilizes over 30 individual water right priorities for the operations at Climax. All of the Tenmile Creek water rights are junior to the Shoshone Power Plant right for 1,250 cfs, such that the depletions to the flow of Tenmile Creek and the Eagle River are generally limited to the spring snowmelt runoff period. The major industrial direct flow rights used at Climax are summarized in Table 2.6.

Table 2.6
Climax Mine and Mill
Major Direct Flow Water Rights

Name	Amount (cfs)	Adjudication Date	Appropriation Date	Administration Number
Ten Mile Pipeline	1.78	11/26/1921	07/21/1917	25924.24673
Enlarged Buffer Ditch	17.12	11/26/1921	03/24/1918	25924.24919
Fremont Ditch No. 1	100.00	2/27/1931	6/10/1927	29228.28284
Clinton Creek Ditch	50.00	02/27/1931	10/12/1927	29228.28408
Wills Tunnel Pipeline	55.00	08/22/1932	04/12/1929	29642.28956
Chalk Mountain Ditch	31.00	10/26/1937	06/04/1926	30184.27913
Supply Canal No. 1	100.00	10/26/1937	8/15/1935	31272.00000
Supply Canal No. 2	60.00	10/26/1937	08/15/1935	31272.00000
Ten Mile Diversion No. 1	35.00	10/26/1937	06/04/1936	31566.00000
Ten Mile Diversion No. 2	20.00	10/26/1937	06/04/1936	31566.00000

For the purposes of the CRDSS Upper Colorado River Model, all the Climax water rights in the Tenmile Creek basin can be modeled as a single diversion located at the Climax property line on Tenmile Creek. This aggregated water right can be represented with an appropriation date of June 10, 1927 (administration no. 29228.28284) with a capacity of 118.9 cfs, representing the first three water rights shown above. Depletions to the flow of Tenmile Creek are limited by the volume of water physically and legally available for diversion on the Climax property, further limited by the mining and milling requirements. From engineering studies provided by Climax's water rights consultant, a time series representing the historical stream depletion to Tenmile Creek has been prepared for the CRDSS study period (1975 through 1991) and is included in HydroBase. Because it represents depletions, there are no return flows associated with this time series. Depletions attributable to the Eagle and Arkansas River imports are relatively small and can be neglected in the CRDSS modeling.

2.6.4 Henderson Mine and Mill (WDID 511070)

The Henderson Mine is also owned by the Climax Molybdenum Company. It is an underground mine located in the South Platte drainage basin near Berthoud Pass. The mine was opened in 1977 and it has been operated almost continuously since that date. Water is pumped from the mine to maintain dry working conditions and this water is discharged into a tributary of Clear Creek. Because the mine and mine water discharge is located in the South Platte River basin, this operation has no effect on streamflows in the Upper Colorado River basin. Ore from the mine is hauled from the mine through a 12-mile underground train tunnel to the Henderson Mill, located in the Ute Creek drainage basin, a tributary of the Williams Fork River, upstream of Williams Fork Reservoir. The milling

process employed at the Henderson Mill is generally identical to the process used at the Climax Mine, based on flotation of molybdenum concentrate and slurry transport of tailing for deposition in large tailing ponds. Water is used and reused in the milling process through an elaborate system of pumping stations, pipelines, reservoirs, tanks, and a single large tailing pond. Consumptive use of water is primarily associated with evaporation from the tailing pond and reservoirs, together with the consumption of water trapped within the deposited tailing sands. Historic stream depletions averaged about 2,200 acre-feet during the CRDSS study period of 1975 through 1991, with a maximum of about 3,700 acre-feet in 1980.

Water to replace the system losses and provide the necessary process water is diverted from Ute Creek, a small tributary of the Williams Fork, at several intake points. Additional water is diverted from the mainstem of the Williams Fork River at the Williams Fork pump station on an as-needed basis. The pump station capacity is 8.8 cfs.

The Henderson Mill is a closed circuit, non-discharging facility. Accordingly, all water that is diverted into the industrial process system is ultimately 100 percent consumed. Storage facilities at the mill include Ute Creek Reservoir (100 acre-feet) and East Branch Reservoir (2,000 acre-feet). The tailing pond itself is capable of storing several thousand acre-feet of additional water, which can be used and re-used in the milling processes.

Water rights used at the Henderson Mill include the Henderson Mine Water System, the Ute Park storage right, and the Cabin-Meadow Creek water rights agreement. The Henderson Mine Water System water rights include a number of senior irrigation water rights that were changed in Case No. W-528 to allow industrial use. The annual volume of water that may be diverted into the mill system and consumptively used pursuant to this right is limited to 704 acre-feet per year and the diversions are limited to the spring and summer period when the Shoshone call is not in effect. The Ute Park storage right is absolute in the amount of 2,100 acre-feet and conditional for an additional 3,900 acre-feet. This water right is junior to Denver's Williams Fork Reservoir, so the right may only be exercised during years in which Williams Fork Reservoir fills. The Cabin-Meadow Creek water rights agreement is a complex agreement among the Climax Molybdenum Company, the Denver Water Board, and the City of Englewood (see separate documentation). In the early 1970's, these parties jointly constructed the Cabin Meadow Creek Project, a diversion and storage project in the Fraser River basin. The Henderson Mill does not directly make use of the Fraser basin water, but instead diverts water from the Williams Fork basin pursuant to a replacement agreement with Denver. Pursuant to the agreement, Henderson is entitled to divert up to 3,000 acre-feet per year from Ute Creek and/or the Williams Fork River on a year-round basis as necessary to the meet the milling demand. To the extent that Henderson requires water during periods when Denver would otherwise be exercising its senior rights at its Williams Fork Collection system, Henderson credits its water in Meadow Creek Reservoir to Denver’s account in the reservoir in an amount equivalent to the out-of-priority diversion. Also in accordance with the Agreements, at times when the Shoshone call is in effect, replacement releases are made by Denver from Williams Fork Reservoir for the benefit of Henderson. This Henderson replacement account in Williams Fork Reservoir contains up to 2,200 acre-feet.

Specific water rights used at the Henderson Mill include the following:

Name	Amount (acre-feet)	Adjudication Date	Appropriation Date	Admin. Number
Henderson Mine Water System	704	08/03/1911	Varies	Varies
Ute Park Reservoir Right	6,000	01/14/1957	09/08/1954	38236.00000
Cabin-Meadow Creek Agreement	3,000	Uses Denver Water Rights	Varies	Varies

In order to simplify the CRDSS modeling effort, it is recommended that the Henderson Mill diversions be modeled as a single diversion at the Williams Fork Pump Station. This aggregated node should be in the amount of 8.8 cfs (the capacity of the pump station) with a recommended administration number of 31359.00001, a value that is slightly junior to Denver's Williams Fork Reservoir. This assumption may tend to slightly understate the yield, which could be realized from the more senior Henderson Mine Water System (volumetrically limited to no more than 704 acre-feet annually), but is a reasonable approximation. As necessary, when this aggregated water right is out-of-priority with respect to Denver's water rights for the Williams Fork collection system, the diversions should be augmented using the water available in Henderson's 3,000 acre-foot account in the Meadow Creek Reservoir (Cabin-Meadow Creek Project). When the call originates from the mainstem of the Upper Colorado River, the replacement should be from Henderson's 2,200 acre-foot storage account in Williams Fork Reservoir.

From engineering studies provided by Henderson's water rights consultant, a time series has been prepared which represents the historical depletions to the Williams Fork River attributable to the operations at the Henderson Mill during the CRDSS study period, 1975 through 1991. This historical time series has been incorporated into the CRDSS Upper Colorado River Model database. This time series represents depletions and as such there are no return flows associated with the diversions.

2.6.5 Redlands Power Canal

The Redlands Canal physically diverts water from the Gunnison River (Division 4) and its diversions are not affected by administration of water rights on the mainstem of the Upper Colorado River (Division 5). However, the irrigated lands under the Redlands Canal are located in the Upper Colorado River basin and the return flows from irrigation and from hydroelectric power generation accrue to the Upper Colorado River downstream of Grand Junction. The canal serves about 4,500 acres and is owned and operated by the Redlands Water and Power Company.

The Redlands Canal diverts water from the Gunnison River for irrigation and for hydroelectric power generation. The canal diverts from the Gunnison about two miles upstream of its confluence with the Upper Colorado River and about 6 miles downstream of the principal USGS stream gage on the Gunnison River (Gage No. 09152500). Historically, a portion of the power production was used to pump the irrigation water from the main diversion up to the irrigation laterals at higher elevations. Currently all of the power is sold to Public Service Company and the revenues are used to buy back electrical power to drive the irrigation lift pumps. There are four pumping stations and over 26 miles of lateral ditches in the system.

The Redlands Water and Power Company own the following direct flow water rights from the Gunnison River.

Adjudication Date	Appropriation Date	Administration Number	Amount (cfs)	Use
07/22/1912	07/31/1905	22283.20300	60	Irrigation
07/22/1912	07/31/1905	22283.20300	610	Commercial
07/21/1959	06/26/1941	34419.33414	80	Commercial

During the summer irrigation season, the Redlands Canal is normally operated to divert about 690 cfs for power generation and about 60 cfs for irrigation use. During the non-irrigation season, the system is operated to divert up to 750 cfs solely for hydroelectric power generation. The Division 4 Engineer separately accounts for each type of diversion.

Return flows from hydroelectric power diversions accrue to the Upper Colorado River about four miles downstream of the confluence of the Upper Colorado and Gunnison Rivers. Irrigation return flows accrue to the river along a 10-mile reach of the river downstream of the confluence. The locations of these return flows were determined using the State's irrigated acreage database and topographic mapping and have been incorporated into the CRDSS.

2.7 Independence Pass Transmountain Diversion System

The Independence Pass Transmountain Diversion System is privately owned and operated by the Twin Lakes Reservoir and Canal Company (TLRCC) in the headwaters of the Roaring Fork River basin. The project was initially developed in the 1930's for the purpose of collecting surplus spring runoff from tributaries of the Roaring Fork and transporting the water through Tunnel No. 1 to the Lake Fork drainage in the Arkansas River Basin within Division 2. The transmountain water was stored in the Company's Twin Lakes Reservoirs and subsequently released to provide a supplemental irrigation water supply for lands under the Colorado Canal, east of Pueblo. In 1977, the water rights were changed in the Water Court to allow the water to be used for all beneficial uses, including municipal and industrial purposes. Today, the water is used predominantly for these new uses and less water is used for irrigation.

2.7.1 Description of Physical Facilities

Twin Lakes Tunnel No. 1 (WDID 384617). This tunnel is used to transport the waters collected in the Roaring Fork River basin, under the Continental Divide to the Eastern slope. The tunnel is approximately 3.8 miles long and has an estimated capacity of about 625 cfs. The headworks for the tunnel are located adjacent to Grizzly Reservoir on Lincoln Creek. Total diversions through the tunnel are measured at its east portal.

Grizzly Reservoir (WDID 383779). Grizzly Reservoir is located on Lincoln Creek and serves as the forebay for diversions into Tunnel No. 1. It receives water from (a) the Roaring Fork drainage via Tunnel No. 2 and the Lincoln Gulch Connection Canal, (b) New York Collection System, and (c) Lincoln Creek above the reservoir. The reservoir commands a drainage area of about 16 square miles on Lincoln Creek. It has an estimated capacity of about 400 acre-feet, which is used for regulation of water into Tunnel No. 1.

Twin Lakes Tunnel No. 2 (WDID 381763). This tunnel is used to convey waters diverted from Lost Man Creek and the mainstem of the Roaring Fork River through a basin divide to Grizzly Reservoir in the Lincoln Creek drainage, where it can then be diverted through the transmountain Tunnel No. 1. The tributary drainage area above the diversion dam for Tunnel No. 2 is approximately 9.9 square miles, not including the area tributary to the Lost Man Diversion Dam. The tunnel currently has a capacity estimated to be between 325 and 350 cfs.

Lincoln Gulch Connection Canal. This structure is used to convey water from the south portal of Tunnel No. 2 to Grizzly Reservoir. A portion of this canal is an open-channel structure and portions are closed conduit. The canal currently has a capacity estimated to be about 330 cfs. The TLRCC has a decree to capture seepage and side-hill runoff that enters the canal.

Lost Man Diversion Dam and Diversion Canal (WDID 381767). This diversion structure and conveyance canal is used to divert surplus spring runoff from Lost Man Creek and deliver it to a point on the Roaring Fork River above the diversion dam for Tunnel No. 2. The drainage area tributary to the Lost Man Diversion Dam is approximately 9 square miles.

New York Collection Canal. This structure is used to collect surplus spring runoff from three tributaries of Lincoln Creek and transport that water by gravity to Grizzly Reservoir for subsequent transmountain diversion through Tunnel No. 1. Headgate No. 1 (WDID 381764) diverts water from New York Creek and commands a drainage area of about 3.2 square miles. The water is transported through a 48-inch pipeline for a short distance to Brooklyn Gulch. Headgate No. 2 (WDID 381765) diverts water from Brooklyn Gulch and combines with the diverted flows from Headgate No. 1. The Brooklyn Gulch drainage area tributary to Headgate No. 2 is about 2.4 square miles. The combined flow from these two sources is transported in a 60 inch pipeline to Tabor Gulch. Headgate No. 3 (WDID 381766) is located on Tabor Gulch and diverts additional water into the collection system. The drainage area tributary to Headgate No. 3 is about 3.7 square miles. From the Tabor Gulch inlet, the combined diversions are conveyed in a 72-inch pipeline to Grizzly Reservoir.

2.7.2 Water Rights

The water rights for the Independence Pass Transmountain Diversion System are summarized in Table 2.8. In the 1977 decree, which changed the use of the water rights, there were certain volumetric limitations imposed on the project diversions. (1) The maximum diversion through Tunnel No. 1 cannot exceed 68,000 acre-feet in any one year; and (2) the diversions through Tunnel No. 1 cannot exceed a volume of 570,000 acre-feet in any consecutive 10-year period (average annual diversion of 57,000 acre-feet per year).

Table 2.7
Independence Pass Transmountain Diversion Project Water Rights

Name	Structure ID	Adjud. Date	Approp. Date	Admin. Number	Amount (cfs) Absolute	Amount (cfs) Conditional
New York Collection System						
Headgate No. 1	381764	8/25/1936	8/23/1930	30941.29454	77	-
Headgate No. 2	381765	8/25/1936	8/23/1930	30941.29454	127	-
Headgate No. 3	381766	8/25/1936	8/23/1930	30941.29454	171	-
Headgate No. 1	381764	12/31/1973	4/30/1973	45045.00000	-	20
Headgate No. 2	381765	12/31/1973	4/30/1973	45045.00000	15	35
Headgate No. 3	381766	12/31/1973	4/30/1973	45045.00000	39	61
Roaring Fork/Lost Man Collection System						
Lost Man Diversion	381767	8/25/1936	8/23/1930	30941.29454	251	24
Tunnel No. 2	381763	8/25/1936	8/23/1930	30941.29454	322	28
Connection Canal	381768	8/25/1936	8/23/1930	30941.29454	-	20
Tunnel No. 1	384617	8/25/1936	8/23/1930	30941.29454	625	-
Grizzly Reservoir	383779	12/31/1974	10/30/1974	45593.00000	400 ac-ft	-

2.7.3 Exchange with Fryingpan-Arkansas Project

Pursuant to the authorization of the Fryingpan-Arkansas Project, the TLRCC agreed to bypass up to 3,000 acre-feet of water that would have normally been diverted through Tunnel No. 1 at times when the flow of the Roaring Fork River, at its confluence with Difficult Creek, is less than the following minimum monthly flow values (in acre-feet) recommended by the U. S. Fish and Wildlife Service (FWS):

Month	Average Flow	Month	Average Flow
October	2,700	April	3,800
November	2,100	May	6,200
December	1,800	June	7,100
January	1,600	July	6,200
February	1,400	August	3,980
March	1,500	September	2,600

In order to compensate TLRCC for this bypass, the Fry-Ark Project is obligated to deliver up to 3,000 acre-feet from its project water supplies to the TLRCC, deliverable to TLRCC's storage account in Twin Lakes.

TLRCC's obligation to forego diversion at its collection system is applicable only to the extent of up to 3,000 acre-feet per year, delivered by exchange from the Fry-Ark Project and TLRCC is not required to forego diversions except to the extent that a like quantity of water is furnished to the TLRCC.

In practice, this exchange has been operated by the TLRCC bypassing divertible flow at Grizzly Reservoir on Lincoln Gulch and at the Roaring Fork diversion dam in the following amounts: At times when the TLRCC diversions are in priority, the above

bypasses are accumulated against the 3,000 acre-foot exchange obligation from the Fryingpan-Arkansas Project.

Month	Bypass At Grizzly Reservoir	Bypass At Roaring Fork
January	3.0 cfs	-
February	3.0 cfs	-
March	3.0 cfs	-
April	3.0 cfs	-
May	3.0 cfs	1.0 cfs
June	2.0 cfs	1.5 cfs
July	2.0 cfs	1.5 cfs
August	3.0 cfs	4.0 cfs
September	3.0 cfs	4.0 cfs
October	3.0 cfs	4.0 cfs
November	3.0 cfs	-
December	3.0 cfs	-

2.8 Municipal Diversions

The municipal water rights used by small towns and community water systems on the Western Slope are relatively small and are typically smaller than the decreed flow rate selected as the cutoff for each river basin. Municipal water use also does not constitute a significant depletion to the natural streamflow since much of the water returns to the stream as domestic wastewater and/or urban irrigation return flows. For these reasons, the majority of the municipal diversion structures used by small towns and community water systems are not included in the Upper Colorado River Model. Unless there are other specifically identified reasons, municipal diversion structures are included in the model only if they satisfy the following criteria. All other municipal diversions are assumed to be left in the historical gage record.

1. The cumulative net absolute decreed water rights for the structure are greater than or equal to the selected cutoff for the river basin being modeled (11 cfs in the Upper Colorado River basin).

2. The municipal diversions are made from the surface stream rather than from groundwater sources (unless the municipal diversions are significantly large, i.e. Vail Valley Consolidated Water District).

3. Average annual diversions for municipal purposes are no less than 1,000 acre-feet per year.

4. The municipal diversion structure is on a stream or tributary stream that is included in the model because of the inclusion of other non-municipal diversion structures.

5. The municipal diversion structure is an integral part of the operation of a reservoir that is included in the model.

Given the above criteria, the municipal diversion structures, which are included in the model, are described in the following paragraphs.

2.8.1 The Town of Breckenridge

The Breckenridge Pipeline (WDID 361008) diverts water from Goose Pasture Tarn, a small storage reservoir located on the mainstem of the Blue River, and which provides Breckenridge with its municipal water supply. The town makes its initial diversions under a senior decree for 4.87 cfs, diversions that do not need to be augmented. Diversions in excess of 4.87 cfs become the subject of a reasonably complex augmentation plan involving separate identification of irrigation, municipal and snowmaking diversions, releases from the Tarn, augmentation credits from senior irrigation water rights and replacement contracts in Green Mountain and Dillon Reservoirs, including water in Dillon under the Summit County Agreement.

The town provided historical water use data consisting of monthly treated water deliveries at the water treatment plant for the period January 1975 through December 1975 and monthly municipal diversions at the Tarn for the period November 1990 through October 1992. For purposes of the CRDSS, the annual total for calendar year 1975 was assumed to be equal to a total for the 1975 Water Year.

Annual totals for the intermediate water years in which no records were available (1976 through 1990), were linearly interpolated between the 1975 and 1990 values. The monthly distribution of the annual amounts were determined using the average monthly water distribution percentages as determined from the January 1975 through December 1975 and November 1990 through October 1992 data. This time series has been included in HydroBase.

For the CRDSS Upper Colorado River Model, the town's municipal water diversions at the Breckenridge Pipeline should be supported via an operational right to the Summit County account in Dillon Reservoir (602 acre-feet) and the town's account in Clinton Gulch Reservoir (390 acre-feet).

2.8.2 The Town of Dillon – Dillon Valley Water & Sanitation District (DVWSD)

The town of Dillon owns a 3.5 cfs water right in the Straight Creek Ditch (WDID 360829), a water right that is decreed for year round municipal uses under an administration number 18005.00000. The Dillon Valley Water and Sanitation District (DVWSD) owns a 3.5 cfs water right in the Rankin No. 1 Ditch (WDID 360784), a water right that is decreed for year round municipal use under administration number 12191.00000. Diversions for both of these water rights are made at a common point of diversion on Laskey Gulch, a tributary of Straight Creek. By agreement, the town and the DVWSD equally share the yield from the two water rights, up to a total diversion of 7.0 cfs. For example, if the available flow at the point of diversion were only 4 cfs, each entity would be entitled to 2 cfs. If one of the entities is not using its entire allocation, the other has the right to use it. The town of Dillon also has a small amount of storage in Dillon Reservoir pursuant to the Summit County Agreement (84 acre-feet) and the Clinton Gulch Reservoir Agreement (60 acre-feet).

The town provided monthly records of the amount of water used (or raw water diversions in some cases) for the period January 1986 through September 1991. For the remainder of the CRDSS study period, data for the missing months (October 1974 through December 1985) were filled using the monthly data for the 1986 calendar year. These data are incorporated into HydroBase.

