APPRAISAL REPORT
TO EVALUATE
FUTURE RAW WATER DEMANDS
AND
WATER SUPPLY ALTERNATIVE PLANS
AS OF MARCH 2003

Prepared for:
SAN JUAN WATER CONSERVANCY DISTRICT
And
PAGOSA AREA WATER AND SANITATION DISTRICT

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SUMMARY OF TECHNICAL DATA

The Pagosa Area Water and Sanitation District (PAWSD) and the San Juan Water Conservancy District (SJWCD) jointly funded Harris Water Engineering, Inc. to prepare this report. The report was initiated in the spring of 2000 and concluded in the spring of 2003 to evaluate the raw water supply needed in 2040 within the two Districts and the possible alternative plans which might be constructed to serve the 2040 water needs. The study period included the 2002 drought which was the worst drought in historic record and resulted in the firm yield from the alternatives presented herein being modified downward from the initial work in 2000 and 2001.

New information is continually being developed and new conditions are occurring such that the results shown in this report are likely to change in the future; therefore, this report documents the findings as of March of 2003. Any and all of the results summarized in the following bullets are subject to change in the future.

- PAWSD has constructed facilities that will meet the PAWSD water demands through about 2010. With the enlargement of Stevens Reservoir and the Dutton Ditch Pipeline Improvement, the available supply will extend about another 5 years. PAWSD and SJWCD are not in a position of having to develop facilities to meet the current demand, but can focus on meeting the future demands approximately 10 years from now.

- The PAWSD service area has grown at a rate of about 7.1% per year for the past seven years based on equivalent unit usage growth. The Archuleta County population has grown at a rate of 6.4% from 1990 to 2000 based on the US Census data. Since 1980 Archuleta County has grown a rate of 5.1% per year.

- The present PAWSD water usage is 215 gallons per day per permanent resident which was determined by dividing the total water treated by PAWSD by the permanent population within PAWSD (based on 2000 Census data). The water usage by the transient and part time residents is factor into the 215 gallons per day

- The SJWCD/PAWSD annual demand in 2040 based on extrapolation of the historic population growth and water usage is estimated to be 11,732 acre-feet. The water usage and population projections used to estimate the water demand are recommended to be re-evaluated every five years.

- A total flow of 25.4 cfs of water is needed constantly during the peak month for existing and new estimated future water needs.

- Presently there is 6.9 cfs available from the San Juan River in the worst drought; 2.3 cfs from the Snowball Pipeline and 4.6 cfs from the San Juan River Intake.

- 18.5 cfs of new capacity is needed, however, the San Juan River does not have adequate water in a 2002 type drought during July to September requiring storage to supply the demand during the three months.

- A minimum of 4,000 acre-feet of storage is needed to meet the 2040 Demand in July through September including evaporation, seepage and other losses.

- Presently PAWSD has 2,630 acre-feet of existing useable storage. An additional 900 acre-feet of new storage will be provided by the Stevens enlargement and a minimum of another 500 acre-feet is needed at another location. These volumes will just barely meet 2040 demand and will result in all Stollsteimer basin reservoirs being empty in a dry year.

- Enlargement of Stevens Reservoir is assumed to proceed.

- The SJWCD/PAWSD Board of Directors have decided to incorporate the concept of a Supply Safety Margin to establish water supplies through facilities or other measures which will provide the safety margin water managers can rely on when in the middle of drought conditions. This is water in addition to the 25.4 cfs and 4,000 acre-feet of water described above. The Safety Supply Margin components may include:
  - Storage of a one year supply in 2040 or about 12,000 acre-feet of yield.
  - Drought year water restrictions could reduce storage requirement a small amount.
  - The temporary use of up to 18.7 cfs of firm senior water rights (probably irrigation) that could be used during a drought. These water rights would only be used during significant droughts, in most years the water would be used as it was historically.

- One year of storage is the only option that positively provides a Safety Supply Margin. Purchase of senior water rights in a dry year will significantly reduce storage requirement but probably not eliminate storage. Water restrictions do not reduce demand adequately to provide a significant portion of the safety supply margin.

- The Dry Gulch Pump Station is the least costly method to provide the 18.5 cfs of new diversion capacity. This alternative would also replace the 2.3 cfs of existing Snowball pipeline capacity, for a total diversion capacity of 20.8 cfs. This combination with the 4.6 cfs San Juan Pump system will provide 25.4 cfs needed in 2040.

- Dry Gulch Reservoir is the least costly storage alternative for any size reservoir. Dry Gulch Reservoir could be constructed to provide all of the storage requirements.

- The West Fork Reservoir or East Fork Reservoir may be necessary if the Dry Gulch site cannot be developed.

TABLE OF CONTENTS

TABLE OF CONTENTS
Continued

LIST OF TABLES AND FIGURES

FUTURE WATER DEMANDS & SUPPLY
FOR THE
PAGOSA AREA WATER AND SANITATION DISTRICT
AND
SAN JUAN WATER CONSERVANCY DISTRICT

The San Juan Water Conservancy District (SJWCD) and Pagosa Area Water and Sanitation District (PAWSD) are working together to develop plans to supply the year 2040 raw water needs within the Districts. The purpose of this summary is to provide the public with an overview of the year 2040 water needs and the status of alternative plans being considered to meet those needs. A firm water supply is defined as "adequate raw water facilities incorporated with conservation measures to provide the normal water demand without mandatory restrictions plus a one year supply safety margin".

How many people will reside in the SJWCD in the year 2040? Based on the US Census data, the Archuleta County population grew at a rate of 4% per year between the years 1980 to 1990, and 6.4% per year between the years 1990 to 2000, for an average of 5.1% per year from the years 1980 to 2000. From the years 1995 to 2001, PAWSD equivalent water units grew at a rate of 7.1% per year. Extrapolating the historic growth, the year 2040 population is estimated to be approximately 52,000.

How much water will be needed? The historic average yearly water usage per person within PAWSD has been 215 gallons per day per person. The value was determined by dividing the total water treated by the permanent population within PAWSD; therefore, the water usage by tourists and commercial use is factored into the 215 gallons per day per person. Extrapolating the historic water usage including anticipated reductions for future water conservation measures, approximately 11,700 acre-feet of water will be necessary in the year 2040 within the boundaries of the Districts.

How accurate are the estimates of population and water demand? Projecting population and water demands nearly 40 years into the future is an exercise in crystal ball gazing. The Districts used the best data available, which is the actual population and equivalent water unit growth rates over the past 20 years. The Districts hope that the estimates are on the high side because having extra capacity in the year 2040 is preferable, rather than having less than the actual needs. The Districts intend to formally review the growth projections and actual water usage approximately every five years to continually monitor water needs and adjust new facilities requirements as appropriate.

Have conservation measures been incorporated into the future estimates? Although not yet adopted, water conservation measures have been assumed that will reduce the average usage per person from the present 215 gallons per day to 200 gallons per day in the year 2035. The Districts will continually review water conservation measures to attempt to reduce the water usage even further.

What is the present annual water usage? The residents of PAWSD presently use about 2,500 acre-feet per year.

What types of facilities are needed to meet the year 2040 demand? The Districts have conducted studies to evaluate the types of facilities needed in the year 2040. A total of 18.5 cfs of new diversion capability is needed from the San Juan River, in addition to the existing 6.9 cfs (2.3 cfs at Snowball and 4.6 cfs at the San Juan Pump). Also, new storage of approximately 500 acre-feet is needed without a safety margin, in addition to the Stevens Reservoir enlargement. These facilities are projected to barely meet the year 2040 demand during a drought such as occurred in the year 2002.

Are the Districts considering a supply safety margin in the event of an even worse drought or some other type of unforeseen situation? Yes! The Districts are investigating three options for a safety supply margin: (1) additional storage to provide 12,000 acre-feet of yeild; (2) emergency conservation measures; and (3) purchase of an interruptible supply from high priority water rights. The Districts are conducting investigations to attempt to have an adequate safety supply margin from any one or a combination of the three options.

How bad was the year 2002 drought? The flow of the San Juan River at the USGS gage at Pagosa Springs was only 13% of the average from April through November. More importantly, during the highest water demand months of June, July and August the San Juan River flow was only 5% of the historic average. In the year 2002, PAWSD was barely able to divert 2.3 cfs at the Snowball Pipeline and 4.6 cfs from the San Juan Pipeline from the San Juan River. Also, the reservoirs were at 45% of capacity in October of 2002.

Did residents reduce water consumption in 2002? The PAWSD residents significantly reduced water usage in 2002, more than was expected. When asked, the residents reduced summer usage by 30% to 40% to levels normally seen in the winter. The Districts sincerely thank the residents for reducing water usage during the drought.

What does the year 2003 water supply look like? The year 2003 water supply looks to be better than the year 2002 but still below average. With the completion of the San Juan Pipeline and assuming somewhat better flows in the San Juan River in year 2003, the PAWSD water needs can be met. However, there is very little safety margin because all of the existing reservoirs may not fill.

How has the drought impacted the ability to meet the year 2040 water demand? The previous driest year, 1977, had adequate summer flows in the San Juan River to meet the summer demands without storage. This was not the case in year 2002, and raw water storage will be necessary to meet nearly the entire year 2040 summer time demand if the San Juan River flows are the same in year 2040 as in the year 2002. The year 2002 drought significantly increased the amount of storage needed to meet the year 2040 demand.

Are existing facilities adequate to meet the existing demand? The present facilities are adequate to provide the daily water demand with the availability of the 4.6 cfs San Juan Pipeline and the 2.3 cfs of direct diversion capability through the Snowball pipeline. If filled, the existing reservoirs (approximately 2,600 acre-feet in Hatcher Reservoir, Stevens Reservoir, Lake Pagosa, and Forest Lake, exclusive of Village Lake) would provide a one year safety supply margin for the present 2,500 acre-foot demand. The Districts do not need to "play catch up" with the raw water facilities but can concentrate on meeting demands after year 2010. Further, with the planned enlargement of Stevens Reservoir in the next two to four years, the existing facilities will meet the demand beyond year 2010.

Where would the additional 18.5 cfs of diversions from the San Juan River and new reservoir sites be located? The Districts are presently evaluating a full range of alternative facilities to meet the raw water demands and no decisions have been made.

Will a vote of residents in one or both Districts be held before construction can begin? Yes. In order to finance construction of the facilities, residents of one or both Districts will vote on the issuance of bonds, depending on whether one or both Districts finance the facilities. Prior to the vote, the Districts will provide specific information on the facilities to be constructed, why those facilities were selected, the cost of the facilities, the ability of the facilities to meet the future water demand, and other pertinent information.

Since there are adequate facilities to meet the demand through about year 2010, why begin evaluating plans now? The lead time to construct a new reservoir is typically a minimum of 10 years and commonly 20 years or more. Therefore, serious work to construct a new reservoir must begin immediately in order to have any chance of having a reservoir constructed when needed.

What needs to be done during the next few years? The Districts will continue to study the potential facilities to determine which facilities are feasible and develop a specific plan to meet the year 2040 demand. The impacts of the year 2002 drought will continue to be evaluated. Water conservation opportunities will continue to be evaluated and incorporated as appropriate.

APPRAISAL REPORT TO EVALUATE FUTURE RAW WATER DEMANDS And WATER SUPPLY ALTERNATIVE PLANS

1.0 INTRODUCTION

The San Juan Water Conservancy District (SJWCD) encompasses a significant portion of Archuleta County including the Town of Pagosa Springs (Town) and the Pagosa Area Water and Sanitation District (PAWSD).

