ArkDSS

Task 2.8 Appendix D - ArkDSS URF Notes for Selected Groundwater Zones

Fountain Creek Groundwater Zone 1

There are two major creeks that flow through this zone: Fountain and Monument Creek. Monument Creek runs from North to South, predominantly parallel to the foothills. Based on review of geologic maps, alluvium exists in the nearby (0.5 mile) on Monument Creek but is not considered a major aquifer. The vast majority of wells are bedrock wells in this Groundwater Zone. Fountain Creek flows in the southern part of this Groundwater Zone from the mountains from NW to SE and intersects Mountain Creek at the southern edge of the Zone in Colorado Springs. Fountain Creek flows, predominantly, over bedrock and in thin alluvial cover.

There are no irrigated parcels in Zone 1 per the Div2_Irrig_2015 shapefile.

Fountain Creek Groundwater Zone 2

Fountain Creek runs NW-SE through Zone 2 and is perennial for the entirety of this stretch except for a short stretch NHD code 55800. For about half of its length in this zone, Fountain Creek does not flow through an alluvial aquifer as mapped. The southeastern section of Fountain Creek flows through mapped alluvial aquifer (ArkansasRvrBasin_Alluvial_Aquif_5_2). There is some mapped alluvial aquifers of tributary channels to the North of Fountain Creek. These aquifers are not physically connected to the main river channel however. CWCB aquifer tests (CWCB_Circular_11_ArkRivBasin_Tests) show the following:

PAGE75, Valley-Fill Deposits, T1=220,000, P1=k=8500 gpd/sq-ft (1136 ft/d)

PAGE76, Valley-Fill Deposits, T1=200,000, S=.07, P=k=5900 gpd/sq-ft (789 ft/d)

PAGE77, Valley-Fill Deposits, T1=145,000; P=k=5,000 gpd/sq-ft (668 ft/d)

Average of the Three: 188,333

There are 6 specific capacity tests with resultant T-values in Fountain Creek Zone 2: HRS Counter 3014, 3039, 3015, 3016, 3035, 3003. Their values are outlined in the table below:

HRS Counter	Transmissivitygpd/ft/Kft/d	Aquifer Thickness	Drawdown(uncorrected)	Percent Dewatered
3014	63,600/304	28	22	79
3039	NA/NA	22	21	95
3015	181,100/673	36	11	31
3016	185,400/751	33	11	33
3035	90,300/302	40	29	73
3003	434,700/2,235	26	22	85

The Transmissivity is likely highest in the middle of the channel and closer to 200,000 gpd/ft while towards the edge of the aquifer is 60-90,000 gpd/ft. In HRS' estimate, the average aquifer Transmissivity is likely in the range of 135,000 to 145,000 gpd/ft. The calculated storativity by CWCB of 0.07 is reasonable though may be higher (0.15-0.2) considering the high T-values.

Fountain Creek Groundwater Zone 3

Fountain creek itself is perennial the entirety of its length through Groundwater Zone 3. There are short stretches where the creek is located outside of the alluvial aquifer boundary. Likely this is an error in the drawing of the boundary. The main stem of Fountain Creek has 3 CWCB aquifer tests with T values of:

Page 78 115,000 gpd/ft, P=k=7,200 gpd/sq-ft (963 ft/d)

Page 79 210,000gpd/ft, P=k=12,400 gpd/sq-ft (1,658 ft/d)

Page 80 150,000 gpd/ft, P=k=5,600 gpd/sq-ft (749 ft/d)

Average T is 158,333 gpd/ft. The 150,000 gpd/ft T is most reasonable and close to the T-value calculated for Zone 2.

There are 30 specific capacity tests within Fountain Creek alluvium in Groundwater Zone 3. These range in T-value from 5,600 up to 596,200 gpd/ft. T-values in the northern end of Zone 3 near Widefield are in the range of 145,000 gpd/ft. Towards Fountain the T-values are all over from 5,600 to 115,000 gpd/ft and might average close to 75,000 gpd/ft. Further south towards the Little Creek Tributary mouth T-values increase again and range from 101,600 up to 596,200 and may average closer to 200,000 gpd/ft.

The northernmost tributary is located on the east side of Fountain Creek approximately 0.4 miles south of the boundary with Groundwater Zone 2. There are irrigated parcels that exist on this tributary system. The tributary is un-named in the NHD Flowline database and is listed at intermittent. However, the alluvial aquifer extent extends partway up this tributary and is likely the conduit for accretions. The creek flow is likely controlled by releases from Big Johnson Reservoir and Carp Lake. This tributary is also fed by and connected to a ditch that flows from Zone 2 into Zone 3.

The second northernmost tributary is located on the west side of Fountain Creek and is un-named in the NHD Flowline dataset. It is listed as an Intermittent Stream and its headwaters appear to be linked as a canal/ditch. It is loosely associated with the alluvial aquifer in that it flows within the aquifer boundary for some of its length. A wastewater treatment plant exists on this tributary and is a likely source of flow.

The next tributary on Fountain Creek is un-named on the western side of Fountain and considered intermittent by NHD Dataset except for a 1.25 mile-stretch of one of its headwater tributaries. This stretch seems to be spring fed. This tributary system has some reservoirs that likely control flow to much of the system.