The DVWSD provided monthly records of municipal raw water diversions for the period January 1983 through September 1991. Data for the missing months of the CRDSS study period (October 1974 through December 1982) were filled using the recorded values for Water Year 1984, the first complete water year with records. These data are incorporated into HydroBase.

For purposes of the CRDSS, the water rights should be modeled assuming that each municipality owns a 50 percent interest in each water right, i.e. 1.75 cfs in administration no. 12191.00000 (Rankin No. 1 Ditch) and 1.75 cfs in administration no. 18005.00000 (Straight Creek Ditch).

2.8.3 Keystone Municipal Use

Keystone's municipal water is supplied by the Snake River Water District, which was formed in August 1982. The municipal water supply is provided using a number of shallow wells located in the Snake River alluvium; there are no surface diversions for municipal use. In the CRDSS Upper Colorado River Model, a composite demand node, KEYS (WDID 955002) is used to represent the cumulative diversions from the four wells used during the CRDSS study period: (1) SRWD No. 1 (WDID 365221), (2) SRWD No. 1A (WDID 365222), (3) Owners Well 3 (WDID 365070), and (4) Site No. 1 (WDID 365094). The State's diversion database contains monthly records of pumping from these sources from November 1987 through September 1991, and annual totals for water years 1985, 1986, and 1987.

The missing diversion data for the remaining months of the CRDSS study period were filled based on recommendations of the water commissioner and the water district manager. Annual groundwater pumping values during 1985 through 1987 were distributed on a monthly basis according to the average monthly percentages determined from the pumping records during the period November 1987 through September 1991. The October 1987 diversion was estimated using the average October pumping values during 1989 through 1991. October 1981 through September 1984 diversion data were filled with monthly pumping values during 1989 through 1991. No diversion data is developed prior to 1982, since this precedes the formation of the District.

Pursuant to the Summit County Agreement, the Snake River Water District has a storage entitlement of 100 acre-feet in Dillon Reservoir. This amount was not changed in the Clinton Gulch Reservoir Agreement.

In 1970, the Keystone Ski Area became the first major ski area in Colorado to artificially make snow. According to Keystone personnel, alluvial groundwater wells were initially used to provide the primary snowmaking water supply from 1970 to 1982. In 1982, Keystone began using the Keystone Snowline Ditch (WDID 360908) to divert water for snowmaking. Historic diversion records for this use are available in the State's database for water years 1989 through

1991. Missing diversion data for the CRDSS study period were filled as follows: (1) Data for October 1974 through September 1981 were filled using zeros; (2) Data for the period October 1981 through September 1988 were filled using the monthly averages from the three years of recorded data.

Pursuant to the Summit County Agreement, Keystone was entitled to an allotment of 1,500 acre-feet of storage water in Dillon Reservoir. However, pursuant to the terms of the Clinton Gulch Reservoir Agreement (see separate discussion) this storage allotment was reduced to 15.5 acre-feet and Keystone obtained the right to pump as much as 2,170 acre-feet per year (firm) for snowmaking purposes pursuant to the Clinton Gulch Reservoir Agreement. Up to 1,500 acre-feet of this amount may be diverted directly from Denver's Roberts Tunnel via the Montezuma Shaft.

2.8.4 Copper Mountain Ski Area

At this time, municipal uses at Copper Mountain do not represent a significant depletion to the flows of Tenmile Creek and are not included in the CRDSS Upper Colorado River Model. However, a node (WDID 361016) has been included in the Upper Colorado River Model to represent the present and future snowmaking demands at the ski area, even though actual diversions for this purpose were relatively small during the CRDSS study period.

The Clinton Gulch Reservoir Agreement provides that up to 343 acre-feet of storage water in Clinton Gulch Reservoir can be released for subsequent diversion by Copper Mountain for snowmaking. The ski area is planning to construct diversion facilities on Tenmile Creek for future diversions of the Clinton Gulch Reservoir storage water.

In the original Summit County Agreement, Copper Mountain Ski Area was allotted 331 acre-feet of storage in Dillon Reservoir. However, pursuant to the Clinton Gulch Reservoir Agreement, this storage allotment in Dillon was reduced to 61 acre-feet. Copper Mountain also had the option to convert up to 97.3 acre-feet of its original Summit County Agreement water to future water in Dillon Reservoir. In November 1995, Copper Mountain converted this entitlement, resulting in a net Future Dillon Account in the amount of 37.7 acre-feet (The agreement required compensation to Denver on a 1.58 to 1.0 ratio).

2.8.5 Vail Valley Consolidated Water District (VVCWD)

The Vail Valley Consolidated Water District (VVCWD) was formed in 1982 by the consolidation of six small water and sanitation districts in the Gore Creek valley. The VVCWD provides water for variety of municipal uses, including golf course irrigation and snowmaking at the Vail Ski Area. It has been represented that as of 1996, the VVCWD service area is about 90 percent built out. An alluvial well field (Wells R1, R2, R3 and R4) located adjacent to Gore Creek between Booth Creek and Spraddle Creek provides most of the VVCWD municipal water supply. The combined capacity of these wells is about 10.8 cfs. Supplemental sources include three additional wells in West Vail, and an infiltration gallery in East Vail. These supplemental sources have a combined capacity of about 2.8 cfs. For the CRDSS Upper Colorado River Model, the VVCWD municipal

demand is represented by a composite demand structure, which is inclusive of all the water rights pertinent to the existing well facilities.

VVCWD essentially has three different types of water rights: (1) junior direct flow rights that are decreed for year round municipal use: (2) senior irrigation rights that historically irrigated in the Gore Creek Valley (the consumptive use attributable to this historical use is used to augment out-of-priority municipal diversions); (3) reservoir storage, in local reservoirs (Black Lake and others) and from Green Mountain Reservoir (historic user pool and contract water). Use of these three basic types of water depends on the time of year, the priority call on the river and the terms and conditions of the VVCWD's augmentation plan decreed in Case No. 82CW328.

The historical consumptive use credits attributable to the senior rights total about 902 acre-feet per year and are generally available during the irrigation season from mid-May to late October. Most of VVCWD's more junior rights are protected from downstream calls using releases from the historic user pool in Green Mountain Reservoir. VVCWD also has contracted for 934 acre-feet of water from the contract pool in Green Mountain Reservoir to support snowmaking at the ski area (602 acre-feet) and junior water uses perfected by use after 1977 (332 acre-feet/year).

VVCWD also developed additional storage reserves in Black Lakes, near the top of Vail Pass. Pursuant to an agreement with the Colorado Water Conservation Board, VVCWD can release up to 300 acre-feet of water from the Black Lakes during the winter months to supplement and enhance the Gore Creek streamflows and to replace out-of-priority diversions caused by potable water uses and snowmaking.

To illustrate the complexity of modeling the VVCWD system, it is noted that the augmentation plan includes 38 different priorities originating from about 25 different senior ditch structures. There are also over 30 junior water right priorities (wells, springs, and other municipal diversion points) and over 20 small reservoirs. Because of the complexity of the system, particularly given the relatively small annual diversions, detailed modeling is beyond the scope of the CRDSS Upper Colorado River Model.

For purposes of the CRDSS, the operation of the VVCWD water rights can be reasonably simulated base on the following criteria:

1. Seven of the senior irrigation water rights are senior to the calling right at the Shoshone power plant. Cumulatively, these priorities add up to 11.2 cfs. Since they were all adjudicated in the 1894 adjudication, a single administration number can reasonably represent this aggregated group of priorities, being No. 15646.00000 (the most junior of the seven water rights). According to the change of use decrees, the consumptive use attributable to the historical use of these seven irrigation water rights is about 317 acre-feet annually. Monthly values of the historical consumptive use are shown in the table below.

2. These senior aggregated rights can only be exercised during the summer irrigation season. In accordance with the augmentation plan, the consumptive use can be used to augment higher rates of diversion for municipal uses. Monthly rates of municipal

diversion for these aggregated senior irrigation rights can be calculated using the monthly historical consumptive use values from the VVCWD augmentation decree (Case No. 82CW328), divided by the municipal depletion percentages also defined in the decree. The calculated monthly diversion rates are shown below.

Month	Historic C.U. (acre-feet)	Municipal Depletion (%)	Municipal Diversion (ac-ft)	(cfs)
May	24.4	12.9	189	3.0
June	89.5	19.0	471	7.9
July	78.3	17.2	455	7.3
August	51.4	13.7	375	6.1
September	51.4	16.6	310	5.2
October	22.0	7.9	278	4.5
November - April			-	-

3. The remainder of the historical irrigation rights (those junior to Shoshone) need not be specifically modeled for municipal uses at VVCWD in the CRDSS Upper Colorado River Model. The flow rates given in Paragraph 2 above should be sufficient for the municipal demands.
4. During the non-irrigation season (November through April), the municipal diversion at VVCWD can be represented as an aggregated demand equal to about 13 cfs with an aggregated priority represented by administration no. 42420.41366.

5. During the non-irrigation season, when this aggregated junior water right (Item 4 above) is out-of-priority, releases can be made from the VVCWD account in the historic user pool in Green Mountain Reservoir. In the Upper Colorado River Model, this would be represented as an exchange from the Upper Colorado River upstream on the Eagle River to Gore Creek.

6. In practice, there may be times that the exchange of Green Mountain Reservoir water cannot be made because of the CWCB instream flow rights on the Eagle River and Gore Creek. In this situation, VVCWD would likely release water from one of its small reservoirs in the headwaters of Gore Creek (including the Black Lakes) as necessary to augment the municipal diversions. These smaller reservoirs are not incorporated into the CRDSS and it is believed that this is a level of complexity beyond the scope of the Upper Colorado River Model.

For the CRDSS, the municipal demand time series for the VVCWD was developed using monthly historical use records provided by the VVCWD's consultant for the period January 1981 through September 1991. Diversion data for the missing months of the CRDSS study period (October 1974 through December 1980) were filled using the actual diversion records for calendar year 1981. These data are included in HydroBase.

2.8.6 Upper Eagle Valley Water Authority

The Upper Eagle Valley Water Authority (Authority) was formed in 1984 and provides treated, potable water supplies to the Eagle-Vail, Avon, Beaver Creek, Arrowhead, Edwards, and Berry Creek Metropolitan Districts. These districts are located along the Eagle River from Gore Creek to Squaw Creek. The districts lease their owned water rights to the Authority in return for treated water deliveries. The water supplies are diverted at the headgate of the Metcalf Ditch (WDID 370708).

In the CRDSS Upper Colorado River Model, the Metcalf Ditch is used to represent the cumulative water rights used for municipal purposes by the Authority. A monthly time series for the historical municipal demand was developed using actual municipal water use data provided by the Authority's consultant for the period November 1990 through October 1992 and the actual water diverted through the Metcalf Ditch in 1992. Upon the recommendation of the Authority's consultant, data for the remaining years of the CRDSS study period were generated assuming the following: (1) 1992 Metcalf Ditch diversions are equal to those in 1991 and (2) the 1975 demand was 50 percent of the 1992 demand. Annual totals for intermediate years were then computed through linear interpolation and the monthly values were estimated using the monthly distribution percentages for 1992. This generated time series is incorporated into HydroBase.

2.8.7 Town of Aspen

Historically, Aspen has obtained the majority of its municipal water supply by diversion from Castle Creek through the Midland Flume Ditch (WDID 380869). This structure has an estimated physical capacity of about 25 cfs. The Town also owns water rights in the Maroon Creek Pipeline (WDID 381156), which diverts from Maroon Creek. This source is occasionally used to supplement the municipal demand when the Castle Creek source is inadequate. The Maroon Creek Pipeline has a capacity of about 27 cfs for municipal uses. If these two sources are insufficient to meet the potable demands, Aspen can pump from an alluvial well field adjacent to the Roaring Fork River. According to the town's consultant, Aspen typically meets the majority of its demands using the Midland Flume water right and diverts water from Maroon Creek primarily for the generation of hydroelectric power (The Maroon Creek Pipeline has a decreed water right for 65 cfs for hydroelectric generation). Historically, the power plant was operated only a few months out of each year and was not used extensively prior to 1995. Currently, the Maroon Creek hydroelectric plant is operated in a manner which will bypass sufficient water to satisfy the junior instream flow right (CWCB for 14 cfs) and divert the remaining flow for hydroelectric power production. The hydroelectric plant diversions are non-consumptive and are returned right back to the stream.

The measuring device for the municipal diversions is situated to measure the contribution from both the Castle Creek and Maroon Creek sources, without specifically identifying the amount from each source. Furthermore, the historical record for diversion from both sources likely overstates the actual municipal water use. Because of remote access, the gated diversion structures were typically set to divert a constant amount of flow and any water in excess of the actual municipal demand, although measured, was released back to the streams, unused.

Accordingly, for purposes of the CRDSS, the municipal water demand was based on actual water usage data for the period October 1991 through September 1992, provided by the town's consultant. In 1992, Aspen satisfied nearly all of its municipal water needs using diversions through the Midland Flume Ditch. For the CRDSS study period, the municipal demand was generated assuming that the 1992 level of use is representative of the demand for each year of the entire study period. Based on the consultant's recommendation, the Maroon Creek Pipeline was not used to provide any of the town's demands. It is included for purposes of the hydro-electric generation (and possible future municipal use).

2.8.8 Snowmass Water & Sanitation District (Snowmass)

Snowmass obtains the majority of its municipal water supply from East Snowmass Creek, using the East Snowmass and Brush Creek Pipeline (WDID 381441). Additional sources include water rights on the West Fork of Brush Creek and from the mainstem of Snowmass Creek. Monthly records of the historical municipal water use were obtained from Snowmass for calendar years 1975 through 1988 and 1990 through 1991. Based on recommendations of the consultant for Snowmass, the missing data for the CRDSS study period were filled as follows: (1) Data for October 1974 - December 1974 were filled using the 1975 data for these same months; (2) Data for the period January 1988 - December 1988 were filled using 1989 recorded data.

2.8.9 Town of Carbondale

The town of Carbondale currently diverts the majority of its municipal water supply from Nettle Creek, a tributary of the Crystal River. The town's water rights are in the Carbondale Water System and Pipeline (WDID 381052), decreed for about 5.7 cfs. For future supplies, the town is developing wells in the alluvium of the Roaring Fork River.

According to the water commissioner and the town's consultant, there is some question about the reliability of the historical diversion records for this structure in the State database (available for the period November 1974 through September 1980). The town recently completed an analysis and quantification of its existing demand (1995±). Previous engineering investigations had determined the town's water demand in 1977, a known dry year. It was concluded that the 1977 municipal water demand was about 75 percent of the existing demand.

For the CRDSS Upper Colorado River Model, the municipal demand time series was generated assuming the following: (1) The 1991 demand is assumed to be equivalent to the existing demand (1995); and (2) the 1975 demand is equivalent to 75 percent of the 1991 demand. Annual totals for the intermediate years of the study period were linearly interpolated and the monthly distribution of the annual amounts was determined using the 1991 monthly water distribution percentages.

2.8.10 Town of Glenwood Springs

The town of Glenwood Springs obtains the majority of its municipal water supply from surface diversions on Grizzly Creek via the Glenwood Water Co. System (WDID 531051) and from No Name Creek, also through the Glenwood Water Co. System (WDID 530585), both of which are tributaries of the Upper Colorado River. The Grizzly Creek structure has a decreed water right for 8 cfs and the No Name structure has a decreed right for 12 cfs. The Grizzly Creek structure is also named as an alternate point of diversion for the No Name water.

The total combined diversions from both sources are recorded and the State database contains reasonably reliable records for the period November 1974 through October 1975 and November 1984 through September 1991. The remainder of the historical demand time series for the CRDSS study period was filled assuming the following: (1) The October 1974 value was assumed to be equal to the October 1975 diversion and (2) the October 1984 value was assumed to be equal to the October 1985 diversion. Annual totals for the intermediate water years of the study period (1976 through 1983) were linearly interpolated and the monthly distribution of the annual values was determined using the 1984 monthly water distribution percentages.

2.8.11 Town of Rifle

The town of Rifle obtains the majority of its municipal water supply from the Upper Colorado River using the town of Rifle Pump and Pipeline (WDID 390967). The State database contains reasonably consistent records of the municipal diversions for the period January 1984 through September 1991. Based on conversations with town personnel, diversion data for the remainder of the CRDSS study period was generated by assuming that diversions for the earlier years were equivalent to the measured diversion values for 1984.

2.8.12 Town of Palisade

The town of Palisade diverts the majority of its municipal water supply from sources on Rapid Creek, a tributary of the Upper Colorado River. Water is diverted through the Palisade Town Pipeline (WDID 720816). The town provided records of the monthly raw water diversions entering the water treatment plant for the period October 1985 through September 1991. For purposes of the CRDSS, diversion data for the remaining years of the CRDSS study period (October 1974 through September 1985) were estimated by filling with the average monthly data from the 1985 through 1991 period.

2.8.13 Clifton Water District (Town of Clifton)

The town of Clifton diverts the majority of its municipal water supply from the Upper Colorado River via an ownership interest in the Grand Junction-Colorado River Pipeline (WDID 720644). The Clifton Water District owns 18.57 cfs of this water right, the remainder being owned by the City of Grand Junction. An additional 4 cfs is diverted under the water rights for the L. H. Hurt Ditch (WDID 720710). In most years, diversions from these sources provide an adequate water

supply. In low runoff years, the Water District must rely more heavily upon shares it owns (1,417 shares) in the Grand Valley Irrigation Company (WDID 720645) and generally takes delivery from this source during the summer season, April through October. Pursuant to an agreement with the City of Grand Junction, the Water District occasionally sells and delivers treated water to the City during the summer months and Grand Junction occasionally sells treated water back to the Water District in the winter months.

Clifton provided records of the total municipal diversions on an annual basis for the years 1980 through 1989, as well as records of monthly diversions for the months October 1993 through September 1995. For purposes of the CRDSS, annual diversion data for the remaining years of the CRDSS study period (1974 through 1979 and 1990 through 1991), were assumed to be equivalent to the average annual diversion for the 1980 through 1989 period. The monthly distribution of the annual diversions was determined using the monthly patterns for the October 1993 through September 1995 period.

2.8.14 City of Grand Junction

The majority of the City of Grand Junction's (Grand Junction) municipal water supply is diverted from sources in the Gunnison River drainage and is not included as a municipal demand node in the CRDSS network for the mainstem of the Upper Colorado River. However, return flows from Grand Junction's municipal use accrues to the Upper Colorado River and therefore needs to be represented in the Upper Colorado River Model.

Grand Junction owns water rights on the Upper Colorado River, Gunnison River, and Kannah Creek. The Grand Junction-Colorado River Pipeline (WDID 720644) is the city's point of diversion on the Upper Colorado River. Several alternate points of diversion have been decreed and the Clifton Water District has made absolute a portion of the water right that it acquired (18.57 cfs out of the 100 cfs decreed to the pipeline). Grand Junction does not rely on this water right as a source of supply and the remainder of the water right is still conditional (81.43 cfs).

Grand Junction will occasionally divert water directly from the Gunnison River using the Grand Junction-Gunnison River Pipeline (WDID 420520). At this time, only 18.6 cfs out of the decreed 120 cfs water right has been made absolute. This Gunnison River source is used as a standby and emergency source of supply.

The primary source of supply is an integrated system of reservoirs and pipelines in the Kannah Creek Basin, a tributary of the Gunnison River (upstream of the USGS stream gage No. 09152500). Principal features of this system include the City Ditch, Hallenbeck Reservoir, Juniata Reservoir, the Purdy Mesa Flow Line, and the Kannah Creek Flow Line. Grand Junction diverts water from the North Fork of Kannah Creek through the City Ditch (WDID 450512). This ditch feeds the Hallenbeck and Juniata Reservoirs. The Purdy Mesa Flow Line is used to convey water from these reservoirs to the city's water treatment plant. The Kannah Creek Flow Line (a.k.a. City of Grand Junction Pipeline (WDID 420513)) diverts from the mainstem of Kannah Creek and extends to the water treatment plant. It is not physically connected to Hallenbeck or Juniata Reservoirs. According to City of Grand Junction personnel, the Kannah Creek source is used to meet most of the city's municipal demand. However, water from the City

Ditch source is desirable because Hallenbeck and Juniata reservoirs provide a level of pre-treatment benefit. Grand Junction tries to keep the reservoirs full year around.

The City of Grand Junction provided monthly records of its treated water production for the entire CRDSS study period, October 1974 through September 1991. These data were compared to the diversion data available from the State database. Although reasonably similar, there were significant variances in the data in many years. To resolve the issue, it was decided to populate HydroBase with the municipal diversion data provided by the city.

For the CRDSS Upper Colorado River Model for the mainstem of the Upper Colorado River, the Grand Junction municipal diversions are modeled as an import to the Upper Colorado River. This is accomplished by creating a new tributary stream to receive the imports and upon which a future municipal demand node can be established. For the historical CRDSS scenario, this new municipal demand node is populated with the data provided by the city. Return flows from Grand Junction's municipal use return to the Upper Colorado River at the Persigo wastewater treatment plant, about six miles downstream of the city.

