Yampa Valley
Water Demand Study

FINAL REPORT

Yampa Valley Water Demand Study

Prepared For

Recovery Program for Endangered Fishes of the Upper Colorado River
Yampa Fish Recovery and Water Management Plan
and the Yampa River Project Management Team

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Table of Contents

Executive Summary — Yampa Valley Demand Study

Study Overview ES–1
Historical Perspective ES–3
Yampa Valley Economic Base Prospects ES–4
Projected 2045 Total Employment and Population ES–5
Yampa Valley Water Demand Projections ES–7

I. Study Background and Approach

Study Context I–1
Purposes of the Study I–3
Acknowledgment of Study Participants I–3
Caveats and Limitations I–4
Study Approach I–4

II. A Historical Perspective of Yampa Valley Economic and Demographic Conditions

Historical Growth in the Yampa Valley II–1

III. Yampa Valley Economic Base Prospects

Agriculture III–1
Tourism and Recreation III–12
Energy and Mining III–24
Manufacturing III–35
Construction III–39

IV. Economic and Demographic Projections

Projected Changes in Total Employment IV–1
Projected Growth in Population IV–4
Interim Economic and Demographic Projections for 2025 ..... IV–9

V. Water Demand Projections

Current Water Demand in the Yampa Valley V–1
Water Demand Factors V–5
Base Case Water Demand Projections for 2045 ..... V–11
Sensitivity Evaluation (Upper and Lower Bounding Scenarios) V–13
Interim Water Demand Projections for 2025 ..... V–16

Appendixes.

A. List of Persons Interviewed A–1
B. List of References B–1
C. Projected 2045 Water Demands Base Case and Bounding Scenarios C–1

EXECUTIVE SUMMARY.
Yampa Valley Demand Study

The Yampa River is an important but as yet underdeveloped tributary of the Upper Colorado that contains resources which might help preserve natural habitat areas for the endangered Colorado River system fish species. How to best manage the uses of the Yampa River flows to meet both environmental and other human needs is one focus of the ongoing Yampa Fish Recovery and Water Management Plan ("Yampa Plan"), which is part of the Recovery Program for Endangered Fishes of the Upper Colorado.

Study Overview

In January 1997, BBC Research & Consulting (BBC) was retained by the Yampa Management Team to examine and quantify reasonably foreseeable, long-term water demand for human use in the Yampa River Basin. The location of this river basin is indicated in Exhibit S-1. The study adopted a 50-year time horizon to represent the long-term future. A secondary focus of the study was to develop interim projections of water demand approximately 25 years into the future. These projections might eventually be used in the evaluation of relatively nearer-term infrastructure investments.

An important objective of this study was to develop the long-term projections in a participatory manner, obtaining as much local input and review of data sources, assumptions and results as possible. To this end, BBC worked closely with the Yampa River Basin Partnership ("Partnership"), an organization comprised of representatives of local governments, industry, agriculture, water providers, recreationists and other local interests throughout Moffat County and Routt County. Public meetings were held in both Routt County and Moffat County to review the economic and demographic projections. BBC also conducted dozens of interviews with individuals throughout the Yampa Basin with specialized knowledge of local industry, resources, institutional limitations to growth

Insert Exhibit S-1. (MAP)

and other factors affecting long-term development and water needs. An independent peer reviewer, Dr. John Loomis of Colorado State University, provided helpful comments and suggestions which also led to refinements in the projections.

The water demand projections set forth in this study were derived from two principal components. The first component was the development of detailed economic and demographic projections for the Yampa River Valley which was defined in this study to include all of Moffat County and Routt County. The second component was development of water demand factors corresponding to elements of the economic and demographic projections — for instance, residential gallons per capita, and gallons per kilowatt hour of electricity generated in the Yampa Valley.

To develop the economic and demographic projections, BBC examined the prospects for each component of the Yampa Valley economic base in terms of resource constraints, market factors and institutional factors influencing future development. Projections of employment in direct, basic economic activities such as agriculture, coal mining, electricity generation and tourism were then incorporated into BBC's economic and demographic model of the Yampa Basin to project changes in employment, population and economic activity over the 50-year horizon.

BBC then developed estimates of future water diversions and consumptive use corresponding to the projections of economic and demographic growth in the Yampa Basin. The water demand projections were comprised of four elements: estimated water demands for major water use activities, such as agriculture, electric generation and mining; water demand projections for other economic activities, including commercial and retail businesses, manufacturing, snowmaking and golf courses; water demand for residential, or domestic consumption; and water demands for other purposes including export out of the Yampa Basin and reservoir evaporation.

In addition to the base case water demand forecasts corresponding to the economic and demographic projections, BBC also conducted several sensitivity analyses. These analyses examine the effects of higher and lower growth assumptions in key sectors, alternative views of future irrigated agriculture prospects and differing water use coefficients corresponding to high demand conditions, such as unusually dry years.

Historical Perspective

A long-term historical perspective helps inform long-term forecasting efforts. The Yampa Valley has, since the early 1900's, been characterized by periods of rapid growth followed by periods of stagnation or even decline. Over the past 90 years, the Yampa Valley population grew at an average annual 1.8 percent rate, although the 1965 to 1995 period experienced a more rapid 2.6 percent growth rate. The Valley's economic fluctuations are illustrated by unemployment which reached almost 12 percent in the early 1980s and was less than five percent in the mid-1990s.

The current economic structure of the Yampa Valley points to the relative importance of retail trade services, mining, construction and utilities in terms of employment opportunities and personal earnings of local residents. The historical

perspective suggests that tourism, energy-related development and agriculture deserve close attention for the future. The manufacturing sector, as yet underdeveloped, was also examined for future potential.

Yampa Valley Economic Base Prospects

To project future Yampa Valley economic growth, BBC examined the prospects for each of the existing components of the Yampa Valley economic base and considered the possibility of other activities which might develop and further expand the Moffat County and Routt County economies. The following discussion highlights the key results of these evaluations — the bases for these findings are discussed in Section III of the report.

Agriculture. The long-term history of Yampa Valley agriculture is marked by one dominant characteristic: stability. The evidence from nearly 60 years of history indicates remarkable persistence in the agricultural sector, the acreage under irrigation and the number of people working on farms and ranches. The projections used in this analysis reflect this stability:

- Livestock production will decline modestly over the 50-year time horizon.
- Irrigated acreage and crop production will remain approximately the same as they are as of 1997.
- The economic influence of production agriculture will decline as further consolidation and technological advances gradually reduce the number of employees.

Tourism and recreation. BBC developed year 2045 estimates of recreational visitor days (RVDs) based upon an examination of the prospects for a wide range of discrete winter and summer activities. Over the course of the next 50 years:

- Winter tourism and recreation will more than double, from roughly 660,000 RVDs to about 1.5 million RVDs.
- Summer and fall tourism and recreation will more than double from a total of 2.7 million RVDs to approximately 5.7 million RVDs.
- The local economic base required to support tourism and recreation will increase by 115 percent, from about 5,300 jobs to 11,300 jobs in 2045.

Energy and mining. Coal and power generation are not resource constraints in the Yampa Valley and regional demand prospects are favorable. Rail and market competition will eventually constrain coal expansion. Environmental issues will influence the direction of generator capacity along with a new institutional influence, electric deregulation. Based upon examination of resource constraints, market factors and institutional factors related to coal mining and energy generation in the Yampa Valley, we project the energy sector to change by year 2045 in the following ways:

- Electric generation capacity in the Yampa Valley will increase with the addition of two integrated gasification, combined cycle generating units with a combined capacity of 800 megawatts. Existing generating units will be operated at higher utilization rates, averaging 90 percent of capacity. Electric generation will employ about 750 people in 2045.

- Coal production will increase to about 36 million tons per year, including exports of about 25 million tons to other markets. Coal mining employment will increase to a lesser degree, reflecting a 50 percent increase in productivity. Year 2045 mining employment will be about 1,200 workers.

Other economic base activities. Two other industries complete the economic base of the Yampa Valley: manufacturing and construction. BBC incorporated the following projections for these industries in the 2045 projections:

- Manufacturing job growth of three percent to four percent per year in the Yampa Valley is reasonably foreseeable. By year 2045, the Yampa Valley will add between 1,200 and 2,100 new manufacturing jobs.

- By 2045, the share of Routt County jobs accounted for by construction will diminish to between ten and eleven percent of all jobs in the county, while Moffat County construction employment will increase to seven to eight percent of all jobs in that county. Overall, the construction sector will represent between nine and ten percent of all Yampa Valley jobs. Year 2045 construction employment will include between 2,400 and 3,000 more jobs than in 1995.

Projected 2045 Total Employment and Population

The projected long-term changes in the Yampa Valley economic base can be expected to trigger other changes throughout the local economy. Exhibit S-2 presents projected changes in employment by sector for the Yampa Valley. Note that the mining sector includes jobs in gravel mining as well as coal mining, and the agriculture section includes jobs such as landscaping that are not directly tied to commercial farming and ranching.

Based upon analyses of commuting patterns, multiple job holding and labor force participation rates, the 2045 Yampa Valley employment projections were used to derive the projected population. The low end of the projected Yampa Valley employment range in 2045 (approximately 49,300 jobs) is consistent with a combined population in Moffat County and Routt County of about 62,500 residents. The high end of the projected employment range (about 60,700 jobs) is consistent with a combined population of about 77,000 residents.

EXHIBIT S-2.
Current and Projected Yampa Valley Employment
by Major Economic Sector

	1995		2045 Range					
	Jobs	Share of Total	Jobs			Share of Total		
Farm/Agricultural Services	1,270	5.6%	1,450	to	1,500	2.9%	to	2.5%
Mining	1,150	5.1%	1,930	to	2,090	3.9%	to	3.4%
Construction	2,520	11.2%	4,950	to	5,630	10.0%	to	9.3%
Manufacturing	340	1.5%	1,510	to	2,410	3.1%	to	4.0%
Transportation/Communications/ Public Utilities	1,390	6.2%	2,690	to	3,240	5.4%	to	5.3%
Retail and Wholesale Trade	6,170	27.3%	14,130	to	17,140	28.6%	to	28.2%
Finance/Insurance/Real Estate	1,160	5.1%	2,850	to	3,490	5.8%	to	5.7%
Services	7,330	32.5%	17,240	to	21,660	34.9%	to	35.7%
Government	1,230	5.5%	2,620	to	3,570	5.3%	to	5.9%
Total	**22,560**	**100.0%**	**49,370**		**60,730**	**100.0%**		**100.0%**

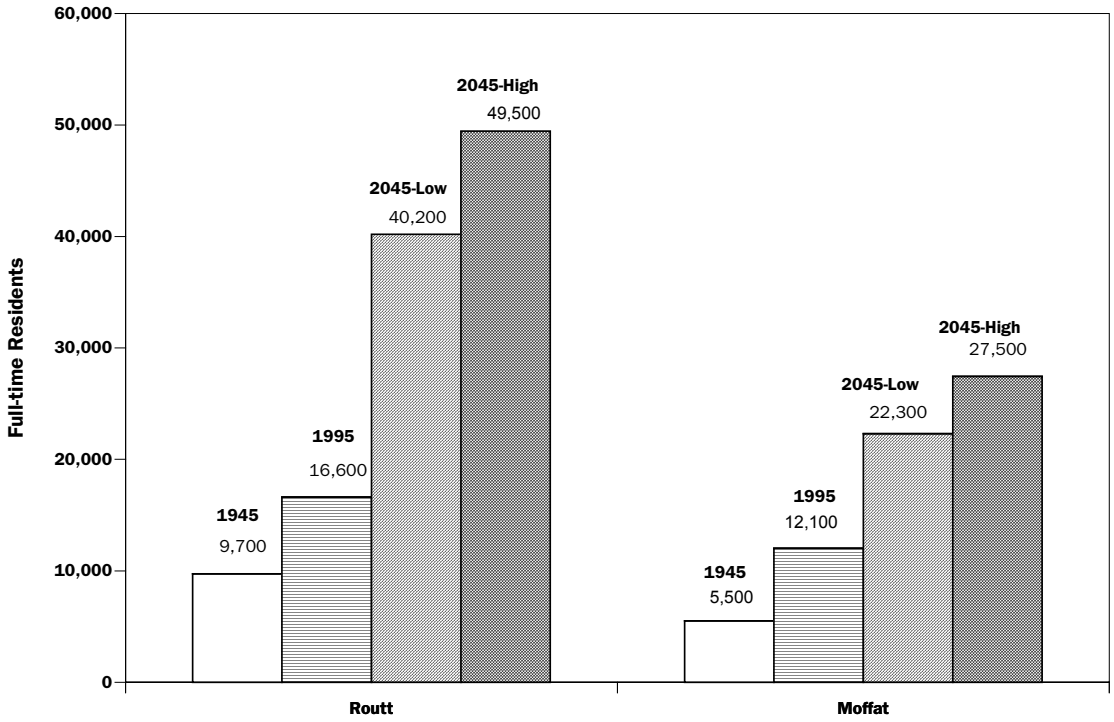
Source: BBC Research & Consulting, 1998.

There are several ways to evaluate the projected growth in Yampa Valley population over the next 50 years. Exhibit S-3 depicts the historic population totals of Moffat County and Routt County in 1945 and 1995, as well as the projected totals for each county in 2045.

The projected 2045 population of the Yampa Valley can also be visualized in the context of the current populations of other regions on Colorado's Western Slope. According to the low projected population range, the Yampa Valley population would be roughly comparable to the 1996 population of the Durango and Cortez area (La Plata County and Montezuma County) or the 1996 population of the Delta and Montrose area. Under the high 2045 population range, the Yampa Valley population would be similar in size to the 1996 population of the Vail/Aspen/Glenwood Springs area.

The interim, 2025 population projections reflect the same approach used in developing the 2045 projections. The range of projected 2025 total population in the Yampa Valley is between 46,900 and 52,700 residents. Routt County population is projected to perhaps double by 2025 while Moffat County population is anticipated to increase by as much as one half.

EXHIBIT S-3.
Historic and Projected Totals by County



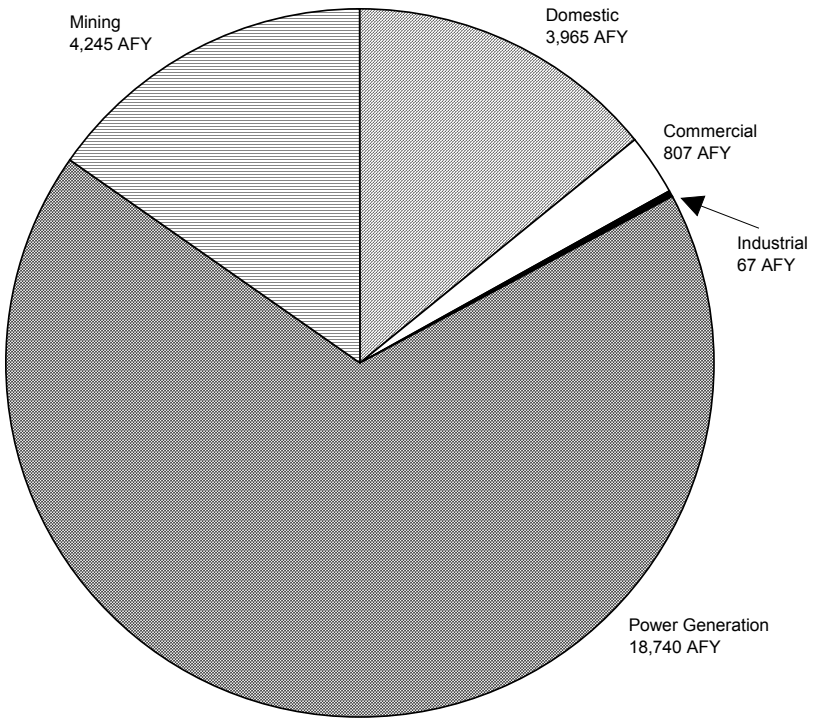
Source: U.S. Bureau of Census; BBC Research & Consulting.

Yampa Valley Water Demand Projections

Over the past nine years, total water diversions in the Yampa Valley have ranged between 40,000 acre-feet per year and 500,000 acre-feet per year. Much of the water diverted from the Yampa River ultimately returns to the stream, so consumptive use is considerably less than total diversions. Based upon relationships between diversions and consumptive use by type of use, annual consumptive use has varied from about 110,000 acre-feet to 130,000 acre-feet.

Irrigated crop production and livestock watering account for more than ninety percent of water diversions in the Yampa Valley and about eighty percent of water consumption. Among non-agricultural water uses, cooling water for electric generation far exceeds municipal demands and all other types of use combined, as shown in Exhibit S-4.

EXHIBIT S-4.
USGS Estimates of 1990 Non-Agricultural Water Withdrawals by Sector in the Yampa Valley



Source: U.S. Geological Survey National Water Use Data, 1990.

Base case water demand projections for year 2045. To project how diversions and consumption may change over the next 50 years, BBC incorporated the economic and demographic projections along with water demand factors for each major category of water use. We developed three sets of water demand projections for the base case, reflecting the range of the 2045 population and employment projections (high and low), plus the high 2045 economic and demographic projections coupled with "high demand" conditions for water use — when drought and/or other external factors generate unusual water requirements. The following text summarizes the results of the water demand projections. Key assumptions and analyses regarding water use by type of use are described in Section V of the report.

Under the base case projections, BBC projects an increase in annual water diversions in the Yampa Valley under "normal" year conditions from about 464,000 acre-feet per year at present to between 492,000 and 497,000 acre-feet per year. Under "high-demand" conditions, water diversions in 2045 could be as much as 622,000 acre-feet per year.

BBC projects an increase in annual water consumption, under the base case projections, is anticipated to increase from about 119,000 acre-feet per year at present under normal conditions to between 138,000 and 140,000 acre-feet per year in 2045. Under high demand conditions, consumption in 2045 could be as much as 169,000 acre-feet per year under the base case projections of economic and demographic growth.

Sensitivity analyses: Upper and lower bounding scenarios. The base case water demand projections for 2045 reflect reasonably foreseeable economic and demographic changes described earlier. Over a 50-year period, however, changes may occur in technology and economic and demographic conditions which cannot be foreseen at present. To provide an assessment of how the water demand projections might change under alternative assumptions about the future, BBC developed upper and lower bounding scenarios.

The upper bounding scenario incorporated more aggressive assumptions about additional electric generation development in the Yampa Valley, an additional 1,000 jobs in manufacturing and a 200 percent increase in tourism and visitor activity relative to current levels. The number of acres under irrigation was also projected at 15 percent above current "normal" year levels, consistent with the upper end of recent historical experience. In sum, these more aggressive growth assumptions would result in a projected population about 25,000 greater than under the base case projections — or a total 2045 population in the Yampa Valley of about 100,000 residents. For purposes of projecting an upper bound on 2045 water demands, this revised economic scenario was coupled with the "high demand" water use factors.

In contrast, the lower bounding scenario assumed lower growth than under the base case, including limited expansion of existing electric generation capacity, no increase in coal exports to other areas and a 15 percent decline in irrigated acreage. This scenario is consistent with a slightly lower population than under the base case projections, but considerably lower water demand. BBC coupled the lower bound economic assumptions with "normal" water use factors in developing water demand projections for this scenario to represent our estimate of the foreseeable water demands in 2045.

Summary of projected 2045 diversions under alternative scenarios. Exhibit S-5 compares current water diversions under "normal" demand conditions with projected water diversions under the base case and bounding scenarios in 2045. Under the upper bound scenario (incorporating high demand water use conditions), annual diversions in 2045 are projected at nearly 716,000 acre-feet per year — about 96,000 acre-feet more than under the base case, high demand projections. Under the lower bound scenario, projected annual diversions of 424,000 acre-feet per year in 2045 would be less than current "normal" year diversions of about 464,500 acre-feet.

Summary of projected 2045 consumption under alternative scenarios. Exhibit S-6 provides a comparison of current annual water consumption in the Yampa Valley with alternative 2045 projections.

EXHIBIT S-5.
Estimated 1995 and Projected 2045 Base Case Water Diversions

	Estimated 1995 Water Diversions		Projected 2045 Water Diversions Base Case		
	Actual	Normal Year	Low Range	High Range	High Range/ High Demand
Irrigation	370,320	408,674	408,674	408,674	520,390
Livestock Use	18,236	17,301	17,301	17,301	19,268
Municipal/Domestic	5,379	5,379	11,640	13,899	17,373
Commercial	1,063	1,063	2,446	3,011	3,764
Thermoelectric Generation	16,431	16,613	29,928	29,298	32,348
Mining	4,751	4,751	10,350	11,270	11,270
Industrial	166	166	571	911	911
Snowmaking/Golf	453	473	1,264	1,264	3,117
Export	4,209	3,383	3,383	3,383	4,788
Reservoir Evaporation*	6,769	6,769	6,769	6,769	6,769
Total	**427,777**	**464,572**	**492,326**	**496,410**	**619,998**
Total, excluding agriculture	**39,221**	**38,597**	**66,351**	**70,435**	**80,340**

* Reservoir evaporation projections assume no new storage facilities.
Source: BBC Research & Consulting, 1998.

EXHIBIT S-6.
Estimated 1995 and Projected 2045 Water Consumption

	Estimated 1995 Water Diversions		Projected 2045 Water Diversions Base Case		
	Actual	Normal Year	Low Range	High Range	High Range/ High Demand
Irrigation	77,767	85,822	85,822	85,822	109,282
Livestock Use	2,918	2,768	2,768	2,768	3,083
Municipal/Domestic	1,614	1,614	3,492	4,170	5,212
Commercial	159	159	367	452	565
Thermoelectric Generation	16,431	16,613	29,928	29,928	32,348
Mining	2,375	2,375	5,175	5,635	5,635
Industrial	60	60	205	328	328
Snowmaking/Golf	106	99	298	298	691
Export	4,209	3,383	3,383	3,383	4,788
Reservoir Evaporation*	6,769	6,769	6,769	6,769	6,769
Total	112,408	119,662	138,207	139,552	168,700
Total, excluding agriculture	31,723	31,072	49,617	50,962	56,336

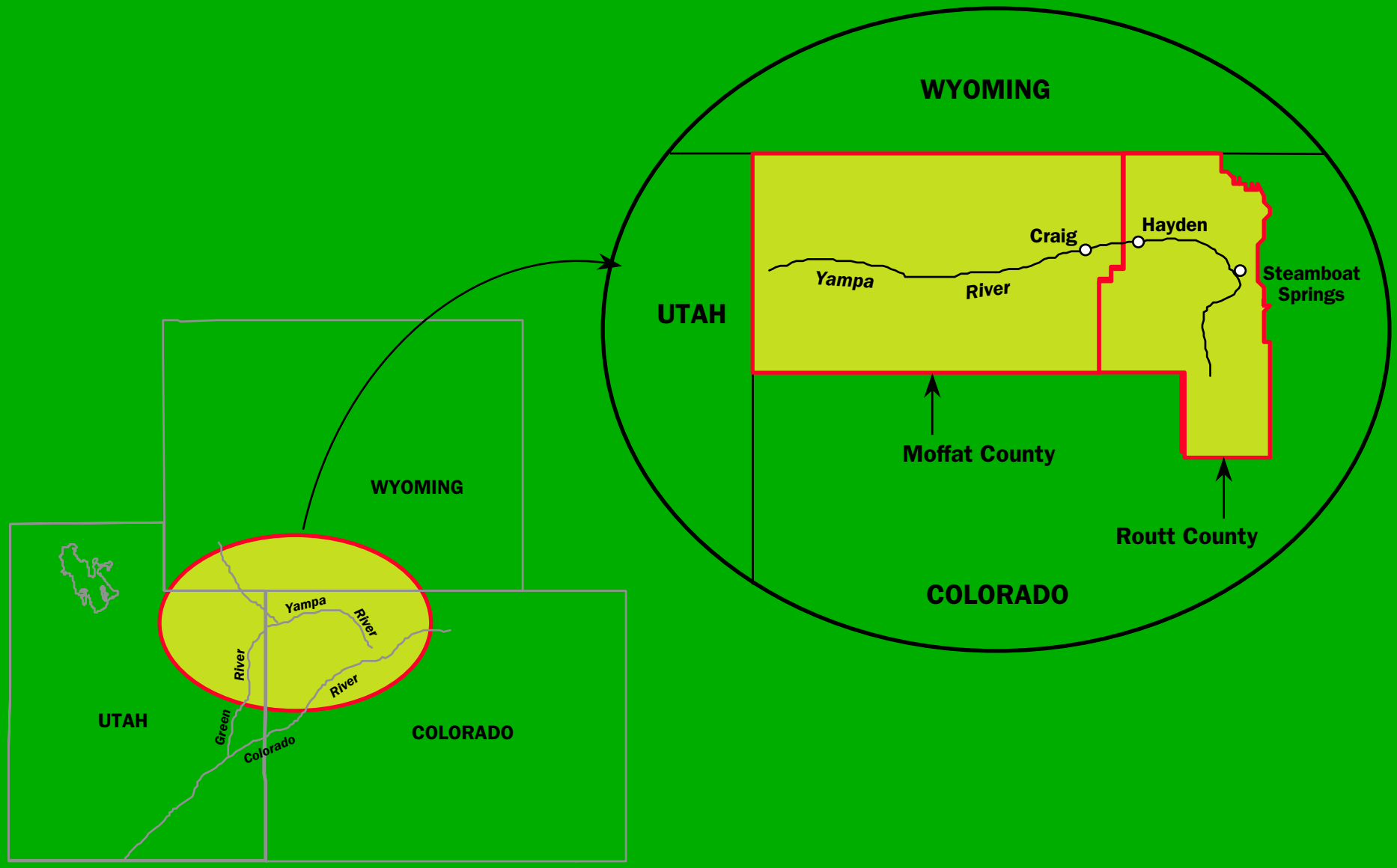
* Reservoir evaporation projections assume no new storage facilities.
Source: BBC Research & Consulting, 1998.

Under the base case projections, annual consumption under normal water demand conditions in 2045 would be approximately 20,000 acre-feet greater than 1995 normalized consumption, a 17 percent increase. Base case annual water consumption under high demand conditions in 2045 would be approximately 49,000 acre-feet greater than 1995 consumption under normal conditions, a 41 percent increase.

BBC projects upper bound annual water consumption in 2045 at slightly more than 195,000 acre-feet per year, an increase of about 75,000 acre-feet (63 percent) from current consumption. Lower bound water consumption in 2045 would be approximately equal to current annual consumption, with increases in non-agricultural consumption offset by decreases in irrigated use.

Interim water demand projections for 2025. We project 2025 annual Yampa Valley water diversions to increase by 17,000 to 19,000 acre-feet compared to current diversions under normal water demand conditions, an increase of about 4 percent. Annual water consumption in the Yampa Valley is projected to increase by about 12,000 acre-feet between 1995 and 2025, an increase of 10 percent. Both consumption totals reflect normal year water demand conditions.

EXHIBIT S-1.
Location of the Yampa Valley



SECTION I.
Study Background and Approach

In January 1997, BBC Research & Consulting was retained by the Yampa Management Team through a contract with the Colorado River Water Conservation District (CRWCD) to examine and quantify reasonably foreseeable, long-term out-of-stream water demands for human use in the Yampa River Basin. These demand projections are intended to assist in development of the Yampa Plan to manage the uses of the river. This report presents the background, methodology, analysis and results of the study.

Study Context

In 1988, an agreement between the United States Secretary of the Interior, the Western Area Power Administration and the governors of Colorado, Utah and Wyoming established the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin ("Recovery Program"). The intent of the Recovery Program is to implement a range of measures to assist the recovery of four species of endangered fish in the Upper Colorado River system.

The Yampa River is an important but as yet underdeveloped tributary of the Upper Colorado that contains resources which might help preserve natural habitat areas for the endangered Colorado River system fish species. How to best manage the uses of the Yampa River flows to meet both environmental and other human needs is one focus of the ongoing Yampa Fish Recovery and Water Management Plan ("Yampa Plan"), which is part of the Recovery Program. This study, along with biological evaluations and other work, represent technical concurrent inputs to the Yampa Plan.

Funding for this study was provided by the Recovery Program, through the United States Bureau of Reclamation ("Reclamation"). Study oversight was provided by the Yampa Management Team, consisting of representatives of the U.S. Fish and Wildlife Service, the Colorado River Water Conservation District, the United States Bureau of Reclamation, the Colorado Department of Natural Resources, the Yampa River Basin Partnership and environmental groups represented by the Nature Conservancy.

Exhibit I-1.: MAP

Purposes of the Study

This study was designed to identify the magnitude of reasonably foreseeable, human water needs for the distant future in the Yampa River Basin. A map of the Yampa River Valley and the affected counties and towns is provided in Exhibit I-1. The primary focus of the study was on long-term water needs. Long-term projections are important in this instance because:

1. The Yampa River Valley will continue to evolve economically and availability of water supplies to support that economic evolution are considered vital by local leaders; and

2. Once the water is dedicated to the fish, there is concern that it will never again be available for human uses. Measures may be available that could mitigate these concerns.

Following common convention in water supply planning work, the study adopted a 50-year time horizon to represent the long-term future. Selection of a 50-year horizon also recognizes that although longer-term projections could be developed, the uncertainty of forecasts increases considerably beyond a 50-year horizon.

A secondary focus of the study was to develop interim projections of water demands approximately 25 years into the future. These projections might eventually be used in the evaluation of relatively nearer-term infrastructure investments.

This present study both updates and goes beyond a previous Yampa River Basin study which addressed future water demands among other issues. The *Yampa River Basin Alternatives Feasibility Study* (performed by Hydrosphere in 1992-1993) included projections of long-term water demands in the Yampa River Basin based upon data from the 1980s and prior to the 1990 census. Water demands were only one component of that earlier work, which focused heavily on water supply alternatives modeling and evaluation. By focusing only on water demands, this study provides a current, more in-depth examination of economic and demographic prospects — and corresponding water needs — than the earlier Hydrosphere work.

Acknowledgment of Study Participants

An important objective of this study was to develop the long-term projections in a participatory manner, obtaining as much local input and review of data sources, assumptions and results as possible. To this end, BBC worked closely with the Yampa River Basin Partnership, an organization comprised of representatives of local governments, industry, agriculture, water providers, recreationists and other local interests throughout Moffat County and Routt County. BBC held four meetings with the Partnership to discuss the study and interim findings and results. The Partnership's contribution regarding economic prospects and water use patterns was substantial.

Public meetings were held in both Routt County and Moffat County to review the economic and demographic projections. Based upon suggestions from the meetings, BBC revisited a number of elements of the projections and made modifications where appropriate.

In addition to assistance from the Partnership, BBC also conducted dozens of interviews with individuals throughout the Yampa Valley with specialized knowledge of local industry, resources, institutional limitations to growth and other factors affecting long-term development and water needs. Many documents were identified and reviewed. Lists of interviews conducted and documents examined are provided at the end of this report.

An independent peer reviewer, Dr. John Loomis — Professor of Agricultural and Resource Economics at Colorado State University — provided helpful comments and suggestions which also led to refinements in the projections.

Caveats and Limitations

Long-term economic and demographic projections are, by nature, subject to considerable uncertainty. Over the next 50 years, technology, markets, infrastructure and household characteristics and preferences may change in ways which can scarcely be predicted today. To address these uncertainties, BBC endeavored to examine new technologies which might be feasible within the next few decades and to envision other foreseeable changes in transportation and other factors which could affect development in the Yampa Basin. It is recognized that as careful and unbiased as our forecasting efforts were, the assumptions and the projections will be proven wrong. Mitigating the importance of this situation is the tendency for errors to be offsetting. We also conducted a number of sensitivity analyses to identify and examine the effects of altering key assumptions. Such analyses demonstrate the impacts of incorrect assumptions on ultimate water demands.

Study Approach

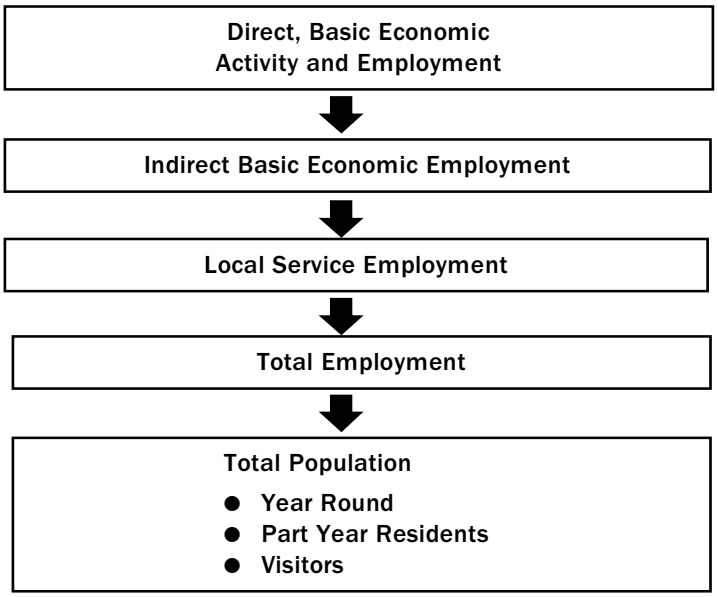
The water demand projections set forth in this study were derived from two principal components. The first component was the development of detailed economic and demographic projections for the Yampa River Valley which was defined in this study to include Moffat County and Routt County.[1] The second component was development of water use factors corresponding to elements of the economic and demographic projections — for instance, residential gallons per capita, and gallons per kilowatt hour of electricity generated in the Yampa Valley. BBC's general approach to these components is described below. Specific details regarding the research, analysis, assumptions and results of each component are provided in respective report sections.

[1] A portion of Moffat County and a smaller part of Routt County are outside of the watershed of the Yampa River. These areas are, however, relatively sparsely populated and the two counties represent data and political focal points.

