TABLES

mple Date	Fie[illegible] pH	Lab pH	Lab TDS	Ca	Mg	Na	[illegible]	HCO3	SO4	Chl	NH3 as N	NO3 as N	T[illegible]s (Chloroform)	Al
	SU	SU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ug/l	mg/l
C Standard	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	80	NA
A Standard	NA	NA	4800	NA	NA	NA	NA	NA	2125	250	NA	190	NA	5
42	42	42	42	42	42	42	42	42	42	42	40	23	0	0
/4/2000	8.40	8.38	2280.00	35.10	16.30	665.00	7.50	326.00	1150.00	176.00	3.48	5.19	N/A	N/A
'22/1989	6.70	7.12	903.00	19.10	6.40	273.00	2.40	195.00	458.00	15.40	0.07	0.06	N/A	N/A
N/A	7.55	7.94	1074.33	25.82	11.49	323.69	3.58	252.43	532.83	48.25	0.48	0.47	N/A	N/A
N/A	7.60	8.00	1037.00	25.55	11.35	305.50	3.30	254.50	515.00	31.65	0.37	0.25	N/A	N/A
95	95	95	95	95	95	95	95	95	95	95	82	45	1	21
/16/2012	8.40	8.42	1500.00	82.20	46.80	362.00	11.90	309.00	797.00	26.60	2.04	1.40	7.09	1.18
/12/1989	6.50	7.09	986.00	18.20	8.50	272.00	2.50	220.00	481.00	12.00	0.06	0.10	7.09	0.10
N/A	7.70	7.90	1111.40	33.40	16.08	317.02	3.77	255.77	593.48	18.30	0.30	0.26	7.09	0.34
N/A	7.75	7.94	1080.00	31.00	14.00	317.00	3.50	251.00	580.00	18.00	0.25	0.20	7.09	0.20
43	43	43	43	43	43	43	43	43	43	43	42	31	0	0
/4/2000	8.00	8.41	1098.00	38.90	19.90	334.00	5.40	254.00	620.00	23.40	1.00	2.08	N/A	N/A
'22/1989	6.50	7.07	857.00	25.10	12.80	256.00	1.70	207.00	457.00	9.50	0.10	0.06	N/A	N/A
N/A	7.58	7.97	980.00	31.05	16.01	277.02	3.32	235.65	518.91	16.14	0.31	0.29	N/A	N/A
N/A	7.60	8.05	975.00	30.90	15.90	275.00	3.20	239.00	517.00	16.20	0.28	0.18	N/A	N/A
234	233	234	234	234	234	234	234	234	234	234	233	66	1	31
.0/2007	7.42	8.09	5610	651	637	315	19	641	3882	252	2.23	51.80	0.91	0.60
7/1989	6.14	5.89	2490	328	141	127	5.6	108	1410	19.40	0.13	0.01	0.91	0.10
N/A	6.61	7.16	4225	500.72	337.54	194.71	8.15	225.18	2703	37.13	0.77	1.77	0.91	0.19
N/A	6.60	7.17	4569	521	366	191	8	193.5	2952	37.90	0.75	0.16	0.91	0.14

Desc	Sample Date	Co	Pb	Mn	Mo	Ni	Se	V	U	Rad-226	Rad-228	Rad Total	Th-230	Pb-21
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	pci/l	pci/l	pci/l	pci/l	pci/l
	NRC Standard	NA	0.05	NA	NA	0.05	0.01	0.1	0.3	NA	NA	9.4	5	1
	EPA Standard	0.05	0.05	2.6	1	0.2	0.01	0.7	5	NA	NA	5	NA	NA
etect/count	42	1	0	41	3	1	15	0	41	25	5	42	3	7
ax detect	1/4/2000	0.01	N/A	0.43	0.14	0.05	0.007	N/A	0.334	8.40	3.70	12.10	1.60	28.0
in detect	7/22/1989	0.01	N/A	0.05	0.02	0.05	0.001	N/A	0.0006	0.20	1.40	0.00	0.60	1.0
ve. detect	N/A	0.01	N/A	0.17	0.06	0.05	0.002	N/A	0.0156	1.30	2.40	1.06	0.93	6.0
edian detect	N/A	0.01	N/A	0.15	0.02	0.05	0.001	N/A	0.0050	0.60	2.50	0.45	0.60	2.0
etect/count	95	1	1	81	5	0	12	0	47	64	18	95	4	9
ax detect	10/16/2012	0.01	0.05	0.39	0.76	N/A	0.007	N/A	0.015	2.40	3.40	5.10	0.60	6.10
in detect	10/12/1989	0.01	0.05	0.01	0.02	N/A	0.001	N/A	0.0003	0.20	1.10	0.00	0.30	1.2
ve. detect	N/A	0.01	0.05	0.04	0.22	N/A	0.002	N/A	0.0026	0.74	2.14	1.04	0.40	2.6