2.8.15 Ute Water Conservancy District

The Ute Water Conservancy District (Ute WCD) is the largest rural water provider in the Upper Colorado River basin, with a service area that extends from near Cameo to the northwest and including the town of Fruita. The service area includes most of the rural land on both sides of the Upper Colorado River, but excludes the towns of Palisade, Clifton, Whitewater and Grand Junction, all of which have their own municipal supplies. During the 1993 Water Year, the Ute WCD provided in excess of 7,000 acre-feet of treated water to its customers. According to Ute WCD personnel, the majority of the water (~85 percent) is used for in-house domestic purposes, with less than 15 percent used for lawn irrigation and other outside uses (Note that most of the service area has access to irrigation water supplies from the numerous ditch systems in the area). It is estimated that about 75 percent of the Ute WCD service area is served by a centralized wastewater collection system, conveying the wastewater either to the Persigo Wastewater Treatment Plant (Grand Junction) or to the treatment plant at Fruita. The remaining 25 percent of the service area is served by septic tank/leach fields systems. These approximate percentages are used to estimate the efficiency of the municipal water deliveries from the Ute WCD as well as the location of return flows.

For this municipal water system, it was assumed that the efficiency for that portion of the system served with a centralized wastewater system is 10 percent (90 percent return flow) and the efficiency for that portion using septic tank/leach fields would be 20 percent (80 percent return flow). For the centralized portion of the service area, the returns would all occur in the same month and for the remainder, the returns would be in accordance with the standard return flow table for irrigation return flows.

Raw water diversions for the Ute WCD are made through four main structures: (1) the Ute Pipeline Headgate No. 1 (WDID 720920); (2) the Mason Eddy Ditch (WDID 720766); (3) the Coon Creek Pipeline (WDID 721339); and (4) Rapid Creek Pumping Plant (WDID 721329). The Ute Pipeline (a.k.a. the Plateau Creek Pipeline or the Grand Mesa Pipeline) diverts water from

two sources; the tailrace of the penstock for the Lower Molina Power Plant, operated by the USBR as part of the Collbran Project and directly from Plateau Creek. The capacity of the pipeline at these diversion structures is reported to be about 50 cfs. According to Ute WCD personnel, the preference is to divert the higher quality water from the penstock tailrace rather than the lower quality water in Plateau Creek itself. The water diverted from the tailrace and Plateau Creek are delivered by pipeline to two off-channel reservoirs, Jerry Creek No. 1 and Jerry Creek No. 2. These reservoirs are operated in a manner to keep them as full as possible such that most of the direct flow diversions are either bypassed through the reservoirs or delivered directly into the Grand Mesa Pipeline and conveyed to the Ute WCD treatment plant on Rapid Creek. There are some pre-treatment benefits that can be realized if the water is allowed to flow through the reservoirs. Water diverted from the tailrace and/or Plateau Creek that is in excess of the demands at the treatment plant are generally spilled back to Plateau Creek. When the Molina Power Plant is not operating and the quality of the Plateau Creek streamflow is poor, water is released from the reservoirs to meet the demand.

Municipal diversions are also made from Mesa Creek via the Mason Eddy Ditch and the Carver Ranch Pipeline (WDID 721334) and occasionally from Coon Creek via the Coon Creek Pipeline. The Coon Creek source is seldom used and the water rights are often leased back for agricultural irrigation. These diversions are delivered directly into the Grand Mesa Pipeline and conveyed to the treatment plant.

The records of diversion for these structures, as contained in the Division of Water Resources database, are incomplete and cannot readily be used to determine whether the water is being delivered for municipal use, stored or spilled back to Plateau Creek. The Ute WCD provided daily records of the operation of its raw water diversion and storage system for the period October 1982 September 1991. Limited records of the inflow to the treatment plant (via the Grand Mesa Pipeline) are also available for the period 1979 through 1982. These user-supplied records were used to synthesize a demand for the Ute Pipeline at the Molina tailrace and Plateau Creek (WDID 720920). This was accomplished in the following manner:

1. The total raw water deliveries into the Rapid Creek water treatment plant were tabulated using the user supplied records for the Grand Mesa Pipeline. Missing data were filled using average monthly data.

2. The user-supplied historical diversions from Mesa Creek (WDID 720766) and Coon Creek (WDID 721339) were subtracted from the total raw water deliveries determined in Step 1. The resulting remainder represents the total diversion from the Molina Power Plant and Plateau Creek sources, inclusive of all effects of storage in the Jerry Creek Reservoirs and spills back to Plateau Creek. For the CRDSS, this synthesized time-series was adopted for the municipal demand at WDID 720920. All reservoir operations are disregarded.

Operation of the Ute WCD system involves the diversion of raw water from Plateau Creek and its tributaries (Mesa Creek, Coon Creek and Jerry Gulch) for delivery and use along the mainstem of the Upper Colorado River. As such the municipal return flows bypass the USGS gage near the mouth of Plateau Creek and a number of major water rights on the mainstem of the

Upper Colorado River, including the Grand Valley Canal. The location of the return flows was assumed to occur at the Persigo wastewater treatment plant and the Fruita wastewater treatment plant.

2.9 Silt Project/Rifle Gap Reservoir

The Silt Project is located in west-central Colorado near the Towns of Rifle and Silt. The Project was authorized in 1956 in accordance with the Colorado River Storage Project Act and was constructed by the USBR from 1964 to 1967. The Project is operated to provide a supplemental supply of irrigation water for approximately 4,628 acres and a full service supply to 2,416 acres on the north side of the Upper Colorado River.

The main features of the Silt Project include Rifle Gap Dam and Reservoir on Rifle Creek and the Silt Pump Plant on the mainstem of the Upper Colorado River. The project has also enhanced the use of existing irrigation facilities owned by the Farmers Irrigation Company, including the Grass Valley Canal, Harvey Gap Reservoir, the East Lateral and the West Lateral.

Rifle Gap Dam and Reservoir is maintained by the USBR in conjunction with the Silt Water Conservancy District (District). The District and the Farmers Irrigation Company operate the remainder of the project features.

2.9.1 Description of Physical Facilities

The following discussion provides a brief description of the physical facilities pertinent to the Silt Project.

Rifle Gap Dam and Reservoir (WDID 393508). Rifle Gap Dam and Reservoir is located at the confluence of West Rifle Creek and East Rifle Creek, about 5 miles north of the town of Rifle. The reservoir has a tributary drainage area of about 142 square miles. The reservoir is operated to capture and store surplus spring runoff for later release to supplement irrigation demands on Davie Mesa and demands under the Grass Valley Canal/Harvey Gap irrigation system, as will be discussed below, the latter is accomplished by an exchange.

Rifle Gap Reservoir has a total capacity of about 13,602 acre-feet, of which 894 acre-feet is dead storage, 540 acre-feet is inactive storage and 12,168 acre-feet is active. At its normal high water line (Elevation 5960 feet), the water surface area of the reservoir is about 359 acres. The principal outlet works for the reservoir has a capacity rated at 326 cfs at full reservoir condition. At the outlet gate chamber, there is a branch outlet leading directly to the rehabilitated Davie Ditch. The capacity of this 30-inch pipeline is estimated to be about 18 cfs.

There are no known formal operating rules for Rifle Gap Reservoir and at this time, the USBR does not use forecasting technologies to predict reservoir inflows. Data related to historical EOM storage contents, reservoir outflows and computed reservoir inflows were obtained from the USBR and have been incorporated into HydroBase. Inspection of these data indicates that the reservoir is operated to store as much water as possible, beginning in October and continuing

until maximum storage is achieved. The latter generally occurs in March or April, but occasionally in May. The records indicate that in the last 25 years (1970 through 1994), the reservoir has filled to capacity in 16 years (64 percent). Water is generally released upon demand for irrigation water beginning in May. In many years, the reservoir was drawn down to near the bottom of the active pool. (Note that the EOM storage data provided by the USBR is based on the active storage content).

According to personnel at the USBR, the reservoir is operated to maintain a winter flow below the dam (November 1 through April 15) of five cfs or the reservoir inflow, whichever is less.

Davie Ditch (WDID 390547). The Davie Ditch was an existing ditch that had not been used for many years and was rehabilitated as part of the Project construction. It is used to deliver Project water to about 650 irrigated acres on Davie Mesa, southeast of the reservoir. The Davie Ditch diverts directly out of the Rifle Gap Reservoir outlet works and has a capacity of about 18 cfs. The acreage is estimated from the CRDSS irrigated acreage database.

Silt Pump (WDID 390663). This facility was constructed to provide Project irrigation water to the lower areas of Harvey Mesa. The pump is located on the mainstem of the Upper Colorado River about 2 miles east of the town of Silt and has a rated capacity of 36 cfs. The water is lifted into the Silt Pump Canal, which extends about 7.6 miles to the northwest and conveys irrigation water to about 1,950 acres on the lower part of the mesa (USBR estimate).

As part of the Silt Project, the USBR reserved 5,000 acre-feet of water in Green Mountain Reservoir (See separate discussion related to Green Mountain operations). This water can be used to replace out-of-priority diversions at the Silt Pump.

Grass Valley Canal (WDID 390563). The Grass Valley Canal was an existing ditch that historically diverted water from East Rifle Creek for delivery to lands in the Dry Elk Valley and Harvey Gap Reservoir and accordingly to the irrigated lands under the Farmers Irrigation Company system. With construction of the Silt Project, the ditch is now used to carry irrigation water to additional full-service Project lands in Dry Elk Valley in addition to its historical uses under Harvey Gap Reservoir. Project water is delivered to the Grass Valley Canal by exchange from Rifle Gap Reservoir. The Canal has a reported capacity of 60 cfs.

Harvey Gap Reservoir (WDID 393505). This reservoir is a privately owned facility, constructed on a small unnamed tributary of the Upper Colorado River. It is not part of the Silt Project. However, the Project is operated to provide supplemental irrigation water supplies to the lands lying under the East Lateral and West Lateral, both of which receive water from this reservoir. Very little information could be obtained from the State or the District about Harvey Gap Reservoir or its operations. Using old area-capacity data provided by the USBR, the capacity of the reservoir is estimated to be about 5,920 acre-feet.

In general, the reservoir has historically filled using early season diversions through the Grass Valley Canal and was operated to provide regulation of the available water supplies to enhance late summer irrigation needs. Since commencement of the Silt Project operations, Harvey Gap Reservoir, which formerly filled and emptied each year, can now store and regulate water for a

longer irrigation season. Sporadic records of the inflows, outflows, and EOM storage contents were available from the District. However, the data was too incomplete to accurately assess the project operations and could only be used as a basis to estimate diversions and evaluate irrigation practices.

2.9.2 Water Rights

The water rights associated with the Silt Project, either directly or indirectly, are summarized below.

Name	Adjudication Date	Appropriation Date	Amount	Administration Number
Rifle Gap Reservoir	11/10/1966	01/10/1951	13,601 ac-ft	37503.36899
Silt Pump	11/10/1966	11/21/1956	36 cfs	39041.00000
Grass Valley Canal	04/30/1892	07/20/1887	100 cfs	15458.13715
Rif.Gap/Grass Valley Exchange	11/10/1966	01/10/1951	100 cfs	36899.00000
Harvey Gap Reservoir	04/03/1893	04/01/1891	3,902 ac-ft	15667.15066
Harvey Gap Reservoir	11/10/1966	09/15/1946	3,087 ac-ft	37503.35321
Davie Ditch	12/08/1911	03/23/1909	8.66 cfs	22605.21631
Davie Ditch	12/08/1911	03/23/1909	5.88 cfs (C)	22605.21631
Davie Ditch	11/10/1966	07/15/1949	9.34 cfs	37503.36355

There are also some small domestic and stock water rights decreed to the Grass Valley Canal.

2.9.3 Operation of the Silt Project

The key operational component of the Silt Project is the storage of surplus spring runoff in Rifle Gap Reservoir. Upon demand, Project water is released directly from the reservoir into the Davie Ditch for irrigation of about 654 acres on Davie Mesa. When the natural flow of Rifle Creek begins to taper off, downstream senior water rights can place an administrative call against upstream junior rights, including the water rights of the Grass Valley Canal. Under these circumstances, previously stored Project water is released from Rifle Gap Reservoir to the downstream water rights and a like amount is diverted, by exchange, at the upstream headgate of the Grass Valley Canal. These Project diversions (by exchange from Rifle Gap Reservoir) are delivered to approximately 1,521 acres of supplemental and full-service Project lands in the Dry Elk Valley (estimated from the CRDSS irrigated acreage database) and to supplemental service lands previously irrigated under Harvey Gap Reservoir.

The Silt Pump is operated to deliver irrigation water to an estimated 1,950 acres under the Silt Pump Canal, an acreage value estimated by the USBR. To the extent diversions at the Silt Pump are out-of-priority, releases from Green Mountain Reservoir can be made.

Using the same irrigated acreage data from the State, it is estimated that there are about 3,800 acres irrigated under the facilities of the Farmers Irrigation Company (West Lateral and East Lateral), including acreage that is irrigated from the Silt Pump. The supply for this acreage is a

combination of water from Harvey Gap Reservoir storage and direct flow diversions through the Grass Valley Canal. The diversions are also supported by Project water from Rifle Gap Reservoir and from a 5,000 acre-foot storage account in Green Mountain Reservoir (Silt Pump only).

2.10 Transmountain Diversion Projects

In Division 5, there are 16 structures, which are used to export water from the Upper Colorado River basin, including its tributaries, into the headwaters of the South Platte River basin (Division 1) and the Arkansas River basin (Division 2). Six of these structures divert significant quantities of water (in excess of 20,000 acre-feet per year) and are discussed in detail in other sections of this documentation. These large transmountain diversion projects include:

Transmountain Structure	Project/Owner
Adams Tunnel	(Colorado - Big Thompson Project)
Charles Boustead Tunnel	(Fryingpan - Arkansas Project)
Homestake Tunnel	(Homestake Project)
Independence Pass Tunnel No. 1	(Twin Lakes Reservoir and Irrigation Co.)
Moffat Tunnel	(Denver Water)
Roberts Tunnel	(Denver Water)

2.10.1 Description of Structures

The remaining structures, which export water from the Upper Colorado River basin, are discussed below.

The Eureka Ditch (WDID 514602) is a small diversion structure, which diverts water from the headwaters of Tonahutu Creek, a tributary of the North Fork of the Upper Colorado River and delivers it into the headwaters of Spruce Creek, a tributary of the Big Thompson River (Division 1). The water is typically diverted during the peak runoff months of May, June, and July. Sporadic records of the transmountain diversions through this structure are available from the USGS (1974 through 1980) and the Division of Natural Resources (DNR) for the period 1981 through 1991. From these data, the average annual diversion is estimated to be about 20 acre-feet. Current plans for the ditch are to discontinue transmountain diversions and dedicate the diversions to instream flow uses in Division 5. Because of this plan and the small quantities of water involved, the Eureka Ditch is not included in the CRDSS Upper Colorado River Model.

The Grand River Ditch (WDID 514601) diverts from numerous tributary streams in the headwaters of the North Fork of the Upper Colorado River and delivers the water over La Poudre Pass into Long Draw Creek, a tributary of the Cache la Poudre River (Division 1). The structure and water rights are owned by the Water Supply and Storage Co. (WSSC) and the diversions have historically been used to supplement irrigation demands under the WSSC system. The ditch has a total decreed capacity of 524.6 cfs. The Grand River Ditch is generally opened up in the late spring, typically late May or early June, and diverts until late September, when the flow

tapers off. The flows are measured through a 10-foot Parshall Flume, equipped with radio telemetry, and reliable diversion records are available from the USGS and from the DNR. Long-term average diversions are about 18,530 acre-feet per year.

The Berthoud Pass Ditch (a.k.a. the Berthoud Canal Tunnel) (WDID 514625) diverts from the headwaters of the Fraser River and delivers it into the headwaters of the West Fork of Clear Creek (Division 1). The water is used for municipal uses by the City of Golden (1/2) and the City of Northglenn (1/2). The Berthoud Pass Ditch typically diverts during the snowmelt runoff months of May, June and July and during the 1974 through 1991 study period, the diversions averaged about 600 acre-feet per year. Reasonably reliable records of the diversion were obtained from the USGS.

The Continental-Hoosier Diversion System (WDID 364699) diverts water from several tributaries at the headwaters of the Blue River (near Hoosier Pass) and delivers it through the Hoosier Pass Tunnel into Montgomery Reservoir in the headwaters of the Middle Fork of the South Platte River (Division 1). The collection and diversion facilities and the pertinent water rights are owned by the City of Colorado Springs, which uses the diversions as a major source of municipal water supply.

There are two separate water right priorities associated with the Continental-Hoosier System, summarized as follows:

1929 Water Rights (appropriation date August 5, 1929)	
East Hoosier Creek	40 cfs
Hoosier Creek	20 cfs
Bemrose Creek (Silver Creek)	17 cfs
Total	77 cfs

1948 Water Rights (appropriation date May 13, 1948)	
East Hoosier Creek	50 cfs
Hoosier Creek	40 cfs
Bemrose Creek (Silver Creek)	20 cfs
Crystal Creek	40 cfs
Spruce Creek	60 cfs
McCullough Gulch	60 cfs
Monte Cristo Creek	200 cfs
Interceptor Ditch (to Tunnel)	50 cfs
Tunnel Seepage	20 cfs
Total	540 cfs

The priority dates are of particular importance because the 1929 water rights are senior to the water rights at Green Mountain Reservoir and Denver's storage and direct flow water rights used at Dillon Reservoir and the Roberts Tunnel, whereas the 1948 water rights are junior. The yield to the 1929 water rights is generally controlled by an administrative call from the Shoshone power right in Glenwood Canyon. At other times, the yield is limited primarily by the physical

water supply at the various diversion headgates. Diversions typically occur from April through October, with the majority in May through September.

In accordance with the stipulations contained in the Blue River Decree (Civil Action Nos. 2782, 5016 and 5017), the total diversions at the Continental-Hoosier System "... shall not exceed in any calendar year, ten percent of the natural flow of the Blue River near Dillon below its confluence with the Snake River and Ten Mile Creek." From inspection of streamflow data, it appears that this requirement is generally not the limiting factor with respect to the Continental-Hoosier diversions. The historical diversions are relatively constant and more typically, the diversions are limited by the physical yield at the collection system.

Pursuant to the Blue River Decree, Colorado Springs is allowed to divert water at the Continental-Hoosier collection system out-of-priority with respect to the more senior storage rights at Green Mountain Reservoir. The amount of out-of-priority diversions are recorded and in the event that Green Mountain does not subsequently fill in that year, the out-of-priority diversions must be released or otherwise paid back to the United States. Denver's Dillon Reservoir/Roberts Tunnel system may store/divert out-of-priority under the same conditions. Historically, in the few years that Green Mountain has not filled and both Colorado Springs and Denver owe water to Green Mountain, Denver has taken responsibility for the payback, using releases from Dillon storage and/or exchanges from Williams Fork Reservoir. Colorado Springs has then compensated Denver for its share of the shortage through mutual agreements between the two parties.

It is noted that the 1929 water rights are decreed for diversion only from three relatively small drainage basins near the top of Hoosier Pass. The tributary drainage area available to the 1929 water rights (2 square miles) represents about 14 percent of the total drainage basin tributary to the entire collection system (approximately 14.3 square miles). Records of the total diversions through the Hoosier Tunnel are available from the USGS for the entire CRDSS study period, 1974 through 1991. For this period, the average annual diversion was approximately 8,840 acre-feet per year. According to Colorado Springs personnel, the capacity of the Hoosier Tunnel is estimated at about 500 cfs.

The Boreas Pass Ditch (WDID 364685) is a very small ditch structure that diverts water from the headwaters of Indiana Creek, a tributary of the Blue River and delivers it into the headwaters of North Tarryall Creek, a tributary of the South Platte River (Division 1). The ditch and water rights are owned by the City of Englewood, which uses the water as a supplemental source of municipal water. Diversions through this structure generally occur during the peak snowmelt runoff months of June and July. Diversions by the Boreas Pass Ditch were recorded by the USGS for the period 1974 through 1980 and by the DNR for the period 1981 through 1991. For this study period, the average annual diversion was only about 40 acre-feet.

The Vidler Tunnel (WDID 364626) diverts water from the headwaters of Peru Creek, a tributary of the Blue River and delivers it into the headwaters of Leavenworth Creek, a tributary of Clear Creek (Division 1). The structure and water rights are privately owned and the water is used for augmentation and municipal purposes in the Clear Creek basin. The majority of diversions occur during the snowmelt runoff months of June, July and August and were recorded

by the USGS (1974 through 1980) and the DNR (1981 through 1991). For this study period, the average annual diversion was approximately 520 acre-feet.

The Columbine Ditch (WDID 374641) diverts water from the headwaters of the East Fork of the Eagle River and delivers it into the headwaters of Chalk Creek, a tributary of the Arkansas River (Division 2). The Columbine Ditch is owned by the City of Pueblo and it is generally leased out to other individuals for supplemental irrigation. It can also be used as a municipal water supply for the City. The majority of diversions through the Columbine Ditch occur during the snowmelt runoff months of May through August and were recorded by the USGS (1974 through 1981) and the DNR (1982 through 1991). For this study period, the average annual diversion through the Columbine Ditch was about 1,760 acre-feet.

