

Hendrix Wai Engineering, Inc.

Water Resources, Water Rights and GIS/Computer Modeling

P.O. Box 4487
Parker, CO 80134

Telephone: (720) 930-4360
E-Mail: Randy@Hendrix-Wai.com

To: Peter Ampe – Hill & Robbins, P.C. – Counsel for the Republican River Water Conservation District
Deb Daniel – Republican River Water Conservation District Manager

From: Randy L. Hendrix, Ayrton Hendrix
Willem Schreuder – Principia Mathematica

Date: April 6, 2020

Subject: April 2020 Projected Delivery for the Colorado Compact Compliance Pipeline

The RRCA approved the “Resolution by the Republican River Compact Administration Approving Operation and Accounting for the Colorado Compact Compliance Pipeline and Colorado’s Compliance Efforts in the South Fork Republican River Basin” August 24, 2016. Colorado is operating the Compact Compliance Pipeline (CCP) in 2019 under the provisions described in that resolution.

The projected CCP delivery requirement to meet Colorado’s obligation under the Compact in 2020 is approximately 9,000 ac-ft under the approximate delivery obligation of:

Time Period	Amount of CCP Delivery (ac-ft)
January - March	5,594
April	160
November - December	3,750
Total	9,504

January 1st through April 5th values represent actual deliveries and November through December are estimated at a delivery rate of 31 cfs per day. Therefore, our recommendation is for no more delivery in April and then start the winter deliveries for the pipeline on November 1st. The attached Tables 1 and 2 summarizes the calculations used to derive the delivery amount. The following section briefly describe the data and the estimated data used to develop the projections.

Data Utilized to Determine Delivery Amount

The Republican River Compact Administration (RRCA) Groundwater Model was run to obtain an estimate of the Groundwater Computed Beneficial Consumptive Use (CBCU). For Colorado groundwater pumping the 2019 data was repeated for 2020. For Kansas and Nebraska, the data from 2018 was repeated for 2020. Historical precipitation, reservoir stage, evapotranspiration and streamflow data were utilized when available. Long term average data was used when historical data was not available. Streamflow records for 2020 were estimated using engineering judgement and historical streamflow records.

The projections were made assuming that water short year administration on Harlan County Reservoir would not be in effect. The 5-run model approach was utilized in these projections.

Table 1 (page 1 of 3)
Operation of the Colorado Compact Compliance Pipeline
(units of ac-ft)