The SJWCD and PAWSD are working in partnership to develop plans to supply the 2040 raw water needs within the two districts. The purpose of this report is to estimate future raw water usage within SJWCD/PAWSD through the year 2040 and to determine what water rights and alternative facilities might be able to provide the firm future raw water supply. A firm water supply for this report is defined as "adequate raw water facilities incorporated with conservation measures to provide the normal water demand without mandatory restrictions plus a one year supply safety margin".

The water treatment and distribution facilities necessary to deliver water to customers are not addressed in this report. The location of the growth relative to County Planning issues are also not addressed.

This report utilizes past work and studies to the maximum extent. For instance, the reports and evaluations for the proposed enlargement of Stevens Reservoir and the improvement of Dutton Ditch for PAWSD have been integrated.

The preparation of this report began in the spring of 2000 and initially used the 1977 drought to estimate the firm yield. Before the completion of the report, it became clear that the 2002 drought was much drier than 1977 and redefined the firm water supply from existing and proposed facilities. Data from and lessons learned in 2002 have been incorporated to the extent available.

2.0 ESTIMATED WATER DEMAND

2.1 Population Estimate

The future water use projections are based on historic population growth using the results of the 1980, 1990, and 2000 US Census and equivalent unit data from PAWSD. The census data shows the population of Archuleta County to be 3,664 in 1980, 5,346 in 1990, and 9,898 in 2000. The associated annual growth rates are: 4% from 1980 to 1990, and 6.4% from 1990 to 2000, and an average of 5.1% from 1980 to 2000. The PAWSD equivalent water units have increased at a rate of about 7.1% per year from 1995 to 2000.

The census populations are for the entire Archuleta County. The SJWCD does not encompass the entire County and for purposes of estimating the population within SJWCD, it is assumed that 95% of the County population is within the SJWCD boundaries. Further, it is assumed that PAWSD serves 75% of the 2000 County population. Based on these assumptions in the year 2000, approximately 9,400 people resided within the SJWCD boundaries and approximately 7,420 people resided within the PAWSD service area. Approximately 2,000 people resided within the SJWCD but outside of PAWSD.

2.2 Analysis of 2002 Drought Year

2002 was the worst drought on record, especially during the summer high usage months. Table A shows a comparison of the flow of the San Juan River at the USGS gage at Pagosa Springs for 1977 (the previous worst drought year), 2002 and the historic average. The entire summer from April through November was only 13% of average. As can be seen the drought was worst in the highest water demand months of June, July and August when there was only 5% of the historic average; 1977 had considerably more flow due to summer rains than 2002.

Table B shows the number of days below 30 cfs, 20 cfs, and 10 cfs during historic low flow periods from 1952 to present. The last row shows 2002 which is the only year that has had flows less than 10 cfs for a significant length of time and 2002 had the most days below 20 cfs. To compound the impact on the ability to provide the 2040 water demand the drought occurred during the highest usage period for June, July and August.

The PAWSD Water Conservation Plan initiated in 2000 describes four water conservation levels that can be instituted in drought conditions. A summary of the conservation levels is below. Refer to the Water Conservation Plan for a full description of each level.

> Alert Status: PAWSD will begin daily observations of water levels in the reservoirs and direct flow rates in the river. Preliminary notification given to customers explaining that if the conditions responsible for the water depletions continue, water restrictions may be forthcoming and asking for their voluntary help in conserving water.
>
> Conservation Level One: Raw water irrigation of lawns (including golf course) will be restricted to the hours of 8:00 pm to 8:00 am on odd numbered days. Treated water irrigation will be allowed every other day based on street address from 8:00 pm to 8:00 am.

TABLE A

COMPARISON OF AVERAGE, 1977 AND 2002 SAN JUAN RIVER FLOW AT PAGOSA SPRINGS

	San Juan River at Pagosa Springs USGS Gage (09342500)								
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Accum.
1977 Monthly volume (af)	8,376	15,535	9,684	5,942	15,084	8,547	9,452	4,123	76,743
1977 % of average	26%	19%	13%	27%	118%	88%	97%	71%	31%
2002 Monthly volume (af)	9,124	9,823	3,573	913	810	1,572	4,141	3,252	33,208
2002 % of average	28%	12%	5%	4%	6%	16%	42%	56%	**13%**
Historical average (af)	32,100	79,980	73,890	22,413	12,748	9,742	9,794	5,831	246,498

May through September 2002 flow was	8%	of the historic average.
June through August 2002 flow was	5%	of the historic average.

Assumptions: 2002 flow data is provisional and subject to small changes by USGS when published.

TABLE B

DAYS SINCE 1952 WITH LESS THAN 30 CFS AT THE SAN JUAN RIVER AT PAGOSA SPRINGS GAGE

Period	Season of Year	Total # Of Days Less Than 30 cfs	Days Between 20 - 30 cfs	Days Between 10 - 20 cfs	Days Less Than 10 cfs
(1)	(2)	(3)	(4)	(5)	(6)
9/4/53 to 10/14/53	fall	39	15	24	
11/28/54 to 12/18/54	winter	6	6		
11/2/55 to 11/16/55	fall	20	18	2	
9/1/56 to 10/23/56	early fall	53	18	33	2
9/1/62 to 9/20/62	late summer	14	12	2	
1/9/64 to 2/22/64	winter	20	20		
10/27/66 to 11/6/66	fall	11	11		
9/5/74 to 9/21/74	early fall	12	12		
11/10/75 to 11/27/75	fall	10	10		
12/21/76 to 1/1/77	winter	12	12		
8/18/78 to 10/22/78	late summer	48	28	20	
11/28/89 to 2/17/90	winter	59	56	3	
6/26/02 to 9/27/02	summer	82	15	47	20

Assumptions: Gage records for San Juan at Pagosa gage begin in 1952.

The days below a certain flow are not always consecutive during the period.

Conservation Level Two: Raw water irrigation of lawns and gardens will be restricted to the hours of 8:00 pm to midnight one day per week. Treated water irrigation will be allowed once per week for 4 hours. Significant rate increases are instituted for usage over 8,000 gallons per equivalent unit per month. Please see the Water Conservation Plan for the details of implementing this Conservation Level.

Conservation Level Three: No outside watering. Monthly minimum usage is reduced to 5,000 gallons from 10,000 gallons and water usage over 5,000 gallons has a major cost penalty. Please see the Water Conservation Plan for the details of implementing this Conservation Level.

Table C shows the results of initiating the various Conservation Levels in 2002, measured in gallons used per capita per month. Table C shows the historic usage per capita in column 2, the actual usage in 2002 resulting from restrictions in column 3, the 2002 percent of average in column 4, and column 5 lists the Conservation Level.

PAWSD initiated Alert Status in May of 2002 with essentially the same per capita usage as occurred historically. Level One Conservation began on about June first with a substantial reduction in water usage, 77.5% of average. The usage decreased further in July under Level One Conservation to 60.2% of average. Level Two Conservation began on about August first and the usage dropped further per capita to 175 in August then 156 in September and 143 in October. The September and October usage was below the historic winter usage. Once the Level One Conservation measures were implemented the PAWSD water users significantly reduced water consumption to respond to the drought. The average percentage decrease in per capita usage for the June through October period is about 70% of the historic average.

The drought of 2002 showed the following:

- ✓ The firm supply from the San Juan River during the drought is only about 6.9 cfs.
- ✓ Mandatory conservation reduced the water usage during the drought by about 30% of the historic average usage.
- ✓ The reduction in water usage was primarily achieved by restricting outside irrigation. However, in-house use was also reduced as indicated by the September and October usage amounts that are less than the historic winter use.
- ✓ Promotion of water conservation measures to reduce outside irrigation will reduce the per capita usage to a large extent and in-house measures will reduce usage to a lesser extent.
- ✓ In the middle of a drought, water managers will be extra conservative because the water availability may continue to worsen. A supply safety margin is needed to provide water over and above the “normal” supply.

		TABLE C		
2002 WATER RESTRICTION RESULTS				
	Historic	**2002**	**% of**	
Month	**Average**	**Average**	**Average**	**Restriction**
	(g/cap/day	**(g/cap/day**		**Level**
(1)	**(2)**	**(3)**	**(4)**	**(5)**
=========	=========	=========	=========	==========
January	164			none
February	168			none
March	169			none
April	169			none
May	238	251	105.4%	voluntary
June	332	257	77.5%	Level 1
July	312	188	60.2%	Level 1
August	253	175	69.4%	Level 2
September	240	156	65.3%	Level 2
October	184	143	77.5%	Level 2
November	168			
December	178			
Assumptions:	The historic average is calculated using the PAWSD water treatment plant			
	production each month from 1995 through 2000 and dividing the production by the population. The population is determined by a straight line			
	interpolation between the 1990 and the 2000 Census data shown in Table D.			
	PAWSD has approximately 1.5 people per equivalent unit.			

2.3 Existing Water Usage

At the end 2000, PAWSD was serving 5,081 equivalent units. Based on the US Census explained above, the permanent population estimate within PAWSD is 7,420. Therefore, there is approximately 1.5 people per equivalent unit.

The population estimate used herein only includes permanent residents as defined by the Census Bureau. Therefore, the population estimate does not include the significant transient population from tourism from over 1,350 motel rooms, condos/time shares, cabins, and bed and breakfasts within the PAWSD service area. In addition, many of the homes in the service area are used only part of the year, with the residents having their permanent homes in other states. The water usage by the transient population is factored into the permanent population per capita water usage.

In order to determine the water usage, the records kept by PAWSD were used to estimate the per capita (permanent resident) and per equivalent unit water usage and are summarized in Table D.

The Table D columns are:

- Column 1 shows the years from 1995 to 2000 which data is available.
- Column 2 is the estimated permanent population within PAWSD for each year, estimated by a straightline interpolation between the 1990 and 2000 Census data.
- Column 3 is the actual end of year equivalent units determined by PAWSD.
- Column 4 is the actual total water treated each year.
- Column 5 is the average yearly usage per person, determined by dividing the water treated (Column 4) by population (Column 2).

The average daily water usage for PAWSD for the 6 year period from 1995 through 2000 is 215 gallons per capita (325 gallons per equivalent unit). The average yearly use of 215 gallons per person per day is assumed to reflect the water usage for the entire SJWCD area.

The projection of population within the SJWCD/PAWSD service area is for the purposes of estimating future raw water demands and the resulting need for facilities. The population estimates are NOT meant to be used for land use planning nor were they correlated with land use plans. An attempt was made to make the projections slightly on the high side, because being too low could result in future water shortages due to lack of facilities. The projections should be reevaluated every five years to assess whether adjustments should be made in the projections and the resulting need for facilities. At this point in time, the worst that can happen if the population projections are a little high is the facilities may be able to meet the water demand a few years past 2040.

TABLE D
PAWSD WATER USAGE PER CAPITA AND EQUIVALENT UNITS

Year	Estimated Population (persons)	Actual Equivalent Units (eq)	Actual Total Water Treated (mg)	Average Yearly Per Capita Usage (g/p/d)
(1)	(2)	(3)	(4)	(5)
1995	5410	3593	442.43	212
1996	5815	3905	461.99	209
1997	6215	4215	486.31	208
1998	6615	4482	574.08	233
1999	7020	4761	547.90	211
2000	7420	5081	594.46	220
Six Year Average Usage				215

Table D Assumptions:
The population estimates for each year are a straightline extrapolation between the 1990 and 2000 census estimates.

The Equivalent units are year end values.

The Total Water Treated is water produced at the treatment plants and does not include raw water irrigation, primarily at the golf course. Losses in the distribution system are included with the per capita use estimates, per capita usage at each home will be less.