The Ewing Ditch (WDID 374642) (a.k.a. the Ewing Placer Ditch (WDID 371091)) diverts water from the headwaters of Piney Creek, a tributary of the Eagle River and delivers it into the headwaters of Tennessee Creek, a tributary of the Arkansas River (Division 2). The Ewing Ditch is owned by the City of Pueblo, which generally leases the water to private individuals as a supplemental irrigation water supply. The water can also be used for municipal purposes. Diversion records for the ditch are available from the USGS (1974 through 1981) and the DNR (1982 through 1991). For this study period, the average annual diversion through the Ewing Ditch averaged about 1,125 acre-feet.

The Warren Wurts Ditch (WDID 374648) diverts water from the headwaters of several tributaries of the South Fork of the Eagle River and delivers it into the headwaters of Tennessee Creek, a tributary of the Arkansas River (Division 2). The ditch and water rights are owned by the City of Pueblo, which historically has leased the water to individuals for use as a supplemental irrigation supply. Diversions through the Wurts Ditch typically occur during the snowmelt runoff months of May through September, although the majority occurs during May and June. The diversions were recorded by the USGS (1974 through 1981) and the DNR (1982 through 1991). For this period, the average diversions were about 2,940 acre-feet per year.

The Busk-Ivanhoe Tunnel (WDID 384613) diverts from the headwaters of Ivanhoe Creek, a tributary of the Fryingpan River and delivers it through the old Carlton Railroad Tunnel for regulating storage in Turquoise Lake, in the headwaters of the Arkansas River (Division 2). The tunnel and the water rights are owned by the City of Pueblo, which uses the water as a supplemental municipal water supply. The majority of the diversions are made during the peak snowmelt runoff months, sometimes extending into October. Diversion records for the tunnel are available from the USGS for the entire CRDSS study period, 1974 through 1991. The average annual diversion for this period was 5,870 acre-feet per year.

The capacity of the Carlton Tunnel is reported to be approximately 300 cfs. However, due to failure of sections of the tunnel, the current capacity is limited to about 50 cfs through a 30-inch steel pipe installed on the floor of the tunnel. In order to make up for some of the lost capacity, the City of Pueblo has contracted with the United States (USBR) to take deliveries of a portion of the Busk-Ivanhoe System yield through the Boustead Tunnel of the Fryingpan-Arkansas Project. The Busk-Ivanhoe water can readily be exchanged into the Fryingpan-Arkansas collection system and both tunnels deliver the water to the same point, Turquoise Lake.

2.11 Collbran Project/Vega Reservoir

The Collbran Project is a multiple use water project designed to develop the surplus water supplies in the Plateau Creek basin, on the northern side of the Grand Mesa. The project was constructed by the USBR during the period 1957 through 1962. The Collbran Project provides supplemental irrigation water supplies to an estimated 19,700 acres and full service to an additional 2,500 acres of land adjacent to Plateau Creek and a number of its tributaries, including Salt, Grove, Big, Cottonwood, Bull, Coon and Mesa Creeks. The project also includes facilities for the generation of hydroelectric power for sale and use in west-central Colorado. The project also rehabilitated and modified the operation of several small privately owned storage reservoirs located on the Grand Mesa in the headwaters of Big Creek and Cottonwood Creek. This modification includes an exchange in which reservoir water is released for the generation of hydroelectric power in exchange for a like amount of water stored in Vega Reservoir, the principle storage facility of the project.

Features of the Collbran Project include Vega Dam and Reservoir, the Leon-Park Creek Feeder Canal, Park Creek Ditch, the Southside Canal, Bonham Dam and Reservoir, East Fork Diversion Dam and Feeder Canal, the Bonham-Cottonwood Pipeline, the Upper Molina penstock and power plant and the Lower Molina penstock and power plant. These facilities are discussed in more detail below.

The Collbran Project is operated jointly by the USBR and the Collbran Water Conservancy District (District). The USBR is responsible for the operation of the Grand Mesa Reservoir system and the power facilities. The District is responsible for the irrigation component of the Project, including operation of Vega Reservoir and deliveries into the Southside Canal, Galbraith Ditch, and Plateau Creek.

2.11.1 Description of Physical Facilities

Vega Dam and Reservoir (WDID 723844). Vega Dam and Reservoir was constructed on the mainstem of Plateau Creek, about 10 miles east of the town of Collbran. It has a tributary drainage area of about 88 square miles. The reservoir is used to provide regulatory storage for surplus spring runoff for subsequent release to the project lands during the late summer months of the irrigation season. The reservoir stores water from Plateau Creek and also receives water diverted from Leon Creek and Park Creek, via the Leon-Park Creek Feeder Canal and Park Creek Ditch.

Vega Reservoir has a total capacity of about 34,131 acre-feet, of which 820 acre-feet is dead storage and 33,311 acre-feet is active storage. At its normal high water line (elevation 7,984 feet), the water surface area of the reservoir is about 924 acres. The outlet works for the reservoir has an estimated capacity of about 1,100 cfs at full reservoir levels. The outlet discharges directly into the Southside Canal for delivery of reservoir water to the project lands. The Southside Canal has a siphon to deliver water from the reservoir to the Galbraith Ditch and a waste-way to deliver reservoir water down Plateau Creek.

There are no known operating rules for the reservoir and at this time, the USBR does not use forecasting technologies to predict reservoir inflows. However, EOM storage content data for Vega Reservoir is available from the USBR for the period 1961 through 1995. These data indicate that the reservoir is operated to store as much water as possible, beginning at the first of the USGS water year (October) and continuing until maximum storage is achieved. The latter generally occurs from late May to late June. Records obtained from the USBR indicate that in the last 25 years (1970 through 1994), the reservoir has achieved maximum storage in 19 years (76 percent). Of the years that it did not fill, only in the dry year 1977 was the total storage of severe consequence (maximum storage of 9,364 acre-feet). Water is released for irrigation beginning in late June or July and continues until late fall, with the low point of storage generally occurring in late September or October. The low point in storage is often less than 10,000 acre-feet.

Water stored in Vega Reservoir is allocated either to the replacement account (the power exchange account) or to the project irrigation account. The replacement account represents that water which is stored for replacement of water diverted from Big Creek and Cottonwood Creek and delivered through the USBR's Molina power plants. The project irrigation account represents water stored for the purpose of providing supplemental irrigation supplies to District lands.

There are no requirements to release water for instream flow benefits below the reservoir.

Leon-Park Creek Feeder Canal. This facility is used to divert water from Leon Creek and Park Creek into Vega Reservoir. The canal begins at a diversion structure on Leon Creek (WDID 720746) and extends about two miles to a siphon under Park Creek. The Park Creek diversion (WDID 720820) diverts from Park Creek about 1,000 feet above the siphon and combines with the flow from Leon Creek for delivery into Vega Reservoir. The capacity of the canal at the Leon Creek diversion is 350 cfs and the diversion capacity on Park Creek is 150 cfs. The total capacity of the feeder canal is about 350 cfs.

An additional component of the diversions into Vega Reservoir is the Park Creek Ditch (WDID 720819). This ditch is used in conjunction with the Leon-Park Creek Feeder Canal to maximize the water right yields on Leon Creek and Park Creek to fill Vega Reservoir.

Southside Canal (WDID 720879). The Southside Canal is used to deliver Project water from Vega Reservoir to the project lands. Water from the reservoir is delivered directly through the reservoir outlet works to the Southside Canal. Just downstream of the dam, there is a turnout structure in the canal that is used to bypass water back to Plateau Creek for downstream senior water rights and a separate turnout for direct deliveries to the Galbraith Ditch (WDID 7200628). The District on its daily accounting sheets records these deliveries.

The Southside Canal extends 33.8 miles in a westerly direction from the reservoir. It has an initial capacity of about 240 cfs at the reservoir and a terminal capacity of about 50 cfs at Mesa Creek. Thirteen siphons are used to carry the canal across major north-flowing tributary streams along its alignment (the canal does not intercept these tributary flows) and in one portion the canal is carried in a 2,400 foot long tunnel between Salt Creek and Tea Creek. Delivery of Project water from the Southside Canal is made through 57 individual headgates, 12 of which are

larger drop structures that deliver water directly into the tributary streams where the water is subsequently allocated to individual users by the State Water Commissioners.

Bonham Dam and Reservoir. This storage facility is an enlargement of an existing reservoir constructed on Big Creek on the Grand Mesa. As part of the Collbran Project, the dam was raised to provide a total capacity of about 1,222 acre-feet. Bonham Reservoir serves as the forebay for diversions into the Bonham Branch Pipeline (WDID 720542), which conveys water to the USBR Upper Molina Power plant. The Pipeline has a physical capacity of 50 cfs, but its water right is decreed for 45 cfs.

East Fork Diversion Dam and Feeder Canal (WDID 720609). This facility was constructed to divert natural flows from the East Fork of Big Creek, together with releases from Lambert Reservoir and Atkinson Reservoir, for delivery into Bonham Reservoir. This water can ultimately be delivered to the Upper Molina Power plant. The feeder canal has a capacity of 30 cfs.

The Bonham-Cottonwood Pipeline. This pipeline collects water from the small streams and reservoirs in the headwaters of Big Creek and Cottonwood Creek and delivers it into the penstock for the Upper Molina Power plant. The Bonham Branch Pipeline (WDID 720542) conveys water from Bonham Reservoir (including contributions from the East Fork Feeder Canal). The Cottonwood Branch Pipeline (WDID 720583) begins at Cottonwood Reservoir No. 1 and delivers water from this reservoir, together with releases from storage in the upstream DeCamp and Big Meadows Reservoirs and six smaller reservoirs. The Cottonwood Branch Pipeline has a capacity of 28.3 cfs.

Upper and Lower Molina Penstocks and Power plants. Water from the Bonham-Cottonwood Pipeline is delivered into the penstock of the Upper Molina Power plant, where it is used for the generation of hydroelectric power. The tailwater from the Upper Molina plant is discharged into the Molina Equalization Reservoir, which then serves as the forebay for delivery into the penstock for the Lower Molina Power plant. The tailrace from the Lower Molina Power plant discharges into Plateau Creek, near the town of Molina. The capacity of the Molina penstocks is 50 cfs.

A tap into the tailrace of the Lower Molina power plant is used as a point of diversion for the Ute Pipeline Headgate No. 2 (WDID 720920), owned by the Ute Water Conservancy District. This diversion is used for municipal uses by the district and is described elsewhere in this documentation.

2.11.2 Water Rights

The water rights associated with the Collbran Project are summarized as follows. Most of the water rights were adjudicated on July 21, 1959 and granted an appropriation date of August 19, 1952. The state engineer's administration number is 37486.00000.

Vega Reservoir	33,500 ac-ft
Southside Canal	240 cfs
Bonham Branch Pipeline	45 cfs
East Fork Feeder Canal	30 cfs
Cottonwood Branch Pipeline	28 cfs
Leon-Park Feeder Canal	450 cfs

Three other absolute rights are associated with the Project.

Name	Adjudication Date	Appropriation Date	Amount	Administration Number
Leon-Park Feeder	12/31/1971	05/28/1968	100 cfs	44194.43247
Leon-Park Feeder	04/13/1972	08/16/1963	100 cfs	41500.00000
Park Creek Ditch	07/25/1941	04/27/1914	6.5 cfs	30895.23492

2.11.3 Operation of Collbran Project

Prior to construction of Vega Reservoir, irrigation of the lands adjacent to the tributaries of Plateau Creek was well established. Direct flow water rights were developed and numerous small private reservoirs were constructed on Grand Mesa to regulate the runoff from the watersheds of Big, Cottonwood, and Bull Creeks. These reservoirs were filled during the spring runoff and the stored water was released upon demand of the downstream irrigators to supplement the low natural streamflow in the late summer.

Replacement Account (power exchange pool). Upon completion of the Collbran Project facilities in the early 1960's, the historical irrigation operations were modified. The fundamental principle of the project is the use of storage in Vega Reservoir to provide supplemental water for late season irrigation. Water stored in Vega is substituted for stored water in the Grand Mesa reservoirs (and natural flows in Big Creek and Cottonwood Creek) that now is no longer released for irrigation but rather is diverted through the Molina power plants and returned to Plateau Creek, bypassing the irrigation headgates. Although the exchange operations are complex, the project is essentially operated in a manner such that for every acre-foot of out-of-priority direct flow diversions through the Bonham Branch Pipeline (WDID 720542) and the Cottonwood Branch Pipeline (WDID 720583), together with releases from the Grand Mesa Reservoirs made for power uses, one acre-foot is credited to the replacement account in Vega Reservoir. Then, throughout the irrigation season, as the irrigators demand water, storage releases from the replacement account are made upon request and delivered through the Project's Southside Canal.

Records of the historical diversions into the Molina penstocks during the CRDSS study period were obtained from the USBR. These power diversions represent the maximum amount of water that could theoretically be exchanged for storage in Vega Reservoir. In practice, much of this

diversion occurs on a direct flow basis during periods when there is no demand from downstream irrigators and therefore no replacement is required. The amount of replacement water in Vega Reservoir, as required by operation of the exchange, is determined on a daily basis by the Reservoir Companies, with the cooperation of the USBR.

In dry runoff years, there may be insufficient inflows to Vega Reservoir to fully satisfy the replacement needs for the power exchange. In this situation, supplemental irrigation water can be released from the Grand Mesa Reservoirs as needed, to the extent there is water remaining in storage at these facilities. Similarly, there are a number of direct flow water rights on Big Creek and Cottonwood Creek that are physically located upstream of the point where the Southside Canal crosses that stream and therefore cannot receive direct deliveries from the Replacement account in Vega Reservoir. Under these circumstances, water can be delivered by an exchange on the tributary itself. For example, additional replacement water can be delivered from the Southside Canal to downstream users and simultaneously, the upstream users can divert a like amount from the natural flows in the stream above the canal. If there were insufficient physical flow above the Southside, it would be necessary to release from one of the Grand Mesa reservoirs.

The USBR and Reservoir companies report regularly to the District regarding the amount of water to be reserved in the Vega replacement account. The District is responsible for delivery of this water upon demand by the irrigators entitled to that water.

Project Irrigation Account. In addition to providing storage capacity for the operation of the exchange associated with the Molina power diversions, Vega Reservoir is operated to store additional surplus flows from the drainages of Plateau, Leon and Park Creeks during the spring runoff. This water is subsequently released to provide a supplemental supply of irrigation water to the project lands during the late summer months (project irrigation water). This water is also delivered through the Southside Canal. The accounting for this project irrigation water supply is the responsibility of the District.

Delivery of Water from Vega Reservoir. On a daily basis (typically a three/four day rotation), the water users contact the District and place an order for delivery of project irrigation water and/or Power Exchange Water (if they are entitled to this water). The District accumulates all of the individual orders, separately accounting for each class of water, and delivers that amount into the Southside Canal. District ditch riders administer and record deliveries at most of the individual turnout structures, accounting for both water classifications. At each of the major tributaries, the total deliveries required for all users on that stream are accumulated and released at the drop structures. From this point, the State Water Commissioners are responsible for distribution of the water turned out from the Southside Canal, as among the various ditches on those tributaries. For Power Exchange Water that is attributable to out-of-priority direct flow diversions for power generation at the Bonham Branch Pipeline and Cottonwood Pipeline, this water is released at the Big Creek and Cottonwood Creek drop structures and is not delivered to specific water rights, but rather is allocated on the basis of priorities on the stream.

The District also keeps track of direct flow water delivered through the Southside Canal. For example, if a water user calls for early season water while Vega Reservoir is still filling, the

District will deliver the water as free water and will treat it as a delivery pursuant to the direct flow right of the Southside Canal, with the priority assumed to be just senior to the storage decree. If Vega Reservoir does not subsequently fill in that year, any free water delivered is charged against that user's project account in the reservoir. If the reservoir achieves a fill, the free water delivery is canceled out.

Although the District administers the system on a daily basis, separately accounting for the different classes of water deliveries to each water user, monthly summaries of these data are not readily available. With respect to the District operations as a whole, there is very little information available in the State Database. State diversion records for each individual ditch that receives project water do reflect the source of water diverted (i.e. direct flow, project irrigation from Vega and Power Exchange Water). In order to supplement the database, representative examples of the daily operation records, provided by the District, were reviewed. Key inflow, diversion and delivery data were summarized on a monthly basis for the CRDSS study period. These data are incorporated into HydroBase.

3. Upper Colorado River Structure Information and Basin Meeting Notes

This section contains information that was gathered during the initial CDSS development phase, regarding specific, individual diversion structures. The objective at the time was to identify which structures should be included explicitly in the Upper Colorado River Model. The information is historical, reflecting the thinking and conditions at the time. It is valuable, however, for its detail on specific structures from those who have observed the diversion systems and have first-hand familiarity with their operations.

3.1. Annotated Structure List

The tables in this section list the structures in the database that were considered for modeling explicitly in the Upper Colorado River Model. The initial key structure list was selected in an attempt to explicitly represent 75 percent of the decreed water rights in the river basin. This initial list was further refined through meetings and correspondence with the Division Engineers and Water Commissioners and examination of data available from the database.

The initial cut-off value for the Upper Colorado River basin was 11 cfs. Some structures with net absolute decree amounts smaller than this were included in the model because they were deemed important to the administration of the river by the Division Engineer's Office. Table 3.1 lists initial structures in the Upper Colorado River basin from the database, with comments next to those structures that were unusual or not included in the Phase II model.

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
720646	GRAND VALLEY PROJECT	2313.7	0.06289	Yes	
360881	GREEN MTN HYDRO-ELECTRIC	1726	0.10981	Yes	
530584	SHOSHONE POWER PLANT	1408	0.14809	Yes	
510678	CBT GRANBY PUMP CANAL	1100	0.17799	No	Represented by operating rule
384625	FRY ARK PR BOUSTEAD TUNL	963	0.20416	Yes	
720645	GRAND VALLEY CANAL	940.28	0.22972	Yes	
514655	FRASER RIVER DIVR PROJ	928	0.25495	Yes	
720783	MESA CO IRR DIST CANAL	667	0.27308	No	(6) 950001
384617	IND P TM DVR TUNNEL NO 1	625	0.29007	Yes	
514700	WINDY GAP PUMP PL CANAL	600	0.30638	Yes	
720817	PALISADE IRR DIST CANAL	573	0.32196	No	(6) 950001
514634	CBT ALVA B ADAMS TUNNEL	550	0.33691	Yes	
514601	GRAND RIVER DITCH	524.6	0.35117	Yes	
364684	BLUE RIVER DIVR PROJECT	468	0.36389	Yes	
720746	LEON PARK FEEDER CANAL	450	0.37612	Yes	

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
510958	CBT WILLOW CREEK FEEDER	400	0.38699	Yes	
381763	IND P TM DVR TUNNEL NO 2	322	0.39575	No	(6) 384617
374614	HOMESTAKE PROJ TUNNEL	300	0.4039	Yes	
511237	WILLIAMS FORK POWER COND	295	0.41192	Yes	
720879	SOUTHSIDE CANAL	240	0.41844	Yes	
510529	BIG LAKE DITCH	231	0.42472	Yes	
514603	WILLIAMS FORK DIVR PROJ	214	0.43054	Yes	
381766	IND P TM DVR N YORK HGT3	210	0.43625	No	(6) 384617
360985	BLUE VALLEY RANCH HYDRO	206	0.44185	No	(2)
364683	CON-HOOSIER SYS BLUE R D	200	0.44729	Yes	
390752	WILLCOX CANAL	200	0.45272	No	(3)
374643	HOMESTAKE PROJ CONDUIT	179.8	0.45761	Yes	
360805	SNAKE RIVER DITCH	160.715	0.46198	No	(1)
380869	MIDLAND FLUME DITCH	160	0.46633	Yes	
450576	DIVIDE CREEK HIGHLINE D	155	0.47476	Yes	
510848	REDTOP VALLEY DITCH	150	0.47884	Yes	
374648	WARREN E WURTS DITCH EXT	129	0.48235	Yes	
390563	GRASS VALLEY CANAL	119.537	0.4856	Yes	
720859	ROSE POINT POWER CANAL	113.25	0.48867	No	(1)
452000	BLUESTONE VALLEY DITCH	106	0.49156	Yes	Modeled as 450969
360625	FREMONT NO 1 DITCH	100	0.49427	No	(6) 360841
360830	SUPPLY CANAL NO 1	100	0.49699	No	(6) 360841
720820	PARK CREEK DITCH (VEGA)	100	0.49971	Yes	
500606	MISSOURI DITCH	98	0.50237	Yes	
360829	STRAIGHT CREEK DITCH	97.5	0.50502	Yes	
380981	SALVATION DITCH	96.5	0.50765	Yes	
390649	EAST RIFLE CR PL NO 2	90	0.51009	No	(7)
364689	CON-SYS EAST HOOSIER D	90	0.51254	No	(6) 364683
360606	ELLIOTT CREEK FEEDER	90	0.51499	Yes	
500593	KRITZ DITCH NO 2	77.45	0.51709	Yes	
360709	LOBACK DITCH	75.8	0.51915	Yes	
381038	SWEET JESSUP CANAL	75	0.52119	Yes	
500576	HAYPARK CANAL HGT NO 1	75	0.52323	Yes	
381078	WALKER WONDER DITCH	71.92	0.52519	Yes	
374644	HOMESTAKE PROJ EAST FORK	70.8	0.52711	No	(6) 374516
381762	HIDDEN LAKE CREEK DITCH	70	0.52901	No	(6) 384613
510728	HAMILTON-CABIN CR DITCH	70	0.53092	Yes	
380854	MAROON DITCH	68.4	0.53277	Yes	
500734	DEBERARD DITCH	66.75	0.53459	Yes	
380930	PATERSON D JACOB EXT	65	0.53636	Yes	
510763	KINNEY BARRIGER DITCH	65	0.53812	Yes	
510941	VAIL IRR SYS HGT NO 2	63.5	0.53985	Yes	
510924	SYLVAN DITCH	62.5	0.54155	Yes	
380749	HERRICK DITCH	60.86	0.5432	Yes	
371253	HOMESTAKE PROJ CONDUIT	60.1	0.54484	No	(6) 374643
380757	HOME SUPPLY DITCH	60	0.54647	Yes	