Jimmy Camp Creek is the next tributary system located on the east side of Fountain Creek. This system is labeled as intermittent by NHD Dataset and flows through the alluvial aquifer system. A connecting ditch flows north to Fountain Creek Regional Park. The alluvial aquifer extends far along this creek channel.

CWCB T value for Jimmy Camp Creek alluvium was estimated at 30,000 (Page 71) at the alluvial edge to 65,000 gpd/ft (Page 73) closer to the main channel. The k-value calculated on Page 73 was 1500 gpd/sq-ft or 201 ft/d. This is an average of 47,500 gpd/ft T-value. A storativity value was calculated at 0.06 (Page 73) which is reasonable.

There are thirteen specific capacity derived T-values in Jimmy Camp Creek. They range from 110,800 gpd/ft near the Fountain Creek alluvium to 10,800 at the north end of the creek. Likely the average T-value for Jimmy Camp Creek is in the range of 20-35,000 gpd/ft.

The next major tributary to Fountain is Little Fountain Creek. Little Fountain Creek is perennial for much of its length. There is a short section of Little Fountain Creek that is intermittent coming out of Deadman Canyon while the stretch in Deadman Canyon that is perennial. There is a housing development and associated small reservoir at the headwaters of Deadman Canyon that likely contribute to the perennial flow along with numerous small tributaries and possibly some groundwater flow from the bedrock. There is another stretch of Little Fountain Creek, upstream of Deadman Canyon that is intermittent. This is likely due to a small reservoir in section 2. Little Fountain Creek Flows in the Alluvial aquifer beginning in Section 17.

Rock Creek is tributary to Little Fountain Creek and is perennial for much of its length. Where perennial Rock Creek is primarily spring fed. In sections 36 and 31 Rock Creek is intermittent until spring fed perennial tributaries feed into it further downstream in section 6. Rock Creek primarily flows on bedrock until Section 15 where it flows within the alluvial aquifer until reaching Little Fountain Creek.

Irrigated Parcels in Zone 3

Big Johnson Reservoir & Carp Lake Parcels

There are 7 parcels that exist between Big Johnson Reservoir and Carp Lake. These parcels are likely irrigated by a ditch flowing from Big Johnson Reservoir and likely return flows return to Carp Lake via overland flow and throughflow of thin alluvial cover as the underlying formation is Upper Pierre shale and the alluvial aquifer does not extend this far north. Returns are then regulated by releases from Carp Lake along an intermittent stream (intermittent due to releases) which flows through the town of Widefield, into the alluvial aquifer and to a perennial stretch of Fountain Creek.

These 7 parcels are: 21000075, 21000079, 21000076, 21000078, 21000080, 21000077, 21000081

Jimmy Camp Creek Parcels

Jimmy Camp Creek has substantial alluvial aquifer which many but not all irrigated parcels are located on. For those parcels located within the alluvial aquifer, Jimmy Camp Creek is intermittent and so return flows will be through groundwater flow in the alluvial aquifer and will have to be timed to Fountain Creek. Likely a URF zone will reach up Jimmy Camp Creek draw to a certain distance representing 95% within 20 years and those parcels north of this extent will be excluded. This has not been calculated yet.

Those parcels located within the Jimmy Camp Creek alluvial aquifer include; 21000082, 21007032, 21000084, 21000085, 21000083, 21007031, 21000090, 21000087, 21000086, 21000073, 21000102, 21000105, 21007024, 21000093, 21000095, 21000096, 21000094, 21000337, 21000099, 21000098, 21000097, 21007026.

Jimmy Camp Creek parcels not located within alluvium: 21000088 & 21000089, this is flood irrigated by Fountain Mutual Canal. Return flows likely flow south by overland flow, throughflow of thin alluvial cover as the underlying geologic formation is Pierre Shale and into the Jimmy Camp Creek alluvial aquifer in the SE of Section 21. Parcels: 21007033, 21000101 are flood irrigated by Fountain Mutual Canal and likely flow westward into parcels 21000102 & 21000105 which are connected to the Jimmy Camp Creek Alluvial aquifer. Parcels: 21000104, 21000103 return flows are likely transmitted NW by an un-named intermittent tributary to Jimmy Camp Creek. Parcel 21000106 returns via an unnamed intermittent tributary to Jimmy Camp Creek (it likely flows due to irrigation). Parcels 21000110, 21000109, 21000116, 21000112, 21000114, 21000112, 21000115, 21000113, 21000118, 21000117, 21000107, 21000108 all have return flows W by NW along an un-named intermittent tributary that likely flows due to irrigation. They return to the Jimmy Camp Creek alluvium.

Parcels 21000121, 21000120, 21000119, 21000122, 21000111, 21000001 all flow SW or S along intermittent streams, some involving impoundment via small reservoirs, eventually leading to Fountain Creek alluvium.