2.4 2040 Water Demand Estimate

Table E shows the estimated future water usage in five year increments from 2000 to 2040 based upon: (1) 215 gallons per capita per day in the first 10 years decreasing to 200 in 2035 to reflect water conservation measures; (2) 7.1% per year from 2000 to 2010 to coincide with growth during the 1990's reflected in the census data (6.4% per year) and the equivalent tap growth (7.1% per year); (3) 4.0% per year from 2010 to 2025 to reflect the growth during an economically depressed period such as occurred in the 1980's; and (4) 3% per year from 2025 to 2040 to reflect the long term growth rate for purposes of this report. The average growth rate for the 40 year period is 4.4% per year.

The columns in Table E are:

- Column 1 shows the years in 5 year increments from 2000 to 2040.
- Column 2 is the yearly growth rate during each 5 year increment.
- Columns 3 and 4 show the equivalent units and the population for each 5 year increment.

- Column 5 is the per capita use estimate of 215 gallons per person per day initially derived in Table D decreased to 200 in 2035 to reflect water conservation.
- Columns 6 and 7 are the estimated water demand for each 5 year increment in acre-feet and million gallons. The total water demand in SJWCD/PAWSD in 2040.

The PAWSD portion of the SJWCD water requirements is shown on Table F which has the same format and columns as Table E. Of the 11,732 acre-feet requirement within SJWCD, 9,261 acre-feet is estimated to be needed within the PAWSD service area if PAWSD water usage and/or boundaries expand at the same rate as the population. PAWSD could have greater or smaller expansion depending upon policies to include areas presently not in PAWSD, resulting in a larger or smaller population in PAWSD. Also, the cooperation and cost sharing relationship of service to homes in the SJWCD but outside PAWSD is not considered herein.

TABLE E

ESTIMATED SJWCD/PAWSD FUTURE RAW WATER DEMANDS

Year	Annual Growth Rate	Equivalent Units (EQ)	Estimated Permanent Population	Per Capita Daily Usage (g/per/day)	Total Annual Demand (acre-feet)	Total Annual Demand (million gallons)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2000		6,437	9,400	215	2,264	738
	7.1%					
2005		9,070	13,246	215	3,190	1,039
	7.1%					
2010		12,781	18,665	215	4,495	1,465
	4.0%					
2015		15,550	22,709	210	5,342	1,741
	4.0%					
2020		18,919	27,628	210	6,499	2,118
	4.0%					
2025		23,018	33,614	205	7,719	2,515
	3.0%					
2030		26,684	38,968	205	8,948	2,916
	3.0%					
2035		30,934	45,175	200	10,120	3,298
	3.0%					
2040		35,861	52,370	200	11,732	3,823

Assumptions:

* The growth rates are based on 1980, 1990, and 2000 census data and PAWSD Equivalent growth from 1995 to 2001.
* The per capita usage is decreased from 215 to 200 to reflect water conservation actions.
* The SJWCD service area is assumed to have 95% of the Archuleta County 2000 census.

TABLE F

ESTIMATED PAWSD FUTURE RAW WATER DEMANDS

Year	Annual Growth Rate	Equivalent Units (EQ)	Estimated Permanent Population	Per Capita Daily Usage (g/per/day)	Total Annual Demand (acre-feet)	Total Annual Demand (million gallons)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2000		5,081	7,420	215	1,787	582
	7.1%					
2005		7,160	10,456	215	2,518	821
	7.1%					
2010		10,089	14,733	215	3,548	1,156
	4.0%					
2015		12,275	17,925	210	4,217	1,374
	4.0%					
2020		14,934	21,809	210	5,130	1,672
	4.0%					
2025		18,170	26,534	205	6,093	1,985
	3.0%					
2030		21,063	30,760	205	7,063	2,302
	3.0%					
2035		24,418	35,659	200	7,989	2,603
	3.0%					
2040		28,308	41,339	200	9,261	3,018

Note: The year 2000 equivalent units are the actual PAWSD units at the end of 2000.

The year 2000 population is 75% of the 2000 census for Archuleta County.

The growth rates are based on census data and equivalent units.

2.5 Estimated Existing Supply

With the completion of the San Juan River Intake in the spring of 2002 and the record drought in 2002, the operation and yield of the existing facilities has changed from estimates made previous to 2002. The existing supply described herein is based on criteria developed during 2002 (see Section 2.2).

A firm water supply for this report is defined as "adequate raw water facilities and conservation measures to provide the normal (non-shorted) water demand in 2040 plus a one year supply safety margin of one year".

Preliminary conclusions from the 2002 drought include changing the PAWSD operation in order to keep the upper reservoirs full to the extent possible. The Hatcher and Stevens Treatment Plants would only be used when there is water in excess of the amount needed to keep the upper reservoirs full. The San Juan Pipeline and Treatment Plant would be utilized most of the time. The following hierarchy would implement the concept through the allocation of Dutton Ditch water and runoff in the reservoirs:

Priority 1. Fill Hatcher Reservoir and keep full by continually replacing evaporation
Priority 2. Fill Stevens Reservoir and keep full by continually replacing evaporation
Priority 3. Fill Lake Pagosa and keep full by continually replacing evaporation
Priority 4. Operate Hatcher Treatment Plant to serve Just Hatcher Area
Priority 5. Fill Lake Forest and keep full by continually replacing evaporation
Priority 6. Fill Village Lake but do not replace evaporation
Priority 7. Use Hatcher and/or Stevens Treatment Plants to serve the entire PAWSD area to the extent of the water supply available after meeting the Priorities 1 through 7 and treatment plant capacity is available
Priority 8. Keep Village Lake full
Priority 9. Spill

By the end of 2002, PAWSD will have the following facilities installed:

- Direct diversion firm supply from Snowball of 2.3 cfs
- Direct diversion firm supply from San Juan Intake of 4.6 cfs
- Ability to convey treated water from San Juan TP to entire Hatcher service area
- Available active storage of 2,630 acre-feet in Hatcher, Stevens, Pagosa and Forest (Village not included) assumes that Dutton Ditch will be able, as a minimum, keep these reservoirs filled

If the proposed Dutton Ditch/Upper Reservoir operating criteria and the facilities listed above had been in place in the year 2000 and fully operational prior to the drought of 2002, PAWSD would have had 6.9 cfs of firm direct supply from the San Juan River (2.3 cfs Snowball and 4.6 cfs San Juan Pipeline) and 2,630 acre-feet of capacity in the four lakes other than Village. This water supply would have been adequate to supply the non-restricted water demands during 2002 with a one year supply in reserve storage, thus meeting the definition of a firm water supply for the 2000 and 2005 PAWSD water demand.

In summary, PAWSD has done an excellent job in constructing facilities to meet the existing demand and have a good supply safety margin. PAWSD and SJWCD do not have to "catch up" with facilities to meet existing demand but can focus on new facilities to meet future water demands.

2.6 Estimated New Supply to Meet 2040 Demand

Table G shows a dry year scenario, such as occurred in 2002, to estimate the new diversion capacity and storage requirement to meet the 2040 demand.

- Column 1 – Month of the year.
- Column 2 - The 2040 monthly demand in acre-feet based on the historic monthly use pattern for PAWSD. June is the peak month needing 1,512 acre-feet.
- Column 3 - The 2040 monthly demand in average cfs for the month. June is the peak month needing 25.4 cfs.
- Column 4 - The firm supply in acre-feet from the existing 4.6 cfs San Juan diversions.
- Column 5 - The firm supply in acre-feet from the existing 2.3 cfs Snowball diversion.
- Column 6 - The remaining demand to be met by future diversions and existing storage.
- Column 7 - New diversions from the San Juan River of 18.5 cfs to meet the 25.4 cfs demand but there is insufficient flow in the San Juan River from July through September in a dry year to provide the new 18.5 cfs.
- Column 8 – 2,403 acre-feet of water needed from storage to supplement the direct diversions from the San Juan River from July through September.
- Column 9 – Potential inflow to Stollsteimer Reservoirs (Hatcher, enlarged Stevens, Pagosa, Forest, not Village) from the Dutton Ditch, assumed to be 3 cfs during November and December.
- Column 10 - The Stollsteimer basin reservoirs with 3,530 acre-feet of available capacity (2,630 acre-feet existing plus 900 acre-feet from enlarged Stevens, refer to Table H) are used to supplement the direct diversions, but are totally emptied by the end of August. The reservoirs are partially filled by inflow in November and December. The calculation assumes 30 acre-feet per month per reservoir of evaporation (total 120 acre-feet per month) from May through September. The reservoirs are emptied by the end of August leaving 493 acre-feet of water to be provided by another reservoir.
- Column 11 – Assumes an offstream reservoir such as Dry Gulch that can be filled with San Juan River water either by pumping or gravity. This reservoir will be used to meet the 493 acre-feet of demand not met by the Stollsteimer Reservoirs. Assumes 60 acre-feet per month of evaporation from May through September.
- Column 12 – Inflow from the San Juan River to refill the reservoir.

Table G shows that the facilities needed to meet the 2040 demand must provide:

- At least 25.4 cfs of direct supply from the San Juan River, 6.9 cfs already exists; therefore, 18.5 cfs of new diversion capacity is required.

- About 4,000 acre-feet of active storage capacity is needed when the San Juan River diversions are inadequate and to account for evaporation. The existing storage capacity in the Stollsteimer Basin Reservoirs including the Stevens Reservoir Enlargement is about 3,530 acre-feet. An additional 493 acre-feet is needed.

- A Supply Safety Margin - see discussion below.

This study focuses on the water demand in 2040 and potential facilities to meet the demand. The net new water supply needed in 2040 is:

- 18.5 cfs of direct diversion (25.4 cfs minus 6.9 cfs)

- Enlargement of Stevens Reservoir with existing Stollsteimer basin reservoirs will provide about 3,530 acre-feet of storage.

- Additional storage of at least 493 acre-feet is required to just barely meet the 2040 demand.

- Supply Safety Margin of approximately a one year supply, available in unforeseen circumstances, as discussed below.

TABLE G

2040 Demand versus Dry Year Supply

	SJWCD 2040 Demand (Ac-Ft)	SJWCD 2040 Demand (cfs)	San Juan Intake 4.6 cfs (Ac-Ft)	Snowball Intake 2.3 cfs (Ac-Ft)	Remaining Demand (Ac-Ft)	New SJ Diversion(s) 18.5 cfs (Ac-Ft)	Needed From Storage (Ac-Ft)	Inflow to Stoll Storage (Ac-Ft)	Stollsteimer Reservoirs EOM (Ac-Ft)	Dry Gulch Reservoir EOM (Ac-Ft)	Inflow to Dry Gulch Res (Ac-Ft)
Month	(Ac-Ft)	(cfs)	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
January	750	12.2	283	141	326	326	0		3530	4000	
February	766	13.8	256	128	383	383	0		3530	4000	
March	773	12.6	283	141	349	349	0		3530	4000	
April	768	12.9	274	137	357	357	0		3530	4000	
May	1085	17.6	283	141	661	661	0		3410	3940	
June	1512	25.4	274	137	1101	1101	0		3290	3880	
July	1420	23.1	283	141	996	0	996		2174	3820	
August	1152	18.7	283	141	728	0	728		1327	3760	
September	1090	18.3	274	137	679	0	679		647	3700	
October	842	13.7	283	141	418	418	0		647	4193	493
November	765	12.9	274	137	354	354	0	180	827	4193	
December	809	13.2	283	141	385	385	0	180	1007	4193	
Totals	11732		3331	1666	6735	4333	2403				

Assumptions:

* Stollsteimer Reservoirs include: Hatcher, Enlarged Stevens, Pagosa, Forest, not Village.
* Assumes that the Stollsteimer Reservoirs will be filled in the spring before a 2002 type drought.
* The monthly water demand in columns 2 and 3 was derived from PAWSD usage data from 1995 to 2000.
* Evaporation is estimated as 30 acre-foot per month from May to Sept. for each Stollsteimer Reservoir and accounted for in Reservoir EOM.
* Evaporation is estimated as 60 acre-foot per month from May to Sept. for Dry Gulch and accounted for in Reservoir EOM.
* Column 9 assumes 3 cfs of inflow from the Dutton Ditch beginning in November to fill the Stollsteimer Basin Reservoirs.
* Dry Gulch Reservoir is used to supply the additional 493 acre-feet as an example with inflow capacity of at least 9 cfs.
* The 2002 drought showed that the San Juan River would not yield more than 6.9 cfs therefore there are no new diversions during July to September.
* EOM is end of month.