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
364692	CON-HOOSIER D CLAIM 1	60	0.5481	No	(6) 364683
364697	CON-HOOSIER SYS SPRUCE D	60	0.54973	No	(6) 364683
500653	TOM ENNIS DITCH	60	0.55136	Yes	
364690	CON-HOOSIER SYS MCCULL D	60	0.55299	No	(6) 364683
360831	SUPPLY CANAL NO 2	60	0.55462	No	(6) 360841
374641	COLUMBINE DITCH	60	0.55625	Yes	
450725	PORTER DITCH	60	0.55788	Yes	
364626	VIDLER TUNNEL COLL SYS	58.7	0.55948	Yes	
380653	EAST SNOWMASS BRUSH CR D	57.45	0.56104	No	
360877	WILLS TUNNEL PIPELINE	55	0.56254	No	(2)
720758	LEON TUNNEL CANAL	54	0.564	Yes	
514625	BERTHOUD CANAL TUNNEL	53.4	0.56546	Yes	
380881	MOUNTAIN MEADOW DITCH	53	0.5669	Yes	
370642	HOLLINGSWORTH DITCH	50.72	0.56828	Yes	
700521	CLEAR CREEK DITCH	50.43	0.56965	Yes	
510804	MOORE CATCH DITCH	50	0.57101	No	(2)
360566	CLINTON CREEK DITCH	50	0.57236	No	(6) 360841
450668	LAST CHANCE DITCH	50	0.57372	Yes	
390612	LOWER CACTUS VALLEY D	50	0.57508	Yes	
381761	LYLE DITCH	50	0.57644	No	(6) 384613
510530	BIG SIX DITCH	50	0.5778	Yes	
450790	TALLMADGE AND GIBSON D	49.68	0.57915	Yes	
370823	STRATTON AND CO DITCH	49.4	0.58049	Yes	
380996	SLOUGH D AND BANNING LAT	49.26	0.58183	Yes	
380712	GLENWOOD DITCH	47.888	0.58314	Yes	
380809	BASALT PROJ LANDIS CANAL	47	0.58441	No	(4)
360649	HAMILTON DAVIDSON DITCH	46.39	0.58567	Yes	
360671	INDEPENDENT BLUE DITCH	46.2	0.58693	Yes	
390687	WARE AND HINDS DITCH	45.9	0.58818	Yes	
720542	BONHAM BRANCH PIPELINE	45	0.5894	Yes	
380528	BASIN DITCH	45	0.59062	Yes	
510546	BUNTE HIHGLINE DITCH	45	0.59185	Yes	
380968	ROBINSON DITCH	44.133	0.59305	Yes	
360727	MARYLAND NO 2 DITCH	43.5	0.59423	No	(2)
500567	FAY DEBERARD DITCH NO 1	43.09	0.5954	Yes	
370539	CHATFIELD BARTHOLOMEW D	42.34	0.59655	Yes	
720616	NEW ERIE CANAL	42.28	0.5977	Yes	
370736	NOTTINGHAM & PUDER DITCH	42.23	0.59885	No	(6) 370708
380651	EAST MESA DITCH	41.8	0.59998	Yes	
390645	RIFLE CREEK CANON DITCH	41.7	0.60112	Yes	
360645	GUTHRIE THOMAS DITCH	41.38	0.60224	Yes	
371256	HOMESTAKE PROJ CONDUIT	41.3	0.60337	No	(6) 374643
380574	CARBONDALE DITCH	41.24	0.60449	Yes	
380880	MOUNT SOPRIS DITCH	41	0.6056	Yes	
380840	LOWLINE DITCH	40.5	0.6067	Yes	
364687	CON-HOOSIER SYSCRYSTAL D	40	0.60779	No	(6) 364683
530704	MIDDLE DERBY DITCH	40	0.60888	Yes	

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
360869	WEST TENMILE DITCH	40	0.60996	No	(5)***
371255	HOMESTAKE PROJ CONDUIT	39.8	0.61105	No	(6) 374643
371254	HOMESTAKE PROJ CONDUIT	38.6	0.6121	No	(6) 374643
381073	WACO DITCH	38.2	0.61313	Yes	
700580	RESERVOIR DITCH	37.4	0.61415	Yes	
452001	LARKIN DITCH	37.29	0.61516	Yes	(6) 450861
364696	CON-HOOSIER D CLAIM 2	37	0.61617	No	(6) 364683
390663	SILT PUMP CANAL	36	0.61715	Yes	
381101	WILLOW CREEK DITCH	36	0.61813	Yes	
500617	MCMAHON DITCH	36	0.61911	Yes	
370848	WARREN DITCH	35.466	0.62007	Yes	
380970	ROCKFORD DITCH	35.2	0.62103	Yes	
384613	IVANHOE RESERVOIR TUNNEL	35	0.62198	Yes	
360946	HOAGLAND CANAL(ELLIOT C)	35	0.62293	Yes	(6) 360662
360841	TENMILE DIVERSION NO 1	35	0.62388	Yes	
390548	DEWEESE DITCH	33.7	0.6248	Yes	
370683	LEONARD HORN DITCH NO 1	33.25	0.6257	Yes	
700530	CREEK AND NEWMAN DITCH	33	0.6266	Yes	
720870	SILVER GAUGE DITCH	32.646	0.62749	Yes	
360683	KEYSTONE DITCH(UPPER)	32.646	0.62837	No	(2)
450793	TAUGHENBAUGH DITCH	32.6	0.62926	Yes	
720799	MORMON MESA DITCH	32.06	0.63013	Yes	
530800	SOUTH DERBY DITCH	32	0.631	Yes	
530547	D D DITCH	32	0.63187	No	(2)
530678	LION BASIN DITCH	31.76	0.63273	Yes	
500539	CLIFF DITCH	31.33	0.63358	Yes	
500601	MARTIN NO 1 DITCH	31	0.63443	Yes	
381062	UNION DITCH	31	0.63527	Yes	
390709	DOW PUMP PLANT AND PL	30.89	0.63611	No	(5)
510585	COFFEE MCQUEARY DITCH	30.23	0.63693	Yes	
500574	HARDSCRABBLE DITCH	30.027	0.63775	Yes	
510584	COBERLY BROTHERS DITCH	30	0.63856	No	(6) 510529
720609	EAST FORK FEEDER CANAL	30	0.63938	No	(2)
721487	UTE PIPELINE HGT NO 1	30	0.64019	No	(6) 720920
360803	SMITHS NO 2 DITCH	30	0.64101	No	(6) 360801
360801	SMITH DITCH	30	0.64183	Yes	
370514	BOLTS DITCH	30	0.64264	No	(7)
380755	HOLDEN DITCH	30	0.64346	Yes	
390825	WILLIAMS CANAL	29.6	0.64426	Yes	
450701	MOSQUITO LAKE D UPPER	28.75	0.64504	No	(4)
720703	HOOSIER DITCH	28.2	0.64581	Yes	
720938	WILDCAT DITCH (BIG CR)	28.114	0.64657	Yes	
720583	COTTONWOOD BRANCH PL	28	0.64733	Yes	
510913	ST LOUIS NO 2 DITCH	28	0.6481	Yes	
530555	DERBY DITCH	28	0.64886	Yes	
390610	LOW COST DITCH	27.94	0.64962	Yes	
390638	PIERSON AND HARRIS DITCH	27.8	0.65037	Yes	

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
720533	BERTHOLF LANHAM UPDIKE D	27.608	0.65112	Yes	
381481	VAN CLEVE-FISHER FDR D	27.4	0.65187	No	(2)***
390635	PARACHUTE DITCH	27.22	0.65261	Yes	
381012	SNOWMASS DIVIDE DITCH	27.2	0.65335	Yes	
380902	NEEDHAM DITCH	27.2	0.65409	Yes	
390574	GRAND TUNNEL DITCH	26.508	0.65481	Yes	
380517	ATKINSON CANAL	26.33	0.65552	Yes	
510788	LYMAN DITCH	26	0.65623	Yes	
360590	DOIG DITCH	26	0.65694	No	
720730	KIGGINS SALISBURY DITCH	25.28	0.65762	Yes	
510594	CROOKED CREEK DITCH NO 1	25.25	0.65831	Yes	
510593	CROOKED CREEK SUPPLY D	25.22	0.65899	Yes	
360660	HIGH MILLER DITCH	25.1	0.65968	Yes	
511250	HAMILTON-CABIN CR EXTEN	25	0.66036	No	(6) 510728
380924	PARADISE DITCH	25	0.66104	Yes	
510810	MUSGRAVE DITCH	25	0.66172	Yes	
500568	FAY DEBERARD DITCH NO 2	25	0.6624	Yes	
381028	STEIN ARLIAN MAROLT D	25	0.66307	Yes	
361018	HOAGLAND CANAL (DEEP CR)	25	0.66375	Yes	(6) 360662
381760	PAN DITCH	25	0.66443	No	(6) 384613
530657	KAYSER DITCH	25	0.66511	Yes	
450704	MULTI-TRINA DITCH	24.66	0.66578	Yes	
450519	BEAVER CR GRASS MESA D	24.64	0.66645	Yes	
380740	HARRIS & REED DITCH	24.273	0.66711	Yes	
510893	SOPHRONIA DAY DITCH	24.125	0.66777	Yes	
384680	THOMPSON CR FEEDER DITCH	24	0.66842	No	(2)
500631	PINTO CREEK DITCH	24	0.66907	No	(2)
720784	MESA CREEK DITCH	23.96	0.66973	Yes	
381790	RED MOUNTAIN EXT DITCH	23.94	0.67038	Yes	
450584	EAST DIVIDE CREEK DITCH	23.82	0.67102	Yes	
370830	TERRELL AND FORD DITCH	23.75	0.67167	Yes	
450699	MOSQUITO DITCH	23.5	0.67231	No	(2)
500654	TROUBLESOME DITCH	23.5	0.67295	Yes	
360738	MEADOW DILLON DITCH	23.3	0.67358	No	(1)
370561	DAGGETT AND PARKER DITCH	23.26	0.67421	Yes	
380890	MCKENZIE WILDCAT DITCH	23.14	0.67484	Yes	
510776	LEHMAN DITCH	23	0.67547	Yes	
510910	ST LOUIS DITCH	23	0.67609	Yes	
720506	ANDERSON FEEDER DITCH	22.7	0.67671	No	(2)
381147	KAISER AND SIEVERS DITCH	22.4	0.67732	Yes	
510931	THOMAS DITCH (263)	22	0.67851	No	(4)
530780	ROGERS DITCH	21.4	0.6791	Yes	
370743	ONEILL AND HOLLAND DITCH	21.17	0.67967	Yes	
360780	PLUNGER DITCH	21	0.68024	Yes	
530870	WEST END NO 1 DITCH	21	0.68081	No	(2)
390672	THOMPKINS DITCH	21	0.68138	Yes	
510802	MONARCH WATER WORKS	21	0.68195	No	(7)

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
450743	RISING SUN DITCH	20.83	0.68252	Yes	
370545	C K P DITCH	20.82	0.68309	Yes	
520662	BEST DITCH	20.8	0.68365	No	(4)
380715	GRACE AND SHEHI DITCH	20.74	0.68422	Yes	
370857	WILKINSON DITCH	20.71	0.68478	Yes	
380572	CAPITOL FALLS DITCH	20.58	0.68534	Yes	
380893	MCKOWN DITCH	20.5	0.6859	Yes	
370560	CREAMERY DITCH	20.46	0.68645	Yes	
370686	LOVE AND WHITE DITCH	20.4	0.68701	Yes	
530767	H M S RELOCATED DITCH	20.3	0.68756	Yes	
720818	PALMER DITCH	20.23	0.68811	Yes	
370708	METCALF DITCH	20	0.68865	Yes	
380547	BOWLES AND HOLLAND DITCH	20	0.6892	Yes	
380805	KOCH DITCH	20	0.68974	No	(7)
510948	WALDON HOLLOW DITCH	20	0.69028	Yes	
360842	TENMILE DIVERSION NO 2	20	0.69083	No	(6) 360841
720920	UTE PIPELINE HGT NO 4	20	0.69137	Yes	
450808	WANDERING JEW DITCH	19.97	0.69191	No	(2)
370835	TOWNSEND DITCH	19.514	0.69244	No	(5)
450749	RODERICK DITCH	19.502	0.69297	Yes	
370694	MATHEWS DITCH	19.34	0.6935	Yes	
380660	ELK CREEK DITCH	19.29	0.69402	No	(2)
720731	KING DITCH	19.286	0.69455	Yes	
720559	BULL ELK DITCH	19.05	0.69507	No	(2)
720814	OWENS CREEK DITCH	18.9	0.69558	Yes	
510883	SHERIFF DITCH (156)	18.75	0.69609	Yes	
360734	MCKAY DITCH	18.67	0.6966	Yes	
500526	BLICKLEY DITCH	18.67	0.6971	Yes	
380853	MAROLT DITCH	18.6	0.69761	Yes	
720644	GRAND JCT COLO R PL	18.57	0.69811	Yes	
721233	UPPER HIGHT DITCH	18.54	0.69862	Yes	
450693	MINEOTA DITCH	18.53	0.69912	Yes	
370613	GRACE PARK DITCH	18.5	0.69963	No	(6) 370708
371091	EWING PLACER DITCH	18.5	0.70013	Yes	
500744	NORTH MEADOW FEEDER D	18.4	0.70063	Yes	
530591	GRAND RIVER L AND C CO D	18.4	0.70113	Yes	
370535	CASTLE NO 2 DITCH	18.075	0.70162	No	(2)
390547	DAVIE DITCH	18	0.70211	Yes	
380570	COLO ST G F PROP COL SYS	18	0.7026	No	(8)
450514	BATTLEMENT DITCH	17.84	0.70308	Yes	
390532	CLOUGH NO 1 DITCH	17.8	0.70357	Yes	
500572	GEORGE JONES DITCH	17.625	0.70405	Yes	
500662	WHEATLEY DITCH NO 2	17.54	0.70452	No	(2)
720649	GROVE CR DITCH CO NO 1 D	17.5	0.705	Yes	
380720	GREEN MEADOW DITCH	17.44	0.70547	Yes	
380516	ATKINSON DITCH	17.2	0.70594	Yes	
450705	MURRAY AND YULE DITCH	17.15	0.70641	Yes	

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
360796	SAUMS DITCH	17.04	0.70687	Yes	
381200	TROY DITCH 1ST & 2ND ENL	17	0.70733	No	(3)
360729	MAT NO 2 DITCH	17	0.70779	Yes	
381132	WALTHEN DITCH	16.944	0.70825	Yes	
380925	PARK DITCH	16.9	0.70871	Yes	
380639	DESERT DITCH	16.87	0.70917	Yes	
390539	CORYELL DITCH	16.8	0.70963	Yes	
370655	H O R DITCH	16.69	0.71008	Yes	
520658	WILMOT DITCH	16.68	0.71054	Yes	
360687	KIRKWOOD DITCH	16.65	0.71099	Yes	
380606	COLLINS CREEK DITCH	16.64	0.71144	Yes	
500656	TYLER DITCH	16.63	0.71189	Yes	
530535	COFFEE POT DITCH HGT 1	16.6	0.71234	No	(2)
380800	KESTER DITCH	16.555	0.71279	Yes	
500620	NIGHTCAP DITCH	16.5	0.71324	No	(2)
380966	ROBERTSON DITCH	16.5	0.71369	Yes	
370790	S B AND A H DITCH	16.32	0.71414	No	(5)
380545	BORAM AND WHITE DITCH	16.1	0.71457	Yes	
360868	WESTLAKE DITCH	16.07	0.71501	Yes	
720558	BULL CREEK DITCH	16.04	0.71545	Yes	
530662	KEEP DITCH	16	0.71588	No	(2)
370590	EMPIRE ZINC CO PIPELINE	16	0.71632	No	(2)
510826	OSTRANDER DITCH	16	0.71675	Yes	
530621	HIGHWATER DITCH	16	0.71719	Yes	
364685	BOREAS NO 2 DITCH	16	0.71762	Yes	
530728	MCKINLAY DITCH	15.9	0.71805	No	(2)
500598	LANDSLIDE DITCH	15.875	0.71848	Yes	
720852	R M G DITCH	15.79	0.71891	No	(2)***
390537	CORNELL DITCH	15.675	0.71934	Yes	
720628	GALBRAITH DITCH	15.63	0.71976	Yes	
360728	MAT NO 1 DITCH	15.53	0.72019	Yes	
360726	MARYLAND NO 1 DITCH	15.5	0.72061	No	(2)
450731	GARDNER DITCH	15.26	0.72144	No	(2)
370682	L E D E DITCH	15.23	0.72185	No	(5)
390546	DAVENPORT DITCH	15.11	0.72226	No	(2)
500768	MARTIN LILY POND FEEDER	15.05	0.72267	Yes	Modeled as 500744
721329	RAPID CREEK PUMPNG PLANT	15	0.72349	No	(2)
381765	IND P TM DVR N YORK HGT2	15	0.7239	No	(6) 374617
390540	CORYELL JOINT STOCK IRRI	15	0.7243	Yes	
370684	LEONARD HORN DITCH NO 2	15	0.72471	No	(2)
381095	WILLIAMS NO 1 D CAP CR	15	0.72512	Yes	
381773	ALICIA LAKE RES DIR FLOW	15	0.72553	No	(7)
381775	WOODS LAKE RES DIR FLOW	15	0.72593	No	(7)
381661	SALVATION DITCH VAGN EXT	15	0.72634	Yes	
370658	HOWARD DITCH	15	0.72675	Yes	
530754	PIPELINE DITCH	15	0.72716	No	(2)

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
721039	CAMEO PUMPING PIPELINE	15	0.72757	No	(7)
360670	INDEPENDENT DITCH	15	0.72797	No	
380768	HUNTER CREEK FLUME & PL	15	0.72838	No	(2)
510939	UTE BILL NO 2 DITCH	15	0.72879	Yes	
380659	ELI CERISE DITCH	14.99	0.7296	Yes	
360765	PALMER-MCKINLEY DITCH	14.87	0.73001	Yes	
370548	C M STREMME GATES DITCH	14.82	0.73041	Yes	
720831	PIONEER OF PLATEAU DITCH	14.819	0.73081	Yes	
380663	ELLA DITCH	14.8	0.73122	Yes	
370616	GRAHAM NO 1 DITCH	14.8	0.73162	No	(6) 370708
520632	SCHLEGAL DITCH (ALKALI)	14.76	0.73202	Yes	
510880	SELAK LARRABEE DITCH	14.75	0.73242	Yes	
720764	MARTIN CRAWFORD DITCH	14.6	0.73282	No	(2)
720574	COAKLEY KIGGINS DITCH	14.58	0.73321	Yes	
500584	HILL CREEK DITCH	14.5	0.73361	No	(2)
510629	FARRIS SOUTH SIDE DITCH	14.405	0.734	Yes	
700583	ROAN CREEK NO 2 DITCH	14.4	0.73439	Yes	
381170	WEST THREE MILE DITCH	14.4	0.73478	Yes	
700596	UPPER ROAN CREEK DITCH	14.25	0.73517	Yes	
700642	BRIDGES-HAYES DITCH	14.2	0.73556	No	(2)
721330	COLORADO R PUMPING PLANT	14	0.73594	Yes	(4)
380569	C AND M DITCH	14	0.73632	Yes	
510858	ROCK CREEK DITCH	14	0.7367	Yes	
720675	HAWXHURST DITCH	13.99	0.73708	No	(2)
381026	STAPLETON BROTHERS DITCH	13.95	0.73746	Yes	
511148	THOMPSON PUMP NO 1	13.84	0.73783	No	(6) 511149
511149	THOMPSON PUMP NO 2	13.84	0.73821	Yes	
370822	STATON AND CISSNA DITCH	13.84	0.73859	No	(2)
370635	HERNAGE DITCH	13.81	0.73896	Yes	
360725	MARY DITCH	13.8	0.73934	Yes	
520523	JOHN L CONGER DITCH	13.8	0.73971	Yes	
390618	MINGS CHENOWETH WOLVERTO	13.6	0.74008	Yes	
720933	WEST SIDE DITCH	13.558	0.74045	Yes	
360543	BUFFEHR DITCH	13.47	0.74082	No	(6) 360841
380989	SHIPPEE DITCH	13.41	0.74118	Yes	
380838	LOWER DITCH	13.4	0.74154	Yes	
360800	SLATE CREEK DITCH	13.4	0.74191	Yes	
380959	RED ROCK BLUFF DITCH	13.4	0.74227	Yes	
450635	HUDSON & SULLIVAN DITCH	13.34	0.74264	Yes	
370579	EAGLE DITCH	13.2	0.74299	No	(6) 370708
720744	LEON DITCH	13.14	0.74335	Yes	
360541	BRUSH CREEK DITCH	13.1	0.74371	Yes	
450638	HUNTLEY DITCH	13.033	0.74406	Yes	
371087	AVON METRO MUN WTR SYS	13.01	0.74442	No	(7)
450750	RUPLE DITCH	13	0.74477	No	(2)
381104	WILLOW AND OWL DITCH	13	0.74512	Yes	