Economic and demographic projections. BBC developed an economic and demographic model of the Yampa Basin to project changes in employment, population and economic activity over the 50-year horizon. The model begins with projections of employment in direct, basic economic activities such as agriculture, coal mining, electricity generation and tourism that bring income into the Yampa Valley. The model then estimates the number of jobs required in indirect basic activities — businesses which support direct, basic economic industries. Examples of indirect basic activities include farm implement dealers and feed stores, vendors providing tires to coal mining operations, and snowmobile repair shops. Employees in direct and indirect basic economic activities, and their families, also require goods and services to meet their household needs. These types of local, resident-supported businesses are termed local service employment; they represent the final component of the overall employment projections.

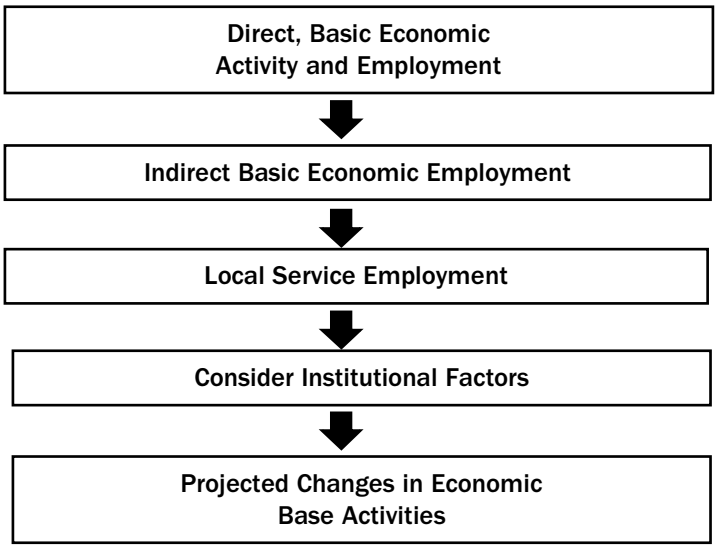
Based upon the projection of total employment in the Yampa Basin, the model then estimates the number of residents. The employment-to-population relationship incorporates important assumptions about commuting patterns, labor force participation rates and other factors which are discussed in Section IV of this report. The basic structure of the economic and demographic model is highlighted in Exhibit I-2.

EXHIBIT I-2.
Overview of Yampa Basin Economic and Demographic Model



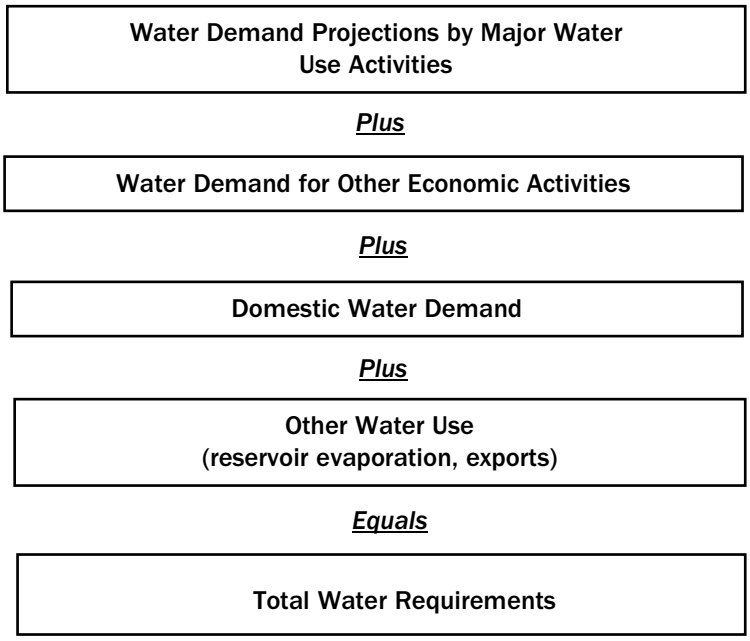
To identify the sources of Yampa Valley economic and population growth, BBC examined the existing direct, basic industries of the area and considered other potential direct, basic activities which might spring up over the next 50 years. We examined considerations such as the amount of recoverable coal reserves and developable land in the area. National projections, competition, transportation and cost factors were examined in evaluating market opportunities and constraints to growth. Finally, institutional considerations such as public land management policies, local government master plans, and environmental policy regulatory constraints were examined as institutional factors which could affect growth, up or down. These tasks are summarized in Exhibit I-3.

EXHIBIT I-3.
Analytical and Research Tasks Underlying Growth Assumptions



Water demand projections. BBC developed estimates of water diversions and consumptive use to correspond with the projections of economic and demographic growth in the Yampa Basin. The water demand projections were comprised of four elements: estimated water demands for major water use activities, such as agriculture, electric generation and mining; water demand projections for other economic activities, including commercial and retail businesses, manufacturing, snowmaking and golf courses; water needs for residential, or domestic consumption; and water demands for other purposes including export out of the Yampa Basin and reservoir evaporation. Exhibit I-4 summarizes the components of the water demand projections.

EXHIBIT I-4.
Components of the Water Demand Projections



The first three components of the water demand projections relied upon projected measures of economic and demographic activity, coupled with water demand factors (or "unit water demands") corresponding to each activity. For example, the projection of the number of irrigated acres in the Yampa Basin was multiplied by average water requirements per acre to calculate projected diversions for irrigated agriculture. Similar calculations based upon projected mining and electric generation volumes were used to calculate water demands for other major water-using activities. Industrial and commercial water demands were based upon separate estimates of water demand per employee in those sectors. Domestic water demand was based upon estimated water use per capita for residential purposes, factoring in the effects of the substantial number of visitors and seasonal workers in the Yampa Basin.

The water demand factors, and similar coefficients relating consumptive use to diversions for each type of water use, were based upon data from several sources:

- U.S. Geological Survey Water Use Data for each county;
- Colorado Division of Water Resources — Water Division 6 records;
- data and information supplied by municipal utilities serving Steamboat Springs, Craig and Hayden;

- data contained in the 1993 Hydrosphere study;
- water demand factors for diverse commercial and industrial activities drawn from surveys; and
- interviews with managers of mines, power plants, golf courses and Steamboat Ski Corporation.

Ed Blank and Ken Holt from Colorado Division of Water Resources — Division 6 were particularly helpful in providing data to assist in this effort.

The base case water demand forecasts correspond to the economic and demographic projections. BBC also conducted several sensitivity analyses to examine the effects of higher and lower growth assumptions in key sectors, alternative views of future irrigated agriculture prospects and differing water use coefficients corresponding to high demand conditions, such as unusually dry years. These sensitivity analyses are also described in Section V.

Future water use is, of course, determined by available supplies, and cost of supply, as well as water demands. Since the Yampa River is not fully appropriated, supply availability has not been as much of a constraint on water use in the Yampa Valley to date as it has been in other river basins. Because the purpose of this study was to identify demands for water supply planning purposes, supply limitations were not incorporated as a restriction on future demands.

SECTION II.
A Historical Perspective of Yampa Valley Economic and Demographic Conditions

Very long-term projections of economic and demographic activity require a broad perspective. History, current conditions, and comparisons with other areas are all useful vantage points to gain this perspective. This section provides an overview of Yampa Valley development and current conditions. Section IV offers a comparison with other locations.

Historical Growth in the Yampa Valley

In considering the potential development of a region over a long period of time, it is often useful to begin by reviewing the area's evolution from the distant past. Like many rural regions of Colorado, the Yampa Valley has a history of volatile economic and demographic change.

Long-term changes in population. Prior to the creation of a separate Moffat County jurisdiction in 1920, Routt County encompassed both its current area and the northwestern corner of Colorado. Yampa Valley population expanded rapidly during the early part of this century as the area's coal mining industry boomed and first Steamboat Springs, and then Craig, became major inland shipping points for cattle and sheep. The agriculture and mining industries were fostered by completion of David Moffat's railroad from Denver to Steamboat Springs in 1908 and on to Craig in 1913.[1] During the period 1905 through 1945, Yampa Valley population increased at an average annual rate of about 2.5 percent.

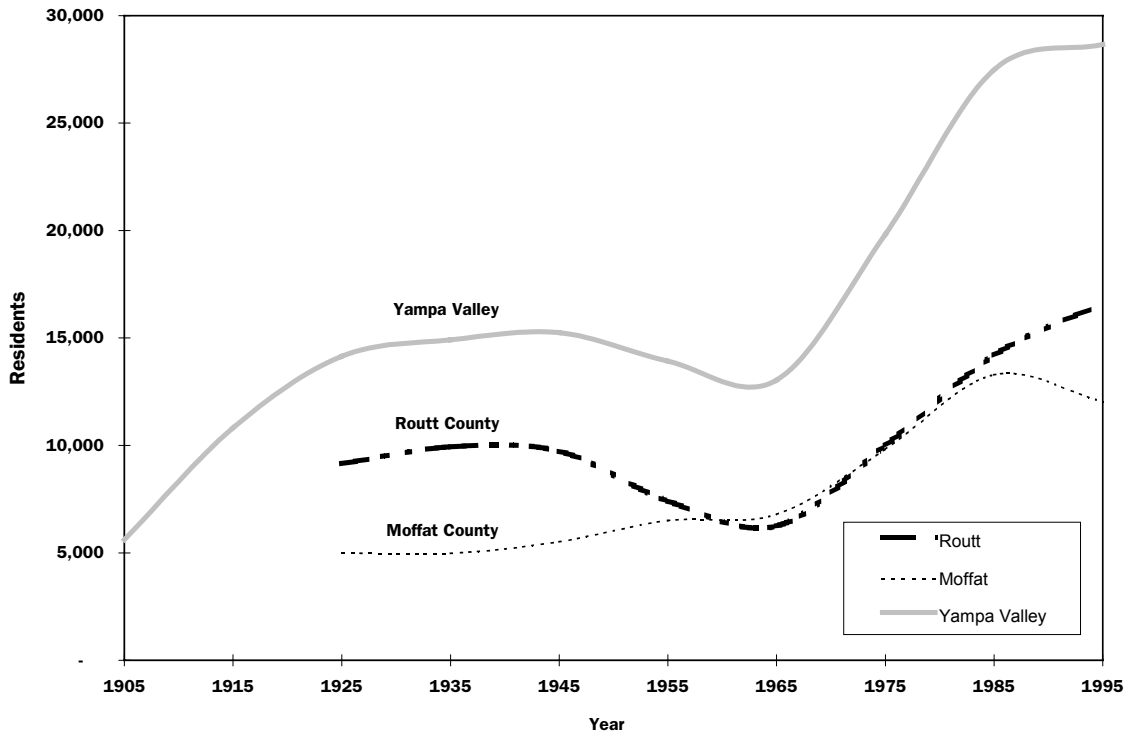
[1] J. Garren, *A Sketch of the Early Growth and Development of Routt County, Colorado, to Approximately the Beginning of the Great War to End All Wars; Being a Brief Inquiry into the Manner by Which it Achieved Its Present Form that Has Left More Questions Unanswered than Answered,* URP6635, May 1, 1996.

The Yampa Valley population declined following World War II as the substitution of diesel fuel and other petroleum products diminished the market for coal and increasing mechanization reduced the labor requirements for farming and ranching. From 1945 to 1965, the combined population of Routt and Moffat counties declined at an average annual rate of 0.8 percent, reducing the population by about 2,000 residents.

Beginning in the mid 1960s, the economic fortunes of the Yampa Valley reversed again, and the population grew rapidly. This expansion was spawned by the development of two large electric generating stations, the resurgence of the northwest Colorado coal industry, and the emerging recognition of the area as a tourist destination. The average annual population growth rate from 1965 to 1995 was about 2.6 percent per year.

Exhibit II-1 depicts the history of change in the Yampa Valley population since 1905. Population totals for Moffat County and Routt County are shown individually for the years since the division of the two counties. In the same 90-year period, the Yampa Valley average population growth rate of 1.8 percent is slightly lower than the statewide population growth rate of 1.9 percent. However, the Yampa Valley grew faster than the state average during the economic expansion period of 1905 to 1935 and 1965 to 1995.

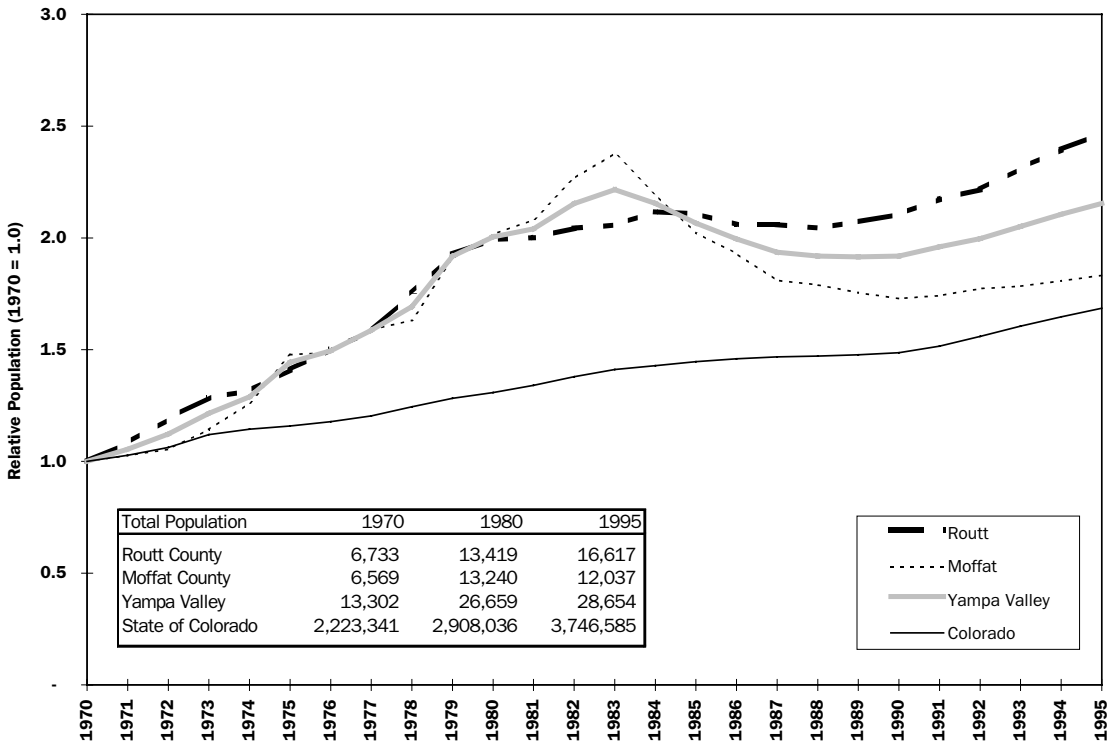
EXHIBIT II-1.
Permanent Population of the Yampa Valley, 1905 to 1995



Note: Moffat county lands were included within Routt County prior to 1920.
Source: U.S. Bureau of Census, various years.

A closer view of more recent population and economic growth. Exhibit II-2 offers a more detailed look at population growth in the Yampa Valley from 1970 to 1995. This chart portrays annual population totals for Moffat County, Routt County, the entire Yampa Valley and the State of Colorado as multiples of the 1970 population in the same area. This facilitates a visual comparison of the relative rates of growth in each area.

EXHIBIT II-2.
Population Growth in the Yampa Valley, 1970 to 1995



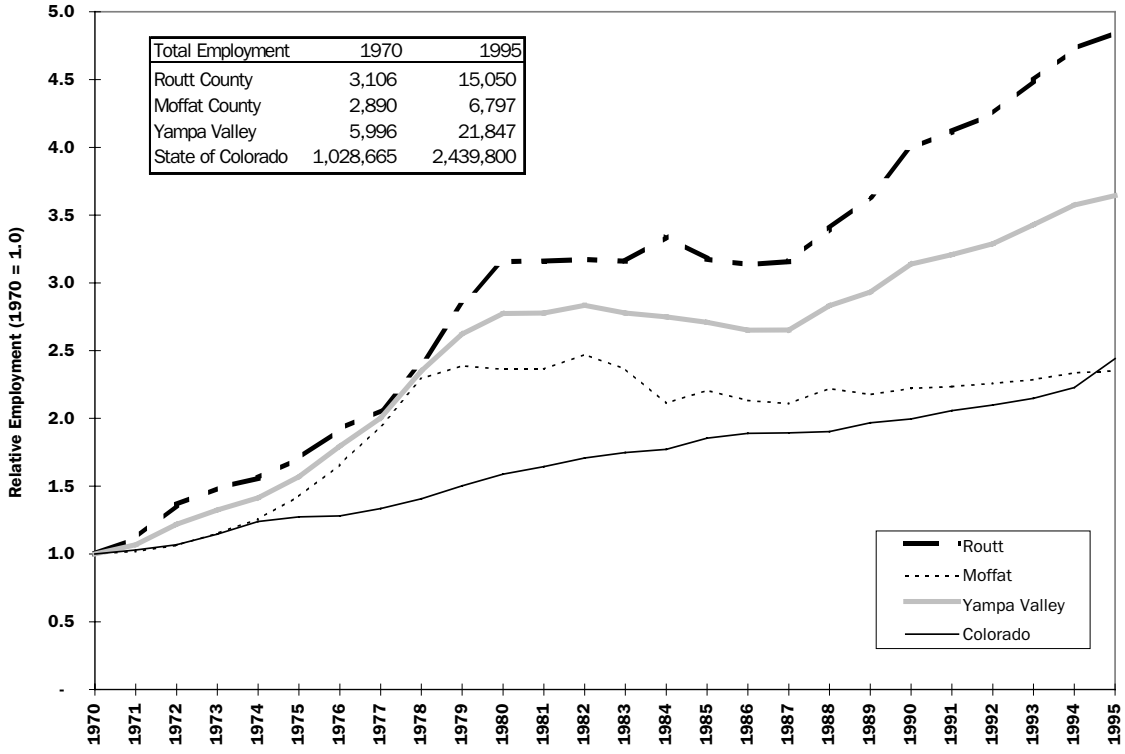
Total Population	1970	1980	1995
Routt County	6,733	13,419	16,617
Moffat County	6,569	13,240	12,037
Yampa Valley	13,302	26,659	28,654
State of Colorado	2,223,341	2,908,036	3,746,585

Source: Colorado Division of Local Government, December 1996.

The Yampa Valley grew very rapidly during the decade of the 1970s, more than doubling in population between 1970 and 1982. Moffat County population peaked in 1982 during construction of the Craig power plant, followed by a decline until 1990. During the early 1990s, both counties increased in population, though the expansion in Routt County was considerably greater. Exhibit II-2 also demonstrates the volatility of the Yampa Valley economies, even in the short-term, relative to the comparatively stable growth statewide in Colorado.

Underlying this Yampa Valley population growth was an even more rapid increase in the area's employment since 1970. In 1995, there were nearly 22,000 jobs in the Yampa Valley, more than three and one-half times the total in 1970. The Routt County economy has expanded particularly rapidly. Relative employment growth for each area is shown in Exhibit II-3.

EXHIBIT II-3.
Total Employment in Yampa Valley and Colorado, 1970 to 1995

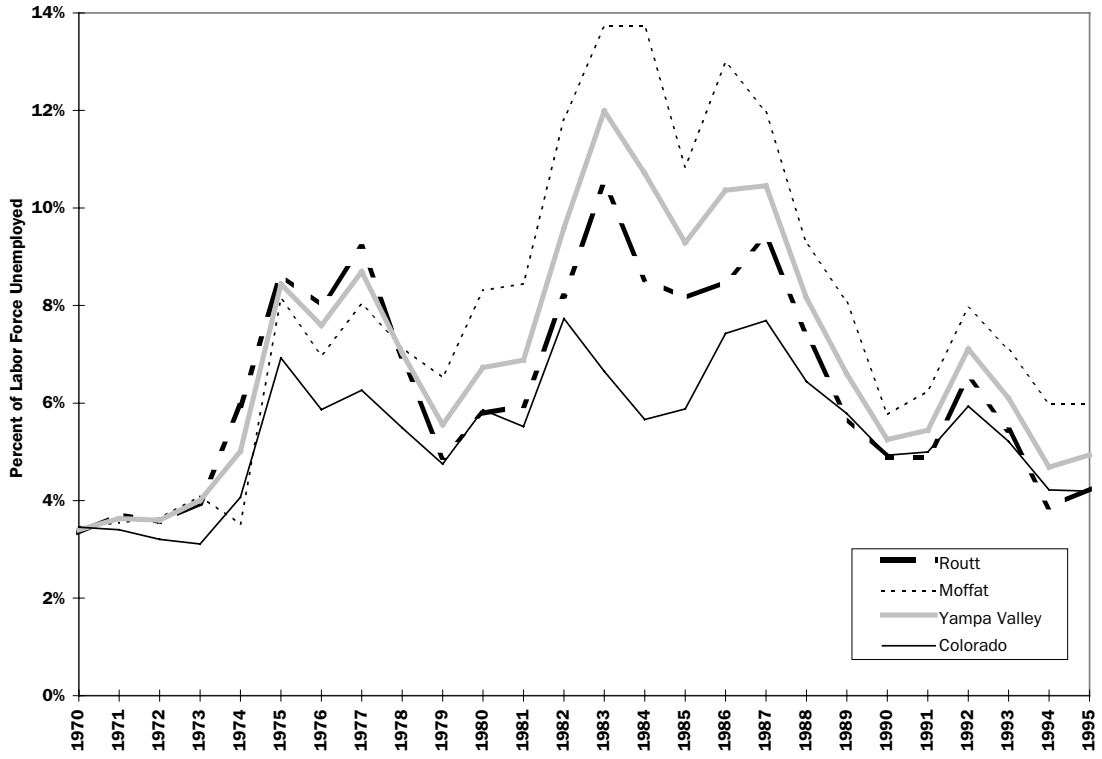


Total Employment	1970	1995
Routt County	3,106	15,050
Moffat County	2,890	6,797
Yampa Valley	5,996	21,847
State of Colorado	1,028,665	2,439,800

Source: U.S. Bureau of Economic Analysis, selected years.

The Yampa Valley economic health as of 1995 is indicated by relatively low unemployment rates. Exhibit II-4 depicts unemployment rates for the area, and for Colorado as a whole, between 1970 and 1995. This exhibit also underscores once again the volatility of the Yampa Valley economy. During the mid-1980s, more than one in every ten persons in the Yampa Valley labor force were unemployed.

EXHIBIT II-4.
Unemployment Rates, Yampa Valley and Colorado, 1970 to 1995

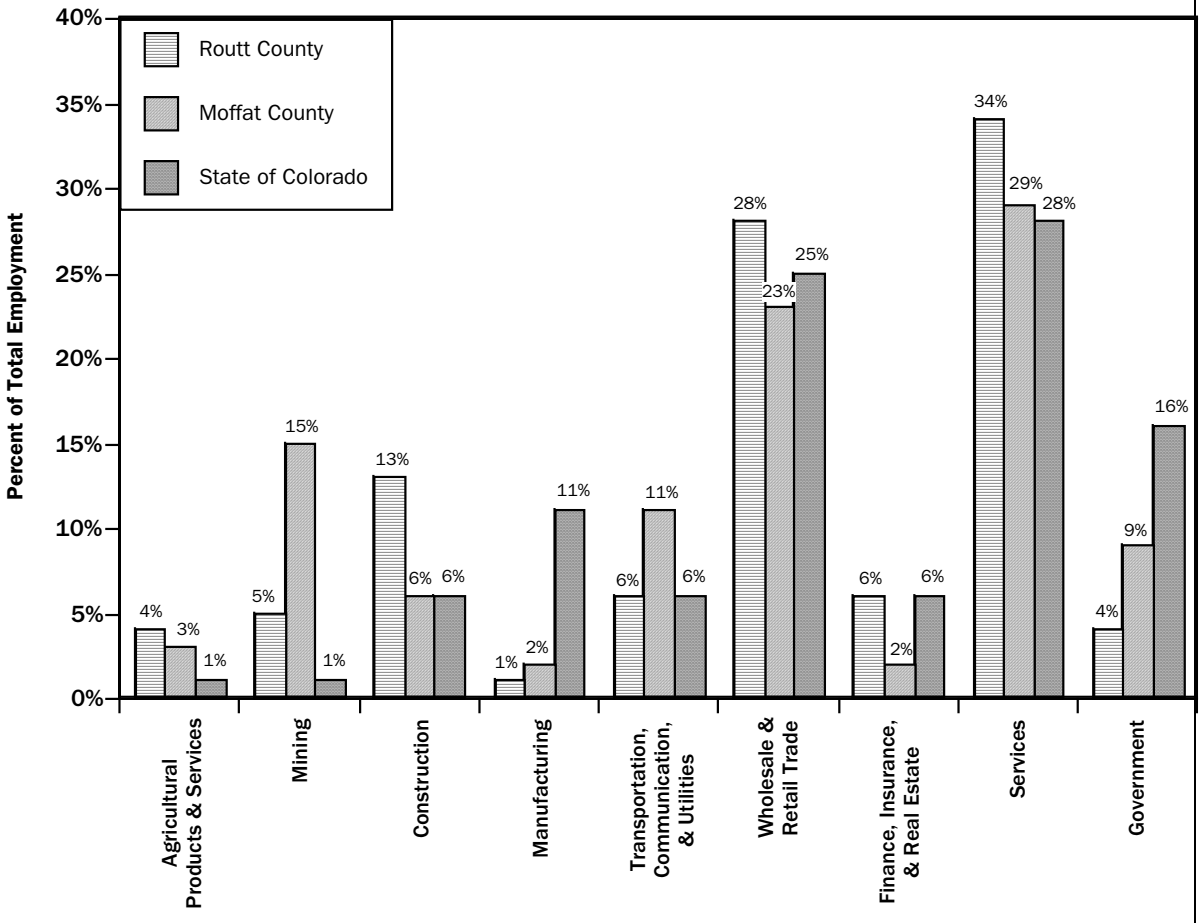


Source: Colorado Division of Local Government, December 1996.

Current structure of the Yampa Valley economy. The economic base of local economies is generally comprised of industries or other economic activities that bring money into the local area. In the Yampa Valley, the economic base consists of three principal components — agriculture, tourism, and energy-related activities including coal mining and electricity generation.

Exhibit II-5 separates total employment in Moffat County and Routt County, as well as the State of Colorado, into employment by major economic category. This graphic points out the considerable employment opportunities in services, retail trade, mining and construction in the Yampa Valley. Comparing the proportion of Yampa Valley versus statewide employment in each sector also reflects upon the economic base of the Yampa Valley. The Yampa Valley counties have a disproportionate share of employment in agricultural products and services, energy-related sectors (mining and transportation/communication/utilities) and tourism-related sectors (services, retail trade and construction). Manufacturing and government, on the other hand, represent a much smaller share of the Yampa Valley economy than the average for Colorado.

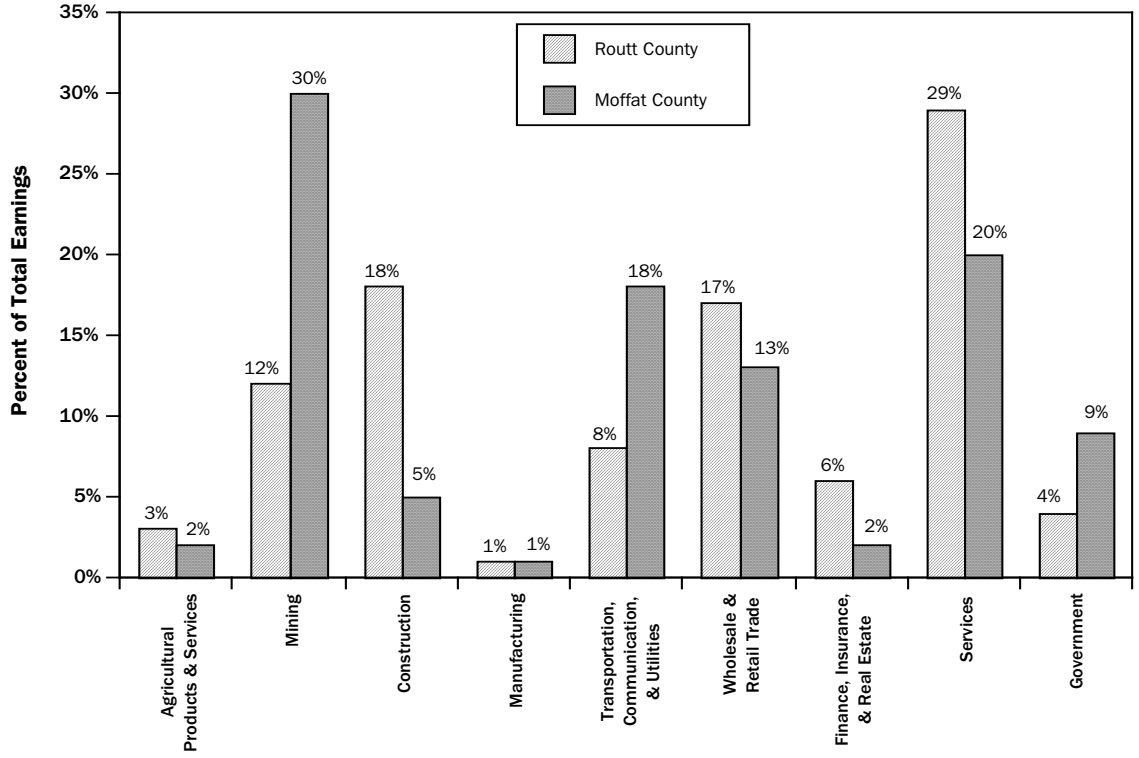
EXHIBIT II-5.
Composition of 1995 Employment by Sector in the Yampa Counties and State of Colorado



Source: Colorado Division of Local Government, 1997.

While tourism-related sectors account for the largest number of jobs in the Yampa Valley, the economic importance of energy-related activities is revealed in the personal earnings by sector found in Exhibit II-6. This chart demonstrates that the higher paying jobs in the mining, construction and the transportation/communication/utilities sectors account for a disproportionate share of total earned income in the area.

EXHIBIT II-6.
Composition of 1995 Earnings by Sector,
in the Yampa Counties and State of Colorado



Note: Includes proprietor's earnings.

Source: Colorado Division of Local Government, 1997.

To project future Yampa Valley economic growth, BBC examined the prospects for each of the existing components of the Yampa Valley economic base and considered the possibility of other activities which might develop and further expand the Moffat County and Routt County economies. Each of these key economic base sectors is addressed in the next section.

SECTION III.
Yampa Valley Economic Base Prospects

For rural areas that depend on a few, relatively discrete sources of outside income to provide their economic base, a detailed examination of the prospects for each individual component of that base should provide a solid foundation for long-term projections. BBC followed this approach in developing projections for the Yampa Valley, and each relevant sector is examined in this report section. Further, in light of the long-term focus of this study, each basic economic sector was evaluated in terms of its ultimate growth potential based on physical resources, the limitations to its growth based on market forces, and the impact which institutional considerations might have on its growth.

Agriculture

Production agriculture has long been a staple of the Yampa Valley economy. Agriculture is deeply imbedded in the culture and values of the region, owing to its sustained activity since early settlement.

Background. The Valley economy was once largely supported by cattle and sheep production.[1] Early in this century, Moffat County was the "wool capital of the world," producing more wool than any other county in the nation.[2] The economic influence of agricultural production and related businesses has diminished somewhat with the growth of tourism since the mid-1900s. As of the mid-1990s, employment and earnings in production agriculture remained significant to the area. The Bureau of Economic Analysis estimates that farm and ranch employment in 1969 was about 1,300 jobs. In 1994, the number of farm and ranch jobs was over 1,000. The earnings associated with these jobs fluctuates widely, from net losses to positive earnings above $12 million. Exhibit III-1 depicts these trends.

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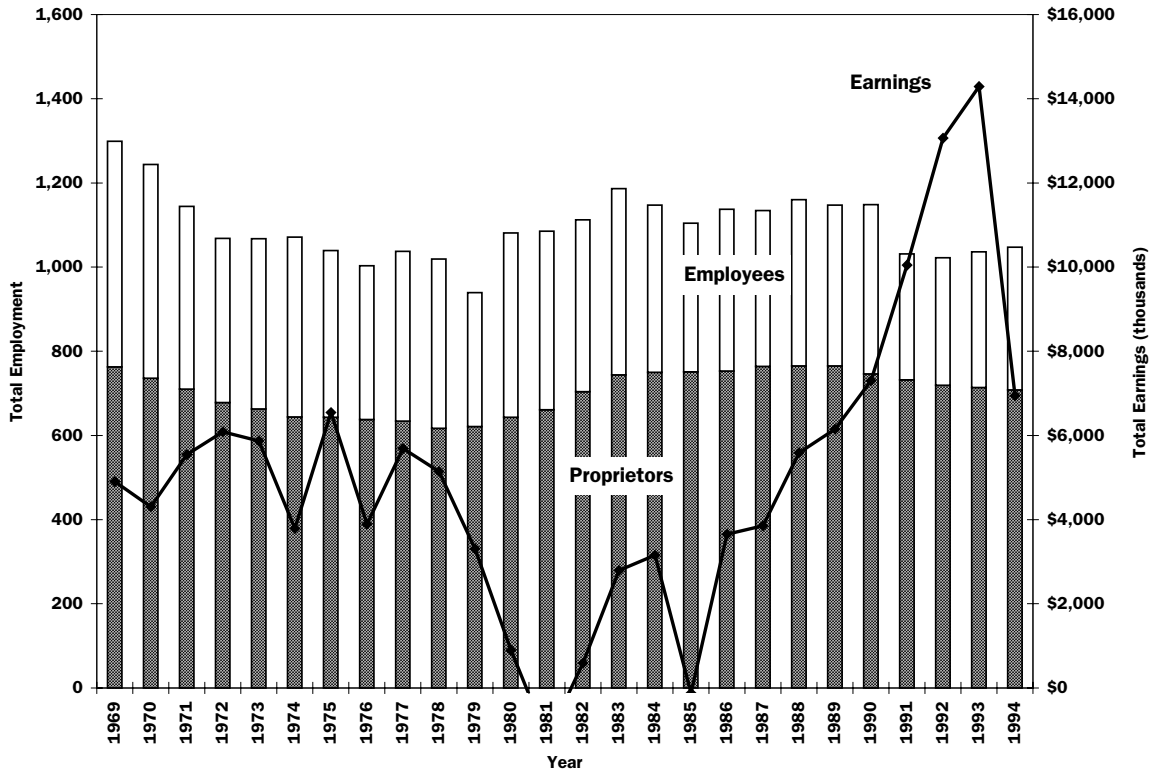
[1] *Economic survey – Yampa Valley*, University of Colorado, Bureau of Business Research, 1956.

