DRAFT Memorandum

To:	File 1527TWF05, Task 8 CWP Grant Task 1.8
From:	Gregg Ten Eyck, LRE
Reviewed by:	Jordan Furnans, PhD., LRE
Copy to:	Julie Pasillas, Dave Lindsay, Brad Grasmick, Russell Sands, Michael Cook
Date:	January 25, 2019
Project:	Colorado Water Plan Grant: Modeling Reservoir Operations
Subject:	Memorandum to Document Model Results

I. Background

The purpose of this Draft Memorandum to Document Model is to summarize the work effort and to report on the completion of the Colorado Water Plan Grant to the Town of Firestone for Modeling Reservoir Operations. This Draft Memorandum is for review by the Colorado Water Conservation Board.

II. Attached Memoranda

Memoranda describing the work completed for Tasks 1 through 6 are attached as a pdf file, as follows

Task 1.1 Water Demands
Task 1.2 Water Supplies
Task 1.3 Partnerships
Task 1.4 Tool Development
Task 1.5 Configuration and Scenario Development
Task 1.6 Peaking Model

III. Model Use and Results

We used the model to analyze a baseline 2027 configuration and seven alternative 2027 configurations and a baseline 2050 configuration and seven alternative 2050 configurations. The alternative configurations were developed both to represent anticipated water demand and water supply configurations and to test the model operation under a range of assumed water supply configurations. In our opinion the model is ready to use to model real alternatives that will be considered, such as adding more NISP water or a second reservoir to Firestone's water portfolio.

Basic conclusions that we have reached from the use of the model thus far are:

1) Acquiring and changing additional native water rights will help to fill the reservoir that is designed to support non-potable irrigation demands;
2) The amount of reuse credits generated from indoor use of Windy Gap and fully augmented pumping of the Gould Wellfield (returned to St Vrain Creek from the St Vrain Sanitation District) in the Baseline 2027 configuration is in the range of 320 acre-feet per year.
3) In the 2050 demand mode additional NISP water will likely be needed. It is also likely that one of the Town's reservoirs will be used to store reuse credits diverted by exchange, as well as being used to supply the St Vrain Water Treatment Plant to meet year 2050 treated water demands;
4) The available climate change mode allows the Town to use this model to evaluate how the system may need to be configured to minimize unmet demands at mid-century.
5) The ability to specify a fixed quota for C-BT units will be useful to model situations where the Northern Colorado Water Conservancy District may be required to change how they set allocation quotas in light of Colorado River drought response planning.

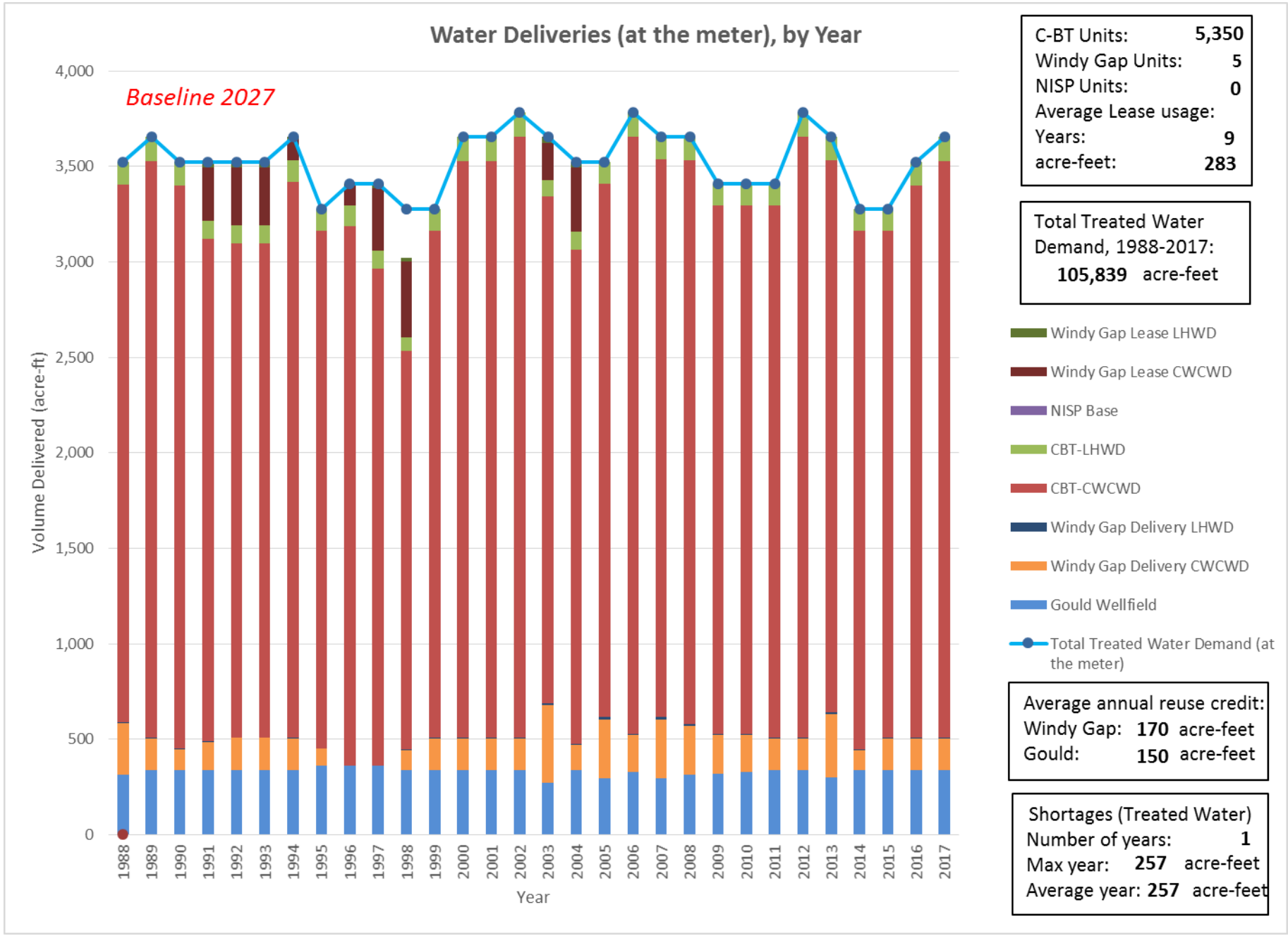
In addition, while evaluating the potential for partnering or collaborating the Town identified the need to create a St Vrain Water Authority to own and operate the new St Vrain Water Treatment Plant that the Town is developing. The Town also determined that partners in that plant will have to own their own water rights to feed the treatment plant. Because of this likely arrangement that each participant in the St Vrain Water Authority will be responsible for their own raw water supplies (water rights, well fields, and storage, for example) we did not use the partner options built into the model to configure any alternative model runs.

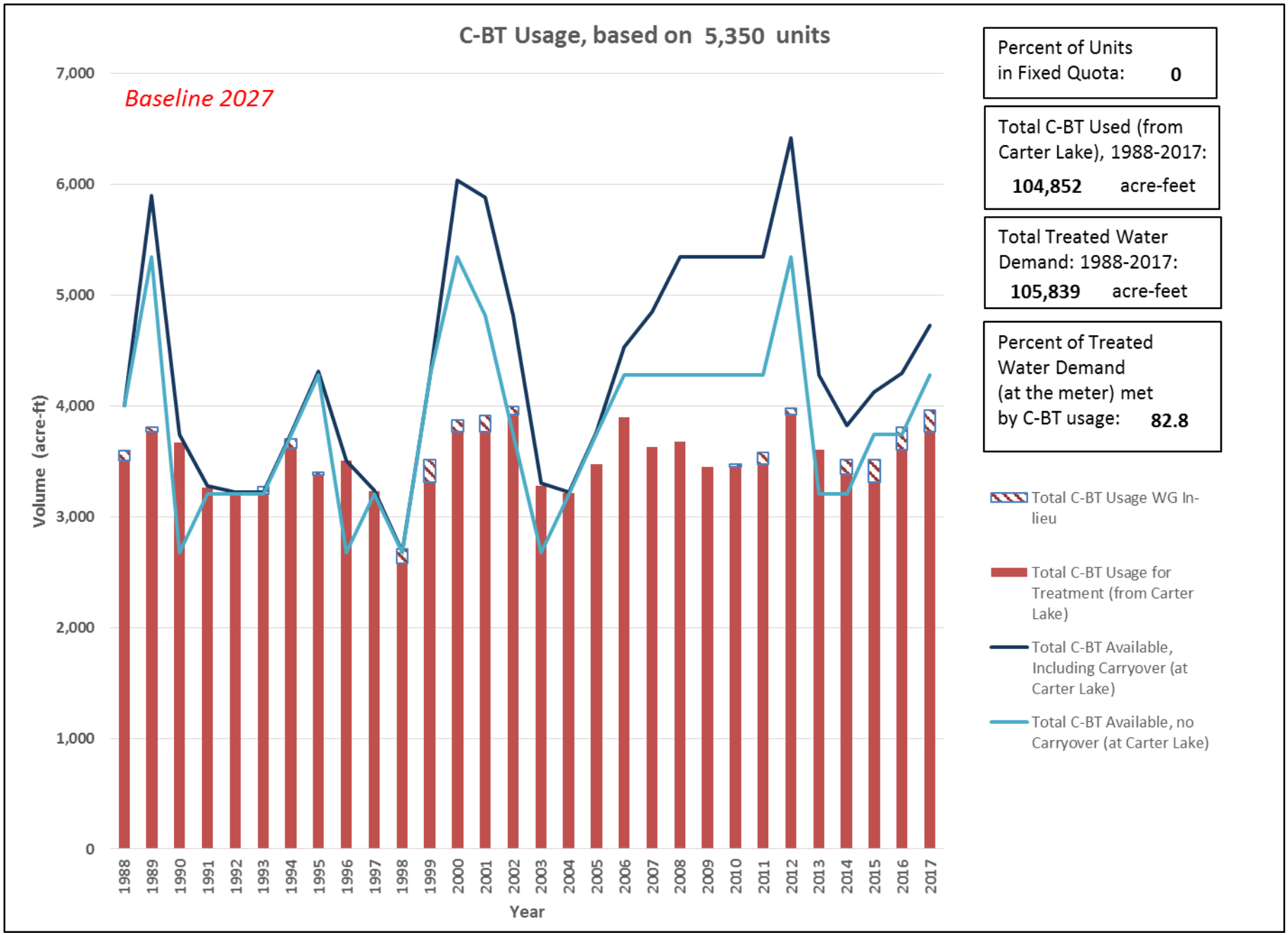
A partner supply and partner demand can be added if and when that configuration needs to be evaluated.

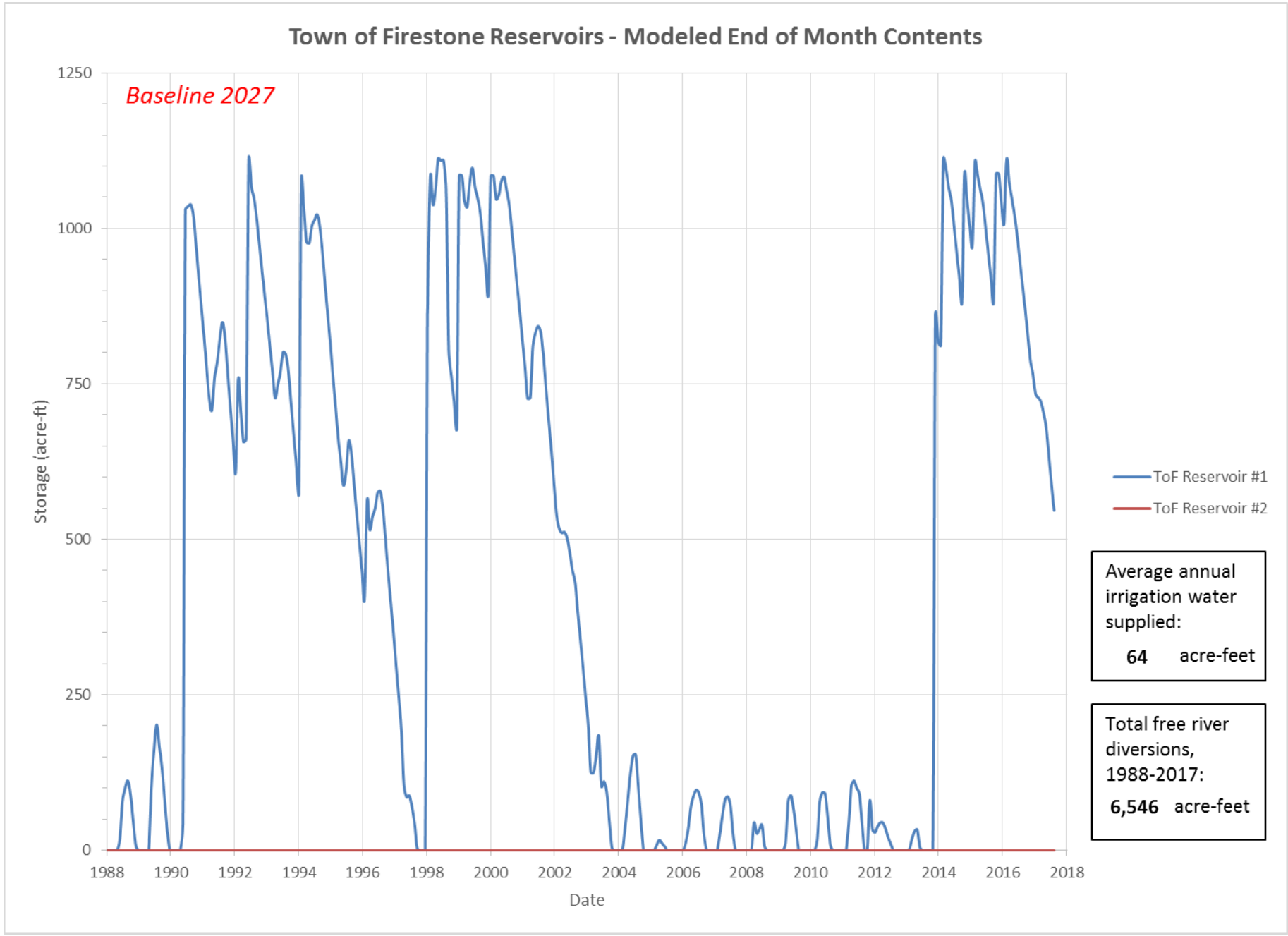
a. Sample Results

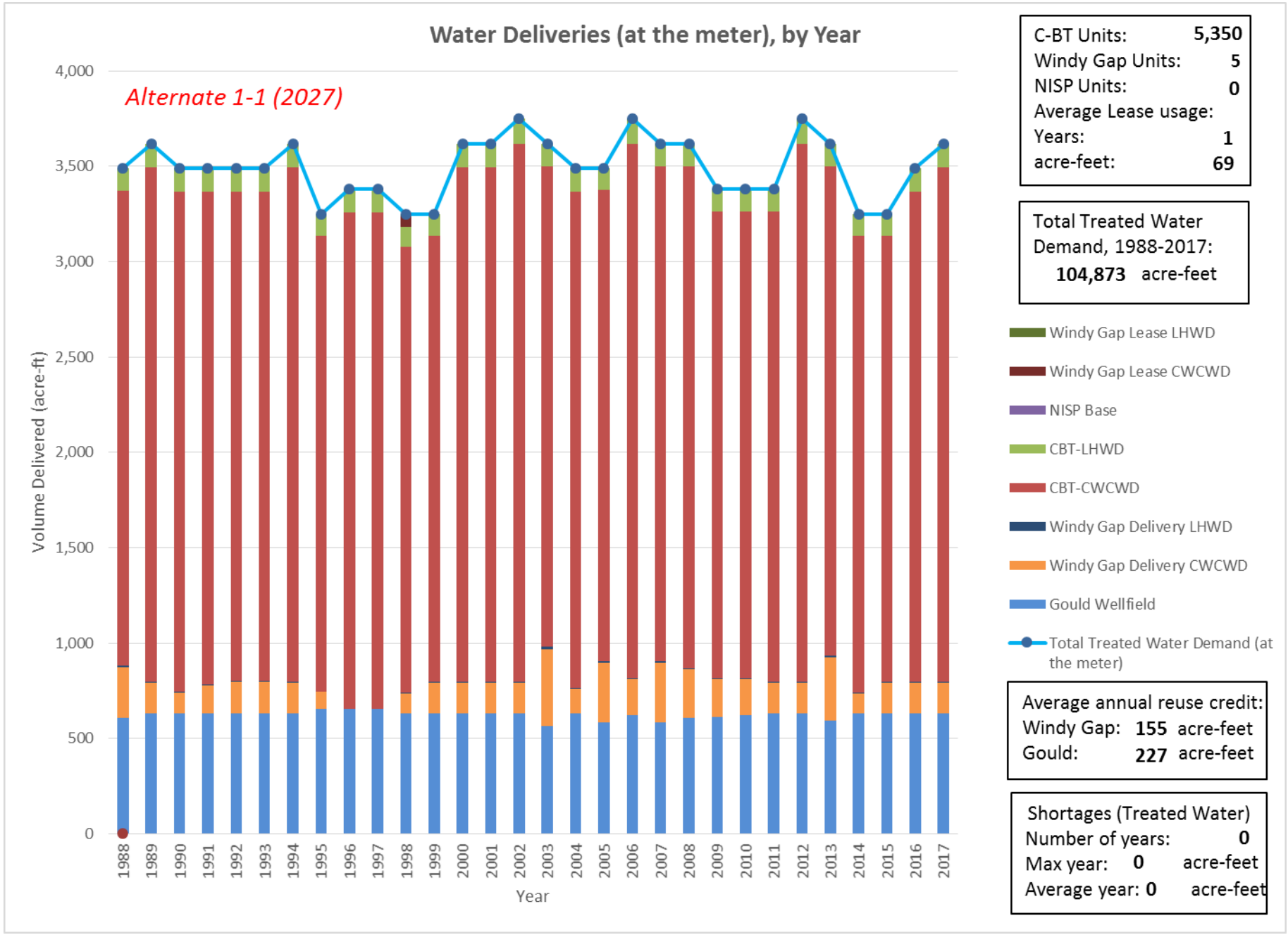
Results for the baseline 2027 scenario and for Alternate 1-1 are presented on the next six pages.

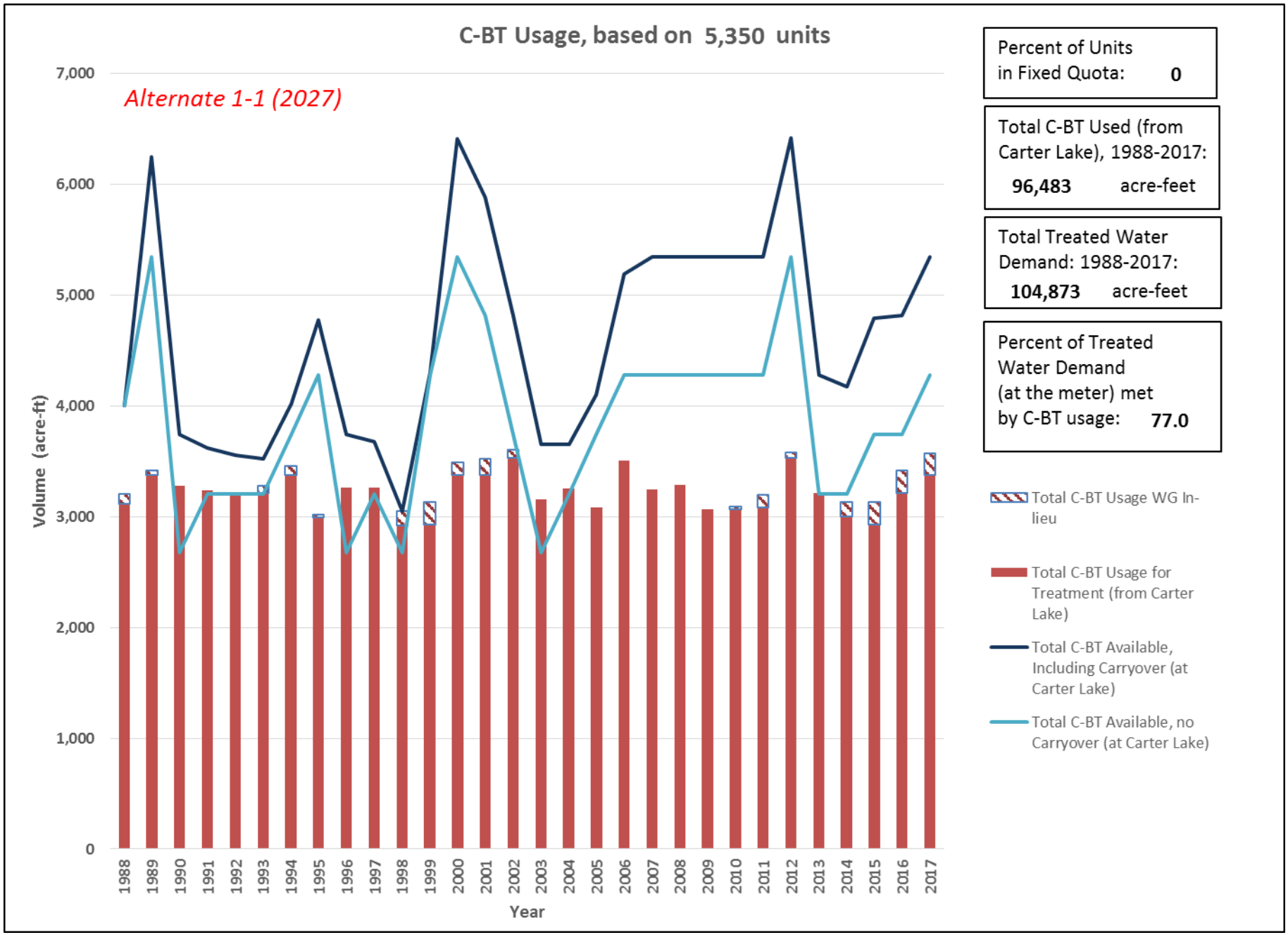
Note that the model was between the time that the graphs that are attached to the Task 1.4 Memorandum were prepared and when this Draft Final Memorandum was prepared. The main modifications included adding C-BT carryover storage to the available supply in Carter Lake and adding reporting on the amount of C-BT water used as "in-lieu" for Windy Gap deliveries.

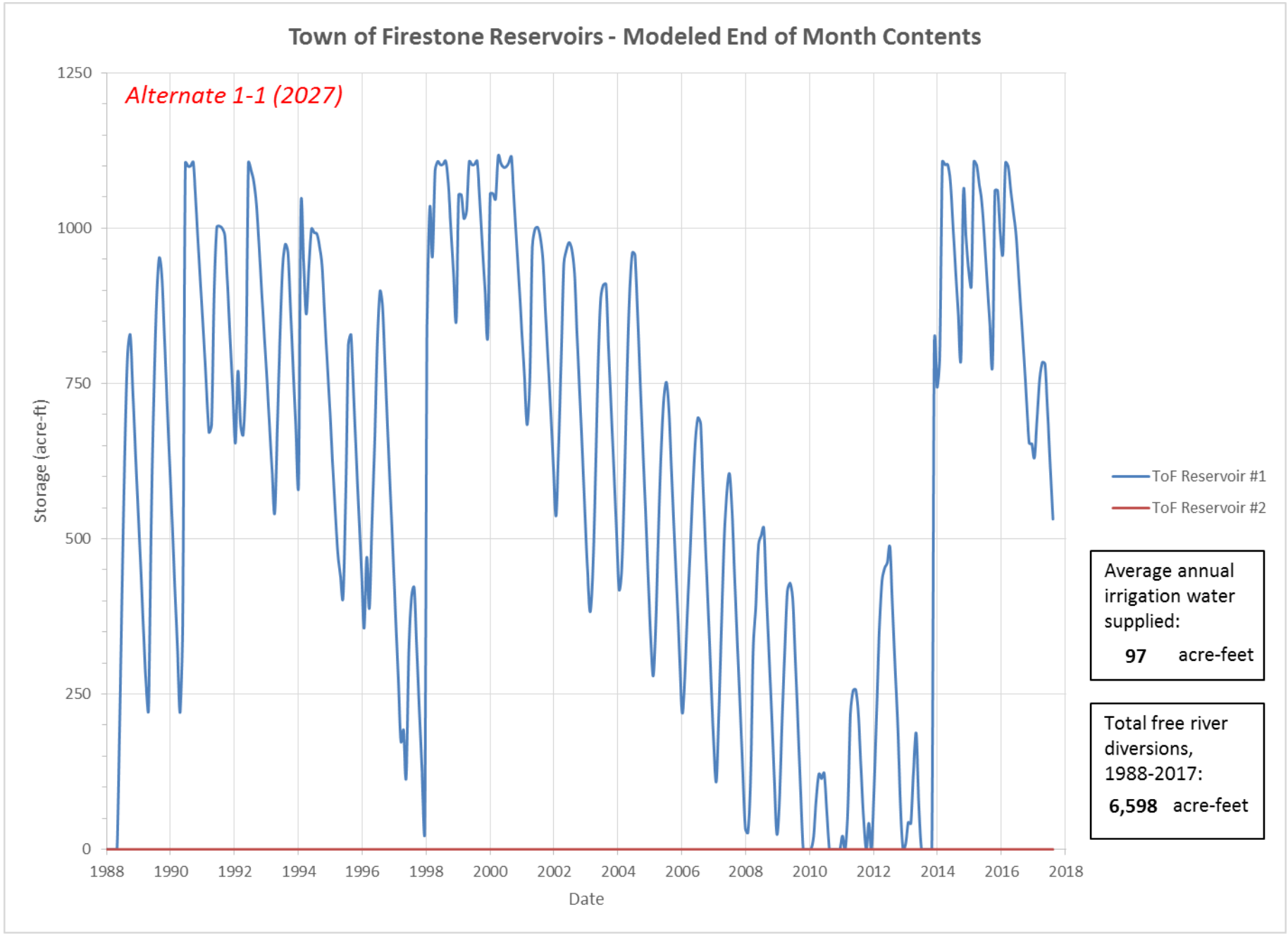

Water Deliveries (at the meter), by Year
Baseline 2027
Volume Delivered (acre-ft)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
C-BT Units: 5,350
Windy Gap Units: 5
NISP Units: 0
Average Lease usage:
Years: 9
acre-feet: 283
Total Treated Water Demand, 1988-2017:
105,839 acre-feet
Windy Gap Lease LHWD
Windy Gap Lease CWCWD
NISP Base
CBT-LHWD
CBT-CWCWD
Windy Gap Delivery LHWD
Windy Gap Delivery CWCWD
Gould Wellfield
Total Treated Water Demand (at the meter)
Average annual reuse credit:
Windy Gap: 170 acre-feet
Gould: 150 acre-feet
Shortages (Treated Water)
Number of years: 1
Max year: 257 acre-feet
Average year: 257 acre-feet


C-BT Usage, based on 5,350 units
Baseline 2027
Volume (acre-ft)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 104,852 acre-feet
Total Treated Water Demand: 1988-2017: 105,839 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 82.8
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Baseline 2027
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
64 acre-feet
Total free river diversions, 1988-2017:
6,546 acre-feet


Water Deliveries (at the meter), by Year
Alternate 1-1 (2027)
Volume Delivered (acre-ft)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
C-BT Units: 5,350
Windy Gap Units: 5
NISP Units: 0
Average Lease usage:
Years: 1
acre-feet: 69
Total Treated Water Demand, 1988-2017:
104,873 acre-feet
Windy Gap Lease LHWD
Windy Gap Lease CWCWD
NISP Base
CBT-LHWD
CBT-CWCWD
Windy Gap Delivery LHWD
Windy Gap Delivery CWCWD
Gould Wellfield
Total Treated Water Demand (at the meter)
Average annual reuse credit:
Windy Gap: 155 acre-feet
Gould: 227 acre-feet
Shortages (Treated Water)
Number of years: 0
Max year: 0 acre-feet
Average year: 0 acre-feet


C-BT Usage, based on 5,350 units
Alternate 1-1 (2027)
Volume (acre-ft)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 96,483 acre-feet
Total Treated Water Demand: 1988-2017: 104,873 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 77.0
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 1-1 (2027)
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
97 acre-feet
Total free river diversions, 1988-2017:
6,598 acre-feet

IV. Some Interpretations from the Graphs

The graph of Annual Usage by Source on page 3 shows that under the 2027 demand and supply configuration the treated water demands are fully met 97 percent of the time—29 out of 30 years. To meet those demands, the City of Loveland lease is used about 30 percent of the time—9 out of 30 years.

The indoor use of Windy Gap supplies through the Carter Lake Filter Plant and the indoor use of fully augmented St Vrain alluvial wellfield supplies through the St Vrain Water Treatment Plant produce a total of about 320 acre-feet of return flow credits. On average this is enough to cover most, but not all of the augmentation requirements for the Gould wellfield under this configuration. For example, in 1996 and 1997 there was no Windy Gap water available. This model is based on preliminary estimates of monthly requirements for augmentation of each wellfield; these may be updated when they are available.

The graph of End of Month Contents of the reservoir on page 4 shows that this model run began with an empty reservoir. A wet month such as June of 1990 could allow the reservoir to nearly fill, however use of the reservoir to supply irrigation demands and return flow demands will deplete the reservoir storage. Additional senior water rights would help to keep more water in the reservoir.

The graph of C-BT Usage on page 5 shows that in the 2027 Baseline configuration about 83 percent of the treated water demands will be met from C-BT usage. The graph also shows that C-BT water is needed in most years to be dedicated to Windy Gap in-lieu of actual Windy Gap pumping (based on the assumed historical performance of Windy Gap). The graph also shows the importance of carryover storage of unused C-BT water from year to year.

V. Use of the Model

Now that this tool has been developed we anticipate that the Town will use the model to evaluate such options as increasing the amount of irrigation supplied from the Reservoir No, 1, adding St Vrain native supplies, adding the TOF Reservoir No. 2, or short-term leasing of C-BT supplies or reservoir storage capacity.

VI. Additional Model Features

The model may be modified to evaluate certain conservative water quality parameters, such as total dissolved solids. That option is not yet functional.

VII. Additional Model Results

Table 1, below, summarizes some of the results for the 12 configurations.

VIII. Attachments

Attached to this memorandum are:

Task Memoranda: Memoranda for Tasks 1 through 6.

Model Inputs and Results: four pieces of information for each of 12 alternate model configurations: model configuration, graphs of annual deliveries by source, C-BT usage and TOF Reservoir contents.

Table 1
Sample Results, page 1

Configuration No.	1	2	3	4	5	6	7
Name	Baseline 2027	Alternate 1-1	Alternate 1-2	Baseline 2050	Alternate 2-1	Alternate 2-2	Baseline 2050 w/ Climate Change
Input Data, from Configurations Worksheet							
Demands for Year	2027	2027	2027	2050	2050	2050	2050
Climate Change	No	No	No	No	No	No	Supply Decrease
Fixed Quota %	0	0	0	0	0	0	0
C-BT Units	5,350	5,350	5,350	5,450	5,450	5,450	5,450
WG Units	5	5	5	5	5	5	5
Windy Gap Lease, AF	500	500	500	0	0	0	0
NISP Units	0	0	0	1,300	2,600	3,200	1,300
Lower Boulder Preferred Shares	3.97	12	12	3.97	16	14	3.97
Lower Boulder Common Shares	6.667	16	16	6.667	24	20	6.667
Rural Shares	2.41	8	8	2.41	24	20	2.41
MS Park Well Field Annual Limit, AF	65	100	200	200	300	493	200
Gould Well Field Annual Limit, AF	363	654	992	496	992	1985	496
Results							
Total Treated Water Demand, 1988-2017, AF	105,839	104,873	258,502	235,068	232,573	226,335	235,068
Total C-BT Quota Available at CL, 1988-2017, AF	115,280	115,280	94,688	117,360	117,360	117,360	94,688
Total C-BT Available, Including Carryover, 1988-2017, AF	130,630	138,569	94,690	117,373	117,379	117,415	94,692
Total C-BT Used from CL, 1988-2017, AF	104,852	96,483	93,316	116,007	115,950	115,880	93,377
Total Free River Diversions, 1988-2017, AF	6,546	6,598	9,629	10,231	10,231	10,231	9,629
Average Annual C-BT Available at CL, AF	3,528	3,496	8,617	7,836	7,752	7,544	7,836
Average Annual C-BT Used from CL, AF	3,843	3,843	3,156	3,912	3,912	3,912	3,156
Average Annual Free River Diversions, AF	3,495	3,216	3,111	3,867	3,865	3,863	3,113
Average Annual Irrigation from Reservoir, AF	64	97	344	208	291	499	208
Number of Years that Lease is Used	9	1	0	0	0	0	0
Average Annual Use of Lease, AF	283	69	0	0	0	0	0
Number of Years with Unmet Treated Water Demand	1	0	30	30	30	30	30
Maximum Annual Unmet Treated Water Demands, AF	257	0	4,187	3,955	2,637	1,427	4,688
WG Reuse Credits, Average Annual, AF	170	155	99	141	141	141	99
Gould WF Reuse Credits, Average Annual, AF	150	227	393	205	410	807	206

Table 1

Sample Results, page 2

Configuration No.	8	9	10	11	12
Name	Alternate 2-1 w/ Climate Change	Alternate 2-2 w/ Climate Change	2050 Baseline w/ Climate Change and Increased Irrigation	Alternate 2-1 w/ Climate Change and Increased Irrigation	Alternate 2-2 w/ Climate Change and Increased Irrigation
Input Data, from Configurations Worksheet					
Demands for Year	2050	2050	2050	2050	2050
Climate Change	Supply Decrease	Supply Decrease	Supply Decrease & Demand Increase	Supply Decrease & Demand Increase	Supply Decrease & Demand Increase
Fixed Quota %	0	0	0	0	0
C-BT Units	5,450	5,450	5,450	5,450	5,450
WG Units	5	5	5	5	5
Windy Gap Lease, AF	0	0	0	0	0
NISP Units	2,600	3,200	1,300	2,600	3,200
Lower Boulder Preferred Shares	16	14	3.97	16	14
Lower Boulder Common Shares	24	20	6.667	24	20
Rural Shares	24	20	2.41	24	20
MS Park Well Field Annual Limit, AF	300	493	200	300	493
Gould Well Field Annual Limit, AF	992	1985	496	992	1985
Results					
Total Treated Water Demand, 1988-2017, AF	232,573	226,335	261,449	258,502	251,136
Total C-BT Quota Available at CL, 1988-2017, AF	94,688	94,688	94,688	94,688	94,688
Total C-BT Available, Including Carryover, 1988-2017, AF	94,695	94,704	94,690	94,690	94,694
Total C-BT Used from CL, 1988-2017, AF	93,316	93,213	93,377	93,316	93,215
Total Free River Diversions, 1988-2017, AF	9,629	9,629	9,629	9,629	9,629
Average Annual C-BT Available at CL, AF	7,752	7,544	8,715	8,617	8,371
Average Annual C-BT Used from CL, AF	3,156	3,156	3,156	3,156	3,156
Average Annual Free River Diversions, AF	3,111	3,107	3,113	3,111	3,107
Average Annual Irrigation from Reservoir, AF	291	499	246	344	589
Number of Years that Lease is Used	0	0	0	0	0
Average Annual Use of Lease, AF	0	0	0	0	0
Number of Years with Unmet Treated Water Demand	30	30	30	30	30
Maximum Annual Unmet Treated Water Demands, AF	3,347	2,027	5,467	4,187	2,697
WG Reuse Credits, Average Annual, AF	99	99	99	99	99
Gould WF Reuse Credits, Average Annual, AF	415	831	195	393	786

DRAFT Memorandum

To:	File 1527TWF05, Task 1 CWP Grant Task 1.1
From:	Gregg Ten Eyck, LRE
Reviewed by:	Jordan Furnans, PhD., LRE
Copy to:	Julie Pasillas, Dave Lindsay, Brad Grasmick
Date:	June 12, 2018
Project:	Colorado Water Plan Grant: Modeling Reservoir Operations
Subject:	Tabulation of 2027 and 2050 Monthly Water Demands

I. Background

The purpose of this memorandum is to tabulate water demand projections for treated water and non-potable water that will be needed by the Town of Firestone (Town) in 2027 and 2050 in a format that can be used for the spreadsheet model. In addition, daily demands are estimated for the months of June, July and August.