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
390590	JANGLE DITCH	12.97	0.74547	Yes	
370701	MCCOY AND TAYLOR DITCH	12.83	0.74582	No	(2)
720557	BULL BASIN HIGHLINE D	12.79	0.74617	Yes	
510660	GASKILL DITCH	12.78	0.74652	Yes	
450623	HAYWARD AND WYATT PL	12.725	0.74686	No	(2)
380861	MAURIN DITCH	12.7	0.74721	Yes	
390562	GRANLEE DITCH	12.69	0.74755	Yes	
380994	SLOSS DITCH	12.66	0.7479	Yes	
520572	HOG EYE DITCH	12.64	0.74824	Yes	
370571	J M DODD DITCH	12.64	0.74859	Yes	
380688	FOUR MILE DITCH	12.64	0.74893	Yes	
380939	PIONEER DITCH	12.51	0.74927	Yes	
360832	SUTTON NO 1 DITCH	12.5	0.74961	No	
721080	FINLEY RANCH PMP PLANT	12.4	0.74995	Yes	
381018	SOUTHARD AND CAVANAUGH D	12.4	0.75028	Yes	
381082	WEAVER AND LEONHARDY D	12.36	0.75062	Yes	
360715	LOWLINE NO 2 DITCH	12.36	0.75096	No	(7)
700550	H V C AND S DITCH	12.3	0.75129	Yes	
720643	GOLDEN AGE DITCH	12.272	0.75162	Yes	
370843	UPPER FROST DITCH	12.25	0.75196	Yes	
500582	HERDE DITCH	12.198	0.75229	Yes	
720652	GUNDERSON CARTER DITCH	12.08	0.75262	No	(2)
530585	GLENWOOD L WATER CO SYS	12	0.75294	Yes	
511315	REDTOP VALLEY DITCH	12	0.75327	Yes	(6) 510848
380618	CRANE AND PEEBLES DITCH	12	0.75359	Yes	
510699	HAMMOND NO 1 DITCH	12	0.75392	Yes	
360730	MAY DITCH	12	0.75425	No	
450547	CLARKSON DITCH	12	0.75457	No	(4)
500613	MCELROY NO 2 DITCH	12	0.7549	Yes	
380920	OXFORD NO 1 DITCH	12	0.75523	Yes	
500612	MCELROY NO 1 DITCH	12	0.75555	Yes	
500754	KIRTZ DITCH NO 2 HG NO 4	12	0.75588	No	(6) 500593
380822	LIGNITE DITCH	12	0.7562	Yes	
520633	SEVEN PINES DITCH	12	0.75653	No	(2)
530719	MCFARLAND AND CROSSAN D	12	0.75686	Yes	
380789	JOHNSON BLUE CR DITCH	12	0.75718	No	(7)
360964	BRECKENRIDGE RES 1 FEEDR	12	0.75751	No	(7)
380819	LIGHT DITCH	12	0.75784	No	(2)
381077	WALKERS GULCH SPG DITCH	11.96	0.75816	No	(2)
720823	PARK VIEW DITCH	11.952	0.75849	Yes	
500517	BECKER NO 3 DITCH	11.9	0.75881	Yes	
450616	H AND S DITCH	11.89	0.75913	Yes	
720580	COOK DITCH	11.833	0.75945	Yes	
520559	GUTZLER DITCH	11.81	0.75977	Yes	
510686	GRIFFITH DITCH	11.75	0.76009	Yes	
370727	PETER NELSON DITCH	11.71	0.76041	No	(1)

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
530883	WILSON AND DOLL DITCH	11.7	0.76073	Yes	
700511	CANNON DITCH	11.65	0.76105	No	(2)
370519	BRAGG NO 1 DITCH	11.58	0.76136	Yes	
700571	NEW HOBO DITCH	11.56	0.76168	Yes	
530632	HORSE MEADOWS DITCH	11.5	0.76199	Yes	
360658	HIGHLINE DITCH	11.4	0.7623	No	(2)
531039	DOME RANCH DITCH HGT 1	11.33	0.76261	No	(2)
381146	JOUFLAS DITCH HGT 1	11.24	0.76291	No	(4)
370659	HOWARD AND WINSLOW DITCH	11.23	0.76322	No	Berry Creek not modeled
450685	MAMM CREEK DITCH	11.17	0.76352	Yes	
530810	STEWART IRRIGATING DITCH	11.1	0.76382	Yes	
360540	BROWN ACORN DITCH	11.08	0.76412	No	Acorn Creek not modeled
380573	CAPITOL PARK DITCH	11	0.76442	Yes	
500632	PLEASANT VIEW DITCH	11	0.76472	Yes	
721334	CARVER RANCH PIPELINE	11	0.76502	No	(6) 720920
360703	LIND RILEY DITCH	11	0.76532	No	(4)
531051	GLENWOOD L WATER CO SYS	11	0.76562	Yes	
510700	HAMMOND NO 2 DITCH	11	0.76592	Yes	
510831	PETERSON DITCH NO 1	10.9	0.76651	Yes	(a)
450818	WEST DIVIDE CREEK DITCH	10.89	0.76681	Yes	(a)
370820	SQUIRE & HAMMOND DITCH	10.7	0.76827	Yes	(a)
381441	EAST SNOWMASS BRUSH C PL	10.57	0.76913	Yes	
500585	HOGBACK DITCH	10.4	0.77056	Yes	(a)
390701	RED ROCK DITCH	10.2	0.77252	Yes	(a)
500627	PASS CREEK DITCH	10	0.77661	Yes	(a)
380879	MONARCH DITCH	10	0.77688	Yes	(a)
390685	VULCAN DITCH	10	0.78014	Yes	(a)
450675	LOUIS REYNOLDS DITCH	9.99	0.7815	Yes	(a)
720729	KIGGINS GOYN DITCH	9.58	0.78416	Yes	(a)
510950	WASATCH DITCH	9.5	0.78597	Yes	(a)
380667	EUREKA NO 1 DITCH	9.5	0.78623	Yes	(a)
500628	PICKERING DITCH	9.5	0.78649	Yes	(a)
370723	NEILSON SOUTH DITCH	9.41	0.78726	Yes	(a)
450810	WARD AND REYNOLDS DITCH	9.05	0.78978	Yes	(a)
360535	BOBO DITCH	9	0.79149	No	(a)
370698	MCBRAYER DITCH	8.98	0.79296	Yes	(a)
720766	MASON EDDY DITCH	8.842	0.79513	Yes	(a)
381052	CARBONDALE WTR SYS & PL	8.75	0.79704	Yes	(a)
390967	RIFLE TOWN OF PUMP + PL	8.5	0.80055	Yes	(a)
370856	WHITE DITCH	8.46	0.80193	Yes	(a)
510876	SCYBERT DITCH	8.4	0.80468	Yes	(a)
720911	TEMS DITCH	8.252	0.80558	Yes	(a)
720607	EAKIN-SMITH DITCH	8.2	0.80625	Yes	(a)
450632	HOLMES DITCH	8.03	0.80802	Yes	(a)
720514	ARKANSAS DITCH	7.55	0.81893	Yes	(a)

Table 3.1
Initial Structure List

WDID	Structure Name	Decree Amount (cfs)	Cumulative Percent of Total	Included in Ph IIIa Model	Comments
700584	ROAN CREEK NO 3 DITCH	7.4	0.82137	Yes	(a)
390585	HIBSCHLE BENBOW DITCH	6.7	0.83036	Yes	(a)
370841	ULIN AND CO DITCH	6.39	0.83677	Yes	(a)
530577	FOUR CREEK DITCH HGT 1	5.4	0.85848	Yes	(a)
450788	SYKES AND ALVORD DITCH	5.1	0.8643	Yes	(a)
390990	WEST LAT RIFLE CR CANON	5.1	0.86444	Yes	(a)
721339	COON CREEK PIPELINE	4.1	0.88926	Yes	(a)
381121	ALEXIS ARBANEY DITCH	3.86	0.89978	Yes	(a)
360784	RANKIN NO 1 DITCH	3.5	0.90851	Yes	(a)
360662	HOAGLAND CANAL	3	0.92588	Yes	(a)
720512	ARBOGAST PUMPING PLANT 3	3	0.92825	Yes	(a)
370583	EAGLE TOWN OF GRAV SYS	2.6	0.93604	Yes	(a)
360908	KEYSTONE SNOWLINE DITCH	2.5	0.94233	Yes	(a)

(1) Structure is abandoned.
(2) Structure has small irrigated acreage or small historical diversions.
(3) Structure is non-existent or unusable.
(4) Structure has little or no time series available.
(5) Structure is for a municipality not modeled.
(6) Structure's water rights, diversions/demands and acreage are included in the aggregate structure listed.
(7) Structure is non-consumptive.
(a) Although below the decreed cutoff, the structure was included because it was determined to be key to the administration of the river by the division engineer.
*** Added in Phase IIIa model.

Several structures listed above contain aggregated drainage areas and water rights for one particular use. These diversion structures include the Climax Mine node (360841), Government Highline Canal node (950001), Independence Pass node (384617), and the Homestake Project (modeled as three nodes: 374643, 374516, and 374614). The reader is referenced to the special operations and basin meeting notes, following in this section, for further information pertaining to these aggregated diversion systems.

The water rights for the three structures included in the Busk-Ivanhoe Tunnel diversion system were assigned to the Busk-Ivanhoe structure (384613). The water rights of two additional structures were added to the Hoagland Canal (360662) to model the decrees of its other collection points to supplement the 3 cfs diversion at the main headgate. Finally, several structures were recognized in the Division 5 basin meetings as diverting from the Metcalf Ditch (370708). Their aggregated demand is modeled as the Metcalf Ditch node.

3.2. W.W. Wheeler Notes on Division 5 Meetings

Meetings were held on July 26 and 27, 1995 at the offices of the Division 5 Engineer in Glenwood Springs. An additional meeting was held on August 3, 1995 at the State Engineer's Office in Denver. The purpose of the meetings was to discuss the development of the water rights planning model for the Upper Colorado River basin and to gain better understanding of the administration of water rights in this basin. In attendance at the meetings were the following:

Orlyn Bell	Division 5 Engineer
Alan Martellaro	Assistant Division 5 Engineer
Ross Bethel	Colorado Water Conservation Board (present during 8/3/1995 meeting)
Ray Bennett	Division of Water Resources
Markus Ritsch	Riverside Technology, inc. (present during 7/26/1995 and 7/27/1995 meetings)
Bill Owen	Riverside Technology, inc. (present during 8/3/1995 meeting)
George Fosha	W.W. Wheeler and Associates, Inc.
Jim Hyre	W.W. Wheeler and Associates, Inc.

Prior to the meetings, George Fosha and Jim Hyre prepared maps (1:100,000 scale) of the Upper Colorado River basin showing the locations of key structures (ditches and reservoirs), which are being proposed for inclusion in the CRDSS water rights planning model. The locations of the structures were based primarily on the descriptions given in the water rights tabulation database.

Also prior to the meetings, Markus Ritsch prepared a summary of the years in which there were available diversion records for the key structures.

The meetings proceeded in a general manner in which, working with the maps showing the key structures, the following issues were discussed:

- Administration issues in each Water District
- Irrigation practices
- Irrigation and municipal return flow locations
- Availability of diversion records
- Irrigated acreage estimates

One of the objectives of the meetings was to attempt to decide which of the key structures, if any, would not need to be included in the model, but rather be left in the historical gage record. The discussions also addressed the identification of critical, water short, river reaches within the river basins.

3.2.1 General Overview of StateMod and Administration Practices

- The CRDSS planning model uses a monthly time step.
- 75 percent of decreed absolute water rights are modeled which represents that water rights less than 11.33 cfs are not explicitly modeled but are left in the historical streamflow gage record.
- It was stated that some conditional water rights in the basin may be diverting and consuming water from the river. These conditional water rights are probably small.
- The ditch capacities given in the database may not all be accurate and reliable.
- Most of the water consumption occurs within the smaller tributaries of the basin by the smaller water rights. The large water diverters in the basin generally do not consume much water. As a result, the quality and effort of administration is greatest in the areas of the basin where the water rights consume the greatest amount of water. The division engineer generally does not put as much effort into the administration of the large water diverters that consume small amounts of water.
- It was felt that the small water rights that consume a lot of water probably will not change greatly in the future and as a result, to leave these water rights in the historical gage for modeling may be a reasonable assumption.
- Some streams in the basin are over appropriated but they are not administrated very closely.
- The annual division engineer's report states a total of 350,343 acres are irrigated in the Upper Colorado River basin.
- It was asked if StateMod could be run daily during the month of June to help analyze the flushing flows for fish. Apparently, StateMod can be run this way but it would be tricky to input the data properly.

3.2.2 Water District 51

- Grand River Ditch: measurement is at the continental divide. Approximately 150 cfs goes out of basin (maximum). Part of water right may be on the abandonment list. Historical diversions will be used as constraint.
- Red Top Ditch: owned by Northern, approx. 2,000 to 3,000 acre-feet of consumption.
- Monarch Water Work (802): Non-consumptive hydroelectric power use. No diversions records are available. Contact Hal Bishop for information. Leave out of model.
- Northern supplies the division engineer with water use reports. For administration of Northern's water diversions, division engineer uses its own gage data except for measurements by Northern of the Granby Pump and Windy Gap Pump. Prior to 1985, all data supplied by Northern.
- Adams Tunnel (4634): Diversion data may be recorded in Water Division 1.
- Redtop Valley Ditch (1315): significant point of diversion for administration. Ditch diverts a minimum of 10 cfs during June through July.
- Bunte Highline (546): Northern makes releases to satisfy the demand at this ditch.
- Coffee McQueary (585): located on right bank.
- No structures are proposed to be modeled on Stillwater Creek. division engineer states that there is some amount of water consumption on this creek.

- Senate Document 80 gives minimum flow release requirements for Lake Granby: 75 cfs summer release below Coffee McQueary Ditch and 25 cfs winter release.
- Generally, there is a flat release rate from Lake Granby.
- Minimum flow release between Shadow Mtn. and Lake Granby is 50 cfs year round per Senate Doc. 80.
- Windy Gap Project came on-line around 1986. Windy Gap agreements define bypass requirements for the project. Key minimum flow reach is 90 cfs to Williams Fork.
- Willow Creek Res: Senate Doc. 80 does not give any minimum flow releases for the reservoir. In recent years, Northern has bypassed approx. 7 cfs year round (Northern is not required to make any minimum bypasses).
- Berthoud Canal Tunnel (4625): rebuilt in 1990's, no diversion records available.
- Diversion records for water rights senior to Shoshone may not be available. Diversion records prior to 1985 exist generally only for those creeks that were administered.
- Moffat Tunnel diversions include many sources (DWD, Climax, and Englewood). Diversions also include transbasin water from Williams Fork (Jones Pass T. and Vasquez T.). Water for snowmaking at Winter Park comes from the Moffat Tunnel.
- Williams Fork Diversion Project (4603): diversions recorded under id 505 (Vasquez and Gumlick T.).
- Big Six Ditch (530): part of water right sold to the Willows District in south Denver metro area. Water diverted is used to irrigate lands in different basin.
- Gaskill Ditch (660): owned by town of Fraser (in whole or part?). Used for some irrigation.
- Hammond No. 1 Ditch (699): irrigates swamp land.
- Hamilton-Cabin Creek Ditch (728): Water rights owned by Englewood.
- Diamond Bar T is junior to Ranch Creek system. DWD may have subordinated their Ranch Creek water rights to the Diamond Bar T (presently in Court).
- Vail Ditch account in Meadow Creek Reservoir is for first 850 acre-feet by agreement.
- Add to the model Meadow Creek Headgate (1231) located on Meadow Creek below reservoir.
- Number of water rights on various tributaries which have some irrigation consumption and are not in the model. Case No. W1881, structure id's 918, 601, 602, and 826 (need to decide whether or not to include in model).
- Add to model and combine structure id's 876 and 877 for the Scybert Ditch; model as one structure under id 876.
- Add to model Wasatch Ditch (950).
- Sylvan Ditch (924) is tied to a reservoir.
- Add the Henderson Project (id 1070) as a depletion node above 788 (below gage).
- Coberly Brothers Ditch (584) is included in the Big Lake Ditch (529) therefore, take out 584.
- Moore Catch Ditch (804): tailwater from ditch returns to Blue River basin.
- Power generation at Williams Fork and Dillon is alternated between plants. Hydroelectric power at Dillon began around late 1980's.
- No diversion records available for Thomas Ditch (931).
- Musgrave Ditch (810): tied with a reservoir, irrigation returns go to Rock Creek and Sulphur Gulch.

- Northern may have data and information concerning Thompson Pump Nos. 1 and 2 (1148 and 1149).
- Water for Winter Park snowmaking is obtained from the Moffat collection system (id 1327).

3.2.3 Water District 50

- Question whether or not to include Matheson Reservoir (3625) in the model. The reservoir is tied to structures 606, 593, and 628.
- Pickering Ditch (628) add to the model (tied to Matheson Res.).
- Kirtz No. 2 Ditch: no diversion records available (remove from model).
- Tom Ennis Ditch (653): structures 756 and 741 are part of same ditch system and should be added to model.
- Wheatley No. 2 (662) diverts mainly return flows (remove from model).
- division engineer generally keeps track of all diversions at designated alternate points of diversion.
- Add to model structure id 612 and McElroy State Pump (id 755).
- N. Meadow Feeder (744) and Martin Lily Pond Feeder (768) are one ditch.
- Remove from model Nightcap Ditch (620) and Pinto Creek Ditch (631): actual diversions are less than 75 percent cutoff of 11.3 cfs.
- Antelope Creek exchange with Matheson Res. (??).
- Sarvis Ditch in the Yampa River basin imports water to the Upper Colorado River basin.
- Hill Creek Ditch (584): remove from model?
- Fay Deberard Ditch (567): irrigated land may be inundated by Wolford Mountain Reservoir.
- Deberard Ditch (734) and 548 are the same ditch; 548 was transferred to 734.
- George Jones (572) and Fay Deberard (568) inundated by Wolford Mtn Res. but should keep in the model. Water rights may be transferred to new locations and continued to be used.
- Pass Creek: add to model Pass Creek Ditch (627) and Hogback Ditch (585) ??