2.7 Supply Safety Margin

The need for a Supply Safety Margin became very clear during the drought of 2002. Even though the supply numbers showed there was probably adequate water without restrictions, the PAWSD Board instigated Level One then Level Two restrictions in order to assure adequate water this winter and next summer. In short, when you are in the middle of a drought you do not know how long the drought will last so conservatism is the best policy. The concept of a Supply Safety Margin is to establish water supplies through facilities or other measures which will provide the safety margin water managers can rely on when in the middle of drought or other unforeseen conditions.

Through discussions with the PAWSD and SJWCD Boards, the minimum Supply Safety Margin was determined to be a one year supply in reserve through one or all of the following methods.

Three conceptual types of safety margins:

1. **Construct facilities that can provide a firm supply if all other sources of supply are not available.** This requires storage and is assumed to be a one year supply in storage which would be about 12,000 AF of annual yield. The actual storage amount is dependent upon reservoir location, water supply and other conditions.

2. **Emergency conservation measures.** Based on Level 1 and 2 restrictions, the 2040 summer demand could be reduced about 1,800 AF and the amount needed from storage from 2,400 AF to 1,300 AF. Thus, the supply safety margin storage amount is only reduced to about 11,000 AF of annual yield. The estimated does not include additional conservation measures that may be instituted by the District's to attempt to reduce the 2040 demand.

3. **Develop plans to purchase water during dry years from high priority irrigation water rights to supplement summer demands.** Approximately 18.7 cfs of additional firm water supply during a drought year might replace most, if not all, of the one year safety supply storage volume. This supply is only needed in the worst drought case, maybe once in 50 or 100 years.

2.8 Water Demand Location

The location of the water demands is important in evaluating alternative facilities to provide the 2040 supply. Though difficult to predict, the majority of the water demands are expected to occur in and west of Pagosa Springs in the Stollstiemer Creek basin. Though there will be increases east and south of Pagosa Springs, as well.

This report is based upon the existing SJWCD boundaries but no assumption is made regarding the future PAWSD boundaries. When water service is provided within the SJWCD but outside the existing PAWSD, it is not yet clear whether PAWSD will expand to include the new areas or whether SJWCD will serve these areas. The net 2040 raw water demand is only generally separated by service area as shown in Table F.

2.9 Comparison to 1989 Report

An engineering report was prepared in 1989 to estimate the population and water usage from 1990 to 2025. The Report assumed that the 1990 population of the SJWCD was 8,935 persons which was significantly higher than the 1990 census population of 5,346; as a result, the 2000 population was over-estimated to be 13,240 rather than the actual number of 9,898. However, the rate of growth was underestimated to be 4.8% from 1990 to 1995 and 3.9% from 1995 to 2000; the actual rate was over 6.5 %.

The 2025 population estimate in 1989 was 23,665 compared to the current estimate of 33,614.

Even though the 1989 population estimate was high through 2000, it was low for the following years. Also, the population estimate outside of the PAWSD was significantly over-estimated in 1989. Most of the growth in the SJWCD has occurred in the PAWSD service area.

3.0 AVAILABLE WATER RIGHTS

The water rights available to SJWCD and PAWSD are listed in Table I. The water rights are separated into Stollsteimer Creek Basin and San Juan River Basin. A comment is included for each right to indicate its current status and availability for future water supply. These water rights are described in more detail below.

3.1 Stollsteimer Creek Basin Water Rights

3.1.1. Dutton Ditch

The Dutton Ditch has three water rights, 8.0 cfs of absolute rights for diversion from Four Mile Creek, 40 cfs of conditional water rights for diversion from Four Mile Creek half held by PAWSD and half by SJWCD, and 12.5 cfs of absolute water rights to collect intervening runoff into the Dutton Ditch.

PAWSD is planning to improve the Dutton Ditch by installation of a pipeline to more efficiently convey the 8.0 cfs of absolute and maybe a portion of the 40 cfs of conditional rights.

3.1.2 Hatcher Reservoir

Hatcher Reservoir is an existing reservoir with 1,734 acre-feet of capacity of which 884 acre-feet is active and available. Hatcher is filled primarily by the Perkins Ditch and Dutton Ditch. The improved Dutton Ditch will provide more water to the reservoir.

3.1.3 Existing Stevens Reservoir

Stevens Reservoir is an existing reservoir with 634 acre-feet of capacity with 530 acre-feet active and available, 104 acre-feet is inactive to allow for sediment and poor water quality. Stevens is filled by the Dutton Ditch and basin runoff. The improved Dutton Ditch will provide more water to the reservoir.

3.1.4 Lake Pagosa (aka Sullenberger Reservoir)

Pagosa Lake is an existing reservoir with 1,120 acre-feet of capacity of which 920 acre-feet is active and available, 200 acre-feet is inactive to allow for sediment and poor water quality. Pagosa is filled primarily from basin runoff and spills from Stevens Reservoir. The improved Dutton Ditch will provide more water to the reservoir.

3.1.5 Village Lake

Village Lake is an existing reservoir with 615 acre-feet of capacity. Village is filled primarily from basin runoff and spills from Lake Pagosa. The reservoir is the source of water for the golf course and the water supply is used primarily for the golf course. PAWSD and the golf course are attempting to develop facilities so that the reservoir can also be filled using the San Juan Pipeline.

For purposes of the analysis herein, Village Lake is assumed to be used exclusively for the golf course. Filling of this reservoir is the last priority for PAWSD water supplies.

3.1.6 Lake Forest

Lake Forest is an existing reservoir with 450 acre-feet of capacity of which 300 acre-feet is active and available, 150 acre-feet is inactive to allow for sediment and poor water quality. Forest can be filled from basin runoff, spills from Lake Pagosa, and the San Juan Pipeline.

3.1.7 Stollsteimer Basin Storage Summary

Table H is a summary of storage in the Stollsteimer Basin.

TABLE H
SUMMARY OF STOLLSTEIMER BASIN STORAGE

Reservoir Name (1)	Capacity When Full (ac-ft) (2)	Approx. Unusable Capacity (ac-ft) (3)	Maximum Useable Capacity (ac-ft) (4)
Hatcher	1734	854	880
Stevens	634	104	530
Forest	450	150	300
Village	615	Golf course	0
Pagosa	1120	200	920
Totals	4553	970	2,630

Table H Assumptions:
Village Lake is assumed to be used totally for golf course irrigation and is not available for municipal water supply.

Hatcher Reservoir unuseable amount is due to the configuration of the reservoir and outlet pipe which precludes use of 854 acre-feet without removing a ridge in the reservoir.

The inactive capacities for Stevens, Forest, and Pagosa are to allow loss of storage due to sediment and poor water quality when the reservoirs are nearly empty. The values are subjective estimates.

The primary assumption for the Stollsteimer Creek basin water rights is that all of the water available in Stollsteimer Creek and from Dutton Ditch diversions from Fourmile Creek will be

utilized with the Steven's Reservoir enlargement and the Dutton Ditch improvement. The data from the 2002 drought indicates that if the new Dutton Ditch procedures (section 2.5) had been used prior to the 2002 drought, the Stollsteimer Creek reservoirs would have been full in the spring of 2002.

The analysis also assumes that the water collected from the improved Dutton Ditch will be at least adequate to fill the enlarged Stevens Reservoir but the data is not adequate to predict additional water. Therefore, if additional facilities (e.g. Martinez Reservoir) are developed in the Stollsteimer basin, another water source is necessary to provide the raw water supply, such as the San Juan River. The additional water source could be an extension of the San Juan River Pipeline to fill Village, Pagosa and possibly Stevens Reservoirs.

3.1.8 Enlarged Stevens Reservoir

PAWSD is planning to enlarge Stevens by about 900 acre-feet at about the same time as the Dutton Ditch is improved. A portion of the 2,900 acre-foot conditional decree for Martinez Reservoir will be used as the water right for the 900 acre-feet Stevens enlargement.

3.1.9 Martinez Reservoir

Martinez Reservoir is a potential reservoir located adjacent to Hatcher Reservoir. The reservoir is decreed for 2,900 acre-feet but about 900 acre-feet is planned to be transferred to the Stevens enlargement leaving about 2,000 acre-feet for Martinez. Preliminary plans for the reservoir construction indicate a capacity of about 700 acre-feet is appropriate.

3.1.10 Summary of Stollsteimer Basin Water Rights Supply

The dry year water supply from the Dutton Ditch with improvements and runoff from Martinez Creek are believed to be adequate to fill the existing 2,630 acre-feet of storage capacity plus the additional 900 acre-feet of storage in the enlarged Stevens Reservoir.

The supply is not believed to be adequate to fill 700 acre-feet of Martinez Reservoir.

3.2 San Juan River Water Rights

The San Juan River water rights are also listed in Table I. Most of the San Juan River water rights are not currently being used, particularly the large rights. The current status and future availability of these water rights is summarized in this section. The water rights are incorporated into alternative plans in Section 4.

3.2.1 A.D. Archuleta, Keith, and Pagosa Lumber Co. #1 Ditches

The A.D. Archuleta (2.5 and 1.0 cfs), Keith (1.0 cfs), and Pagosa Lumber Co. #1 (2.0 cfs) Ditch water rights total 6.5 cfs of allowed diversions but are limited to an annual consumptive use from the San Juan River of 105.11 acre-feet. These water rights have been transferred to the San Juan Intake and are used for the existing diversions. Refer to cases W-1061-73, 97CW51, and 99CW71.

3.2.2 Snowball Pipeline

A total of 5.0 cfs of water rights are available at the Snowball Pipeline headgate from the alternative points of diversion (see decree W-1433-76) for the Pagosa Springs #3, #8, and #10 water rights. The Snowball Pipeline is presently restricted to 2.3 cfs of the decreed 5.0 cfs due to pipeline capacity limitations between the diversion point and the Snowball Treatment Plant in

Pagosa Springs. In order to increase the diversion above the existing 2.3 cfs, a new pipeline must be constructed around the Jackson Mountain slide area, as described in Section 4.

Based on the experience in 2002, 2.3 cfs can be diverted at the Snowball intake at all times, but diversions greater than 2.3 cfs would be curtailed from July through September of an extremely dry year. Full use of the existing 5.0 cfs Snowball Pipeline water right is recommended for inclusion in future water supply plans, either at the existing location or transfer to an alternate point.

3.2.3 San Juan River Intake and Pipeline

The San Juan River Intake has two decrees. A 6.5 cfs senior water right is used for current diversions. A second conditional water right for 16.58 cfs, decreed for nearly all uses including storage, is available for additional diversions. The existing intake/pump/pipeline capacity is 4.6 cfs and was operational in 2002.

The drought in 2002 showed that diversions above 4.6 cfs are not firm and there may be a period from July through September of an extreme dry year when no additional water is available.

This water right will likely be a significant component in plans to meet future water demands.

3.2.4 Dry Gulch Reservoir

Dry Gulch Reservoir is an offstream conditional decree for 6,300 acre-feet of storage. The reservoir site is capable of up to approximately 35,000 acre-feet, subject to geotechnical evaluations of the dam site. If the Park Ditch is used to fill the reservoir, the capacity would be restricted to 4,000 acre-feet. Capacities greater than 4,000 acre-feet will require a pump into the reservoir.