The main source of information for this tabulation is a draft memorandum dated November 20, 2017. Some updates to that data have been included, as will be noted below. That memorandum incorporated land use and population growth data to develop indoor and outdoor demand projections for 2027 and 2050.

We express future water demands below as "at the master meter." This means that modeled demands for water to be delivered to the Central Weld County Water District or the Left Hand Water District will be larger by the amount of surcharge as required by each District or by the amount of operational loss expected at the proposed St Vrain Water Treatment Plant.

The water demand projections in this memo do not include the portions of the Town that are served by the Little Thompson Water District. This is because that District is responsible for providing the water supply as well as treating and delivering the water to those lands.

II. Summary of Results

In a draft memorandum dated November 20, 2017, LRE estimated incremental demand increases for new lands that are slated for development as residential, commercial, mixed-use and park projects. Those incremental demands were added to an estimate of current average year demand, based on 2016 irrigation water use adjusted to match a modeled M-J-J-A-S PDSI (described later) of 0.0. The adjustment factor for 2016 was 1.11, based on the amount of

residential irrigation water that was actually supplied in 2016 compared to a modeled residential irrigation demand for the 0.0 M-J-J-A-S PDSI.

Future demands are tabulated by indoor use, outdoor use and Government irrigation, which is water supplied to Town-owned or Town-operated parks. The outdoor use and Government irrigation demands in the model are subject to adjustment based on drought condition, as discussed later.

Some of the future demand for Government irrigation will be met by the non-potable water system currently under development by the Town.

a. 2027 Demands

Table 1 shows the total average year demands, by month for 2027.

Table 2 shows the average year demands for the Central Weld County Water District service area, by month for 2027.

Table 3 shows the average year demands for the area served by the Left Hand Water District, by month for 2027.

b. 2050 Demands

Table 4 shows the total average year demands, by month for 2050.

Table 5 shows the average year demands for the Central Weld County Water District service area, by month for 2027.

Table 6 shows the total average year demands for the Left Hand Water District service area, by month for 2050.

Table 1
Town of Firestone 2027
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Indoor Use	111.4	111.4	107.6	106.4	104.3	105.1	111.4	111.4	111.4	111.4	111.4	111.4	1,314.3
Outdoor Use	155.3	24.3	0.0	0.0	0.0	0.1	28.8	121.1	352.0	471.9	456.7	335.8	1,945.9
Govt Irrigation	26.0	4.1	0.0	0.0	0.0	0.0	4.8	20.2	58.8	78.9	76.3	56.1	325.2
TOTAL	**292.6**	**139.7**	**107.6**	**106.4**	**104.3**	**105.2**	**145.0**	**252.7**	**522.2**	**662.1**	**644.3**	**503.2**	**3,585.4**

Table 2
Town of Firestone 2027
Central Weld County Water District Service Area
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Indoor Use	107.2	107.2	103.6	102.4	100.4	101.2	107.2	107.2	107.2	107.2	107.2	107.2	1,265.6
Outdoor Use	149.6	23.4	0.0	0.0	0.0	0.1	27.7	116.6	339.0	454.4	439.8	323.3	1,873.9
Govt Irrigation	25.6	4.0	0.0	0.0	0.0	0.0	4.7	20.0	58.1	77.8	75.3	55.4	321.0
TOTAL	**282.4**	**134.7**	**103.6**	**102.4**	**100.4**	**101.3**	**139.7**	**243.8**	**504.3**	**639.5**	**622.3**	**486.0**	**3,460.5**

Table 3
Town of Firestone 2027
Left Hand Water District Service Area
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Indoor Use	4.1	4.1	4.0	3.9	3.9	3.9	4.1	4.1	4.1	4.1	4.1	4.1	48.6
Outdoor Use	5.7	0.9	0.0	0.0	0.0	0.0	1.1	4.5	13.0	17.5	16.9	12.4	72.0
Govt Irrigation	0.3	0.1	0.0	0.0	0.0	0.0	0.1	0.3	0.8	1.0	1.0	0.7	4.2
TOTAL	**10.2**	**5.1**	**4.0**	**3.9**	**3.9**	**3.9**	**5.2**	**8.9**	**17.9**	**22.6**	**22.0**	**17.3**	**124.9**

Table 4
Town of Firestone 2050
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Indoor Use	251.8	251.8	243.3	240.5	235.8	237.6	251.8	251.8	251.8	251.8	251.8	251.8	2,971.3
Outdoor Use	333.5	52.2	0.0	0.0	0.0	0.2	61.8	260.0	755.7	1,013.1	980.5	720.9	4,177.9
Govt Irrigation	70.0	11.0	0.0	0.0	0.0	0.0	13.0	54.6	158.7	212.7	205.9	151.4	877.2
TOTAL	**655.3**	**314.9**	**243.3**	**240.5**	**235.8**	**237.9**	**326.5**	**566.3**	**1,166.2**	**1,477.6**	**1,438.1**	**1,124.0**	**8,026.4**

Table 5
Town of Firestone 2050
Central Weld County Water District Service Area
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Indoor Use	218.3	218.3	211.0	208.5	204.4	206.0	218.3	218.3	218.3	218.3	218.3	218.3	2,576.1
Outdoor Use	289.1	45.2	0.0	0.0	0.0	0.2	53.6	225.4	655.2	878.4	850.1	625.0	3,622.2
Govt Irrigation	66.2	10.4	0.0	0.0	0.0	0.0	12.3	51.6	150.0	201.0	194.5	143.0	829.0
TOTAL	**573.6**	**273.9**	**211.0**	**208.5**	**204.4**	**206.2**	**284.1**	**495.3**	**1,023.5**	**1,297.7**	**1,262.9**	**986.3**	**7,027.3**

Table 6
Town of Firestone 2050
Left Hand Water District Service Area
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Indoor Use	33.5	33.5	32.4	32.0	31.4	31.6	33.5	33.5	33.5	33.5	33.5	33.5	395.2
Outdoor Use	44.4	6.9	0.0	0.0	0.0	0.0	8.2	34.6	100.5	134.7	130.4	95.9	555.7
Govt Irrigation	3.9	0.6	0.0	0.0	0.0	0.0	0.7	3.0	8.7	11.7	11.3	8.3	48.2
TOTAL	**81.7**	**41.0**	**32.4**	**32.0**	**31.4**	**31.6**	**42.4**	**71.1**	**142.7**	**179.9**	**175.2**	**137.7**	**999.1**

c. Demand Adjustment for Wet and Dry Years

Based on 2009 - 2016 data for residential taps, 1-inch irrigation taps, and 1-1/2 inch Government irrigation taps, Table 7 was developed to adjust future irrigation/outdoor demand in wet and dry years. The measure of wet and dry years is the average Palmer Drought Severity Index (PDSI) in the Platte Basin [i] for the months of May, June, July, August and September (M-J-J-A-S)—the months when most of the irrigation water is applied.

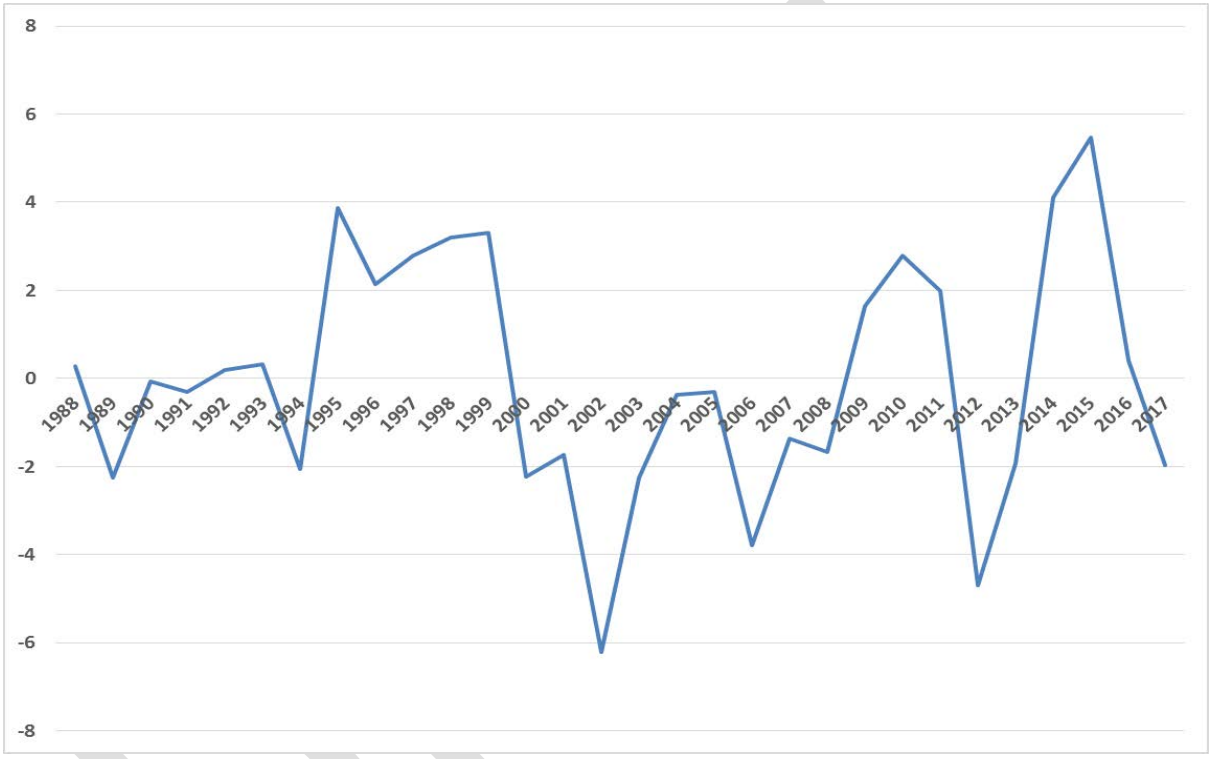
Table 7
Adjustment Factor for Irrigation/Outdoor Demand
Based on M-J-J-A-A PDSI

M-J-J-A-S PDSI Range	< -3	-3 to -1	-1 to +1	+1 to +3	> +3
Factor	1.12	1.06	1.0	0.95	0.89

d. M-J-J-A-S Data for Period of Record

Figure 1 shows the average MJJAS PDSI for each year in the period of record[ii]. The above factor will be applied to increase or decrease monthly irrigation/outdoor demand in Firestone.

Figure 1
M-J-J-A-S Data for Period of Record



Endnotes

[i] **PDSI**—drought index that includes demand (via potential evapotranspiration)

The Palmer Drought Severity Index (PDSI) uses readily available temperature and precipitation data to estimate relative dryness. It is a standardized index that spans -10 (dry) to +10 (wet). It has been reasonably successful at quantifying long-term drought. As it uses temperature data and a physical water balance model, it can capture the basic effect of global warming on drought through changes in potential evapotranspiration.

[ii] https://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp# for the period of record of 1987 to 2017.

DRAFT Memorandum

To:	File 1527TWF05, Task 2 CWP Grant Task 1.2
From:	Gregg Ten Eyck, LRE
Reviewed by:	Jordan Furnans, PhD., LRE
Copy to:	Julie Pasillas, Dave Lindsay, Brad Grasmick
Date:	July 16, 2018 (edited October 1, 2018)
Project:	Colorado Water Plan Grant: Modeling Reservoir Operations
Subject:	Tabulation of 2027 and 2050 Water Supplies

I. Background

The purpose of this memorandum is to tabulate water supplies that will be available to the Town of Firestone (Town) in 2027 and 2050 in a format that can be used for the spreadsheet model. Generally, this means that data will be provided for the 1988 through 2017 period of record that is being modeled. In addition, daily limits for the months of June, July and August will be identified.

The main source of information for this tabulation is the draft memoranda that were prepared for review by the Lower Boulder Ditch Company and the Rural Ditch Company for their review under "Catlin Bylaw" provisions.

Groundwater supplies at the Gould Well Field and at the Mountain Shadows Park are estimated from data provided by McGrane Water Engineering, LLC (MWE).

The water supplies identified in this memo may have restrictions on how they can be used, based on current or projected infrastructure or based on current or projected agreements with treatment providers or water court decrees. These will be identified in each section as necessary.

II. Summary of Results

In this section we present the source of water and the amount of supply associated with that source. Limitations on use or return flow requirements are also identified.

a. C-BT Units

The number of C-BT units owned by the Town will be an input variable for the model. The yield from the units will be a function of the historic final quota declared by the Northern Colorado Water Conservancy District. Table 1 shows the final quota for the 1988 through 2017 period. This water will be available at Carter Lake or at the headgate of the Lower Boulder Ditch.

This water is not available for reuse, nor are there limits on when and where the water may be used.

b. Lower Boulder Ditch Preferred Shares

The number of shares of Lower Boulder Ditch Preferred stock will be an input variable in the model. Table 2 shows the farm headgate yield estimated for the period 1988 through 2017. This supply will be available for delivery through the Lower Boulder Ditch and the Coal Ridge Ditch to the Town of Firestone Reservoir.

Annual farm headgate deliveries of Lower Boulder Preferred Shares will be limited to 57.66 acre-feet per share.

Farm headgate deliveries of Lower Boulder Preferred shares will be limited to a total of 482.8 acre-feet per share over any consecutive 10-year period.

Return flows will be made to St Vrain Creek during the April through October period, as a percent of daily or monthly delivery of Lower Boulder Preferred shares, in the following percentages:

April	May	June	July	August	September	October
13.13%	27.5%	19.6%	20.6%	28.4%	33.6%	97.9%

Return flows will be made to St Vrain Creek during the November through April period, as a percent of the previous year's farm headgate delivery of Lower Boulder Preferred shares, in the following percentages:

November	December	January	February	March	April
2.03%	2.03%	2.03%	2.03%	2.03%	2.03%

Lower Boulder water that is diverted and used under the above conditions may be available for reuse.

c. Lower Boulder Ditch Common Shares

The number of shares of Lower Boulder Ditch Common stock will be an input variable in the model. Table 3 shows the farm headgate yield estimated for the period 1988 through 2017. This supply will be available for delivery through the Lower Boulder Ditch and the Coal Ridge Ditch to the Town of Firestone Reservoir.

Annual farm headgate deliveries of Lower Boulder Common shares will be limited to 21.8 acre-feet per share.

Farm headgate deliveries of Lower Boulder Common shares will be limited to a total of 79.9 acre-feet per share over any consecutive 10-year period.

Return flows will be made to St Vrain Creek during the April through October period, as a percent of daily or monthly delivery of Lower Boulder Common shares, in the following percentages:

April	May	June	July	August	September	October
13.13%	27.5%	19.6%	20.6%	28.4%	33.6%	97.9%

Return flows will be made to St Vrain Creek during the November through April period, as a percent of the previous year's farm headgate delivery of Lower Boulder Preferred shares, in the following percentages:

November	December	January	February	March	April
2.03%	2.03%	2.03%	2.03%	2.03%	2.03%

Lower Boulder water that is diverted and used under the above conditions may be available for reuse if the return flows are under the dominion and control of the Town.

d. Rural Ditch Company Shares

The number of shares of Rural Ditch Company stock will be an input variable in the model. Table 4 shows the farm headgate yield estimated for the period 1988 through 2017. This supply will be available for delivery through the Rural Ditch and the Last Chance Ditch to the Town of Firestone Reservoir.

Annual farm headgate deliveries of Rural Ditch water will be limited to 161 acre-feet per share.

Farm headgate deliveries of Rural Ditch water will be limited to a total of 1,005 acre-feet per share over any consecutive 10-year period.

Return flows will be made to St Vrain Creek during the April through October period, as a percent of daily or monthly delivery of Rural Ditch water, in the following percentages:

April	May	June	July	August	September	October
22.8%	51.3%	44.3%	47.8%	41.3%	69.2%	20.8%

Return flows will be made to St Vrain Creek during the October through April period, as a percent of the previous year's farm headgate delivery of Rural Ditch water, in the following percentages:

October	November	December	January	February	March	April
3.8%	3.0%	2.8%	2.5%	2.3%	2.2%	2.3%

Rural Ditch water that is diverted and used under the above conditions may be available for reuse if the return flows are under the dominion and control of the Town.

e. Windy Gap Units

The number of units of Windy Gap owned by the Town will be an input variable in the model, with the water delivered to Carter Lake. Table 5 shows the estimated yield of a Windy Gap unit for the period 1988 through 2017, and how much of that yield is derived from "In-Lieu Water".

The main source of data for Table 5 is a table prepared by the Municipal Subdistrict titled Historical Schedule of Water Pumped and Delivered, which shows data from 1987 through 2016. We assumed no pumping by Windy Gap in 2017 and a delivery of 40 acre-feet of In-Lieu Water in 2018; that assumption may be replaced by actual data when we receive actual data.

"In-Lieu Water" is defined in the 2014 Contract among the Northern District, the Municipal Subdistrict and the Bureau of Reclamation. The amount listed in Table 5 as In-Lieu Water will be subtracted from the amount of C-BT Project water available to the Town in that year.

Windy Gap water is reusable if the return flows are under the dominion and control of the Town.

Table 1
Final Quota for Colorado-Big Thompson Units

1988	80%
1989	100%
1990	50%
1991	60%
1992	60%
1993	60%
1994	70%
1995	80%
1996	50%
1997	60%
1998	50%
1999	80%
2000	100%
2001	90%
2002	70%
2003	50%
2004	60%
2005	70%
2006	80%
2007	80%
2008	80%
2009	80%
2010	80%
2011	80%
2012	100%
2013	60%
2014	60%
2015	70%
2016	70%
2017	80%

Table 2
Farm Headgate Deliveries Attributable to Lower Boulder Ditch Preferred Shares
(Values in AF/share)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1988	0.00	0.00	0.00	0.00	9.73	12.92	10.07	6.66	6.12	0.00	0.00	0.00	45.49
1989	0.00	0.00	0.00	2.17	12.40	10.56	8.68	6.73	4.43	0.00	0.00	0.00	44.97
1990	0.00	0.00	0.00	0.00	7.66	13.28	13.08	6.65	6.49	0.73	0.00	0.00	47.89
1991	0.00	0.00	0.00	3.75	10.37	9.67	7.55	6.24	4.86	0.00	0.00	0.00	42.45
1992	0.00	0.00	0.00	3.09	11.83	9.21	7.85	7.61	5.85	1.22	0.00	0.00	46.67
1993	0.00	0.00	0.00	1.00	10.71	12.36	13.62	6.93	4.85	0.00	0.00	0.00	49.48
1994	0.00	0.00	0.00	1.28	11.73	13.87	6.16	6.12	5.40	0.95	0.00	0.00	45.50
1995	0.00	0.00	0.00	1.32	3.33	3.30	11.45	11.98	4.75	0.17	0.00	0.00	36.30
1996	0.00	0.00	0.00	1.45	13.30	11.39	13.76	6.26	4.05	0.00	0.00	0.00	50.21
1997	0.00	0.00	0.00	0.00	8.84	5.90	14.38	8.63	5.17	0.40	0.00	0.00	43.32
1998	0.00	0.00	0.00	0.00	10.27	12.90	11.42	10.26	5.76	2.19	0.00	0.00	52.81
1999	0.00	0.00	0.00	0.84	4.39	11.35	13.45	10.31	6.16	0.75	0.00	0.00	47.26
2000	0.00	0.00	0.00	2.95	12.19	12.79	8.29	5.56	5.60	4.36	0.00	0.00	51.75
2001	0.00	0.00	0.00	0.00	5.18	12.99	10.52	8.66	6.01	3.48	0.00	0.00	46.83
2002	0.00	0.00	0.00	6.70	7.20	8.76	5.40	5.49	5.21	5.03	0.00	0.00	43.80
2003	0.00	0.00	0.00	2.24	6.87	12.74	11.69	5.97	7.62	4.42	0.00	0.00	51.56
2004	0.00	0.00	0.00	4.70	11.73	11.14	10.04	8.96	5.79	4.88	0.00	0.00	57.23
2005	0.00	0.00	0.00	3.93	8.49	10.60	10.44	6.98	5.40	3.35	0.00	0.00	49.19
2006	0.00	0.00	0.00	6.92	11.02	13.05	9.92	5.47	6.12	3.84	0.00	0.00	56.34
2007	0.00	0.00	0.00	0.00	10.84	13.14	9.70	6.00	5.89	4.67	0.00	0.00	50.24
2008	0.00	0.00	0.00	3.92	11.39	13.08	10.27	7.41	6.43	3.98	0.00	0.00	56.48
2009	0.00	0.00	0.00	2.60	9.25	8.03	10.88	6.25	5.60	4.71	0.00	0.00	47.31
2010	0.00	0.00	0.00	1.73	5.15	10.63	10.97	6.97	5.79	5.85	0.00	0.00	47.09
2011	0.00	0.00	0.00	4.62	4.47	11.87	13.41	9.96	7.11	6.22	0.00	0.00	57.66
2012	0.00	0.00	0.00	5.89	12.53	8.68	7.84	5.94	6.48	4.40	0.00	0.00	51.76
2013	0.00	0.00	0.00	1.55	7.34	13.08	11.96	6.07	1.97	0.00	0.00	0.00	41.97
2014	0.00	0.00	0.00	1.62	8.48	12.98	13.32	8.90	5.84	4.72	0.00	0.00	55.85
2015	0.00	0.00	0.00	0.67	4.31	6.34	12.78	6.06	6.25	6.78	0.00	0.00	43.18
2016	0.00	0.00	0.00	0.00	4.19	9.81	9.06	5.49	5.72	5.70	0.00	0.00	39.97
2017	0.00	0.00	0.00	5.63	4.44	11.85	10.68	6.26	5.42	3.46	0.00	0.00	47.75

Table 3
Farm Headgate Deliveries Attributable to Lower Boulder Ditch Common Shares
(Values in AF/share)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1988	0.00	0.00	0.00	0.00	0.63	4.69	5.04	0.00	0.00	0.00	0.00	0.00	10.36
1989	0.00	0.00	0.00	0.00	1.29	4.05	0.09	0.00	0.00	0.00	0.00	0.00	5.43
1990	0.00	0.00	0.00	0.00	5.29	7.95	8.56	0.00	0.00	0.00	0.00	0.00	21.80
1991	0.00	0.00	0.00	0.00	3.08	3.03	1.86	0.00	0.00	0.00	0.00	0.00	7.97
1992	0.00	0.00	0.00	0.00	4.45	1.47	1.93	0.00	0.00	0.00	0.00	0.00	7.84
1993	0.00	0.00	0.00	0.00	1.58	4.29	9.59	0.00	0.00	0.00	0.00	0.00	15.45
1994	0.00	0.00	0.00	0.00	2.50	8.81	0.00	0.00	0.00	0.00	0.00	0.00	11.30
1995	0.00	0.00	0.00	0.00	0.00	0.00	7.80	6.96	0.00	0.00	0.00	0.00	14.77
1996	0.00	0.00	0.00	0.00	8.54	1.96	10.18	0.92	0.00	0.00	0.00	0.00	21.60
1997	0.00	0.00	0.00	0.00	1.97	0.31	9.18	0.42	0.00	0.00	0.00	0.00	11.87
1998	0.00	0.00	0.00	0.00	3.28	5.33	7.85	0.17	0.00	0.00	0.00	0.00	16.64
1999	0.00	0.00	0.00	0.00	0.00	1.80	8.20	0.89	0.00	0.00	0.00	0.00	10.88
2000	0.00	0.00	0.00	0.05	2.96	7.09	0.42	0.00	0.00	0.00	0.00	0.00	10.52
2001	0.00	0.00	0.00	0.00	0.00	4.09	1.54	0.04	0.00	0.00	0.00	0.00	5.68
2002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	0.00	0.00	0.00	0.00	0.03	0.59	2.35	0.00	0.00	0.00	0.00	0.00	2.97
2004	0.00	0.00	0.00	0.00	0.93	0.93	0.28	0.00	0.00	0.00	0.00	0.00	2.15
2005	0.00	0.00	0.00	0.00	0.40	0.46	2.90	0.00	0.00	0.00	0.00	0.00	3.77
2006	0.00	0.00	0.00	0.00	3.21	4.50	0.25	0.00	0.00	0.00	0.00	0.00	7.95
2007	0.00	0.00	0.00	0.00	0.00	5.52	1.92	0.00	0.00	0.00	0.00	0.00	7.43
2008	0.00	0.00	0.00	0.00	0.94	4.04	5.18	0.00	0.00	0.00	0.00	0.00	10.16
2009	0.00	0.00	0.00	0.00	0.12	0.03	2.53	0.00	0.00	0.00	0.00	0.00	2.67
2010	0.00	0.00	0.00	0.00	0.00	0.72	1.13	0.08	0.00	0.00	0.00	0.00	1.93
2011	0.00	0.00	0.00	0.00	0.00	1.29	6.32	2.14	0.00	0.00	0.00	0.00	9.75
2012	0.00	0.00	0.00	0.04	0.55	0.63	0.45	0.00	0.00	0.00	0.00	0.00	1.66
2013	0.00	0.00	0.00	0.00	0.24	3.92	2.59	0.00	0.00	0.00	0.00	0.00	6.75
2014	0.00	0.00	0.00	0.00	0.00	2.17	3.64	0.06	0.00	0.00	0.00	0.00	5.87
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.90
2016	0.00	0.00	0.00	0.00	0.00	0.22	0.91	0.00	0.00	0.00	0.00	0.00	1.13
2017	0.00	0.00	0.00	0.00	0.00	0.64	1.97	0.00	0.00	0.00	0.00	0.00	2.61

Table 4
Farm Headgate Deliveries Attributable to Rural Ditch Company Shares
(Values in AF/share)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1988	0.0	0.0	0.0	0.0	5.4	36.7	35.8	26.4	3.8	0.0	0.0	0.0	108.0
1989	0.0	0.0	0.0	0.0	27.6	16.9	43.2	31.5	0.4	0.0	0.0	0.0	119.7
1990	0.0	0.0	0.0	0.0	14.6	20.1	24.9	25.1	15.2	0.0	0.0	0.0	99.8
1991	0.0	0.0	0.0	0.0	19.7	31.8	50.1	41.6	6.6	0.0	0.0	0.0	149.8
1992	0.0	0.0	0.0	0.0	15.9	23.4	40.7	22.7	0.0	0.0	0.0	0.0	102.7
1993	0.0	0.0	0.0	0.0	29.0	21.4	30.0	17.5	6.0	0.0	0.0	0.0	103.9
1994	0.0	0.0	0.0	0.0	12.0	27.0	35.4	31.2	18.9	6.7	0.0	0.0	131.3
1995	0.0	0.0	0.0	0.0	0.0	0.0	28.9	44.0	17.2	0.0	0.0	0.0	90.0
1996	0.0	0.0	0.0	0.0	25.2	19.7	25.4	22.9	5.4	0.0	0.0	0.0	98.5
1997	0.0	0.0	0.0	0.0	14.5	11.3	32.6	19.0	18.5	0.0	0.0	0.0	95.9
1998	0.0	0.0	0.0	3.7	35.2	33.1	34.5	27.7	23.8	0.0	0.0	0.0	158.0
1999	0.0	0.0	0.0	3.6	10.8	20.6	35.9	22.3	15.6	9.0	0.0	0.0	117.8
2000	0.0	0.0	0.0	1.7	27.8	32.7	29.3	32.5	27.7	0.0	0.0	0.0	151.7
2001	0.0	0.0	0.0	0.0	7.8	28.3	29.7	22.8	20.9	6.5	0.0	0.0	116.0
2002	0.0	0.0	0.0	5.7	17.1	18.1	20.1	7.9	6.1	15.6	0.0	0.0	90.7
2003	0.0	0.0	0.0	1.4	19.1	22.1	35.3	28.9	38.5	16.4	0.0	0.0	161.6
2004	0.0	0.0	0.0	13.5	26.1	29.9	37.9	30.2	30.9	2.2	0.0	0.0	170.7
2005	0.0	0.0	0.0	0.0	21.3	25.6	23.4	20.4	19.8	7.5	0.0	0.0	117.9
2006	0.0	0.0	0.0	13.4	21.2	21.5	20.6	23.8	23.4	15.4	0.0	0.0	139.4
2007	0.0	0.0	0.0	10.7	23.0	19.5	28.6	25.1	21.9	6.9	0.0	0.0	135.7
2008	0.0	0.0	0.0	8.1	18.7	24.9	20.7	23.1	12.6	17.8	0.0	0.0	126.0
2009	0.0	0.0	0.0	14.6	26.6	20.1	23.9	19.0	26.5	13.8	0.0	0.0	144.6
2010	0.0	0.0	0.0	10.9	6.2	19.3	24.4	17.6	17.4	21.0	0.0	0.0	116.8
2011	0.0	0.0	0.0	3.4	6.3	9.1	6.0	14.6	12.1	17.2	0.0	0.0	68.7
2012	0.0	0.0	0.0	11.2	13.1	13.7	13.0	10.0	13.1	17.4	0.0	0.0	91.4
2013	0.0	0.0	0.0	10.1	16.6	23.6	21.4	16.9	6.7	0.0	0.0	0.0	95.4
2014	0.0	0.0	0.0	0.0	12.5	13.1	21.6	17.4	9.0	0.0	0.0	0.0	73.6
2015	0.0	0.0	0.0	2.9	1.8	3.6	11.5	10.1	6.5	1.0	0.0	0.0	37.4
2016	0.0	0.0	0.0	1.0	0.0	3.0	5.8	4.9	4.7	4.0	0.1	0.0	23.6
2017	0.0	0.0	0.0	2.1	1.8	4.2	8.1	9.3	8.2	0.2	0.0	0.0	34.1

Table 5
Deliveries Attributable to Windy Gap Units
(Values in AF/unit)

Year	Modeled In-Lieu Delivery	Total Modeled WG Delivery
1988	3	40
1989	23	40
1990	0	27
1991	0	36
1992	0	41
1993	0	41
1994	20	40
1995	14	40
1996	0	7
1997	0	0
1998	0	0
1999	40	40
2000	40	40
2001	13	40
2002	40	40
2003	0	100
2004	0	32
2005	0	77
2006	0	47
2007	0	77
2008	0	63
2009	0	49
2010	0	47
2011	8	40
2012	30	40
2013	0	84
2014	0	23
2015	40	40
2016	40	40
2017	40	40

f. Northern Integrated Supply (NISP)

The Town is currently subscribed to NISP for 1,300 acre-feet. This supply will be modeled as available on demand, with a maximum rate of delivery of 15 percent of the annual total in any given month. NISP water will be delivered to the St Vrain Water Treatment Plant.

For the 2050 demand scenario an additional block of NISP water supply will be assumed, which will be an input variable in the model.

We will assume that 50 percent of NISP water is reusable if the return flows are under the dominion and control of the Town.

g. City of Loveland Lease

The Town has entered into a lease with the City of Loveland for up to 300 acre-feet of water, which is intended to be Windy Gap water. The lease stipulates that Firestone utilize second and any subsequent use of the water for the term of the lease. This supply will be assumed to be available on demand, delivered at Carter Lake.

The lease may be extended to a term that expires on December 31, 2031; this supply will not be included in the 2050 demand scenarios.

The City of Loveland water is reusable if the return flows are under the dominion and control of the Town.

h. Mountain Shadows Park Alluvial Supply

The Mountain Shadows Alluvial Supply will be available on demand, at a rate not to exceed 1.77 acre-feet per day or 54.80 acre-feet per month, and not to exceed 320 acre-feet per year. This source will be delivered either directly to Mountain Shadows Park (up to a maximum of 26 acre-feet per year assuming 2 acre-feet per acre for 13 acres), or to the Firestone Reservoir.

Return flows will be made to St Vrain Creek during the October through September period, as a percent of the previous year's total pumping of Mountain Shadows Park water. If the pumped water is delivered to storage, the return flow amount will be a constant 8.25 percent per month of the previous year's pumping. If the pumped water is delivered to meet irrigation demands at Mountain Shadows Park, the return flow will be a constant 7.84 percent per month of the previous year's pumping.

Mountain Shadows Park water that is diverted under the above conditions is reusable if the return flows are under the dominion and control of the Town.

i. Gould Wellfield Alluvial Supply

The Gould Wellfield Alluvial Supply will be available on demand, at a rate not to exceed 1.33 acre-feet per day or 41.10 acre-feet per month, and not to exceed 320 acre-feet per year. This source will be delivered to either the St Vrain Water Treatment Plant or the Firestone Reservoir.

Return flows will be made to St Vrain Creek during the October through September period, as a percent of the previous year's total pumping of Gould Wellfield water, at a constant rate of 8.25 percent per month of the previous year's pumping.

Gould Wellfield water that is diverted under the above conditions is reusable if the return flows are under the dominion and control of the Town.

j. Junior Water Rights

The Town is acquiring junior storage rights with the Firestone Reservoir that it is purchasing from L.G. Everist. In addition, the reservoir that is subject to an option to purchase from L.G Everist will also include a junior water right. The Last Chance Ditch is the structure that will deliver water to either reservoir.

To model an estimated yield of a junior water right, we first looked at available administrative call records to estimate flow that would be available for diversion by a junior right. Stream gage data was available at the confluence of the St Vrain Creek and the South Platte River. Because that gage is approximately miles below the headgate of the Last Chance Ditch and there are return flows from the Rural Ditch, the Last Chance Ditch, the St Vrain Sanitation District in that reach, there may be more flow in the St Vrain that is available upstream. In addition, it is our opinion there will be less water available in 2027 and in 2050 to a 2017 priority date diversion right under future administration and future development of conditional rights—other diversions to storage, for example—than a strict call analysis would indicate.

To estimate storable flows that seemed more reasonable for this modeling effort we made two adjustments to the estimated flows. First, we limited the junior right to operation in November through March because the availability of excess capacity in the Last Chance Ditch will likely be less during the irrigation season. Second, we assumed that the first 165 cfs of flow in any winter month in that showed free river conditions in our estimation of point flows would include unmeasured return flows that were not present at the Last Chance Ditch headgate or that would be taken by existing conditional rights that will enlarge their use beyond what it was taken during the 1988 to 2017 period. In other words, it is our estimate that the first 165 cfs of estimated free river are not actually going to be available to the Last Chance Ditch headgate.

Under these assumptions, Table 6 shows that an average of about 1,000 acre-feet of storable flows per year are available. This average annual volume is before capacity limits based on the reservoir turnout capacity or available storage capacity are imposed. Flow was available in only 11 years—no water was available in 19 years of the 30-year period of record.

The capacity of the turnout from the Last Chance Ditch to the reservoir will be an input variable to the model. Current plans are to design the turnout from the Last Chance Ditch to a 15 cfs capacity, with the ability to direct diversions into either reservoir that Firestone is planning on.

Water diverted under the junior rights will not have return flow obligations.

Table 6
Storable Flows at Last Chance Ditch
(Values in AF)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1988		0	0	0	0	0							0
1989		0	0	0	0	0							0
1990		0	0	0	0	2,832							2,832
1991		0	0	0	0	0							0
1992		200	0	0	0	6,087							6,287
1993		0	0	0	0	0							0
1994		1,035	0	0	0	0							1,035
1995		0	0	0	0	0							0
1996		0	206	0	0	0							206
1997		0	0	0	0	0							0
1998		5,129	2,205	0	0	1,561							8,895
1999		555	313	0	0	0							868
2000		1,172	408	0	0	0							1,581
2001		0	0	0	0	0							0
2002		0	0	0	0	0							0
2003		0	0	0	0	0							0
2004		0	0	0	0	0							0
2005		0	0	0	0	0							0
2006		0	0	0	0	0							0
2007		0	0	0	0	0							0
2008		0	0	0	0	0							0
2009		0	0	0	0	0							0
2010		0	0	0	0	0							0
2011		0	0	0	0	0							0
2012		123	0	0	0	0							123
2013		0	0	0	0	0							0
2014		0	3,156	0	0	2,110							5,266
2015		619	0	0	0	1,007							1,626
2016		746	95	0	0	293							1,134
2017		0	0	0	0	0							0

DRAFT Memorandum

To:	File 1527TWF05, Task 3 CWP Grant Task 1.3
From:	Gregg Ten Eyck, LRE
Reviewed by:	Jordan Furnans, PhD., LRE
Copy to:	Julie Pasillas, Dave Lindsay, Brad Grasmick
Date:	October 18, 2018
Project:	Colorado Water Plan Grant: Modeling Reservoir Operations
Subject:	Configuration of Partnerships

I. Background

The purpose of this memorandum is to describe the configuration of potential water supply partnerships that the Town of Firestone (Town) may participate in. There are two types of partnerships: raw water supply for non-potable park irrigation and joint operation of the St Vrain Water Treatment Plant.