[2] Interview with Paul Meiman, Moffat County Cooperative Extension Agent, 1997.

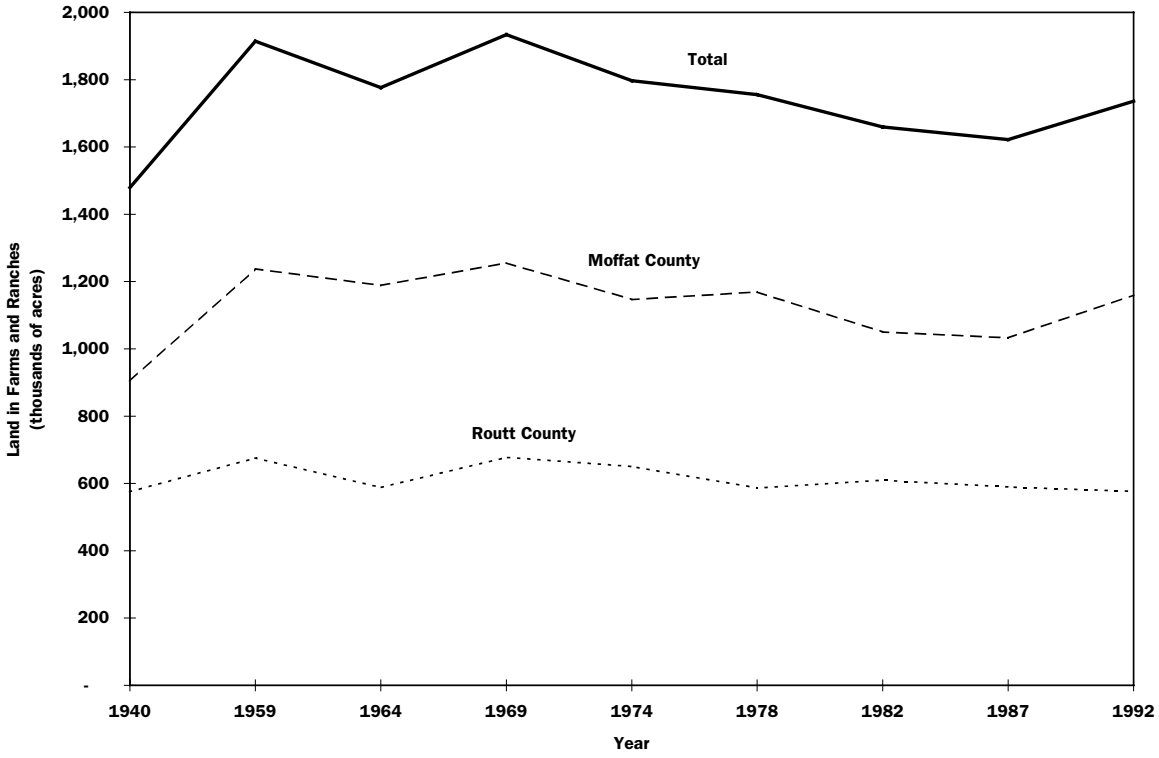
EXHIBIT III-1.
Farm Employment and Earnings,
Yampa Counties, 1969-1994



Source: U.S. Bureau of Economic Analysis, 1996.

Agricultural land use. Historical statistics from the Census of Agriculture dating back as far as 1940 indicate that a range of about 1.5 to 2 million acres have been used at one time in farms and ranches, as shown in Exhibit III-2. According to the 1992 Census of Agriculture, an estimated 1.8 million acres remained in farms and ranches.

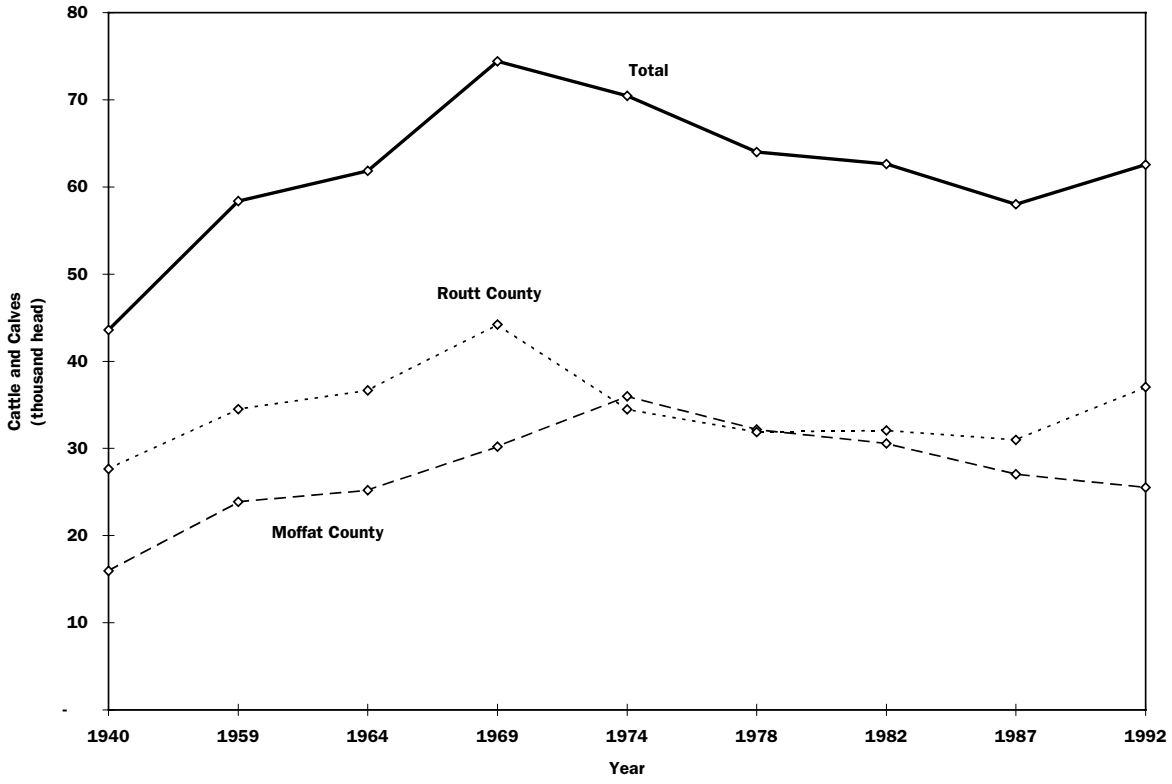
EXHIBIT III-2.
Land in Yampa County Farms, 1940-1992



Source: Census of Agriculture, selected years.

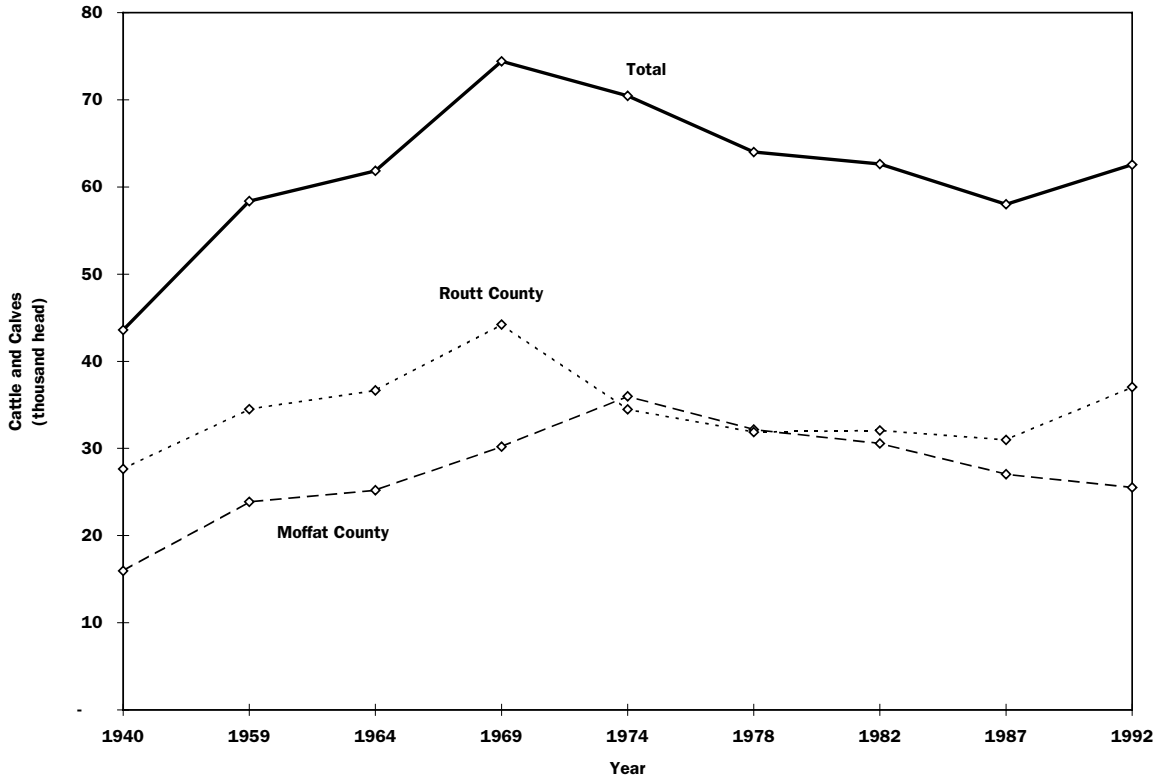
Historically, the dominant agricultural land uses have been the production of beef, lamb and wool. The bulk of ranch lands are devoted to grazing pasture. The Yampa livestock inventory was at its peak in the 1960s when cattle numbered 70,000 head and sheep 220,000 head. Yampa sheep numbers have experienced a steady decline since that time, while cattle numbers have dwindled only gradually. The cattle and sheep inventory trends are found in Exhibits III-3, and III-4, respectively.

EXHIBIT III-3.
Number of Cattle and Calves in Inventory, 1940-1992



Source: Census of Agriculture, selected years.

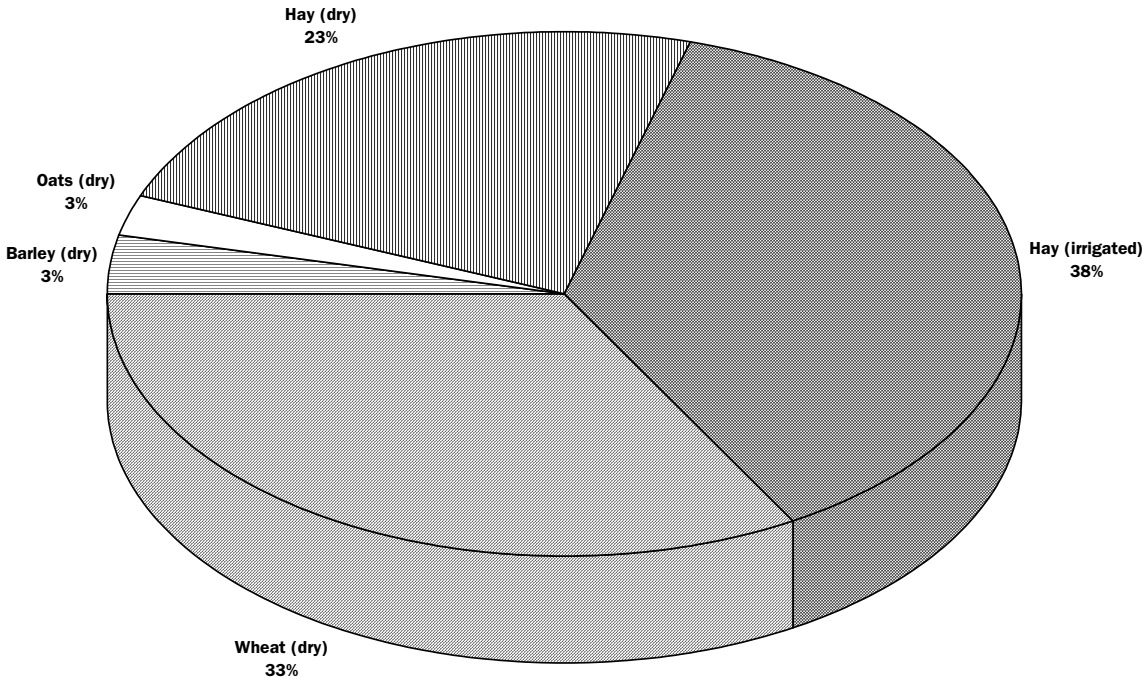
EXHIBIT III-4.
Number of Sheep and Lambs in Inventory, 1940-1992



Source: Census of Agriculture, selected years.

Ranch land devoted to crop production, whether for harvest or grazing, varied from 240,000 acres to 260,000 acres in the Yampa counties for four decades. Through the mid-1990s, the bulk of agricultural cropland produced mostly dryland crops of hay and wheat, alongside small crops of barley and oats. In the mid-1990s more than one-third of the cropland supported irrigated hay, the dominant irrigated crop practice in the Yampa Valley. Exhibit III-5 illustrates the 1995 proportion of crop types in the Yampa Valley. The high mountain hay has attained a reputation as superior feed for the growing horse business in the mountains and Front Range of Colorado.

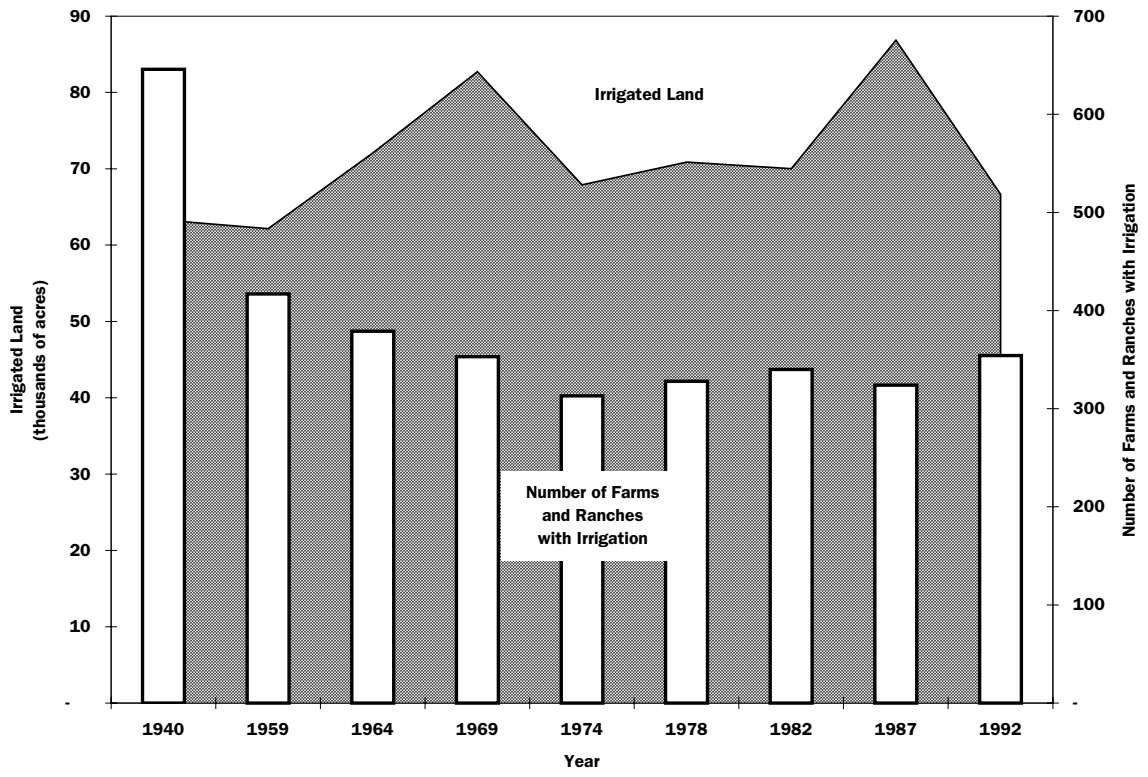
EXHIBIT III-5.
Composition of Harvested Crop Acreage for Yampa Counties, 1995



Source: Colorado Agricultural Statistics, 1996.

Bringing water to the high mountain meadows was a preoccupation of Yampa Valley ranchers almost upon their arrival. Historical statistics indicate that the total number of irrigated acres in the area had already reached 62,000 by 1940, climbing gradually to average more than 70,000 acres in recent decades. The number of separate farms and ranches applying irrigation water to their fields dwindled from 1940 to 1970 and stabilized since that time. The trend of surviving agricultural operations to become even larger has been typical throughout the West in this century. In the 1990s, smaller "hobby-farms" or ranchettes began to emerge in the Yampa Valley, raising the numbers of ranches but not significantly changing total acreage under irrigation. These operations have non-agricultural as well as agricultural purposes. Exhibit III-6 presents long-term trends in irrigated lands and farms within the Yampa Valley.

EXHIBIT III-6.
Yampa Valley Farms with Irrigation and Land Irrigated, 1940-1992



Source: Census of Agriculture, selected years.

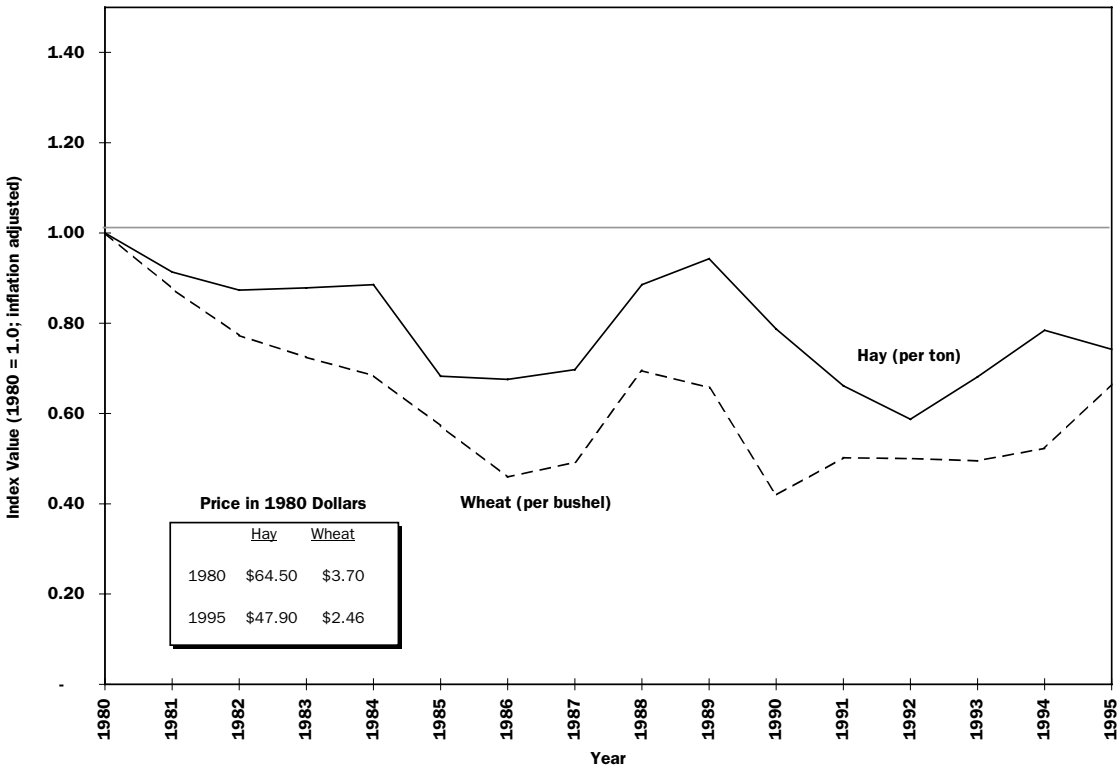
Resource limitations affecting Yampa Valley agriculture. The most important natural limitations on Yampa Valley agriculture are the climatological characteristics. The short, high altitude growing season and harsh winters limit the types of agricultural operations that can prosper in the area. Some vegetable production was undertaken in decades past, including substantial potato production near Hayden. The presence of vegetable operations has since dwindled, apparently due to competition from areas with fairer climates and nearby markets. Unless these crops were to return unexpectedly, the Yampa Valley will mostly be limited to hardy crops such as hay and wheat. The abbreviated growing season means a limit of two hay cuttings and overall marginally profitable agricultural operations, despite best efforts of farmers and ranchers.

The short growing season, coupled with the transportation requirements to food processing centers and then to major consumer markets, constrains the market potential and economic returns of Yampa Valley agriculture. Although some improvements in surface transportation may occur, they are not anticipated to significantly change the relative economics of Yampa Valley agriculture.

Assessment of market factors. Agricultural market conditions are notoriously volatile for Yampa Valley operators as well as others. Exhibits III-7 and III-8 depict inflation — adjusted crop and cattle price fluctuations (respectively) since 1980.

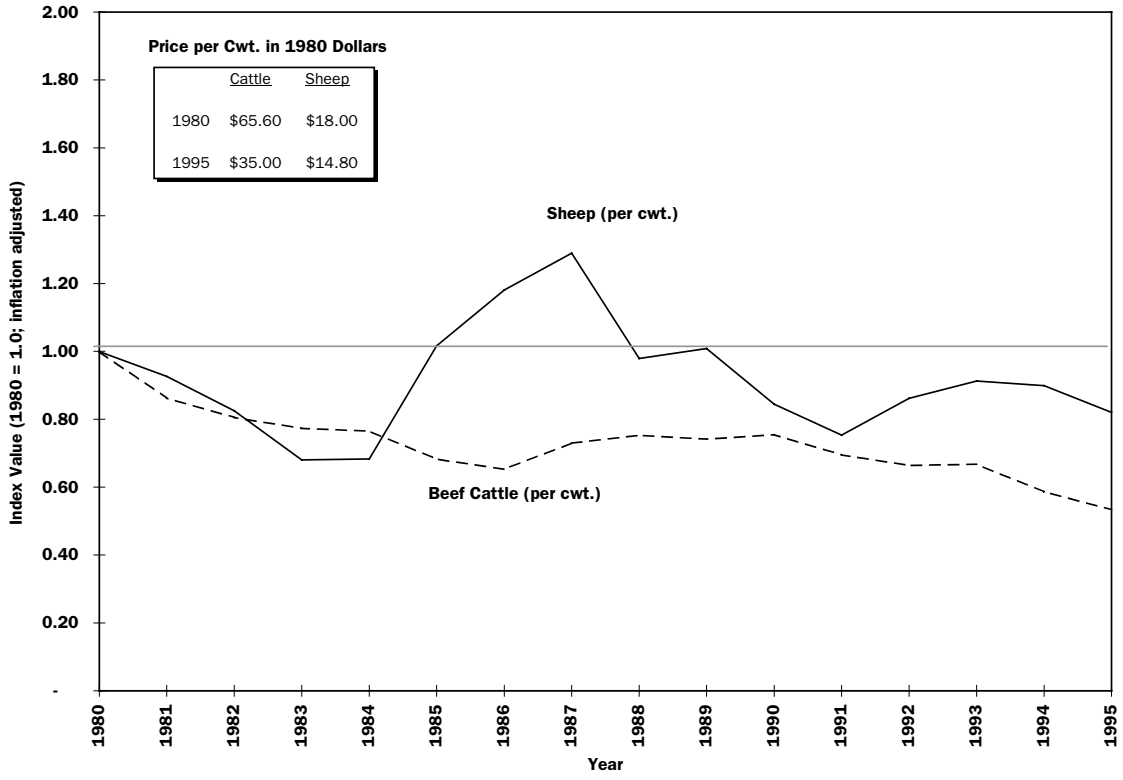
Yampa Valley agricultural practices will be influenced by future changes in the price of livestock and high country crops. However, this analysis does not undertake to forecast commodity prices. Rather, recent trends, interviews with local producers and Extension Agents and information from the USDA were gathered to describe the market prospects for Yampa agriculture.

EXHIBIT III-7.
Relative Crop Prices Received, 1980 to 1995
Adjusted for Inflation



Source: Colorado Agricultural Statistics, various years. Inflation adjustment based on national consumer price index, Bureau of Labor Statistics.

EXHIBIT III-8.
Relative Livestock Prices Received, 1980-1995
Adjusted for Inflation



Source: Colorado Agricultural Statistics, various years. Inflation adjustment based on national consumer price index, Bureau of Labor Statistics.

In the case of sheep ranching, it is likely that local production will continue to diminish. The phase out of the wool incentive continues to challenge the economic viability of sheep operations. In addition, worldwide lamb consumption has declined in recent years. The USDA projects falling per capita lamb consumption in the United States into the next century.[3] Interviews revealed no emerging market or consumer trends that might reverse the decline in sheep ranching viability.

Cattle operations appear to be faring better in the Yampa counties. Over time, additional consolidation among dedicated ranching operations seems likely; in other instances additional hobby ranches will emerge. No distinct market forces were identified

[3] Agricultural Baseline Projections to 2005 Reflecting the *1996 Farm Bill*, U.S. Department of Agriculture, Interagency Agricultural Projections Committee, February 1997.

that suggest a dramatic change for the Yampa cattle industry. In fact, if sheep numbers do continue to decline, some of the vacated grazing acreage might be utilized by cattle, raising their numbers.

Crop production in the Yampa Valley benefits from relatively low costs (in the case of wheat) and a relatively strong market (in the case of hay). The great bulk of wheat production in the Valley is done without irrigation, limiting the investment on the farmer's behalf. Again, no pricing forecasts were made for this analysis: barring a collapse in wheat prices, the viability of these dryland operations should remain.

Hay production supports local livestock operations and provides a cash crop through sales to horse owners outside the Yampa area. The local demand for hay production will remain as long as livestock inventories are maintained. Meanwhile, mountain meadow hay has a loyal following on the Front Range and throughout the West as premium horse hay, commanding a premium price.[4] Hay crops will be a part of the Yampa landscape throughout the foreseeable future.

The response of Valley farmers and ranchers to adverse market conditions has been one key to the long-term survival and stability of this sector in Routt and Moffat Counties. With the growth of big game hunting interest, agriculturalists have supplemented their incomes through "wildlife ranching." Keenly sought game have brought access fees to landowners. Other tourist and local economic development interests have found that traditional agricultural links support the overall attractiveness of the region. Ranching in particular holds an interest for visitors. Efforts to integrate agriculture with tourism will bolster agriculture over the long-term.

Institutional influence on agriculture. Countervaling influences will bear upon the amount of land in agriculture, especially irrigated cropping, over the long-term. In the first instance, Yampa Valley agriculture faces potential encroachment by other land uses. In this arena, market and institutional influences are very much intertwined.

In the past three decades and especially during the 1990s, the value of property in Routt County grew substantially. This was attributable to demand for large lots for "trophy homes," small tracts for hobby ranches and larger tracts for residential development. This land came from various uses, including agriculture. Interestingly, irrigated acreage in Exhibit III-9 shows little overall change, even during the rapid growth in non-agricultural land development and price-escalation.

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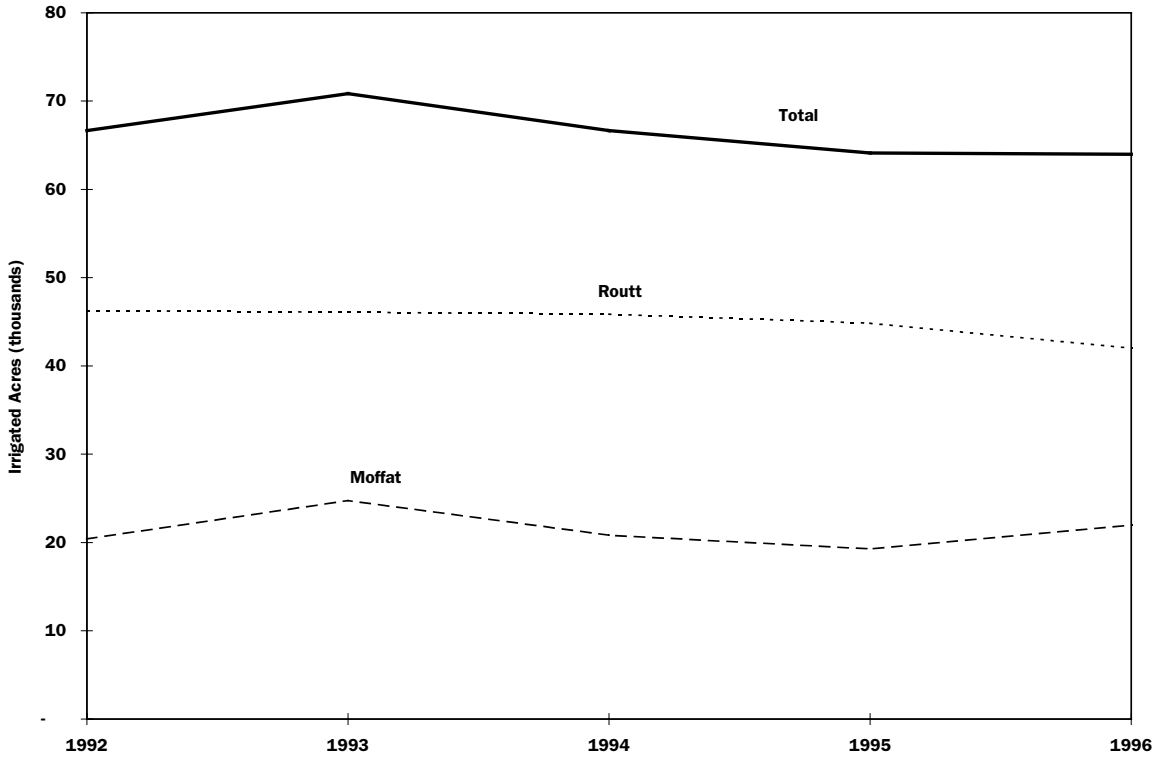
[4] Interviews with C.J. Mucklow, Routt County Cooperative Extension Agent and Ron Cole, *Hay Market News*, 1997.

EXHIBIT III-9.
Approximate Irrigated Acreage, 1992-1996



Source: Census of Agriculture, Division 6 Engineer.

Urbanizing market forces are being countered by public and private efforts to limit the encroachment of development into the areas perceived as most valuable to the area's character and environment. These lands — typically riverbottom hay meadows — have become the focus of property purchases and conservation easements designed to bar or limit future development that would take them out of agricultural use. Several entities, including Routt County, the Nature Conservancy and the American Farmland Trust have combined to bring some 10,000 acres under development restrictions as of the mid-1990s.[5] Public sentiment and the values of local ranchers appear to be lending momentum to the conservation activity. One result is the encouragement of development on higher property away from the stream courses or on otherwise unimportant land for agricultural purposes. Although some lands will undoubtedly be sold and developed in the future, it appears that the bulk of agricultural hay meadows will remain intact.

[5] Interview with Susan Otis, Yampa Valley Land Trust, 1997.

Conversely, expansion of irrigated agriculture and other agricultural activities is possible, but unlikely except at the margin. Although some additional lands have been irrigated in the past, new water development efforts would be needed to substantially and permanently expand irrigation. Pumping costs for irrigation away from stream courses are generally prohibitive. Considerable price increases for cattle, sheep, wool or hay would need to occur to make such developments viable.

Yampa Valley agriculture projections. The long-term history of Yampa Valley agriculture is marked by one ironic characteristic: stability. The evidence from nearly 60 years of history indicates remarkable persistence in the agricultural sector, the acreage under irrigation and the number of people working on farms and ranches. Through extraordinary changes in the national, state, and local economy, through diverse challenges inside and external to the agricultural industry, survival and resiliency have characterized Yampa Valley farming and ranching. Yampa Valley agriculture has remained very similar in character to its earlier self. The projections used in this analysis reflect this stability:

- Livestock production will decline modestly over the 50-year time horizon as a drop-off in sheep inventories will be somewhat ameliorated by increased numbers of cattle to graze the vacated pastureland.

- Irrigated acreage and crop production will remain approximately the same as they were as of 1997. Declines in local livestock feed consumption will not dampen the demand for Yampa Valley hay production due to the presence of outside markets.