edian detect	N/A	0.01	0.05	0.03	0.14	N/A	0.001	N/A	0.0012	0.63	1.90	0.70	0.35	2.6
etect/count	43	2	0	39	4	1	9	0	36	28	10	43	3	5
ax detect	1/4/2000	0.01	N/A	0.10	0.11	0.19	0.007	N/A	0.068	2.00	3.70	4.00	3.00	2.2
in detect	7/22/1989	0.01	N/A	0.01	0.01	0.19	0.001	N/A	0.0009	0.20	1.20	0.00	0.40	1.0
ve. detect	N/A	0.01	N/A	0.03	0.08	0.19	0.002	N/A	0.0058	0.67	1.95	0.89	1.43	1.6
edian detect	N/A	0.01	N/A	0.02	0.10	0.19	0.001	N/A	0.0025	0.60	1.70	0.60	0.90	1.5
etect/count	234	24	1	225	5	3	10	0	194	229	164	213	19	45
ax detect	10/2007	0.06	0.05	4.15	0.27	0.07	0.004	N/A	0.975	5.40	13.8	14.80	4.90	9.1
in detect	7/1989	0.01	0.05	0.66	0.03	0.06	0.001	N/A	0.0004	0.20	1.00	0.20	0.20	1.1
ve. detect	N/A	0.02	0.05	2.43	0.12	0.07	0.002	N/A	0.0086	1.27	3.46	3.62	0.97	2.5
edian detect	N/A	0.01	0.05	2.65	0.13	0.07	0.002	N/A	0.0013	1.20	3.10	3.35	0.70	2.1

)	0006 A	[illegible]7 D	0029 A	0030 D	0101 A	0102 A	0104 D	[illegible]5 A	0109 A	0110 D	0113 A	0330	0331	0[illegible]AD	0509 D
878	6929.325	6925.675	6879.775	6880.6	6930.225	6901.3	6928.2	6926.275		6917.125	6932.275				
864	6929.65	6926.143	6881.264	6880.385	6930.443	6909.723	6928.607	6926.731		6918.3	6933.207				
672	6931.207	6926.994	6883.043	6879.114	6931.271	6907.521	6929.427	6927.475		6921.062	6933.133	6939.475	6937.6		
024	6930.139	6925.64	6884.287	6874.112	6930.725	6912.662	6928.728	6926.876		6921.415	6932.473	6937.774	6935.953		
735	6930.379	6925.295	6885	6873.3	6930.2	6909.053	6928.443	6926.639		6922.505	6933.685	6937.452	6935.635		
456	6931.196	6926.537	6885.629	6873.629	6930.792	6912.715	6929.275	6927.222		6923.225	6936.517	6937.172	6935.316		
883	6931.631	6927.172	6885.98	6873.68	6931.26	6913.24	6929.823	6927.854		6923.829	6932.886	6937.128	6935.183	6931.8	6932.946
	6930.767	6926.9					6927.4	6927.633		6922.267	6935.7	6937.3	6933.933	6932.35	6932.72
	6931.1	6927.533			6930.6	6912.5	6929.867	6928.1		6920.55	6935.033	6937.65	6933.95		
902	6932.933	6928.967	6886.7	6873.8	6930.6	6912.5	6931.567	6929.567		6925.333	6940.233	6937.967	6935.4		
													6935.8		
5	6935.6	6932.1	6884.7	6875.4	6934	6916.1	6934.8	6932.8	6928.7	6928.9			6935.7	6932.3	6933.3
													6935.85	6933.1	6933.9
	6935.4	6932.3	6884.5	6875.5		6916	6934.5	6933		6928.9	6941			6932.9	6938.2
		6934.529						6935.46	6931.747	6931.424			6936.2		
	6937.9	6933.496	6883.5				6936.8	6934.536	6931.496	6930.338	6940.6				
		6932.45						6933.386	6930.723	6929.431			6935.4		
	6935.9	6932.15	6883.2	6874.9	6934.4	6911.8	6934.9	6933.15	6930.217	6929.125			6935.3	6932.4	6933
		6932.8						6933.846	6930.746	6929.9			6935.2		
098	6935.6	6931.94	6882.9	6874.9	6934.1		6934.7	6932.94	6930.425	6929.12	6945.8		6934.6	6931.8	6932.4
		6930.9						6931.967	6929.933	6928.1			6934		
	6932.3	6930.367	6883.4	6874.7	6932.9		6936.6	6931.333	6929.633	6927.733	6943.5	6933.675	6932.743	6931.2	6931.6