II. Raw Water Supply

The potential collaborative raw water supply partnership would involve delivery of irrigation water from the Central Colorado Water Conservancy District (Central). This potential partnership has only been discussed with Central at a very preliminary level.

The operation of this arrangement would involve delivery of raw water to the Town's proposed non-potable distribution system. This supply would take the place of additional Town pumping from alluvial wells.

The annual amount of water supplied to the Town would be replaced to Central in the form of fully consumable return flows delivered to St Vrain Creek from the St Vrain Sanitation District wastewater treatment plant or from the Firestone Reservoir. The schedule for delivery of those return flows is assumed for the purposes of this modeling effort is on a constant basis: we will model the annual demand for irrigation water and divide that amount by 12 to create the replacement schedule.

Table 1, below, was adopted from Table 2 of the June 12 2018 draft Water Demand memo. The parks irrigation line is 20 percent of the total government irrigation (parks irrigation) demand in year 2027 from the June 12 memorandum.

Table 2, below, was adopted from Table 5 of the June 12 2018 draft Water Demand memo. The parks irrigation line is 40 percent of the total government irrigation (parks irrigation) demand in year 2050 from the June 12 memorandum.

Table 1
Town of Firestone 2027
Central Weld County Water District Service Area
Mid-Range Year Projected Demands for Non-Potable Park Irrigation, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
Parks	5.1	0.8	0.0	0.0	0.0	0.0	0.9	4.0	11.6	15.6	15.1	11.1	64.2
TOTAL	**5.1**	**0.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.9**	**4.0**	**11.6**	**15.6**	**15.1**	**11.1**	**64.2**

Table 2
Town of Firestone 2050
Central Weld County Water District Service Area
Mid-Range Year Projected Demands for Non-Potable Park Irrigation, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
Parks	26.5	4.1	0.0	0.0	0.0	0.0	4.9	20.6	60.0	80.4	77.8	57.2	331.6
TOTAL	**26.5**	**4.1**	**0.0**	**0.0**	**0.0**	**0.0**	**4.9**	**20.6**	**60.0**	**80.4**	**77.8**	**57.2**	**331.6**

III. St Vrain Water Treatment Authority

The Town is proceeding with the creation of a regional entity, currently characterized as the St Vrain Water Treatment Authority. This Authority would own and operate the St Vrain Water Treatment Plant. The Town has had conversations about the Authority with Little Thompson Water District, Central Weld County Water District, and the Towns of Dacono and Frederick.

For the purposes of this model we are adding both a demand and a supply to represent at least one partner in the treatment plant operation. The supply will be represented by an exchange from the St Vrain Sanitation District to an assumed alluvial wellfield that is not yet identified. The amount of exchange water available at the St Vrain Sanitation District is assumed to be equal to the demand; we will tabulate the total exchange needed to have data to compare to exchange potential (at some future time, not in this model),

Table 3, below, is the assumed demand in 2027; Table 4 is the assumed demand in 2050. This demand will not be adjusted for PDSI as the augmentation supply available to supply these demands is assumed to be fixed.

Table 3
Partner Treated Water Demand 2027
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Use	24.4	11.6	9.0	8.9	8.7	8.8	12.1	21.1	43.6	55.3	53.8	42.0	299.3
TOTAL	**24.4**	**11.6**	**9.0**	**8.9**	**8.7**	**8.8**	**12.1**	**21.1**	**43.6**	**55.3**	**53.8**	**42.0**	**299.3**

Table 4
Partner Treated Water Demand 2050
Mid-Range Year Projected Demands, acre-feet per month

	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
All Use	49.3	23.6	18.1	17.9	17.6	17.7	24.4	42.6	88.0	111.6	108.6	84.8	604.3
TOTAL	**49.3**	**23.6**	**18.1**	**17.9**	**17.6**	**17.7**	**24.4**	**42.6**	**88.0**	**111.6**	**108.6**	**84.8**	**604.3**

DRAFT Memorandum

To:	File 1527TWF05, Task 4 CWP Grant Task 1.4
From:	Gregg Ten Eyck, LRE
Reviewed by:	Jordan Furnans, PhD., LRE
Copy to:	Julie Pasillas, Dave Lindsay, Brad Grasmick
Date:	January 8, 2019-revised January 11, 2019
Project:	Colorado Water Plan Grant: Modeling Reservoir Operations
Subject:	Model Development

I. Background

The purpose of this memorandum is to report on the completion of the development of the monthly time step model. The model simulates a 30 year time period, using historical data from January 1988 through December 2017.

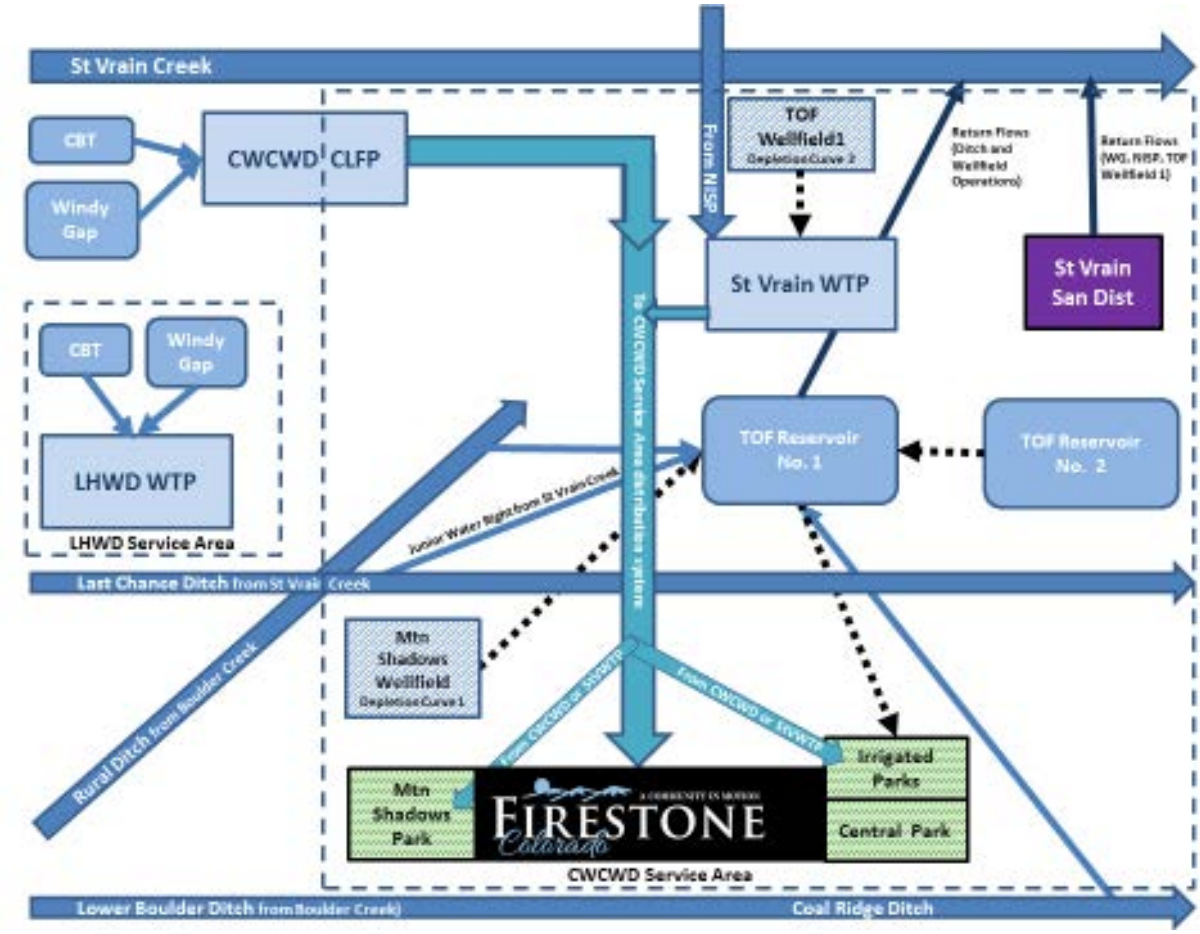
The monthly data used in the model were described in the Task 1.1 and 1.2 memoranda.

As described in the memorandum for Task 1.6, a daily time step model was not developed.

II. Model Schematic

A schematic of the Town of Firestone system as modeled is shown in Figure 1.

Figure 1
Model Schematic



III. Model Structure

The Excel spreadsheet model consists of the following individual worksheets:

ReadMe
Dashboard
Configurations
Input Data
Demands
Supplies
Allocation
Reuse
ToF Reservoir #1
ToF Reservoir #2
ToF Reservoir #3
Partner Reservoir
Evap Calcs
ToF Reservoir Storage (graph)
Unmet Demands (graph)
Usage by Source (graph)
Annual Usage by Source (graph)
C-BT Usage (graph)

IV. Model Operation

To operate the model, the user may select one of 12 pre-determined configurations, may create their own configuration, or may input data directly into the Dashboard worksheet (on non-colored cells only). Pre-determined configurations are stored within the Configurations worksheet, and the model user may add additional configurations directly in that worksheet. Currently the model is setup to contain up to 35 pre-determined configurations, yet only 12 configurations are currently defined.

The screenshots shown below are for the current version of the model and are subject to update.

V. Dashboard Worksheet

a. Model Configuration

A pre-defined model configuration may be specified by using a dropdown menu to select a number 1 through 35. The configuration number relates to one of defined configurations from the configurations worksheet. The 12 pre-determined configurations are described below.

Model Configuration	1	*Baseline 2027*

Selecting a value of 1 through 12 will automatically populate the remainder of the Dashboard with specified values. These 12 configurations can be used with climate change variables as will be described later.

Defined Model Scenarios

Number	Name
1	Baseline 2027
2	Alternate 1-1 (2027)
3	Alternate 1-2 (2027)
4	Baseline 2050
5	Alternate 2-1 (2050)
6	Alternate 2-2 (2050)
7	Baseline 2050 w/ Climate Change
8	Alternate 2-1 (2050) w/ Climate Change
9	Alternate 2-2 (2050) w/ Climate Change
10	Baseline 2050 w/ Climate Change & Increased Irrigation
11	Alternate 2-1 (2050) w/ Climate Change & Increased Irrigation
12	Alternate 2-2 (2050) w/ Climate Change & Increased Irrigation

In addition, individual values may be changed on the non-colored cells, as described below. After the configuration is selected or after individual cells are changed the model automatically performs calculations and produces results.

b. Reservoir Input Variables

The following are input variables related to reservoir modeling that are specified on the Dashboard worksheet:

Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
Active Modeling of ToF Reservoir #2	**0**	Options: 1 = Modeled, 0 = Not Modeled
Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled

c. Demand, Climate Change and Partner Modeling Variables

The following are input variables related to water demands, climate change modeling, and partner demands that are specified on the Dashboard worksheet:

Model Demand Mode	**1**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
Alternate Scenario Modeling	**1**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
Demand Increase Scenario	**0**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
Climate Change Modeling	**0**	Option: 1 = On, 0 = Off
Future Warming	**1**	°C (Limit 0-10)
Flow Reduction Rate	**10**	% Per °C Increase in Temperature
Demand to be met only by reservoirs	**20**	% of total CWCWD Gov. Irrigation Demand
Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input

d. C-BT Input Variables

The following are input variables related to C-BT modeling that are specified on the Dashboard worksheet:

Modeled # of CBT Units Available to Firestone	**5,350**	Units
Surcharge for Central Weld WCD	**1.2**	
Surcharge for Left Hand WD	**1.1**	
TDS Value for CBT Water	**60**	mg/L TDS
Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
Fixed Quota Value	**70**	%
Percentage of Units in Fixed Quota Program for Option #3	**75**	%
Amount available for January 1988	**4,000**	acre-ft

The "Amount Available for January 1988" contains a default starting point of 4,000 acre-feet based on an assumed quota of 80 percent and 9 months remaining in the water year. The actual quota in 1988 was 80 percent.

e. Windy Gap Input Variables

The following are input variables related to Windy Gap modeling that are specified on the Dashboard worksheet:

Modeled # of Windy Gap Units Available to Firestone	**5**	Units
Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
Windy Gap Reset Month	**11**	
City of Loveland Lease Quantity	**0**	acre-ft/yr
Surcharge for Central Weld WCD Lease Usage	**1.2**	
Surcharge forLeft Hand WD Lease Usage	**1.1**	
Surcharge for Central Weld WCD WG Usage	**1.2**	
Surcharge for Left Hand WD WG Usage	**1.1**	
TDS Value for WG Water	**60**	mg/L TDS
Reuse Credit for Indoor Water Usage	**95**	%

f. Ditch Shares Input Variables

The following are input variables related to modeling of ditch company shares that are specified on the Dashboard worksheet:

Lower Boulder Ditch Preferred Shares	**3.97**	Shares
Lower Boulder Ditch Common Shares	**6.667**	Shares
Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
Rural Ditch Company	**2.41**	Shares
Rural Ditch Company - Prior Year Usage	**125**	acre-ft

The "Prior Year Usage" input is used to calculate return flow requirements in model year 1 (1988).

g. NISP Input Variables

The following are input variables related to modeling of NISP supplies that are specified on the Dashboard worksheet:

NISP Base Supply	**1300**	acre-ft/yr
Max Delivery Rate - Per Month	**15%**	per month
Reusable Percentage - Base Supply	**50%**	of Used Quantity
Reuse Credit for Indoor Water Usage	**95%**	
NISP Additional Supply	**0**	acre-ft/yr
Additional Supply Max Delivery Rate	**15%**	per month
Reusable Percentage - Additional Supply	***50%***	of Used Quantity
Reuse Credit for Indoor Water Usage	**95%**	

h. Mountain Shadows Well Field Input Variables

The following are input variables related to modeling of the Mountain Shadows Well Field that are specified on the Dashboard worksheet:

Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	acre-ft/day
Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
Mountain Shadows Park Alluvial Supply - Yearly Limit	**320**	acre-ft/yr
Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft

i. Gould Well Field Input Variables

The following are input variables related to modeling of the Gould Well Field that are specified on the Dashboard worksheet:

Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
Gould Well Field Alluvial Supply - Yearly Limit	**363**	acre-ft/yr
Monthly Return Flow Factor	**8.25%**	
Reuse Credit for Indoor Water Usage	**95**	% Note that the Gould Reuse Credits are calculated using the Windy Gap factor
Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft

j. Junior Water Right Input Variables

The following are input variables related to modeling of junior storage water rights that are specified on the Dashboard worksheet:

Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
Monthly Return Flow Factor	**0.00%**	
Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

k. Monthly Availability

The model allows the user to "turn off" individual sources for any month.

Usage Allowed By Month (0 = No, 1 = Yes)													
J	F	M	A	M	J	J	A	S	O	N	D	#	
1	1	1	1	1	1	1	1	1	1	1	1	1	CBT
1	1	1	1	1	1	1	1	1	1	1	1	2	NISP Base
1	1	1	1	1	1	1	1	1	1	1	1	3	NISP Additional
1	1	1	0	0	0	0	0	0	0	0	1	4	Windy Gap - Delivery
1	1	1	1	1	1	1	1	1	1	1	1	5	Windy Gap - Lease
1	1	1	1	1	1	1	1	1	1	1	1	6	Lower Boulder Ditch Prefered
1	1	1	1	1	1	1	1	1	1	1	1	7	Lower Boulder Ditch Common
1	1	1	1	1	1	1	1	1	1	1	1	8	Rural Ditch
1	1	1	1	1	1	1	1	1	1	1	1	9	Mountain Shadows
1	1	1	1	1	1	1	1	1	1	1	1	10	Gould Wellfield
1	1	1	1	1	1	1	1	1	1	1	1	11	Junior Water Rights

In the example above, C-BT water is usable in every month of the year, whereas Windy Gap – Delivery is only available December-March.

I. Water Source Priority Controls

The priority of use of each of the eleven modeled water supply sources is an input variable that is controlled on the Dashboard worksheet (or specified on the Configurations worksheet). A value of 1 (first priority) through 11 (last priority) is specified for each source of water for each water supply configuration. A sample is shown below:

Priority Source By Month

Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
1	J	4	10	1	2	3	11	6	7	8	9	5
2	F	4	10	1	2	3	11	6	7	8	9	5
3	M	4	10	1	2	3	11	6	7	8	9	5
4	A	11	10	1	2	3	4	6	7	8	9	5
5	M	11	10	1	2	3	4	6	7	8	9	5
6	J	11	10	1	2	3	4	6	7	8	9	5
7	J	11	10	1	2	3	4	6	7	8	9	5
8	A	11	10	1	2	3	4	6	7	8	9	5
9	S	11	10	1	2	3	4	6	7	8	9	5
10	O	11	10	1	2	3	4	6	7	8	9	5
11	N	11	10	1	2	3	4	6	7	8	9	5
12	D	4	10	1	2	3	11	6	7	8	9	5

#	
1	CBT
2	NISP Base
3	NISP Additional
4	Windy Gap - Delivery
5	Windy Gap - Lease
6	Lower Boulder Ditch Prefered
7	Lower Boulder Ditch Common
8	Rural Ditch
9	Mountain Shadows
10	Gould Wellfield
11	Junior Water Rights

The above example shows that in the winter months Windy Gap is the first water source that will be used to meet demands; in the other eight months the model will first try to use any junior water right yield (for diversion to storage) that is available. The Gould Well Field is the second water source used in all months. C-BT is the number three priority in all months and NISP is priority four and five. During the summer months Windy Gap is the number six priority. The ditch company shares are the 7th, 8th and 9th priority for use in all months. The Mountain Shadows well field is priority 10 in all months. The last water source that will be taken is the Windy Gap lease.

Actual use of all of the above sources is still limited or controlled by water availability, by individual volumetric or other limits as specified above, and by how the water can be used, as specified below.

m. Water Source Usage Controls

The model allows the user to specify how water sources can be used, by defining which demands they can satisfy. For example, in the sample table shown below the only sources available to meet demands in the LHWD service area are C-BT, Windy Gap and the Windy Gap lease.

Demands to Satisfy 0 = No, 1 = Yes						
CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
1	1	0	0	0	1	CBT
1	0	0	0	0	2	NISP Base
1	0	0	0	0	3	NISP Additional
1	1	0	0	0	4	Windy Gap - Delivery
1	1	0	0	0	5	Windy Gap - Lease
0	0	1	1	0	6	Lower Boulder Ditch Prefered
0	0	1	1	0	7	Lower Boulder Ditch Common
0	0	0	1	0	8	Rural Ditch
0	0	0	1	0	9	Mountain Shadows
1	0	0	0	0	10	Gould Wellfield
0	0	0	1	0	11	Junior Water Rights

VI. Configuration Worksheet

The Configuration worksheet is used to specify pre-determined model configurations. An example of the listing for the 12- pre-determined configurations is shown below. The model user can create and store up to 35 configurations within the Configuration worksheet.

Modeled Scenario											
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
0	1	1	1	1	1	1	1	1	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	2	2	2	2	2	2	2	2	2
2050	2050	2050	2050	2050	2050	2050	2050	2050	2050	2050	2050
1	2	3	1	2	3	1	2	3	1	2	3
0	0	0	0	0	0	0	0	0	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	2	2	2	2	2	2
10	10	10	10	10	10	10	10	10	10	10	10
20	30	60	25	35	60	25	35	60	25	35	60
0	0	0	0	0	0	0	0	0	0	0	0
5350	5350	5350	5350	5450	5450	5350	5450	5450	5350	5450	5450
1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
60	60	60	60	60	60	60	60	60	60	60	60
1	1	1	1	1	1	1	1	1	1	1	1
70	70	70	70	70	70	70	70	70	70	70	70
75	75	75	75	75	75	75	75	75	75	75	75
4000	3250	3250	3250	3250	3250	3250	3250	3250	3250	3250	3250
5	5	5	5	5	5	5	5	5	5	5	5
2	2	2	2	2	2	2	2	2	2	2	2
11	11	11	11	11	11	11	11	11	11	11	11
0	500	500	0	0	0	0	0	0	0	0	0
1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
60	60	60	60	60	60	60	60	60	60	60	60
95	95	95	95	95	95	95	95	95	95	95	95
3.97	12	12	3.97	16	14	3.97	16	14	3.97	16	14
6.667	16	16	6.67	24	20	6.67	24	20	6.67	24	20
190	190	190	190	190	190	190	190	190	190	190	190
150	150	150	150	150	150	150	150	150	150	150	150
2.41	8	8	2.41	24	20	2.41	24	20	2.41	24	20
125	125	125	125	125	125	125	125	125	125	125	125
1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
0	0	0	0	1300	1900	0	1300	1900	0	1300	1900
15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%

VII. Other Worksheets

a. Data Worksheets

The Input Data, Demands and Supplies worksheets are where the input data as described in the Task 1.1 (Demands) and Task 1.2 (Supplies) memoranda reside.

b. Calculation Worksheets

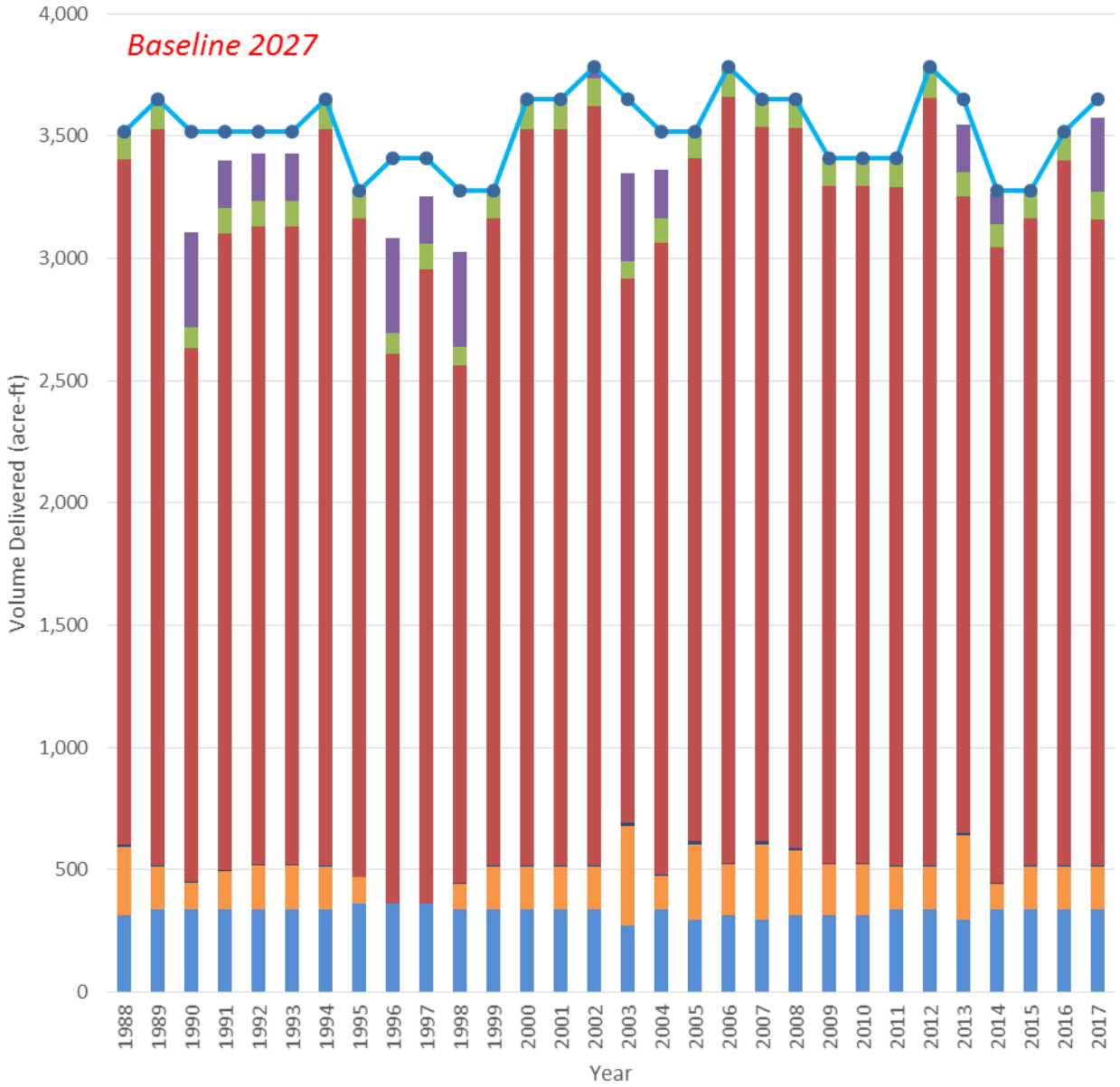
The Allocation worksheet is where the main calculations for water allocation using the monthly demands and priority of source utilization, etc. take place.

The Reuse Worksheet calculates the amount of reuse credits generated by using Windy Gap, Gould Well Field, and NISP water sources.

The Reservoir Worksheets calculate storage volumes and use data from each modeled reservoir. Evaporation rates and reservoir stage-area-capacity data are contained in the Evap Calcs worksheet.

c. Graph Worksheets

Worksheets ToF Reservoir Storage, Unmet Demands, Usage by Source, Annual Usage by Source, and C-BT Usage display graphs of model results. An illustration of the Annual Usage by Source, Reservoir Storage, and the C-BT Usage graphs are shown below.



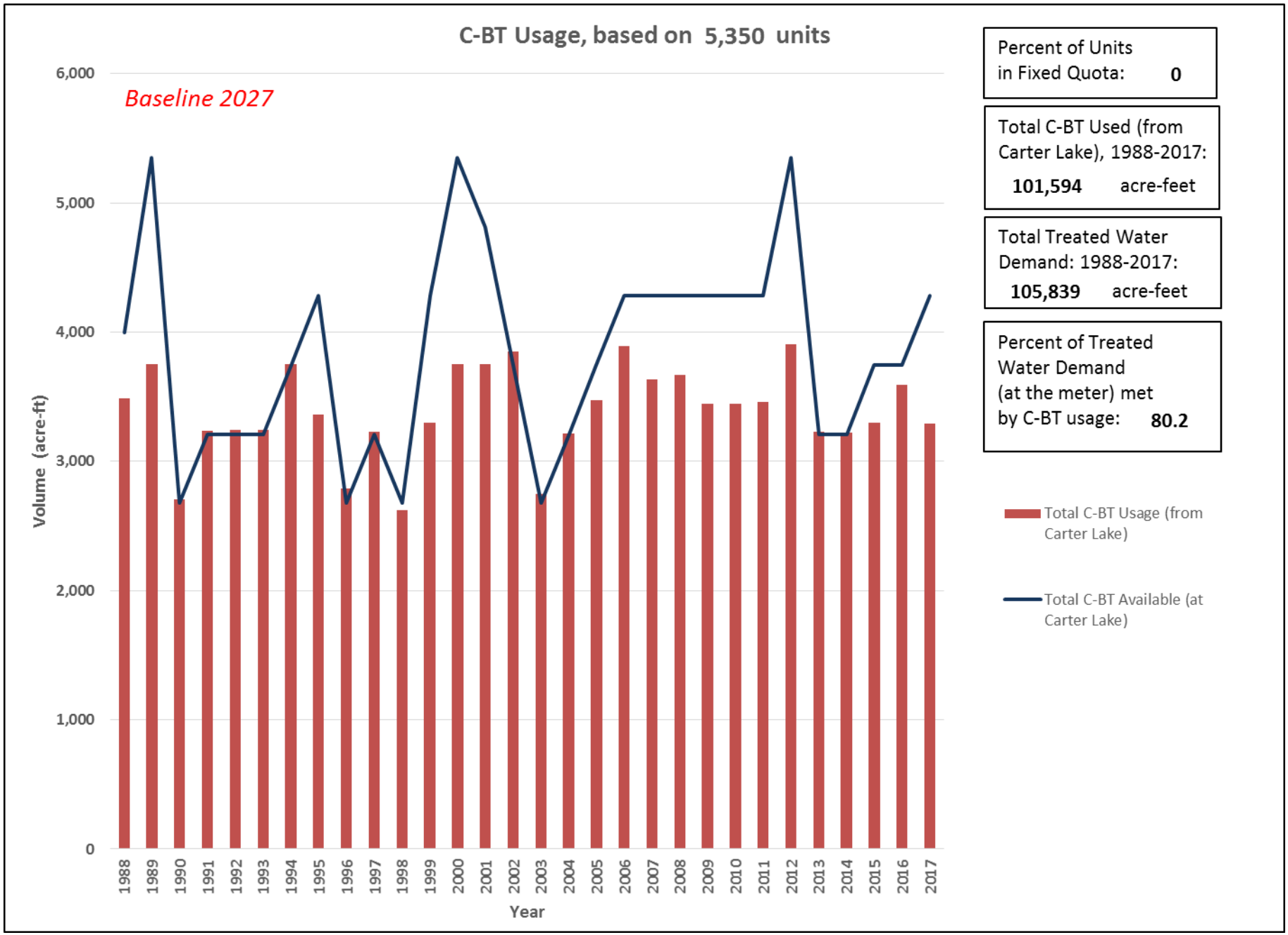
C-BT Units: **5,350**
Windy Gap Units: **5**
NISP Units: **1,300**

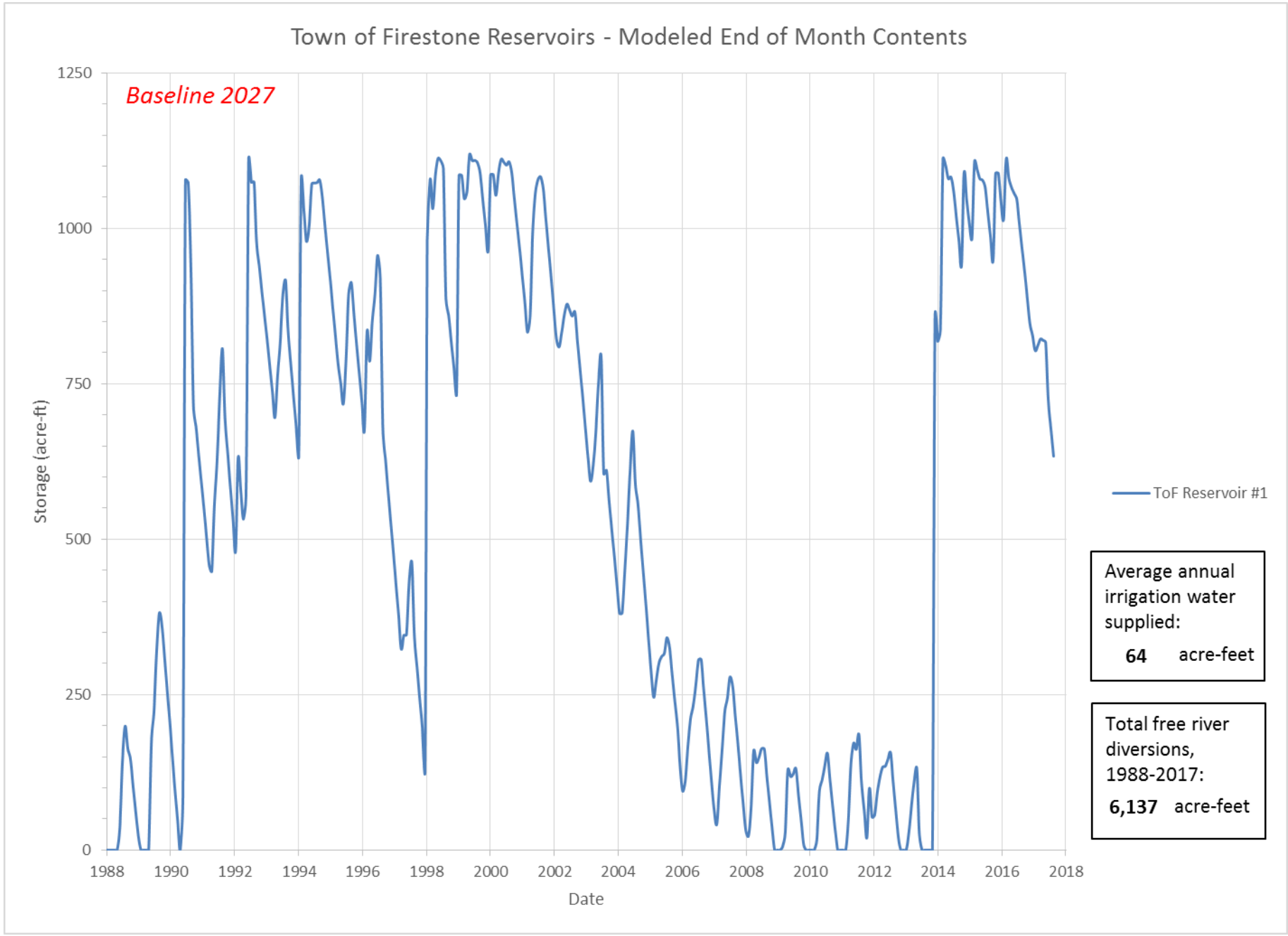
Total Treated Water Demand, 1988-2017:
105,839 acre-feet

- Windy Gap Lease LHWD
- Windy Gap Lease CWCWD
- NISP Base
- CBT-LHWD
- CBT-CWCWD
- Windy Gap Delivery LHWD
- Windy Gap Delivery CWCWD
- Gould Wellfield
- Total Treated Water Demand (at the meter)

Average annual reuse credit:
Windy Gap: **166** acre-feet
Gould: **149** acre-feet

Shortages
Number of years: **18**
Max year: **196** acre-feet
Average year: **33** acre-feet


C-BT Usage, based on 5,350 units
Baseline 2027
Volume (acre-ft)
6,000
5,000
4,000
3,000
2,000
1,000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 101,594 acre-feet
Total Treated Water Demand: 1988-2017: 105,839 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 80.2
Total C-BT Usage (from Carter Lake)
Total C-BT Available (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Baseline 2027
Storage (acre-ft)
Date
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
ToF Reservoir #1
Average annual irrigation water supplied:
64 acre-feet
Total free river diversions, 1988-2017:
6,137 acre-feet

DRAFT Memorandum

To:	File 1527TWF05, Task 5 CWP Grant Task 1.5
From:	Gregg Ten Eyck, LRE
Reviewed by:	Jordan Furnans, PhD., LRE
Copy to:	Julie Pasillas, Dave Lindsay, Brad Grasmick
Date:	December 13, 2018—revised January 8, 2019
Project:	Colorado Water Plan Grant: Modeling Reservoir Operations
Subject:	Configuration of Alternate Water Supplies: 2027 and 2050

I. Background

The purpose of this memorandum is to tabulate the water supply infrastructure configuration alternatives and water supply yield scenarios that will be modeled to meet Town of Firestone water demands projected for 2027 and 2050.

II. 2027 Water Supply Infrastructure Configuration

Table 1 shows the water supply configurations assumed for the Baseline and two alternatives for the year 2027 model runs.

The total number of C-BT units assumed available in 2027 is 5,350. The number of ditch company shares listed in the Baseline configuration in Table 1 is the number of shares that are controlled by the Town in 2018.

The Gould and Mountain Shadows Park well fields also have monthly limits on delivery to the St Vrain Water Treatment Plant and Firestone Reservoir, respectively. These will be discussed below.

For all 2027 scenarios we will model the Loveland lease at 500 acre-feet, and it will be a water source that is only used when all other sources are exhausted.

Table 1
Town of Firestone 2027
Water Supplies for Alternatives

Alternative	C-BT	Windy Gap	Lower Boulder Preferred	Lower Boulder Common	Rural Ditch	Gould Well Field
	units	units	shares	shares	shares	acre-feet
Baseline	5,350	5	3.97	6.667	2.41	363
Alt 1-1	5,350	5	12	16	8	654
Alt 1-2	5,350	5	12	16	8	992

III. 2050 Water Supply Infrastructure Configuration

Table 2 shows the water supply configurations assumed for the Baseline and two alternatives, for the Central Weld service areas, respectively, for the year 2050 model runs.

The total number of C-BT units assumed available in 2050 is 5,450. The number of ditch company shares listed in the Baseline configuration in Table 2 is the number of shares that are controlled by the Town in 2018.