Fountain Creek Alluvium Associated Irrigated Parcels Zone 3

There are three parcels that lie just outside of the alluvium: 21000219, 21000216, 21000220. However, these parcels are connected to other downgradient, irrigated parcels that lie within the Fountain Creek alluvium. Return flows from these parcels flow to the downgradient parcels. These parcels act like an extension of the alluvium. Therefore the three parcels are likely in connection with Fountain Creek and return flows from these should be timed to the nearest location on Fountain Creek using alluvial parameters.

The return flows for parcels within the alluvium will be timed based on the URF zones calculated based on aquifer parameters calculated. These parcels include: 21000092, 21000091, 21000200, 21001179, 21000203, 21000202, 21000201, 21000193, 21000581, 21000192, 21000214, 21000217, 21000218, 21000199, 21000186, 21000215, 21000176, 21000188, 21007023, 21000222, 21000206, 21000209, 21000205, 21000211, 21000213, 21000207, 21000210, 21000204, 21000190, 21000229.

Parcels Located near GW Divide Between Fountain Creek and Little Fountain Creek

There are three parcels located between Little Fountain Creek and Fountain Creek that are located along a topographic divide which separates the two creeks both of which are perennial at this location. Due to proximity to Little Fountain Creek and the majority of irrigated land located on the Little Fountain Creek side of the divide I would place return flows to Little Fountain Creek. However an argument could be made to split return flows to Fountain and Little Fountain. These parcels include: 21000230, 21000231, 21000232.

Parcels South Side of Little Fountain Creek tributary to Little Fountain Creek

These parcels include: 21000228, 21000227, 21000226, 21000225.

There are three parcels on the South Side of Little Fountain Creek that are likely tributary to Little Fountain Creek & Fountain Creek based on topographic divide, these include: 21000336, 21000234, 21000233.

Parcels South Side of Little Fountain Creek tributary to Fountain Creek Mainstem

These parcels include: 21000235, 21000224, 21000178, 21000338, 21000177.

Fountain Creek Zones -additional information

Fountain valley & Jimmy Camp Creek alluvium ranges in thickness from a few feet to hundred ft. Jimmy Camp creek alluvium is finer grained because it is derived from the Fox Hills, Laramie and Dawson formations (less permeable). Extra inflow into these aquifers is from underflow or from Mesa Gravel (Qmg), a gravel ranging from 0-75 ft (avg. 10ft) overlying the Pierre Shale in the area. Particle sizes vary greatly (3-4ft to primarily <1in). However, this gravel is largely drained. Only contains small amounts of groundwater (may act as a conduit though). **REF No. 40**

TABLE 2.—*Summary of the results of aquifer tests in Fountain and Jimmy Camp Valleys*

[Principal aquifer: AF, alluvium of Fountain Valley; AJ, alluvium of Jimmy Camp Valley; AS, alluvium of Sand Creek]

Well location	Owner	Principal aquifer	Depth of well (feet)	Depth to bedrock (feet)	Depth to water below measuring point (feet)	Total saturated thickness (feet)	Duration of pumping (hours)	Average pumping rate (gpm)	Drawdown (feet)	Specific capacity (gpm per ft.)	Coefficient of transmissibility (gpd per ft.)	Average coefficient of permeability (gpd per sq ft)	Radius of influence at end of pumping period (feet)	Specific yield (percent)	Water temperature (°F)	Date
14-65-27ddb1	Banning-Lewis Ranches.	AJ	80.8	80	27.3	53	7	330	35	9	40,000	750	1,000	----	55	3-18-55
34aacl	do	AJ	82	82	25.9	57	24	300	38	8	20,000	350	2,000	----	55	3-17-55
14-66-34cdd	K. J. M. Cornsack	AS	97	88	72.9	16	5	78	10	8	10,000	620	----	----	55	7-29-55
16-65-3dcd4	Janitell Farms	AJ	61.8	66	23.3	44	96	275	29	9	60,000	1,360	1,200	----	54	4-11-55
22dbb1	H. W. Houf	AJ	78.8	87	23.8	64	24	690	22	31	100,000	1,560	700	----	54	5-19-55
15-66-14aacl	Security Village	AF	76.0	74	42.3	34	690	500	15	33	220,000	6,500	3,000	20	55	9-10-54
14abb	T. L. Bender	AF	55.7	55	26.8	29	56	670	10	67	140,000	4,800	----	----	53	7-19-54
16-65-16bba2	Rufus Marshall	AF	59.9	60	45.2	17	10	495	13	38	200,000	11,800	500	----	55	10-20-54
32adal	Clark Hanna	AF	52.3	49	24.4	27	79	525	14	38	150,000	5,500	1,200	----	55	10-27-54
17-65-3ceb	do	AF	37.3	37	13.5	24	51	460	17	27	120,000	5,000	700	----	54	11- 1-54
23dda	Dan Holmes	AF	28.8	29	14.3	15	76	280	10	28	50,000	3,300	----	----	54	10-6-54
18-65-1bba1	Paige Ranch	AF	[1] 29	[1] 29	[1] 4.0	[1] 25	600	900	19	47	180,000	7,200	2,500	27	63	10-22-54

[1] Average battery of 2 wells.