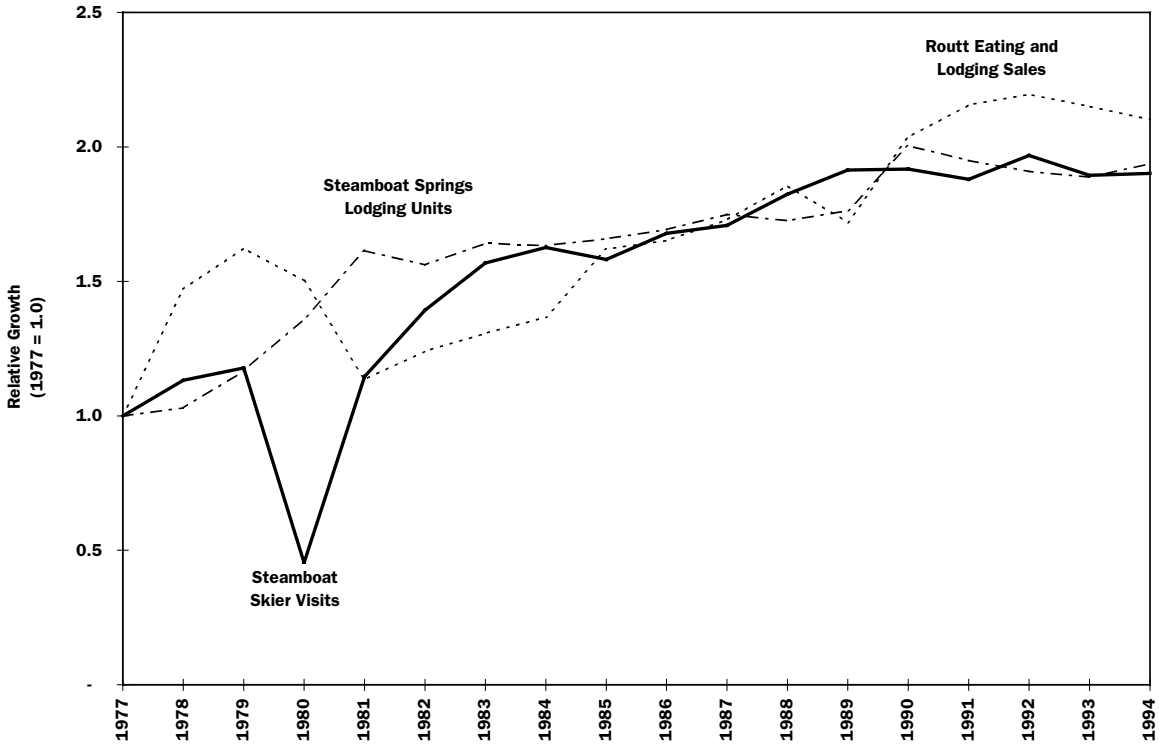
- The economic influence of production agriculture will decline as further consolidation and technological advances gradually reduce the number of employees. Direct agricultural employment of proprietors and employees will be about 900 jobs for the foreseeable future.

Tourism and Recreation

Since the growth in popularity of the Steamboat ski area in the 1970s, tourism and recreation activities have become increasingly fundamental to the Yampa Valley economy. The influence of the tourism economy is apparent in the development patterns in Routt County, the seasonal pattern of business and tax receipts, and the predominance of employment in tourist-related sectors. The Valley's economic future is closely linked to the future of the tourism industry.

Background. For at least the past three decades, the dominant tourist draw in Routt County has been the Steamboat Ski Area. The exceptional average snowfall characteristics and picturesque Western setting have given Steamboat a unique place among Colorado ski resorts. Skier visits grew quickly from about 375,000 in 1972 to about 800,000 skier visits in 1986, according to statistics from Ski Country USA. The pace of growth has moderated since that time. The significance of skiing to the Routt County tourism industry is depicted in Exhibit III-10.

EXHIBIT III-10.
Steamboat Skier Visits, Routt County Eating and Lodging Sales and Steamboat Springs Lodging Units, 1977 to 1994



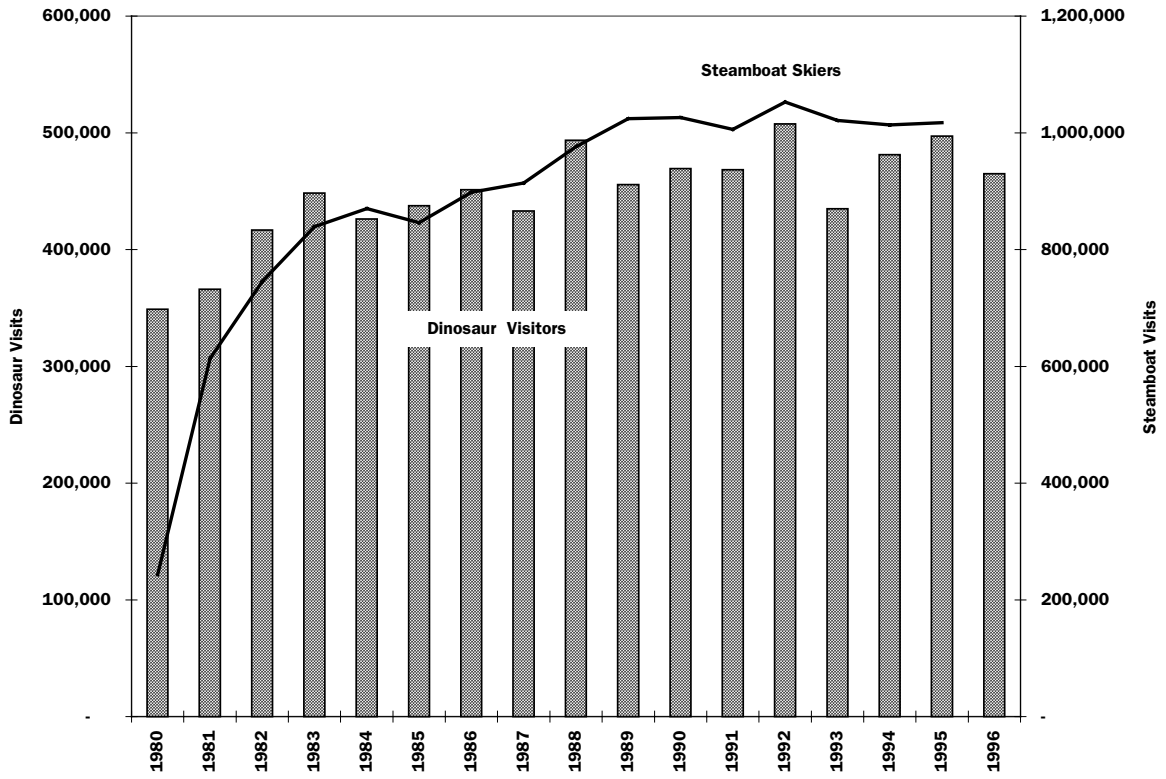
Note: Sales figures adjusted for inflation.

Source: Ski Country, USA; Colorado Department of Revenue; Steamboat Springs Chamber Resort Association.

Moffat County draws tourists with very different attractions, including Dinosaur National Monument and some of Colorado's best elk hunting. In similar fashion to the ski area, visits to Dinosaur National Monument grew briskly for many years, from 150,000 visits in 1960 to more than 400,000 visits in 1970. Since then, annual visitorship has become more steady, ranging from 300,000 to 500,000 for the last 25 years.[6] Like Steamboat Ski Area, Dinosaur experienced modest visitor growth from the mid-1980s to mid-1990s, as depicted in Exhibit III-11.

[6] Statistics provided by Dinosaur National Monument, 1997.

EXHIBIT III-11.
Dinosaur National Monument and Steamboat Ski Area Visits
1980 to 1996



Source: Dinosaur National Monument; Ski Country USA, 1997.

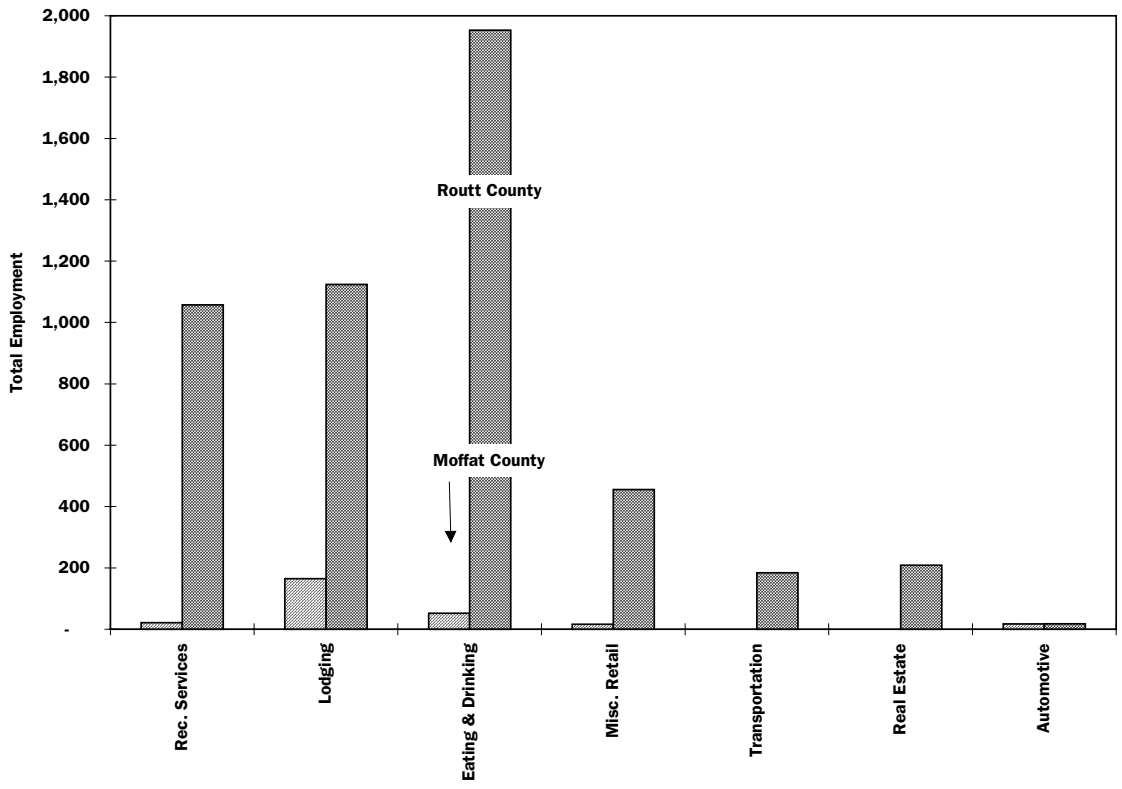
Meanwhile, other winter tourism and recreation activities emerged in the Yampa Valley. In part, it seems that the Yampa playground has been discovered by Front Range Coloradans who increasingly utilize the Valley for other recreational pursuits besides skiing. Among the significant wintertime activities are snowmobiling, cross country skiing and snowshoeing. The Valley tourism sector benefited from an effective marketing and business development effort to broaden the tourist experience and extend visitation periods. As of the mid 1990s, the Yampa Valley has become a competitor for destination tourists in both the national and international marketplace.

The most profound change in Yampa Valley tourism in recent years has been the successful development of numerous summertime tourist activities. Camping and hiking in the Routt National Forest, fishing and rafting on the Yampa, boating on Steamboat Lake and Stagecoach Reservoir, bicycling on and off the roads, golfing, guest ranching and horseback riding have all become outdoor attractions during the temperate months in the Yampa Valley. More structured attractions have become increasingly successful as well.

Local community events draw numerous visitors on many of the summer's weekends in the Yampa Valley, and the Haymaker Golf Course recently opened to complement existing courses.

An analysis of the tourism economy in 1995 provided by the Colorado Division of Local Governments indicates the employment and income derived from tourism-related businesses.[7] In total, the Yampa Valley supports about 5,270 jobs in the tourism industry. The bulk of the jobs were based in Routt County, including almost 2,000 jobs in eating and drinking establishments alone in 1995. As depicted in Exhibit III-12, recreational services and lodging establishments also employed numerous Routt County residents. In Moffat County, most tourism workers were employed in lodging establishments.

EXHIBIT III-12.
Tourism Employment in Yampa Counties, 1995

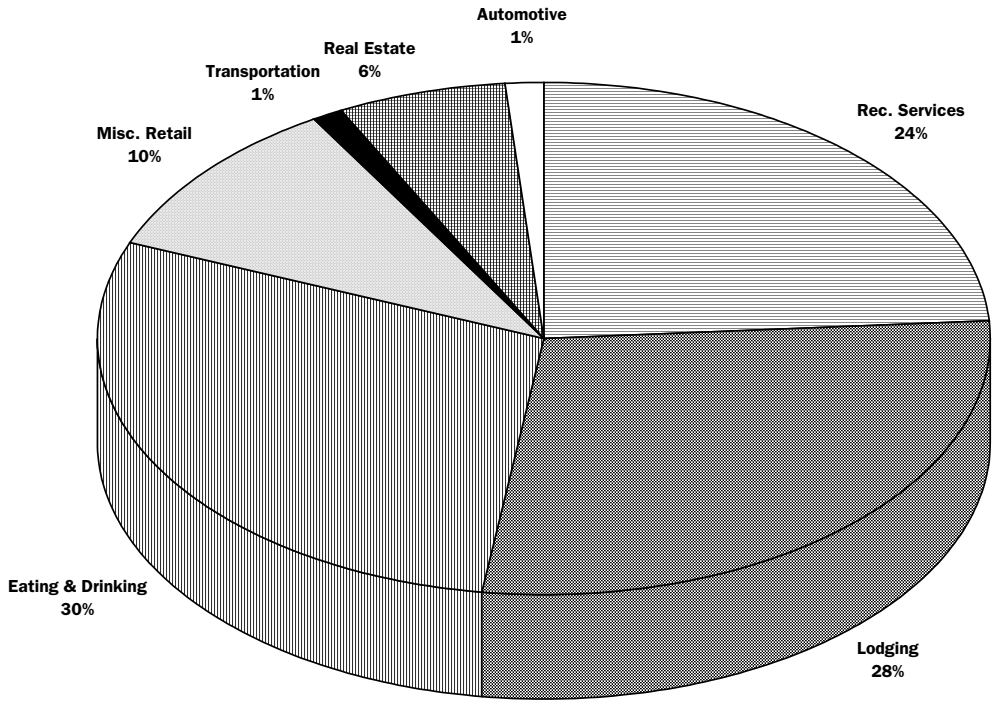


Source: Colorado Division of Local Government, January 1977.

[7] *1995 Data Source Matrix*, Colorado Division of Local Governments, January 1997.

In 1995, personal income generated by Yampa Valley tourism was estimated to be $64 million.[8] Due to the relatively low pay associated with eating and drinking establishments, only slightly more income was generated by these businesses than by lodging or recreation businesses, as shown in Exhibit III-13, despite significantly greater employment.

EXHIBIT III-13.
Composition of 1995 Personal Income from Yampa Valley Tourism



Source: Colorado Division of Local Government, January 1997.

Resource limitations affecting future Yampa Valley tourism and recreation. Some of the area's leading recreational activities depend largely upon the availability of natural resources. The resource base of each recreational activity was examined as the first step in assessing growth potential.

The ski industry requires terrain of the proper snowfall, slope and sun exposure to be successful. The Steamboat Ski Corporation indicated that it's skiable terrain might increase by a maximum of one third over 1997 levels in the 50-year time horizon. Some of

[8] *Economic Base Analysis Data*, Colorado Division of Local Governments, 1997.

this terrain is at Pioneer Ridge with additional acreage at Alpine Lands. Development of the latter property is not yet within the Routt National Forest Plan and might be subject to institutional constraints. The potential Catamount ski area property was under separate ownership in 1997. Catamount offers suitable natural characteristics to potentially be developed as a ski area up to half as large as Steamboat at some point in the future. In sum, the potential for additional ski terrain is evident in the Yampa Valley.

A short-term resource constraint for the Valley ski industry is the bed base. With a maximum skier day of about 14,000 recorded in the mid-1990s, the 17,000 pillows currently available represent a constraint as of 1997. This is likely to be relieved over the long-term.

Similarly, physical resources are critical to growth in hunting and fishing activity. The big game species that bring the greatest number of hunters to the Yampa area — elk and mule deer — have been present in relatively stable numbers for many years. It is unlikely that the Yampa Valley herds will increase substantially within the habitat available to them. A second potential resource constraint to hunting is overcrowding which can result in a diminished experience. Game fish populations, which have increased dramatically since the 1970s, are also believed to be unlikely to expand substantially in the coming years.[9] Whirling disease is one constraint on sport fish populations. To preserve native species, non-native sport fishing species might be restricted to fewer locations or reduced numbers.

For many of the area's fastest-growing recreational activities, there is ample resource capacity for many years of growth. For example, snowshoeing, snowmobiling, mountain biking, back packing, and wildlife viewing are effectively unconstrained in the Yampa high country.

The same is not true of more urban activities, such as Steamboat's summertime community events. Even if the infrastructure develops to accommodate more people in the area on any given weekend, there are only so many weekends each year that will provide cooperative weather for street races, balloon festivals and soccer tournaments. It is estimated that untapped "weekend capacity" for additional community attractions is 50 percent above the current level in Steamboat Springs. There is more capacity for expansion in Craig.[10] Over time, increases in infrastructure will also allow increases in visitorship.

Assessment of market factors. In order to evaluate the future of tourism and recreation in the area, BBC spoke with numerous individuals knowledgeable about Yampa Valley tourism and examined trends in different types of recreation activities relevant to the Yampa Valley. We also examined long-term projections by the U.S. Forest Service (USFS) that estimate growth in various recreational activities throughout the Western United States. Assessments by the BLM, local governments and private interests were also considered.

There are a host of positive considerations which will influence the market for tourism and recreation activities in the Yampa Valley in coming decades. The increasing wealth of the baby boomers and their progression into their leisure years will result in

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[9] Interview with Jim Hicks, Colorado Division of Wildlife, Steamboat Springs Office, 1997.
[10] Interview with Scott Ford, Steamboat Springs Chamber Resort Association, 1997.

strong nationwide demand for quality recreational experiences. The state of Colorado is positioned well to attract relocating families with its job growth and quality of life. Most of the new Coloradans will make their homes along the Front Range and many of them will make the High Country their playground. Over time, these broad trends will favor increasing tourism in the Yampa Valley as more intensive development in the Vail Valley and I-70 corridor will raise the Yampa area's image as an attractive alternative among scenic Colorado destinations. Broad demographic trends and increasing household assets among upper-income Americans will also continue to support demand for part-year residences in the Yampa Valley.

The Yampa Valley also faces certain market constraints which will affect tourism potential:

1. Road transportation is less accessible than for competing areas. The I-70 corridor recreation areas will always be easier to reach for the Front Range consumer.

2. Air transport has improved considerably, but consistent year-round service from U.S. metropolitan areas is unlikely until the Valley population base can help support such air service. Competing recreational areas are aggressively pursuing air carriers to lock in and increase market share.

3. Other ski areas competing in the national marketplace have multiple ski terrain alternatives. With one active mountain, Steamboat will be under increasing pressure to maintain market share, unless and until Catamount or another area is developed.

4. According to the Steamboat Ski Corporation, an estimated 55 percent of skiers are over 35 years old. Market efforts are focused on attracting young people to the sport while trying to keep older ones on the slopes. Clearly, this has been a challenge, as the lack of growth in skier day numbers in recent years indicates.

The rate of future growth in downhill skiing days will likely be moderate compared with the last 20 years, diminishing from about 4 percent growth annually to about 1.5 percent growth per year. Historical skier visits and projections are set forth in Exhibit III-14. Like the Yampa region itself, the Steamboat Ski Area will benefit in the future from its position as less urbanized and more reflective of the "old west" than competing Colorado ski regions.

Other winter activities that currently represent smaller portions of Yampa Valley recreation — cross country skiing, snowshoeing and snowmobiling — have very bright market prospects. Travel agents and other tourism contacts indicate that these types of trips represent the fastest growing part of their winter business. The U.S. Forest Service expects these activities to increase more than three-fold throughout the West in the next 50 years.[11]

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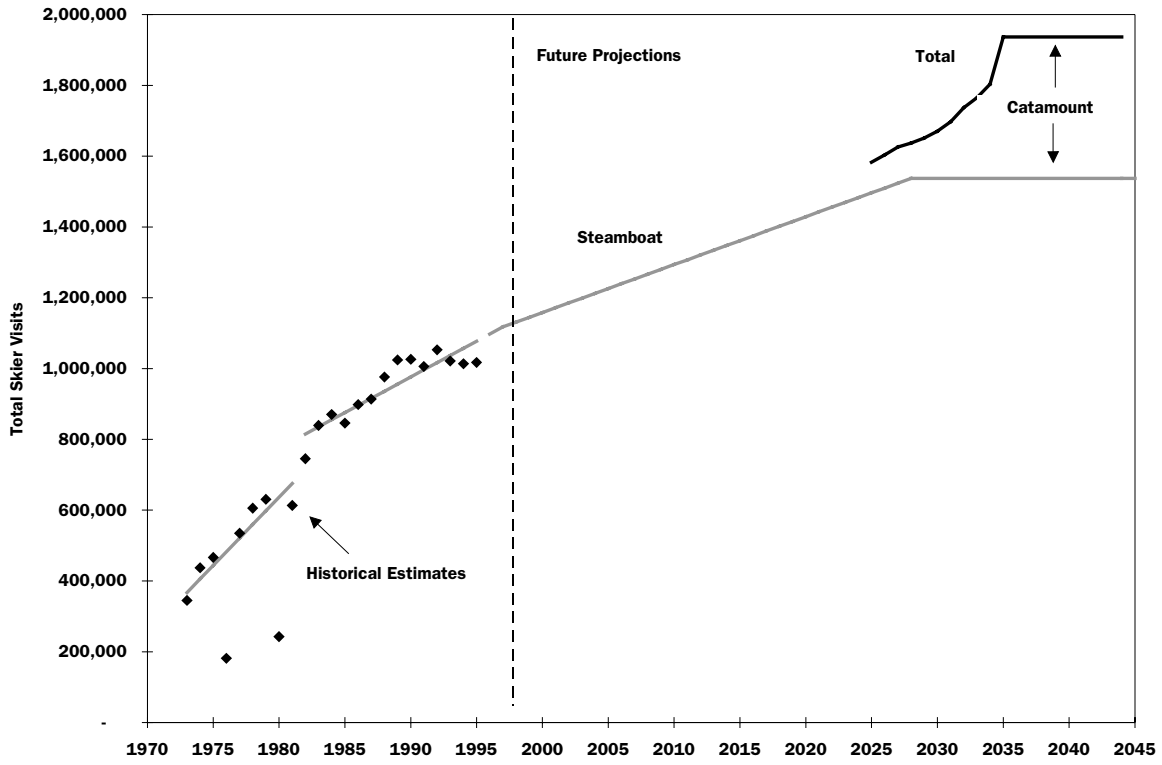
[11] *Regional Demand and Supply Projections for Outdoor Recreation*, U.S. Department of Agriculture, Forest Service, August 1993.

EXHIBIT III-14.
Historical and Projected Skier Visits,
Yampa Counties, 1973 to 2045



Source: Colorado Ski Country USA; BBC Research & Consulting.

Rapid growth in other winter sports will stem from the beauty, availability of suitable terrain and plentiful snowfall in the Yampa Valley as recreationists continue to diversify their winter sports activities.

Fall hunting activity will continue to be attractive to hunting enthusiasts nationwide, but market constraints are evident. The White Mountain and Upper Yampa elk herds attract many hunters to Craig and the Yampa Valley each year, but local Division of Wildlife contacts indicate that habitat and herd depletion are about balanced currently. Hunting interest among young people has been waning in recent decades, although the Yampa Valley would likely attract some growth in hunting due to its exceptional reputation for plentiful game animals. Recent discussions about limiting license sales in the area further suggest modest growth in hunting activity during the rifle season. Relatively strong non-traditional hunting seasons like archery and muzzleloading might well grow

disproportionately, bringing additional people to the area each year at less crowded times without significantly changing overall harvest levels.

Fishing has become more popular over the last 20 years as stocks have expanded and flyfishing has increased in popularity. Stream fishing is also considered exceptional in the Yampa Valley. Nevertheless, access to much of the area's water is becoming limited to guided trips, and crowding on accessible parts of the fisheries will dampen the enthusiasm of newcomers. Fishing might experience moderate growth over the next 50 years.

Scenic drives along the roadways of the Yampa Valley and camping in its developed campgrounds continue to garner increased interest each year. These relatively accessible and popular activities will tend to grow along with the Colorado population. Limited campground developments will be created to accommodate some additional demand, according to the Forest Service.

Meanwhile, community events are likely to be gradually expanded to take advantage of the few remaining summer weekends in Steamboat. Communities will be able to host more visitors as the bed bases in Steamboat Springs and Craig expand over time. These activities are projected to grow moderately.

The fastest growing fair-weather recreational pursuits are likely to be horseback riding, boating, bicycling, hiking, and golf. Horseback excursions, boating and biking are relatively small but growing segments of Yampa Valley recreation. These activities have become much more popular and fit well with demographic trends. Hiking, already a sizable recreation pursuit, is easily accessible to the public and requires no specialized equipment or training.

High country golf will be increasingly viewed as an important amenity to the resort and second-home industry. Local observers say that there are suitable locations for developing 4 to 6 additional golf courses in the Yampa counties.[12] Including the Haymaker course which opened recently, the prospects are for golfing activity to expand several fold over the coming decades.

Institutional constraints to tourism. The institutional constraints to Yampa Valley tourism mostly stem from federal land management and local government. Certain industry segments will be affected more than others.

Downhill skiing expansion will likely require permit modifications from the USFS. Skiable terrain not presently in the Forest Plan, such as Alpine, might be constrained from development. Critical habitat, wetlands, and other concerns might also need to be addressed through the National Environmental Policy Act (NEPA) process. Catamount had the necessary permits, but the landowners were re-examining their development objectives as of 1997.

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[12] Interviews with Chris Wilson, Steamboat Parks and Recreation, Gary Crawford, Sherator Steamboat Golf Course, and other interviews 1997.

Other potential constraints include:

- *Hunting* — A limit on licenses issued by Colorado DOW, and supported by those locals perceiving an overcrowded condition.

- *Camping* — The USFS might limit campground development.

- *Scenic drives* — The USFS and other federal land managers in the area might not develop additional road access and might attempt to limit traffic at certain times.

- *Fishing* — Might be limited by altered DOW fishery management practices. May also be diminished by reduced fish population due to whirling disease.

Yampa Valley tourism and recreation projections. The magnitude of recreation activities is measured in units called recreational visitor days (RVDs), indicating one person participating in an activity for 12 hours. BBC projected changes in RVDs, by activity, based on the factors described previously.

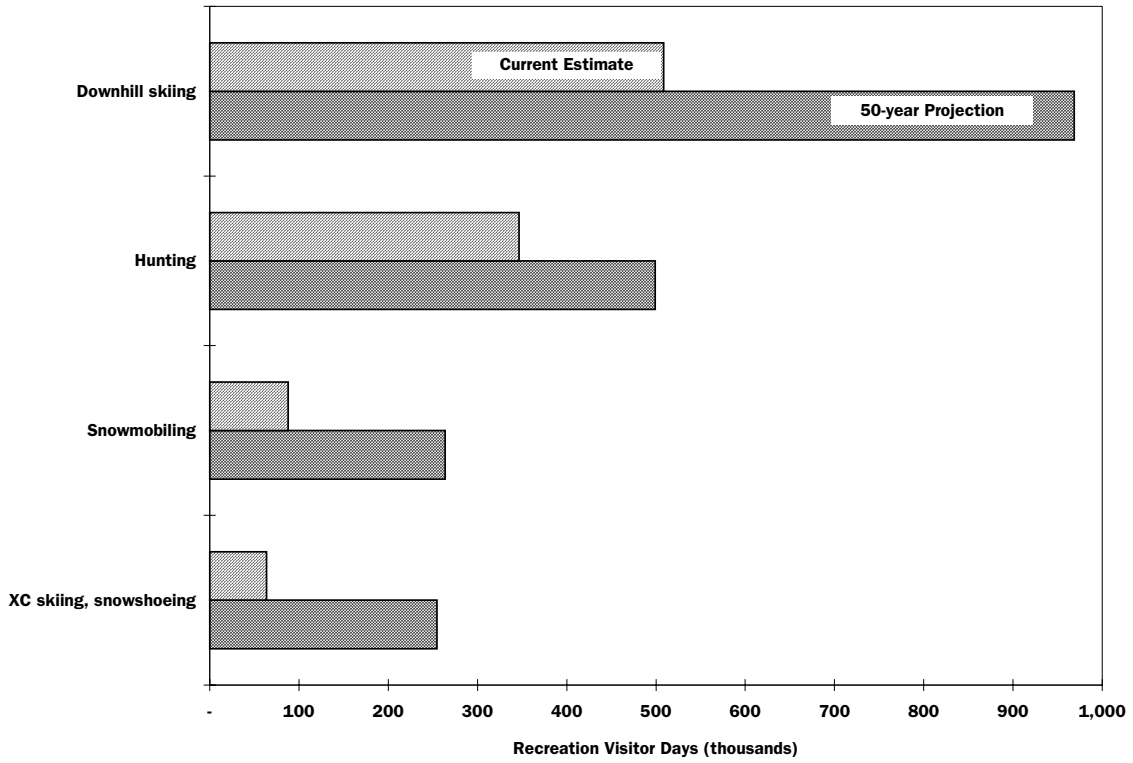
Winter tourism and recreation will more than double, from roughly 660,000 RVDs to about 1.5 million RVDs. Exhibit III-15 offers current and projected estimates of wintertime activities. Downhill skiing will grow more slowly than snowmobiling or back country excursions, but skiing will continue to account for about two thirds of winter-time RVDs. Note that BBC followed USFS conventions in converting measures of activity into visitor days. For example, two skier days equal one skiing RVD.

Summer and fall tourism and recreation will more than double from a total of 2.7 million RVDs to approximately 5.7 million RVDs. A large share of visitor days in these seasons are accounted for by scenic driving, a low-impact activity that appears to make summertime tourism far outpace wintertime. Hiking is expected to be the fastest growing activity. Estimates and projections for each major activity are depicted in Exhibit III-16.

The local economic base required to support tourism and recreation in the Yampa Valley will increase by 215 percent, from about 5,300 jobs to 11,300 jobs in 2045. Most of the new jobs will be in services and trade. Second home construction and an increased number of visitors will also further stimulate population growth.

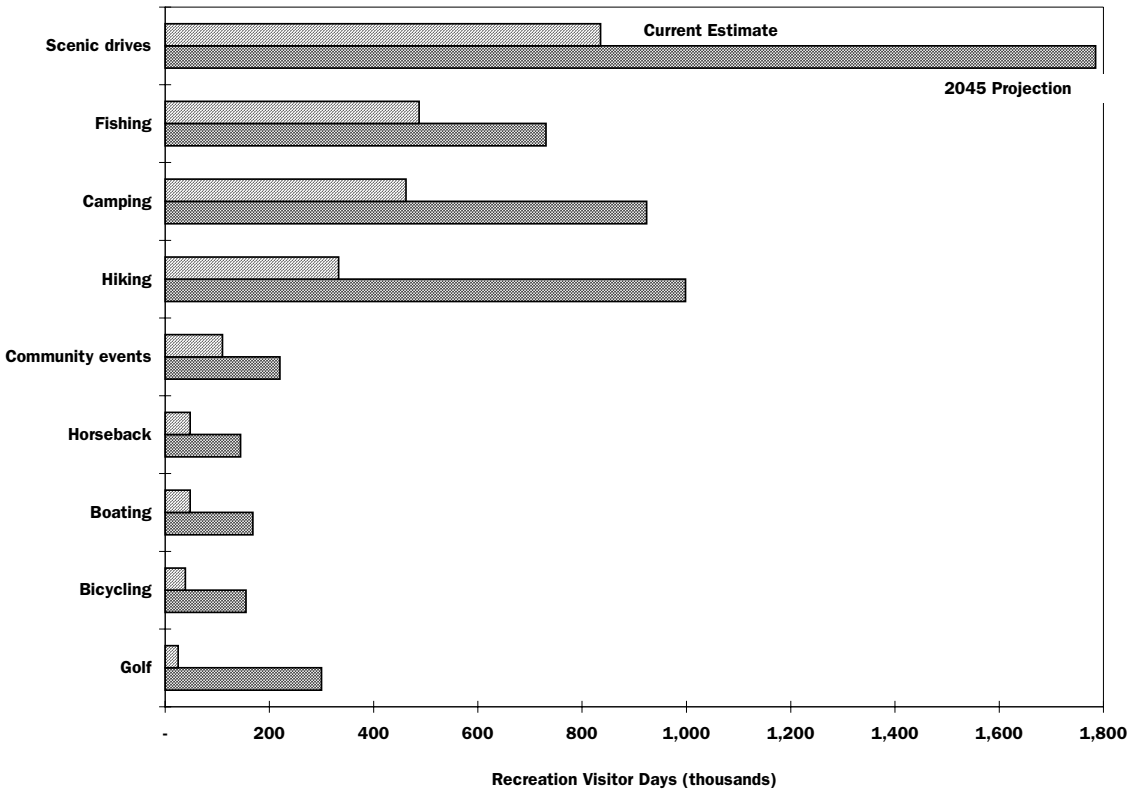
Despite the challenges and limitations described earlier, Yampa Valley tourism has the opportunity for expansion. One goal will be to even out the seasonality in the tourist economy that both Routt and Moffat Counties experience. This seasonality is evident in the monthly 1996 sales statistics for the two counties. See Exhibit III-17.

EXHIBIT III-15.
Current and Projected 2045 Fall/Winter Tourism and Recreation Activity in the Yampa Valley



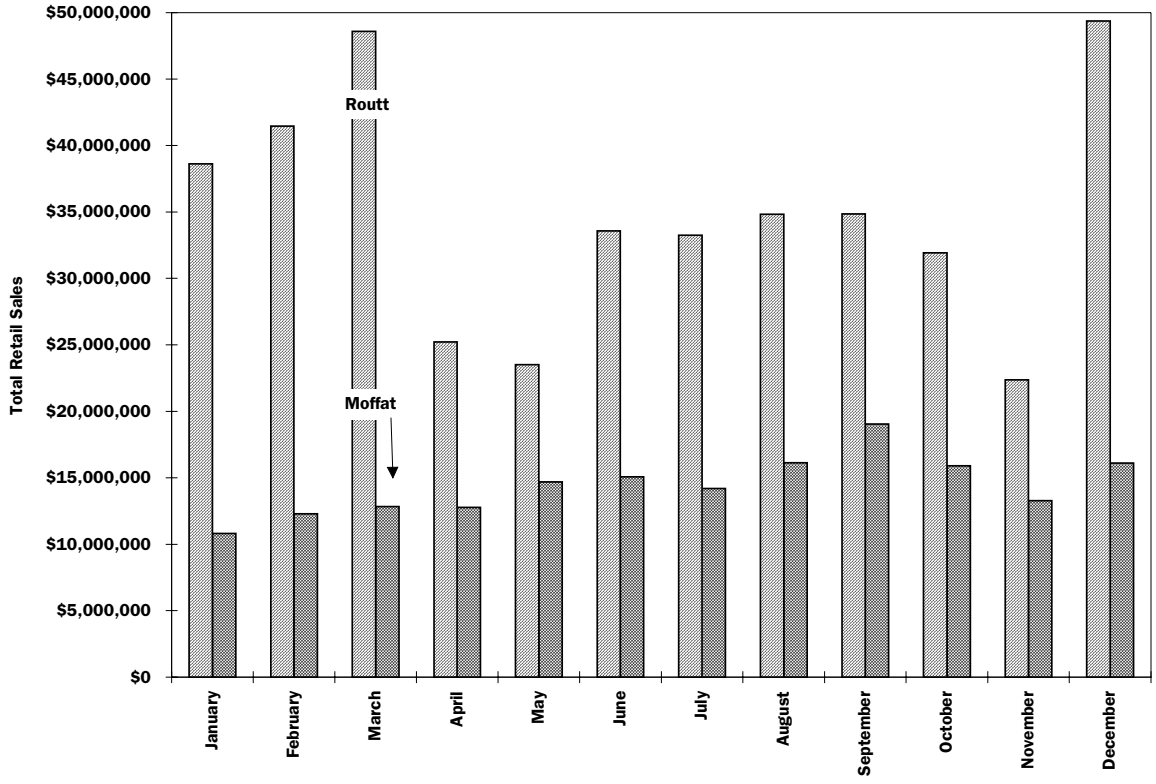
Source: U.S. Forest Service; Bureau of Land Management; BBC Research & Consulting.