		6931.267						6932.233	6929.467	6928.8			6932.636		
	6935	6930.133	6882	6874	6933.5		6933.5	6931.1	6929.533	6927.833	6942.1		6932.025	6930.6	6931
		6928						6929	6929	6925.567			6930.15		
		6926.733	6881.6		6927.7		6927.9	6926.6	6924.95	6923.6			6927.25	6926.7	6927.2
		6924.3	6881.2		6925.2		6925.8							6924.7	6925.2
		6924.1	6881.1		6924.9		6925.1	6924.4		6920.7			6925.3	6924.1	6924.6
		6924	6881.1		6922.8		6924.2	6924.8	6926.9	6920			6924.4	6923.2	6923.7
		6922.2	6880.9		6921.9		6922.7	6922.3	6925.2	6918.4			6923.5	6922.5	6923
		6920.3	6880.7		6920.8		6921.5	6920.9		6917.1			6922.9	6921.6	6922
		6918.9	6880.6		6919.7		6920.2	6919.6		6915.9			6922.3	6920.9	6921.2
		6917.8	6880.5		6918.3			6918.5		6914.7			6921.4	6919.9	6920.15
		6916.6	6880.2		6917.1		6917.6	6917.1		6913.3			6920.5	6919.1	6919.25
															6918.6
			6879.6					6915		6911.3					6917.9
			6879.7					6914.7		6910.4					6917.6
			6879.4												6916.6
			6879.1												6915.8

)	0006 A	[illegible]7 D	0029 A	0030 D	0101 A	0102 A	0104 D	[illegible]5 A	0109 A	0110 D	0113 A	0330	0331	0[illegible]AD	0509 D
			6878.4												6915.3
															6914.3
															6913.4
			6877.4												6912.6
			6877												6908
			6876.8												6907.5
			6876.2												6906.8
			6875.4												6906.2
			6875												6905.5
			6874.8												6904.8
			6873.5												6904
			6872.3												6903.4
			6872.1												6902.9
			6872.2												6902.3
			6865.9												6901.3
			6868.3												6900.6
			6870.3												6900.2
			6870.2												6899.5
			6869.5												6898.9
			6869.1												6898.6
			6869												6898
			6868.7												6897.3
			6868.1												6896.6
			6867.5												6896.2
															6895.7
															6895.1
															6890.1
															6889.6
															6889.2
															6888.5
															6888
															6887.8
															6887.2
															6887
															6886.6
															6886.2
															6885.7
															6885.4
															6884.84
															6884.6
															6884.2

514 AD	0514 D	0521	0524	0525	0624	0625	0626	0627	0631	0632	0634	0635	0637	0639	064
876.1															
6875															
		6925.8	6917.9												
875.25				6936.9											
876.6		6930.5		6936.5											
876.1	6874.3														
6876	6874.2	6931.4		6937.2											
875.9	6874.1														
875.9	6874.2	6932.2		6937											
6876	6874														
875.7	6873.8	6930.8		6935.4							6961.684	6962.917			
875.1	6873.3								6962.8		6961.608	6962.992	6930.30	6954.10	6949.
875.2	6873.4	6932.6		6936.9							6960.4	6962.033	6930.20	6953.20	6948.
874.9	6873.1				6859.9	6862.4	6855.1	6844.4	6862.1	6875.9	6960.7	6964.2	6927.90	6950.20	6947.