Jan - Dec Calendar Year	North Fork Basin Accounting									Arikaree Basin Accounting					
	North Fork Gaged Flow	Consumptive Use								Gaged Flow	Consumptive Use				Virgin Flow
		CCP Deliveries	Net North Fork Gaged Flows for Virgin Flow Calculations	0.40 x Haigler Canal Divs Measured at Stateline	CO SW and Small Res Evap	CO GW Con Use	KS GW Con Use	NE GW and SW Con Use	Virgin Flow		CO SW	CO GW	KS GW and Non- Fed Res Evap	NE GW	Virgin Flow
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
2000	19,435	0	19,435	2,368	3,122	13,173	15	4,709	42,822	3,631	0	1,918	128	196	5,873
2001	19,752	0	19,752	2,004	2,809	13,534	18	4,683	42,800	553	0	1,288	190	341	2,372
2002	15,904	0	15,904	2,258	3,172	13,562	14	5,324	40,234	231	0	401	114	351	1,097
2003	17,700	0	17,700	1,986	2,615	14,023	17	4,381	40,722	1,060	0	242	100	507	1,909
2004	19,759	0	19,759	1,493	3,022	14,373	16	3,685	42,348	341	0	353	157	431	1,282
2005	21,060	0	21,060	1,898	3,171	14,359	17	4,290	44,795	1,151	0	811	163	250	2,375
2006	17,608	0	17,608	1,767	3,140	14,301	12	4,017	40,845	404	0	1,116	130	125	1,775
2007	20,333	0	20,333	1,809	3,014	14,790	0	3,612	43,559	1,308	0	1,143	117	112	2,680
2008	21,638	0	21,638	1,998	671	15,004	0	3,925	43,235	1,567	0	1,536	106	124	3,333
2009	24,405	0	24,405	1,677	265	15,783	0	3,468	45,598	779	0	4,011	162	153	5,106
2010	20,418	0	20,418	2,016	325	15,479	0	3,999	42,238	2,358	49	1,446	109	73	4,035
2011	19,722	0	19,722	1,930	354	15,689	0	3,899	41,594	1,074	33	1,830	170	93	3,200
2012	14,376	0	14,376	2,452	583	15,309	0	4,698	37,418	494	63	1,558	116	78	2,309
2013	18,433	0	18,433	1,536	377	15,649	0	3,362	39,357	91	45	458	214	126	934
2014	26,707	7,448	19,259	1,244	285	16,283	0	2,962	40,034	0	21	1,141	236	128	1,526
2015	27,895	10,760	17,135	1,467	512	16,424	0	3,324	38,862	142	23	2,829	192	108	3,294
2016	28,091	10,130	17,961	1,596	419	16,820	0	3,550	40,346	397	37	2,638	196	147	3,415
2017	26,046	11,330	14,716	1,893	297	16,906	0	4,013	37,825	646	12	2,102	168	77	3,005
2018	32,580	13,578	19,002	1,408	316	17,365	0	3,317	41,408	821	0	2,639	190	112	3,762
2019	26,082	8,905	17,177	2,066	168	17,492	0	4,328	41,231	1,113	0	2,067	120	92	3,392
2020	25,000	9,500	15,500	2,066	170	17,678	0	4,353	39,767	500	0	1,888	112	105	2,605
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 1 (page 2 of 3)
Operation of the Colorado Compact Compliance Pipeline
(units of ac-ft)

Jan - Dec Calendar Year	South Fork Basin Accounting							CO Compact Allocation				
	Gaged Flow at Benkelman	Consumptive Use					Virgin Flow	22.4% 78.5% 44.4%				All Basins
		CO SW + CO Small Res Evap	CO GW + Bonny Res Seepage	CO Bonny Res Evap	KS GW, Non-Fed Res Evap, SW CU	NE GW		North Fork	Arikaree	South Fork	Colorado Allocation of Beaver Creek (See Table 5F in Water Short Year)	
(1)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
2000	4,855	2,732	10,450	5,557	6,333	982	30,909	9,592	4,610	13,723	1,940	29,866
2001	3,097	980	10,964	3,972	7,515	641	27,170	9,587	1,862	12,063	1,500	25,012
2002	1,579	2,288	10,765	5,750	4,933	1,282	26,598	9,012	861	11,809	0	21,683
2003	905	598	12,115	3,375	5,390	1,347	23,730	9,122	1,499	10,536	0	21,156
2004	0	770	12,874	3,158	6,091	1,202	24,094	9,486	1,006	10,698	0	21,190
2005	0	275	14,952	3,430	7,525	1,372	27,553	10,034	1,864	12,233	0	24,131
2006	0	0	11,757	3,031	4,723	1,040	20,551	9,149	1,394	9,124	0	19,667
2007	674	266	12,511	2,428	5,670	1,055	22,605	9,757	2,104	10,036	1,576	23,473
2008	1,397	52	14,707	1,766	5,933	1,021	24,876	9,685	2,617	11,045	3,080	26,426
2009	8,407	101	14,976	1,020	7,856	1,302	33,661	10,214	4,008	14,946	3,100	32,268
2010	12,756	919	11,938	1,921	3,016	625	31,174	9,461	3,167	13,841	2,890	29,360
2011	9,916	177	13,092	1,965	6,164	941	32,256	9,317	2,512	14,322	2,580	28,730
2012	6,441	107	9,321	67	2,568	810	19,314	8,382	1,813	8,575	1,860	20,630
2013	0	52	12,321	0	5,190	473	18,036	8,816	733	8,008	76	17,633
2014	0	150	13,868	0	8,552	1,027	23,597	8,968	1,198	10,477	22	20,665
2015	4,819	408	13,865	0	5,528	918	25,537	8,705	2,586	11,339	724	23,353
2016	3,898	331	13,883	0	5,835	904	24,851	9,037	2,681	11,034	780	23,532
2017	2,385	444	13,537	0	4,733	699	21,798	8,473	2,359	9,678	2,450	22,960
2018	1,970	356	14,602	0	6,736	974	24,638	9,275	2,953	10,939	578	23,746
2019	2,385	0	13,143	0	3,464	611	19,603	9,236	2,663	8,704	2,510	23,112
2020	2,000	0	13,248	0	4,951	751	20,950	8,908	2,045	9,302	2,260	22,515
2021	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0	0	0