EXHIBIT III-16.
Current and Projected 2045 Summer Tourism and Recreation Activity Yampa Valley



Source: U.S. Forest Service; Bureau of Land Management; BBC Research & Consulting.

EXHIBIT III-17
Total Retail Sales by Month, 1996



Source: Colorado Department of Revenue.

Energy and Mining

Coal mining has been an important economic activity in the Yampa Valley throughout most of this century. During the past few decades, coal-fired electric generation has also employed Yampa Valley residents and contributed to the local economy.

Apart from this vital role in supporting the Yampa Valley economic base, energy-related activities and future prospects are particularly important in this study because of their water use characteristics. After agriculture, the thermoelectric power plants at Craig and Hayden are the largest water users in the Yampa Valley.[13]

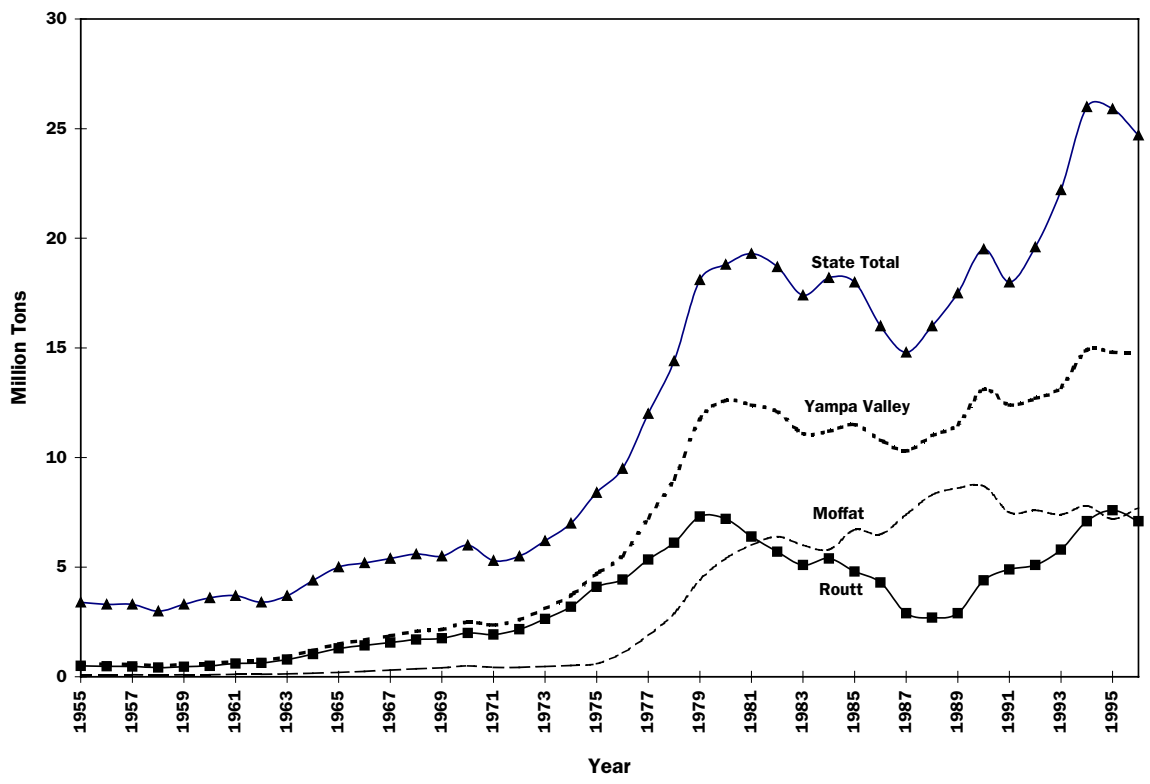
Background. Yampa Valley coal has low ash and low sulfur content along with high heating value (BTU content) compared with some competing Western coals, such as those in Wyoming and Montana's Powder River Basin. Four coal mines were active in the Yampa

[13] Annual water diversion summary reports, Colorado Division of Water Resources, Division 6 Engineer.

Valley in 1997, including three surface operations (ColoWyo, Seneca II and Trapper) and one underground operation (Foidel Creek or Twenty-mile). The ColoWyo surface mine, located in Moffat County between Craig and Meeker and the Twenty-mile underground mine, located in Routt County near Oak Creek, were the largest 1997 producers in this northwestern Colorado coal region.

In 1996, Yampa Valley mines produced about 15 million tons of coal, representing 60 percent of all Colorado coal production on a tonnage basis. The average annual rate of increase in Yampa coal production was nearly eight percent from 1955 through 1996, although the percentage growth in production since 1980 has been more gradual. Yampa coal production more than tripled since 1975 as shown in Exhibit III-18. Yampa Valley coal mines accounted for more than one-half of all Colorado coal production in each year since 1973.

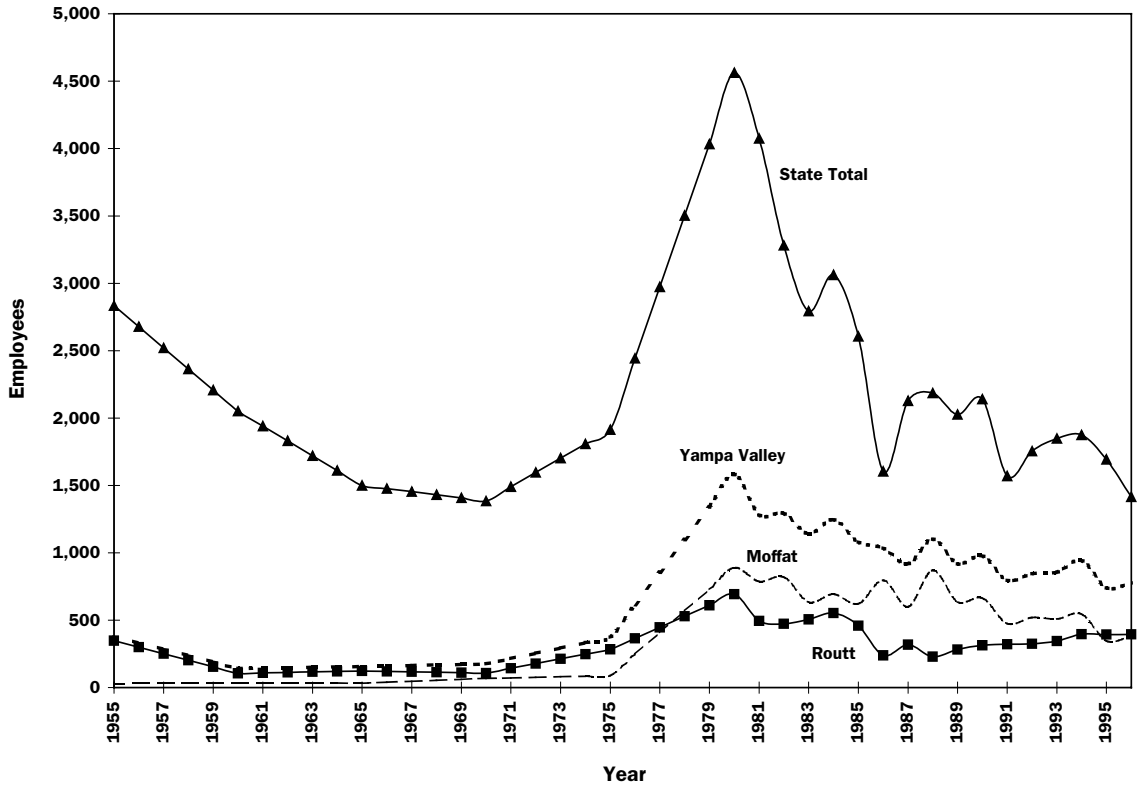
EXHIBIT III-18.
Colorado and Yampa Valley Coal Production, 1955-1996



Source: Colorado Geological Survey and Division of Mines, various reports.

Mining employment in the Yampa Valley increased dramatically with the growth in production during the 1970s, peaking at more than 1,500 workers in 1980. During the past two decades, however, remarkable increases in coal mining productivity outpaced increases in mine production. Mine employment has been relatively stable since 1990, with Yampa Valley coal mines employing about 800 workers as of 1996.. Exhibit III-19 portrays coal mining employment in the Yampa Valley, and throughout the State of Colorado, from 1955 through 1996.

EXHIBIT III-19.
Colorado and Yampa Coal Mining Employment, 1955-1996

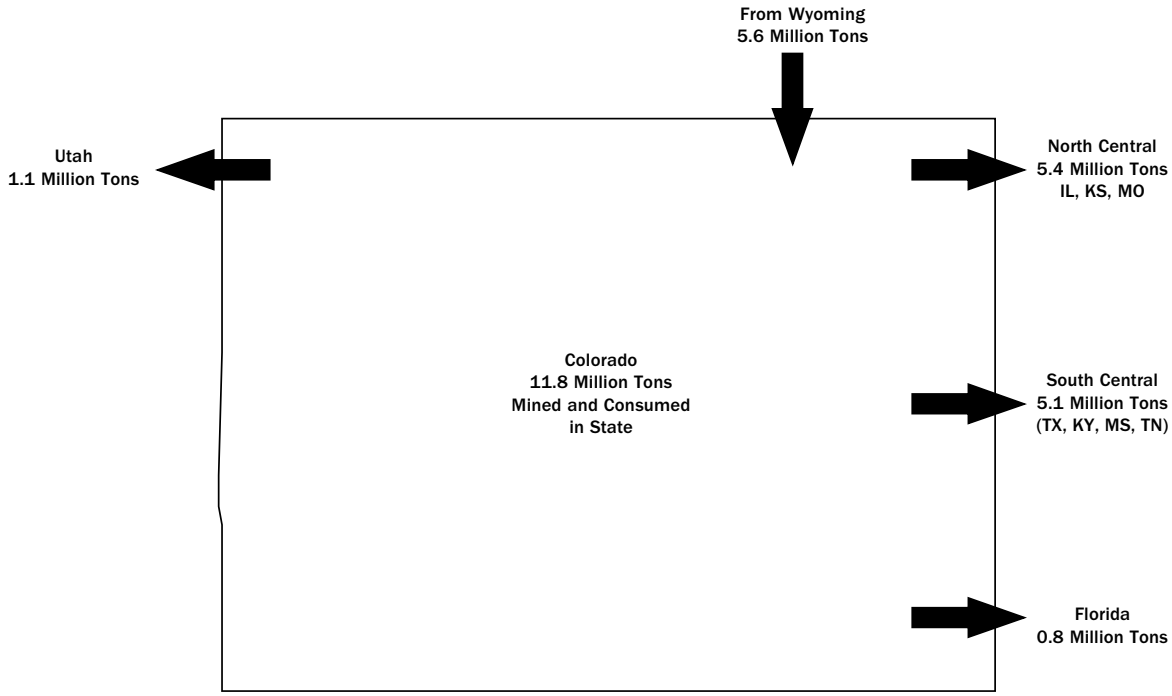


Source: Colorado Geological Survey and Division of Mines, various reports.

Yampa Valley coal is exported for use by other utilities throughout the country and is also burned within the basin at the Craig and Hayden powerplants. Recently, the Twenty-mile mine also secured a contract to export coal to Mexico under the North American Free Trade Agreement. In 1996, about six million tons of Yampa Valley coal were burned at the two power plants, compared to the nearly nine million tons exported out of the Yampa Valley.[14] Exhibit III-20 portrays statewide imports and exports of coal in 1995.

[14] Interviews with managers at the Twenty-mile and ColoWyo coal mines, 1997.

EXHIBIT III-20.
Colorado Coal Exports/Imports
1995



Source: United States Geological Survey, Coal Resource Database, BBC estimates, 1997.

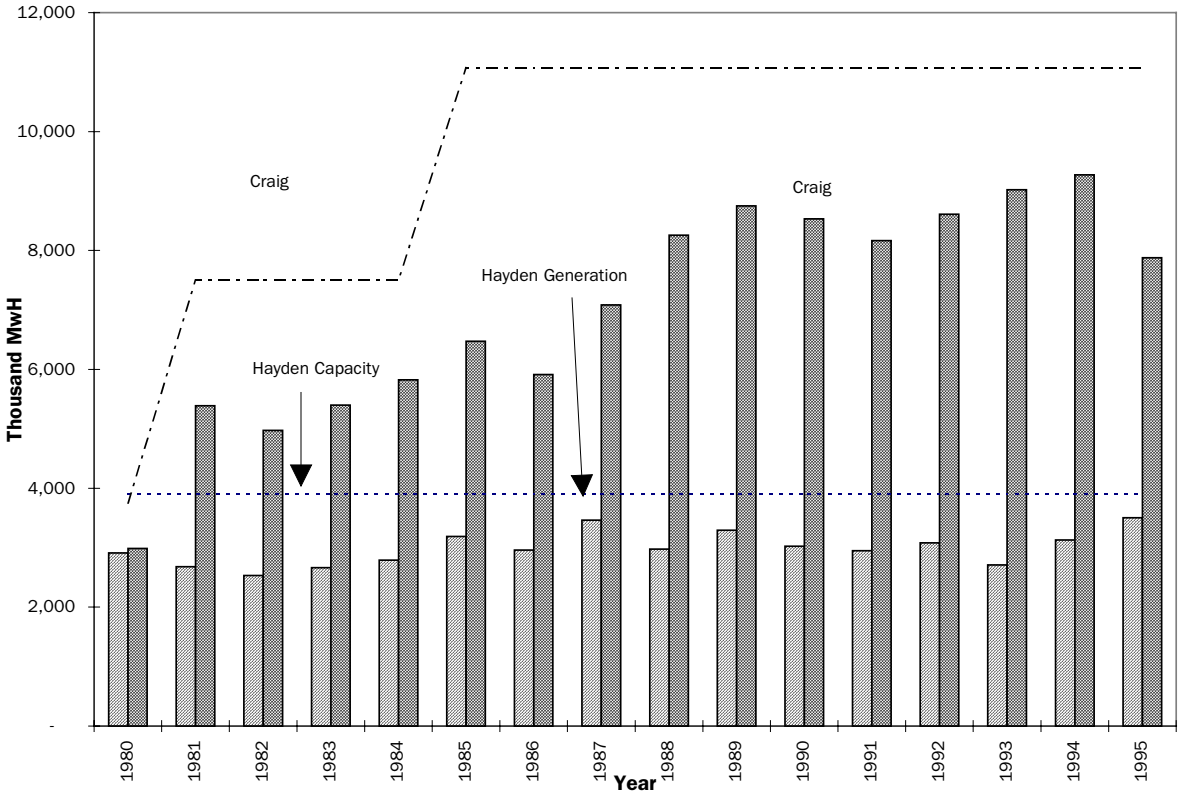
The two Yampa Valley electric power plants currently have the capacity to generate 15 million megawatt hours of electricity per year. The Hayden plant, operated by Public Service Company of Colorado, has two units with rated capacities of 184 megawatts and 262 megawatts. The Craig station, operated by Tri-State Generation and Transmission, has three units with rated capacities of 428 megawatts (two units) and 408 megawatts.

Exhibit III-21 depicts Yampa Valley electric generation and capacity from 1980 through 1995. The second and third Craig units came on line in 1981 and 1985, respectively. Over this 15-year period, Craig's generation averaged 73 percent of capacity, while Hayden generation averaged 77 percent of capacity.

The two power plants employed about 470 Yampa Valley residents in 1996.

Factors affecting future Yampa Valley coal production and electric generation. To assess energy sector potential in the Yampa Valley, BBC examined national forecasts of energy demand and coal production, reviewed research into new coal technologies and estimates of coal resources, and conducted a number of interviews with mine managers, local and national energy companies and industry observers. Future coal production and other energy activities were evaluated in terms of resource potential, market and institutional factors.

EXHIBIT III-21.
Yampa Valley Electric Generation, 1980-1995



Source: Energy Information Administration.

Resource limitations. The United States Geological Survey employs a standard set of definitions to define coal resources:[15]

- *Identified resources* — Provides a broad measure of coal resources whose location, quality and quantity are known or estimated based on specific geologic evidence. This measure, however, includes coal which is inferred to exist and resources which may not be economical to mine.

- *Reserve base* — The part of identified resources that are economically recoverable or have a reasonable potential for becoming economically recoverable. Reserve base includes resources that may be lost in the mining process.

- *Reserves* — The part of the demonstrated reserve base believed to be economically recoverable with current technological practices, legal and environmental constraints.

[15] *Coal Resource Classification System of the U.S. Geological Survey*, 1983.

The amount of identified resources in an area changes over time — diminishing as coal is extracted, and increasing or decreasing with new geologic data. Reserve measures also change in response to improvements in technology and changes in prices and markets which make formerly unrecoverable coal economic to mine. Given historical improvements in equipment and mining practices which have allowed mining of deeper resources and narrower seams, current estimate of reserves likely provide a low estimate of the coal volume which might ultimately be produced.

Although coal has been mined in the Yampa Valley for more than 80 years, coal resources in Moffat and Routt Counties remain substantial, as indicated in Exhibit III-22. According to the broadly defined identified resources, Yampa Valley coal resources are estimated at nearly 29 billion tons. By the narrow definition of estimated reserves, recoverable coal in the Yampa Valley is estimated at about 5.3 billion tons, as illustrated in Exhibit III-22.

The timeline depicted in Exhibit III-23 points out the sustainability of these resources at future potential extraction rates. At the 1996 production level of 14.8 million tons, the coal reserves of the Yampa Valley could last for at least 350 years, excluding inferred reserves. Increasing production levels would obviously shorten the time horizon. If total Yampa Valley mine production increased at a rate of three percent per year (implying production levels by 2045 of more than 50 million tons per year), the measured and indicated reserves could be exhausted within the next 100 years, but would likely last at least 75 years. This is considered a conservative estimate of coal mining's possible tenure in the Yampa Valley from a resource perspective.

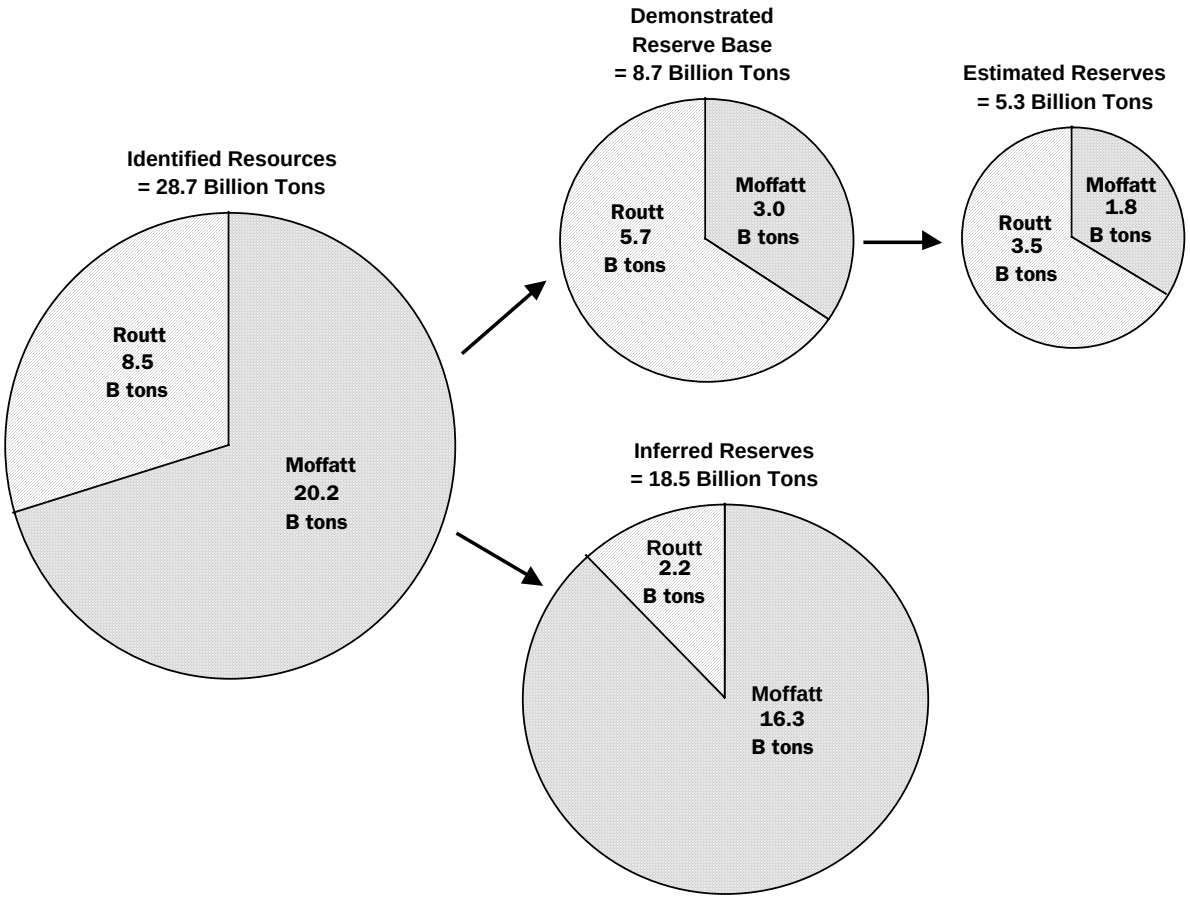
Assessment of market and institutional factors. Five interrelated market and institutional factors are likely to influence the magnitude of future Yampa Valley coal production:

- demand for coal for local electric generation;
- regional and national demands for low sulfur, low ash, high BTU coal;
- competition with other coal-producing areas;
- transportation capacity and cost; and
- permitting and environmental policies.

As of 1997, the electric utility industry was in an abnormally uncertain state because of possible deregulation and added competition in the generation and transmission sectors. While the effects of these potential changes are difficult to predict, most knowledgeable persons believe that deregulation will favor low-cost producers, lead to increases in capacity utilization at relatively low-cost plants, and encourage existing power plants to remain on-line for longer than their 40-year theoretical design life.[16]

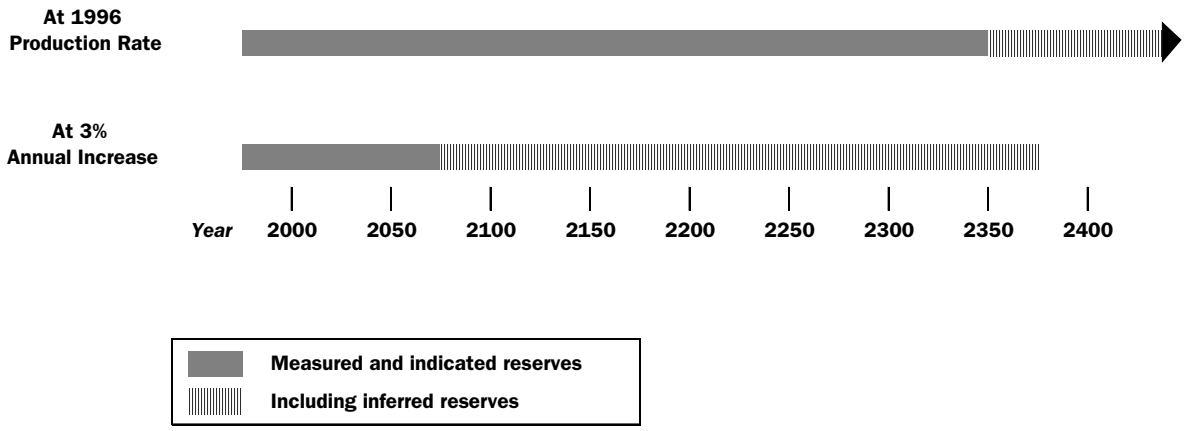
[16] Interviews with managers at Tri-State Generation and Transmission Corporation and Public Service Company of Colorado, 1997.

EXHIBIT III-22.
Sustainability of Coal Reserves in the Yampa Basin



Source: United States Geological Survey, Coal Resource Database, BBC estimates, 1997.

EXHIBIT III-23.
Sustainability of Coal Reserves in the Yampa Basin



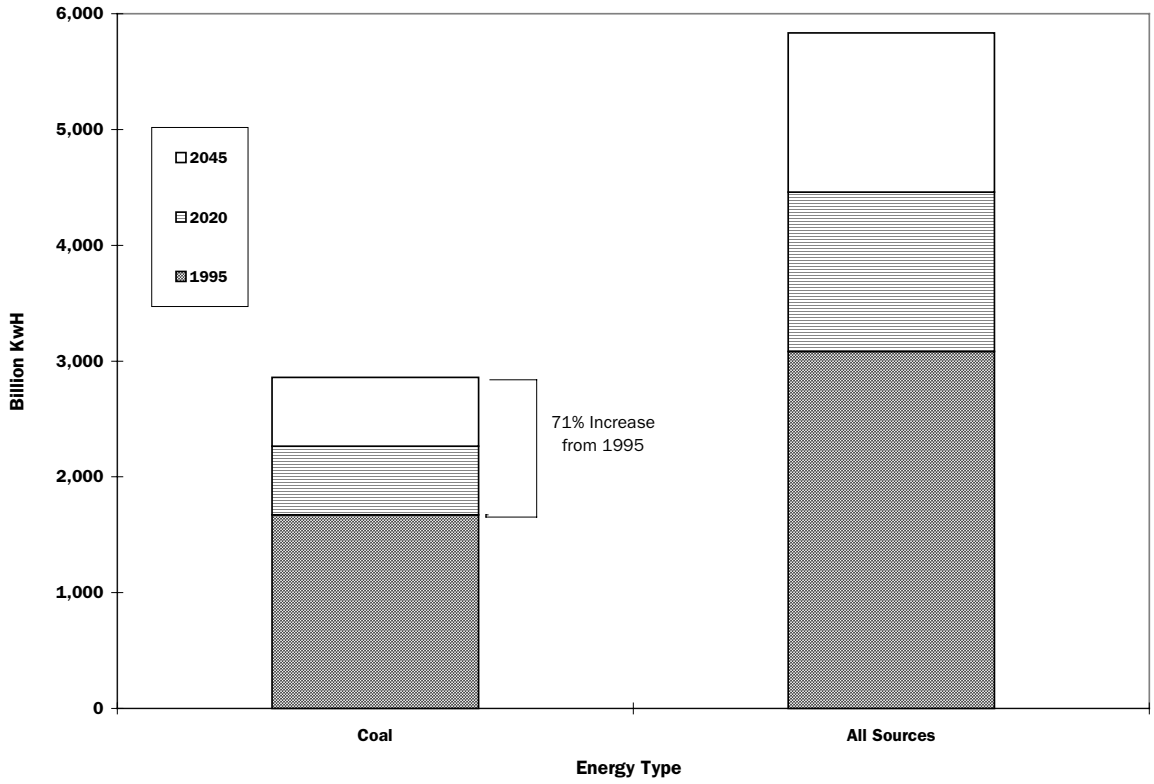
Source: BBC estimates based on USGS reserve data, mine production rates, statewide recovery factor and historic depletions analysis conducted by Colorado Geological Survey.

It is possible that additional, conventional coal-fired generating units could be added at Craig, or Hayden, during the 50-year projection period. These sites are favorable in terms of low-cost supplies, transmission system capacity and power generation infrastructure, and, ironically, availability of water supply for cooling. However, environmental considerations — principally concern over visibility and acid deposition within the Mt. Zirkel wilderness — argue against new, conventional units at Craig and Hayden.

Nonetheless, additional coal-fired generating capacity will likely be needed to meet growing demands in the region and the nation during the next 50 years. As shown in Exhibit III-24, U.S. Department of Energy (DOE), Energy Information Administration (EIA) projections call for a considerable increase in national electricity generation by 2020, including coal-fired generation. Assuming the same increment of growth (representing a lower annual growth *rate)* for the period 2020 to 2045, a 71 percent increase in coal-fired generation would be called for by 2045. Even with such an increase, coal would likely represent a considerably smaller proportion of total electric generation than at present, due to environmental (global arming) concerns and an industry preference for gas turbines, combined cycles or other load-following generation technologies.

The prospect of additional electric generation demand, economic pressure to use low-cost fuels and increasing concern over powerplant emissions are stimulating innovative research into alternative coal processing technologies. The DOE, in partnership with private industry, is currently funding several hundred million dollars worth of test projects throughout the country. The largest current research projects are focused on two approaches: coal liquefaction; and integrated gasification and combined cycle (IGCC) power generating facilities.

EXHIBIT III-24.
Projected Growth in U.S. Electricity Generation, 1995-2045



Source: U.S. Energy Information Administration, Annual Energy Outlook, 1998; BBC estimates.

Several factors suggest that the Yampa Valley might not be a prime location for a coal liquefaction facility. Liquefaction research is currently focusing on lower rank, and lower cost coal resources. Further, a commercial facility would be more economically attractive if it had relatively easy access to refineries and large end-use markets. The Yampa Valley does not offer such advantages.

However, based on projected growth in electricity, generation and locational advantages of the Yampa Valley discussed earlier, BBC believes additional Yampa Valley generating capacity utilizing new IGCC units is reasonably foreseeable within the 50-year projection period. IGCCs are designed to have substantially reduced emissions compared to conventional power plants and might ultimately offer lower capital costs as well. Commercial IGCCs will be on-line shortly after year 2000 in Tampa, Florida and other locations — but the technology is not expected to be widely adopted for at least 15 years. A commercial IGCC unit could have the capacity to generate 400 megawatts and might employ 150 to 200 people.[17]

[17] Interview with Robert Kornosky, Office of Project Management, Federal Energy Technology

Projected national increases in coal-fired generation are linked to corresponding increases in coal production. Depicted in Exhibit III-25, EIA's projections call for an annual increase in national coal production of about one percent per year through year 2015. These base case projections are lower than those made by some other leading industry observers, including the Gas Research Institute (GRI), Data Resources International (DRI) and the Wharton Economic Forecasting Associates (WEFA).

EIA also develops projections of coal production at the regional level. The EIA regional forecast for the Rocky Mountain Region, which includes all of Colorado and Utah, points to an increase from about 50 million tons per year in 1995 to nearly 80 million tons per year by 2015. This projection suggests that Rocky Mountain coal production will increase at an annual rate of about two percent per year, approximately twice as fast as national coal production. The faster growth rate reflects the continuing shift of coal production from the eastern U.S. to western mines, as well increased demand under Phase II of the Clean Air Act Amendments for the low sulfur, low ash and high BTU characteristics of Utah and Colorado coal.

Another important influence on future Yampa Valley coal production will be competition from other coal mining regions, particularly the Powder River Basin (PRB) in Wyoming and Montana. The PRB is the fastest growing coal production region in the United States and produced more than 250 million tons of coal in 1996, nearly one-fourth of all U.S. coal production.[18]

Strong demand for Powder River Basin coal is driven by clean air requirements and economics. PRB coal has low sulfur characteristics relative to Eastern coal resources (sulfur content is generally comparable to Yampa Valley coal resources). Thick coal seams and low overburden ratios have led to development of very large highly efficient surface mines in northeastern Wyoming and the lowest coal production costs in the United States. The Wyoming portion of the PRB also has excellent rail transportation access to markets.

Historically, Yampa Valley coal mines have served different markets than the PRB mines. Yampa Valley coal has a greater heat content (higher BTU) and can be burned in older Midwestern utility boilers which cannot currently use PRB coal. Some utilities are currently weighing the capital investment required to convert boilers to burn PRB coal versus the higher operating cost of continuing to use higher BTU coal from other Western coal resources, such as those in the Yampa Valley.