The reservoir drainage basin will not yield adequate water to fill the reservoir and would require diversions from the San Juan River. The diversions might be made using the West Fork Canal water rights moved to an appropriate location. The conveyance from the San Juan River to the reservoir might use a new pump station such as the Dry Gulch Pump location to pump water into the reservoir or a conveyance agreement with the Park Ditch (see size limitation above).

The reservoir is best used in conjunction with a direct diversion, such as the San Juan River Intake and Pipeline. The direct diversion would be used to provide water during most months, then releases would be made from the reservoir in the high demand months.

3.2.5 West Fork Canal

The West Fork Canal water right is for 70 cfs at a diversion point about 4 miles upstream from the confluence of the East and West Forks. The water right is for irrigation, municipal and industrial uses but the existing point of use does not include the PAWSD service area which may require modification.

The water right would be out of priority for at least July through September of an extreme dry year and maybe longer depending on how much of the 70 cfs water right is used.

3.2.6 West Fork Reservoir

West Fork Reservoir is decreed for 39,356 acre-feet for nearly all purposes. A reservoir at the decreed capacity would inundate 3 miles of Highway 160, the Wolf Creek Campground and all of the other campgrounds and buildings at the foot of Wolf Creek Pass. A reservoir size of about 8,000 acre-feet would only inundate about 1 mile of the highway and none of the campgrounds; however, most of the flat area in the valley would be inundated. The yield in the drought of 2002 would be the reservoir capacity of 8,000 acre-feet. The reservoir would best be used in conjunction with the West Fork Canal which was the original concept. An 8,000 acre-foot reservoir is used in the evaluations herein, though a larger size is not precluded in future evaluations.

In order to construct the dam and reservoir, right-of-way must be obtained. Also, the cost of the dam is expected to be significant due to the spillway cost to pass the large design flood; a roller compacted embankment would appear to be the best option.

3.2.7 San Juan River Canal System

The San Juan River Canal System is a water right for up to 150 cfs from a combination of the East and West Forks; however, it is decreed for irrigation only and therefore cannot be used for municipal and industrial uses. This water right is not likely to be a component used in meeting future demands due to the use restriction. This water right is held by the Southwestern Water Conservation District.

3.2.8 East Fork Reservoir

East Fork Reservoir is a conditional water right for 35,200 acre-feet of storage for nearly all uses. The dam is about 2 miles upstream from the confluence. The reservoir would require the relocation of the Forest Service Road and a gas pipeline. The Piano Creek development is well upstream of the reservoir. A Forest Service permit would be required which will include an unknown bypass flow. This water right is held by the Southwestern Water Conservation District.

Due to the potential land acquisition problems with the West Fork Reservoir this reservoir is evaluated as an alternative.

3.2.9 Potential, Non-Decreed San Juan River Facilities

The following are potential facilities along the San Juan River but do not have existing water rights.

3.2.10 Dry Gulch Pump

The Dry Gulch Pump location presently does not have any water rights at the potential location, near the confluence of Dry Gulch and San Juan River. The Dry Gulch Pump could be used in conjunction with the Snowball pipeline or replace the Snowball Pipeline in order to eliminate the problems with the Jackson Mountain slide.

This plan is predicated upon either moving the necessary water rights to the diversion locations or a new water right. The CWCB instream flow water right will have an impact, though unknown at this time, on the amount of water that can be transferred to this new diversion point.

3.2.11 Turkey Creek Reservoir

Turkey Creek Reservoir does not have a water right but was studied in the early 1980's to provide water to the Town of Pagosa Springs. Based on the earlier studies, the maximum reservoir size is about 4,000 acre-feet capacity with a 140 foot high dam at the mouth of Turkey Creek.

The reservoir would be used in conjunction with the Snowball Pipeline. The pipeline would be oversized from the headgate to the reservoir so that the reservoir could be filled from the San Juan River if there was insufficient flow in Turkey Creek. The pipeline would be sized from the reservoir to Pagosa Springs to provide the portion of the 2040 demand needed from the Snowball Pipeline. The West Fork Canal water right would likely be used for the San Juan diversions.

3.2.12 San Juan River Summary

All of the water rights listed are decreed for municipal, industrial, and domestic except for the San Juan River Canal System which is for irrigation only. The other water rights can potentially be used to meet a part or all of the 2040 water demand at the existing locations or through transfers.

TABLE I

SJWCD AND PAWSD WATER RIGHTS

Name	Amount	Units	Comment	Available for Future Use
San Juan River				
A D Archuleta	2.5	cfs	PAWSD has the use of the diversion amounts shown but the total annual consumptive use is limited	
A D Archuleta	1	cfs	to 105.11 AF from combined diversions of all four ditches at the San Juan River Intake. Refer to	
Keith Ditch	1	cfs	water court cases W-1061-73 and 97CW51. These water rights have been transferred to San Juan	
Pagosa Lumber Co. #1	2	cfs	River Intake.	
San Juan River Intake	6.5	cfs	Present pump capacity 4.6 cfs.	yes
Pagosa Springs Sp #3	3	cfs	Transfered to and diverted at Snowball Pipeline heading	
Pagosa Springs Sp #8	1	cfs	Transfered to and diverted at Snowball Pipeline heading	
Pagosa Springs Sp #10	1	cfs	Transfered to and diverted at Snowball Pipeline heading	
West Fork - Snowball	5	cfs	Snowball Pipeline, presently limited to 2.3 cfs at slide.	yes - 2.7 cfs
San Juan River Intake	16.58	cfs	Present pump capacity of 4.6 cfs not using the conditional water rights.	yes
West Fork Canal	70	cfs	Could be used in conjunction with Snowball Pipeline or separately	yes
West Fork Reservoir	35,797	AF	Need partnership with land owner. 10,000 AF PAWSD & 25,797 AF SJWCD	yes
San Juan River Canal Sys	150	cfs	West or East Fork, decreed for irrigation only, held by SWCD	no
East Fork Reservoir	35200	AF	Held by SWCD	yes
Dry Gulch Reservoir	6300	AF	Requires diversion from SJ River using Park Ditch or Pump/Pipe from San Juan River.	yes
Stollsteimer Creek				
JB Martinez	1.25	cfs	Being used as part of Hatcher/Stevens Yield	used now
Linn & Clark Ditch	8.5	cfs	Being used as part of Hatcher/Stevens Yield	used now
GS Hatcher Ditch	7.5	cfs	Being used as part of Hatcher/Stevens Yield	used now
Hersch Ditch	8	cfs	Being used as part of Hatcher/Stevens Yield	used now
Dutton Ditch & Extension	8	cfs	Being used as part of Hatcher/Stevens Yield	used now
Dutton Ditch Collection	12.5	cfs	Will be used with Dutton Ditch Pipeline Expansion	used now
Perkins Ditch	20	cfs	Being used as part of Hatcher/Stevens Yield	used now
Linn & Clark Reservoir	426	AF	aka Lake Pagosa	used now
Linn & Clark Res Enlg	571.26	AF	aka Lake Pagosa	used now
GS Hatcher Reservoir	193.24	AF	Being used as part of Hatcher/Stevens Yield	used now
GS Hatcher Res Enlg	1536.05	AF	Being used as part of Hatcher/Stevens Yield	used now
Stevens Reservoir	634.84	AF	Being used as part of Hatcher/Stevens Yield	used now
Hersch Reservoir	32.04	AF		not avail
Town Center Lake	600	AF	aka Village Lake	used now
Lake Forest	500	AF		used now
Pinon Lake	161.85	AF	Can't be utilized in storage plans.	not avail
Stevens Reservoir Enlg	795	AF	Part of Dutton Ditch and Stevens Enlargement, plan to transfer from Martinez decree	will be used
Martinez Reservoir	2900	AF	Will be used as part of Hatcher/Stevens Yield	yes
Dutton Ditch Enlargement	20	cfs	PAWSD Share, Used with Dutton Ditch & Stevens Enlargements	will be used
Dutton Ditch Enlargement	20	cfs	SJWCD Share, May not be water available	unsure

4.0 EVALUATION OF ALTERNATIVE PLANS

Alternative facilities to utilize the water rights described in Section 3.0 are described in this section. The plans described below include numerous assumptions such as: cost estimates, availability of right-of-way for construction, facilities can be constructed as generally described, able to either acquire or transfer water rights to new locations, and water availability where there are no gage records. Specific assumptions are included in the narrative for each plan. Additional studies are recommended to address the overall constructability of the plans.

The cost estimates for each of the alternatives are "ball park". The same unit cost amounts were used for each alternative so the cost are comparable. The final construction cost will be different than the amounts shown herein, but the relative cost for each alternative should remain the same. For example, the more expensive alternatives will remain the more expensive alternatives even if the unit costs increase or decrease.

4.1 Direct Diversion Alternatives

The following is a description of the alternatives to develop: (1) at least 25.4 cfs of direct diversion capability of which 18.5 cfs would be new capability and (2) storage facilities to provide 500 acre-feet of water to meet the 2040 demand and meet the one year Supply Safety Margin criteria.

4.1.1 Snowball Pipeline Improvement and Replacement Plans

There are two options for the Snowball Pipeline. The smaller option involves reconstruction of the existing pipeline to convey 5.0 cfs, 2.7 cfs more than the existing 2.3 cfs. The second option involves construction of a large pipeline to provide 16.7 cfs.

5.0 cfs Option:

The smaller option would modify the existing pipeline to remove the 2.3 cfs restriction due the Jackson Mountain Slide. A new pipeline varying in diameter from 18 to 24 inches is required to convey 5.0 cfs to the Snowball Treatment Plant. The new pipeline must bypass the Jackson Mountain slide. The additional yield is 2.7 cfs. Full utilization of this water right at the existing location, or an alternate point, is recommended so the unused portion will not be abandoned.

The available streamflow data from 2002 indicates that only about 2.3 cfs is available on a firm supply. Therefore, 2.7 cfs of the 5.0 cfs capacity is not firm from July through September based on the 2002 drought. The firm supply from the new 5.0 cfs pipeline would be 1,666 acre-feet from 2.3 cfs and 1,462 acre-feet from January through July and October through December, total of 3,128 acre-feet.

20.8 cfs Option:

If construction of a 5.0 cfs pipeline is considered, then building a larger pipeline to provide 20.8 cfs (2.3 cfs existing and 18.5 cfs new capacity) should be evaluated to meet the 2040 water demand. The larger option would involve construction of a 30 inch pipeline from the present Snowball Pipeline diversion point to the Snowball Treatment Plant. The Snowball pipeline water rights would be used for the existing 5.0 cfs plus transfer of 15.8 cfs of the West Fork Canal water rights to the Snowball diversion point.

Of the 20.8 cfs capacity, 2.3 cfs is firm year round and 18.5 cfs is not firm from July through September. The new firm supply from the 20.8 cfs pipeline would be 4,332 acre-feet plus the existing firm supply of 1,666 acre-feet, for a total of 5,998 acre-feet.

The cost of the small option is shown on Table J and the large option on Table K. The primary advantage of the Snowball Pipeline is gravity flow into the Snowball Treatment Plant. The disadvantages are: (1) the cost of the long pipeline; (2) the upstream diversions deplete the river flows for the longest distance of any plan; (3) water rights must be transferred; and (4) constructing the pipeline to avoid the slide area.