The Gould and Mountain Shadows Park well fields also have monthly limits on delivery to the St Vrain Water Treatment Plant and Firestone Reservoir, respectively. These will be discussed below.

The NISP water is assumed to be available for use in Firestone in the year 2050 model.

The Loveland lease will not be available in any of the 2050 configurations.

Table 2
Town of Firestone 2050
Water Supplies for Alternatives

Alternative	C-BT	Windy Gap	Lower Boulder Preferred	Lower Boulder Common	Rural Ditch	Gould Well Field	NISP
	units	units	Shares	shares	shares	acre-feet	acre-feet
Baseline	5,450	5	3.97	6.667	2.41	496	1,300
Alt 2-1	5,450	5	16	24	24	992	2,600
Alt 2-2	5,450	5	14	20	20	1,985	3,200

IV. Configuration of Town of Firestone Park Irrigation Supplies, 2027 and 2050

A portion of the total "Government Irrigation" demand for irrigation water is assumed to be supplied from the Firestone Reservoir in 2027 and 2050. Tables 3 and 4 show the amount of supply, in percent of total demand for Government Irrigation that can be met from the Reservoir for the Baseline and for each of the Alternatives.

Table 3
Town of Firestone 2027
Central Weld County Water District Service Area

Alternative	Supply from Reservoir, percent of demand
Baseline	20
Alt 1-1	30
Alt 1-2	60

Table 4
Town of Firestone 2050
Central Weld County Water District Service Area

Alternative	Supply from Reservoir, percent of demand
Baseline	25
Alt 2-1	35
Alt 2-2	60

V. Configuration of Well Fields, 2027 and 2050

a. Gould Well Field. The Gould well field that will pump from the alluvium to supply the St Vrain Water Treatment Plant is assumed to have monthly supply limits, as shown in Tables 5 and 6, for 2027 and 2050 respectively.

   The actual supply may be developed from more than one well field; for modeling purposes the volumes in the tables shown below are the sum of several possible well fields that can supply the St Vrain Water Treatment Plant.

Table 5
Town of Firestone 2027
Gould Well Field
Monthly Pumping Limits, acre-feet

	Base	Alternative 1-1	Alternative 1-2
January	23.8	23.8	47.6
February	21.5	21.5	43.0
March	23.8	23.8	47.6
April	26.2	31.4	52.4
May	25.0	59.1	74.5
June	40.0	91.3	124.2
July	45.0	94.3	152.4
August	40.0	94.3	149.0
September	38.0	91.3	120.6
October	30.0	69.0	82.1
November	25.7	30.1	51.4
December	23.8	23.8	47.6
Total	**362.8**	**653.8**	**992.4**

Table 6
Town of Firestone 2050
Gould Well Field
Monthly Pumping Limits

	Base	Alternative 2-1	Alternative 2-2
January	23.8	47.6	95.1
February	21.5	43.0	85.9
March	23.8	47.6	95.2
April	26.2	52.4	104.9
May	37.2	74.5	148.9
June	62.1	124.2	248.5
July	76.2	152.4	304.8
August	74.5	149.0	298.0
September	60.3	120.6	241.3
October	41.0	82.1	164.2
November	25.7	51.4	102.9
December	23.8	47.6	95.1
Total	**496.2**	**992.4**	**1984.8**

b. Mountain Shadows Park Well Field. The Mountain Shadows Park well field monthly pumping limits are shown in Table 7 and Table 8. This well field is assumed to be used for Town of Firestone parks, either directly delivered to parks, or delivered to the reservoir. Actual modeled pumping from this well field will be controlled or limited by irrigation demands and/or reservoir storage capacity.

Table 7
Town of Firestone 2027
Mountain Shadows Park Well field
Monthly Pumping Limits, acre-feet

	Base	Alternate 1-1	Alternate 1-2
January	0.0	0.0	16.7
February	0.0	0.0	16.7
March	0.0	0.0	16.7
April	1.0	1.5	16.7
May	4.0	6.2	16.7
June	12.0	18.5	16.7
July	16.0	24.6	16.7
August	15.0	23.1	16.7
September	11.0	16.9	16.7
October	5.0	7.7	16.7
November	1.0	1.5	16.7
December	0.0	0.0	16.7
Total	**65.0**	**100.0**	**200.4**

Table 8
Town of Firestone 2050
Mountain Shadows Park Well field
Monthly Pumping Limits, acre-feet

	Base	Alternate 2-1	Alternate 2-2
January	16.7	25.0	41.1
February	16.7	25.0	41.1
March	16.7	25.0	41.1
April	16.7	25.0	41.1
May	16.7	25.0	41.1
June	16.7	25.0	41.1
July	16.7	25.0	41.1
August	16.7	25.0	41.1
September	16.7	25.0	41.1
October	16.7	25.0	41.1
November	16.7	25.0	41.1
December	16.7	25.0	41.1
Total	**200.4**	**300.0**	**493.2**

VI. Reservoir Configurations: 2027 and 2050

Firestone Reservoir No. 1 will be available in 2027 and 2050; the operational volume available will be 1,123 acre-feet at elevation 4,817.0 feet. The storage volume and area-capacity curve for Reservoir No. 1 are based on recent survey data.

Firestone Reservoir No. 2 will also be available in 2050. The storage volume and area-capacity curve for Reservoir No. 2 will be based on the ratio of storage assumed for Reservoir No. 2, which is 1,050 acre-feet. This is 86 percent of the Firestone Reservoir No. 1 volume, so each volume and area value for Reservoir No. 2 will be 86 percent of the value for Reservoir No. 1.

VII. Scenarios: Water Supply/Irrigation Demand Variation

The 2050 Baseline configuration will be modeled with two scenarios: one will reflect a water supply decrease, and one will reflect both a water supply decrease with an irrigation demand increase.

a. Supply Decrease: For the 2050 Baseline and 2050 Alternate 2-1 we will model a decrease in surface water supplies (C-BT, Windy Gap, NISP, ditch rights and free river water) of 20 percent. Each surface water supply will reflect the 20 percent loss in each month of the 1988 through 2015 data. This percentage is based on review of Table 5 of Udall and Peck (2016) for mid-century moderate emission assumptions. The model has broader flexibility to evaluate other flow reduction assumptions.

b. Supply Decrease and Demand Increase: The second scenario, for the 2050 Baseline and 2050 Alternate 2-1. will assume the same supply decrease as above, and in addition we will assume an increase in demand for outdoor irrigation by individual homeowners and for parks (government irrigation). We are assuming that the monthly demand in May will grow to be the same as the demand in June, and that the monthly demand in September will grow to be the same as the demand in August. This has the effect of increasing the annual demand for outdoor use by about 27 percent, see Table 9, below.

   We are not assuming any increase in peak month irrigation demand.

Table 9
Year 2050 Demand Increase Scenario

Central Weld County Water District Service Area: Mid-Range Year Projected Irrigation Demands, acre-feet per month

Baseline, from Table 5 of Demand Memo

2050	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
Outdoor Use	289.1	45.2	0.0	0.0	0.0	0.2	53.6	225.4	655.2	878.4	850.1	625.0	3,622.2
Govt Irrigation	66.2	10.4	0.0	0.0	0.0	0.0	12.3	51.6	150.0	201.0	194.5	143.0	829.0
TOTAL	**355.3**	**55.6**	**0.0**	**0.0**	**0.0**	**0.2**	**65.8**	**277.0**	**805.2**	**1,079.4**	**1,044.6**	**768.0**	**4,451.2**

Year 2050 Demand Increase Scenario

2050	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
Outdoor Use	625.0	45.2	0.0	0.0	0.0	0.2	53.6	655.2	655.2	878.4	850.1	850.1	4,613.0
Govt Irrigation	143.0	10.4	0.0	0.0	0.0	0.0	12.3	150.0	150.0	201.0	194.5	194.5	1,055.7
TOTAL	**768.0**	**55.6**	**0.0**	**0.0**	**0.0**	**0.2**	**65.8**	**805.2**	**805.2**	**1,079.4**	**1,044.6**	**1044.6**	**5,668.7**

Left Hand Water District Service Area: Mid-Range Year Projected Demands, acre-feet per month

Baseline, from Table 6 of Demand Memo

2050	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
Outdoor Use	44.4	6.9	0.0	0.0	0.0	0.0	8.2	34.6	100.5	134.7	130.4	95.9	555.7
Govt Irrigation	3.9	0.6	0.0	0.0	0.0	0.0	0.7	3.0	8.7	11.7	11.3	8.3	48.2
TOTAL	**48.2**	**7.5**	**0.0**	**0.0**	**0.0**	**0.0**	**8.9**	**37.6**	**109.2**	**146.4**	**141.7**	**104.2**	**603.9**

Year 2050 Demand Increase Scenario

2050	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
Outdoor Use	95.9	6.9	0.0	0.0	0.0	0.0	8.2	100.5	100.5	134.7	130.4	130.4	707.6
Govt Irrigation	8.3	0.6	0.0	0.0	0.0	0.0	0.7	8.7	8.7	11.7	11.3	11.3	61.4
TOTAL	**104.2**	**7.5**	**0.0**	**0.0**	**0.0**	**0.0**	**8.9**	**109.2**	**109.2**	**146.4**	**141.7**	**141.7**	**769.0**

VIII. Scenario: Time Series Demand Growth

One set of model runs contemplated is to model a year-over-year growth in water demand, from 2027 through 2050. This section describes some of the demand and supply assumptions for that analysis. These runs will use the 2027 Baseline and the 2027 Alternate 1-2 supply configurations, with the 1988 through 2015 hydrology.

a. Demand: For the 2027 Alternate 1-2 configuration, Table 10 below shows a time series demand to be modeled, for the Central Weld Service Area only. The monthly demand for indoor use, outdoor use and government irrigation in 2027 will be multiplied by the value in the table for each year from 2027 to 2050 to arrive at the monthly demand for the selected year.

b. Supply available to meet government irrigation demand: Table 11 below shows the amount of demand for government irrigation that can be met from the Town of Firestone Reservoir No. 1 as a percent of total annual demand.

c. Reservoir availability: Only Reservoir No. 1 will be available from 2027 through 2036; both Reservoir No. 1 and Reservoir No. 2 will be available from 2037 through 2050.

d. NISP availability: 1,300 acre-feet per year will be available in 2027 through 2036; 2,600 acre-feet will be available from 2037 through 2050.

Table 10
Town of Firestone 2027 Baseline and 2027 Alternate 1-2
Monthly Multiplier on 2027 Demand

Year	All Indoor Use	Outdoor Use	Govt Irrigation
2027	1.00	1.00	1.00
2028	1.06	1.05	1.08
2029	1.12	1.11	1.15
2030	1.18	1.16	1.23
2031	1.23	1.21	1.30
2032	1.29	1.27	1.38
2033	1.35	1.32	1.45
2034	1.41	1.37	1.53
2035	1.47	1.43	1.60
2036	1.53	1.48	1.68
2037	1.59	1.53	1.75
2038	1.65	1.59	1.83
2039	1.70	1.64	1.90
2040	1.76	1.70	1.98
2041	1.82	1.75	2.05
2042	1.88	1.80	2.13
2043	1.94	1.86	2.20
2044	2.00	1.91	2.28
2045	2.06	1.96	2.35
2046	2.12	2.02	2.43
2047	2.17	2.07	2.50
2048	2.23	2.12	2.58
2049	2.29	2.18	2.65
2050	2.35	2.23	2.73

Table 11
Town of Firestone 2027 Baseline and 2027 Alternate 1-2
Supply Available from Firestone Reservoir #1
for Government Irrigation

Year	Supply to Govt Irrigation Non-Potable, Percent of Demand
2027	20
2028	18
2029	17
2030	16
2031	33
2032	31
2033	30
2034	28
2035	41
2036	39
2037	38
2038	36
2039	35
2040	48
2041	46
2042	45
2043	43
2044	42
2045	53
2046	51
2047	50
2048	48
2049	58
2050	56

DRAFT Memorandum

To:	File 1527TWF05, Task 6 CWP Grant Task 1.6
From:	Gregg Ten Eyck, LRE
Reviewed by:	Jordan Furnans, PhD., LRE
Copy to:	Julie Pasillas, Dave Lindsay, Brad Grasmick
Date:	December 10, 2018
Project:	Colorado Water Plan Grant: Modeling Reservoir Operations
Subject:	Develop Peaking Model

I. Background

The purpose of this memorandum is to describe why the peaking model for daily operations that was contemplated at scoping is not being completed.

II. Water supplies do not generally vary on a daily basis

The main sources of water that are being modeled to meet treated water demands do not vary on a daily basis—the stored C-BT or Windy Gap Carter Lake, or the NISP water delivered from Glade Reservoir are available on demand.

The main source for non-potable irrigation is the Firestone Reservoir, and it too is available on demand.

Reservoir inflows do vary on a daily basis, however the current monthly modeling of reservoir inflows is adequate to represent performance of the reservoir.

III. St Vrain Water Authority Water Treatment Plant

When the original scope of work was prepared in the fall of 2017, the treatment plant configuration and operation was unknown, but it was assumed that the plant would operate to help meet peak day demands during the summer. At this stage of preliminary design the alluvial well field that will feed the plant and the design of the plant both lead us to conclude that the rates of daily operation of the water treatment plants will not vary enough, or vary quickly enough to warrant daily modeling.

IV. Budget Implications

The original budget of $9,561.00, which included $4,800.00 from the grant from CWCB, has not been used, and it will not be used. We propose that the total project budget and the CWCB budget be reduced accordingly.

	Model Configuration	**1**	*Baseline 2027*
Reservior Modeling	Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	**1**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
	Alternate Scenario Modeling	**1**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	**0**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	**0**	Option: 1 = On, 0 = Off
	Future Warming	**1**	°C (Limit 0-10)
	Flow Reduction Rate	**10**	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	**20**	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	**5,350**	Units
	Surcharge for Central Weld WCD	**1.2**	
	Surcharge for Left Hand WD	**1.1**	
	TDS Value for CBT Water	**60**	mg/L TDS
	Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	**70**	%
	Percentage of Units in Fixed Quota Program for Option #3	**75**	%
	Amount available for January 1988	**4,000**	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	**5**	Units
	Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	**11**	
	City of Loveland Lease Quantity	**500**	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	**1.2**	
	Surcharge forLeft Hand WD Lease Usage	**1.1**	
	Surcharge for Central Weld WCD WG Usage	**1.2**	
	Surcharge for Left Hand WD WG Usage	**1.1**	
	TDS Value for WG Water	**60**	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	**95**	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**3.97**	Shares
	Lower Boulder Ditch Common Shares	**6.667**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**2.41**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**0**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**0**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**65**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**363**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

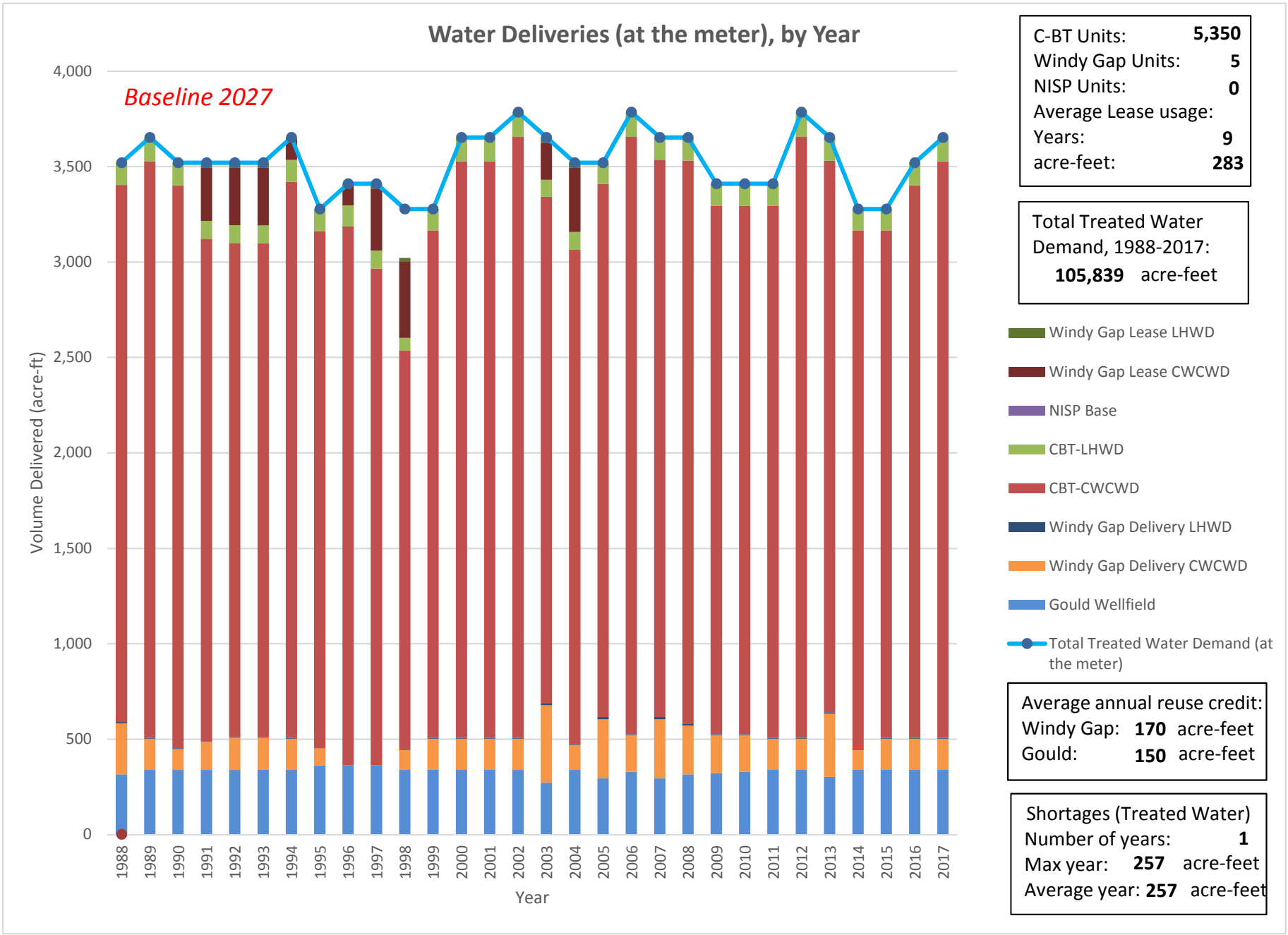
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

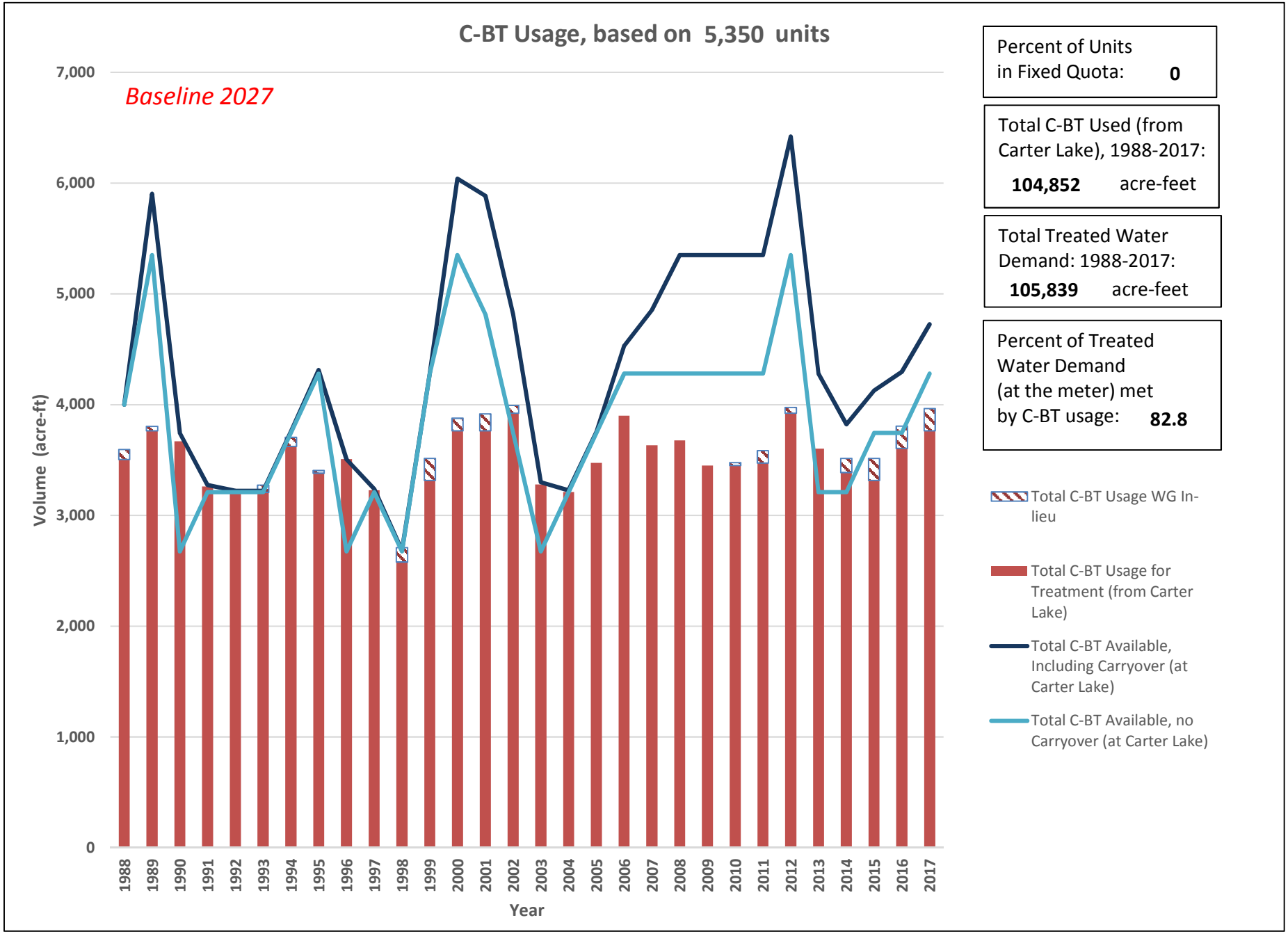
Modeled Water Source Priority Controls

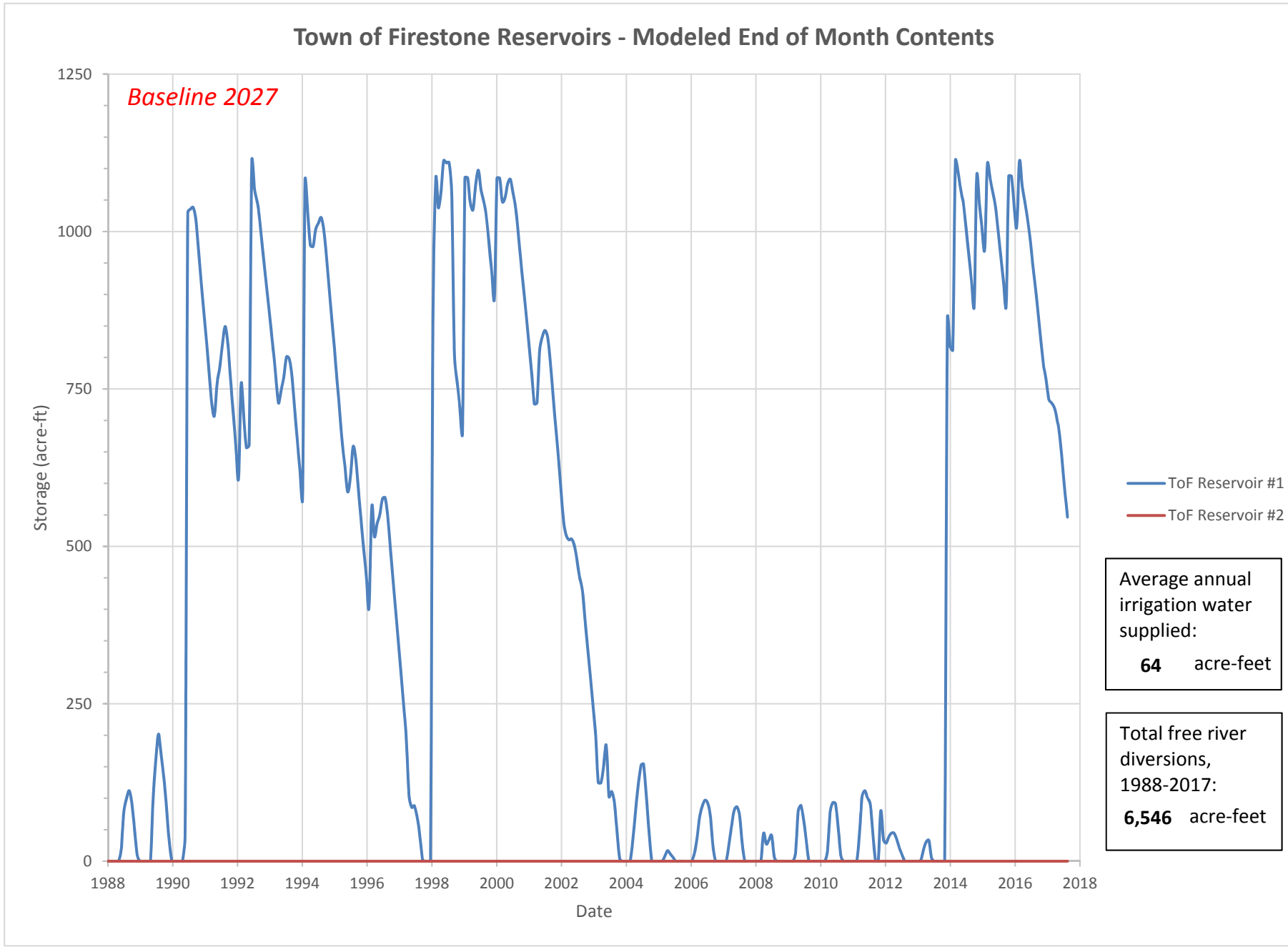
		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights


Water Deliveries (at the meter), by Year
Baseline 2027
Volume Delivered (acre-ft)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Windy Gap Lease LHWD
Windy Gap Lease CWCWD
NISP Base
CBT-LHWD
CBT-CWCWD
Windy Gap Delivery LHWD
Windy Gap Delivery CWCWD
Gould Wellfield
Total Treated Water Demand (at the meter)
C-BT Units: 5,350
Windy Gap Units: 5
NISP Units: 0
Average Lease usage:
Years: 9
acre-feet: 283
Total Treated Water Demand, 1988-2017:
105,839 acre-feet
Average annual reuse credit:
Windy Gap: 170 acre-feet
Gould: 150 acre-feet
Shortages (Treated Water)
Number of years: 1
Max year: 257 acre-feet
Average year: 257 acre-feet


C-BT Usage, based on 5,350 units
Baseline 2027
Volume (acre-ft)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 104,852 acre-feet
Total Treated Water Demand: 1988-2017: 105,839 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 82.8
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Baseline 2027
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
64 acre-feet
Total free river diversions, 1988-2017:
6,546 acre-feet

	Model Configuration	**2**	*Alternate 1-1 (2027)*
Reservior Modeling	Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	**1**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
	Alternate Scenario Modeling	**2**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	**0**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	**0**	Option: 1 = On, 0 = Off
	Future Warming	**1**	°C (Limit 0-10)
	Flow Reduction Rate	**10**	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	**30**	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	**5,350**	Units
	Surcharge for Central Weld WCD	**1.2**	
	Surcharge for Left Hand WD	**1.1**	
	TDS Value for CBT Water	**60**	mg/L TDS
	Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	**70**	%
	Percentage of Units in Fixed Quota Program for Option #3	**75**	%
	Amount available for January 1988	**4,000**	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	**5**	Units
	Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	**11**	
	City of Loveland Lease Quantity	**500**	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	**1.2**	
	Surcharge forLeft Hand WD Lease Usage	**1.1**	
	Surcharge for Central Weld WCD WG Usage	**1.2**	
	Surcharge for Left Hand WD WG Usage	**1.1**	
	TDS Value for WG Water	**60**	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	**95**	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**12**	Shares
	Lower Boulder Ditch Common Shares	**16**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**8**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**0**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**0**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**100**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**654**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

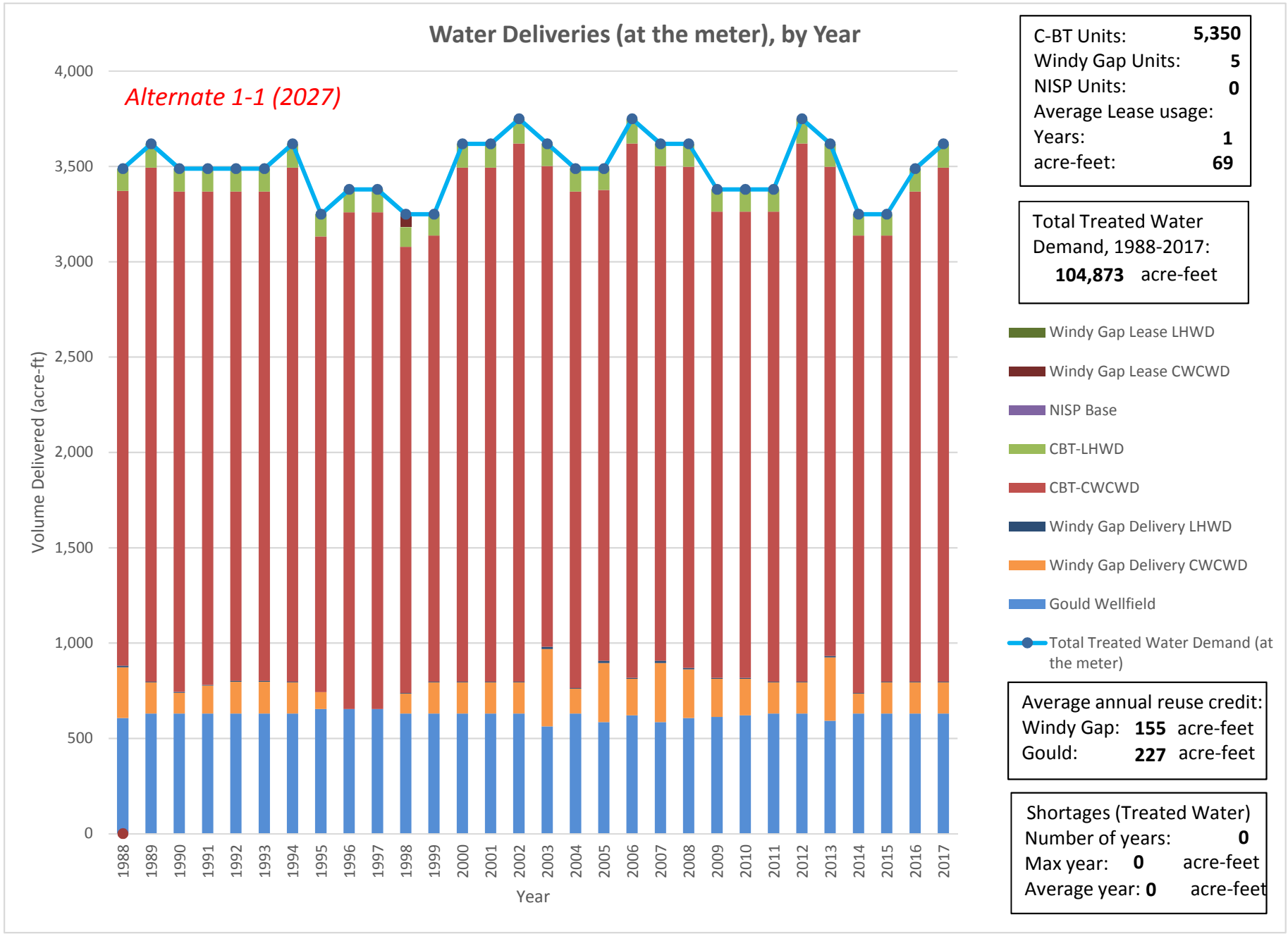
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

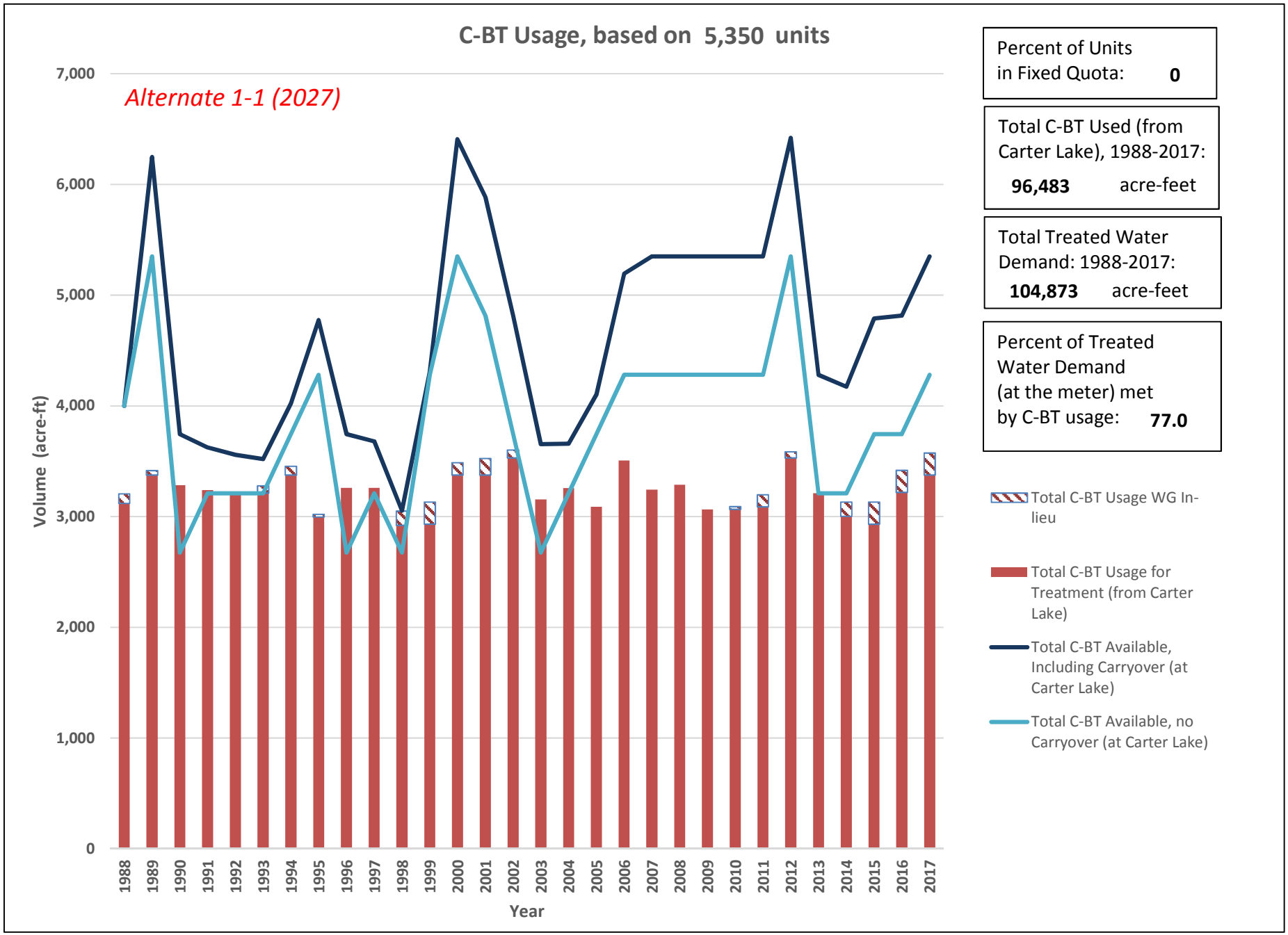
Modeled Water Source Priority Controls

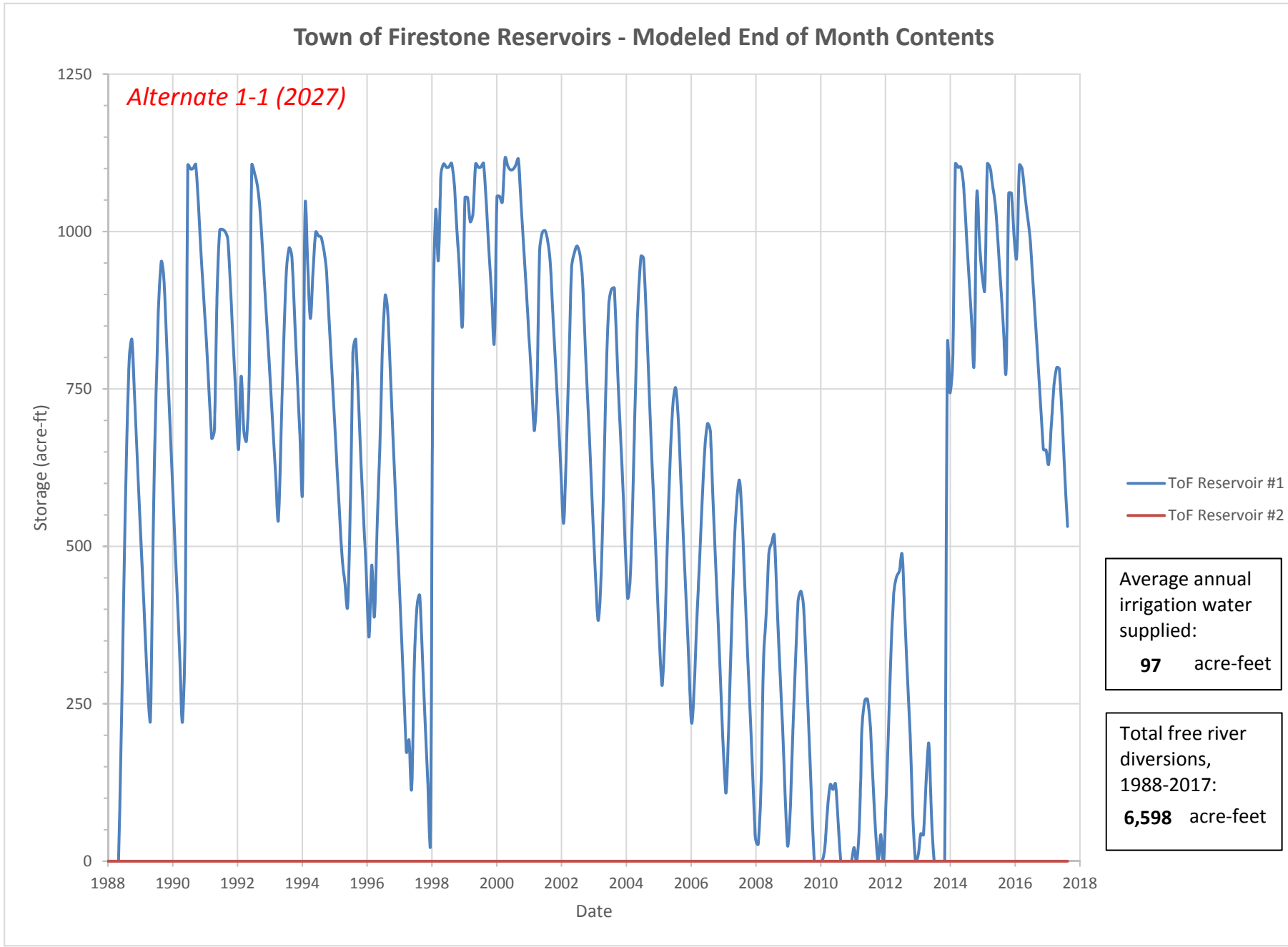
		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights


Water Deliveries (at the meter), by Year
Alternate 1-1 (2027)
Volume Delivered (acre-ft)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
C-BT Units: 5,350
Windy Gap Units: 5
NISP Units: 0
Average Lease usage:
Years: 1
acre-feet: 69
Total Treated Water Demand, 1988-2017:
104,873 acre-feet
Windy Gap Lease LHWD
Windy Gap Lease CWCWD
NISP Base
CBT-LHWD
CBT-CWCWD
Windy Gap Delivery LHWD
Windy Gap Delivery CWCWD
Gould Wellfield
Total Treated Water Demand (at the meter)
Average annual reuse credit:
Windy Gap: 155 acre-feet
Gould: 227 acre-feet
Shortages (Treated Water)
Number of years: 0
Max year: 0 acre-feet
Average year: 0 acre-feet


C-BT Usage, based on 5,350 units
Alternate 1-1 (2027)
Volume (acre-ft)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 96,483 acre-feet
Total Treated Water Demand: 1988-2017: 104,873 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 77.0
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 1-1 (2027)
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
97 acre-feet
Total free river diversions, 1988-2017:
6,598 acre-feet

	Model Configuration	**3**	*Alternate 1-2 (2027)*
Reservior Modeling	Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	**1**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
	Alternate Scenario Modeling	**3**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	**0**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	**0**	Option: 1 = On, 0 = Off
	Future Warming	**1**	°C (Limit 0-10)
	Flow Reduction Rate	**10**	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	**60**	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	**5,350**	Units
	Surcharge for Central Weld WCD	**1.2**	
	Surcharge for Left Hand WD	**1.1**	
	TDS Value for CBT Water	**60**	mg/L TDS
	Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	**70**	%
	Percentage of Units in Fixed Quota Program for Option #3	**75**	%
	Amount available for January 1988	**4,000**	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	**5**	Units
	Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	**11**	
	City of Loveland Lease Quantity	**500**	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	**1.2**	
	Surcharge forLeft Hand WD Lease Usage	**1.1**	
	Surcharge for Central Weld WCD WG Usage	**1.2**	
	Surcharge for Left Hand WD WG Usage	**1.1**	
	TDS Value for WG Water	**60**	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	**95**	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**12**	Shares
	Lower Boulder Ditch Common Shares	**16**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**8**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**0**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**0**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**200**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**992**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

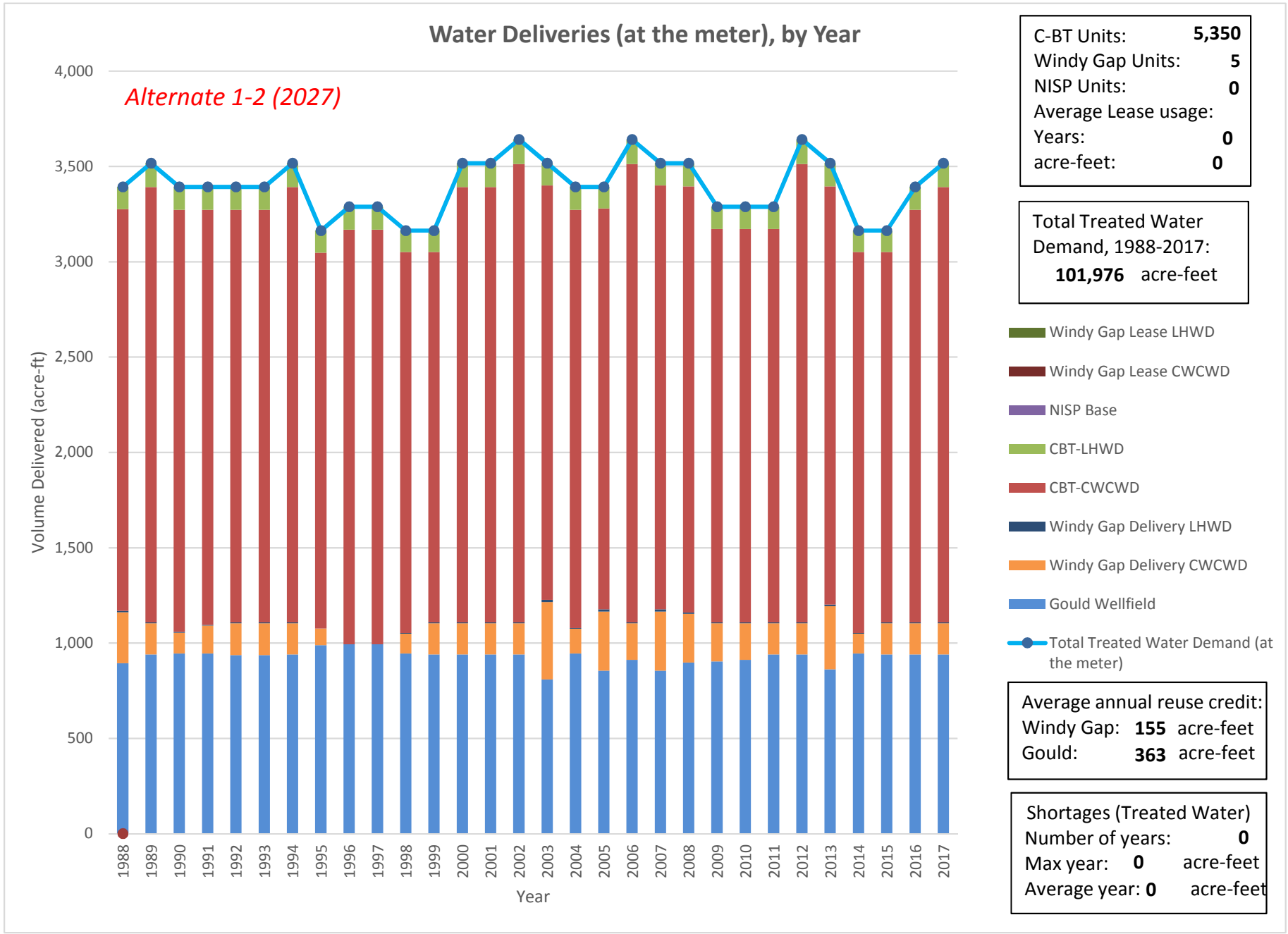
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

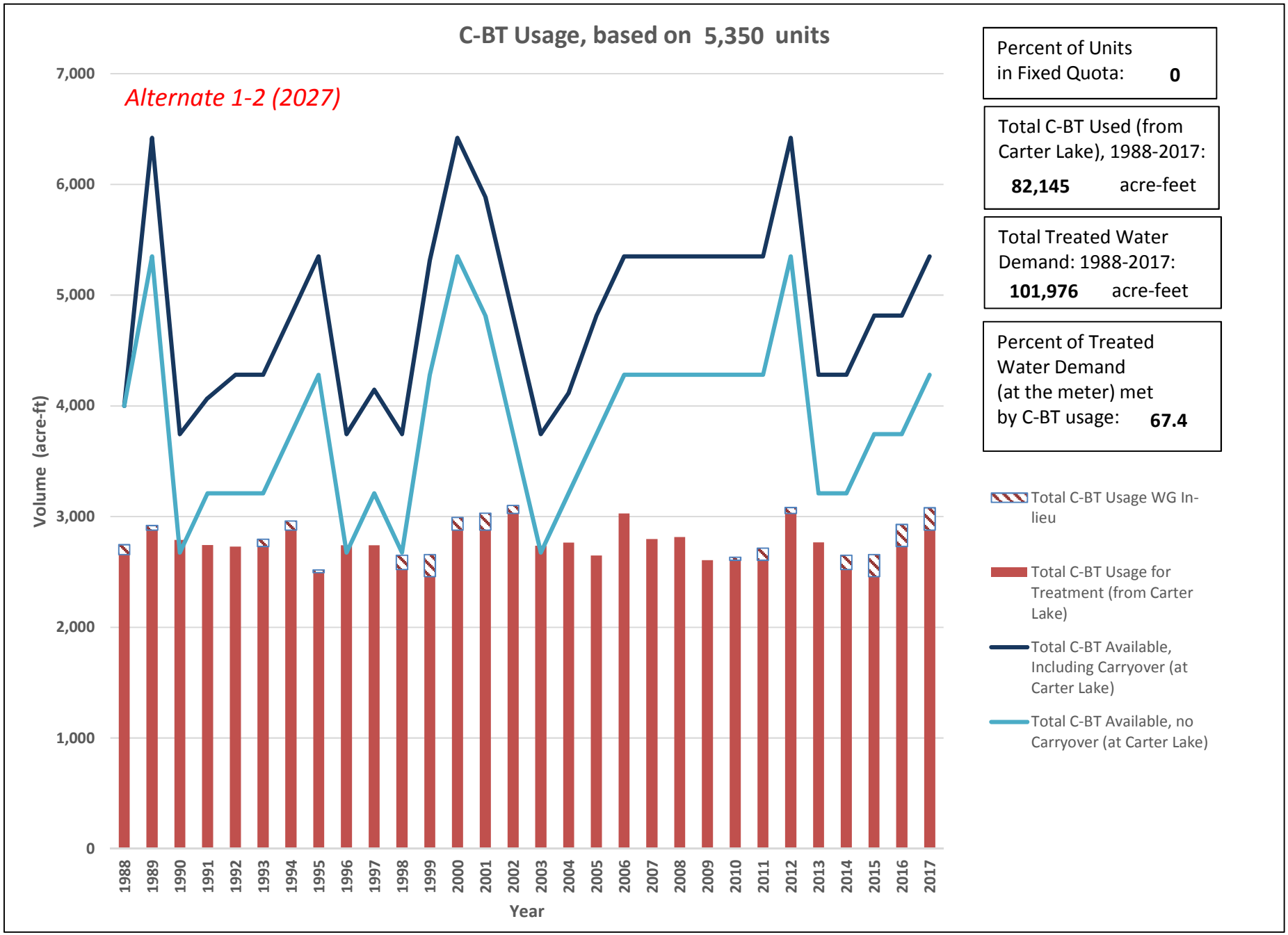
Modeled Water Source Priority Controls

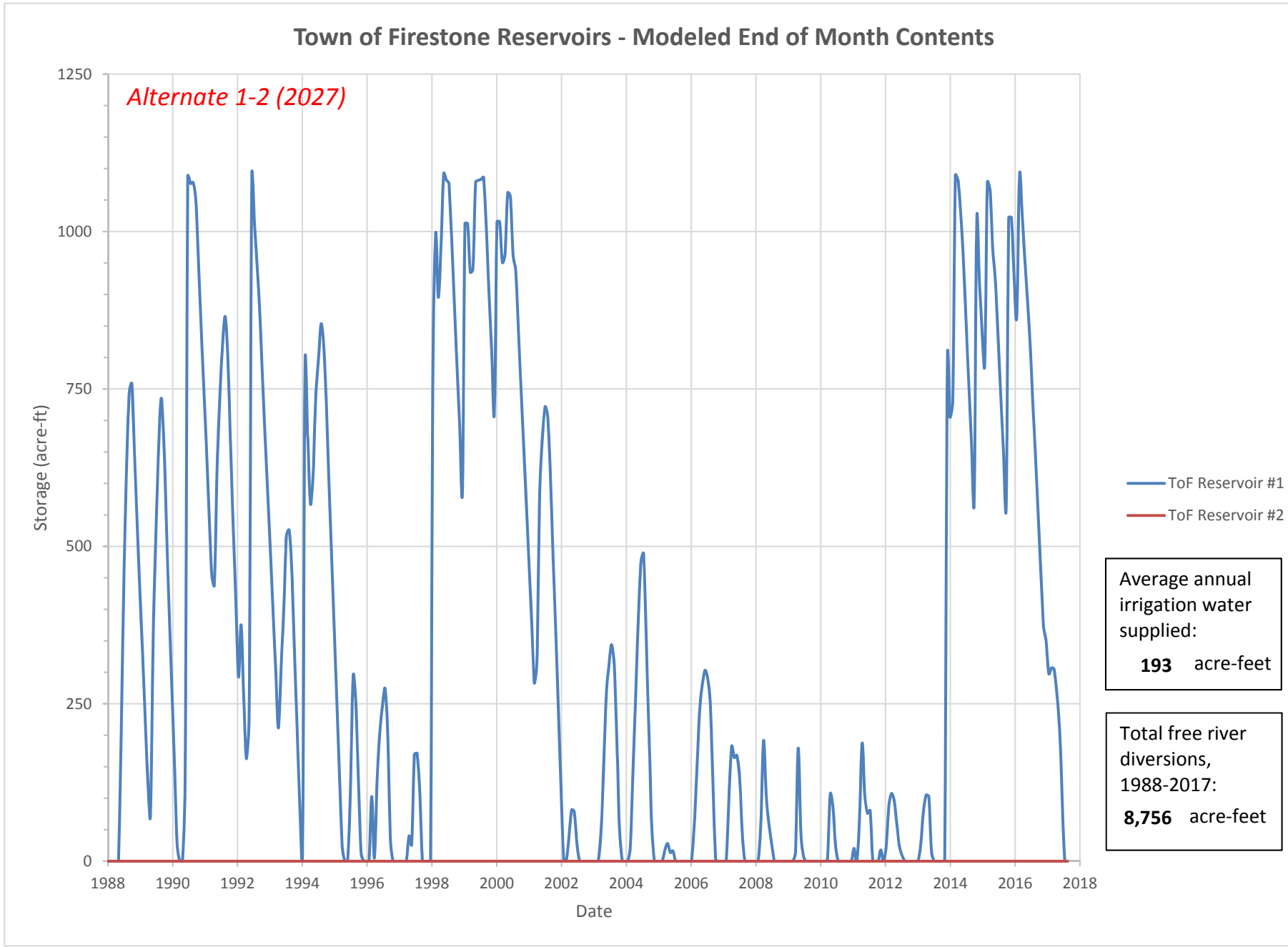
		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights


Water Deliveries (at the meter), by Year
Alternate 1-2 (2027)
Volume Delivered (acre-ft)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
C-BT Units: 5,350
Windy Gap Units: 5
NISP Units: 0
Average Lease usage:
Years: 0
acre-feet: 0
Total Treated Water Demand, 1988-2017:
101,976 acre-feet
Windy Gap Lease LHWD
Windy Gap Lease CWCWD
NISP Base
CBT-LHWD
CBT-CWCWD
Windy Gap Delivery LHWD
Windy Gap Delivery CWCWD
Gould Wellfield
Total Treated Water Demand (at the meter)
Average annual reuse credit:
Windy Gap: 155 acre-feet
Gould: 363 acre-feet
Shortages (Treated Water)
Number of years: 0
Max year: 0 acre-feet
Average year: 0 acre-feet


C-BT Usage, based on 5,350 units
Alternate 1-2 (2027)
Volume (acre-ft)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 82,145 acre-feet
Total Treated Water Demand: 1988-2017: 101,976 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 67.4
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 1-2 (2027)
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
193 acre-feet
Total free river diversions, 1988-2017:
8,756 acre-feet

	Model Configuration	4	*Baseline 2050*
Reservior Modeling	Initial Storage within ToF Reservoir #1	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	0	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	0	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	1	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	1	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	0	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	0	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	2	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	2050	Options: 2027 through 2050
	Alternate Scenario Modeling	1	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	0	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	0	Option: 1 = On, 0 = Off
	Future Warming	1	°C (Limit 0-10)
	Flow Reduction Rate	10	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	25	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	0	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	5,450	Units
	Surcharge for Central Weld WCD	1.2	
	Surcharge for Left Hand WD	1.1	
	TDS Value for CBT Water	60	mg/L TDS
	Quota Options	1	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	70	%
	Percentage of Units in Fixed Quota Program for Option #3	75	%
	Amount available for January 1988	4,000	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	5	Units
	Windy Gap Modeled Year	2	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	11	
	City of Loveland Lease Quantity	0	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	1.2	
	Surcharge forLeft Hand WD Lease Usage	1.1	
	Surcharge for Central Weld WCD WG Usage	1.2	
	Surcharge for Left Hand WD WG Usage	1.1	
	TDS Value for WG Water	60	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	95	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**3.97**	Shares
	Lower Boulder Ditch Common Shares	**6.667**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**2.41**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**0**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**200**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**496**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

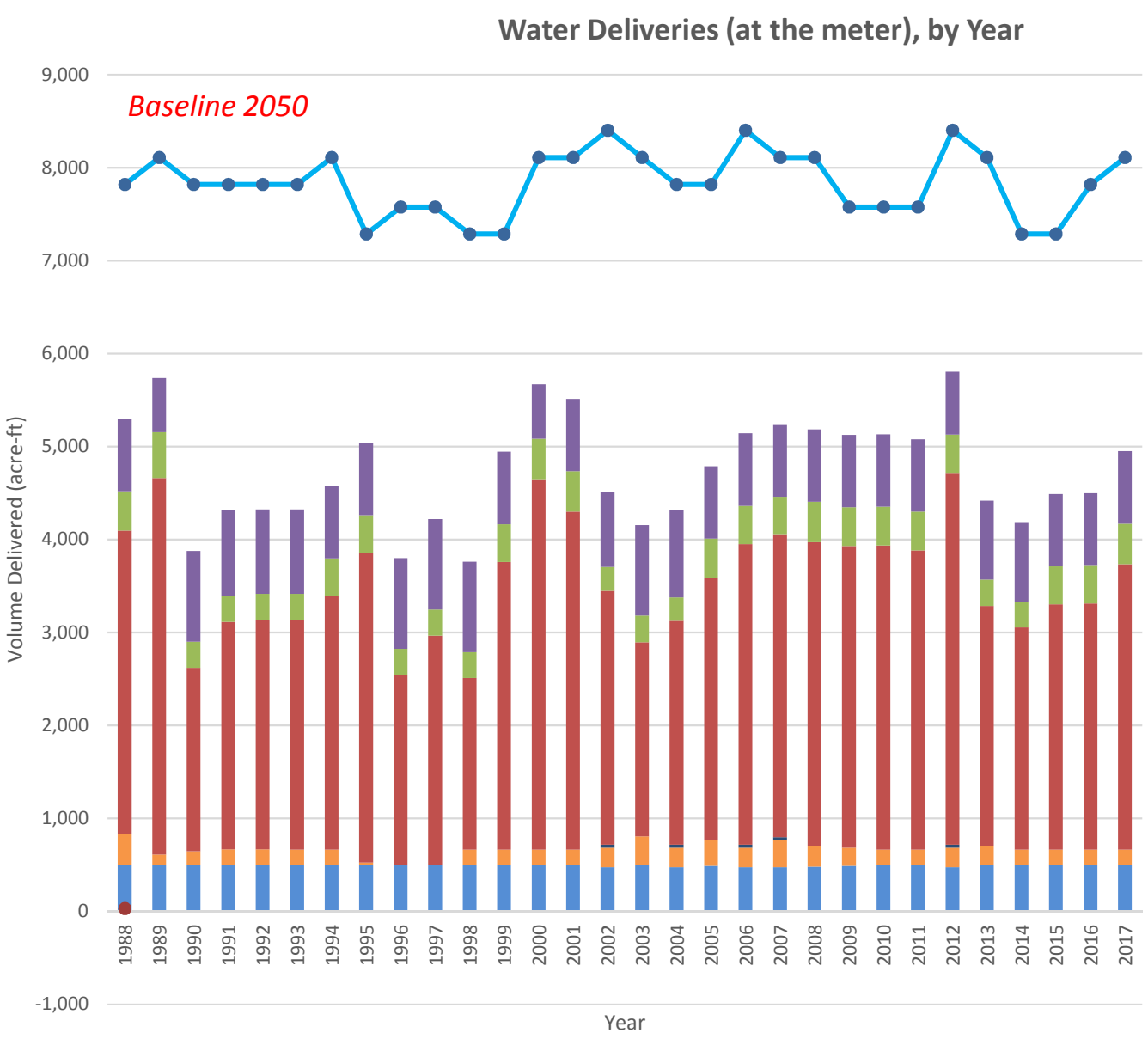
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

Modeled Water Source Priority Controls

		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights



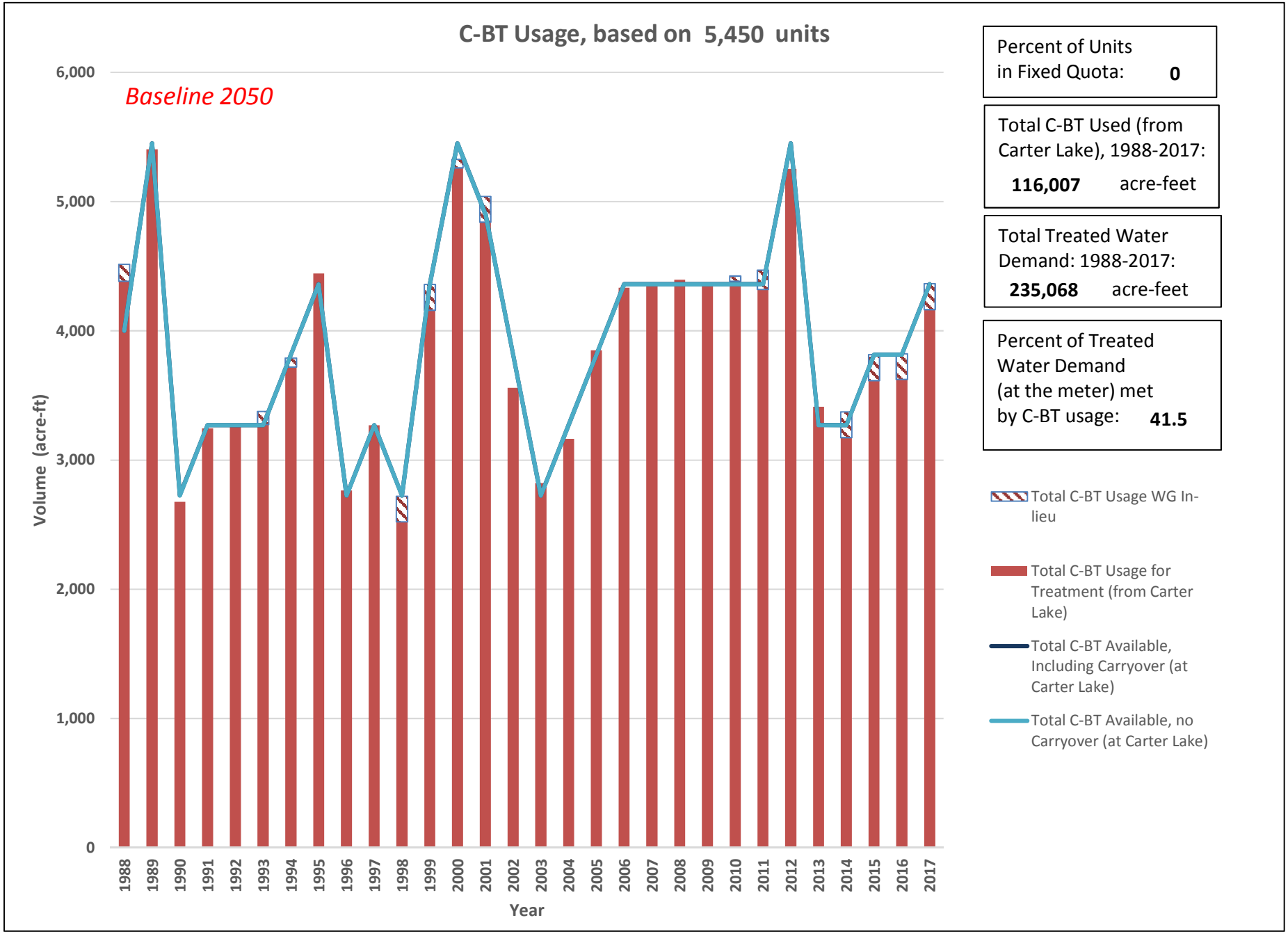
C-BT Units:	**5,450**
Windy Gap Units:	**5**
NISP Units:	**1,300**
Average Lease usage:	
Years:	**0**
acre-feet:	**0**

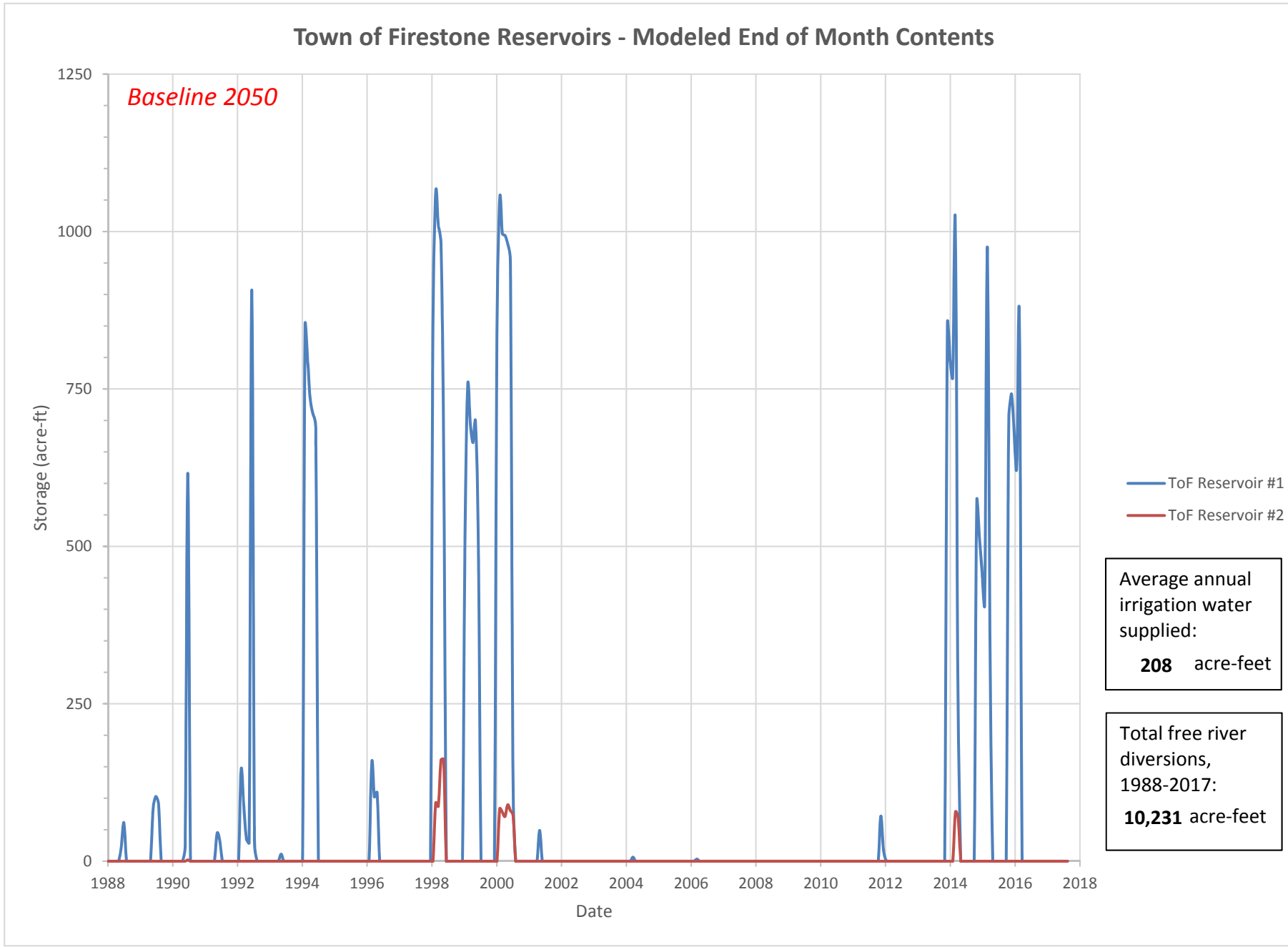
Total Treated Water Demand, 1988-2017:
235,068 acre-feet

- Windy Gap Lease LHWD
- Windy Gap Lease CWCWD
- NISP Base
- CBT-LHWD
- CBT-CWCWD
- Windy Gap Delivery LHWD
- Windy Gap Delivery CWCWD
- Gould Wellfield
- Total Treated Water Demand (at the meter)

Average annual reuse credit:
Windy Gap: **141** acre-feet
Gould: **205** acre-feet

Shortages (Treated Water)
Number of years: **30**
Max year: **3,955** acre-feet
Average year: **3,089** acre-feet


C-BT Usage, based on 5,450 units
Baseline 2050
Volume (acre-ft)
6,000
5,000
4,000
3,000
2,000
1,000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 116,007 acre-feet
Total Treated Water Demand: 1988-2017: 235,068 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 41.5
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Baseline 2050
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
208 acre-feet
Total free river diversions, 1988-2017:
10,231 acre-feet

	Model Configuration	**5**	*Alternate 2-1 (2050)*
Reservior Modeling	Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	**1**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	**2**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
	Alternate Scenario Modeling	**2**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	**0**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	**0**	Option: 1 = On, 0 = Off
	Future Warming	**1**	°C (Limit 0-10)
	Flow Reduction Rate	**10**	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	**35**	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	**5,450**	Units
	Surcharge for Central Weld WCD	**1.2**	
	Surcharge for Left Hand WD	**1.1**	
	TDS Value for CBT Water	**60**	mg/L TDS
	Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	**70**	%
	Percentage of Units in Fixed Quota Program for Option #3	**75**	%
	Amount available for January 1988	**4,000**	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	**5**	Units
	Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	**11**	
	City of Loveland Lease Quantity	**0**	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	**1.2**	
	Surcharge forLeft Hand WD Lease Usage	**1.1**	
	Surcharge for Central Weld WCD WG Usage	**1.2**	
	Surcharge for Left Hand WD WG Usage	**1.1**	
	TDS Value for WG Water	**60**	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	**95**	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**16**	Shares
	Lower Boulder Ditch Common Shares	**24**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**24**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**1,300**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**300**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**992**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

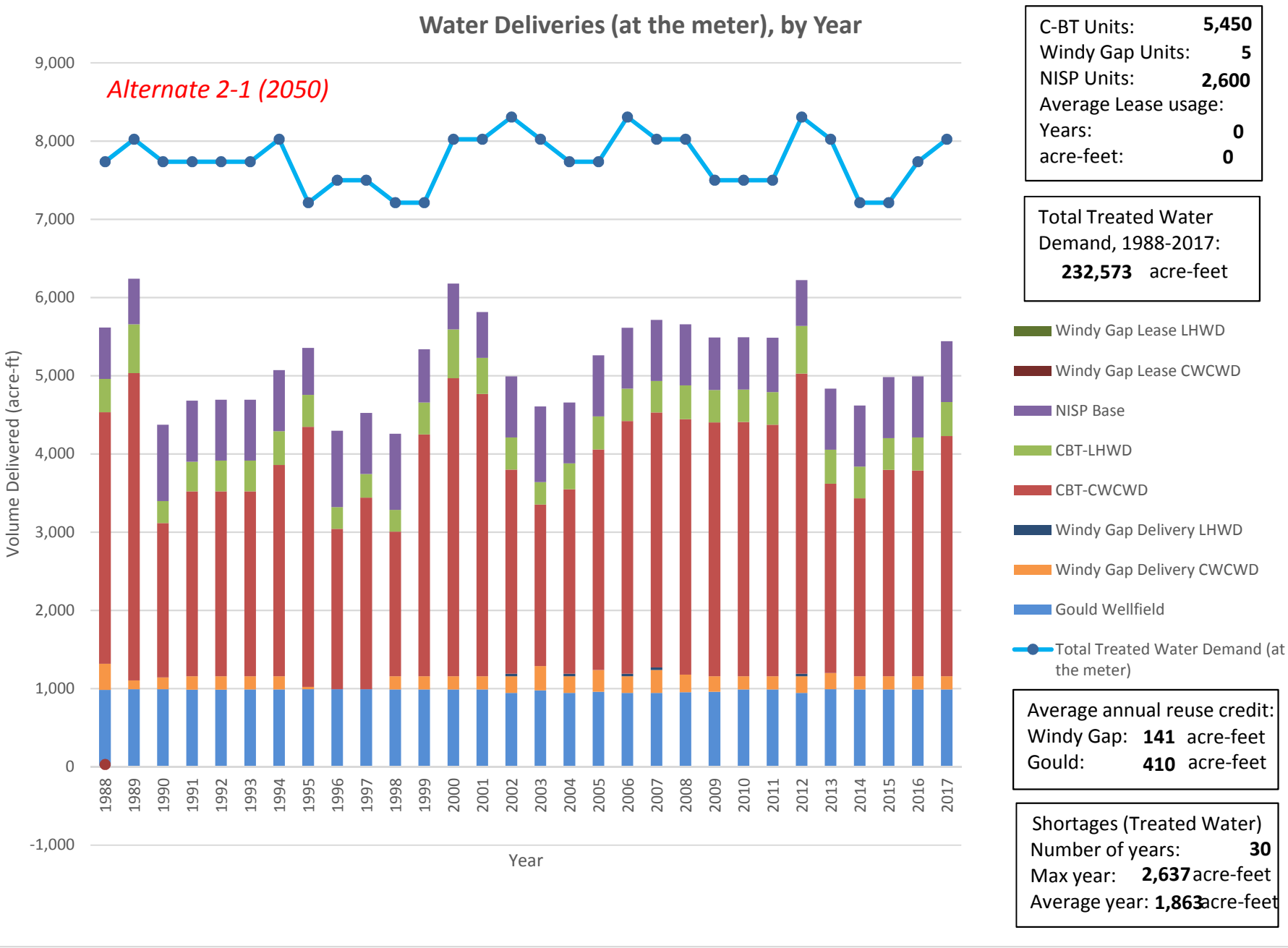
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