TABLE 3.—*Summary of laboratory determinations of hydrologic properties of alluvial sediments*

Location	Depth of sample (feet)	Specific retention (percent)	Porosity (percent)	Specific yield (percent)	Coefficient of permeability (gpd per sq ft)
15-66-3acc	35-45	9.4	37.4	28.0	4,200
15-66-10aab	15				3,600
	25				1,700
	35	1.6	31.3	29.7	3,500
	45	2.1	30.5	28.4	1,300
15-66-11bcd	42	1.2	28.7	27.5	3,100
	52	.7	30.2	29.5	5 800
	62	.6	30.5	29.9	5,900
	72	1.2	30.5	29.3	8,600
	79	3.0	29.8	26.8	5,200
15-66-14aacl	38	6.3	32.1	25.8	6,300
	70	2.0	34.0	32.0	1,800
15-66-14aac2	60	4.3	39.6	35.3	10,000
16-65-16bbb2		11.9	35.8	23.9	1,300
16-65-17aaa3	52	11.6	35.5	23.9	860
17-65-3cdb1	16-19	12.0	30.6	18.6	1,300
17-65-4dda	24-26	5.4	35.1	29.7	4,800
18-65-1bba	7				8,000

REF No. 263 provides plate # three – Saturated thicknesses in the Fountain Creek alluvial aquifer near Colorado Springs

Fountain Creek Zone 4

The northernmost perennial stream in Zone 4 is Williams Creek. The upstream section of the stream flows on Upper Pierre shale based on the Tweto map. It becomes intermittent periodically, especially once it begins flowing in alluvium near Calhan reservoir. There are parcels in this area:

Parcel ID 21000221: Is NW of Calhan Reservoir and not located in alluvium. It is located on middle Pierre Shale per Tweto (1980). Based on topography return flows from this location likely go to Calhan reservoir and follow releases from Calhan in ditches to Fountain Creek.

Parcel ID 21000187: Directly south of Calhan Reservoir and is fed by a ditch flowing out of Calhan Reservoir. Return flows from this likely follow the ditch path southward until reaching Fountain Creek Alluvium.

Parcel ID 21000223: Is E of Calhan Reservoir and fed by Chilcotte Ditch 27. Return Flows from this Parcel likely feed into the parcels directly south.

Parcel ID 21000198: Is directly south of Parcel 21000223. This parcel is fed by return flows and a ditch from Calhan Reservoir. Return Flows from this feed the parcels directly south of this one. These parcels include: 21007027, 21000189, 21007028, 21000197, 21007029, 21000236, 21000236, 21007030. It is located on Pierre shale so flows likely are through thin alluvial cover used for farming and overland flow. The parcels in this area likely flow south east due to “The Buttes” creating a divide, on top of pierre shale until reaching alluvium in the NW corner of Section 35. There they follow the alluvium and associated intermittent streams until reaching Williams Creek which is intermittent here.

Transmissivity in Fountain Creek Zone 4

There are two CWCB tests in the Fountain Creek alluvium:

Page82: T= 45,000 gpd/ft, K= 1900 gpd/sq-ft or 254 ft/d.

Page121: T=60,000 gpd/ft, K= 3,000 gpd/sq-ft or 401 ft/d.

There are 23 specific capacity tests in this Zone. They range in value from 37,000 gpd/ft to 240,900 with an average of 86,900 gpd/ft.

The Fountain Creek main-stem is perennial over the length of Zone 4 except for ¾-mile stretch in Section 24. There is uncertainty as to why this stretch would be intermittent.

Sand Creek is a Perennial tributary to Fountain Creek with a connection to Fountain via the Jackson & Burke Ditch.

Young Hollow is not perennial as a tributary to Fountain Creek and any returns along this path flow through the alluvium as groundwater flow.

Fountain Creek Groundwater Zone 5

There do not appear to be any CWCB tests in this zone. There are 5 specific capacity tests associated with the alluvium. The associated T-values range from 44,900 to 93,400 gpd/ft. With an average of 69,000 gpd/ft. The alluvium is narrower here and the saturated thickness is seemingly lowered according to reported values in well logs used to derive the specific capacities. This would indicate T has diminished along Fountain Creek from Groundwater Zone 3 into Zone 4 and further still into Zone 5.

Fountain Creek is considered an artificial path in the southern section of Groundwater Zone 4 through Groundwater Zone 5. It is sinuous and seemingly natural so it is unclear why the NHD classified it as such. HRS considers this to be a perennial stretch of stream and URFs will lag to the nearest location on this stream. The shapefile Perennial_FtnCrk5_HRS corresponds this stream.

Fountain Creek Alluvial Aquifer Parameters from bibliography

A reconnaissance water-quality appraisal…: b= 0-50, bavg=20, k= 400 – 1,600 ft/d (from aq tests), Sy = 0.2-0.3, Syavg= 0.25. T = 8,000-32,000 ft^2/d or 60,000-240,000 gpd/ft . This matches the estimates given from CWCB and Spec Cap tests.