The extent to which direct competition with the PRB will affect future Yampa Valley coal production is unclear. It appears likely that Yampa Valley coal will continue to be burned at the Craig and Hayden powerplants because of both design and transportation cost issues. Consistent with the EIA regional coal production forecasts described earlier, this study also assumes that there will continue to be some growth in Yampa Valley coal

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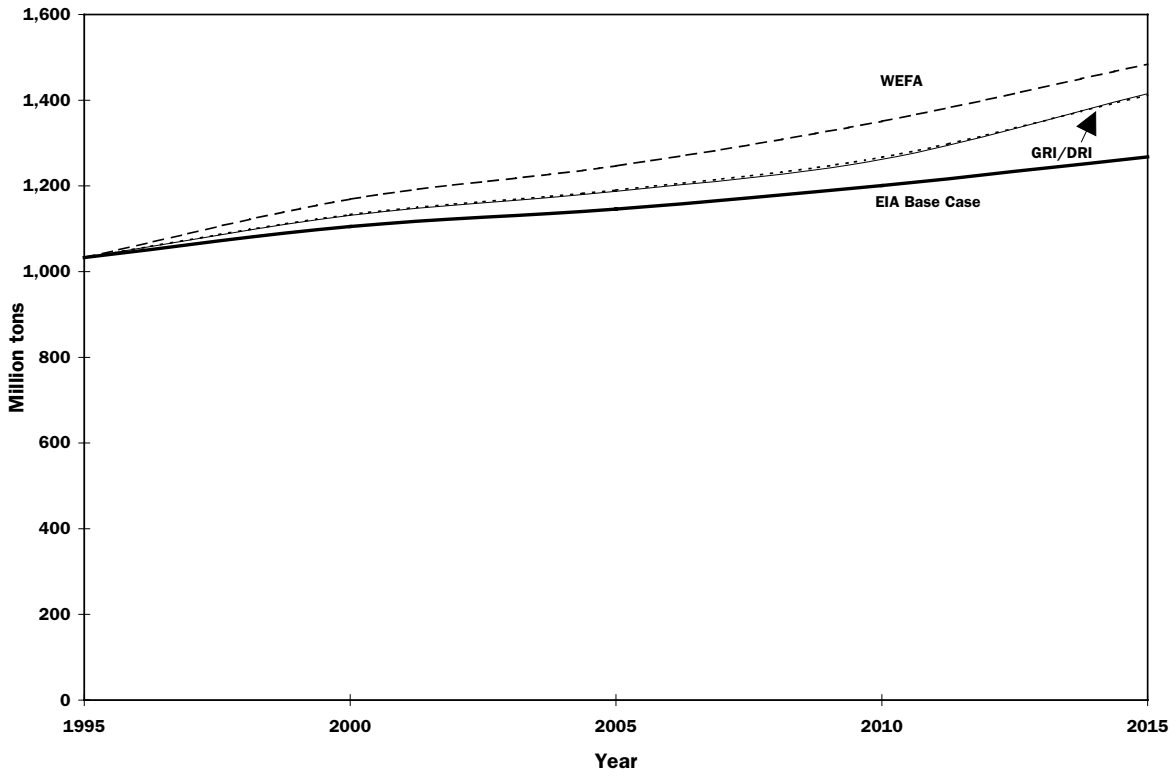
Center, August 1997.

[18] *Coal Market Potential and Regional Competitiveness Study, Selected Coal Fields of Montana*, Stagg Engineering Services, Inc., Natural Resource Consultants and BBC Research & Consulting, 1996; *U.S. Coal Supply and Demand: 1996 Review*, U.S. Department of Energy, Energy Information Administration, 1997.

exports to serve niche markets. The majority of future increases in U.S. coal production, however, will almost certainly be served by the PRB.

EXHIBIT III-25.
Alternative National Coal Production Forecasts, 1995-2015



Source: Energy Information Administration Annual Energy Outlook, 1997.

Transportation will probably be an additional constraint on growth in Yampa Valley coal production. While there has long been discussion of building a rail line north from Craig to the main Southern Pacific line in Wyoming, the likely rate of return from this line would be insufficient under most circumstances to encourage development. Further, some industry participants believe that if the line were completed, it could reduce the advantages for Yampa Valley coal within the basin relative to importing PRB coal.

In the absence of an additional rail line, the capacity of the Moffat Tunnel may be the most binding limitation on the amount of coal which can be exported out of the Yampa Basin. The Yampa Valley coal production projections described below reflect this constraint, confirmed by Cyprus Amax coal transportation specialists.

A final factor influencing the prospects of the Yampa Valley energy sector may be permitting and environmental policy. Most of the Yampa Valley coal resources are located on Federal land, administered by the Bureau of Land Management. The Bureau does not

presently seek to discourage mining through its permitting regulations and the Bureau's most recent local management plans allow for the possibility of additional mining on these lands.[19]

Yampa Valley energy sector projections. Based upon the preceding evaluations, BBC incorporated the following assumptions regarding the Yampa Valley energy sector:

- Electric generation capacity in the Yampa Valley will be increased by the addition of two integrated gasification, combined cycle generating units with a combined capacity of 800 megawatts. This addition will maintain the Yampa Valley's share of national coal-fired generation capacity. Due to the economics of deregulation, existing generating units will be operated at higher utilization rates, averaging 90 percent of capacity. Electric generation will employ about 750 people in 2045.

- Coal production will increase to about 36 million tons per year, including exports of about 25 million tons to other markets. Coal mining employment will increase to a lesser degree, reflecting a 50 percent increase in productivity. Year 2045 mining employment will be about 1,200 workers.

Manufacturing

As an economic sector, manufacturing is composed of basic, indirect basic and local service components. Yampa Valley manufacturing operations which sell their products to firms or consumers in other geographic areas comprise the direct basic element of the Yampa Valley economic base. Other businesses categorized as manufacturing, such as publishing of local newspapers, are actually local service activities that tend to respond to changes in the size of the local economy and population.

Background. Historically, manufacturing has represented a very small share of the Yampa Valley economy. As of 1996, manufacturing jobs accounted for less than two percent of total employment in the Yampa Valley, or less than 400 total jobs.

Yampa Valley manufacturing was fragmented among many small operations in 1996. According to the 1992 economic census, only seven of 41 manufacturing operations in the Yampa Valley had more than ten employees. Printing and publishing is the largest type of manufacturing employment in the Yampa Valley, representing almost one-half of all manufacturing jobs.

Other current manufacturing activities in the Yampa Valley are classified in the following industrial categories:

- lumber and wood products;
- industrial machinery;
- furniture;

[19] Interview with Jerry Strahan, Coal Specialist, Bureau of Land Management — Little Snake Resource Management Area, 1997.

- stone, clay and glass;
- food and kindred products;
- apparel;
- rubber and miscellaneous;
- fabricated metal products; and
- transportation products.[20]

Resource limitations affecting future Yampa Valley manufacturing. To evaluate future Yampa Valley manufacturing prospects, BBC examined historical changes in manufacturing in the Yampa Valley and other areas and interviewed local residents and officials knowledgeable about economic development conditions and prospects. Manufacturing is a broad economic category encompassing a wide variety of activities — with highly varied requirements. For many types of manufacturing, site selection depends on some or all of the following criteria:

- reasonably priced land
- adequate and cost-effective supplies of electricity, water and other infrastructure and services
- availability of skilled workers
- transportation efficiency
- access to supplies and suppliers
- access to markets

Assessment of these factors suggests growth potential for Yampa Valley manufacturing. Although land values have risen substantially in Steamboat Springs and some other parts of Routt County, affordable land is still available in Moffat County. The tax burden shouldered by the power plants provides a favorable tax climate for individuals and other businesses in the area. Particularly in the Craig area, there is infrastructure capacity to support growth.[21] A large pool of skilled workers might be a limitation, but at present these workers are in short supply in most areas.

The site selection criteria also indicate that the area is unlikely to become a major manufacturing center. The most limiting factors will likely continue to be access to supplies, suppliers and markets due to the relative geographic isolation of the Yampa Valley. Manufacturing activities using existing local resources, such as past efforts to develop a wool products industry, might overcome some of these limitations. Improvements in US 40 might be necessary to support development of large-scale manufacturing in the area. Rail transport will continue to be an important constraint. Air access will probably improve substantially over the 50-year time horizon.

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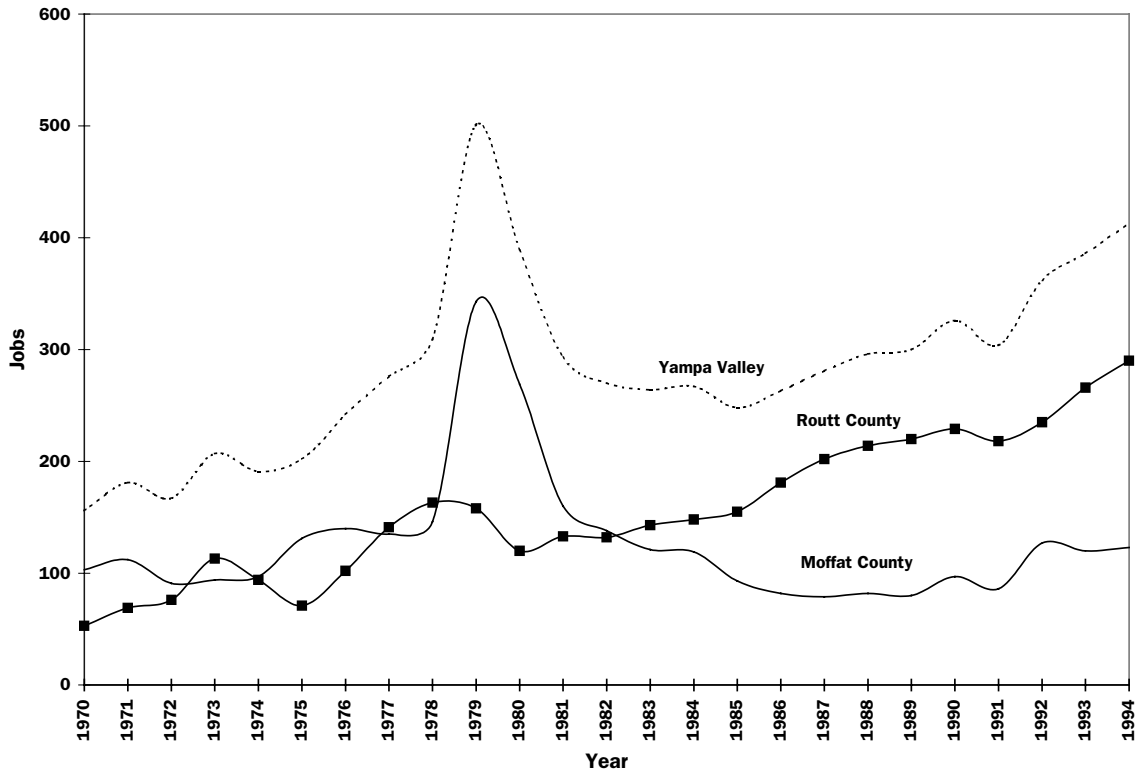
[20] *1992 Census of Manufacturing*, U.S. Department of Commerce, Bureau of Census.
[21] Interview with Ron Stock, former Craig City Manager, 1997.

Assessment of market and institutional factors. Although the Yampa Valley manufacturing sector remains small, manufacturing employment has increased fairly steadily over the past 25 years. Exhibit III-26 depicts Yampa Valley manufacturing employment from 1970 through 1994.

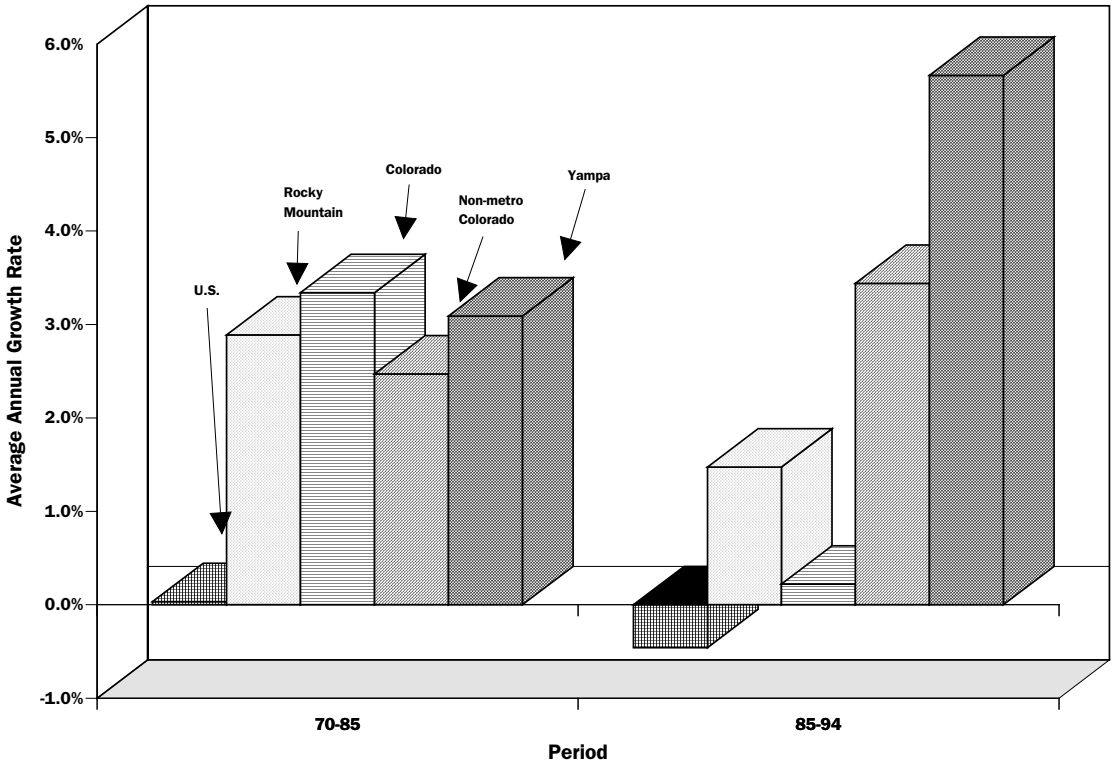
EXHIBIT III-26.
Yampa Valley Manufacturing Employment, 1970-1994



Source: U.S. Bureau of Economic Analysis, 1997.

Manufacturing job growth in the Yampa Valley is a small-scale reflection of nationwide changes in the location of manufacturing activities. Since 1970, there has been a gradual shift in manufacturing employment from the Eastern United States to the West, and from metropolitan areas to non-metropolitan locations. Exhibit III-27 compares the national manufacturing job growth rate from 1970 to 1994 with manufacturing job growth rates in the Rocky Mountain Region, state of Colorado, non-metro areas in Colorado and the Yampa Valley. Despite an overall decline in the number of U.S. manufacturing jobs over this period, non-metropolitan areas of Colorado have experienced an average annual increase in manufacturing of more than three percent per year, while Yampa Valley manufacturing has increased at an average rate of more than four percent per year.

EXHIBIT III-27.
Manufacturing Job Growth Rates, 1970-1994



Source: U.S. Bureau of Economic Analysis, 1997.

La Plata County and Garfield County provide other examples of manufacturing job growth in non-metro parts of Colorado. In 1970, these two counties had a combined total of about 350 manufacturing jobs — approximately the size of the manufacturing sector in the Yampa Valley today. By 1995, combined manufacturing employment in the two counties included about 1,600 jobs — adding more than 1,200 jobs in 25 years.

Despite flat economic projections in U.S. manufacturing, further growth in manufacturing employment in areas such as the Yampa Valley is likely. Most new manufacturing jobs in the area will probably come from small-scale, specialized manufacturing businesses similar to those currently in place. Potentially, a few larger manufacturing operations could develop in the indirect basic category, related to existing industries. Examples include recreation goods, agricultural processing, or further development of coal processing by-products. The size of the Yampa Valley economy and population itself will spur manufacturing as the workforce expands.

Yampa Valley manufacturing projections. Based upon the foregoing evaluations, the following conditions were incorporated in the economic and demographic projections:

- Manufacturing job growth of three percent to four percent per year in the Yampa Valley is reasonably foreseeable. By year 2045, the Yampa Valley will include between 1,500 and 2,400 manufacturing jobs.

Construction

Like manufacturing, construction is a mix of basic, non-basic and local service activities. In many economies, construction activity is primarily driven by the needs of local residents and businesses. In such cases, construction employment is classified as a local service sector, not part of the area's economic base. When construction activity is related to demands of individuals and businesses primarily residing outside of the local area, however, the construction sector can be an important component of the region's direct economic base. During the 1990s, much of the economic growth experienced in Colorado's resort areas, including the Steamboat Springs area, has been fueled by the demand for second homes.[22]

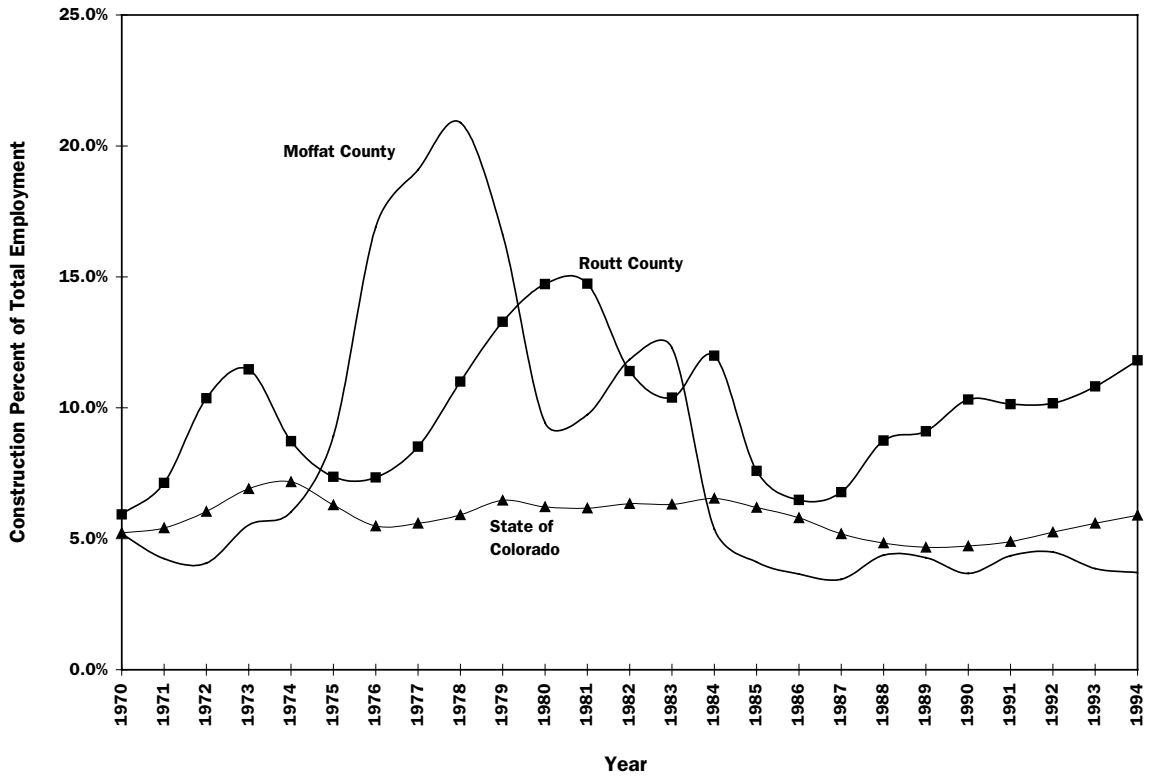
Background. In 1995 there were an annual average of approximately 400 construction jobs in Moffat County and about 2,150 construction jobs in Routt County. Construction employment comprised less than six percent of all employment in Moffat County and more than 13 percent of all employment in Routt County. For comparison, construction jobs made up about 6 percent of all jobs throughout the State of Colorado in 1995. The extraordinary share of Routt County employment accounted for by the construction sector demonstrates that construction is a key part of the current economic growth in the county. The relatively high "wages" or "earnings" of construction workers further accentuates the economic importance of Yampa Valley construction.

Historically, construction employment in the Yampa Valley has been highly volatile, indicative of pronounced economic cycles. Construction jobs comprised as much as 20 percent of Moffat County employment during work on the Craig Station in the late 1970s, but declined to less than five percent of Moffat County jobs by the late 1980s. In Routt County, construction employment represented more than ten percent of total employment during the late 1970s and early 1980s, but it declined to less than eight percent of county jobs during the mid 1970s and late 1980s. Exhibit III-28 depicts the construction sectors share of total employment in each county, and statewide, 1970 to 1994.

Factors affecting future Yampa Valley construction. A number of factors contribute to the recent strength of the second home market in the Steamboat area and corresponding growth of the construction industry in Routt County:

[22] Interviews with Scott Ford, Steamboat Resort Chamber, and Jim Weskott, Colorado State Demographer, 1997.

EXHIBIT III-28.
Construction Sector Share of Total Employment



Source: U.S. Bureau of Economic Analysis, Regional Economic Information System, 1996.

a. despite occasional recessions, the decades since World War II have been a period of unprecedented prosperity for the U.S. economy as a whole,

b. many "baby boomers" are now reaching a point in their lives where they can make decisions based on lifestyle rather than career demands,

c. the Yampa Valley offers a high quality of life, with recent improvements in air service and community amenities; and

d. recent low interest rates have made investments in second homes relatively affordable.

Moffat County, on the other hand, has recovered more slowly from its economic downturn of the late 1980s. Construction employment in Moffat County not only represents a smaller share of total employment than it has for most of the past 25 years, it also represents a smaller share of overall employment in the county than at the statewide level.

Yampa Valley construction projections. A 50-year economic projection cannot, by nature, reflect the vagaries of economic cycles. While Yampa Valley construction

employment will undoubtedly rise and fall during the projection period, the sustainable share of Routt County employment accounted for by construction is likely to be lower than the current share of jobs in the sector. Moffat County construction employment, conversely, is likely to represent a larger share of county jobs in the long-term than it does at present due to the shift of some residential and commercial growth to the western end of the valley.

The 2045 economic and demographic projections incorporate the following assumptions regarding construction employment:

- By 2045, the share of Routt County jobs accounted for by construction will diminish to between ten and eleven percent of all jobs in the county, while Moffat County construction employment will increase to seven to eight percent of all jobs in that county. Overall, the construction sector will represent between nine and ten percent of all Yampa Valley jobs.

SECTION IV.
Economic and Demographic Projections

This section presents projections of employment, population and related variables for the Yampa Valley through the year 2045. The forecasting steps and assumptions are also set forth.

Projected Changes in Total Employment

The projected long-term changes in the Yampa Valley economic base described earlier can be expected to trigger other changes throughout the local economy. Indirect basic business activities provide support materials and services for the economic base industries. For instance, industrial equipment retailers, agricultural coop dealers, or snowmobile repair shops are likely to expand along with the growth in energy, tourism and other parts of the economic base. These direct and indirect basic business expansions will stimulate growth for local service business, catering primarily to the needs of the resident population.

Yampa Valley economic model. To quantify total employment growth resulting from Yampa Valley economic base expansion, BBC developed a model of the Yampa Valley economy by following these steps:

1. Adoption of the 1995 economic base analysis for Moffat and Routt counties prepared by the Colorado Division of Local Government (CDLG) as the starting point;

2. Modification of 1996 employment estimates by sector based upon local interviews and other data sources;

3. Refinement of 1996 "multipliers" — relationships between direct basic, indirect basic and local service employment totals;

4. Incorporation of future direct basic employment changes from the economic base analyses described in Section II;

5. Projection of future multipliers as the economy expands; and

6. Application of 2045 economic base projections and revised multipliers to project total employment.

Employment multipliers are often subject to debate among economists — particularly when the economy in question is nearly 50 years in the future. In larger economies such as metropolitan areas, where consumers and local businesses can find most of the goods and services they require locally, multipliers tend to be higher than in more rural communities. However, the size of the multipliers is also affected by the nature of the economic base. All else being equal, higher paying jobs will support more additional employment in the local area than lower paying jobs.

To envision how the employment multipliers in the Yampa Valley might change over the next 50 years, BBC reviewed CDLG estimates of the multipliers for other counties on the Western Slope. CDLG has undertaken an evaluation of the economic base in a range of large and small western Colorado counties, including Delta County, Gunnison County, La Plata County, Mesa County, Montezuma County and Montrose County. The CDLG analyses indicate that Mesa County, which is the most populous county on the Western Slope, also has the largest multipliers — with an estimated ratio of total jobs to direct basic jobs of more than four to one. Gunnison County, the least populous county examined by CDLG to date, has the smallest estimated multipliers — reflecting a total employment to direct basic employment ratio of less than two to one.

As shown in Exhibit IV-1, BBC anticipates that the structure (and multipliers) of the Yampa Valley economy will change over the next 50 years along with growth in the economic base. Because these structural changes are uncertain, we have included a high case and low case estimate of the future multipliers to capture a reasonably likely range. Reflecting a larger proportion of high paying jobs in energy and other activities, the Moffat County economy is expected to continue to have higher multipliers than the Routt County economy. The Routt County economy will still remain the indirect basic and local service center of the Yampa Valley.

The economic model supporting these total employment projections operates at a detailed level, forecasting employment change for each economic sector. These sectoral projections are important for producing water demand projections. Exhibit IV-2 presents projected changes in employment by sector for the Yampa Valley. Although the economic base analyses incorporated in these projections reflect growth in mining and other energy-related activities, the energy and agricultural sectors represent a smaller share of total employment in the 2045 Yampa Valley economy. Growth in farm and agricultural services employment reflects increases in local service activities classified in this sector, such as veterinary services and landscaping, rather than an increase in commercial agriculture. The trade and services sector will increasingly dominate the Yampa Valley economy.

EXHIBIT IV-1.
Current and Projected 2045 Economic Relationship in the Yampa Valley

	1995	2045 Low Case	2045 High Case
Moffat County			
Total Jobs			
Direct Basic Employment	2,400	4,000	4,300
Indirect Basic Employment	700	1,400	2,000
Local Service Employment	3,400	6,000	7,600
Total Employment	6,500	11,400	13,900
Employment Multipliers			
Indirect Basic/Direct Basic	0.29	0.35	0.47
Local Service/Direct and Indirect Basic	1.10	1.11	1.21
Total/Direct Basic	2.71	2.85	3.23
Routt County			
Total Jobs			
Direct Basic Employment	8,800	17,700	18,000
Indirect Basic Employment	2,300	6,100	8,100
Local Service Employment	5,000	14,300	20,800
Total Employment	16,100	38,100	46,900
Employment Multipliers			
Indirect Basic/Direct Basic	0.26	0.34	0.45
Local Service/Direct and Indirect Basic	0.45	0.60	0.80
Total/Direct Basic	1.83	2.15	2.61

EXHIBIT IV-2.
Current and Projected Yampa Valley Employment
by Major Industrial Sector

	1995		2045 Range					
	Jobs	Share of Total	Jobs			Share of Total		
Farm/Agricultural Services	1,270	5.6%	1,450	to	1,500	2.9%	to	2.5%
Mining	1,150	5.1%	1,930	to	2,090	3.9%	to	3.4%
Construction	2,520	11.2%	4,950	to	5,630	10.0%	to	9.3%
Manufacturing	340	1.5%	1,510	to	2,410	3.1%	to	4.0%
Transportation/Communications/ Public Utilities	1,390	6.2%	2,690	to	3,240	5.4%	to	5.3%
Retail and Wholesale Trade	6,170	27.3%	14,130	to	17,140	28.6%	to	28.2%
Finance/Insurance/Real Estate	1,160	5.1%	2,850	to	3,490	5.8%	to	5.7%
Services	7,330	32.5%	17,240	to	21,660	34.9%	to	35.7%
Government	1,230	5.5%	2,620	to	3,570	5.3%	to	5.9%
Total	**22,560**	**100.0%**	**49,370**		**60,730**	**100.0%**		**100.0%**

Source: BBC Research & Consulting Projections, 1997.

Projected Growth in Population

The link between Yampa Valley employment and the area's population is complex. To develop estimates of the year 2045 Yampa Valley population corresponding to the employment projections, BBC examined:

1. The ratio between the total number of jobs in the employment model, and the number of employed persons, according to the Colorado Department of Labor. This ratio accounts for persons holding multiple or part-time jobs.[1]

2. Commuting patterns between location of residence and place of work.

3. Current and projected labor force participation rates — the measure of the percent of residents between ages 16 and 84 who are either working or actively seeking employment.

4. The proportion of the population that is too young to be in the labor force.

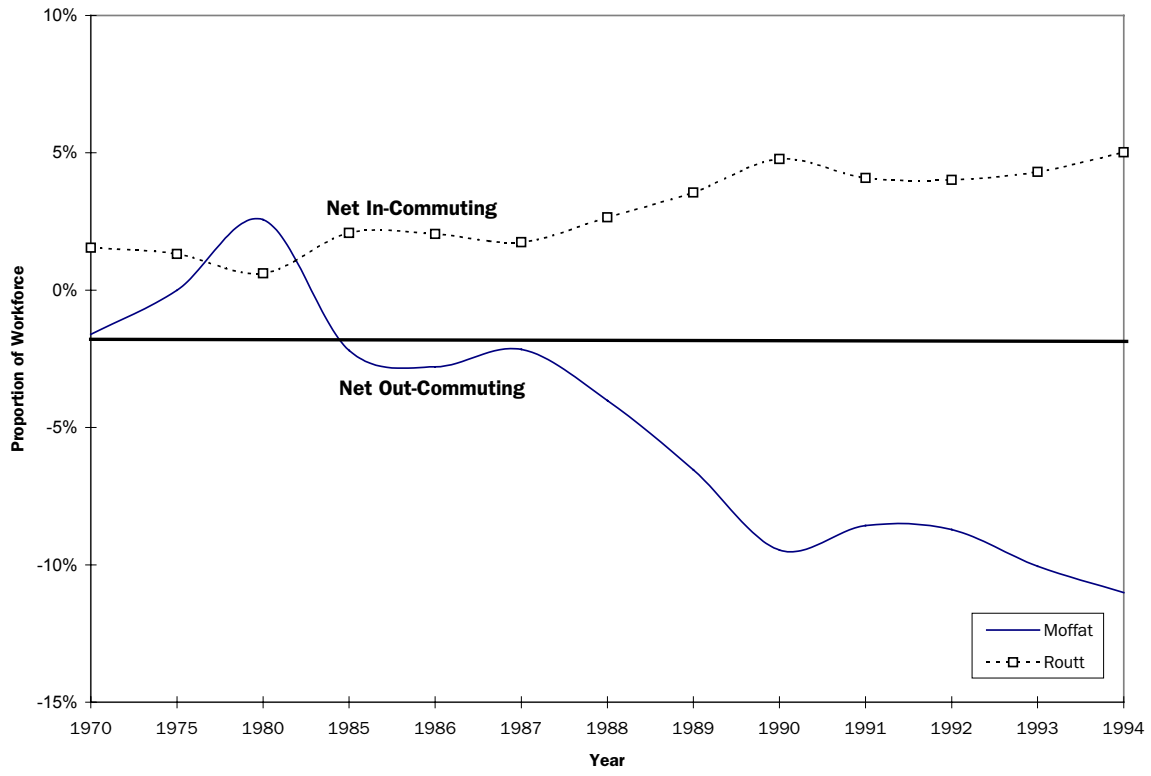
Relationship between jobs and employed residents. BBC compared 1995 estimates of employed persons compiled by CDLG and the Colorado Department of Labor with the number of total jobs in each county. We found that employed Moffat County residents held an average of 1.2 jobs, while employed Routt County residents held an average of 1.6 jobs. Since the total employment estimates include self-employed positions and part-time jobs, and given that multiple job holding is relatively common in resort communities, these results are logical. Allowing for similar patterns of multiple job holding in the future,

[1] Total jobs in the Yampa Valley economic model correspond to the definitions used by the U.S. Bureau of Economic Analysis and includes self-employed proprietors and part-time jobs.

projected 2045 Yampa Valley employment of about 49,400 jobs (low case) corresponds to about 33,200 employed persons. The high case employment projection of about 60,700 jobs, corresponds to approximately 40,900 employed persons.

Commuting. How many employed Yampa Valley residents in 2045 will live in Routt County versus Moffat County? As housing costs continue to rise in the Steamboat Springs area relative to other parts of the Yampa Valley, more and more workers are commuting substantial distances from home to work. Community leaders are well aware of this phenomenon and have examined transportation alternatives and considered the fiscal implications of increased commuting for Craig and other communities.[2] As depicted in Exhibit IV-3, BBC's analysis of BEA county income data indicates that since 1985, net in-commuting to Routt County (the proportion of Routt County jobs held by residents of other counties) has increased from about two percent to more than five percent. During the same time period, net out-commuting from Moffat County (the proportion of Moffat County workers employed outside of the county) has grown from about three percent to about ten percent.

EXHIBIT IV-3.
Net Commuting as Proportion of Workforce, 1975-1994



[2] BBC interviews with Craig City Manager, Moffat County Planner, Moffat County Commissioners, Routt County Commissioners and Routt County Planning Staff, 1997.

The economic pressures encouraging daily commuting out of Moffat County and into Routt County are likely to continue in view of the economic growth projections described earlier. For the 2045 population projections by county, BBC has projected that eight percent of the jobs in Routt County, approximately 1,900 to 2,300 persons, will be held by individuals residing outside the county, primarily in Moffat County. These commuters will make up about 20 percent of the Moffat County labor force.

Labor force participation rates and demographics. In addition to people who will be employed in 2045 in the Yampa Valley, the future population will also include people who do not work and individuals who are too young or too old to be in the labor force. In 1995, about 73 percent of Moffat County residents between the ages of 16 and 84 either worked or were seeking employment. At the same time, about 78 percent of Routt County residents in the same age range participated in the labor force.

Projections by CDLG indicate that the aggregate labor force participation rates for the Yampa Valley are expected to decline somewhat by 2020, reflecting changes in the age structure of the population within the 16 to 84 range as well as national projections of labor force participation changes by age cohort. Since labor force participation projections are not available beyond 2020, the 2045 projections in this study incorporate the projected 2020 participation rates. These projected participation rates are slightly below 70 percent in Moffat County and slightly below 73 percent in Routt County.

In 1995, 27 out of every 100 Moffat County residents and 20 out of every 100 Routt County residents were either under the age of 16 or over the age of 84. The CDLG demographic model indicates that the share of the population that is too young or too old to be in the labor force will decrease to 23 percent in Moffat County by 2020. No change in this share is anticipated for Routt County. In developing the 2045 population projections, BBC has incorporated the projected age structure for each county from the 2020 CDLG projections.