Modeled Water Source Priority Controls

		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights

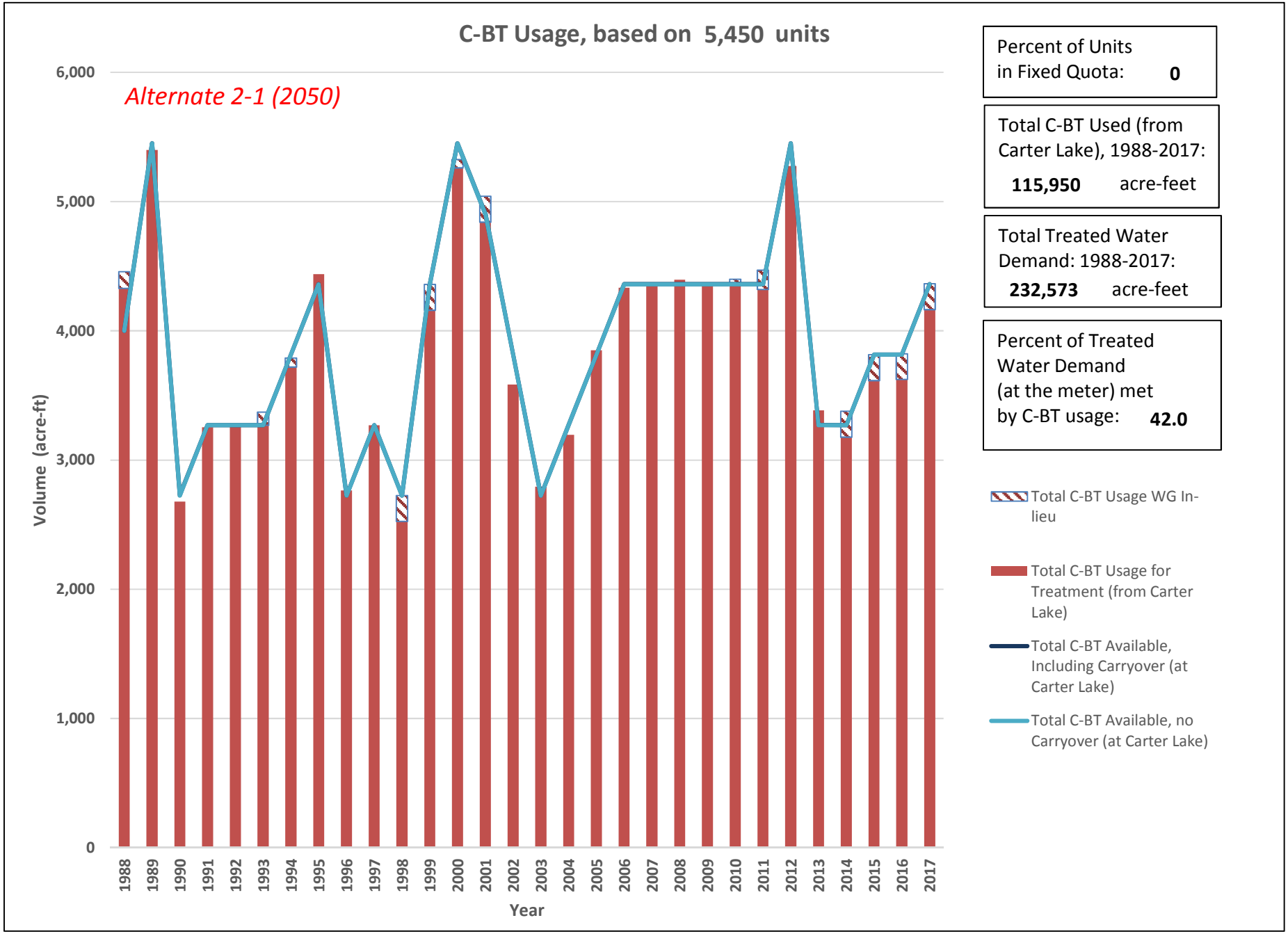


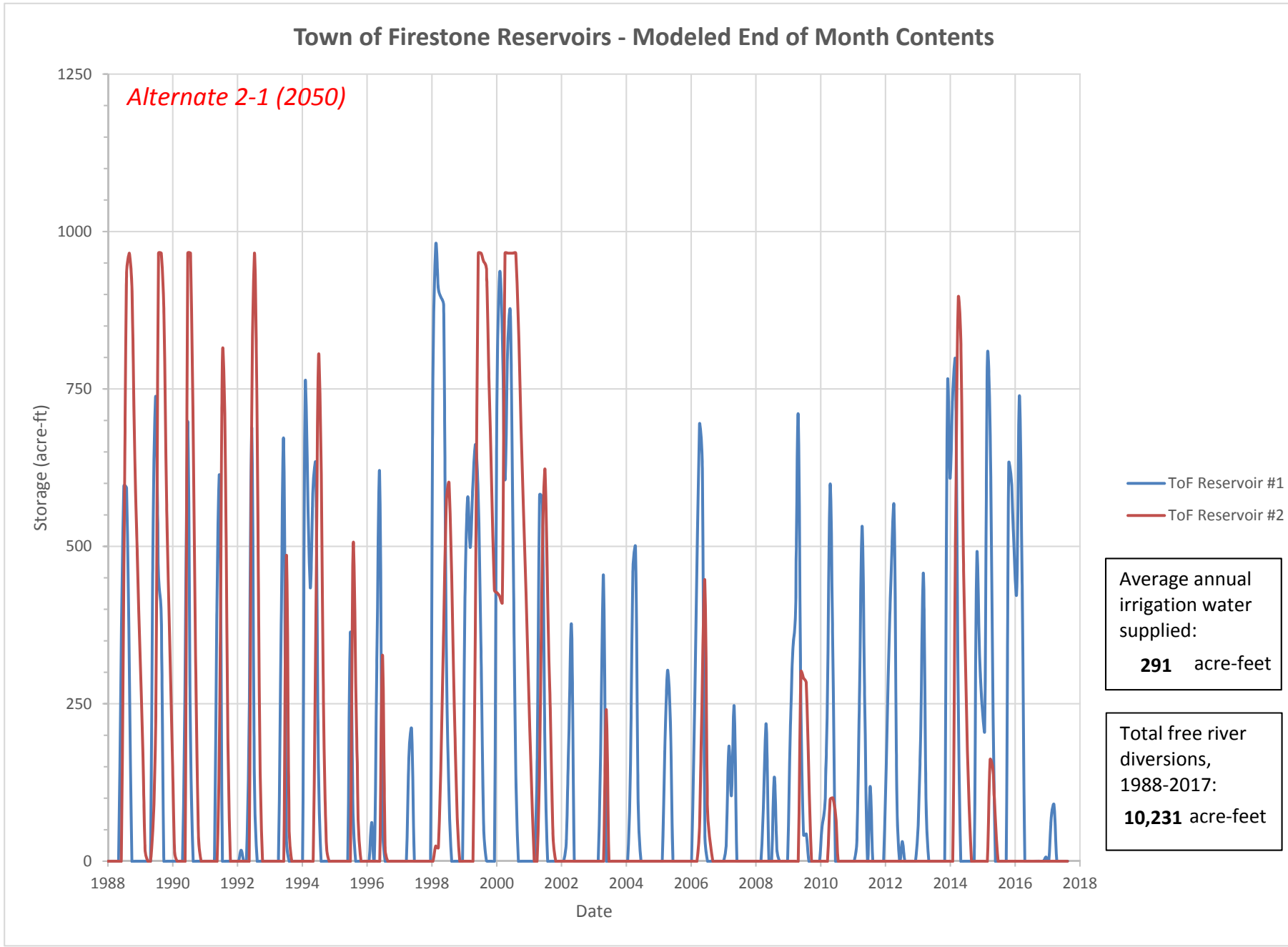
C-BT Units: **5,450**
Windy Gap Units: **5**
NISP Units: **2,600**
Average Lease usage:
Years: **0**
acre-feet: **0**

Total Treated Water Demand, 1988-2017:
232,573 acre-feet

Average annual reuse credit:
Windy Gap: **141** acre-feet
Gould: **410** acre-feet

Shortages (Treated Water)
Number of years: **30**
Max year: **2,637** acre-feet
Average year: **1,863** acre-feet


C-BT Usage, based on 5,450 units
Alternate 2-1 (2050)
Volume (acre-ft)
6,000
5,000
4,000
3,000
2,000
1,000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 115,950 acre-feet
Total Treated Water Demand: 1988-2017: 232,573 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 42.0
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 2-1 (2050)
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
291 acre-feet
Total free river diversions, 1988-2017:
10,231 acre-feet

	Model Configuration	**6**	*Alternate 2-2 (2050)*
Reservior Modeling	Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	**1**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	**2**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
	Alternate Scenario Modeling	**3**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	**0**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	**0**	Option: 1 = On, 0 = Off
	Future Warming	**1**	°C (Limit 0-10)
	Flow Reduction Rate	**10**	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	**60**	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	**5,450**	Units
	Surcharge for Central Weld WCD	**1.2**	
	Surcharge for Left Hand WD	**1.1**	
	TDS Value for CBT Water	**60**	mg/L TDS
	Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	**70**	%
	Percentage of Units in Fixed Quota Program for Option #3	**75**	%
	Amount available for January 1988	**4,000**	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	**5**	Units
	Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	**11**	
	City of Loveland Lease Quantity	**0**	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	**1.2**	
	Surcharge forLeft Hand WD Lease Usage	**1.1**	
	Surcharge for Central Weld WCD WG Usage	**1.2**	
	Surcharge for Left Hand WD WG Usage	**1.1**	
	TDS Value for WG Water	**60**	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	**95**	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**14**	Shares
	Lower Boulder Ditch Common Shares	**20**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**20**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**1,900**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**493**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**1985**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

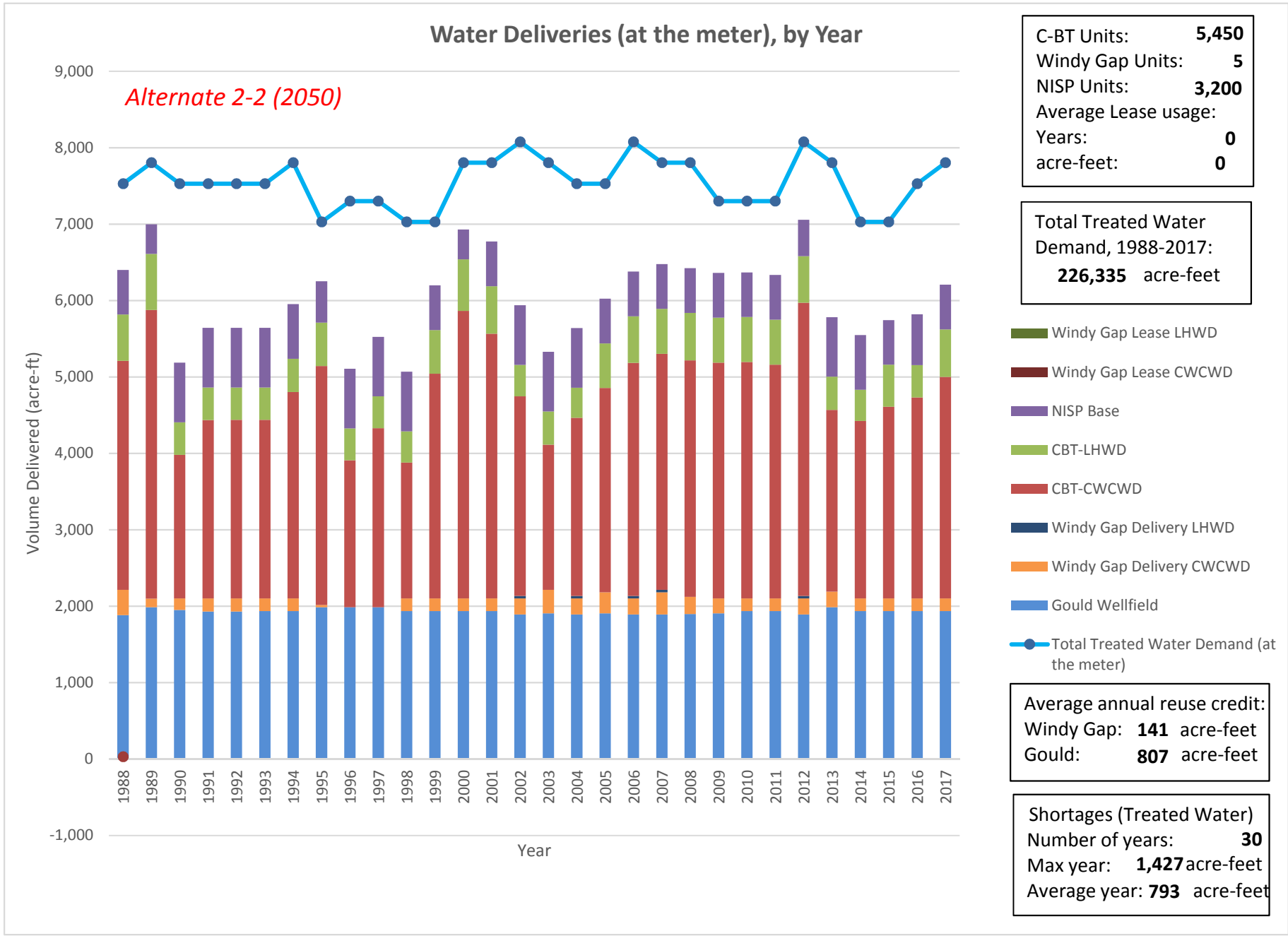
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

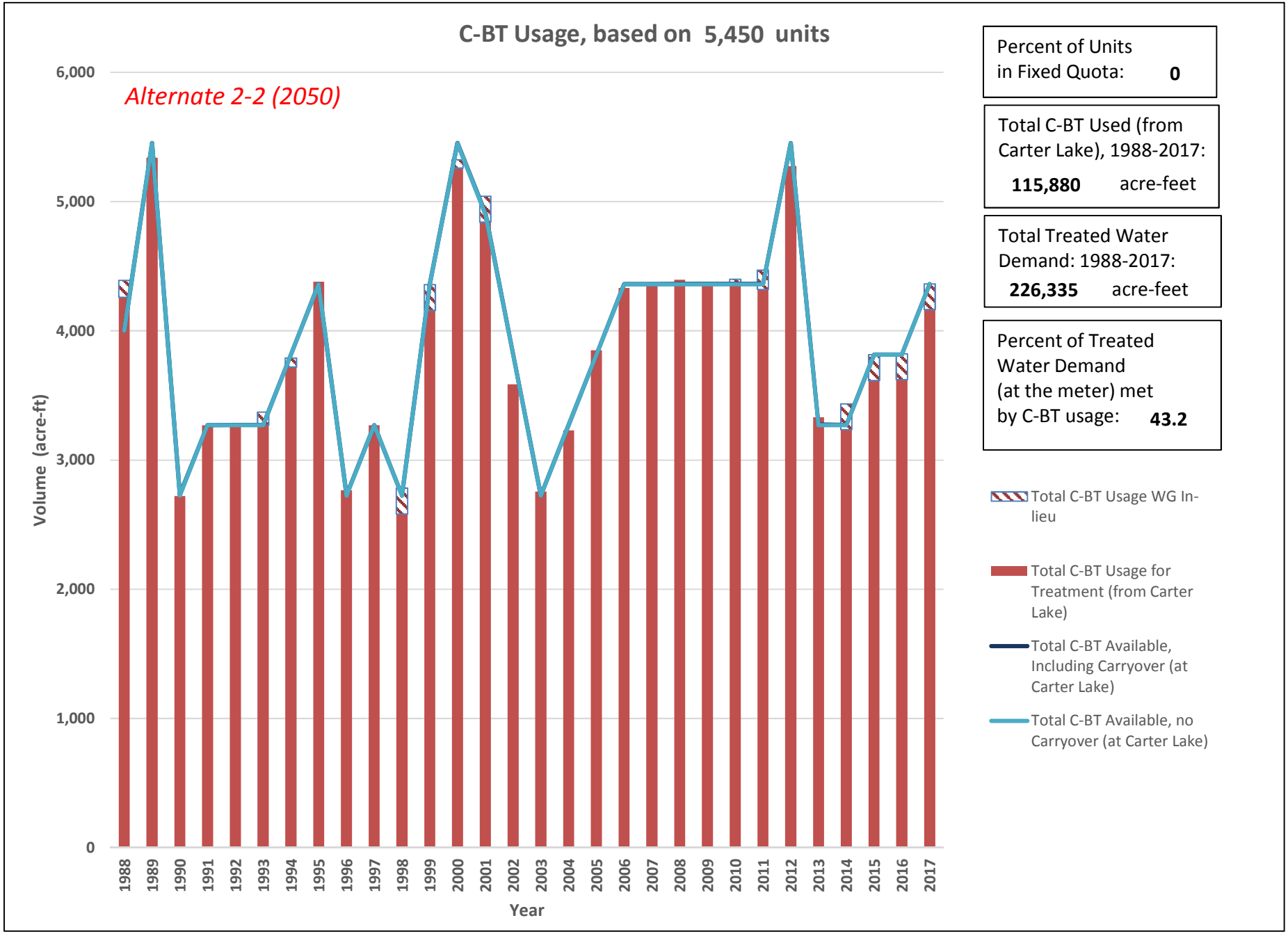
Modeled Water Source Priority Controls

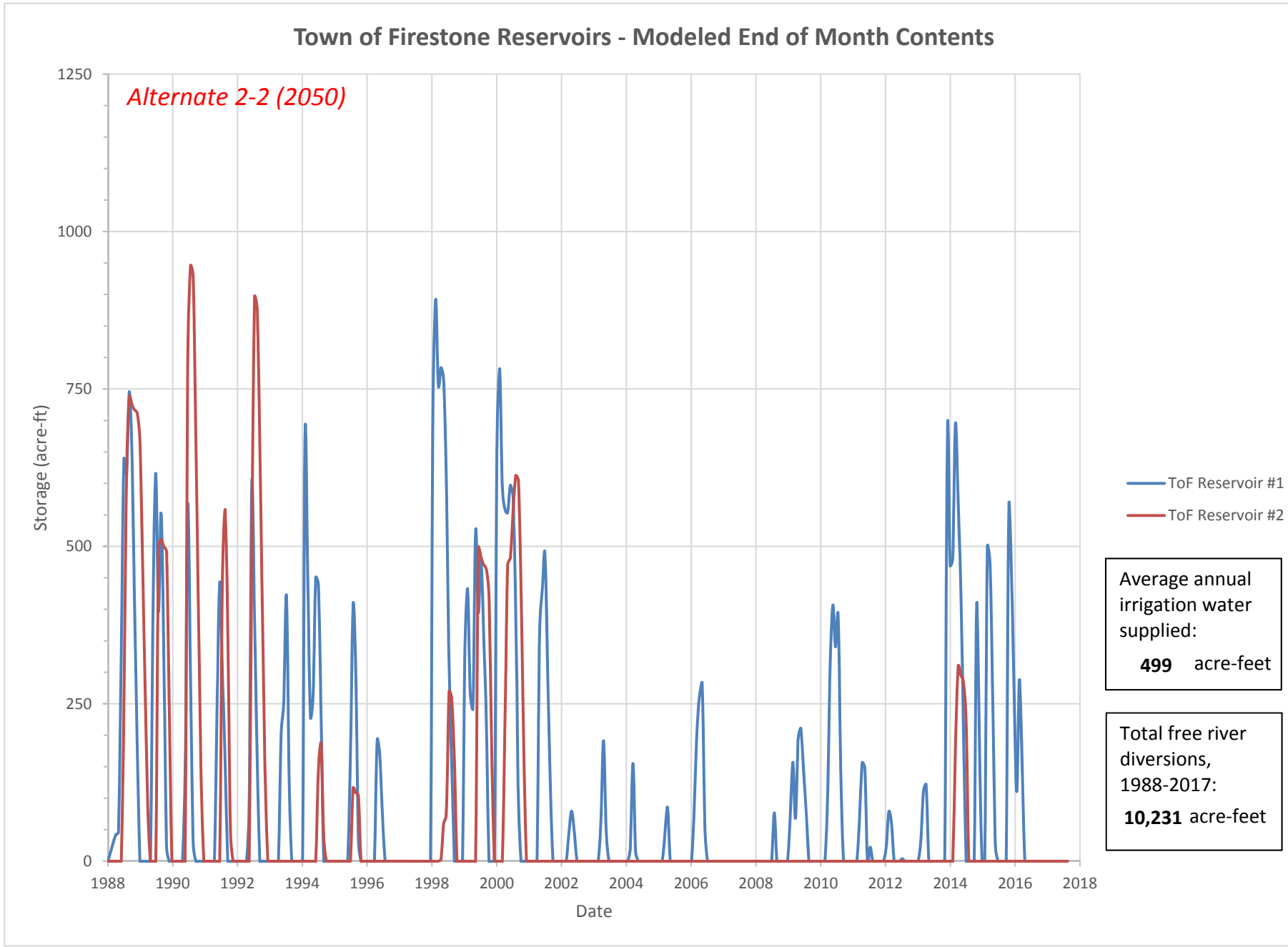
		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights


Water Deliveries (at the meter), by Year
Alternate 2-2 (2050)
Volume Delivered (acre-ft)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-1,000
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
C-BT Units: 5,450
Windy Gap Units: 5
NISP Units: 3,200
Average Lease usage:
Years: 0
acre-feet: 0
Total Treated Water Demand, 1988-2017:
226,335 acre-feet
Windy Gap Lease LHWD
Windy Gap Lease CWCWD
NISP Base
CBT-LHWD
CBT-CWCWD
Windy Gap Delivery LHWD
Windy Gap Delivery CWCWD
Gould Wellfield
Total Treated Water Demand (at the meter)
Average annual reuse credit:
Windy Gap: 141 acre-feet
Gould: 807 acre-feet
Shortages (Treated Water)
Number of years: 30
Max year: 1,427 acre-feet
Average year: 793 acre-feet


C-BT Usage, based on 5,450 units
Alternate 2-2 (2050)
Volume (acre-ft)
6,000
5,000
4,000
3,000
2,000
1,000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 115,880 acre-feet
Total Treated Water Demand: 1988-2017: 226,335 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 43.2
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 2-2 (2050)
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
499 acre-feet
Total free river diversions, 1988-2017:
10,231 acre-feet

	Model Configuration	7	*Baseline 2050 w/ Climate Change*
Reservior Modeling	Initial Storage within ToF Reservoir #1	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	0	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	0	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	1	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	1	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	0	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	0	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	2	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	2050	Options: 2027 through 2050
	Alternate Scenario Modeling	1	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	0	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	1	Option: 1 = On, 0 = Off
	Future Warming	2	°C (Limit 0-10)
	Flow Reduction Rate	10	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	25	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	0	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	5,450	Units
	Surcharge for Central Weld WCD	1.2	
	Surcharge for Left Hand WD	1.1	
	TDS Value for CBT Water	60	mg/L TDS
	Quota Options	1	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	70	%
	Percentage of Units in Fixed Quota Program for Option #3	75	%
	Amount available for January 1988	4,000	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	5	Units
	Windy Gap Modeled Year	2	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	11	
	City of Loveland Lease Quantity	0	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	1.2	
	Surcharge forLeft Hand WD Lease Usage	1.1	
	Surcharge for Central Weld WCD WG Usage	1.2	
	Surcharge for Left Hand WD WG Usage	1.1	
	TDS Value for WG Water	60	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	95	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**3.97**	Shares
	Lower Boulder Ditch Common Shares	**6.667**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**2.41**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**0**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**200**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**496**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

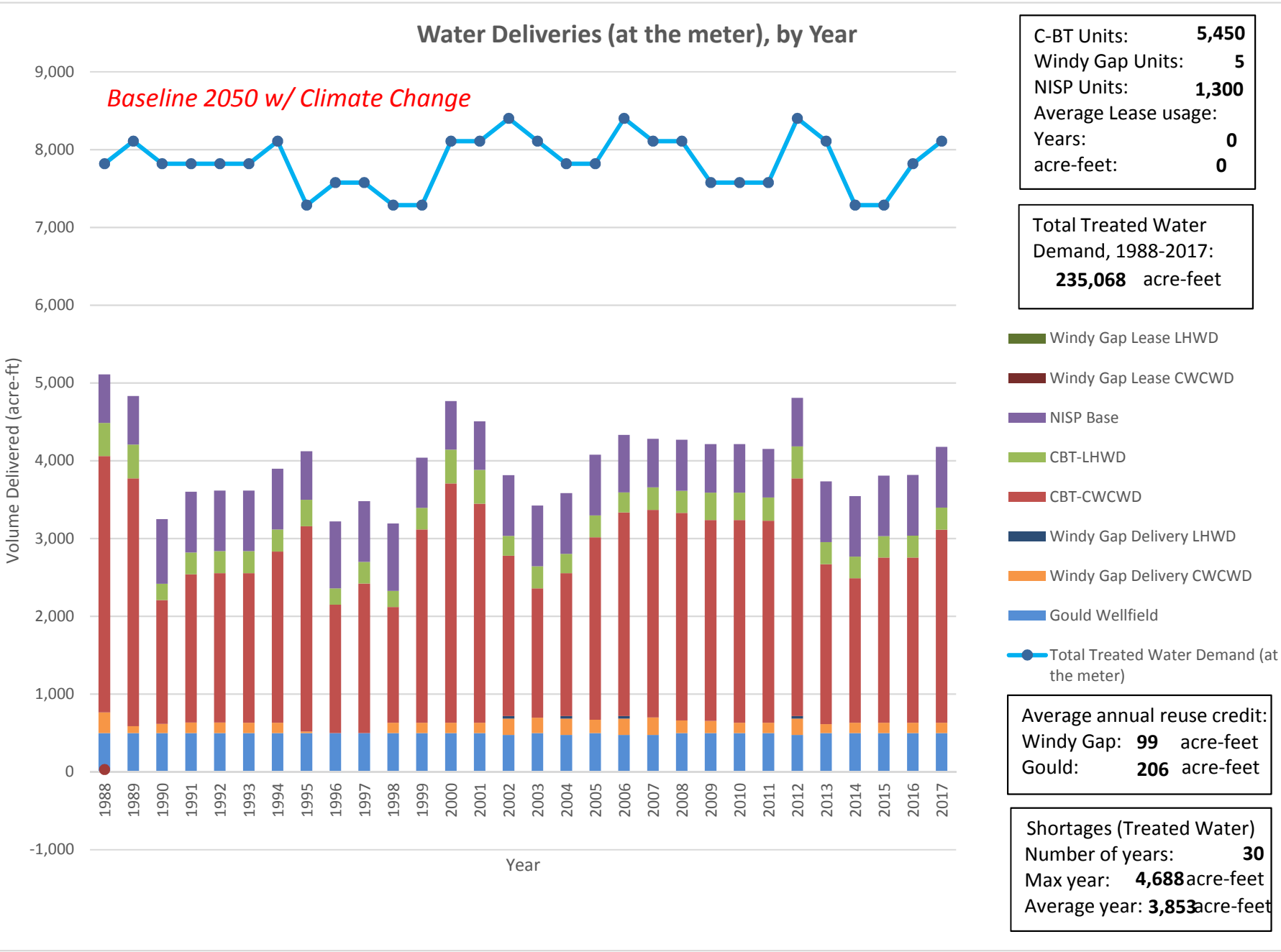
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

Modeled Water Source Priority Controls

		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights

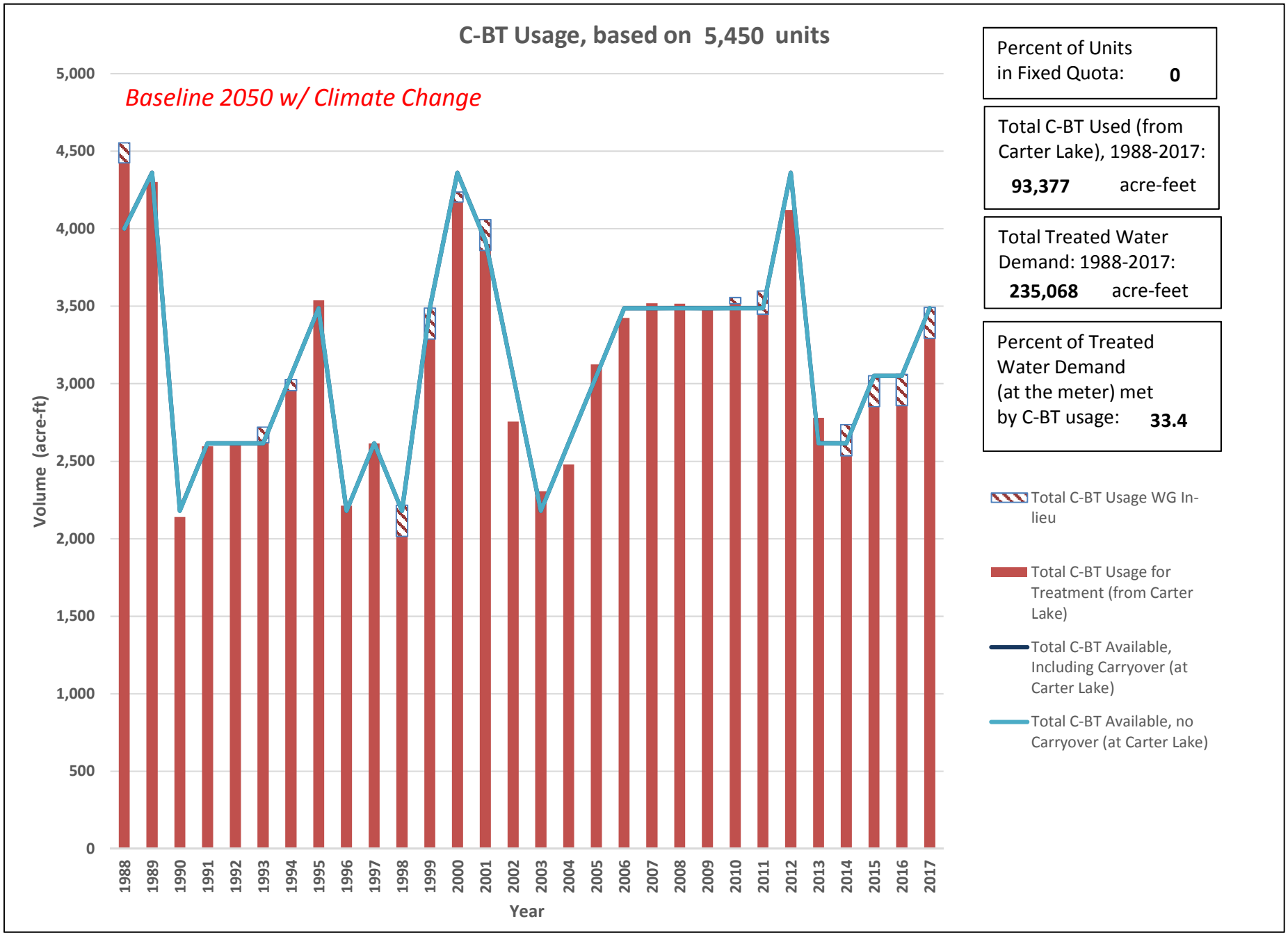


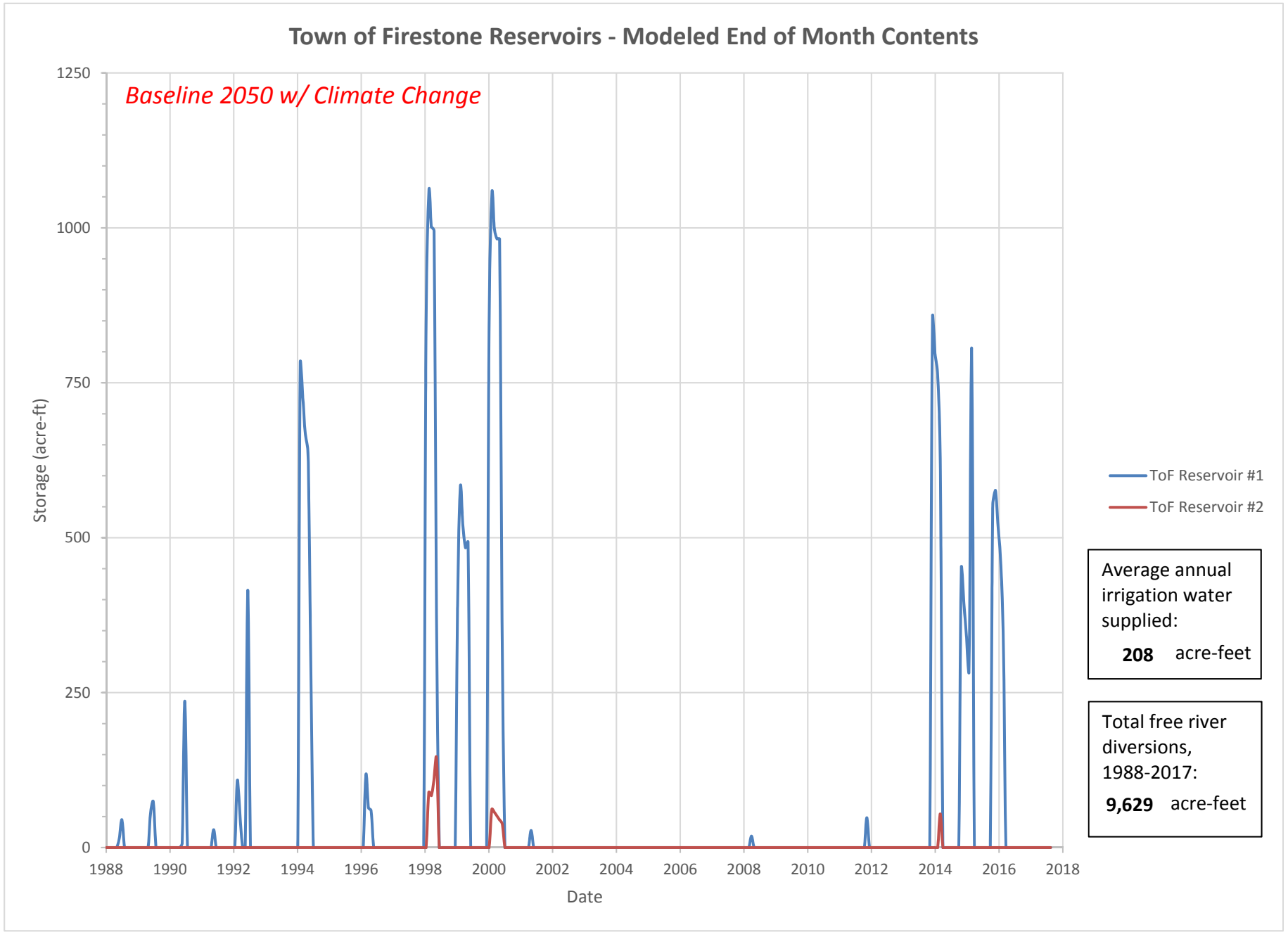
C-BT Units:	**5,450**
Windy Gap Units:	**5**
NISP Units:	**1,300**
Average Lease usage:	
Years:	**0**
acre-feet:	**0**

Total Treated Water Demand, 1988-2017:
235,068 acre-feet

Average annual reuse credit:
Windy Gap: **99** acre-feet
Gould: **206** acre-feet

Shortages (Treated Water)
Number of years: **30**
Max year: **4,688** acre-feet
Average year: **3,853** acre-feet


C-BT Usage, based on 5,450 units
Baseline 2050 w/ Climate Change
Volume (acre-ft)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 93,377 acre-feet
Total Treated Water Demand: 1988-2017: 235,068 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 33.4
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Baseline 2050 w/ Climate Change
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
208 acre-feet
Total free river diversions, 1988-2017:
9,629 acre-feet