Adobe Creek Zone

Adobe creek is a tributary on the northside of the Arkansas River and leads into the HI model coverage between the towns of La Junta and Las Animas. Adobe Creek is perennial from Township 17S Range 54 W until it reaches the HI model boundary. A tributary to Adobe, Mustang Creek is coded as artificial and may be considered perennial for parts of its length however return flows should be directly to nearest location on Adobe Creek that is perennial. Adobe Creek flows into Adobe Creek Reservoir and return flows in Adobe Creek will be controlled by releases in the reservoir.

Adobe Creek flows on bedrock – Kpl (lower Pierre) and Kn (Niobrara) which is likely why it is perennial for a long distance.

There are no CWCB tests along Adobe Creek. There are a few wells in the area from Div2_wells_2015 shapefile but they do not have specific capacity data. There is no alluvial aquifer mapped along Adobe Creek. URF's will have to be considered using bedrock values. A review of Alluvial_All References did not show much for alluvium or its properties in this GW zone.

Big Sandy Creek

Big Sandy Creek has associated alluvial aquifer for the majority of its length. It is perennial for short stretches until it combines with Bush Creek and flows south into the Arkansas River. There are a few CWCB tests along its length. T-values are: 45,000 gpd/ft, 55,000 gpd/ft, and 45,000 gpd/ft.

BigSandyPerennial_HRS.shp is the polyline file HRS interpreted this length of Big Sandy to be perennial and used for URF calculations in the Big Sandy Groundwater Zone. Reasoning includes a majority of the stretch NHD labeled as perennial, however an approximate 3.5 mile bend in Big Sandy is labelled as intermittent this has been included for simplicity and as Big Sandy is considered perennial upstream and downstream from it. This length of Big Sandy is downstream of the confluence of Rush Creek and there are no marked laterals coming from the river along this stretch until the very edge of Big Sandy Zone boundary. A perennial stretch just upstream of this confluence was not considered because it is immediately downstream of a ditch lateral and the stream is considered intermittent just north of this location.

Chico Creek Zone

Chico and Black Squirrel are predominantly considered perennial streams by NHD. Therefore recommendation is to create URF zones parallel to Arkansas River to 20 years and time using these. There are very few irrigated acres or ditches in the southern reaches of Chico Creek which may mean timing is outside of 20-years. The alluvium has no CWCB tests.

The alluvium here is the Chico alluvial aquifer. The portion west the Pueblo Chemical Depot or Pueblo Depot Activity (PUDA) facility was investigated for measurements. The PUDA facility is also underlain by terrace alluvial deposits that flow south rather than feed into the Chico alluvium.

Property (Chico Aquifer) notes:

- Bedrock surface slopes 31 ft/mi to the south
- Sat. thickness ranges from 0-30ft usually less than 15ft
- Total thickness of alluvium in saturation ranges from 16-41 ft
- Measured hydraulic conductivity ranges from 14 to 310 ft/day (median 42ft/day)
- Measured specific conductance of water range from 683 t0 1460 microsiemens per cm

The above data is based on the table snipped from **REF no. 273** below. There were 14 points of measured data in the Chico alluvial aquifer, there were twice that in the terrace deposits. The average of the Chico aquifer Hydraulic Conductivity is approximately 92 ft/d and the geometric mean is approximately 50 ft/day.

Table 1. Values of hydraulic conductivity of the alluvial aquifers at the Pueblo Depot Activity--Continued

Well name	Local well number	Depth of screen (feet below land surface)		Hydraulic conductivity, K (feet per day)	Source of data
		Top	Bottom		
Area 9—Terrace alluvial aquifer					
109MW–01	SC02006233ABB	33.2	42.7	21	(2)
109MW–02	SC02006233ABB	32.3	41.8	75	(2)
109MW–03	SC02006233ABB	29.5	39.0	108	(2)
Area 10—Terrace alluvial aquifer					

Upper Black Squirrel Creek alluvial characteristics from tests show a k-value of 127 ft/d and Sy of 0.2. These tests may not be representative of the entire aquifer. (Artificial Recharge Tests in Upper Black Squirrel Creek Basin). There are no specific capacity tests per the 20180918SpecCapacity.shp file. Alluvial thickness data are sparse in the wells files. A presumed 20 fit alluvial thickness would amount to a T-value of about 20,000 gpd/ft which seems reasonable.

WD14North Zone

Haynes Creek is the only perennial stream in this groundwater zone. It is perennial while it flows along bedrock and then becomes ephemeral once it reaches alluvium (presumably it partially saturates the alluvium). There are no ditches per the Div2_Ditches_Rev2.shp file. There are no Div2 irrigated parcels per the Div2_Irrig_2015.shp file either. There is minimal alluvium located in this GW Zone.

WD17 North Zone

There are no perennial streams in this area. There is no mapped alluvium from the ArkansasRvrBasin_Alluvial_Aquif_5_2.shp file. There is a single irrigated parcel per Div2_Master_Irrigated_Lands (Outside HI).shp file. This zone does not require URF's.