	TABLE J			
5.0 CFS SNOWBALL PIPELINE				
(Note: Increases Snowball supply from 2.3 cfs to 5.0 cfs to utilize the senior water right.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
River Diversion	lump sum	1	$50,000	$50,000
24" DIP Pipe	feet	10400	$60	$624,000
21" DIP Pipe	feet	16690	$55	$918,000
18" DIP Pipe	feet	13720	$50	$686,000
River Crossings	lump sum	2	$30,000	$60,000
Highway Crossings	feet	120	$600	$72,000
Air Release Stations	lump sum	8	$4,000	$32,000
Blow Off Valves	lump sum	8	$3,500	$28,000
Contingency			20.0%	$494,000

Total Field Construction Cost				$2,964,000
Overhead and Miscellaneous Costs			lump sum	$891,000

TOTAL ESTIMATED COST				$3,855,000
Cost Per Acre-Foot of New Firm Yield	1462	acre-feet		$2,637

	TABLE K			
20.8 CFS SNOWBALL PIPELINE				
(Note: 20.8 cfs includes the existing 2.3 cfs diversion and the new 18.5 needed from the San Juan River.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
River Diversion	lump sum	1	$100,000	$100,000
30" DIP Pipe	feet	40810	$95	$3,877,000
River Crossings	lump sum	2	$30,000	$60,000
Highway Crossings	feet	120	$800	$96,000
Air Release Stations	lump sum	8	$4,000	$32,000
Blow Off Valves	lump sum	8	$3,500	$28,000
Contingency			20.0%	$839,000

Total Field Construction Cost				$5,032,000
Overhead and Miscellaneous Costs			lump sum	$1,408,000

TOTAL ESTIMATED COST				$6,440,000
Cost Per Acre-Foot of New Firm Yield	4332	acre-feet		$1,487

4.1.2 San Juan River Pipeline Stages

There are two potential new stages for the San Juan Intake and Pipeline Plan. The existing facility has a capacity of 4.6 cfs and firm supply of 3,331 acre-feet in all months.

Stage 1 would fully utilize the capacity of the existing 16 inch pipeline by increasing the velocity of flow in the pipeline from 3.3 feet per second to about 5 feet per second which would result in conveyance capacity of about 6.6 cfs rather than the current 4.6 cfs. The additional capacity would be a result of larger pumps to deliver more flow and about 100 feet higher head. The capability of the pipeline to withstand the additional pumping head must be evaluated.

The available streamflow data from 2002 indicates that only 4.6 cfs is available on a firm supply; therefore, 2.0 cfs is not firm from July through September. The firm supply from the Stage 1 expansion would be 1,083 acre-feet from January through June and October through December.

Stage 2 would involve construction of a second pipeline and pump system to deliver about 16.5 cfs in order to meet the 2040 demand; 2.3 cfs would be provided by the existing Snowball Pipeline and 4.6 cfs by the existing San Juan Pipeline, and 2.0 cfs by Stage 1. The existing 16.58 cfs of conditional water rights would be used. The facilities would involve a second 27 inch pipeline from the San Juan River and would be placed in the existing 50 foot easement. The firm supply from the Stage 2 expansion would be 3,249 acre-feet from January through June and October through December.

The cost estimate for Stages 1 and 2 are shown on Tables L and M.

The primary advantages of either Stage are: (1) the diversion point is downstream of the Town and will have no impact on flows through Town nor the CWCB instream flow water right; (2) there are existing facilities in place to minimize new impacts; (3) the plan can be developed in stages, with Stage 1 being relatively inexpensive; (4) the water is provided west of the Town where the majority of the growth is occurring; and (5) no transfers of water rights are necessary to implement the plan. The primary disadvantages involve acquiring additional easements if the existing easement is not adequate to construct the second pipeline and the cost of pumping.

	TABLE L			
STAGE 1 - 6.6 CFS SAN JUAN PIPELINE				
(Note: Increases San Juan Pipeline from 4.6 cfs to 6.6 cfs.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
River Diversion	lump sum	1	$50,000	$50,000
Pump Station Expansion	lump sum	1	$80,000	$80,000
Booster Pump Station Expansion	lump sum	1	$80,000	$80,000
Contingency			20.0%	$42,000

Total Field Construction Cost				$252,000
Overhead and Miscellaneous Costs			lump sum	$38,000

TOTAL ESTIMATED COST				$290,000
Cost Per Acre-Foot of New Firm Yield	1083	acre-feet		$268

	TABLE M			
STAGE 2 - 16.5 CFS SECOND SAN JUAN PIPELINE				
(Note: Adds a second San Juan Pipeline to meet deliver 16.5 cfs assuming the 6.6 cfs is built.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
River Diversion	lump sum	1	$100,000	$100,000
27" DIP Pipe	feet	32800	$75	$2,460,000
New Pump Station	lump sum	1	$300,000	$300,000
New Booster Station	lump sum	1	$300,000	$300,000
Air Release Stations	lump sum	6	$4,000	$24,000
Blow Off Valves	lump sum	6	$3,500	$21,000
Contingency			20.0%	$641,000

Total Field Construction Cost				$3,846,000
Overhead and Miscellaneous Costs			lump sum	$962,000
				---------- --
TOTAL ESTIMATED COST				$4,808,000
Cost Per Acre-Foot of NewFirm Yield	3249	acre-feet		$1,480

4.1.3 Dry Gulch Pump Plan

A 20.8 cfs pump facility would be constructed on the San Juan River near the confluence with Dry Gulch to divert San Juan River water to the Snowball Treatment Plant when flow is available. The existing San Juan Pump and Pipeline would continue to deliver 4.6 cfs. The pump facilities would include a diversion structure on the river, a pump station, and a pipeline to the Snowball treatment plant. The diversion location was selected to allow the option of using the diversion and pump to fill Dry Gulch Reservoir. This plan assumes that the Dry Gulch Pump would replace the Snowball Pipeline.

The plan is predicated upon water court proceedings to transfer existing water rights which would be limited to the water supply available at the original points of diversion. Depending on which rights are transferred, the CWCB instream flow water rights will have an impact on the transfer of water rights to the Dry Gulch Pump diversion point. New water rights are also an option.

The new firm supply from the Dry Gulch Pump is 4,332 acre-feet from January through June and October through December plus the existing firm supply of 1,665 acre-feet from the present 2.3 cfs Snowball Pipeline for a total supply of 5,998 acre-feet.

The cost estimate is shown on Table N.

The advantages of the Dry Gulch Pump Plan include: (1) the long pipeline from the West Fork around the slide area is avoided; (2) all San Juan River diversions on the east side of Pagosa Springs are consolidated at one location; (3) the pump can deliver water to both the treatment plant and to the Dry Gulch Reservoir. The disadvantages are the pumping cost and if growth continues to be primarily on the west side of Pagosa Springs and the water must be piped from the east to west side of Pagosa Springs.

	TABLE N			
20.8 CFS DRY GULCH PUMP STATION				
(Note: This facility would replace the Snowball Pipeline.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
River Diversion	lump sum	1	$175,000	$175,000
30" DIP Pipe, to Snowball TP	feet	8000	$95	$760,000
Pump Station	lump sum	1	$350,000	$350,000
River Crossings	lump sum	1	$30,000	$30,000
Highway Crossings	feet	120	$600	$72,000
Air Release Stations	lump sum	3	$4,000	$12,000
Blow Off Valves	lump sum	2	$3,500	$7,000
Contingency			20.0%	$281,000

Total Field Construction Cost				$1,687,000
Overhead and Miscellaneous Costs			lump sum	$532,000

TOTAL ESTIMATED COST				$2,219,000
Cost Per Acre-Foot of Firm Yield	4332	acre-feet		$512

4.1.4 Summary of Diversion Alternatives

The following table compares the cost per acre-foot of useable yield to meet the 2040 demand for each of the diversion alternatives.

TABLE O
COMPARISON OF ALTERNATIVE DIVERSIONS

Alternative	New Firm Yield	$/acre-foot
5.0 cfs Snowball Pipeline	1,462 AF	$2,637
20.8 cfs Snowball Pipeline	4,332 AF	$1,487
2.0 cfs San Juan Pipeline Increase	1,083 AF	$268
16.5 cfs Second San Juan Pipeline	3,249 AF	$1,480
20.8 cfs Dry Gulch Pump	4,332 AF	$503

4.2 Storage Alternatives

The storage alternatives are described in this section. All of the assumptions described for Diversions alternatives apply to the reservoirs plus the assumption that geotechnical evaluations will not significantly increase the construction cost of the reservoirs. All of the analysis is based on USGS Quadrangle maps.

4.2.1 Stevens Reservoir Enlargement

The Stevens Reservoir Enlargement has been extensively described in various studies which are used in this analysis. Based on the preliminary data from 2002, it appears that the existing Stevens Reservoir could have been full in the spring of 2002 if the San Juan Pipeline had been operational, but there does not appear to be adequate water to have filled the enlargement.

Based on work performed by Davis Engineering, approximately 950 acre-feet of additional yield is provided by the Dutton Ditch Improvement which is just adequate to fill the 900 acre-feet of enlarged Stevens.

The costs shown on Table P are taken from the Davis Engineering study with a small increase. The annual yield from the enlargement and Dutton Ditch Improvement is estimated to be 900 acre-feet on any demand pattern.

The advantages of the Stevens Reservoir Enlargement include: (1) an existing reservoir site to minimize the environmental impacts; (2) the reservoir is filled by gravity and gravity flow out of the reservoir; (3) engineering and environmental studies of the enlargement are nearly completed; (4) funding has been approved by vote of PAWSD residents in fall of 2002. The disadvantages are: (1) appears to require the Dutton Ditch Improvement to fill the enlargement; (2) the lack of data on the potential diversions from Four Mile Creek into the Dutton Ditch Improvement to accurately determine the yield from the enlargement; (3) the cost is greater than other alternatives.

	TABLE P			
STEVENS RESERVOIR ENLARGEMENT				
(Note: The enlargement would add 900 acre-feet of firm storage filled by Dutton Ditch Improvement.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
Mobilizatlon	lump sum	1	$50,000	$50,000
Diversion and Dewatering	lump sum	1	$50,000	$50,000
Haul Road	feet	5000	$20	$100,000
Excavation Existing Dam	cubic yards	7833	$2.12	$17,000
Stipping	cubic yards	4000	$1.00	$4,000
Zone 1 Fill	cubic yards	39094	$1.93	$75,000
Zone 2 Fill	cubic yards	39418	$1.62	$64,000
Chimney Drain	cubic yards	2618	$21.17	$55,000
Rip Rap	cubic yards	14653	$40.00	$586,000
Rip Rap Bedding	cubic yards	4884	$15.00	$73,000
Filter Fabric	sq yards	4884	$1.52	$7,000
Clear and Gub	acres	150	$1,000.00	$150,000
Outlet Works Inlet Structure	lump sum	1	$35,000.00	$35,000
Outlet Works Inlet Structure	lump sum	1	$20,000.00	$20,000
Outlet Works 18 inch Pipeline	feet	150	$200.00	$30,000
Outlet Works Extension	feet	100	$80	$8,000
Outlet Works 18 inch BFV	lump sum	1	$5,000	$5,000
Contingency			30.0%	$399,000

Total Field Construction Cost				$1,728,000
Overhead and Miscellaneous Costs			lump sum	$446,000

TOTAL ESTIMATED RESERVOIR COST				$2,174,000
Cost per Acre-Foot of Active Storage	900	acre-feet		$2,416
Dutton Ditch Improvement				
Diversion Structure	lump sum	1	$18,000	$18,000
24" Pipe	feet	19000	$75	$1,425,000
Discharge Structure	lump sum	1	$4,000	$4,000
Isolation Valves	lump sum	19	$5,500	$105,000

Air/Vaccum Release Stations	lump sum	9	$4,500	$41,000
Blow Off Valves	lump sum	19	$1,800	$34,000
Contingency			20.0%	$325,000

Total Field Construction Cost				$1,952,000
Overhead and Miscellaneous Costs			lump sum	$390,000

TOTAL ESTIMATED COST				$2,342,000
TOTAL ESTIMATED COST OF ENLARGEMENT AND DITCH IMPROVEMENT				$4,516,000
Cost Per Acre-Foot of Firm Yield	900	acre-feet		$5,018
Note: The Dutton Ditch Improvement may yield more water than just filling the enlarged				
Stevens Reservoir.				