3.2.4 Water District 36

- Hoosier Pass: model as two structures (1929 and 1948) with diversions limited by physical water supply.
- Boreas Pass: located on Indiana Creek. While the structure was under repair there are a few years of no diversion records.
- Breckenridge Res Feeder (964): remove from model.
- Decision needs to be made concerning which municipalities to include in the model.
- Meadow Dillon Ditch (738) remove from model.
- Vidler Tunnel (4626) export (small amount).
- Snake River Ditch (805) and Keystone upper Ditch (683) remove from the model.
- Structure ids for ski area snowmaking:
    - Keystone - 908 (Snake River)

    - Copper - 1016
    - A-basin - no records available (no recent snowmaking)
    - Breckenridge - 1008 and 989 (Maggie Pond)
- Clinton Gulch exchange agreement
- Arkansas Well (Stevenson and Leightner Ditch) imports water to Tenmile Creek (4677); records located in Water Division 2, Water District 11.
- Possibly model Climax water rights as one node, structure ids: 841, 842, 625, 543, 831, 830, 566
- West Tenmile Ditch (869): Copper Mtn municipal use and irrigation of golf course. Include in model ?
- Straight Creek Ditch (829): town of Dillon (in or out of model?).
- Add to model structure 4658 (export water) and McKay Ditch (734).
- Remove from model the following ditches:
    - Lowline No. 2 (715)
    - Highline (658)
    - Maryland Nos. 1 and 2 (726 and 727)
    - Independent (670)
    - May (730)
- Hamilton Davidson (649) irrigation returns go to Squaw Creek.
- Leave in or out of model the following ditches:
    - Mary (725)
    - Mat 2 (729)
    - Mat 1 (728)
- Guthrie Thomas (645) located on Elliott Creek
- Sutton No. 1 (832) located on Martin Creek; irrigates approx. 200 acres.
- Hoagland Canal (946/662): receives 90 percent of its water supply from Elliott Creek.
- Model as one structure Smith Creek No. 2 (803) and Smith Ditch (801).
- Blue Valley Ranch Hydroelectric (985) remove from the model.
- Green Mountain Reservoir:
    - Historically draw reservoir down to approx. 40,000 to 50,000 acre-feet by April or May each year.
    - In recent years, reservoir has been drawn down lower starting in July (larger releases).
    - All irrigation water rights senior to October 20, 1977 benefit from reservoir (referred to as the benefactors).
    - Reservoir capacity: 152,000 acre-feet (actual cap. may be greater)
        - 100,000 acre-feet reserved for irrigation
            - 66,000 acre-feet reserved for augmentation of water consumed by water rights senior to 1977 (determined by amount of water released in 1977).
            - 34,000 acre-feet reserved for contract sales.
        - 52,000 acre-feet reserved for Colorado - Big Thompson Project.
    - Senate Doc. 80 required that releases are to be made from April 15 through October 15 when flow at Shoshone drops below 1,250 cfs.
    - 1935 refill right (6,000 acre-feet) and power right (1,726 cfs)

    - Prior to 1987, division engineer's policy was that transmountain diverters should not benefit from reservoir. Therefore, all transmountain diversions would be shut off to satisfy the call at Shoshone before releases from Green Mtn would be made to replace depletions (irrigation consumption) by any benefactors. Transmountain diverters would be shut down even if they were senior in priority to any of the benefactors.
    - Present policy is to use priority system to shut down water rights to satisfy call at Shoshone.
    - Diversion records reflect if structure received reservoir water.
    - Types of releases:
        - replacement for Colorado - Big Thompson project
        - replacement for evaporation
        - augmentation for junior rights (CU basis)
        - direct supply for irrigation (Grand Valley rights)
    - Three day delivery time from reservoir to Cameo.
    - The yield of the Blue River is estimated to be around 300,000 acre-feet/year and should provide enough water in the basin for Green Mtn. to always fill.
- Total downstream demand in Cameo area (Grand Valley) is 2,260 cfs.
- Prior to Green Mtn. Res., during the 1920's, downstream canals would be water short and also during this time, Denver began building the Moffat system. Orchard Mesa Check was built by two downstream ditches (funded by Orchard Mesa Grand Valley Water Users and the Bureau) to provide protection during low streamflow conditions.
- After 1987, division engineer formed the Water SWAT Team: Northern, Denver, Colorado Springs, and State Engineer's Office. Other entities and individuals are occasionally invited to participate.
- Summit County and Clinton Gulch agreements were made to help benefactors upstream of Green Mtn. Res. using water from Clinton Gulch Reservoir and Vidler Tunnel.
- Court cases define how Green Mtn. Res. exchanges operate:
    - Cases eliminated 1,250 cfs release requirement and the seasonal release period limitation.
    - Cases define priorities for Denver, Green Mtn., and Colorado Springs.
- Division engineer prior to Orlyn Bell (1987?) did not honor the 1408 Shoshone water right.
- Junior diversions by AMAX are not protected by Green Mtn. Res. (industrial uses).

3.2.5 Water District 37

- Remove the following structures from the model:
    - Empire Zinc (590), small water use
    - Ewing Placer (1091), small water use
    - 613, used at Metcalf Ditch (708)
    - 579, used at Metcalf Ditch (708)
    - 616, used at Metcalf Ditch (708)
    - 736, used at Metcalf Ditch (708)
    - 790, moved to Beaver Crk municipal (878)
    - 835, moved to Beaver Crk municipal (878)

    - McCoy and Taylor (701)
    - 684
    - Castle No. 2 (535)
    - LEDE (682)
    - 822
- Add the following structures to the model:
    - Ewing (4642)
    - Eagle/Vail municipal use (1084) located on Eagle River
    - Raw Water Booster on Eagle River (1202)
    - Vail snowmaking (1157)
    - Beaver Creek snowmaking (878)
    - 858
    - 820
    - 723
    - 856
- Model Ewing (4642) and Wurtz as one node at headwaters.
- Forest Service minimum flow requirement below Homestake Reservoir is 8 cfs.
- Bolts Ditch (514); non-consumptive
- Should Vail municipal uses be modeled?
- Minimum streamflow requirements on Gore Creek cause problems for water users during winter.

3.2.6 Water District 52

- Remove the following structures from the model:
    - Best Ditch (662)
    - John Conger (523)
    - Hog Eye (572)
    - Horse Meadows (632)
- Add two inflow model nodes for Piney Creek and Sheephorn Creek.

3.2.7 Water District 38

- Independence Pass water rights:
    - Model as two nodes to represent diversions from two different watersheds.
    - Exchange agreement involving USBR and Twin Lakes - 2,000 acre-feet per year.
- Add new node on Hunter Creek (1594) which represents export water to the Fryingpan River.
- Granite Crk, Sawyer Crk, Carter Crk, and South Fork of Cunningham do not have any minimum flow requirements.
- Remove from model structure 768.
- Bad and/or misleading diversion records may exist on most creeks. Good records have been kept on Cattle Creek and Four-mile Creek.
- Lands irrigated under the Salvation Ditch (981) begin around Woody Creek.

- The following structures divert water for Aspen's municipal uses:
    - Midland Flume Ditch (869)
    - Holden (755)
    - Marolt Ditch (853)
    - Herrick (749)
    - Maroon (854)
- Treated water is used for snowmaking at Aspen Mountain.
- Stapleton Brothers Ditch (1026) provides some water for snowmaking at Buttermilk ski area.
- Willow Creek Ditch (1101) is tied together with the Herrick Ditch (749).
- Willow and Owl (1104) irrigates land along Owl Creek.
- Collins Creek Ditch (606) diverts water from Woody and Collins Creek.
- E. Snowmass Brush (653) diverts water for municipal uses and snowmaking at Snowmass ski area.
- Remove from model the following structures:
    - Elk Creek Ditch (660)
    - Basalt Proj. Landis (809)
    - Koch Ditch (805)
    - Alicia Lake Res. Direct Flow (1773)
    - Woods Lake Res. Direct Flow (1775)
    - Troy Ditch 1st & 2nd Enl (1200); inundated by Ruedi Res.
    - Light Ditch (819)
    - Johnson Blue Creek (789); used for fish ponds
    - 570 (water used for fish hatchery)
    - Van Cleve (1481)
- Add to model the Alexis Ditch (1121)
- Ruedi Reservoir:
    - Two accounts - 1) Basalt for 500 acre-feet, 2) West Divide for 100 acre-feet.
    - Releases for augmentation plans and replacements for Fry-Ark Project.
    - Minimum bypass requirements:
        - lessor of 110 cfs or inflow (summer)
        - lessor of 40 cfs or inflow (winter)
- Add to model node for town of Basalt municipal use located just upstream of Glenwood Springs.
- Add to model node for West Divide located at Rifle.
- Shippee Ditch (989) irrigates land above Home Supply Ditch (757)
- Add to model the Thompson Creek Feeder Ditch (1771). Diversion records may be found under the structures 1770, 1772, and 4680.
- Crystal Creek will dry up at the Carbondale Ditch (574).
- Mountain Meadow Ditch (881) is used to fill Spring Park Reservoir.
- Return flows from lands irrigated on south side of Cattle Creek return to Missouri Heights.
- Add to the model Monarch Ditch (879) and Eureka No. 1 (667).
- West Three Mile Ditch (1170) is used as a feeder ditch for the Sykes (450788) and Roderick (450749) ditches located in Water District 45.

3.2.8 Water District 53

- Remove from model the following structures:
  - West End No. 1 Ditch (870)
  - Grimes Brooks Ditch (595)
  - McKinley Ditch (728)
  - Dome Ranch (1039)
  - Keep Ditch (662)
  - DD Ditch (547)
  - Coffee Pot (535)
- Add to model the Four Creek Ditch (577). Diversion records for Four Creek Ditch may be found under structure id's 1047, 1048, and 1049. Model the Horse Meadows Ditch (632) and the Four Creek Ditch as one node.
- Derby (555), Middle Derby (704), and Grand River L&C (591) are carrier ditches from Derby Creek to Cabin Creek. Use total acreage on Cabin Creek.

3.2.9 Water District 39

- Add to the model the following structures:
  - Vulcan Ditch (685) - located on Canyon Creek and irrigates land on both sides of the creek (approx. 80 acres on north side of the Colorado River and the remaining acreage is on the south side of the river).
  - Red Rock Ditch (701)
  - 585 - returns from this structure all return to a reservoir.
  - Rifle Creek Canyon Ditch, west lateral (990)
- Remove from the model East Rifle No. 2 Ditch (649) - this structure diverts water for use at a fishery (use is essentially non-consumptive).
- Remove from the model the Davenport Ditch (546) - structure is owned by UniCal and is leased for small irrigation uses.
- Deweese Ditch (548) irrigates approximately 130 acres in Bear Wallow.
- Coryell Joint Stock (540) exports water to Canyon Creek and around New Castle for irrigation of approximately 500 acres. Structure will dry up Boiler Creek and Water Commissioner allows ditch to divert under a futile call.
- Corell Ditch (539) irrigates land down to New Castle.
- Silt Project:
  - Used by Grass Valley Canal and Farmers Irrigation Ditch Company.
  - Rifle Gap Reservoir was built as a replacement source for diversions under the Grass Valley Canal.
  - Grass Valley Canal diverts water to Harvey Gap Reservoir. There is some irrigation along canal up-ditch of Harvey Gap Reservoir.
  - Harvey Gap Reservoir will fill about 2 out of 5 years.
  - The Silt Pump has 5,000 acre-feet available from Green Mountain Reservoir. The SWAT team has been debating what pool this 5,000 acre-feet comes from in Green Mtn.
  - The Silt Pump is used last to divert water because of the pumping costs.

    - Harvey Gap Reservoir has very little native inflow.
- Rifle Creek Canyon Ditch (645) irrigates land on both sides of the creek.
- Dow Pump Plant (709) should be put in model as structure id 451116 in Water District 45.
- Municipal uses at Battlement Mesa are insignificant and do not need to be included in the model.

3.2.10 Water District 45

- Add to the model the following structures:
    - 788 - Diversion connected with the Three Mile Ditch.
    - West Divide Ditch (818)
    - Ward and Reynolds (810)
    - Louis and Reynolds (675)
    - Rifle municipal (739) located on Beaver Creek
- Remove from the model the following structures:
    - Mosquito Ditch (699)
    - Mosquito Lake Ditch (701) - no records available
    - Clarkson Ditch (547) - no records available
    - Ruple Ditch (750)
    - Wandering Jew (808) - exports water to Battlement Creek
    - Gardner Ditch (731)
    - 623
- H and S Ditch (616) - if ditch is included in the model, the following structures should also be included:
    - Holmes (632)
    - R & AG Anderson/Bernkalu
    - Martin and Kennedy
    - Bluebird
    - Campbird No. 1
- Divide Creek Highline (576) receives import water from Owens Creek Feeder (72814, diversion records are probably under 45716) in Water District 72 and from Clear Fork Feeder/Divide Creek Feeder in Water Division 4. Irrigation returns go to Dry Hollow and Mamm creeks.
- Multa-Trina (704) receives import water from 384680 located on North Thompson Creek in Water District 38.
- Porter Ditch (725) irrigation returns go to Dry Hollow.
- Bluestone Valley Ditch (2000) diversion records may be under id 969.
- Larkin Ditch (2001) diversion records may be under id 861.

3.2.11 Water District 70

- Add Roan Creek No. 3 (584) to the model.
- Remove the Bridges-Hayes Ditch (642) and the Cannon Ditch (511) from the model.
- Creek and Newman Ditch (530) presently includes diversions under the Snow Ditch

- Reservoir Ditch (580); some irrigation returns go to the Colorado River. Part of the water right is used for irrigation by the town of DeBuque.

3.2.12 Water District 72

- Add to the model the following structures:
    - Arbogast Pumping Plant Nos. 1 (510), 2 (511), and 3 (512).
    - Eakin Smith (607)
    - Arkansas (514)
    - Mason and Eddy (766) owned by (Ute Water Conservancy)
- Remove from the model the following structures:
    - Rapid Creek (1329)
    - Cameo Pumping Plant (1039); non-consumptive
    - Martin Crawford (764); small acreage irrigated
    - Rose Point Power (859); not used
    - Colorado River Pumping (1330); talk with Jim Rookes and decide whether or not to take structure out of model.
    - Anderson Feeder (506)
    - Bull Elk (559)
    - Gunderson Carter (652)
    - Hawxhurst (675)
    - East Fork Feeder (609)
    - Bonham Branch Pipeline (542)
    - RMG (852)
    - Ute Pipeline No. 1 (1487); records are under 920
    - Cottonwood Branch (583); records are under 807
- Palisade Irrigation (817) actually diverted at Highline (646). Separate records are kept.
- Mesa Co. Irr. (783) actually diverted at Highline (646).
- Grand Junction Colorado River Pipeline (644) may be used in part by the town of Clifton.
- Orchard Mesa (813) is diverted at Highline (646). Some irrigation returns go to the Gunnison River.
- New Erie Canal (616); some irrigation returns go directly into Vega Reservoir and some return above the reservoir.
- Galbraith (628) and the South Side (879) divert directly from Vega Reservoir.
- Vega does not always fill during dry years.
- Vega Reservoir Project:
    - 34,000 acre-feet capacity -
        - 16,000 acre-feet Project Pool; used for Power Plants and replacement water (operated by the USBR)
        - 18,000 acre-feet District Pool; Collbran Conservancy District
    - South Side Ditch does not divert water from any of the tributaries that it intercepts.
    - There is a proposed 2nd fill decree for Vega Reservoir.
    - There is no bypass requirement below Vega Reservoir.

    - Plateau Creek and Vega Project are independent of the Colorado River (locally control).
    - See hand-drawn picture in notes taken during the meeting. Also see USBR Project Data Book.
- The Ute Water District supplies water to everyone on the north side of the Colorado River (including Fruita) except Grand Junction, Clifton, and Palisade.
- Information concerning the upper reservoirs on Big and Cottonwood creeks can be obtained from the Division Engineer's Office (e.g., actual capacities versus decreed capacities).
- Lean Tunnel (758) exports water to Division 4.
- Kiggins Salisbury (730) diverts water to Salt Creek.
- Hoosier Ditch (703) receives water from District Pool in Vega Reservoir.
- Upper Hight (1233) no diversion records are available (records may be under different ditch).
- 807 is penstock for power generation (tied to Vega Project).
- Possibly add a new node for Vega Reservoir Project lands.

3.3 RTi's Notes Covering the Modeling Meetings

Notes taken during March 15 and 16 meetings with State management team, Randy Seaholm, George Fosha, John Eckhardt, and Bill Owen.

3.3.1 Return Patterns

- WWW will prepare curves for cut-off of 1 percent
- WWW will identify structures in other basins where delay patterns need adjustment for distance from river
- Ray B. will adjust code for variable # of return patterns
- RTi implements above

3.3.2 Colorado-BigThompson Project

- New 5,000 acre-feet Silt pool (from 14,000 inactive pool) for Green Mountain
- Accounts for Green Mountain:

Historic User Pool	66,000 acre-feet
Colorado - Big Thompson	52,000
Contract	20,000
Silt	5,000
Inactive&Dead	10,639
Total	153,639

- Elliot Creek Feeder is not charged against storage decree (already implemented)
- Historical simulation: Green Mountain supplies replacement water from historic user pool for those structures decreed prior to January 24, 1984

- Baseline simulation: Green Mountain supplies replacement water from historic user pool for those structures prior to October 15, 1977; those decreed between this date and the one above will receive water from the 20K Contract pool
- Prior to 1984, operate Green Mountain to maintain 1,250 cfs at Dotsero gage; see Shoshone section for more details
- Transmountain and industrial diversions (including USA Power) cannot call for replacement water from Green Mountain
- Shadow Mtn and Granby have bypass nodes that are senior to their respective storage rights; if short, they will pull water from respective storage accounts
- WWW will ask NCWCD about need for Windy Gap pool in Granby Reservoir and implementation of Windy Gap bypasses for downstream instream flow requirements
- Contract users that are in the model will be tied to the Green Mountain contract pool.
- RTi will add a demand node below Green Mountain and above the minimum flow node to represent contract users not in the model. This demand will be 100 percent consumptive, since these users are primarily associated with augmentation plans.

3.3.3 Denver Water

- Agreed Moffat Tunnel direct flow rights are turned off since it does not divert itself.
- State will develop logic to handle release from Williams Fork related to Blue River Decree storage in Dillon (see #D.2.4 on page D-15 of the Denver Water Special Operations memo)
- Green Mountain account in Dillon = capacity of Green Mountain Reservoir
- In baseline scenario, Dillon Reservoir target will be full
- Dillon accounts:

Denver	252,015 acre-feet
Green Mountain	(153,639) when space available
Summit	1,021
1000 acre-feet	1,000
Dead	3,269
Total	257,305

- Denver-Climax exchange (related to 3,000 acre-feet in Meadow Creek Reservoir) can be ignored for now
- Denver-Climax exchange with Williams Fork of 2,200 acre-feet will be implemented
- WWW to speak with instream flow group at CWCB concerning Summit County agreement and operation of Clinton Gulch Reservoir
- Aggregation for Moffat Tunnel individual collection system was acceptable

3.3.4 Cameo Demands

- Network structure of the Cameo area was acceptable
- State needs to develop logic to operate the Orchard Mesa check based upon streamflow at Cameo and Plateau gages for baseline scenario
- Historical diversions will be used to operate the OM Check for the historical simulation

- Power estimates on page G-6 INCLUDE mechanical power plant for Orchard Mesa irrigation water
- RTi to revise the efficiencies at the OMID irrigation node (WDID 720813) to reflect irrigation losses only (will not include mechanical power plant returns)
- RTi to add Palisade gage below instream flow node at the top of the 15-mile reach (between GVIC diversion - 720645 - and the instream flow node)
- Consideration will be given for data filling at the Palisade gage or simply including for future use.
- WWW will revise footnote 3 in Table 1 concerning water rights of the USA Power Plant

3.3.5 Collbran Project

- Vega Reservoir accounts:

Project Irrigation	15,300 acre-feet
Unallocated	18,011
Power replacement	(18,011)
Dead Pool	820
Total	35,761

- Bookover operations will be implemented needed for out-of-priority diversions by 720542 and 720583; water will be booked-over from the Unallocated account to Power replacement account for access to selected irrigation diverts on Big and Cottonwood Creeks.
- It was recognized that out-of-priority diversions could not be easily separated from priority diversions by these structures. Therefore, a book-over operation will occur whenever the structures divert.
- Diverters on all creeks which the Southside Canal serves will pull water from the Project Irrigation account
- To simplify the operation of ditches located upstream of the Southside Canal, they will be operated as receiving Vega Reservoir water directly from the Southside Canal, rather than by exchange.
- An aggregated reservoir which serves the Molina Power Plant diversions (720542 and 720583), approximated at 5,000 acre-feet, may be required to simulate the historical diversions. The decision will be made during historical calibration.
- RTi will revise ties to project accounts per table on pages V-6,7.
- State will check irrigated acreage assignment on Plateau Creek

3.3.6 Transbasin Diversions

- The Con-Hoosier system can divert up to 10 percent of natural Dillon Res. inflow. It was agreed this constraint would not be simulated because it typically does not limit diversions. The baseline demand should be around 10,000 acre-feet/year using the historical monthly average distribution.
- WWW and the State will determine if the Con-Hoosier system's administration number should be modeled as senior to Dillon's storage rights in order to implement the Blue River Decree.

- WWW will add text describing the Grand River Ditch capacity changes the occurred over time
- The historical and calculated data sets will include historical transmountain diversions as demands. The baseline data sets will include the average unless described in the WWW memos.
- Aggregation for individual collection systems was accepted.
- Eureka Ditch was removed from the model due to termination of this transmountain diversions in the future

3.3.7 Homestake Pipeline

- Aggregated collection point (Missouri Tunnel node) for Homestake Reservoir

3.3.8 Shoshone Diversion

- Diversions provided by Public Service from 1975-1991 are included in the model
- Prior to 1984 model the delivery from Green Mountain to Shoshone as an instream flow support at the Dotsero gage. Assign its administration numbers to be very junior as follows:

Instream demand @ Dotsero	99999.80000
Green Mountain Support to Dotsero	99999.90000

- From 1985 to 1991, turn off the instream flow support from Green Mountain. Note, from 1985 on, Dotsero flows will be a function of Green Mountain replacement reservoir operations.