874.8		6928.12			6860.1	6862.3	6855.2	6844.5				6962.3	6926.00	6949.00	
874.3		6926			6860.2	6862.3	6855.6	6844.8					6924.30	6947.90	
874.4		6924.95			6860.65	6862.5	6855.9	6845			6960	6963	6923.15	6947.25	
874.7		6924.2			6860.5	6862.6	6856	6845.2			6960.3	6963.1	6922.40	6947.00	
874.5		6922.9			6860.5	6862.6	6856	6845.5			6961.4	6962.4	6921.00	6946.00	
874.2		6921.7			6861.1	6862.7	6856.1				6962.1	6962	6919.80	6945.40	
874.2		6920.3			6860.5	6862.6	6856.1	6846			6961.5	6961.2	6918.40	6944.70	
874.1		6919.1			6860.4	6862.5	6856.1	6846.2		6874.867	6960.9	6961.35	6917.10	6944.10	
873.8		6917.7				6861.4	6855.8	6846.2			6965.3	6961.2	6916.00	6943.30	
								6845.8		6874.6					
										6874.3					
										6874.5					
					6860.4			6846.4		6874.2				6940.70	
873.1					6860.4			6846.8		6874				6940.30	

514 AD	0514 D	0521	0524	0525	0624	0625	0626	0627	0631	0632	0634	0635	0637	0639	064
6872					6860.3			6846.55		6871.8				6939.60	
					6860.4			6846.4		6870.4				6939.00	
					6859.7			6846.2		6871.1				6938.60	
					6859.8			6846.2		6870.4				6938.40	
					6860			6846.2		6869.9				6938.00	
					6860.1			6846.2		6869.9				6937.80	
					6859.2			6845.9		6868.3				6937.40	
					6858.8			6845.6		6867.5				6937.00	
					6858.5			6845.4		6867.6				6936.80	
					6858.3			6845.1		6868.3				6936.70	
					6857.9			6844.9		6864.5				6936.50	
					6857.5			6844.6		6863				6936.40	
					6857.1			6844.4		6864.8				6936.10	
					6857.1			6844.3		6865.6				6936.00	
					6856.6			6843.8		6862.2				6935.70	
					6856.4			6843.6		6860.4				6934.60	
					6856			6843.4		6862.4				6935.60	
					6855.6			6843.2		6862.5				6935.30	
					6855.2			6842.9		6862.7				6935.10	
					6855			6842.9		6861.1				6935.50	
					6854.7			6842.6		6861.7					
					6854.4			6842.5		6860.9				6934.60	
					6854.4			6842		6860.3				6934.40	
					6853.8			6841.8		6860.3				6934.10	
					6853.6			6841.7		6859.1					
					6853.2			6841.5		6859.3					
					6852.9			6841.2		6858.8					
					6852.9			6841		6859.3					
					6852.6			6840.8		6858.6					
					6852.4			6840.5		6858.3					
					6852			6840.2		6858.8					
					6852.5			6840.2		6858.4					
					6852.4			6840		6858.1					
					6851.9			6840.2		6857.9					
					6851.7			6840		6858.1					
					6851.3			6839.8		6859					
					6851.2			6839.5		6857.4					
					6851.1			6839.5		6857.3					
					6850.77			6839.22		6857.09					
					6851.8			6839.2		6858.1					
					6851.2			6839.1		6857.6					

0648	0649	0650	0656	0663	0664	0801	0802	0803	0804	0805	0806	0807	B 0001	B 0002	B 000
													6944.2	6941.507	6950.
													6947.256	6947.232	6957.
													6947.629	6949.412	6955.
													6946.498	6950.134	6951.
													6944.911	6962.72	6948.
													6943.393	6967.811	6946.
													6943.588	6968.076	6946.
															6944.
															6944.
															6946.
															6945.
															6944
															6942
															6943.
															6941
															6941
															6940
															6939.
															6939.
															6938.
															6937.
													6940.375	6958.68	6937.
934.50	6933.00	6932.00	6935.5										6937.4	6953.338	6937
934.33	6932.93	6932.00	6934.633										6937	6953.067	6936.