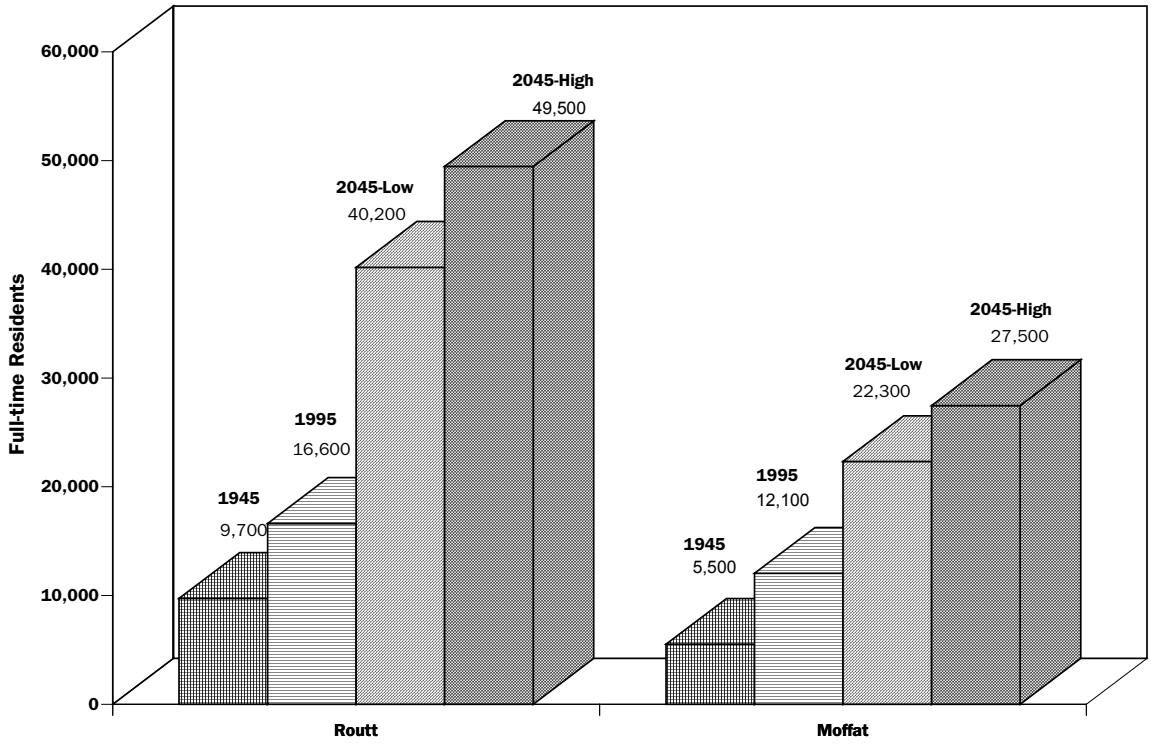
Projected population totals. Based upon the preceding links between employment and population, the 2045 Yampa Valley employment projections can be used to derive the projected population. These calculations are summarized in Exhibit IV-4. The low end of the projected Yampa Valley employment range in 2045 (approximately 49,300 jobs) is consistent with a combined population in Moffat County and Routt County of about 62,500 residents. The high end of the projected employment range (about 60,700 jobs) is consistent with a combined population of about 77,000 residents.

There are several ways to evaluate the projected growth in Yampa Valley population over the next 50 years. Exhibit IV-5 depicts the historic population totals of Moffat County and Routt County in 1945 and 1995, as well as the projected totals for each county in 2045. Total projected population growth for each county over the next 50 years is greater than the total increase in population experienced during the past 50 years.

EXHIBIT IV-4.
Current and Projected Population to Employment Relationship

	1995		2045 - Low		2045 - High	
	Moffat	Routt	Moffat	Routt	Moffat	Routt
Local Jobs - BEA Based	6,429	16,123	11,284	38,070	13,884	46,845
Locally Employed Residents	5,346	10,116	9,384	23,886	11,546	29,392
Commuting Residents	589	(507)	1,877	(1,911)	2,309	(2,351)
Total Employed Residents	5,934	9,609	11,260	21,975	13,855	27,041
Unemployment Rate	6.1%	4.2%	6.0%	6.0%	6.0%	6.0%
Unemployed Residents	386	421	719	1,403	884	1,726
Total Labor Force	6,320	10,030	11,979	23,378	14,739	28,767
Labor Force Participation Rate	72.7%	77.8%	69.7%	72.8%	69.7%	72.8%
Total Labor Force Age Population	8,693	12,892	17,187	32,113	21,147	39,515
Non-Labor Force Age Proportion of Total Population	27%	20%	23%	20%	23%	20%
Total Population	**11,940**	**16,200**	**22,320**	**40,190**	**27,460**	**49,450**

EXHIBIT IV-5.
Historic and Projected Population Totals by County

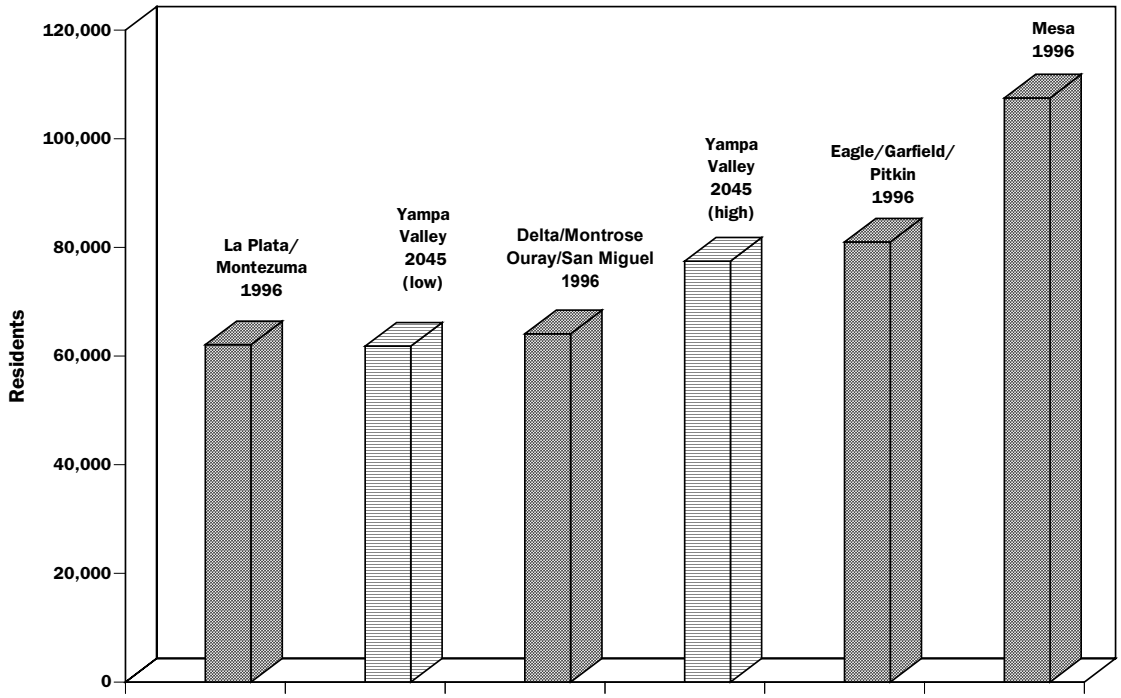


Source: U.S. Bureau of Census; BBC Research & Consulting.

In terms of the average annual rate of population growth, the Moffat County projections imply population increases of between 1.2 percent and 1.6 percent per year, compared to an average rate of increase since 1945 of about 1.6 percent per year. The Routt County projections imply average population growth of 1.8 percent to 2.2 percent per year, compared to an average rate of growth of only 1.1 percent between 1945 and 1995. As discussed at the outset of this section, Routt County actually declined in population from 1945 through the mid-1960s. Since 1970, Routt County's population has grown at an average rate of more than 3.5 percent per year.

Exhibit IV-6 places the projected 2045 population of the Yampa Valley in the context of the current populations of other regions on Colorado's Western Slope. Under the low end of the projected population range, the Yampa Valley population would be roughly comparable to the 1996 population of the Durango and Cortez area (La Plata County and Montezuma County) or the 1996 population of the Delta and Montrose area. Under the high end of the projected population range for 2045, the Yampa Valley population would be similar to the 1996 population of the Vail/Aspen/Glenwood Springs area. Of course, these other Western Slope areas are also likely to experience continued growth and have substantially larger populations in 2045 than the 1996 totals shown in Exhibit IV-6.

EXHIBIT IV-6.
Visualizing the Yampa Valley Population Projections



Source: Colorado Division of Local Governments; BBC Research & Consulting.

Interim Economic and Demographic Projections for 2025

A secondary purpose of this study was to develop interim projections of Yampa Valley water demands, approximately 25 years in the future. These projections may be used for evaluating possible infrastructure investments in the relatively near future. To provide a basis for 2025 water demand estimates, interim economic and demographic projections were also developed.

2025 Yampa Valley employment projections. Employment projections for the Yampa Valley in 2025 were developed using a similar approach to the 2045 projections. Each component of the economic base was re-examined to estimate the amount of the projected change between the present and 2045 which could be reasonably expected to occur within the next 25 to 30 years. These revised economic base projections were then incorporated in the Yampa Valley economic model, described previously, to project total employment. The multipliers used to convert the economic base projections for 2025 into total employment reflect some structural change from the present, but less change than anticipated in the 2045 projections.

Total employment projections, by sector, for the Yampa Valley in 2025 are presented in Exhibit IV-7.

2025 Yampa Valley population projections. The interim, 2025 population projections again reflect the same approach used in developing the 2045 projections. Total employment was converted to an estimate of employed persons which was then used to project population based on labor force participation rates and an estimate of the share of the population below age 16 and over 84. Commuting patterns used in developing the county-specific 2025 population projections reflect a smaller proportion of commuters in the workforce than in the 2045 projections, but more prevalent commuting than in 1997.

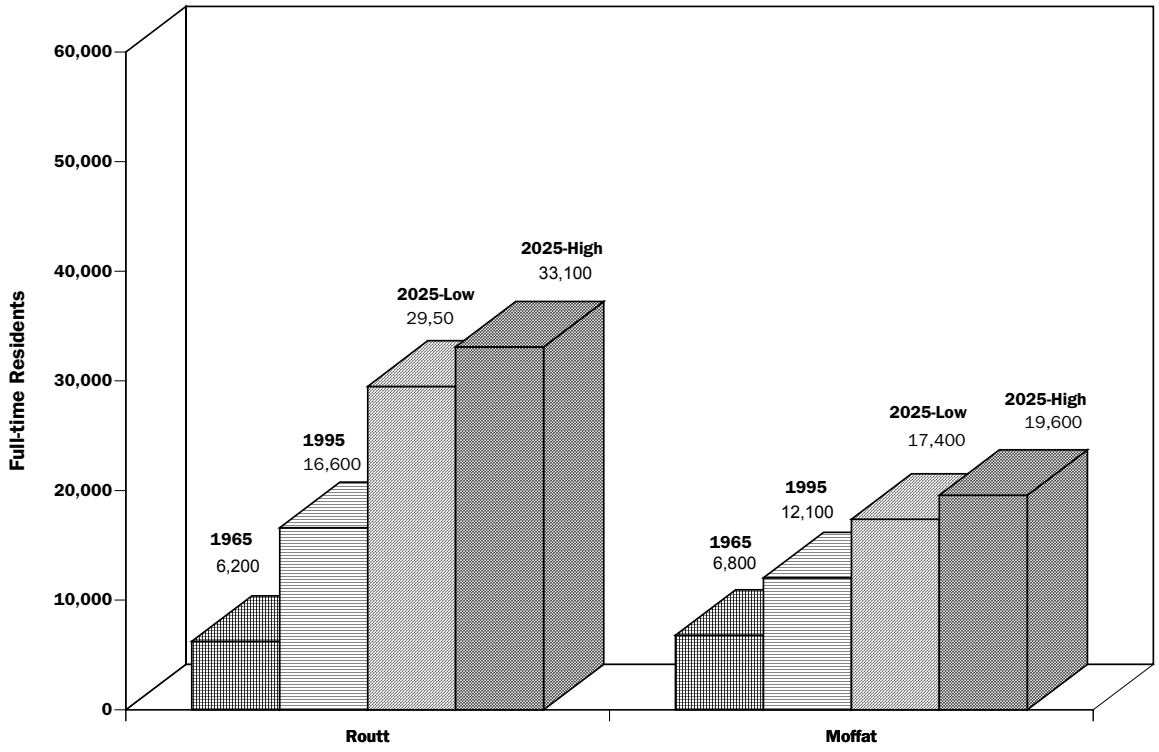
The range of projected 2025 total population in the Yampa Valley is between 46,900 and 52,700 residents. Exhibit IV-8 displays the projected 2025 population by county. Routt County population is projected to perhaps double by 2025 while Moffat County population is anticipated to increase by as much as one half.

EXHIBIT IV-7.
Current and Projected Yampa Valley Employment
by Major Industrial Sector-Interim Projections (2025)

	1995		2045 Range					
	Jobs	Share of Total	Jobs			Share of Total		
Farm/Agricultural Services	1,270	5.6%	1,380	to	1,410	3.8%	to	3.4%
Mining	1,150	5.1%	1,450	to	1,580	4.0%	to	3.8%
Construction	2,520	11.2%	3,860	to	4,140	10.5%	to	10.1%
Manufacturing	340	1.5%	1,090	to	1,535	3.0%	to	3.7%
Transportation/Communications/ Public Utilities	1,390	6.2%	1,880	to	2,080	5.1%	to	5.1%
Retail and Wholesale Trade	6,170	27.3%	10,410	to	11,550	28.4%	to	28.1%
Finance/Insurance/Real Estate	1,160	5.1%	2,050	to	2,300	5.6%	to	5.6%
Services	7,330	32.5%	12,570	to	14,250	34.3%	to	34.6%
Government	1,230	5.5%	1,960	to	2,320	5.3%	to	5.6%
Total	**22,560**	**100.0%**	**36,690**		**41,165**	**99.9%**		**100.0%**

Source: BBC Research & Consulting Projections, 1997.

EXHIBIT IV-8.
Historic and Projected Population Totals by County
Interim Projections for Year 2025



Source: U.S. Bureau of Census; BBC Research & Consulting.

SECTION V.
Water Demand Projections

The long-term Yampa Valley economic and demographic projections set forth in Section IV provide the foundation for corresponding estimates of future water demands. This section describes current water use in the Yampa Valley, water use by sector and projected 2025 and 2045 water demands. We have used the term *base case* water demand projections to describe those which rely upon the Section III economic base assumptions and the Section IV employment and population assumptions.

At the conclusion of this section, BBC offers sensitivity analyses of the effects of alternative economic development scenarios for the Yampa Valley and corresponding effects on long-term water demands.

Current Water Demand in the Yampa Valley

The primary data source for water diversions in the Yampa Valley are records kept by the Colorado Division of Water Resources, Division 6 Engineer. As well as detailed records for each diversion structure, these data provide annual diversion totals by water district and type of water use.[1]

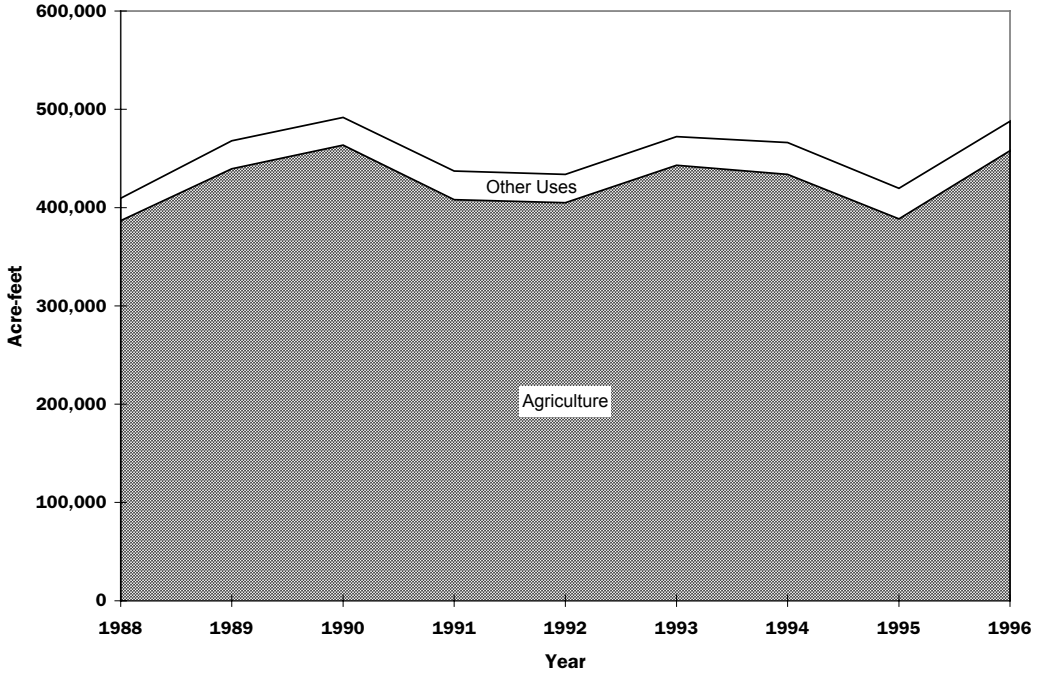
Unlike the economic and demographic information provided in the previous section, the geographic boundaries used by the Division Engineer correspond to watersheds rather than the political boundaries of Moffat and Routt counties. Nonetheless, the aggregated area consisting of water districts 44, 54, 55, 56, 57 and 58 corresponds reasonably closely to the county boundaries. Exhibit V-1 shows the geographic area covered by aggregating the Division Engineer's records overlayed upon the county geographical boundaries of Moffat County and Routt County.

[1] Annual diversion summary reports by water district provided by Colorado Division of Water Resources, Division 6 Engineer's office.

[Insert Exhibit V-1, map of water districts and counties]

Over the past nine years, total water diversions in the Yampa Valley have ranged between 400,000 acre-feet per year and 500,000 acre-feet per year. Based upon relationships between diversions and consumptive use discussed later in this section, annual consumptive use has varied from about 110,000 acre-feet to 130,000 acre-feet. As shown in Exhibit V-2, the variation in annual diversions reflects primarily the variability in annual agricultural diversions, while non-agricultural uses are relatively consistent. Agricultural water use varies from year-to-year depending upon climate conditions, availability of water and the number of acres under irrigation.

EXHIBIT V-2.
Annual Water Diversions in the Yampa Valley, 1988-1996



Source: CDWR, Division 6 Annual Summaries for Water Districts 44, 54, 55, 56, 57 and 58.

For purposes of developing water use projections, Division Engineer's records were supplemented with additional information regarding specific types of water use, including:

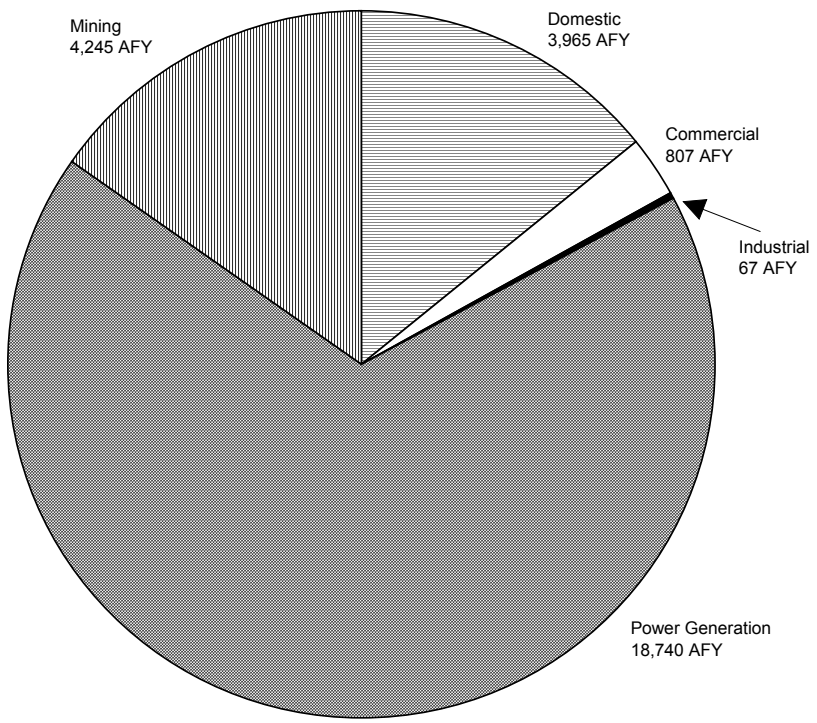
- 1985 and 1990 U.S. Geological Survey National Water Use Data for Moffat County and for Routt County (USGS data);
- data and information supplied by municipal utilities providing water to Steamboat Springs, Craig and Hayden;
- data contained in the 1993 *Yampa River Basin Alternatives Feasibility Study*;

- water use factors for varied commercial and industrial uses based on national surveys; and

- interviews with managers of mines, power plants, golf courses and the Steamboat Ski Corporation.

Although available only for the years 1985 and 1990, the USGS data provides somewhat more detail concerning water use by sector. Geographic boundaries for USGS data correspond to the county political boundaries. Exhibit V-3 provides a breakdown of USGS 1990 non-agricultural water use in the Yampa Valley, demonstrating the predominant influence of energy sector activities on Yampa Valley water use. Water used for cooling the thermoelectric plants at Craig and Hayden and for mining purposes accounted for more than 80 percent of non-agricultural Yampa Valley water withdrawals in 1990.

EXHIBIT V-3.
USGS Estimates of 1990 Non-Agricultural Water Withdrawals by Sector in the Yampa Valley



Source: U.S. Geological Survey National Water Use Data, 1990.

Water Demand Factors

Water demand factors, such as gallons per capita per day for residential use or gallons per killowatt of electricity generated, provide the link between the economic and demographic projections for the Yampa Valley described in Sections III and IV and estimates of future water demands. BBC examined recent water diversions and consumption for each major category of water use in the Yampa Valley to develop these assumptions.

Where possible, three separate water demand factors were identified — corresponding to actual water demand in 1995, "normal" water demand based on average water use factors over several years and "high demand" conditions when drought and/or other external factors such as maximum power needs generate unusual water requirements.

Irrigation. Irrigation water demand factors were developed from analysis of the Division 6 Engineer's records for the period 1981 through 1996. Annual water diversion summaries produced by the Division Engineer's office provide data on the number of acres irrigated, total diversions and average acre-feet diverted for each water district within Division 6.

Both the number of acres under irrigation and the average water use per acre vary considerably from year to year. To establish typical values in a "normal" year, BBC used the average water use per acre and number of acres under irrigation during the 1990s. To examine potential increases in irrigation water demands under "high demand" conditions, BBC incorporated the "normal" irrigated acreage and the highest water use per acre (1982) in the Division Engineer's records since 1981.

The following estimates were incorporated in the water demand projections:

- 1995 irrigated acres 87,600
- "Normal" irrigated acreage 86,980
- 1995 water diversions per acre 4.23 acre-feet
- "Normal" diversions per acre 4.70 acre-feet
- "High Demand" diversions per acre 6.20 acre-feet
- Consumptive use per acre-foot diverted 0.21 acre-feet

The above irrigation water demand factors relate to the aggregation of water districts highlighted in Exhibit V-1, roughly corresponding to the combined geographic boundaries of Moffat County and Routt County. A more narrow focus on the Yampa River basin above the confluence with the Little Snake River (corresponding to water districts 44, 57 and 58 only) would result in approximately 18 percent fewer acres under irrigation for 1995 and about 13 percent lower water use per acre. However, the projected agricultural water use under this more narrow focus, compared with 1995, would not substantially change the

incremental or new future water requirements under the base case projections.

The broader geographic definition of the Yampa River Valley was selected for this study to correspond with the economic and demographic projections which followed political boundaries of the counties.

Thermoelectric demand. Current water demand factors for purposes of cooling the coal-fired power plants at Craig and Hayden were based upon interviews with managers at the Hayden Station and Tri-State Generation and Transmission Corporation, as well as analysis of the Division Engineer's records of water diversions and U.S. Department of Energy Administration records on annual power generation at each plant.

Estimated normal demand reflects analysis of water diversion and electric generation data from 1985 through 1995. High demand use factors incorporate the largest water use coefficients over this historical period for each generating station.

- 1995 diversions per gigawatt hour generated —
  - Craig Station 1.46 acre-feet
  - Hayden Station 1.40 acre-feet
- "Normal" diversions per gigawatt hour generated —
  - Craig Station 1.47 acre-feet
  - Hayden Station 1.60 acre-feet
- "High Demand" diversions per gigawatt hour generated —
  - Craig Station 1.64 acre-feet
  - Hayden Station 1.77 acre-feet
- Consumptive use per acre-foot diverted 1.00 acre-feet

Interviews with the manager of the Hayden Station indicated that water use at the plant is expected to increase by approximately 15 percent in the future due to the installation of new emission controls.[2] This increase was incorporated in the water demand projections discussed later in this section.

The 2045 water demand projections for electric generation also reflect two additional assumptions. As discussed in Section III, utilization of the existing units at the Craig and Hayden plants is projected to increase to 90 percent of capacity. Secondly, the economic and demographic projections for 2045 incorporated the assumption that two 400 megawatt IGCC units would be added in the Yampa Valley.

Analysis of data from pilot IGCC projects and interviews with U.S. Department of Energy representatives indicate that commercial IGCC plants are expected to require approximately 20 percent less water for cooling than conventional plants due to higher efficiency. However, these plants are fed by coal slurry pipelines, requiring an estimated

[2] Interview with Frank Roitsch, Manager of the Hayden Station, 1997.

615 acre-feet per year per plant for the coal slurry feed. Based upon this information, each 400 megawatt IGCC unit is anticipated to require approximately 4,400 acre-feet of water per year.[3]

Residential and commercial water demand. Developing estimates of water demand factors for residential and commercial purposes was complicated by several issues, including considerable variation in water use among the three major municipal systems in the Yampa Valley (Craig, Hayden and Steamboat Springs) and the differences between the Division Engineer reports of municipal, domestic and commercial use and the estimates of the USGS. In 1990, the Division Engineer reported water diversions for municipal, domestic and commercial purposes of more than 7,000 acre-feet in water districts 44, 57 and 58 alone. For the same year, USGS estimated that water demand for these purposes in the larger geographic area encompassing both counties was less than 4,700 acre-feet per year.

To resolve the inconsistency in the aggregate estimates and make use of more detailed annual information, BBC relied primarily on data obtained from the three largest municipal water systems in the Yampa Valley to develop water demand factors for residential and commercial use. BBC analyzed water sales and production data for recent years for each of the municipal systems and interviewed the system managers.

The substantial number of visitors to the Yampa Valley must be recognized in developing water demand factors for residential use. Following the precedent established during the Fish Creek EIS for Steamboat Water, BBC estimated the size of the annual equivalent population represented by tourists to the area.[4] Based upon monthly lodging data obtained from the Steamboat Resort Chamber and seasonal water use patterns, we concluded that water use by visitors to the Yampa Valley was equivalent to the amount of water that would have been used by an additional 5,580 residents in 1995.

Residential and commercial water demand factors were developed by comparing annual water use with a corresponding estimate of the population and commercial employment in each municipal service area. The population estimate included the visitor population equivalent estimate, while the commercial employment estimate included all employment except for jobs in agriculture, mining, power generation and manufacturing. The following water demand factors were derived from these analyses:

- "Normal" residential water use per day — 140 gallons/capita
- "High demand" residential water use per day — 175 gallons/capita
- "Normal" commercial water use per day — 50 gallons/employee
- "High demand" commercial water use per day — 62 gallons/employee

[3] BBC estimates based on interviews with Robert Kornosky, Office of Project Management, Federal Energy Technology Center and Nelson Rekos, Project Manager for the Tampa Electric Integrated Gassification Combined Cycle Project, 1997.

[4] *Baseline Technical Report*, Fish Creek EIS, ACZ Incorporated, 1992.

- Residential consumptive use per acre-foot diverted 0.30 acre-feet

- Commercial consumptive use per acre-foot diverted 0.15 acre-feet

The estimated water demand factors for residential and commercial use include an allowance for system losses. Consumptive use per acre-foot diverted was estimated based on the USGS data for 1985 and 1990.

The reasonableness of the "normal year" water demand factors was tested against historical water sales data for Craig, Hayden and Steamboat in 1992, 1993, and 1994. Based upon estimates of the resident equivalent population and commercial employment total for each area in the same year, the factors produced estimated water requirements for the three systems within two percent of actual use, on average. Across the Yampa Valley as a whole, the residential and commercial water demand factors were used to backcast 1990 water diversions, producing an estimate of about 5,750 acre-feet. This estimate is lower than the Division Engineer's summary for 1990, but higher than the USGS estimate for the same year.

Mining demands. In the Yampa Valley, water is used for both coal mining purposes and for sand and gravel mining (largely evaporative use). Coal mining water demand factors were developed based on interviews with mine representatives and mine production data. Water use in sand and gravel mining was assumed to vary in relation to the size of the population as a whole (since this type of use is primarily tied to construction of roads and other infrastructure).

The following mining water demand factors were estimated:

- Coal mining 160 acre-feet/million tons produced

- Sand and gravel mining 76 acre-feet/thousand residents

- Consumptive use per acre-foot diverted 0.50 acre-feet

Industrial demands. Yampa Valley water demand per employee for manufacturing purposes was calculated based upon the 1985 and 1990 USGS estimates of water requirements for this sector and employment in the manufacturing sector during the same years. Yampa Valley water demand factors for manufacturing were estimated at:

- Manufacturing water demand per day 337 gallons/employee

- Consumptive use per acre-foot diverted 0.36 acre-feet

Given the relatively small size of the existing Yampa Valley manufacturing sector, the range of possibilities regarding the types of future manufacturing activities in the area, and substantial variation in water demands among different types of manufacturing, the industrial water use factor could change considerably in the future. Current Yampa Valley

water demand per employee is greater than typical water demand for certain manufacturing activities, but lower than average use in industries such as food processing, textile products and petroleum and coal products.[5]

Livestock demand. Division Engineer reports of annual diversions for livestock water demand indicate substantially greater diversions from 1992 through 1996 than in previous years. However, interviews with staff suggest that the increase probably reflects better tracking of water use rather than an actual increase in diversions. Given the economic projections of stability in the agricultural sector, "normal" water demand for livestock purposes was based on the average diversions from 1992 through 1996, while "high demand" requirements were based upon the 1993 report of diversions for livestock. Consumptive use per acre-foot diverted was based upon USGS data.

- 1995 diversions for livestock — 18,236 acre-feet
- "Normal" diversions for livestock — 17,301 acre-feet
- "High demand" diversions for livestock — 19,268 acre-feet
- Consumptive use per acre-foot diverted — 0.16 acre-feet

Snowmaking and golf demand. BBC reviewed Division Engineer reports of annual diversions for snowmaking and interviewed representatives of the Steamboat Springs ski area and local golf courses to estimate water use for these activities.[6] The following water demand factors reflect the economic assumptions of future increases in skiable terrain at Steamboat, possible development of an additional ski area during the next 50 years, and a projected total of six golf courses in the Yampa Valley by 2045:

- 1995 diversions for snowmaking — 303 acre-feet
- "Normal" current diversions for snowmaking — 271 acre-feet
- "Normal" diversions for snowmaking in 2045 — 810 acre-feet
- "High demand" diversions for snowmaking in 2045 — 2,430 acre-feet
- "Normal" current diversions for golf — 150 acre-feet
- "Normal" diversions for golf in 2045 — 450 acre-feet
- "High demand" diversions for golf in 2045 — 675 acre-feet

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[5] Average Rates of Nonresidential Water Use from Establishment Level Data, Planning and Management Consultants, Ltd., 1994. Cited in *Water Resources Handbook*, McGraw-Hill, 1996.

[6] Interviews with Robert Koosinan, Mountain Operations at Steamboat Ski Corporation and Bill Wheelihan, Haymaker Golf Course, 1997.

- Consumptive use per acre-foot diverted, snowmaking 0.20 acre-feet
- Consumptive use per acre-foot diverted, golf 0.30 acre-feet

Export and reservoir evaporation. Yampa Valley water requirements also include exports out of the Yampa Basin from three existing transbasin diversions to the Colorado River basin — the Stillwater Ditch, the Dome Creek Ditch and the Sarvis Ditch — and evaporation from Yampa Valley reservoirs. Water use for export and evaporation was projected on the basis of the Division Engineer's records from 1981 through 1996. These projections did not assume development of new reservoirs or enlargement of existing facilities, nor development of additional transbasin diversions.

- 1995 diversions for export 4,209 acre-feet
- "Normal" diversions for export 3,383 acre-feet
- "High demand" diversions for export 4,788 acre-feet
- Annual reservoir evaporation 6,769 acre-feet
- Consumption per acre-foot exported/evaporated 1.00 acre-feet

Potential for conservation efforts to change water use factors over time. The water use factors just described largely reflect current practices in the Yampa Valley. In theory, these use factors could change over the next 50 years in response to conservation efforts, new technologies or changes in the cost of water supplies.

As the largest water-using activity in the Yampa Valley, irrigation would appear to offer the greatest opportunity for water conservation. The water efficiency of Yampa Valley irrigation is not high, due to system losses and evapotranspiration.[7] Irrigation technology and practice in the Yampa Valley has changed very little over the past 100 years.[8] However, while irrigation conservation practices — such as lining canals or installing sprinkler systems — are theoretically possible, the marginal economics of Yampa Valley agriculture suggest that investment in agricultural water conservation is unlikely to be financially feasible without substantial subsidies. Return flows from current irrigation practices are also an integral part of the system in 1997, as farms depend upon the irrigation practices of one another. Hence, institutional and financial support will likely be necessary to accomplish any substantial new agricultural water conservation.

Electric generation is the second largest water-using activity in the Yampa Valley. As discussed previously, new IGCC units would be expected to use less water per megawatt hour of generation than the existing units at the Craig and Hayden powerplants.

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[7] Interviews with the Division Engineer's office.

[8] Interviews with the Routt County Extension Agent, 1997.