Table 1 (page 3 of 3)
Operation of the Colorado Compact Compliance Pipeline
(units of ac-ft)

	CO Consumptive Use							Colorado Compact Compliance Accounting			
	Instate			GW Con Use in Nebraska							
Jan - Dec Calendar Year								Annual Amount Colorado Exceeded Compact Entitlement BEFORE		Annual Amount Colorado Exceeded Compact Entitlement after Accounting for CCP Delivery	5-year Running Average of the Amount Colorado Exceeded Compact Entitlement after Accounting for CCP Delivery
	North Fork	Arikaree	South Fork	Buffalo and Rock Creek	French- man Creek	Rep River Mainstem	Total Colorado Con Use	CCP Deliveries	CCP Delivery	CCP Delivery	
(1)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)
2000	16,295	1,918	18,739	276	599	-4,242	33,585	3,719	0	3,719	
2001	16,343	1,288	15,917	293	569	-4,166	30,244	5,231	0	5,231	
2002	16,734	401	18,804	298	619	-6,155	30,700	9,017	0	9,017	
2003	16,638	242	16,088	324	37	132	33,460	12,304	0	12,304	
2004	17,395	353	16,802	348	39	-1,269	33,668	12,478	0	12,478	8,550
2005	17,530	811	18,656	367	42	-1,954	35,452	11,321	0	11,321	10,070
2006	17,441	1,116	14,788	383	43	-3,009	30,762	11,094	0	11,094	11,243
2007	17,804	1,143	15,205	406	55	-2,062	32,552	9,079	0	9,079	11,255
2008	15,675	1,536	16,525	429	370	-2,487	32,048	5,621	0	5,621	9,919
2009	16,048	4,011	16,097	451	2,917	-1,549	37,975	5,707	0	5,707	8,564
2010	15,804	1,495	14,777	472	3,030	-2,698	32,880	3,520	0	3,520	7,004
2011	16,043	1,863	15,234	492	2,554	-2,305	33,881	5,151	0	5,151	5,816
2012	15,892	1,621	9,495	513	1,485	-6,712	22,294	1,664	0	1,664	4,333
2013	16,026	503	12,373	531	1,125	-1,919	28,639	11,005	0	11,005	5,410
2014	16,568	1,162	14,018	554	951	-1,162	32,092	11,427	7,448	3,979	5,064
2015	16,936	2,852	14,273	584	1,769	-2,649	33,765	10,411	10,760	-349	4,290
2016	17,239	2,675	14,214	608	1,600	-2,436	33,900	10,368	10,130	238	3,307
2017	17,203	2,114	13,981	614	1,206	-3,316	31,802	8,842	11,330	-2,488	2,477
2018	17,681	2,639	14,958	644	1,162	-1,978	35,106	11,360	13,578	-2,218	-168
2019	17,660	2,067	13,143	670	1,576	-2,601	32,515	9,403	8,905	498	-864
2020	17,848	1,888	13,248	651	1,329	-3,144	31,820	9,306	9,500	-194	-833
2021	0	0	0	0	0	0	0	0	0	0	-880
2022	0	0	0	0	0	0	0	0	0	0	-383
2023	0	0	0	0	0	0	0	0	0	0	61
2024	0	0	0	0	0	0	0	0	0	0	-39
2025	0	0	0	0	0	0	0	0	0	0	0