	Model Configuration	**8**	*Alternate 2-1 (2050) w/ Climate Change*
Reservior Modeling	Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	**1**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	**2**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
	Alternate Scenario Modeling	**2**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	**0**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	**1**	Option: 1 = On, 0 = Off
	Future Warming	**2**	°C (Limit 0-10)
	Flow Reduction Rate	**10**	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	**35**	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	**5,450**	Units
	Surcharge for Central Weld WCD	**1.2**	
	Surcharge for Left Hand WD	**1.1**	
	TDS Value for CBT Water	**60**	mg/L TDS
	Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	**70**	%
	Percentage of Units in Fixed Quota Program for Option #3	**75**	%
	Amount available for January 1988	**4,000**	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	**5**	Units
	Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	**11**	
	City of Loveland Lease Quantity	**0**	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	**1.2**	
	Surcharge forLeft Hand WD Lease Usage	**1.1**	
	Surcharge for Central Weld WCD WG Usage	**1.2**	
	Surcharge for Left Hand WD WG Usage	**1.1**	
	TDS Value for WG Water	**60**	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	**95**	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**16**	Shares
	Lower Boulder Ditch Common Shares	**24**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**24**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**1,300**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**300**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**992**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

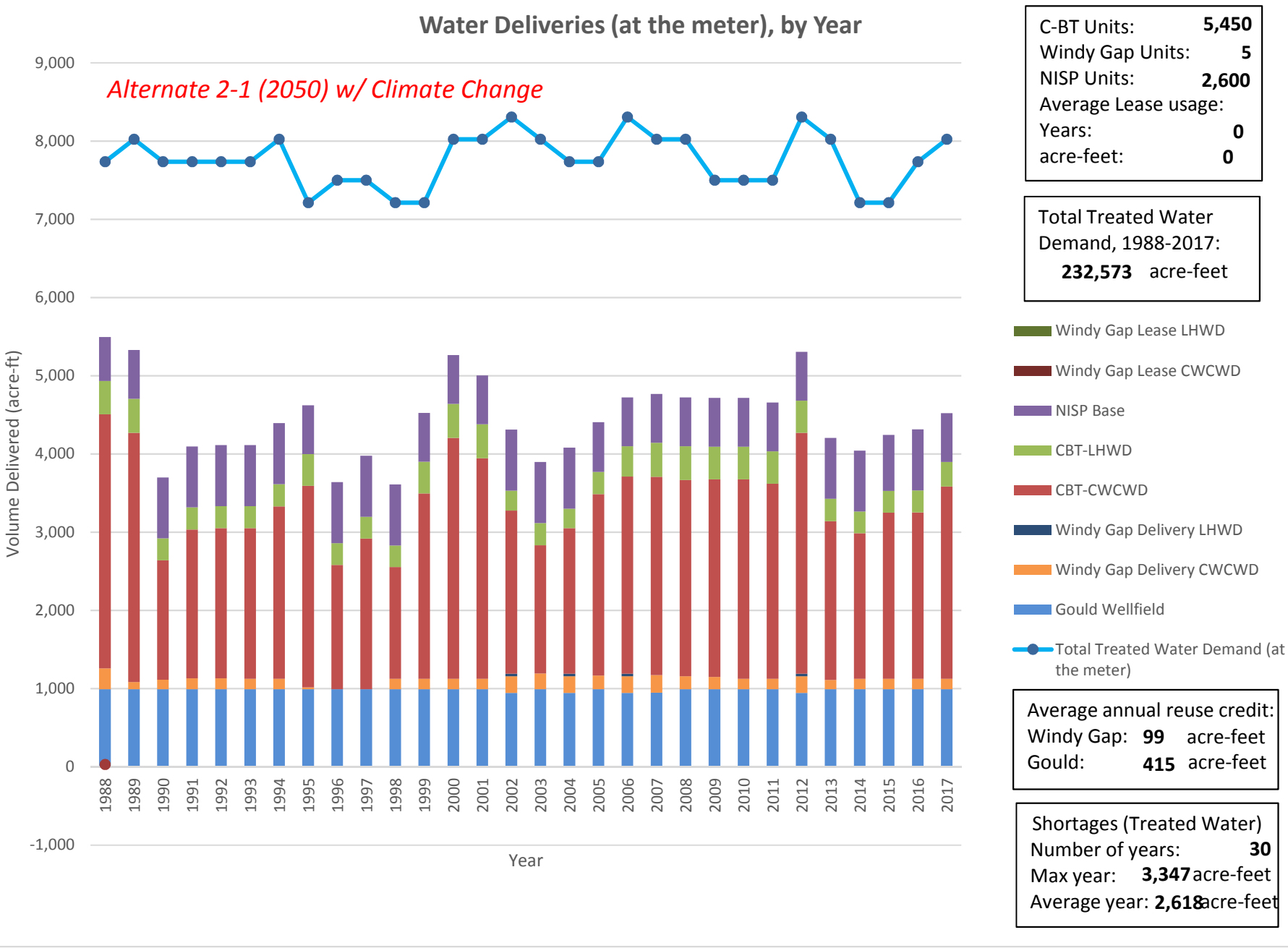
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

Modeled Water Source Priority Controls

		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights

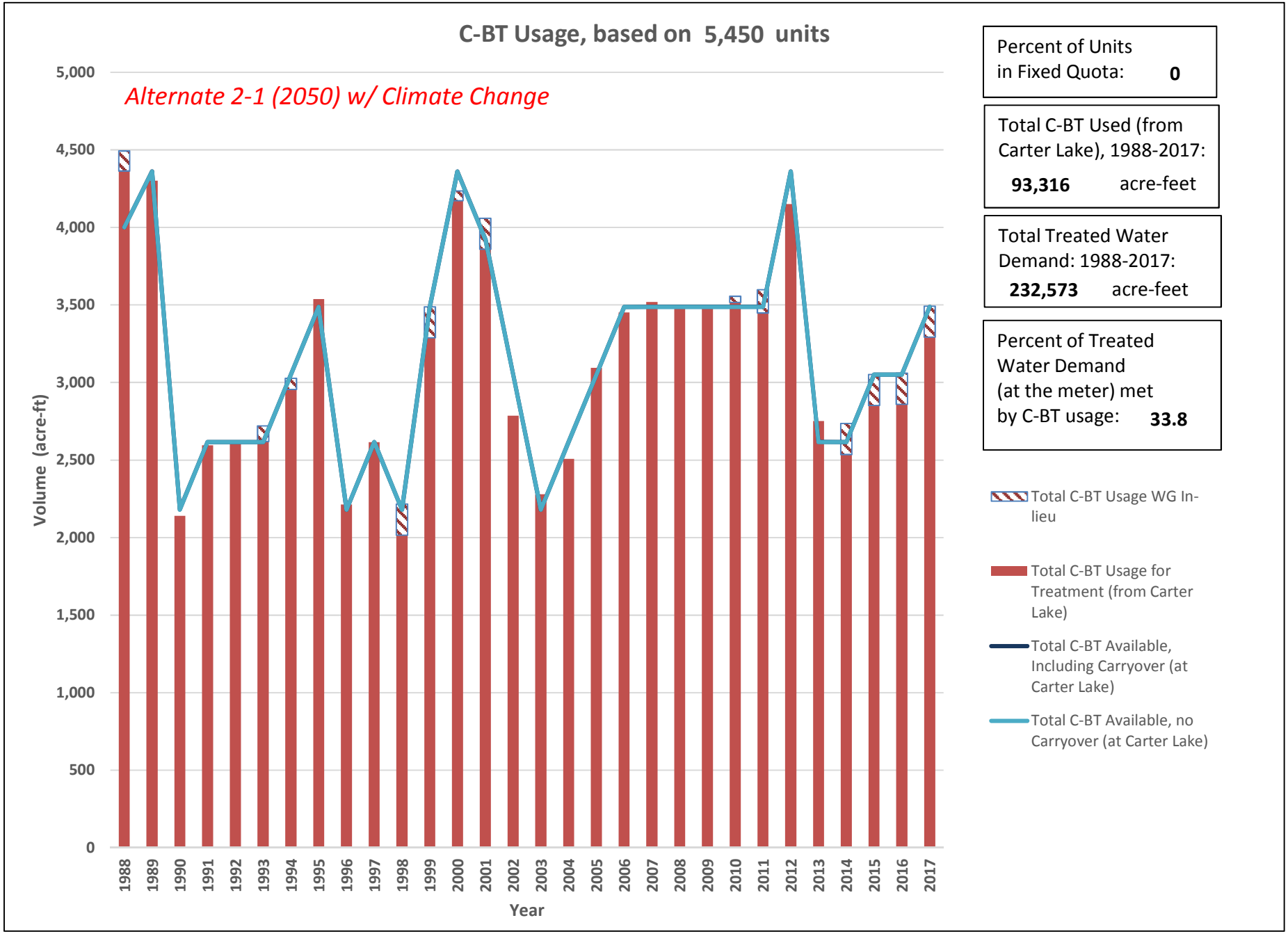


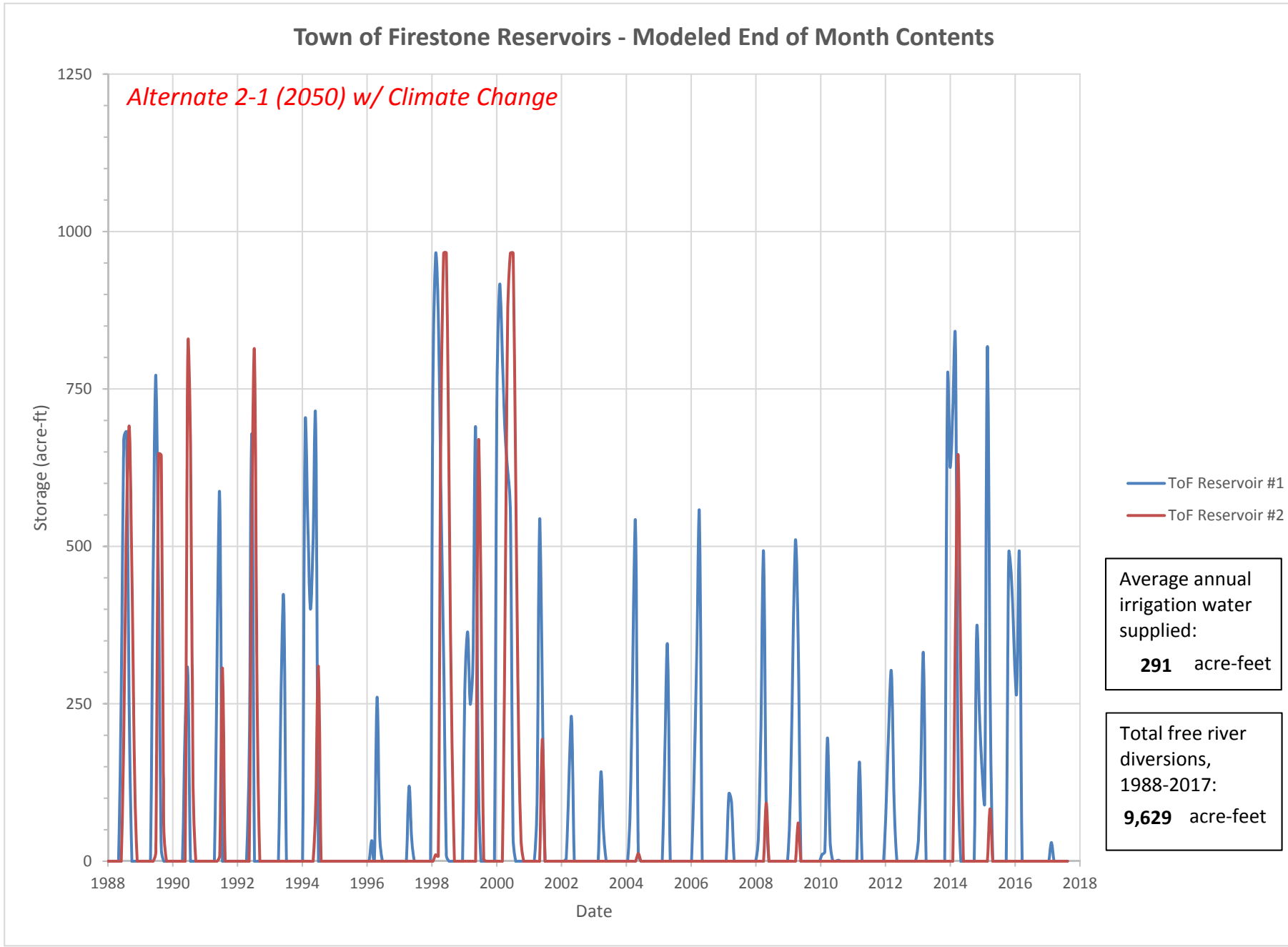
C-BT Units:	**5,450**
Windy Gap Units:	**5**
NISP Units:	**2,600**
Average Lease usage:	
Years:	**0**
acre-feet:	**0**

Total Treated Water Demand, 1988-2017:
232,573 acre-feet

Average annual reuse credit:
Windy Gap: **99** acre-feet
Gould: **415** acre-feet

Shortages (Treated Water)
Number of years: **30**
Max year: **3,347** acre-feet
Average year: **2,618** acre-feet


C-BT Usage, based on 5,450 units
Alternate 2-1 (2050) w/ Climate Change
Volume (acre-ft)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 93,316 acre-feet
Total Treated Water Demand: 1988-2017: 232,573 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 33.8
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 2-1 (2050) w/ Climate Change
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
291 acre-feet
Total free river diversions, 1988-2017:
9,629 acre-feet

	Model Configuration	9	*Alternate 2-2 (2050) w/ Climate Change*
Reservior Modeling	Initial Storage within ToF Reservoir #1	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	0	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	0	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	1	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	1	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	0	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	0	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	2	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	2050	Options: 2027 through 2050
	Alternate Scenario Modeling	3	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	0	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	1	Option: 1 = On, 0 = Off
	Future Warming	2	°C (Limit 0-10)
	Flow Reduction Rate	10	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	60	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	0	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	5,450	Units
	Surcharge for Central Weld WCD	1.2	
	Surcharge for Left Hand WD	1.1	
	TDS Value for CBT Water	60	mg/L TDS
	Quota Options	1	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	70	%
	Percentage of Units in Fixed Quota Program for Option #3	75	%
	Amount available for January 1988	4,000	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	5	Units
	Windy Gap Modeled Year	2	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	11	
	City of Loveland Lease Quantity	0	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	1.2	
	Surcharge forLeft Hand WD Lease Usage	1.1	
	Surcharge for Central Weld WCD WG Usage	1.2	
	Surcharge for Left Hand WD WG Usage	1.1	
	TDS Value for WG Water	60	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	95	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**14**	Shares
	Lower Boulder Ditch Common Shares	**20**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**20**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**1,900**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**493**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**1985**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

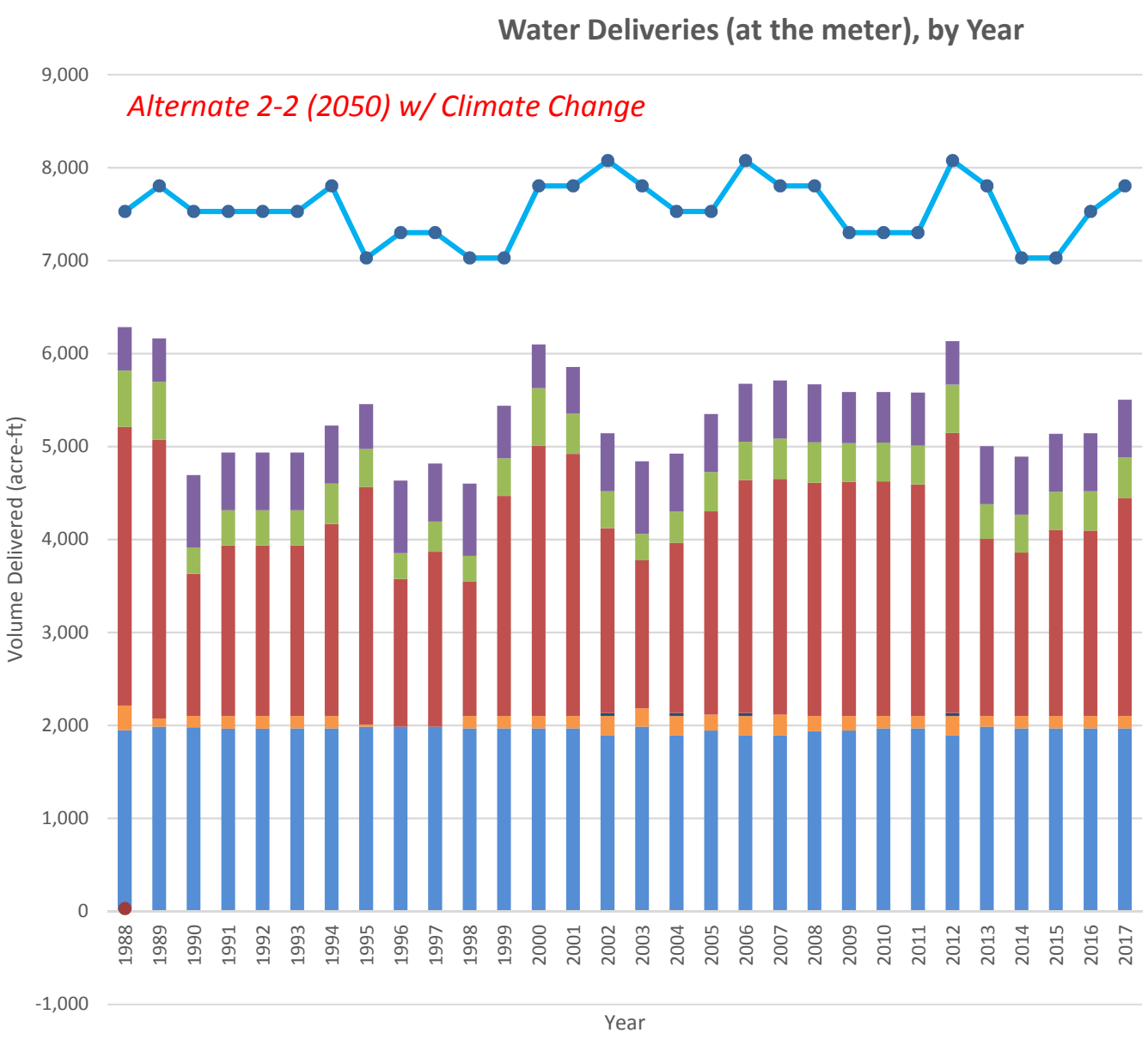
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

Modeled Water Source Priority Controls

		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights



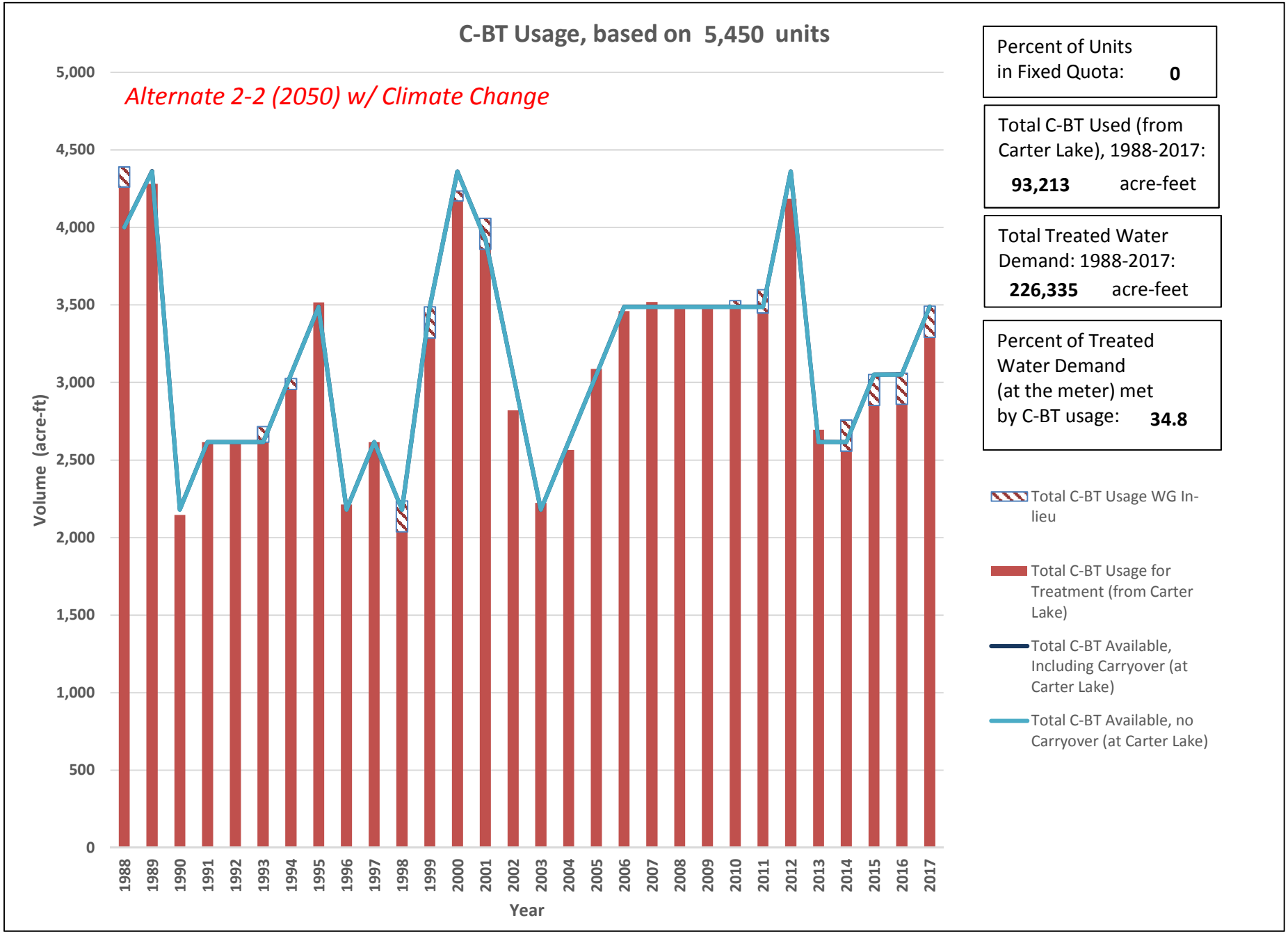
C-BT Units:	**5,450**
Windy Gap Units:	**5**
NISP Units:	**3,200**
Average Lease usage:	
Years:	**0**
acre-feet:	**0**

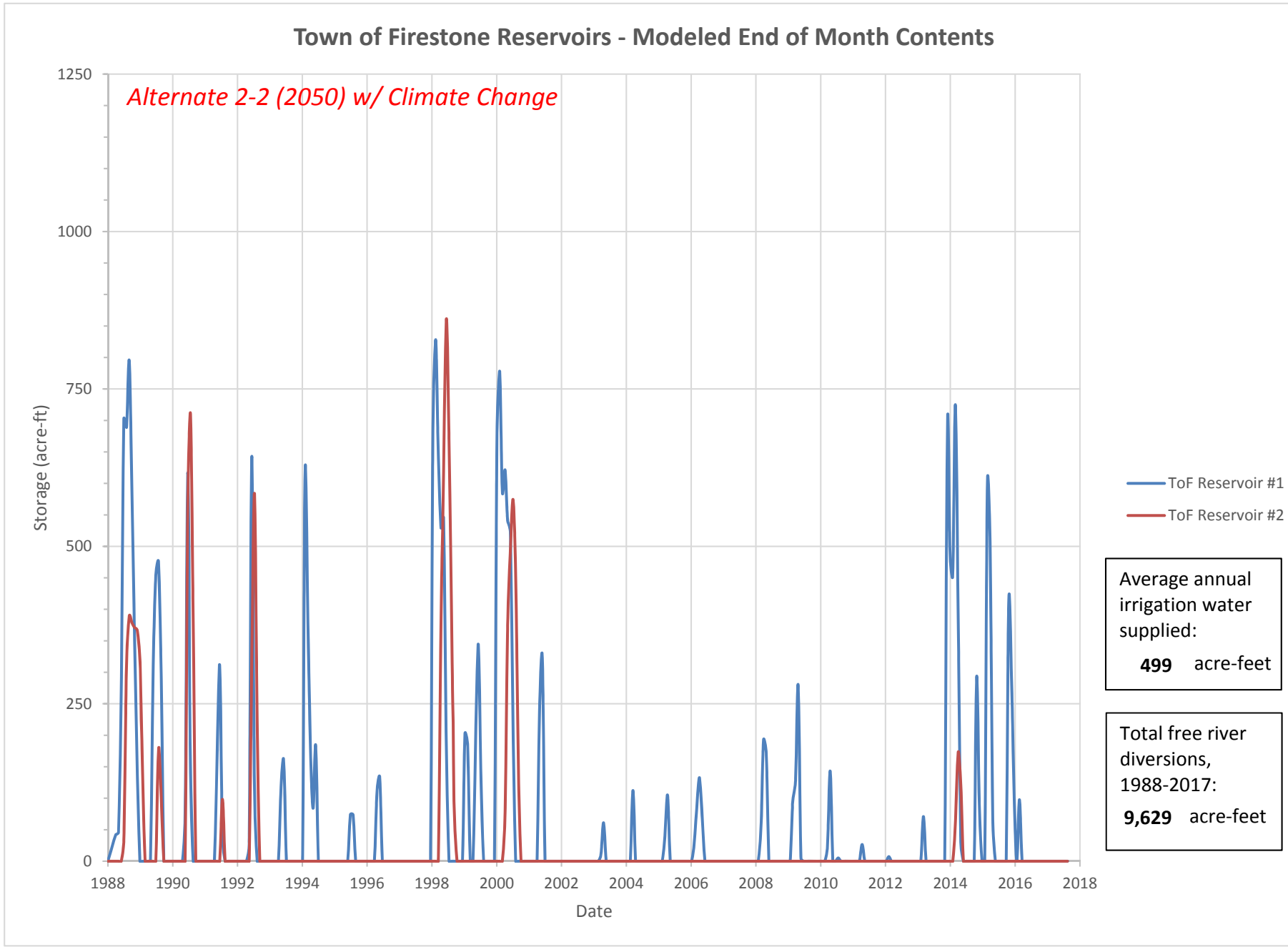
Total Treated Water Demand, 1988-2017:
226,335 acre-feet

- Windy Gap Lease LHWD
- Windy Gap Lease CWCWD
- NISP Base
- CBT-LHWD
- CBT-CWCWD
- Windy Gap Delivery LHWD
- Windy Gap Delivery CWCWD
- Gould Wellfield
- Total Treated Water Demand (at the meter)

Average annual reuse credit:
Windy Gap: **99** acre-feet
Gould: **831** acre-feet

Shortages (Treated Water)
Number of years: **30**
Max year: **2,027** acre-feet
Average year: **1,396** acre-feet


C-BT Usage, based on 5,450 units
Alternate 2-2 (2050) w/ Climate Change
Volume (acre-ft)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 93,213 acre-feet
Total Treated Water Demand: 1988-2017: 226,335 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 34.8
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 2-2 (2050) w/ Climate Change
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
499 acre-feet
Total free river diversions, 1988-2017:
9,629 acre-feet

	Model Configuration	10	*Baseline 2050 w/ Climate Change & Increased Irrigation*
Reservior Modeling	Initial Storage within ToF Reservoir #1	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	0	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	0	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	1	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	1	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	0	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	0	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	2	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	2050	Options: 2027 through 2050
	Alternate Scenario Modeling	1	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	1	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	1	Option: 1 = On, 0 = Off
	Future Warming	2	°C (Limit 0-10)
	Flow Reduction Rate	10	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	25	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	0	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	5,450	Units
	Surcharge for Central Weld WCD	1.2	
	Surcharge for Left Hand WD	1.1	
	TDS Value for CBT Water	60	mg/L TDS
	Quota Options	1	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	70	%
	Percentage of Units in Fixed Quota Program for Option #3	75	%
	Amount available for January 1988	4,000	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	5	Units
	Windy Gap Modeled Year	2	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	11	
	City of Loveland Lease Quantity	0	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	1.2	
	Surcharge forLeft Hand WD Lease Usage	1.1	
	Surcharge for Central Weld WCD WG Usage	1.2	
	Surcharge for Left Hand WD WG Usage	1.1	
	TDS Value for WG Water	60	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	95	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**3.97**	Shares
	Lower Boulder Ditch Common Shares	**6.667**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**2.41**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**0**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**200**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**496**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

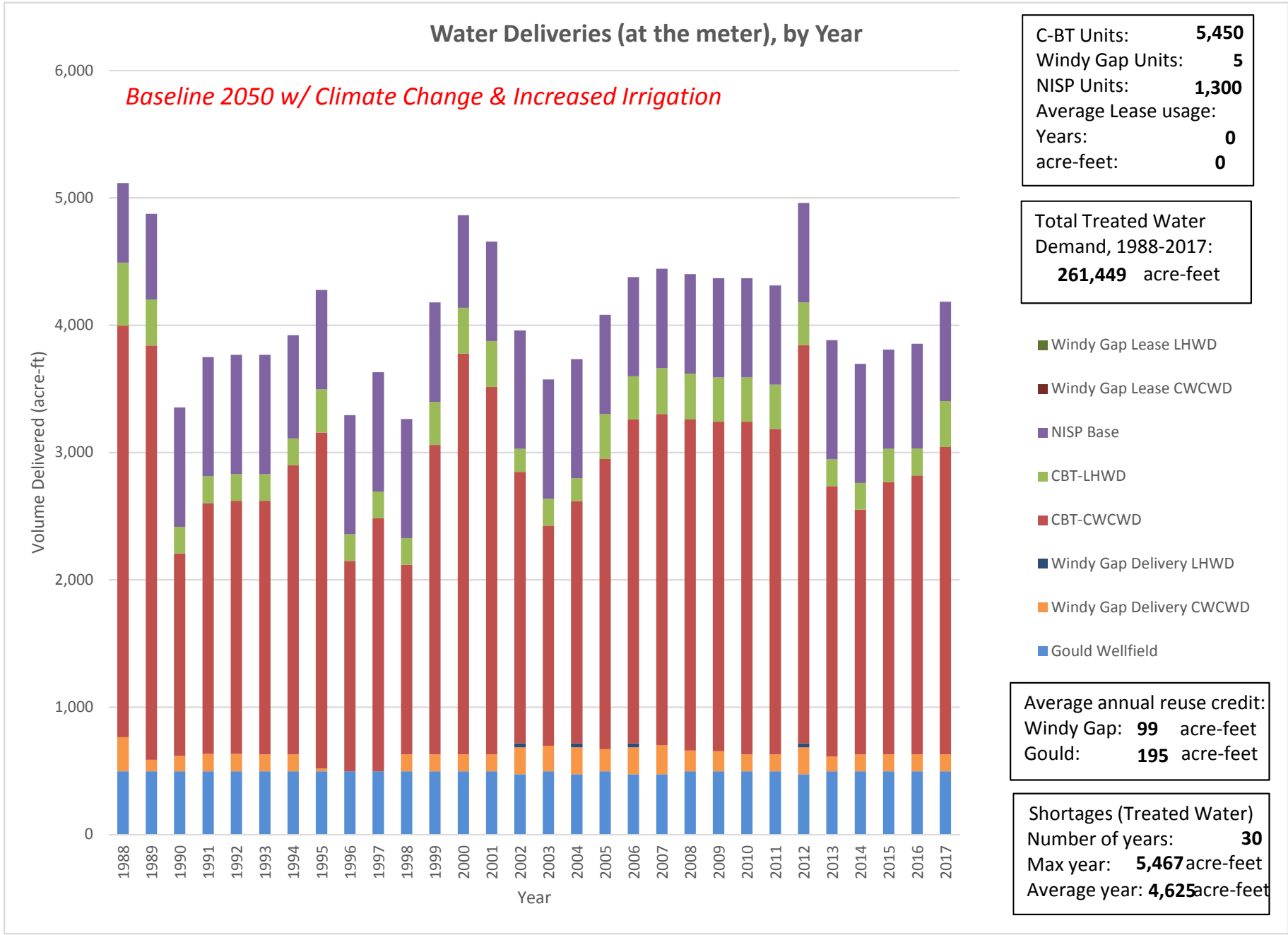
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

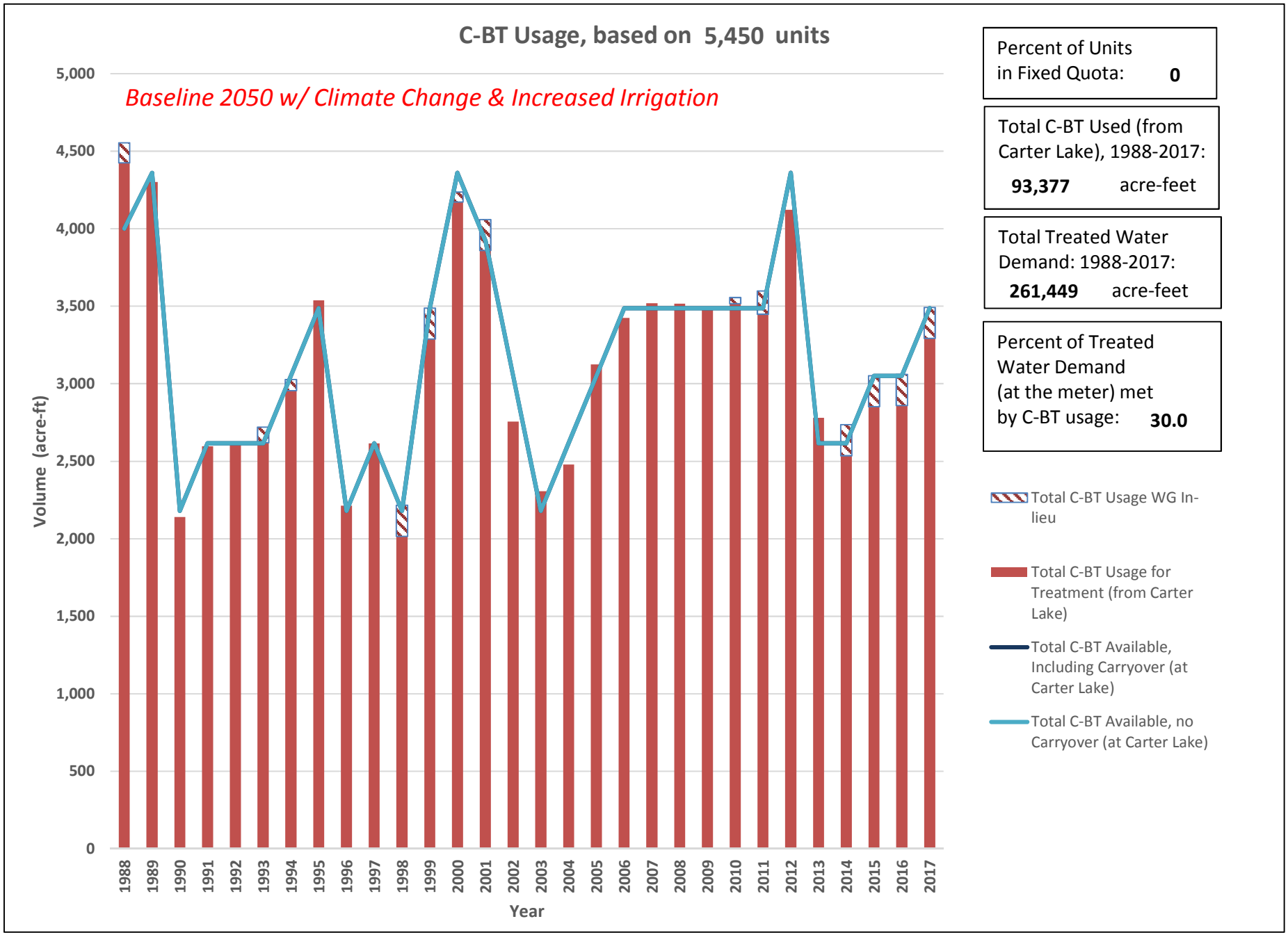
Modeled Water Source Priority Controls

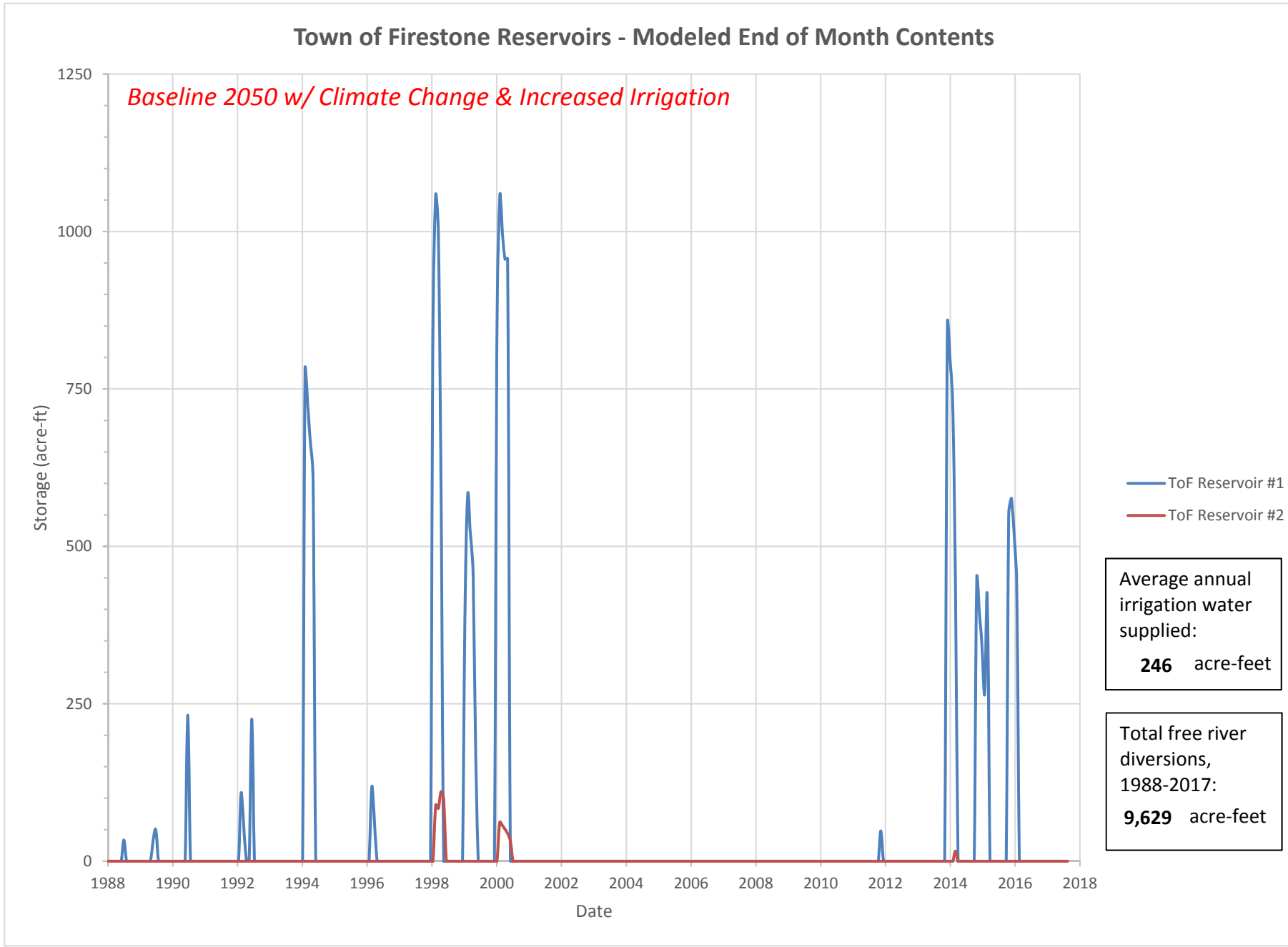
		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights


Water Deliveries (at the meter), by Year
Baseline 2050 w/ Climate Change & Increased Irrigation
Volume Delivered (acre-ft)
6,000
5,000
4,000
3,000
2,000
1,000
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year
Windy Gap Lease LHWD
Windy Gap Lease CWCWD
NISP Base
CBT-LHWD
CBT-CWCWD
Windy Gap Delivery LHWD
Windy Gap Delivery CWCWD
Gould Wellfield
C-BT Units: 5,450
Windy Gap Units: 5
NISP Units: 1,300
Average Lease usage:
Years: 0
acre-feet: 0
Total Treated Water Demand, 1988-2017:
261,449 acre-feet
Average annual reuse credit:
Windy Gap: 99 acre-feet
Gould: 195 acre-feet
Shortages (Treated Water)
Number of years: 30
Max year: 5,467 acre-feet
Average year: 4,625 acre-feet


C-BT Usage, based on 5,450 units
Baseline 2050 w/ Climate Change & Increased Irrigation
Volume (acre-ft)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 93,377 acre-feet
Total Treated Water Demand: 1988-2017: 261,449 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 30.0
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Baseline 2050 w/ Climate Change & Increased Irrigation
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
246 acre-feet
Total free river diversions, 1988-2017:
9,629 acre-feet

	Model Configuration	11	*Alternate 2-1 (2050) w/ Climate Change & Increased Irrigation*
Reservior Modeling	Initial Storage within ToF Reservoir #1	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	0	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	0	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	0	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	1	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	1	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	0	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	0	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	2	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	2050	Options: 2027 through 2050
	Alternate Scenario Modeling	2	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	1	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	1	Option: 1 = On, 0 = Off
	Future Warming	2	°C (Limit 0-10)
	Flow Reduction Rate	10	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	35	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	0	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	5,450	Units
	Surcharge for Central Weld WCD	1.2	
	Surcharge for Left Hand WD	1.1	
	TDS Value for CBT Water	60	mg/L TDS
	Quota Options	1	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	70	%
	Percentage of Units in Fixed Quota Program for Option #3	75	%
	Amount available for January 1988	4,000	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	5	Units
	Windy Gap Modeled Year	2	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	11	
	City of Loveland Lease Quantity	0	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	1.2	
	Surcharge forLeft Hand WD Lease Usage	1.1	
	Surcharge for Central Weld WCD WG Usage	1.2	
	Surcharge for Left Hand WD WG Usage	1.1	
	TDS Value for WG Water	60	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	95	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**16**	Shares
	Lower Boulder Ditch Common Shares	**24**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**24**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**1,300**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**300**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**992**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

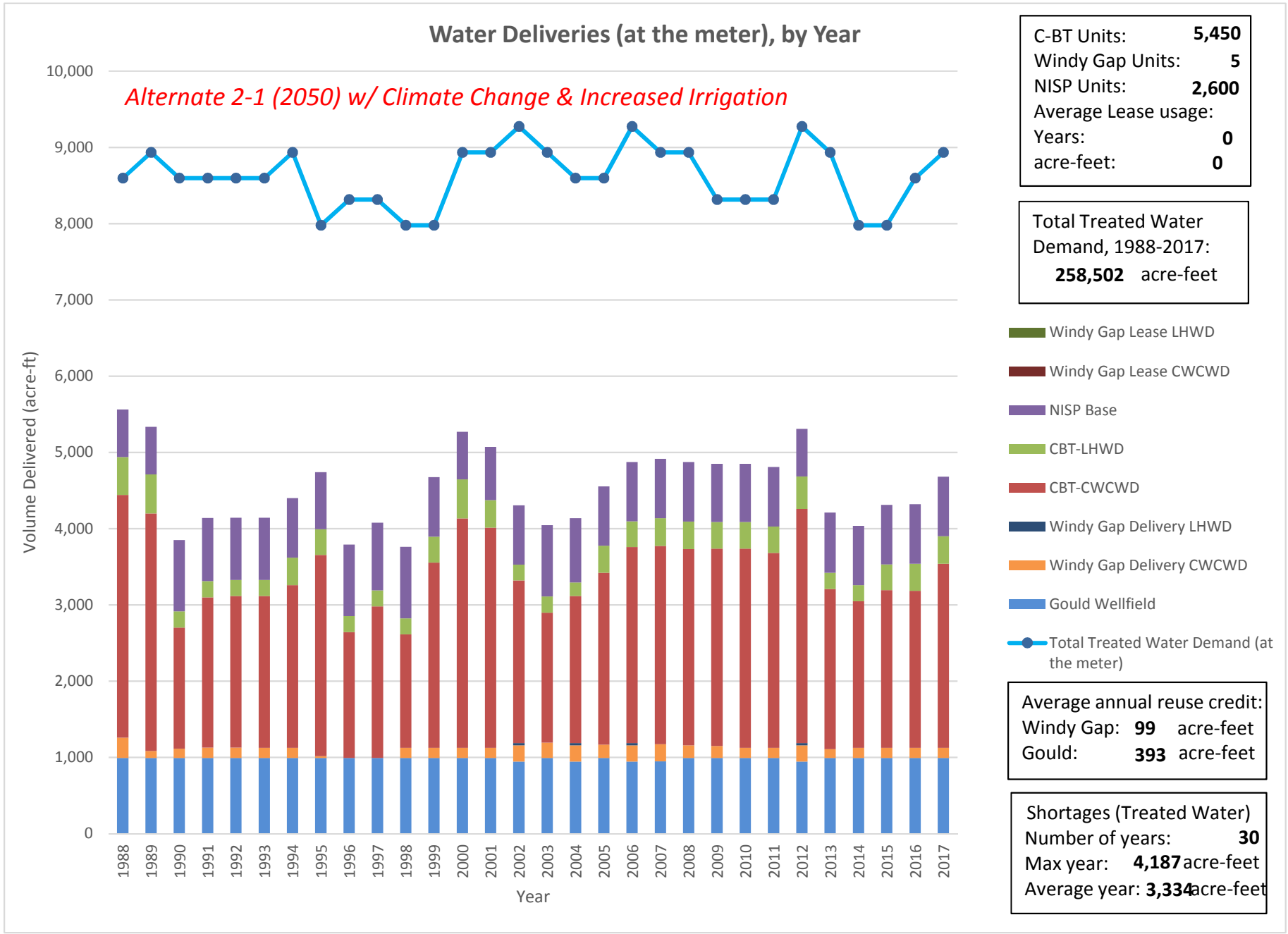
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

Modeled Water Source Priority Controls

		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights

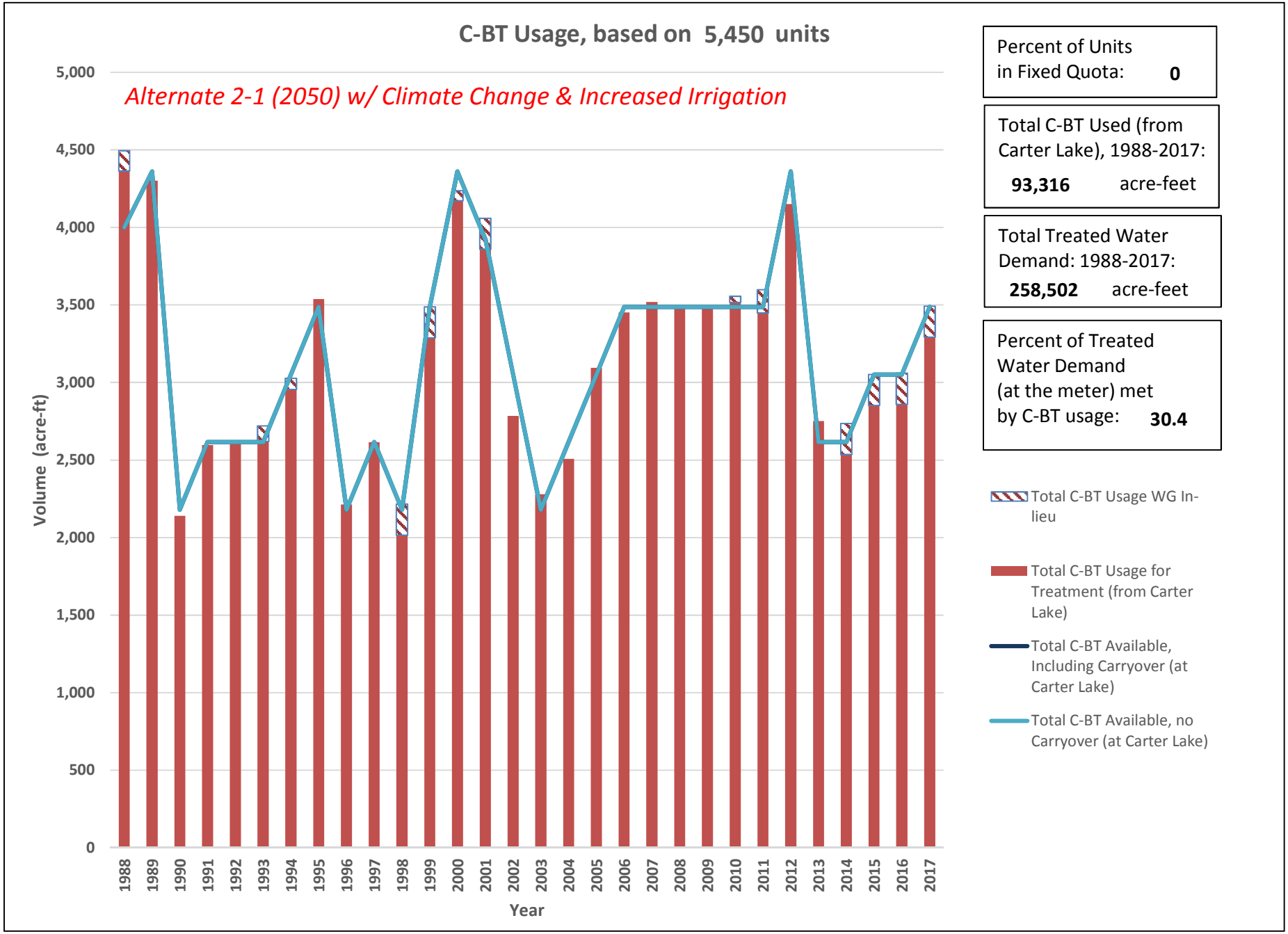


C-BT Units:	**5,450**
Windy Gap Units:	**5**
NISP Units:	**2,600**
Average Lease usage:	
Years:	**0**
acre-feet:	**0**

Total Treated Water Demand, 1988-2017:
258,502 acre-feet

Average annual reuse credit:
Windy Gap: **99** acre-feet
Gould: **393** acre-feet

Shortages (Treated Water)
Number of years: **30**
Max year: **4,187** acre-feet
Average year: **3,334** acre-feet


C-BT Usage, based on 5,450 units
Alternate 2-1 (2050) w/ Climate Change & Increased Irrigation
Volume (acre-ft)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 93,316 acre-feet
Total Treated Water Demand: 1988-2017: 258,502 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 30.4
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)

	Model Configuration	**12**	*Alternate 2-2 (2050) w/ Climate Change & Increased Irrigation*
Reservior Modeling	Initial Storage within ToF Reservoir #1	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #2	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within ToF Reservoir #3	**0**	Options: 1 = Full, 0 = Empty
	Initial Storage within Partner Reservoir	**0**	Options: 1 = Full, 0 = Empty
	Active Modeling of ToF Reservoir #1	**1**	Options: 1 = Modeled
	Active Modeling of ToF Reservoir #2	**1**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of ToF Reservoir #3	**0**	Options: 1 = Modeled, 0 = Not Modeled
	Active Modeling of Partner Reservoir	**0**	Options: 1 = Modeled, 0 = Not Modeled
Demands & Climate Change	Model Demand Mode	**2**	Options: 1 = 2027 Demands, 2 = 2050 Demands, 3 = Demands & Supplies For Year X
	Simulated Model Year for Model Demand Mode #3	**2050**	Options: 2027 through 2050
	Alternate Scenario Modeling	**3**	Options: 1 = Base, 2 = Alternate 1, 3 = Alternate 2
	Demand Increase Scenario	**1**	Options: 0 = No Increase in demands, 1 = Increase in May, Sept. Irrigation
	Climate Change Modeling	**1**	Option: 1 = On, 0 = Off
	Future Warming	**2**	°C (Limit 0-10)
	Flow Reduction Rate	**10**	% Per °C Increase in Temperature
	Demand to be met only by reservoirs	**60**	% of total CWCWD Gov. Irrigation Demand
	Modeling of Future "Partner" Demands	**0**	acre-ft/yr Positive = Constant Value for each month, Negative: demands from Input
CBT Controls	Modeled # of CBT Units Available to Firestone	**5,450**	Units
	Surcharge for Central Weld WCD	**1.2**	
	Surcharge for Left Hand WD	**1.1**	
	TDS Value for CBT Water	**60**	mg/L TDS
	Quota Options	**1**	Options: 1 = Historical Quotas, 2 = Fixed Quota, 3 - Historical & Fixed
	Fixed Quota Value	**70**	%
	Percentage of Units in Fixed Quota Program for Option #3	**75**	%
	Amount available for January 1988	**4,000**	acre-ft
Windy Gap Controls	Modeled # of Windy Gap Units Available to Firestone	**5**	Units
	Windy Gap Modeled Year	**2**	Options: 1 = Calendar Year, 2 = Nov-October Year
	Windy Gap Reset Month	**11**	
	City of Loveland Lease Quantity	**0**	acre-ft/yr
	Surcharge for Central Weld WCD Lease Usage	**1.2**	
	Surcharge forLeft Hand WD Lease Usage	**1.1**	
	Surcharge for Central Weld WCD WG Usage	**1.2**	
	Surcharge for Left Hand WD WG Usage	**1.1**	
	TDS Value for WG Water	**60**	mg/L TDS
	Reuse Credit for WG Indoor Water Usage	**95**	%

Ditch Controls	Lower Boulder Ditch Preferred Shares	**14**	Shares
	Lower Boulder Ditch Common Shares	**20**	Shares
	Lower Boulder Ditch Preferred Shares - Prior Year Usage	**190**	acre-ft
	Lower Boulder Ditch Common Shares - Prior Year Usage	**150**	acre-ft
	Rural Ditch Company	**20**	Shares
	Rural Ditch Company - Prior Year Usage	**125**	acre-ft
NISP Controls	NISP Base Supply	**1,300**	acre-ft/yr
	Max Delivery Rate - Per Month	**15%**	per month
	Reusable Percentage - Base Supply	**50%**	of Used Quantity
	Percentage of NISP Indoor Supply for Reuse	**95%**	
	NISP Additional Supply	**1,900**	acre-ft/yr
	Additional Supply Max Delivery Rate	**15%**	per month
	Reusable Percentage - Additional Supply	***50%***	of Used Quantity
	Percentage of Additional NISP Indoor Supply for Reuse	**95%**	
Mountain Shadows Controls	Mountain Shadows Park Alluvial Supply - Daily Limit	**1.77**	*acre-ft/day*
	Mountain Shadows Park Alluvial Supply - Monthly Limit	***-1***	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Mountain Shadows Park Alluvial Supply - Yearly Limit	**493**	acre-ft/yr
	Monthly Return Flow Factor for Water Delivered to Firestone Reservoir(s)	**8.25%**	
	Monthly Return Flow Factor for Water Delivered to Mountain Shadows Park	**7.84%**	
	Initial Previous-Year Delivery for return flow calculations - To MSP	**50**	acre-ft
	Initial Previous-Year Delivery for return flow calculations - To Firestone	**100**	acre-ft
Gould Wellfield Controls	Gould Well Field Alluvial Supply - Daily Limit	**1.33**	*acre-ft/day*
	Gould Well Field Alluvial Supply - Monthly Limit	**-1**	acre-ft/month (-1 = Monthly Demands based on Modeled Scenario)
	Gould Well Field Alluvial Supply - Yearly Limit	**1985**	acre-ft/yr
	Monthly Return Flow Factor	**8.25%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**50**	acre-ft
Junior Water Right Controls	Capacity of Last Chance Ditch turnout for Junior Water Right Diversion	**15**	cfs
	Daily Diversion Limit - Junior Water Rights	**30**	acre-ft/day
	Monthly Diversion Limit - Junior Water Rights	**900**	acre-ft/month
	Annual Diversion Limit - Junior Water Rights	**1250**	acre-ft/year
	Monthly Return Flow Factor	**0.00%**	
	Initial Previous-Year Delivery for Returnflow Calculations	**0**	acre-ft

Modeled Water Source Controls

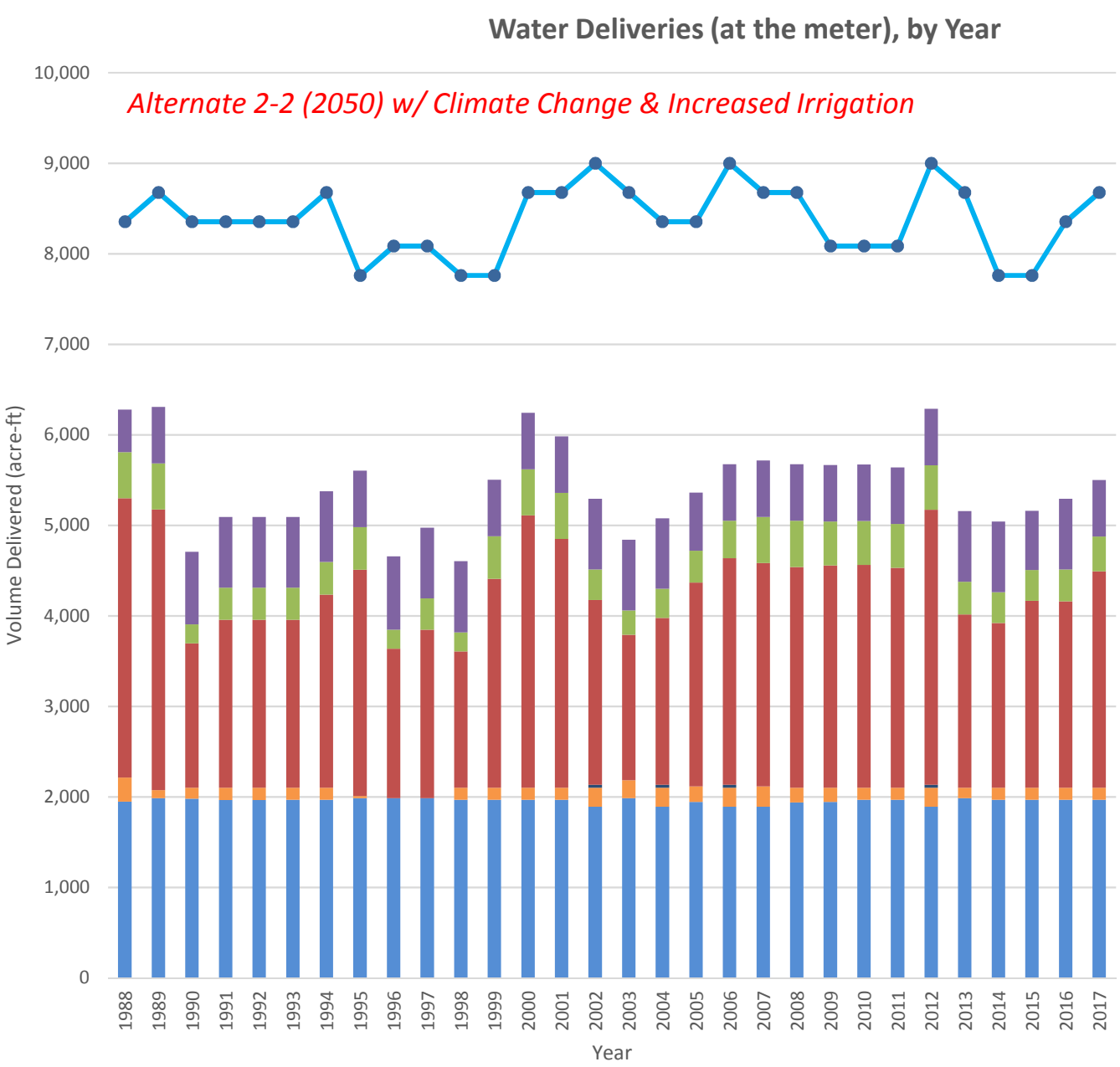
Model Source Information		Usage Allowed By Month (0 = No, 1 = Yes)												
Name	#	J	F	M	A	M	J	J	A	S	O	N	D	#
CBT	1	1	1	1	1	1	1	1	1	1	1	1	1	1 CBT
NISP - Base	2	1	1	1	1	1	1	1	1	1	1	1	1	2 NISP Base
NISP - Additional	3	1	1	1	1	1	1	1	1	1	1	1	1	3 NISP Additional
Windy Gap - Delivery	4	1	1	1	0	0	0	0	0	0	0	0	1	4 Windy Gap - Delivery
Windy Gap - Lease	5	1	1	1	1	1	1	1	1	1	1	1	1	5 Windy Gap - Lease
Lower Boulder Ditch Prefered	6	1	1	1	1	1	1	1	1	1	1	1	1	6 Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	1	1	1	1	1	1	1	1	1	1	1	1	7 Lower Boulder Ditch Common
Rural Ditch	8	1	1	1	1	1	1	1	1	1	1	1	1	8 Rural Ditch
Mountain Shadows	9	1	1	1	1	1	1	1	1	1	1	1	1	9 Mountain Shadows
Gould Wellfield	10	1	1	1	1	1	1	1	1	1	1	1	1	10 Gould Wellfield
Junior Water Rights	11	1	1	1	1	1	1	1	1	1	1	1	1	11 Junior Water Rights

Modeled Water Source Priority Controls

		Priority Source By Month											
Month		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#
1	J	4	10	1	2	3	11	6	7	8	9	5	1 CBT
2	F	4	10	1	2	3	11	6	7	8	9	5	2 NISP Base
3	M	4	10	1	2	3	11	6	7	8	9	5	3 NISP Additional
4	A	11	10	1	2	3	4	6	7	8	9	5	4 Windy Gap - Delivery
5	M	11	10	1	2	3	4	6	7	8	9	5	5 Windy Gap - Lease
6	J	11	10	1	2	3	4	6	7	8	9	5	6 Lower Boulder Ditch Prefered
7	J	11	10	1	2	3	4	6	7	8	9	5	7 Lower Boulder Ditch Common
8	A	11	10	1	2	3	4	6	7	8	9	5	8 Rural Ditch
9	S	11	10	1	2	3	4	6	7	8	9	5	9 Mountain Shadows
10	O	11	10	1	2	3	4	6	7	8	9	5	10 Gould Wellfield
11	N	11	10	1	2	3	4	6	7	8	9	5	11 Junior Water Rights
12	D	4	10	1	2	3	11	6	7	8	9	5	

Modeled Water Source Usage Controls

Model Source Information		Demands to Satisfy 0 = No, 1 = Yes						
Name	#	CWCWD	LHWD	Return flows	Reservoirs	Partner	#	
CBT	1	1	1	0	0	0	1	CBT
NISP - Base	2	1	0	0	0	0	2	NISP Base
NISP - Additional	3	1	0	0	0	0	3	NISP Additional
Windy Gap - Delivery	4	1	1	0	0	0	4	Windy Gap - Delivery
Windy Gap - Lease	5	1	1	0	0	0	5	Windy Gap - Lease
Lower Boulder Ditch Prefered	6	0	0	1	1	0	6	Lower Boulder Ditch Prefered
Lower Boulder Ditch Common	7	0	0	1	1	0	7	Lower Boulder Ditch Common
Rural Ditch	8	0	0	0	1	0	8	Rural Ditch
Mountain Shadows	9	0	0	0	1	0	9	Mountain Shadows
Gould Wellfield	10	1	0	0	0	0	10	Gould Wellfield
Junior Water Rights	11	0	0	0	1	0	11	Junior Water Rights

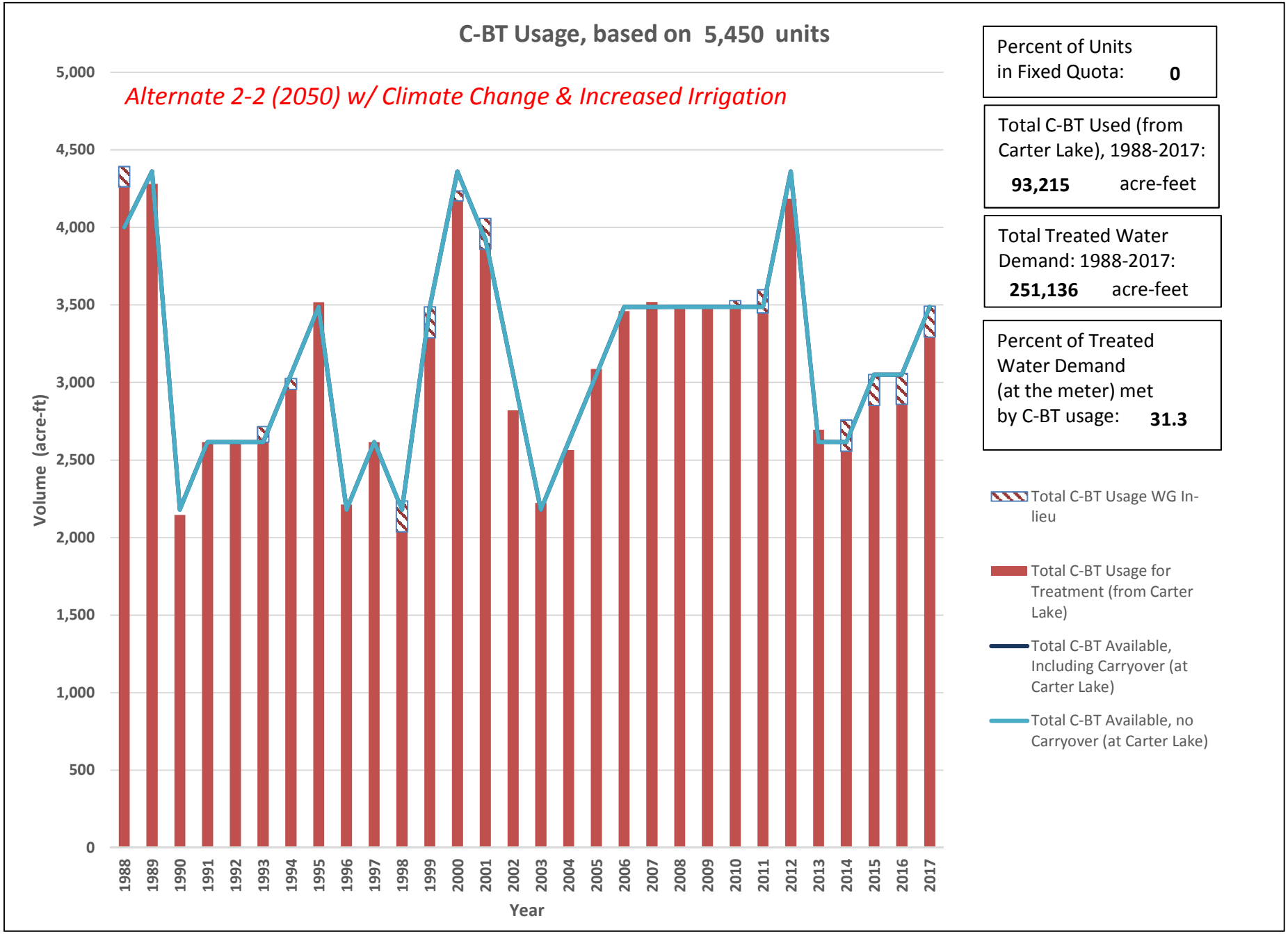


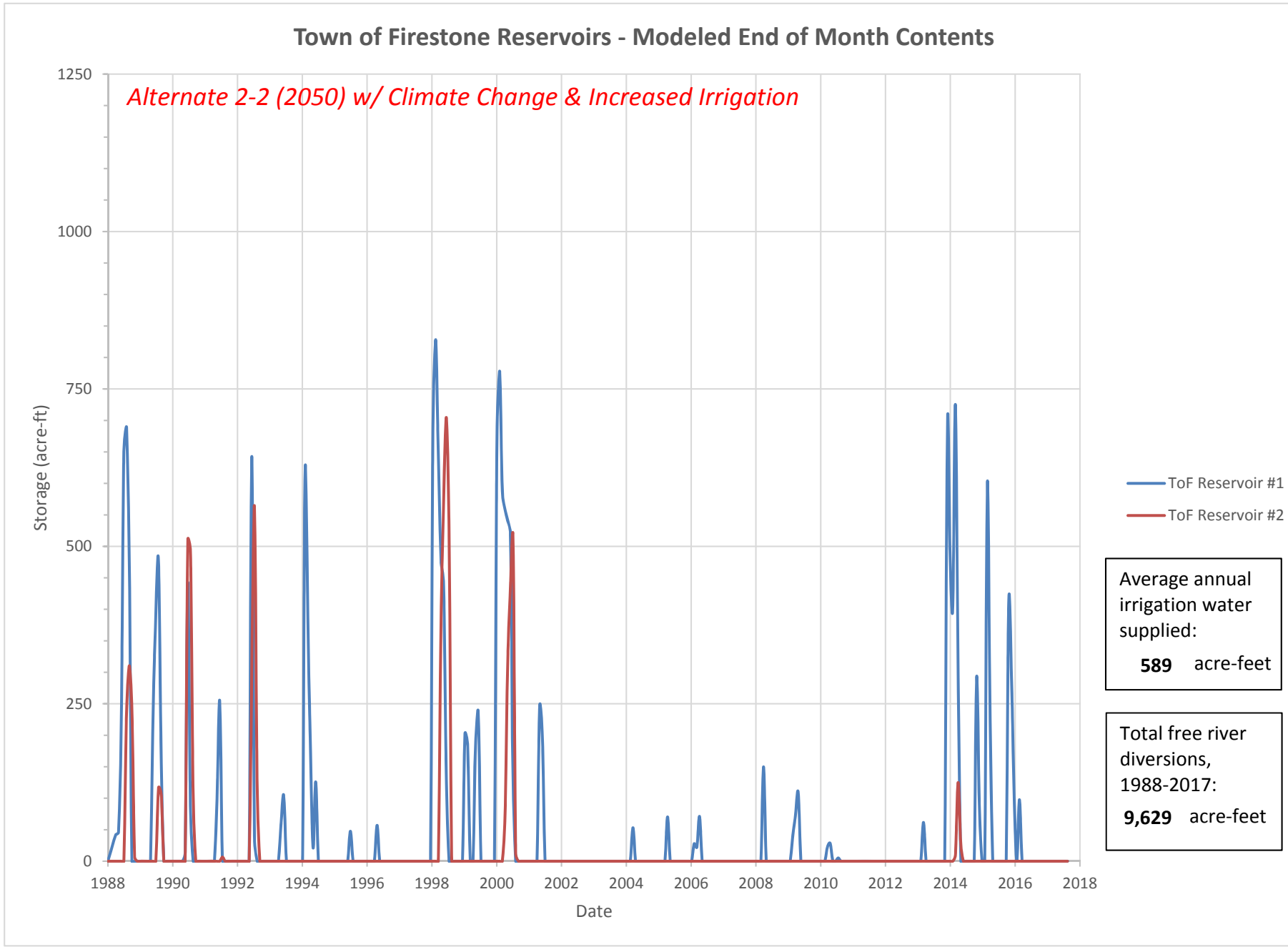
C-BT Units:	**5,450**
Windy Gap Units:	**5**
NISP Units:	**3,200**
Average Lease usage:	
Years:	**0**
acre-feet:	**0**

Total Treated Water Demand, 1988-2017:
251,136 acre-feet

Average annual reuse credit:
Windy Gap: **99** acre-feet
Gould: **786** acre-feet

Shortages (Treated Water)
Number of years: **30**
Max year: **2,697** acre-feet
Average year: **1,988** acre-feet


C-BT Usage, based on 5,450 units
Alternate 2-2 (2050) w/ Climate Change & Increased Irrigation
Volume (acre-ft)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Percent of Units in Fixed Quota: 0
Total C-BT Used (from Carter Lake), 1988-2017: 93,215 acre-feet
Total Treated Water Demand: 1988-2017: 251,136 acre-feet
Percent of Treated Water Demand (at the meter) met by C-BT usage: 31.3
Total C-BT Usage WG In-lieu
Total C-BT Usage for Treatment (from Carter Lake)
Total C-BT Available, Including Carryover (at Carter Lake)
Total C-BT Available, no Carryover (at Carter Lake)


Town of Firestone Reservoirs - Modeled End of Month Contents
Alternate 2-2 (2050) w/ Climate Change & Increased Irrigation
Storage (acre-ft)
1250
1000
750
500
250
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date
ToF Reservoir #1
ToF Reservoir #2
Average annual irrigation water supplied:
589 acre-feet
Total free river diversions, 1988-2017:
9,629 acre-feet