This added efficiency has been incorporated in the water demand projections discussed later in this section. Any water savings from existing water-cooled units are unlikely, given the capital cost necessary to accomplish such water conservation.

The most realistic potential for future water savings through conservation might be in residential and domestic use. Steamboat Springs has successfully implemented conservation measures and already reduced water use on a per capita basis over the past decade. Conservation gains might be possible in Craig and Hayden as well. However, due to the relatively modest proportion of Yampa Valley water use accounted for by residential and commercial demands, future municipal conservation is unlikely to have a large impact on overall water demands. There could be other social and environmental reasons to pursue water conservation from the municipal sector, but effects on the outcome of this study would be negligible.

Base Case Water Demand Projections for 2045

The base case water demand projections for 2045 incorporate the economic and demographic projections described in Sections II and III of this report, as well as the water use factors by activity just described. Three sets of projections were produced for the base case, reflecting the low and high range of 2045 population and employment projections, plus the high end 2045 economic and demographic projections coupled with "high demand" conditions for water use.

Base case projected 2045 water diversions. Under the base case projections, annual water diversions in the Yampa Valley under "normal" year conditions are projected to increase from about 464,000 acre-feet per year at present to between 492,000 and 497,000 acre-feet per year. Under "high demand" conditions, water diversions in 2045 could be as much as 622,000 acre-feet per year. Exhibit V-4 depicts annual diversions, by type of water use, in 1995 and 2045.

Base case projected 2045 water consumption. Annual water consumption, under the base case projections, is anticipated to increase from about 119,000 acre-feet per year at present under normal conditions to between 138,000 and 140,000 acre-feet per year in 2045. Under high demand conditions, consumption in 2045 could be as much as 169,000 acre-feet per year under the base case projections. Annual current consumption estimates and projected future consumption, by type of water use, are summarized in Exhibit V-5.

EXHIBIT V-4.
Estimated 1995 and Projected 2045 Base Case Water Diversions

	Estimated 1995 Water Diversions		Projected 2045 Water Diversions Base Case		
	Actual	Normal Year	Low Range	High Range	High Range/ High Demand
Irrigation	370,320	408,674	408,674	408,674	520,390
Livestock Use	18,236	17,301	17,301	17,301	19,268
Municipal/Domestic	5,379	5,379	11,640	13,899	17,373
Commercial	1,063	1,063	2,446	3,011	3,764
Thermoelectric Generation	16,431	16,613	29,928	29,928	32,348
Mining	4,751	4,751	10,350	11,270	11,270
Industrial	166	166	571	911	911
Snowmaking/Golf	453	421	947	947	2,165
Export	4,209	3,383	3,383	3,383	4,788
Reservoir Evaporation	6,769	6,769	6,769	6,769	6,769
Total	**427,777**	**464,520**	**492,009**	**496,093**	**619,046**
Total, excluding agriculture	**39,221**	**38,545**	**66,034**	**70,118**	**79,388**

Source: BBC Research & Consulting, 1998.

EXHIBIT V-5.
Estimated 1995 and Projected 2045 Water Consumption

	Estimated 1995 Water Diversions		Projected 2045 Water Diversions Base Case		
	Actual	Normal Year	Low Range	High Range	High Range/ High Demand
Irrigation	77,767	85,822	85,822	85,822	109,282
Livestock Use	2,918	2,768	2,768	2,768	3,083
Municipal/Domestic	1,614	1,614	3,492	4,170	5,212
Commercial	159	159	367	452	565
Thermoelectric Generation	16,431	16,613	29,928	29,928	32,348
Mining	2,375	2,375	5,175	5,635	5,635
Industrial	60	60	205	328	328
Snowmaking/Golf	106	99	234	234	500
Export	4,209	3,383	3,383	3,383	4,788
Reservoir Evaporation	6,769	6,769	6,769	6,769	6,769
Total	**112,408**	**119,662**	**138,143**	**139,489**	**168,510**
Total, excluding agriculture	**31,723**	**31,072**	**49,553**	**50,899**	**56,145**

Source: BBC Research & Consulting, 1998.

Sensitivity Evaluation (Upper and Lower Bounding Scenarios)

The base case water demand projections for 2045 reflect the reasonably foreseeable economic and demographic changes in the Yampa Valley discussed in Sections III and IV of this report. Over a 50-year period, however, changes may occur in technology and economic and demographic conditions which cannot be foreseen at present. BBC developed upper and lower bounding scenarios to provide an assessment of how the water demand projections might change under alternative future assumptions. These scenarios incorporate modifications to the base case assumptions, as described below.

Alternative assumptions in upper bounding scenario for 2045 water demand. Relative to the base case projections, several assumptions regarding the future development of Yampa Valley economic base activities were modified to produce the upper bounding scenario for 2045 water demands:

- 100 percent increase over current electric generation capacity in Yampa Valley — four 400 MW IGCC units and corresponding increase in coal mining (versus 2 400 MW IGCCs in base case).

- Tourism activity increases to three times current levels (versus 2.1 times in base case).

- Additional 1,000 employees in manufacturing.

- 15 percent increase in irrigated acreage, consistent with upper-end of recent historical experience.

The assumptions represent the outer limit, in BBC's view, of what may happen on the high end of Yampa Valley economic development. These changes in the magnitude of projected growth in economic base activities produce corresponding increases in indirect-basic and local service employment in the Yampa Valley. Overall population in the Yampa Valley would be approximately 25,000 greater than under the base case projections. The upper bound water demand projections also incorporate the assumption of "high demand" conditions for water use in each category.

Alternative assumptions in lower bounding scenario for 2045 water demand. To develop a lower bound scenario for 2045 water demands in the Yampa Basin, BBC incorporated the following revisions to the base case assumptions:

- 25 percent increase in electric generation capacity in Yampa Valley — one 400 MW IGCC unit (versus 2 400 MW IGCCs in base case).

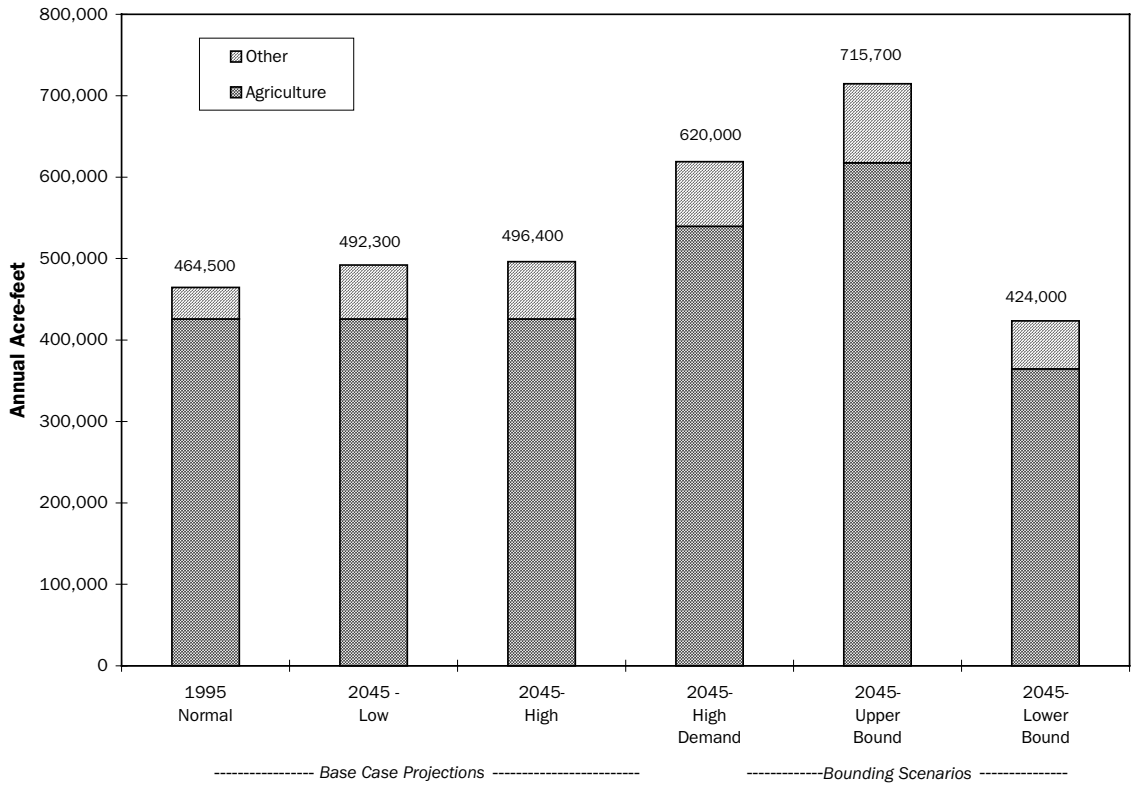
- Coal sales to utilities outside of the Yampa Valley held constant at current levels.

- 15 percent decrease in irrigated acreage, consistent with lower-end of recent historical experience.

These modifications from the base case assumptions produce corresponding decreases in indirect-basic and local service employment in the Yampa Valley. The overall population in the Yampa Valley would be approximately 2,500 lower than under the base case projections. The lower bound water demand projections also incorporate the assumption of "normal" demand conditions for water use in each category.

2045 demand projections — comparison of bounding scenarios with the base case. Exhibit V-6 compares current water diversions under "normal" demand conditions with projected water diversions under the base case and bounding scenarios in 2045. Under the upper bound scenario (incorporating high demand water use conditions), annual diversions in 2045 are projected at nearly 716,000 acre-feet per year — about 96,000 acre-feet more than under the base case, high demand projections. Under the lower bound scenario, projected annual diversions of 424,000 acre-feet per year in 2045 would be less than current "normal" year diversions of about 464,500 acre-feet. The reduction in irrigated acreage assumed under the lower bound scenario more than offsets increased diversions by 2045 for non-agricultural purposes. Appendix C presents the detailed sensitivity results.

EXHIBIT V-6.
Alternative Scenarios of Annual Yampa Valley Water Diversions for Year 2045

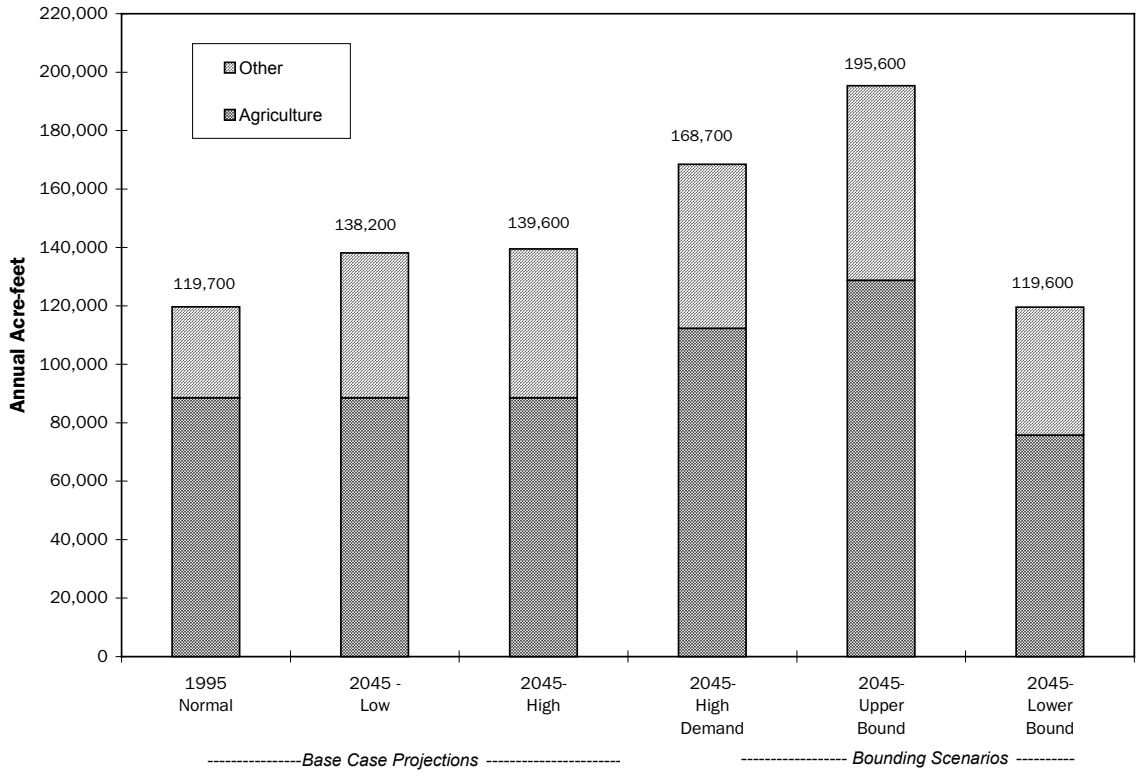


Source: BBC Research & Consulting, 1998.

Exhibit V-7 provides a comparison of current annual water consumption in the Yampa Valley with alternative 2045 projections. Under the 2045 base case projections, annual consumption under normal water demand conditions would be approximately 20,000 acre-feet greater than current consumption. Base case annual water consumption under 2045 high demand conditions would be approximately 49,000 acre-feet greater than current consumption under normal conditions.

Upper bound annual water consumption in 2045 is projected at slightly more than 195,000 acre-feet per year, an increase of about 75,000 acre-feet from current consumption. Lower bound water consumption in 2045 would be approximately equal to current annual consumption, with increases in non-agricultural consumption offset by decreases in irrigated use.

EXHIBIT V-7.
Alternative Scenarios of Annual Yampa Valley Water Consumption for Year 2045



Source: BBC Research & Consulting, 1998.

Interim Water Demand Projections for 2025

Water needs for year 2025 were also projected as part of this study. Interim projections of diversions and consumption in year 2025 were developed based upon the interim economic and demographic growth projections described in Section IV and the water use factors discussed earlier in this section.

By 2025 annual Yampa Valley water diversions are projected to increase by 17,000 to 19,000 acre-feet compared to current diversions under normal water demand conditions. Exhibit V-8 depicts projected water diversions in 2025 by type of water use (see Exhibit V-8).

Annual water consumption in the Yampa Valley is projected to increase by about 12,000 acre-feet between 1995 and 2025. Both consumption totals reflect normal year water demand conditions. Exhibit V-9 depicts projected water consumption in 2025 by type of water use.

EXHIBIT V-8.
Estimated 1995 and Projected 2025 Water Diversions

			Projected 2025 Water Diversions	
	Estimated 1995 Water Diversions		Base Case — Normal Water Demands	
	Actual	Normal Year	Low Range	High Range
Irrigation	370,320	408,674	408,674	408,674
Livestock Use	18,236	17,301	17,301	17,301
Municipal/Domestic	5,379	5,379	8,753	9,660
Commercial	1,063	1,063	1,802	2,017
Thermoelectric Generation	16,431	16,613	25,529	25,529
Mining	4,751	4,751	8,081	8,447
Industrial	166	166	412	580
Snowmaking/Golf	453	421	661	661
Export	4,209	3,383	3,383	3,383
Reservoir Evaporation	6,769	6,769	6,769	6,769
Total	**427,777**	**464,520**	**481,365**	**482,911**
Total, excluding agriculture	**39,221**	**38,545**	**55,390**	**56,936**

Source: BBC Research & Consulting, 1998.

EXHIBIT V-9.
Estimated 1995 and Projected 2025 Water Consumption

	Estimated 1995 Water Diversions		Projected 2025 Water Diversions Base Case — Normal Water Demands	
	Actual	**Normal Year**	**Low Range**	**High Range**
Irrigation	77,767	85,822	85,822	85,822
Livestock Use	2,918	2,768	2,768	2,768
Municipal/Domestic	1,614	1,614	2,626	2,898
Commercial	159	159	270	303
Thermoelectric Generation	16,431	16,613	25,529	25,529
Mining	2,375	2,375	4,040	4,223
Industrial	60	60	148	209
Snowmaking/Golf	106	99	156	156
Export	4,209	3,383	3,383	3,383
Reservoir Evaporation	6,769	6,769	6,769	6,769
Total	**112,408**	**119,662**	**131,511**	**132,060**
Total, excluding agriculture	**31,723**	**31,072**	**42,921**	**43,470**

Source: BBC Research & Consulting, 1998.

EXHIBIT V-1.
Water Districts in the Yampa Valley

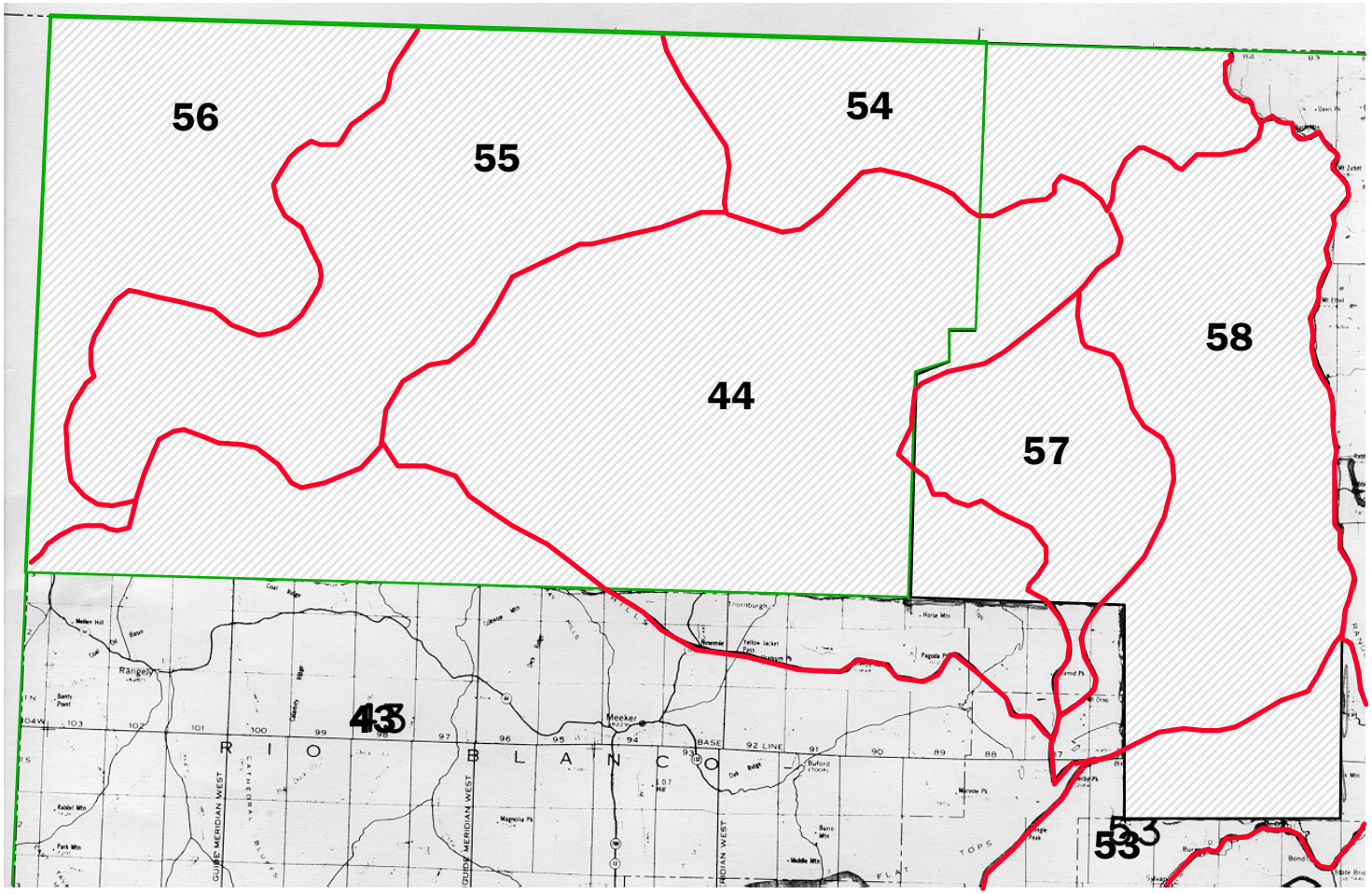
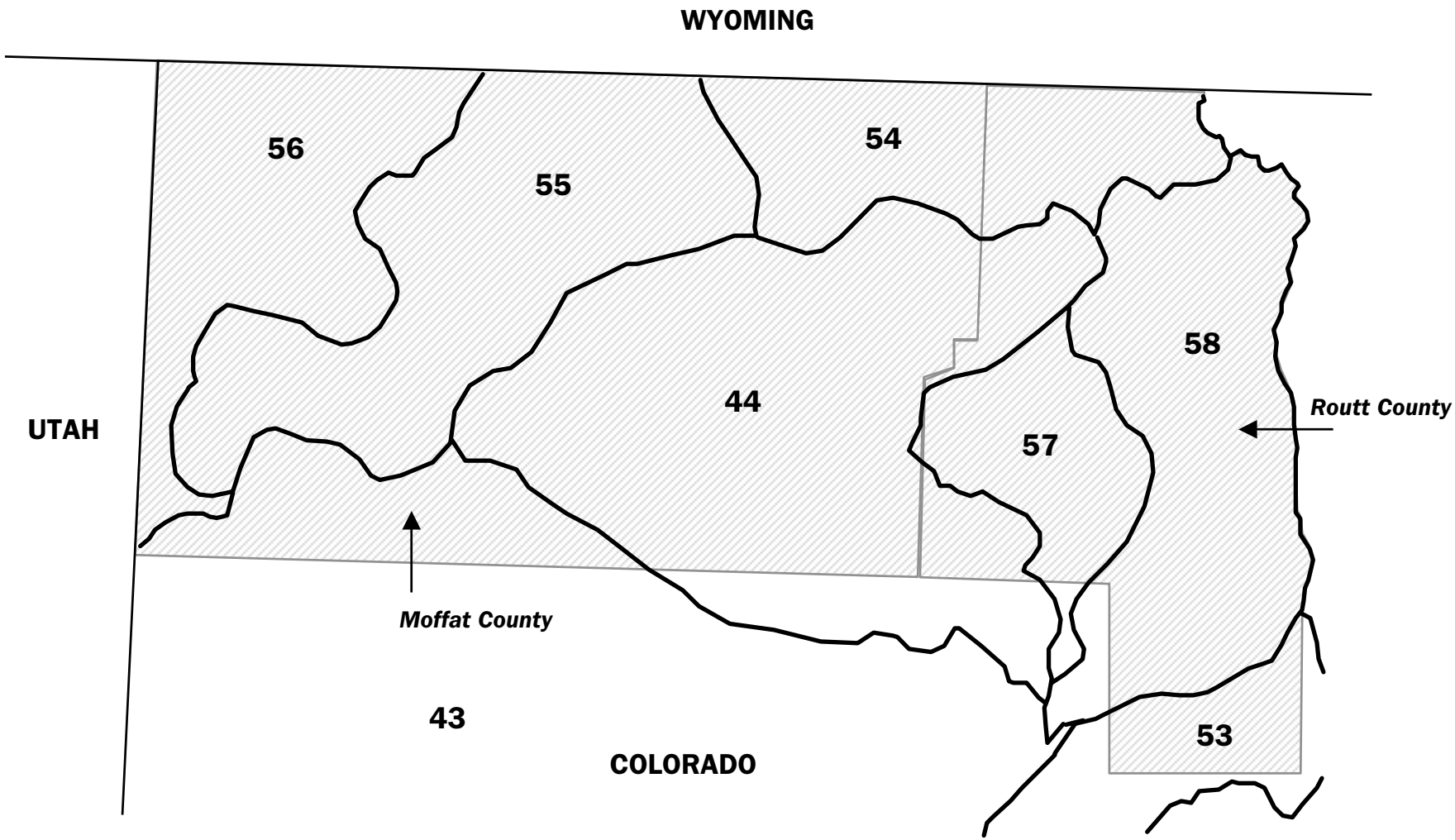


EXHIBIT V-1.
Water Districts in the Yampa Valley



APPENDIX A.
List of Persons Interviewed

Individual	Position/Organization
Ben Beall	Routt County Commissioner
Dan Birch	Upper Yampa Water Conservancy District
Jim Blackburn	Buggywhip's
Ed Blank	CDNR Water Resources Division
David Bray	Bureau of Land Management
Joel Buck	Assistant General Manager, Tri-State Generation and Transmission
Karen Campbell	Steamboat Springs Planning
Steve Colby	Colorado Department of Local Affairs
Chris Comstock	Sportsman Information Center
Clay Condon	Buggywhips
Dennis Conn	Manager Market Development, Cyprus Amax Coal Sales
Gary Crawford	Sheraton Resort Golf Course
Audrey Danner	Yampa Valley Partners
T Wright Dickenson	Moffat County Commissioner
Chuck Donley	Routt County Planning Office
Wynn Eakins	Geologist, Colorado Geological Survey
Richard Elston	V.P. Logistics, Cyprus Amax Coal Sales
Jim Evans	Associated Governments of Northwest Colorado
John Ferguson	Steamboat Airport
John Fetcher	Upper Yampa Water Conservancy District
Scott Ford	Steamboat Chamber Resort Association
Medora Fralick	Norwest Bank
Ray George	Routt National Forest
Michael Gibson	HSEQ and Land Manager, Colorado Coal Company
William Haffner	Fuel and Water Resources Manager, Tri-State Generation and Transmission
John Haller	Sheraton Resort Golf Course
Rod Hanna	Steamboat Ski and Resort Corporation
Jim Hicks	Colorado Division of Wildlife
Stephen Hinkemeyer	Engineering Manager, Colorado Coal Company
Ken Holt	Division 6 Engineer's Office
Leonard Janis	Director Facilities Maintenance, Steamboat Ski and Resort Corporation
Lisa Johnston	Treasurer, Town of Hayden
Linda Kakela	City of Steamboat Springs
James Kiser	Senior Environmental Engineer, Colorado Coal Company
Robert Konosky	Office of Project Management, Federal Energy Technology Center
Robert Koosinan	Mountain Operations, Steamboat Ski Corporation
Dennis Kuntz	Steamboat Board of Realtors
Sylvia LaBrucherie	City of Craig Planning
Martin Landers	MJ Landers & Associates
Alan Lanning	Moffat County Planning
Dorothy Love	Steamboat Board of Realtors
Individual	**Position/Organization**

Jim McBrayer	Bureau of Land Management
Paul Meiman	Moffat County Extension Agent
Nick Metzler	Steamboat Board of Realtors
Rick Mills	Environmental Manager, Twenty-mile Coal Company
Bill Moser	Owner, Moser and Associates
CJ Mucklow	Routt County Extension Agent
Susan Otis	Yampa Valley Land and Trust
Gary Puchan	Engineering Manager, Twenty-mile Coal Company
Nelson Rekos	Project Manager, Tampa Electric Integrated Gassification Combined Cycle Project
Frank Roistch	Manager, Hayden Station, Public Service Company of Colorado
Mary Sanderson	Routt National Forest
Andrew Schissler	Senior Project Engineer, Cyprus Amax Coal Sales
Paula Sears	Steamboat Central Reservations
Kathy Shipley	Colorado Department of Local Affairs
Dan Smith	CSU Agronomy Department
Nancy Stahoviak	Routt County Commissioner
Ron Stock	Craig City Manager
Jerry Strahan	Bureau of Land Management
Joe Theaman	City of Craig Water and Wastewater Operations Director
Floyd Thompson	Bureau of Land Management
Pete Ungerman	President, Underman Engineering, Inc.
Craig Vogel	Manager Technical Marketing, Cyprus Amax Coal Sales
Melinda Reed Weber	Craig Chamber of Commerce
Susan Werner	Colorado Division of Wildlife
Jim Wescott	Colorado State Demographer
Bill Wheelihan	Haymaker Golf Course
Jamie Williams	Routt County Representative, The Nature Conservancy
Chris Wilson	Steamboat Springs Recreation Department

LIST OF REFERENCES

Publication Title	Date	Author, Organization/Sponsor
1989 Outdoor Recreation Participation Rates	Jan-96	Mary Sanderson, Routt National Forest
1996 Abstract of Assessment and Levies	1996	Amy J. Williams, Assessor, Routt County
1996 Big Game Hunting Statistics	1996	Colorado Division of Wildlife
1996 Craig Colorado Community Survey	Dec-96	Sylvia Labrucherie, City of Craig Planning Department
A Sketch of the Early Growth and Development of Routt County Colorado…	May-96	Jean A. Garren
Agricultural Baseline Projections in 2005, Reflecting the 1996 Farm Act	Feb-97	Interagency Agricultural Projections Committee, U.S. Department of Agriculture
An Analysis of the Outdoor Recreation and Wilderness Situation in the United States: 1989-2040	Apr-90	Cordell et al., U.S. Forest Service
An Economic Baseline Study of Moffat County Colorado	Jan-94	Spencer, Mckean and Haslem, Colorado State University Cooperative Extension Service
Annual Energy Outlook 1997	Dec 96	Energy Information Administration, U.S. Department of Energy
Appendices-Draft Environmental Impact Statement for the Proposed Revised Land and Resource Management Plan	Undated	Routt National Forest
Baseline Technical Report, Water Resources	Dec-92	ACZ, Inc.
Benefits of Ranch Open Space to Local Residents	Jun-96	Rosenburger et al., Department of Agricultural and Resource Economics, CSU
Clean Coal Technology Demonstration Program	Sep-96	Assistant Secretary for Fossil Energy, U.S. Department of Energy
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Coal Market Potential and Regional Competitiveness Study, Montana	Jan-96	Stagg Engineering Services, Monttana Department of Commerce
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Colorado Wildlife Economic Impact Model, November 1994, Resident and Out-of-State Direct and Secondary Expenditures	Nov-94	Colorado Division of Wildlife
Colorado's Farm and Food System: It's Contribution to the State Economy in192??	Jul-95	Department of Agriculture and Resource Economics, Colorado State University
Comparison of Retail Sales by Business Class in Moffat, Montrose, Morgan, and Routt Counties	Dec-93	BBC Research & Consulting
Corridor Transportation Plan, Yampa Valley Multi-Modal Corridor, Feasibility Study - Phase I	Feb-94	De Leuw, Cather
Covered Wages and Employment by SIC	1997	Labor Market Information, Colorado Department of Labor and Employment
Craig District-Wilderness Environmental Impact Statement-Final 1 & 2	Nov-90	Craig District Office, U.S. Bureau of Land Management
Draft Environment Impact Statement for the Proposed Revised Land and Resource Management Plan	Undated	Routt National Forest
Economic Base Analysis Data	Jan-97	Colorado Division of Local Government
Economic Diversification Strategy for Northwest Colorado: Highlights	Apr-90	Lazar Management Group
Economic Survey of the Yampa Valley	1956	Bureau of Business Research, UC Boulder, Yampa Valley Development Association

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Publication Title	Date	Author, Organization/Sponsor
Electric Utility Industry Restructuring	1997	Colorado Public Utilities Commission, State of Colorado
Energy and Mineral Impact Assistance Program	Jan-97	Larry Kallenberger, Executive Director, State of Colorado, Department of Local Affairs
Energy Choices, Practical Realities: Renewable Energy and Utility Restructuring	Apr-97	Resource Data International, Inc.
Energy Policy Act Transportation Rate Study: Interim Report on Coal Transportation	Oct-95	Energy Information Administration, U.S. Department of Energy
Estimated Use of Water in Colorado		

APPENDIX C.
Projected 2045 Water Demands Under Base Case and Bounding Scenarios

Estimated 1995 and Projected 2045 Water Diversions
Alternate Scenarios

	Estimated 1995 Water Diversions		Projected 2045 Water Diversions				
			Base Case			Bounding Scenarios	
	Actual	Normal Year	Low Range	High Range	High Range/High Demand	Upper	Lower
Irrigation	370,320	408,674	408,674	408,674	520,390	598,449	347,373
Livestock Use	18,236	17,301	17,301	17,301	19,268	19,268	17,301
Municipal/Domestic	5,379	5,379	11,640	13,899	17,373	23,312	11,272
Commercial	1,063	1,063	2,446	3,011	3,764	4,688	2,378
Thermoelectric Generation	16,431	16,613	29,928	29,928	32,348	38,727	25,529
Mining	4,751	4,751	10,350	11,270	11,270	15,343	8,003
Industrial	166	166	571	911	911	1,289	571
Snowmaking/Golf	453	473	947	947	2,165	2,165	1,041
Export	4,209	3,383	3,383	3,383	4,788	4,788	3,383
Reservoir Evaporation	6,769	6,769	6,769	6,769	6,769	6,769	6,769
Total	**427,777**	**464,572**	**492,009**	**496,092**	**619,046**	**714,796**	**423,619**
Total, excluding agriculture	**39,221**	**38,597**	**66,034**	**70,117**	**79,388**	**97,080**	**58,945**

Estimated 1995 and Projected 2045 Water Consumption
Alternate Scenarios

	Estimated 1995 Water Consumption		Projected 2045 Water Consumption				
			Base Case			Bounding Scenarios	
	Actual	Normal Year	Low Range	High Range	High Range/High Demand	Upper	Lower
Irrigation	77,767	85,822	85,822	85,822	109,282	125,674	72,948
Livestock Use	2,918	2,768	2,768	2,768	3,083	3,083	2,768
Municipal/Domestic	1,614	1,614	3,492	4,170	5,212	6,994	3,382
Commercial	159	159	367	452	565	703	357
Thermoelectric Generation	16,431	16,613	29,928	29,928	32,348	38,727	25,529
Mining	2,375	2,375	5,175	5,635	5,635	7,671	4,002
Industrial	60	60	205	328	328	464	205
Snowmaking/Golf	106	99	234	234	500	500	234
Export	4,209	3,383	3,383	3,383	4,788	4,788	3,383
Reservoir Evaporation	6,769	6,769	6,769	6,769	6,769	6,769	6,769
Total	**112,408**	**119,662**	**138,144**	**139,488**	**168,510**	**195,373**	**119,577**
Total, excluding agriculture	**31,723**	**31,072**	**49,554**	**50,899**	**56,145**	**66,616**	**43,860**