3.3.9 Fryingpan-Arkansas Project

- Ruedi Reservoir accounts:

CWCB Fish Pool	20,000 acre-feet
Contract	31,500
Replacement	28,000
Unallocated	22,873
Total	102,373

- 15-mile reach fish flows:
  - 10,000 acre-feet from Ruedi for historical simulation
  - 20,000 acre-feet from Ruedi for baseline scenario
- RTi to add additional demand node for 15-mile fish requirements; this node will have a 5 percent shrink loss; water right will be one junior to GM release for Dotsero (99999.91000)
- CWCB will provide the last three years of Ruedi release records for the new node; the monthly average will be used to fill this node's time series
- Baseline scenario for Ruedi Reservoir:

June - Labor Day	Keep full
Labor Day - March	Use forecast component of StateMod
March	53,000 acre-feet target

- Baseline scenario time series should have an average of 69,000 diverted for Boustead Tunnel
- RTi to incorporate Thomasville gage, Boustead Tunnel, and Hunter Creek bypasses
- For all data sets (i.e. historical, calculated, and baseline), it was agreed Busk-Ivanhoe Tunnel's limited capacity and use of the Boustead Tunnel will not be modeled. This is consistent with diversion records which report the Busk-Ivanhoe diversions separately in the Boustead Tunnel.
- WWW will change the title Busk-Ivanhoe Exchange on page F-6 to Busk-Ivanhoe Use of Boustead Tunnel
- WWW to perform further research on frequency of Twin Lakes exchange; Independence Pass network structure might change depending on the research results, but current information indicates this exchange should not be modeled.
- Demands for baseline scenario for Independence Pass should average 68,000 acre-feet per year
- WWW will double check the status of Ruedi Reservoir's hydroelectric power rights. Regardless of their status, they will not be modeled since they do not call the river and only operate when Ruedi release for other purposes

3.3.10 Silt Project

- RTi to change operation right for Dry Elk irrigation demands to Rifle exchange number
- Harvey Gap Reservoir targets will be simulated as full
- Farmer's irrigation demands will receive water via Grass Valley Canal, Rifle Res. exchange, and Silt Pump
- Harvey Gap Reservoir will receive water via Grass Valley Canal and the Rifle Res. exchange
- WWW will revise recommendations to reflect current modeling (simulate Harvey Gap Reservoir, operate Farmer's Irrigation Co. as one demand served by Grass Valley Canal, Harvey Gap and Silt Pump, and simulate Dry Elk Valley separately, etc.)
- Dry Elk Valley will be modeled as a beneficiary of the Grass Valley Canal water rights based on information in the Definite Plan Report.
- RTi will evaluate diversions by the Silt Pump to be similar to historical amounts, since it can only serve a portion of the Farmer's Irrigation Company.

3.3.11 Municipal Diversions

- Vail modeled as two nodes: one each for the irrigation and non-irrigation seasons
- Vail node for non-irrigation will have tie to Green Mountain contract pool
- RTi to remove non-functional operations between Ruedi Reservoir and various municipalities; WWW to update Municipal Demands memo concerning these deletions

- Water rights for the Ute Water Treatment Plant (950020) will be the same as those found in UTE PIPELINE HGT NO 4 (720920), MASON EDDY DITCH (720766), and COON CREEK PIPELINE (721339).
- WWW to give new efficiencies for Ute Treatment Plant diversions

3.3.12 Gunnison Contribution

- RTi to include USGS gage 09152500 (GUNNISON RIVER NEAR GRAND JUNCTION, CO.), Redlands Power node, Redlands Irrigation node, and Gunnison Grand Junction Pipeline.
- Redlands power node will have 610 cfs right, while the irrigation node will have the 80 cfs right
- RTi will tie the Division 5 acreage tabulated under Redlands Power Canal (WDID 724713, acreage 2935) to the 60 cfs senior and 80 cfs junior Redlands irrigation demand.
- RTi will estimate irrigation demands to be Redlands diversions less 610 cfs for power use. Note: this calculation will result in winter diversions for irrigation which will assume to be stock water
- WWW to provide return flow locations and pattern for the two Redlands' nodes
- Baseline time series for Redlands' nodes and Gunnison Grand Junction Pipeline obtained from the database. Ray Bennett will check if they are the same as those in the Gunnison model.
- RTi to add a project tributary on the Colorado-mainstem between the Grand Junction Pipeline (720644) and the 15-mile reach instream flow node; an import node and a Grand Junction municipal diversion node will appear on this tributary to represent imports from Kannah Creek to Grand Junction municipal uses.
- WWW to provide demand time series and return locations for Grand Junction municipal diversions (i.e. new node on new project tributary)

3.3.13 Hoagland Canal

- It was recognized Hoagland diverts from several tributaries. It was agreed three of these diversions would be modeled as serving one irrigated parcel currently located under WDID 360662.

3.4 RTi's Notes Covering the Surface Water Administration Team (SWAT)

Notes taken during the April 12 SWAT meeting.

3.4.1 Colorado-Big Thompson

- Check to see if instream flow right exists between Shadow Mtn. and Granby
- Willow Creek Reservoir:

    - Switch Willow Creek Feeder and Willow Creek Reservoir bypass nodes so the former does not capitalize on latter's water
    - Feeder Pump cannot pump unless 7200 acre-feet is present in the Reservoir; Inactive pool currently holds 7224 acre-feet, as described in Colorado - Big Thompson operations memo.
- Green Mountain hydroelectric power should be turned on in the baseline scenario

3.4.2 Denver

- Double counting future demands at Cabin-Meadow Creek for baseline scenario
- Blue River Decree - everything above 60 cfs from Green Mountain
- Dump water at the end of July from Green Mountain-Dillon to GM
- GM substitutions typically done by end of October (future use)
- Palisade Stipulation (substitution exercise)
    - 5000 acre-feet from Wolford (first)
    - 10,000 acre-feet from Williams Fork (second)
    - remainder from Wolford
- Decree exchanges have dates
- Con-Hoosier one senior to Dillon/Roberts Tunnel (10 percent natural flow restriction)
- Drainage to senior Con-Hoosier right is small, relative to its other rights - need to break up into two nodes?

3.4.3 Grand Valley Project Demands

- Add Palisade Gage
- Take out OMID hydraulic pump water from USA power and add to OMID irrigation node - need new efficiencies for latter node
- Baseline scenario: USA Power time series = Total - (consumptive use (cu) for Project irr) - (cu OMID irr)
- How to account for spills at the Roller Dam?
- 15-mile reach fish demands:
    - First, Green Mountain water via USA Power/OMID hydraulic pump or direct
    - Ruedi Reservoir releases
    - 10 percent loss , not 5 percent as originally agreed
    - need to increase time series by 10 percent to include loss

3.4.4 Fryingpan-Arkansas Project

- Ruedi Reservoir
    - Releases restricted to 250 cfs
    - Cannot go below 85,000 acre-feet per day

3.4.5 Miscellaneous

- Exercise care when finalizing structure efficiencies
- Ensure water right and physical assumptions in input file headers
- Turn off Independence Pass diversions for Shoshone Call (for historical run only!)
- Shortages at Ute due to Jerry Creek Reservoir supplement
- Mesa and Coon Creek contributions to Ute do not receive Green Mountain historic user pool water

4. Upper Colorado River Basin Instream Flow Rights

The March 2003 instream flow right tabulation for Division 5 shows there are 370 appropriations covering 1989 stream miles in tributaries and the mainstem of the Upper Colorado River. To obtain a copy of the tabulation, visit the CWCB's website at www.cwcb.state.co.us , click on "Stream and Lake Protection" and then "Instream Flow and Natural Lake Level Water Rights Database".

5. Previous Upper Colorado River Basin Modeling Efforts

Numerous computer applications have been developed for water use and water rights analysis in the Upper Colorado River basin, including models specific to smaller tributary sub-basins and to larger, basin-wide models. Through contact with various government agencies (U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service, Colorado Division of Natural Resources, Colorado Water Conservation Board, Colorado Water Resources and Power Development Authority) and a number of private entities, the following significant water rights modeling efforts were identified and are briefly summarized in this memorandum.

5.1 Colorado River Simulation System (CRSS) (U. S. Bureau of Reclamation)

The Colorado River Simulation System (CRSS) is a simulation model of the Colorado River system and is designed to help evaluate future conditions on the river related to both water supply and water quality as a result of varying assumptions for river management and levels of development. The model is often referred to as the Big River Model and addresses water usage and depletions on a larger scale than does the CRDSS.

In the CRSS, the Colorado River basin (above Lee's Ferry) is divided into 19 sub-basins representing major tributaries of the river. Within Colorado, the mainstem of the river is represented by only two principal sub-basins: (1) the Colorado River at Glenwood Springs and (2) the Colorado River near Cameo.

As part of the CRDSS project, the CRSS and it main control program CRSM (Colorado River Simulation Model) have been ported to the CRDSS environment. Use of the CRSS/CRSM from within the CRDSS interface are described in separate documentation.

Beginning in 1995, the use of the CRSS/CRSM is being phased out by the USBR in favor of the new PRSYM model (Power and Reservoir System Model), being jointly developed by EPRI, the TVA, WAPA and the USBR. PRSYM is a generalized river basin modeling environment which integrates the multi-purposes of reservoir systems, such as flood control, recreation, water supply and water quality with power system economics. When implemented, PRSYM will provide a tool for scheduling, forecasting and planning reservoir operations.

Pertinence to the CRDSS Upper Colorado River Model: Because or the significant difference in the scale of the CRSS in comparison to the more specific CRDSS Upper Colorado River Model, no data from the CRSS was incorporated into the Upper Colorado River Model. It is noted however, that both models rely upon historical exports from the basin in the form of transbasin diversions and both models reflect operation of the major reservoirs in the Upper Colorado River basin, including Shadow Mountain Reservoir, Willow Creek Reservoir, Granby Reservoir, Green Mountain

Reservoir, Dillon Reservoir, Williams Fork Reservoir, Homestake Reservoir, Ruedi Reservoir and Vega Reservoir.

5.2 Green Mountain Exchange Model (Boyle Engineering-1987)

As part of comprehensive studies performed for the Colorado Water Resources and Power Development Authority (CWRPDA), Boyle utilized its in-house hydrologic simulation model, BESTSM, to estimate the potential yield of a number of joint-use reservoir alternatives and to evaluate a proposed exchange involving Green Mountain and Dillon reservoirs.

The Green Mountain Exchange Model accounts for monthly water volumes of inflows, exports, diversions, return flows, river gains (losses) and outflow for each modeled segment of the stream system. For reservoirs, complete water balance accounting is provided, including consideration of inflows and outflows; evaporation; bypasses for downstream rights; and operation of sub- accounts within the reservoirs. The Green Mountain Exchange model incorporates all of the Upper Colorado River basin upstream of the Cameo gage and includes 56 separate stream segments and over 800 major diversion structures. Demands for the Grand Valley area downstream of the Cameo gage are assumed to be a constant 1,650 cfs during the irrigation season and 800 cfs during the winter months. The operations of Lake Granby, Willow Creek, Green Mountain, Williams Fork, Dillon and Ruedi reservoirs are also modeled. The model operates on a monthly time-step for the period 1951 through 1983.

Historical diversions for the modeled structures were obtained from the Division of Water Resources and incomplete or missing data were filled by inspection and through correlation techniques. The consumptive use associated with these diversions was estimated using assumed irrigation efficiencies, ranging from 45 to 60 percent. Irrigated acreage was not examined.

Pertinence to CRDSS Upper Colorado River Model: This prior modeling effort has significant importance to the CRDSS. The Green Mountain version of the BESTSM model was ported to the CRDSS environment and with some modification by the Division of Water Resources and the Colorado Water Conservation Board, was subsequently adopted for use in the CRDSS Upper Colorado River Model. The modified version is referred to as StateMod.

The Green Mountain modeling effort provided insight and additional information concerning some of the more significant water right operations in the Upper Colorado River basin. In particular, the logic for the operation of Green Mountain Reservoir and Dillon Reservoir with respect to the provisions of the Blue River Decree was useful in defining these operations in the CRDSS Upper Colorado River Model. However, the BESTSM model utilized a different study period (1951-1983), different assumptions for procedures to fill missing/incomplete diversion data at structures and a different approach to estimating irrigation efficiencies. Accordingly, none of the basic data developed for the Green Mountain versions of BESTSM were incorporated into the CRDSS Upper Colorado River Model.

5.3 Colorado - Big Thompson/Windy Gap Operations Study (Hydrosphere Res. Consultants - 1990)

This study was performed to examine various ways of operating the Colorado - Big Thompson (CBT) and Windy Gap projects in an integrated fashion in order to maximize the yield of the Windy Gap Project. The study, which was made on the behalf of the Northern Colorado Water Conservancy District (NCWCD), relied in large part on a computer model of the system which represented water rights, system demands and various assumed operating rules. The study utilized the Central Resource Allocation Model (CRAM), a proprietary network flow allocation model.

This particular study was performed on a monthly time-step for the period 1950 through 1989 and includes a west-slope study area primarily defined as the mainstem Upper Colorado River, upstream of the confluence with the Fraser River. Fundamental assumptions in the model include: (1) the 52,000 acre-feet of replacement capacity in Green Mountain Reservoir is adequate to allow CBT to divert all of the physically available inflow above Granby Reservoir; and (2) the estimates of diversions by the Windy Gap Project were obtained from prior modeling efforts of the NCWCD. Windy Gap was assumed to divert only during the months of April through July at a rate not exceeding 600 cfs. Natural flow estimates required by the model were made by adjusting historical gaged flows by the depletive effects of significant upstream reservoir operations and water diversions. Minimum release requirements at Granby Reservoir, Willow Creek Reservoir and the Windy Gap diversion were incorporated.

Pertinence to CRDSS Upper Colorado River Model: Review of the documentation for this model was useful and helpful in understanding the basic operations of the CBT and Windy Gap systems. The CRAM modeling environment is significantly different from the StateMod environment and none of the basic data generated for or by this model were incorporated into the CRDSS Upper Colorado River Model.

5.4 Cache la Poudre Basin Study Extension (Harza/ NCWCD/ Hydro Triad - 1990)

This study was performed for the Colorado Water Resource and Power Development Authority (CWRPDA) to examine the feasibility of a major water storage project on the Cache la Poudre River. It has relevance to the CRDSS because the study included development of a network optimization model (MODSIM) for the Upper Colorado River basin to evaluate transmountain diversion potential from the Colorado - Big Thompson and Windy Gap projects to supplement the native flows of the Poudre.

This MODSIM model operates on a monthly time step for a study period 1954 through 1983. The Upper Colorado River portion of the model extends from the headwaters down to Grand Junction and represents all of the major water uses in the basin. Demands are represented either as consumptive demands (municipal, industrial and irrigation) or non-consumptive flow through demands (instream flows and hydroelectric diversions). Natural flows and net consumptive uses (by irrigation users) were adopted from previous work performed by the USBR for the CRSS database. Sub-basin consumptive uses were estimated as a percentage of the total consumptive use estimated

by the USBR at the key CRSS/CRSM gages. Certain demands, including Shoshone and Cameo were explicitly modeled.

Pertinence to CRDSS Upper Colorado River Model: The written documentation for this application of the MODSIM model was helpful and useful in understanding basic operations in the Upper Colorado River, including the operation of the Colorado - Big Thompson Project and the Windy Gap Project. It also provided a means for a basic comparison of reservoir operational rules and demands by the significant water users in the basin. Upon recommendations of the NCWCD, output from specific model runs was used to develop CRDSS baseline demands at the Adams Tunnel for future operations of the Colorado - Big Thompson and Windy Gap projects.

5.5 Green Mountain Reservoir-Water Marketing Program (RCI/USBR – 1986)

The USBR developed a generalized computer model to study the hydrologic impacts of the proposed water marketing plan for Green Mountain Reservoir, pursuant to the December 1983 Operating Policy. The hydrology model used historical stream gage and reservoir data, modified by removing historical Blue River operations and then adding back in the simulated Blue River operations, including the impacts of water sales depletions. The demands and depletions associated with the proposed water sales were analyzed external to the model by private consultants.

The study was performed using a monthly time-step for the period 1960 through 1982 and included a number of simplifying assumptions, including: (a) it is a generalized system model and does not model the hydrology and water rights on small tributary streams; (b) the model does not model individual streams above Dillon Reservoir but utilizes net inflow to Dillon; (c) the model does not extend below the Cameo gage (the impacts to the Grand Valley area were analyzed outside of the model); (d) Denver, using the Roberts Tunnel, can deplete all of the available inflows to Dillon above the required minimum releases; (e) storage in Dillon and Williams Fork reservoirs was not simulated.

Pertinence to CRDSS Upper Colorado River Model: The hydrology studies performed for the water marketing program provided additional and useful information concerning the operation of Green Mountain Reservoir and helpful information related to municipal demands, snowmaking demands and instream flows on several of the smaller tributaries above Dillon Reservoir and in Grand and Eagle Counties. However, the objectives of this study were specific to the water sales program (as it existed in 1985) and utilized a generalized basin model for a substantially different study period. Accordingly, no data from this modeling effort were utilized in the CRDSS Upper Colorado River Model.

5.6 Fraser River Basin Feasibility Study (CH2M Hill/Resource Consultants – 1989)

This study was performed for the Colorado Water Resource and Power Development Authority (CWRPDA) to evaluate alternative water management plans for the Fraser River valley. The study was isolated to only the hydrology and water resources of the Fraser River above its confluence with the Upper Colorado River (including the Windy Gap Diversion Project). Senior downstream demands were represented only as external demands from Shoshone and from Cameo, as well as the 90 cfs instream flow requirement below the Windy Gap diversion. Diversions by Denver in the Fraser basin were assumed to be senior to these downstream calls because of Denver's ability to release water from Williams Fork Reservoir.

The study utilized the computer model MODSIM for the hydrologic analysis and was configured with 59 nodes and 70 links. The study was performed on a monthly basis for the period 1947 through 1986. Baseline (natural) flows were estimated using three separate procedures. The first involved historical gage data, adjusted for upstream diversions, return flows and exports. The second and third methods involved runoff projections from snowmelt modeling (WATBAL). This hydrologic investigation resulted in reasonably detailed estimates of natural flows in the various sub-basins within the Fraser River basin. The calibration of the MODSIM model required estimates of irrigation depletions and municipal demands. This was accomplished through analysis of decreed ditch capacities and irrigated acreages. Crop consumptive use requirements were estimated using procedures outlined by Haise and Kruse.

The calibrated MODSIM model was used to determine storable flows at a number of potential reservoir sites being considered in the basin study. The storable flows were determined with consideration of future demands by Denver's Moffat system and the Cabin-Meadow Creek project, as well as senior demands from future development in the lower basin.

Pertinence to the CRDSS Upper Colorado River Model: The Fraser River model was specific to hydrology and water resources in the Fraser River basin and is not totally integrated with the water rights and water resources in the remainder of the Upper Colorado River basin. It was also developed in a different modeling environment (MODSIM) from the CRDSS (StateMod). None of the basic data developed for the Fraser study was incorporated into the CRDSS Upper Colorado River Model. The study does, however, provide additional detailed information related to the hydrology of the sub-basins within the Fraser River basin. These data could be very useful in the development of baseflows and calibration for the CRDSS Upper Colorado River Model.

5.7 Colorado River Simulation Model (CORSIM II) (David E. Fleming Co.)

CORSIM II is a proprietary computer model which was originally developed in the early 1970's. As of September, 1996, thirteen entities representing industrial, municipal, agricultural and public utility interests, participate in continued sponsorship of the model.

Until recent years, the CORSIM II model has been considered as the most comprehensive modeling effort of hydrology and water rights for the mainstem of the Colorado River and its principal

tributaries. It reportedly incorporates an extensive database for streamflow data, diversions and operating practices in the basin. CORSIM II is written in an outdated IBM extension of FORTRAN and is still supported at some level.

Pertinence to the CRDSS Upper Colorado River Model: The CORSIM II model is proprietary to its sponsors and accordingly, detailed review of the databases and operational logic could not be performed for possible inclusion in the CRDSS Upper Colorado River Model.

5.8 Model of Denver Water System (BESTSM) (Boyle Engineering – 1995)

The current version of BESTSM has recently been adapted for a detailed modeling effort of the water rights and water supply system operated by Denver Water in the Upper Colorado River basin and South Platte River basin. The model was developed to operate on a daily basis for a 45 year study period. The model has approximately 250 nodes (inclusive of both Upper Colorado River and South Platte River) concentrated heavily in the upper basin.

Pertinence to the CRDSS Upper Colorado River Model: The Denver Water BESTSM model documentation provided detailed background information on Cameo area demands and specifics related to transmountain diversion projects.

5.9 Miscellaneous Project Operation Studies (USBR)

The USBR has performed numerous columnar operation studies to analyze the operations and yields of the federal projects in the Upper Colorado River basin including: Colorado - Big Thompson-Green Mountain Reservoir operations, the Fryingpan-Arkansas Project (Ruedi Reservoir), the Collbran Project (Vega Reservoir), the Silt Project (Rifle Gap Reservoir), the Grand Valley Project, and other projects which have not yet been constructed. Some of these operational studies, in particular the operations of Green Mountain Reservoir, are being computerized for future uses.

Pertinence to the CRDSS Upper Colorado River Model: The USBR operation studies and the documentation describing the projects are useful in understanding the operations of the federal projects. They also are a source of information related to reservoir capacities, water rights, use of the water released from the project reservoirs and other operational rules and criteria.