932.70	6931.57	6930.77	6931.1										6936.9	6952.867	6935
	6930.10			6865.2	6838.2								6937.1	6952.65	
	6928.90			6865	6844.8										
	6928.05			6865.4	6845.65								6937.2	6952.5	6939
	6927.50			6865.5	6844.9								6937.3	6952.4	6941
	6926.70			6865.4	6847.1								6945.4	6952.2	6943
	6924.60			6865.3	6845.2								6946.8	6952.1	6942
	6924.10			6865.3	6847.3								6945.9	6952.1	6941
	6923.00			6865.1	6847.3								6945.6	6951.9	6942
	6921.50			6865.1	6847.1								6945.4	6951.8	694
															6936
															6935
						6873.4	6874.8	6880.4	6874.5	6879.3	6879.8	6884.5			

0648	0649	0650	0656	0663	0664	0801	0802	0803	0804	0805	0806	0807	B 0001	B 0002	B 00
									6871.85	6877.85	6878.25	6883.45			
									6870.7	6877.2	6877.6	6882.9			
									6871	6877.1	6877.6	6882.7			
									6870.7	6876.6	6877	6882.1			
									6870.1	6876.2	6876.5	6881.6			
									6870.2	6876	6876.1	6881.4			
									6868.5	6872.9	6873.9	6880.5			
									6867.6	6872.4	6873.6	6879.7			
									6868.1	6872.5	6873.1	6879.4			
									6868.4	6873.2	6873.7	6879.4			
									6864.8	6869.2	6870.3	6877.7			
									6863	6867.6	6868.6	6876.5			
									6864	6869.9	6871.1	6877.4			
									6865.8	6870.5	6870.8	6877			
									6862.3	6866	6867.1	6874.9			
									6859.9	6865.7	6865.7	6871.7			
									6862.5	6867.8	6868.5	6874.9			
									6862.6	6869.1	6869.4	6874.9			
									6863	6868.6	6869.1	6874.4			
									6861.3	6866.6	6867.3	6873.7			
									6861.6	6867.4	6867.4	6874.6			
									6861.1	6866.4	6867	6873.3			
									6860.3	6863.7	6865	6872.4			
									6859.6	6865.8	6866.2	6872.4			
									6859.5	6865.6	6866	6871.8			
									6859.5	6865.4	6865.9	6871.9			
									6859.5	6865.65	6866	6871.9			
									6859.3	6865.9	6866.1	6871.6			
									6858.3	6865.5	6865.7	6870.9			
									6858.2	6865.4	6865.7	6871			
									6858.2	6865.2	6865.3	6870.7			
									6859	6864.8	6865	6870.4			
									6858.1	6864.7	6864.9	6870.3			
									6857.7	6864.3	6864.6	6870.1			
									6857.4	6863.2	6864	6869.9			
									6857.6	6863.2	6864.1	6870			
									6857.34	6864.7	6865.2	6869.8			
									6857.4	6864.6	6865.2	6869.9			
									6857.7	6864.1	6864.1	6869.3			

Date	EPA 23	EPA 24	EPA 25	EPA 26	EPA 27	EPA 28	GW 1	GW 2	GW 3	GW 4	NP 01	NP 02	SP 01	SP 1A
11/15/1979							[illegible]4	6869.8	6874.3	6902.2				
2/15/1980							6861.4	6870.1	6874	6901.3				
6/15/1980							6867.56	6869.54	6869.675	6931.533				
8/15/1980							6867.784	6869.831	6869.471	6931.207				
11/15/1980							6868.014	6870.15	6869.886	6931.887				
2/15/1981							6868.871	6869.486	6870	6930.522				
5/15/1981							6868.207	6870.414	6870.086	6931.186				
8/15/1981							6868.257	6870.729	6870.5	6931.621				
10/20/1981							6868.44	6871.04	6870.54	6932.364				
2/15/1982										6931.45				
5/15/1982										6931.833				