Horse Creek Zone

No URF's needed above senior calling rights (Carter's Box Springs rights) as all in-basin depletions are mitigated at the Box Springs location by in-basin aug plan (Horse Creek Water Users Assn.). South of the diversion for Box Springs an alluvial aquifer is present southward into the HI-Model area and connected to the Arkansas river valley alluvium. Horse Creek is ephemeral for its entirety south of Box Springs diversion. The Box Springs diversion feeds a few irrigated parcels which are not connected to the Horse Creek Alluvium. Breckenridge Creek is perennial as it flows on bedrock but becomes ephemeral is it meets Horse Creek and associated Horse Creek alluvium. There are few irrigated acres though one exists just outside of the HI model area, objectID 2540 in Div2_Master_Irrigated_Lands (Outside HI) shapefile.

WD67 Northwest Zone

There is no mapped alluvium from the ArkansasRvrBasin_Alluvial_Aquif_5_2.shp file. The streams are predominantly intermittent. There are only a few irrigated parcels per Div2_Irrig_2015.shp. These are located on aeolian sand but there is no mapped alluvial aquifer at this location and no perennial streams.

Big Sandy & Rush Creek Zones

Not necessary – Futile Call per Div 2.

WD67 Northeast Zone

There are some irrigated parcels in this GW zone. There is a very short stretch of artificial stream length in the southern reach of this zone – it is known as Buffalo Creek. There is no mapped perennial stream in this zone.

There is no alluvial aquifer per the ArkansasRvrBasin_Alluvial_Aquif_5_2.shp file. Per the cogeol_dd_polygon.shp file the major surficial geology in this area is Qgo or older gravels and alluviums of Quaternary age. This formation should transmit water. A subset of well construction logs shows:

Permit 209277 – GW derived from bedrock limestone

Permit 3166-F – GW derived from thick sand & gravel unit 90-130' deep.

Permit 4710-F – GW derived from thick sand & gravel unit 90-150' deep.

Permit 2319-F - GW Derived from thick sand & gravel unit 90-150' deep.

Permit 3618-F – GW Derived from deep bedrock sandstone

Permit 140246-A – GW derived from sand & gravel 30-50'

41192 – GW- derived from Dakota sands

It appears that an alluvial aquifer exists though it may be spatially discontinuous. Much of the well construction records indicating an alluvial aquifer are from the 1940s-1970s. Newer well construction records are typically in bedrock aquifers. This may indicate a thinning of the alluvial aquifer such that it no longer exists or no longer feasible for higher-production (i.e., greater than 15 gpm). A thin (20 feet or less) aquifer may still exist in the alluvium but may be spatially discontinuous and likely of low transmissivity.

Specific Capacity tests within the H-I model boundary just south of WD67 NE provide the following data:

HRSCounter Receipt – Specific Capacity (GPM/FT drawdown)

2282_9092655 – 5.63

2526_9092570 – 9.09

2626_9092571 – 9.52

2759_9092656 – 5.63

387_9092572 – 28.57

Average specific capacity – 11.69, Resultant T-value (per Driscoll 1986, 1500*Sc) = 17,500 gpd/ft

This seems reasonable as an estimate.

WD67 South Zone

Muddy Creek is the northwestern-most tributary to the Arkansas in WD67 South. It flows from Muddy Creek Reservoir. It flows on alluvium for a short length. Eagle Rock Ditch flows this length northward to Section 4, T24S R51W in eolian sand. The ditch seems to disappear into these sands. These are not mapped as an alluvial aquifer. Wells in the area: permits 8170, 44236 do not show a viable aquifer.

Therefore, Eagle Rock Ditch is not considered a viable tributary or purveyor of return flows to the Arkansas River or its alluvium. Muddy Creek flows into Rule Creek and becomes ephemeral thereafter. Rule Creek does not flow in alluvium. Rule Creek is perennial starting in Section 36 T23S R 51W. From there it flows into Arkansas River Alluvium.

Caddoa Creek is the next creek going east from Muddy Creek. Caddoa Creek is only perennial for a short length. After that it is intermittent all the way to Arkansas River. There are a couple of irrigated parcels along its length – return flows from these are likely limited to bedrock which is Dakota Sandstone.

The next eastern creek is Mud Creek. Mud Creek runs on Dakota sandstone and is perennial for much of its length. There are no irrigated parcels along Mud Creek but Pierce Ditch runs alongside Mud Creek and a URF could be made for this ditch. Alluvium exists along the length of this ditch per cogeol_dd_polygon.shp file (Tweto, 1980) though the mapped alluvial aquifer (ArkansasRiverBasin_Alluvial_Aquif_5_2.shp) does not extend as far north. In HRS' opinion, the ditch return flows could be timed back to Mud Creek as alluvium exists here, as evidenced by permit 121985 and alluvium is mapped per Tweto.

The next creek eastward is known as Willow Creek. Willow Creek is an intermittent creek that predominantly flows on Dakota sandstone. There are a few irrigated parcels and these will have to be timed through Dakota sandstone if timing of bedrock wells is needed.

The next eastern creek is Clay Creek. Clay Creek runs along a narrow patch of alluvium on top of Dakota sandstone. There are a few irrigated parcels within the Clay Creek watershed. Most are located on bedrock, these include parcel numbers: 26701269(no crop), 26701434 (no crop), 26707803 (no crop), 26701433 (no crop). Two other parcels, 26707545 (no crop) & 26701412 (no crop) intersect with the Clay Creek alluvium and would recommend timing in the alluvium. Clay Creek is considered an artificial path or intermittent downstream of these parcels into the HIM. If completed, HRS would recommend timing zones parallel to Ark River basin southward through Clay Creek alluvium.