Table 2
Surface Water Data Used in Accounting
(units of acre-feet)

	Streamflow Gages					Colo Surface Water Diversions			Reservoir Evaporation						Beaver Creek		
Calendar Year	North Fork at CO-KS Stateline Gage	Measured Compact Compliance Pipeline Delivery	Haigler Canal Stateline Flume	Arikaree at Haigler, NE Gage	South Fork at Benkelman Gage	Total North Fork Divs including CO Pioneer	Colorado Arikaree Divs	Colorado South Fork Divs	Colorado Non-Fed Res Evap in North Fork	Colorado Non-Fed Res Evap in South Fork	Kansas Non-Fed Res Evap in Arikaree	Kansas Non-Fed Res Evap and Small SW Div Con Use in South Fork	Bonny Res Evap	Colorado Compact Entitlement in non-water short years	Colorado Beaver Creek Reduced Allocation' Water Short Years	Water Short Year (Yes/No) CO receives no Beaver Creek Allocation in Water Short Year	
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	
2000	19,435	0	5,921	3,631	4,855	5,203	0	4,554	0	0	0	13	5,557	1,940	0		
2001	19,752	0	5,011	553	3,097	4,682	0	1,634	0	0	0	65	3,972	1,500	0		
2002	15,904	0	5,646	231	1,579	5,286	0	3,814	0	0	0	41	5,750	770	770	Yes	
2003	17,700	0	4,965	1,060	905	4,358	0	996	0	0	0	39	3,375	260	260	Yes	
2004	19,759	0	3,732	341	0	4,960	0	1,283	46	0	41	310	3,158	360	360	Yes	
2005	21,060	0	4,745	1,151	0	5,213	0	458	43	0	41	298	3,430	910	910	Yes	
2006	17,608	0	4,418	404	0	5,150	0	0	50	0	46	325	3,031	1,420	1,420	Yes	
2007	20,333	0	4,522	1,308	674	4,961	0	444	38	0	18	143	2,428	2,320	744	Yes	
2008	21,638	0	4,995	1,567	1,397	1,056	0	87	37	0	14	121	1,766	3,080	0	No	
2009	24,405	0	4,193	779	8,407	394	0	169	28	0	7	65	1,020	3,100	0	No	
2010	20,418	0	5,041	2,358	12,756	474	81	1,336	41	117	11	98	1,921	2,890	0	No	
2011	19,722	0	4,826	1,074	9,916	530	55	39	36	154	14	119	1,965	2,580	0	No	
2012	14,376	0	6,129	494	6,441	886	105	0	51	107	24	213	67	1,860	0	No	
2013	18,433	0	3,839	91	0	553	75	0	45	52	17	147	0	1,130	1,054	Yes	
2014	26,707	7,448	3,110	0	0	412	35	184	38	40	11	100	0	1,250	1,228	Yes	
2015	27,895	10,760	3,668	142	4,819	792	38	616	37	38	14	124	0	2,130	1,406	Yes	
2016	28,091	10,130	3,991	397	3,898	636	62	510	37	25	13	118	0	2,430	1,650	Yes	
2017	26,046	11,330	4,732	646	2,385	432	20	716	38	14	11	96	0	2,450	0	No	
2018	32,580	13,578	3,520	821	1,970	463	0	594	38	0	12	106	0	2,430	1,852	Yes	
2019	26,082	8,905	5,165	1,113	2,385	217	0	0	38	0	12	106	0	2,510	0	No	
2020	25,000	9,500	5,165	500	2,000	217	0	0	40	0	12	106	0	2,260	0	No	
2021																	
2022																	
2023																	
2024																	
2025																	

USGS, BOR, and RRCA Accounting records used when available. Missing data estimated from historical values using engineering judgement.