7/15/1982							6869.9	6872.4	6870.6	6933.325				
11/15/1982														
1/15/1983							6871.3	6874.8	6873.1	6937.7				
5/15/1983							6868.9	6873.8	6873.6	6938.1				
7/15/1983							6871.7	6873.7	6873.6	6939.8				
11/15/1983							6871.6	6873.4	6873.3	6938.6				
1/15/1984														
5/15/1984							6871.3	6873.3	6873.3	6937.6	6957.25	6956.4		6961.35
7/15/1984							6871.2	6873.3	6873.1	6936.5	6957.1	6957.233		6961.2
11/15/1984							6871.1	6873.2	6873	6937.1	6957.033	6957.2		6961.2
1/15/1985							6871.2	6873	6873.1	6936.4	6956.7	6956.533		6960.3
5/15/1985							6871.2	6872.8	6872.8	6935.8	6956.733	6956.85		6960.1
7/15/1985							6870.9	6872.7	6872.8	6934.7	6956.213	6956.543		6960.467
11/15/1985							6870.5	6872.1	6872.3	6935.8	6955.967	6956.1		6960.5
1/15/1986							6870.4	6872.2	6872.3	6935.4	6955.167	6955.433		6959.667
5/15/1986	6901.9	6844.56	6861.2	6865.3	6865.1	6868.7				6929.6	6954.633	6955.35		6959.3
7/15/1986							6869.9	6871.6	6871.7	6930.3				
10/15/1986							6869.7	6871.1	6871.1	6928				
1/15/1987	6901.1	6861.4	6861.3	6865.3	6865.2	6868.5	6869.85	6871.2	6870.5	6927				
4/15/1987	6900.7	6861.2	6861.4	6866.1	6865.3	6869.1	6870.6	6871.4	6871.6	6925.4	6955.7	6955.4		6959.3
7/15/1987							6870	6871.6	6871.4	6924.7	6955.3	6956.7		6960.3
10/15/1987	6900.3	6861.7	6861.8	6865.4	6865.3	6868.4	6869.93	6871.15	6871.3	6923.4	6955.4	6956.7		6960.5
1/15/1988							6869.5	6871	6871.2	6922.3	6955			
4/15/1988	6899.433	6861	6861.333	6865.2	6865	6868.233	6869.5	6870.95	6871.15	6921				
7/15/1988	6897.9		6861.2		6865	6868.1	6869.4	6870.85	6870.95	6919.2	6954.5			6960.9
10/15/1988	6898.4		6861.2		6864.8	6867.9	6869.2	6870.6	6870.7	6918.1				
1/15/1989	6898.3		6861.5		6865	6868	6869	6870.4	6870.7	6917.4				
4/15/1989	6897.7		6861.4		6864.9	6868	6869.3	6870.5	6870.8	6916.6				
7/15/1989	6897.3		6861.3		6864.9	6867.9	6869	6870.3	6870.5	6915.6				
10/15/1989	6896.7		6861.1		6864.8	6867.7	6868.9	6870.1	6870.4	6915				

Date	E[illegible]3	EPA 24	EPA 25	EPA 26	EPA 27	EPA 28	[illegible]1	GW 2	GW 3	GW 4	NP 01	NP 02	SP[illegible]1	SP 1A
1/15/1990	[illegible]		6861.45		6864.95	6867.6	[illegible]4	6869.75	6870.15	6914.6				
4/15/1990	6895.6		6861.2		6864.7	6867.3	6868.2	6869.4	6869.6	6913.6				
7/15/1990	6894.7		6860.6		6864.1	6866.2	6867.2	6868.9	6869.2	6912.7				
10/15/1990	6894.5		6860.7		6864.2	6866.7	6867.6	6868.7	6869.1	6912.4				
1/15/1991	6893.9		6861		6864.3	6866.7	6867.6	6868.9	6869.1	6912.4				
4/15/1991	6893.6		6860.8		6864.3	6866.7	6867.7	6868.8	6869	6912.7				
7/15/1991	6892.9		6860.9		6863.8	6866.2	6866.8	6867.5	6867.8	6914.4				
10/15/1991	6892.4		6859.6	6859.6	6863.3	6865.4	6866.1	6866.8	6866.9	6913.8				
1/15/1992	6891.7		6859.3		6863	6865.1	6865.9	6866.9	6867.2	6913.1				
4/14/1992	6891.5		6859.2		6862.9	6865.3	6865.7	6867	6867.2	6912.2				
7/14/1992	6890.2		6858.5		6862.1	6864.4	6864.8	6865.2	6865.4	6911.5				