The next eastern creek is Wolf Creek. Wolf Creek flows on bedrock and has no irrigate dparcels or ditches associated with it.

The easternmost creek in WD67 South is Granada Creek. Granada Creek flows on bedrock – Kcgg – The Colorado group which is Carlile, Greenhorn, and Graneros formations. There isn't an alluvial aquifer until the HIM boundary and the Arkansas River alluvium. Granada Creek is intermittent for its length. There are several irrigated parcels on Granada Creek. Return flows from these likely flow overland into Granada Creek but may not reach the Arkansas. Some of the return flows may go into bedrock as well and flow through that to the Arkansas River alluvium.

Buena Vista & Salida Zones

Aquifers: River is incised into Qal; glacial outwash deposits; there is deep basin fill in much of this reach; quite permeable to ~300 to 500 ft deep especin BV area; Tertiary Dry Union Fm (Santa Fe Fm

equivalent) generally from Chalk Creek to Salida (not especially permeable; but may be some small Q wells) in foothills. Small capacity wells in bedrock (Paleozoics & PreC) in mountains E and W.

All GW depletions/accretions in the BV – Salida Reach would accrue to Ark River at or above the constriction at Bear Creek confluence ~2 mi east of Salida.

Areas of alluvium (in and out of previously mapped alluvium) often display a sizeable amount of gravel in the unconsolidated column. Sometimes the wells/boreholes are drilled in excess of 400 ft without ever reaching bedrock. These seem to be primarily located on tributaries to the west of the Arkansas River. Likely, these are the result of buildup of poorly sorted river material from nearby mountains.

Static water level in the above-mentioned areas is also quite deep, usually 180-250 ft down the hole, revealing a sizeable amount of water.

URF mapped zones heavily relied on topographic data as well as well data. Both Buena Vista and Salida fall into the Buena Vista-Salida structural basin within the deep Upper Arkansas Graben valley. The second structural basin contains Leadville. Structural basin geologic map (**REF no. 323**):

Glacial till and alluvial outwash are the predominant type of deposit in the area. Outwash deposits are more stratified and similar to alluvium than till. Glacial outwash thickness ranges from 0-500ft in the upper Arkansas Graben valley and the Wet Mountain Valley. Estimated composite thickness in the study area is about 100 ft. Older alluvial deposits in the study area are lithologically similar to glacial outwash and can be sometimes found 700 ft topographically higher than the Arkansas river. Thicknesses of older alluvium range from 15-80 ft with a combined thickness of 165 ft. This paper (REF 323) used only textbook values for hydrologic properties based from the descriptions of the geologic material. Hydraulic Conductivity values were taken from the lower Arkansas River Valley east of pueblo (Chico? Fountain Creek?).

This study also divided this zone into 3 zones going westward:

- Alluvial-Outwash aquifer
- Till aquifer
- Bedrock fill aquifer

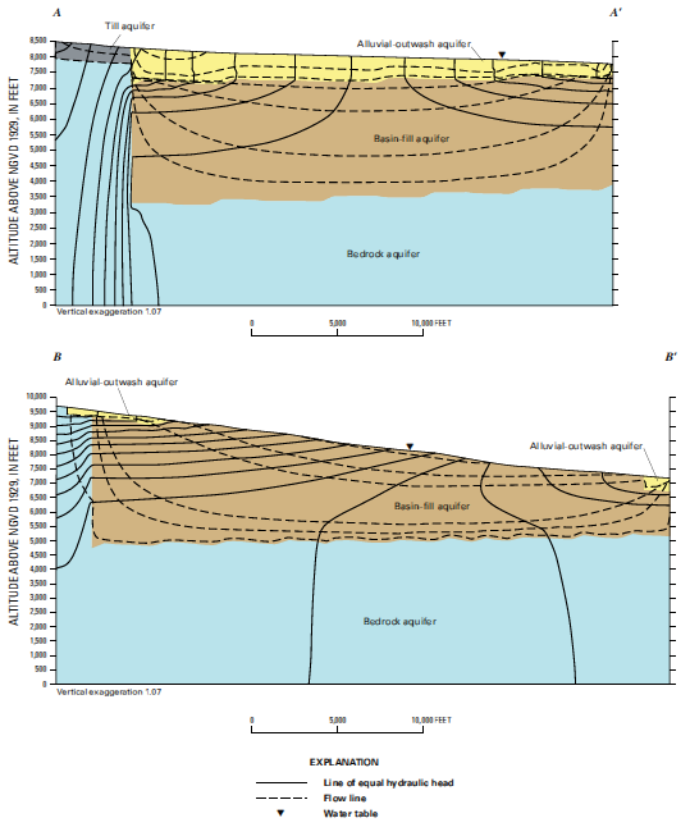

Figure 6 Preliminary cross-sectional models of ground-water flow (A) near Buena Vista, Colorado, and (B) northwest of Salida

Canyon City – Penrose

Saturated alluvium extended to the DEWEESE DYE DITCH (ID: 1200672). GW wells NE (GW flow direction to Arkansas River) of the ditch are numerous and permits mentioned they are producing small irrigation / domestic amounts of water, though there's little information on the saturated thickness here. A report (Ref No. 220 in spatial bibliography) mentions holes drilled SW of the ditch were dry and provided a groundwater contour map of the alluvial aquifer NE of the ditch.