4.2.2 Martinez Reservoir

Martinez Reservoir has also been studied extensively and that data is used herein. Based on the preliminary data from 2002, there does not presently nor with the Dutton Ditch Improvement, appear to be adequate water to fill a 700 acre-foot Martinez Reservoir. In order to provide adequate water, the San Juan Pipeline must be extended to Pagosa Lake so that Dutton Ditch water presently used to fill Pagosa Lake can be used to fill Martinez Reservoir. The San Juan Pipeline will fill Pagosa Lake.

The costs shown on Table Q are taken from the Davis Engineering study with a small increase. The annual yield from Martinez Reservoir in conjunction with the San Juan Pipeline extension to Pagosa Lake is 700 acre-feet.

The advantages of the Martinez Reservoir include: (1) the reservoir is filled by gravity and gravity flow out of the reservoir; (2) can utilize water in the Martinez Creek basin and from Dutton Ditch that are presently not being captured. The disadvantages are: (1) the cost of construction and pumping to provide water to Pagosa Lake to allow Martinez to be filled; (2) the cost is greater than other alternatives.

	TABLE Q			
MARTINEZ RESERVOIR				
(Note: The extension of the San Juan Pipeline to Pagosa Lake is necessary to fill Martinez .)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
Clearing and Grubbing	cubic yards	22500	2.00	$45,000
Placement of Earth Fill	cubic yards	328075	1.50	$492,000
Core Trench Excavation	cubic yards	48425	5.00	$242,000
Chimney & Blanket Drain	cubic yards	23735	15.00	$356,000
Rip Rap and Bedding	cubic yards	10970	15.00	$165,000
Spillway Excavation	cubic yards	318000	2.00	$636,000
Spillway Concrete	cubic yards	200	$450.00	$90,000
Spillway Rip Rap	cubic yards	10000	$15.00	$150,000
Outlet Works 36 inch Pipe	feet	500	$40.00	$20,000
Cut-off Collars	cubic yards	9	$500.00	$5,000
Slide Gate	lump sum	1	$40,000.00	$40,000
Stilling Basin	cubic yards	22	$600.00	$13,000
Perkins Ditch Construction	feet	1400	$25.00	$35,000
Pump To Hatcher TP	lump sum	1	$75,000.00	$75,000
14 inch Pipeline to Hatcher TP	feet	1750	$18.00	$32,000
Contingency			30.0%	$719,000

Total Field Construction Cost				$3,115,000
Overhead and Miscellaneous Costs			lump sum	$779,000

TOTAL ESTIMATED RESERVOIR COST				$3,894,000
Cost per Acre-Foot of Active Storage	700	acre-feet		$5,563
Extension of San Juan Pipeline to Pagosa Lake				
River Diversion	lump sum	1	$100,000	$100,000
18" Pipe to Pagosa Lake	feet	12000	$50	$600,000
Road Crossings	feet	120	$600	$72,000
Air Release Stations	lump sum	1	$4,000	$4,000
Blow Off Valves	lump sum	1	$3,500	$4,000
Contingency			20.0%	$156,000

Total Field Construction Cost				$936,000
Overhead and Miscellaneous Costs			lump sum	$284,000

TOTAL ESTIMATED PIPE COST				$1,220,000
TOTAL ESTIMATED RESERVOIR AND PIPE COST				$5,114,000
Cost Per Acre-Foot of Firm Yield	700	acre-feet		$7,306

4.2.3 Dry Gulch Reservoir and Pump Plan

The Dry Gulch Reservoir is an off-stream reservoir with a maximum reservoir storage capability of about 35,000 acre-feet subject to geotechnical studies to verify that the dam site is adequate. However, for this evaluation two sizes are considered, 4000 acre-feet so that the Park Ditch can be used for inflow and 12,500 acre-feet to provide 500 acre-feet needed to meet the 2040 demand and 12,000 acre-feet for the supply safety margin.

4,000 Acre-Foot Reservoir:

The small 4,000 acre-feet plan, assumes that the Park Ditch may be used for inflow in the future but for the analysis in this report, the Dry Gulch Pump is used to fill the reservoir. The Park Ditch will be siphoned across Dry Gulch rather than inflow into and out of the reservoir which allows the reservoir to operate independently of the ditch. The purpose of the reservoir would be to provide storage to supplement direct diversions from Dry Gulch Pump but could also be used in conjunction with a 20.8 cfs Snowball pipeline or the San Juan River Pipeline.

The dam would be a 75 foot high earth embankment.

The yield analysis is predicated upon inflow from the San Juan River using the Dry Gulch Pump when capacity is available. The Dry Gulch Pump will have from 3 to 13 cfs of unused capacity in all months but June. Dry Gulch Reservoir is planned to be 4,000 acre-feet of the decreed amount of 6,300 acre-feet.

A 20.8 cfs pump facility would be constructed on the San Juan River near the confluence with Dry Gulch to divert San Juan River water to the Snowball treatment plant and fill Dry Gulch Reservoir when flow is available. The pump facilities would include a diversion structure on the river, a pump facility, and a pipeline to the Snowball treatment plant. The diversion location is selected to allow the option of using the diversion and pump to either convey water to the Snowball Treatment Plan and/or fill Dry Gulch Reservoir. This plan assumes that the Dry Gulch Pump would replace the Snowball Pipeline.

The plan is predicated upon water court proceedings to transfer existing water rights which would be limited to the water supply available at the original points of diversion. Depending on which rights are transferred, the CWCB instream flow water rights will have an impact on the transfer of water rights to the Dry Gulch Pump diversion point.

The firm water supply from the Dry Gulch Reservoir and Pump would be 4,000 acre-feet from the reservoir on any demand pattern and 4,332 acre-feet from the Dry Gulch Pump diversions during January through June and October through December, for a total of 8,332 acre-feet of new firm yield.

The reservoir costs shown on Table R are taken from the Davis Engineering study with a small increase.

12,500 Acre-Foot Reservoir:
The large reservoir plan would utilize the Dry Gulch Dam and Reservoir to provide the 500 acre-feet needed to supply the 2040 demand and the 12,000 acre-feet for the supply safety margin, a total of 12,500 acre-feet. All studies to date on Dry Gulch have evaluated a size in the 4,000 acre-foot range, so no evaluations of the larger size have been made from geotechnical, land availability, etc. The obvious advantage of this large plan is to provide all of the storage needed for 2040 at one location rather than two. Also, if the reservoir were larger than 12,500 acre-feet it may be able to provide water beyond 2040, assuming that adequate repayment was available.

The dam would be 114 feet high, also an earth embankment. All inflow would be pumped from the Dry Gulch Pump station.

The Dry Gulch Pump Station would be nearly identical to the version for the smaller reservoir except that the pump lift would be 40 feet greater.

The firm water supply from the Dry Gulch Reservoir and Pump would be 12,500 acre-feet from the reservoir on any demand pattern and 4,332 acre-feet from the Pump diversions during January through June and October through December, for a total of 16,832 acre-feet of new firm yield.

The advantages of either size of the Dry Gulch Reservoir and Pump Plan include: (1) the long pipeline from the West Fork around the slide area is avoided; (2) all San Juan River diversions on the east side of Pagosa Springs are consolidated at one location; (3) the Dry Gulch Pump can deliver water to the Dry Gulch Reservoir and directly to the treatment plant; (4) Dry Gulch Reservoir can work with any diversion plans, not just the Dry Gulch Pump; (5) the construction cost is the least of any alternative. The disadvantages are: (1) the pumping cost; (2) need for a Forest Service Permit for the larger size reservoir; and (3) if growth continues to be primarily on the west side of Pagosa Springs the water must be piped from the east to west side of Pagosa Springs.

	TABLE R			
4,000 AF DRY GULCH RESERVOIR AND 20.8 CFS PUMP STATION				
(Note: Dry Gulch Reservoir and Pump Station are developed together.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
Dry Gulch Reservoir				
Clearing and Grubbing	lump sum	1	$150,000	$150,000
Earth Excavation and Compaction	cubic yards	430000	$7	$3,010,000
Toe Drain	feet	400	$50	$20,000
Rip Rap	cubic yards	2800	$30	$84,000
Spillway	feet	350	$500	$175,000
42 Inch Outlet Pipe	feet	435	$300	$131,000
Cut-off Collars	cubic yards	9	$500	$5,000
Slide Gate	lump sum	1	$40,000	$40,000
Stilling Basin	cubic yards	22	$600	$13,000
30 inch Pipeline To Dry Gulch Pump	feet	3000	$95	$285,000
30 inch Pipeline Park Ditch Siphon	feet	1200	$95	$114,000
Contingencies			35.0%	$1,251,000
Total Field Construction Cost				$5,278,000
Overhead and Miscellaneous Costs			lump sum	$3,060,000

TOTAL ESTIMATED RESERVOIR COST				$8,338,000
Cost per Acre-Foot of Active Storage	4000	acre-feet		$2,085
Dry Gulch Pump				
River Diversion	lump sum	1	$150,000	$150,000
30" DIP Pipe, to Snowball TP	feet	8000	$95	$760,000
Pump Station	lump sum	1	$350,000	$350,000
River Crossings	lump sum	1	$30,000	$30,000
Highway Crossings	feet	120	$600	$72,000
Air Release Stations	lump sum	3	$4,000	$12,000
Blow Off Valves	lump sum	2	$3,500	$7,000
Contingency			20.0%	$276,000
Total Field Construction Cost				$1,657,000
Overhead and Miscellaneous Costs			lump sum	$524,000
TOTAL ESTIMATED PUMP COST				$2,181,000
TOTAL ESTIMATED COST FOR PUMP AND RESERVOIR				$10,519,000
Cost Per Acre-Foot of Firm Yield	8332	acre-feet		$1,262

	TABLE S			
12,500 AF DRY GULCH RESERVOIR AND 20.8 PUMP STATION				
(Note: Dry Gulch Reservoir and Pump Station are developed together.)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
Dry Gulch Reservoir				
Clearing and Grubbing	lump sum	1	$250,000	$250,000
Earth Excavation and Compaction	cubic yards	1120000	$7	$7,840,000
Toe Drain	feet	600	$50	$30,000
Rip Rap	cubic yards	6000	$30	$180,000
Spillway	feet	800	$500	$400,000
42 Inch Outlet Pipe	feet	900	$300	$270,000
Cut-off Collars	cubic yards	20	$500	$10,000
Slide Gate	lump sum	1	$40,000	$40,000
Stilling Basin	cubic yards	22	$600	$13,000
30 inch Pipeline To Dry Gulch Pump	feet	3000	$95	$285,000
30 inch Pipeline Park Ditch Siphon	feet	1200	$95	$114,000
Contingencies			35.0%	$3,143,000

Total Field Construction Cost				$12,575,000
Overhead and Miscellaneous Costs			lump sum	$6,994,000

TOTAL ESTIMATED RESERVOIR COST				$19,569,000
Cost per Acre-Foot of Active Storage	12500	acre-feet		$1,566
Dry Gulch Pump				
River Diversion	lump sum	1	$175,000	$175,000
30" DIP Pipe, to Snowball TP	feet	8000	$95	$760,000
Pump Station	lump sum	1	$400,000	$400,000
River Crossings	lump sum	1	$30,000	$30,000
Highway Crossings	feet	120	$600	$72,000
Air Release Stations	lump sum	3	$4,000	$12,000
Blow Off Valves	lump sum	2	$3,500	$7,000
Contingency			20.0%	$291,000
Total Field Construction Cost				$1,747,000
Overhead and Miscellaneous Costs			lump sum	$547,000
TOTAL ESTIMATED PUMP COST				$2,294,000
TOTAL ESTIMATED COST FOR PUMP AND RESERVOIR				$21,863,000
Cost Per Acre-Foot of Firm Yield	16832	acre-feet		$1,299

4.2.4 West Fork Reservoir

The West Fork Reservoir is located on the West Fork of the San Juan River about 3 miles upstream from the confluence. Harris Water Engineering performed studies on this reservoir site in the 1980's for the Southwestern Water Conservation District. The data presented herein is derived from those studies but the reservoir size has been modified and the costs were updated.