Wells in the NW portion of this area near irrigated lands repeatedly report shale and clay—deemed not part of the alluvium.

Wells in the SW of this zone are likely either deep water wells or wells related to the uranium mill in the area.

Eightmile Creek, tributary to the Arkansas River, did not have alluvium extended along it, despite being marked a perennial stream. Wells along the creek are sparse and reveal little to no alluvium with no saturated thickness.

Bright Hollow Creek (marked perennial) no evidence of alluvium.

The NE section of this zone has large amounts of irrigated land fed by ditches from Bright Hollow Reservoir. A quick search into some of the wells dispersed through the irrigated parcels reveal the area has a very thin layer of topsoil (usually 3ft) overlying limestone and sandstone bedrock. Not included in alluvium.

Salt Creek Zone

Western stretch of the Arkansas River in this area (the outlet to Lake Pueblo) was deemed to be low K alluvium outside of the previously digitized area. There are a few wells which show a saturated thickness >30 ft but are sparse, so the alluvium was traced based on the topography. Alluvium was also extended south just west of the city park in this area. Numerous wells that don't have drillers logs but have shallow depths (30-40ft) and even shallower static water levels (14-5ft).

Cimarron River Zone

No mapped alluvium or perennial streams connected to Arkansas River

WD18 Zone

No mapped alluvium or perennial streams connected to Arkansas River; stretch of perennial stream with irrigated parcels

Leadville, Buena Vista, Salida:

Headwaters down to Twin Lakes / Lake Creek (i.e. constriction where Ark R runs on granite, at Granite CO). = "Headwaters Reach".

- Aquifers: Qal in stream bottom; glacial outwash deposits; possibly some deeper basin fill; bedrock (Paleozoics & Pre C) in mountains E and W.
- All GW depletions/accretions in the Headwaters Reach would accrue to Ark R at or above the constriction at Granite.

Lake Creek to Bear Creek confluence (about 2 miles downstream of Salida), where the Salida/Buena Vista basin constricts to a narrow bedrock canyon, and river runs on bedrock again. = "Buena Vista-Salida Basin Reach".

WD16 Zone

Perennial stretch of the Cucharas river is connected to the Arkansas River from here though no irrigated acreage, and no mapped alluvium. An unconnected stretch of the Cucharas river has a fair amount of irrigated parcels but no alluvium.

WD17 Zone

Small patch of low K alluvium included incase ditch is used for timings. Evidence for alluvium here (5-7ft thick)

WD14 South Zone

West of Huerfano Cucharas Ditch well permits indicate consistent BR close to surface with little overburden. East of the ditch where a concentration of irrigated ditches. Alluvium expand to edge of ditch. Sat thickness is probably on the order of 8ft. Perennial stream connects without break to WD79.

Purgatoire River – Below Thatcher Zone

Furthest downstream area: evidence of sand & clay unconsolidated material on the west side of the river. Alluvium expanded to reflect that but no saturated thickness available.

Confluence: Irrigated area west of the confluence suggests this is a fairly thick area of alluvium (upwards of 60 ft low k material). No saturated thickness.

Two Butte Creek Zone

Small addition to the alluvium near the connected part of the river to the Arkansas. NHD shows that it isn't connected briefly near the entrance to the HIM are and is an artificial path, but this is likely not the case.

Coaldale Zone

There are shallow wells without drilling records that are around 30 ft deep. Other more detailed drilling records indicate about a 20-30ft zone of gravel/cobbles underlain by decomposed granite rock. Static water levels in these wells also indicate the water is near the boundaries between the alluvium and decomposed granite. In these areas small patched of alluvium are assumed to have saturated thickness as the shallow wells would suggest. Either way, the irrigated fields near the Arkansas River are returned underflow to the river.

There are also areas of overburden (20ft) on top of bedrock. The fields are very near the river, would this count to expand the aquifer?

Southeast area in WD12 needs revisiting; lots of old wells without drill logs, probably shallow…. Include? (Jas a few irrigated parcels)

WD13 Zone

Many wells very near (100 or less feet) of each other have juxtaposing opinions on the first 100 or so ft depth geological material. Some call it brown/red sand and gravel while others call it decomposing(ed)

red granite. This indicates material is quite soft and relatively unconsolidated, glacial like deposits and will be considered as part of the URF Boundary.

Hardscrabble Creek Zone

Majority of the wells so far seem to drill into the shale and perforate casing in that. There is ~12 to 20 ft of alluvium under the irrigated fields here. This is located around the confluence nearest to the confluence with the Arkansas.

The rest of the zone seems to have little to no overburden before hitting either sandstone or shale. Alluvium not expanded here.