If the reservoir were constructed to the decreed capacity of about 35,000 acre-feet it would inundate the entire valley including the campgrounds and county roads. A size of about 8,000 acre-feet which would impact only about 1 mile of Highway 160 and none of the campgrounds, is used for the evaluations herein, though a larger size may be necessary.

The preliminary plans for the dam are a roller compacted concrete gravity dam so that the entire crest of the dam can be a spillway to pass the large design flood. The dam is only 85 feet high. The dam is located on the main channel, so filling is assured every year and an annual firm yield of 8,000 acre-feet. The estimated cost is shown on Table T.

The advantages of the West Fork Reservoir include: (1) the reservoir is on the mainstem and can be filled every year, even 2002; (2) the reservoir can provide water to any of the diversion locations; (3) the reservoir site is as large as any alternative; (4) the reservoir could be a new fisherman/tourist attraction for the area. The disadvantages include: (1) the land cost may be higher due to legal complications; (2) a Forest Service permit is required for larger sizes; and (3) the environmental analysis of reservoirs located on major streams can be significant.

	TABLE T			
WEST FORK DAM AND RESERVOIR				
(Note: West Fork Reservoir can be used with any of the diversion locations .)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
Clearing and Gubbing	acres	50	$1,000	$50,000
Mobilization	lump sum	1	$100,000	$100,000
Foundation Excavation	cubic yards	33000	2.00	$66,000
RCC Placement	cubic yards	200000	70.00	$14,000,000
Outlet Works	lump sum	1	$300,000	$300,000
Road Relocation	miles	1	$2,000,000	$2,000,000
Contingency			30.0%	$4,355,000

Total Field Construction Cost				$20,871,000
Overhead and Miscellaneous Costs			lump sum	$13,218,000

TOTAL ESTIMATED RESERVOIR COST				$34,089,000
Cost per Acre-Foot of Active Storage	8000	acre-feet		$4,261
Cost Per Acre-Foot of Firm Yield	8000	acre-feet		$4,261

4.2.5 East Fork Reservoir

The East Fork Reservoir is located on the East Fork of the San Juan River about 1 mile upstream from the confluence with the West Fork. Harris Water Engineering performed studies on this reservoir site in the 1980's for the SJWCD and the Southwestern Water Conservation District. The data presented herein is derived from those studies but the reservoir size has been modified and the costs were updated.

The decreed capacity of the reservoir is about 35,000 acre-feet. The larger the reservoir the lower the cost per acre-foot. For purposes of this report to compare the East Fork with the other reservoir sites a size of 12,000 acre-feet is used in order to supply the 2040 water demand. When this reservoir is considered in the future, a larger size should be investigated.

The preliminary plans for the dam are a roller compacted concrete gravity dam so that the entire crest of the dam can be a spillway to pass the large design flood. The dam is 345 feet high so the embankment volume is very large.

The dam is located on the main channel, so filling is assured every year and an annual firm yield of 12,000 acre-feet. The US Forest Service access road and a gas pipeline must be relocated. The land is US Forest Service land so there would not be a land cost but Forest Service will likely place conditions on approval of a special use permit that will be significant, the estimated cost of the conditions is not included because they are not known. The estimated cost is shown on Table U.

The advantages of the East Fork Reservoir include: (1) the reservoir is on the mainstem and can be filled every year, even 2002; (2) the reservoir can provide water to any of the diversion locations; (3) the reservoir site is the largest of any alternative; (4) the reservoir could be a new fisherman/tourist attraction for the area. The disadvantages include: (1) Forest Service special use permit; (2) the cost of relocating the road and gas pipeline are large; (3) the environmental analysis of reservoirs located on major streams can be significant.

	TABLE U			
EAST FORK DAM AND RESERVOIR				
(Note: East Fork Reservoir can be used with any of the diversion locations .)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
Clearing and Gubbing	acres	50	$1,000	$50,000
Mobilization	lump sum	1	$100,000	$100,000
Foundation Excavation	cubic yards	23000	2.00	$46,000
RCC Placement	cubic yards	791000	70.00	$55,370,000
Outlet Works	lump sum	1	$300,000	$300,000
Road Relocation	miles	5	$1,500,000	$7,500,000
Gas Pipeline Relocation	miles	5	$500,000	$2,500,000
Contingency			30.0%	$16,760,000

Total Field Construction Cost				$82,626,000
Overhead and Miscellaneous Costs			lump sum	$20,657,000

TOTAL ESTIMATED RESERVOIR COST				$103,283,000
Cost per Acre-Foot of Active Storage	12000	acre-feet		$8,607
Cost Per Acre-Foot of Firm Yield	12000	acre-feet		$8,607

4.2.6 Turkey Creek Reservoir

Turkey Creek Reservoir was studied in the early 1980's by Western Engineers (Grand Junction) for the Town of Pagosa Springs. The reservoir size selected for inclusion herein is the largest in the previous study, at 4,000 acre-feet. The dam would be located at the mouth of Turkey Creek. The dam construction quantities shown in Table P were obtained from the Western Engineers report with updated unit costs.

The water supply for Turkey Creek Reservoir would be a combination of Turkey Creek and diversions from the San Juan River. In 2002, there was little if any water available in Turkey Creek so the reservoir must be filled by San Juan River water diverted during the winter and spring. A 30 cfs pipeline is included to convey water from the San Juan River to the reservoir.

The cost of the reservoir is shown in Table Q. The firm yield from the reservoir is 4,000 acre-feet per year on any demand pattern.

The advantages of the Turkey Creek Reservoir include: (1) off stream site; (2) Turkey Creek flows would be adequate in most years to fill the reservoir; (3) San Juan River water can be conveyed to the reservoir by gravity; (4) the reservoir can be operated in conjunction with a large Snowball Pipeline. The disadvantages include: (1) the dam and reservoir site are not optimum as reflected in the high cost per acre-foot and (2) a Forest Service permit is required.

	TABLE V			
TURKEY CREEK RESERVOIR				
(Note: Turkey Creek Reservoir is integrated with enlargement of the Snowball Pipeline .)				
Item Description	**Units**	**Quantity**	**Cost/Unit**	**Total Cost**
Dam and Reservoir				
Mobilization	lump sum	1	$100,000	$100,000
Care and Diversion of Creek	lump sum	1	$100,000	$100,000
Clearing	acres	140	1,000.00	$140,000
Stipping	cubic yards	90000	1.50	$135,000
Foundation Excavation	cubic yards	56300	2.00	$113,000
Grouting	holes	190	$3,000	$570,000
Embankment	cubic yards	1367090	3.00	$4,101,000
Chimney filters	cubic yards	54450	$15	$817,000
Outlet Works	feet	620	$600	$372,000
Spillway RCC Concrete	cubic yards	41910	$100	$4,191,000
Rip Rap	cubic yards	28700	$30	$861,000
Pipeline	feet	800	$50	$40,000
Contingency			30.0%	$176,000

Total Field Construction Cost				$11,716,000
Overhead and Miscellaneous Costs			lump sum	$3,729,000

TOTAL ESTIMATED RESERVOIR COST				$15,445,000
Cost per Acre-Foot of Active Storage	4000	acre-feet		$3,861
30 cfs Inlet Pipe from San Juan River				
River Diversion	lump sum	1	$100,000	$100,000
36" Pipe from SJ to Reservoir	feet	15000	$125	$1,875,000
River Crossings	lump sum	1	$50,000	$50,000
Highway Crossings	feet	120	$600	$72,000
Air Release Stations	lump sum	2	$4,000	$8,000
Blow Off Valves	lump sum	2	$3,500	$7,000
Contingency			20.0%	$422,000

Total Field Construction Cost				$2,534,000
Overhead and Miscellaneous Costs			lump sum	$709,000

TOTAL ESTIMATED INLET PIPE COST				$3,243,000
TOTAL ESTIMATED COST FOR RESERVOIR, INLET PIPE				$18,688,000
Cost Per Acre-Foot of Firm Yield	4000	acre-feet		$4,672

4.2.7 Summary of Reservoir Storage Alternatives

The following table compares the cost per acre-foot of active capacity and the cost per acre-foot of yield for each of the reservoir alternatives.

TABLE W
COMPARISON OF ALTERNATIVE RESERVOIRS

Alternatives	Reservoir Capacity	$ per acre-foot of Capacity	Firm Yield with Related Facilities	$ per acre-foot of Yield
Stevens Enlargement and Dutton Improvement	900	$2,416	N/A	
Martinez Reservoir and San Juan Pipe Extension	700	$5,563	700	$7,306
4,000 AF Dry Gulch Reservoir and Pump Station	4,000	$2,085	8,332	$1,262
12,500 AF Dry Gulch Reservoir and Pump Station	12,500	$1,566	16,832	$1,299
West Fork Reservoir	8,000	$4,261	N/A	
East Fork Reservoir	12,000	$8,607	N/A	
Turkey Creek Reservoir and Inlet Pipe	4,000	$3,861	4,000	$4,672

Table X summarizes the cost of diversion alternatives and storage alternatives including firm supply, cost per acre-foot and total cost of the alternative. The alternatives are listed by cost per acre-foot.

4.3 Water Treatment and Distribution Facilities

The purpose of this report is to evaluate the water rights and facilities to provide at least the net 2040 raw water demand. The impact of the projected population increase from 9,400 in 2000 to over 45,000 in 2040 will require about five times more treatment and distribution facilities. The cost of the treated water facilities will be significantly greater than the raw water facilities.

This report assumes that water treatment will continue to be at the Snowball and San Juan Treatment Plant sites. However, the development pattern of the treated water facilities may have an impact on the location for raw water facilities and the resulting cost. Alternative locations for raw water facilities have been included to attempt to provide flexibility to coordinate with the treated water facility development.

TABLE X			
SUMMARY OF ALTERNATIVE COSTS			
	Firm	**Cost per**	**Total Cost**
	Supply	**Acre-Foot**	**Of**
Diversion Alternatives	**(acre-feet)**	**Of Yield**	**Alternative**
2.0 cfs San Juan Pipeline Increase	1,083	$268	$290,000
20.8 cfs Dry Gulch Pump Station	4,332	$512	$2,219,000
16.7 cfs Second San Juan Pipeline	3,249	$1,480	$4,808,000
20.8 cfs Snowball Pipeline	4,332	$1,487	$6,440,000
5.0 cfs Snowball Pipeline	1,462	$2,637	$3,855,000
Storage Alternatives			
Dry Gulch Reservoir 4,000 AF and Pump	8,332	$1,262	$10,519,000
Dry Gulch Reservoir 12,000 AF and Pump	16,832	$1,299	$21,863,000
Stevens Enlargement	900	$2,416	$2,174,000
West Fork Reservoir	8,000	$4,261	$34,089,000
Turkey Creek Reservoir and Inlet Pipeline	4,000	$4,672	$18,688,000
Martinez Reservoir and SJ Pipeline Extension	700	$7,306	$5,114,000
East Fork Reservoir	12000	$8,607	$103,283,000