10/14/1992	6889.3		6858.1		6861.6	6863.2	6863.7	6864.1	6864.2	6910.9				
1/14/1993	6889.2		6857.8		6861	6862.6	6863.4	6864.2	6864.3	6910.4				
4/14/1993	6888.9		6857.7		6861	6863	6863.9	6864.7	6864.9	6910.3				
7/14/1993	6887.5		6857		6860.4	6862.2	6862.7	6863	6863.4	6910.5				
10/14/1993	6885.7		6855.1		6858.7	6859.6	6862.2	6862.6	6862.7	6910.6				
1/15/1994	6886.7		6856.6		6859.7	6861.1	6861.8	6861.6	6862.7	6911.6				
4/15/1994	6886.6		6856.3		6859.3	6860.9	6861.6	6862.3	6863	6911.7				
7/15/1994	6886		6855.8		6859	6860.5	6861.1	6861.6	6861.8	6910.8				
10/15/1994	6885.4		6855.7		6858.6	6860	6860.7	6861.2	6861.5	6910.7				
1/15/1995	6885.3		6855.4		6858.2	6859.7	6860.5	6861.2	6861.5	6910.3				
4/15/1995	6885		6855.2		6858.1	6859.7	6860.3	6861.7	6862.3	6910.4				
7/15/1995	6884.1		6855.2		6857.8	6859.3	6859.9	6862.4	6860.8	6909.4				
10/15/1995	6883.8		6854.7		6857.4	6858.8	6859.3	6862.6	6860.2	6909.2				
1/15/1996	6883.3		6854.3		6857.1	6858.4	6858.9	6859.6	6859.8	6909.2				
4/14/1996	6883.1		6854		6856.8	6858	6858.6	6859.4	6859.8	6909.2				
7/14/1996	6882.5		6853.7		6856.5	6857.8	6858.4	6859.1	6859.7	6908.6				
10/14/1996	6882.3		6853.6		6856.2	6857.6	6858.4	6859.3	6859.7	6908.5				
1/14/1997	6881.8		6853.3		6855.9	6857.4	6858.1	6858.9	6859.4	6908.6				
4/14/1997	6883.2		6854.2		6855.9	6857.3	6858.3	6858.7	6859.3	6908.5				
7/14/1997	6881.1		6852.9		6855.6	6857	6857.7	6858.6	6859.2	6908.8				
10/14/1997	6880.4		6853		6855.6	6857.1	6857.8	6858.9	6859.4	6909.6				
1/15/1998	6881.1		6852.8		6856	6857.2	6857.5	6858.5	6859.2	6910.5				
4/15/1998	6880.4		6852.7		6855.4	6856.9	6857.5	6858.4	6859.1	6910.5				
7/15/1998	6880.1		6852.6		6855.3	6856.7	6857.5	6858.6	6859	6910.3				
10/15/1998	6880.4		6853.2		6856.1	6858.4	6857	6860.3	6858.6	6910.2				
1/15/1999	6880.1		6853		6855.5	6857.82	6856.9	6858.2	6858.5	6910				
4/15/1999	6880		6852.7			6857.7	6856.8	6858.2	6858.5	6910.4				
7/15/1999	6879.91		6852.68			6856.36	6857.06	6857.98	6858.34	6909.25				
10/15/1999	6880.1		6852.4			6857.3	6857.6	6859.3	6859.3	6909.9				
1/15/2000	6879.6		6852.3			6856.8	6857	6858.7	6858.6					

0509 D	06	0627	0632	0801	0802	0803	08	0807	0808	EPA 23	EPA 25	EPA 28	GW	GW 2	G
6883.7	685	6839	6856.9	6852.1			68	6868.8	6863.3	6879.2	6852.7	6856.6	685	6858.4	6
6883.3	6850.4	6838.6	6856.9	6852	6841.6	6835.5	6865.1	6868.8	6860.5	6878.8	6852.4	6856.4	6856.2	6858.1	68
6883.1	6850.25	6838.65	6856.7	6851.85	6842	6834.5	6862.4	6868.7	6862.6	6878.6	6852.25	6856.15	6855.85	6857.65	68
6882.383	6850.1	6838.45	6859.5	6853.683	6859.667	6855.617	6860.833	6868.75	6863.6	6878.6	6852.117	6856.3	6856.233	6858.517	685
6882.1	6849.967	6838.333	6860.933	6855.067	6861.733	6864.15	6865.033	6869.5	6864.367	6878.567	6852.117	6856.717	6856.85	6859.35	685
6881.6	6850.023	6838.017	6861.473	6855.537	6862.16	6864.317	6865.45	6869.633	6864.667	6878.38	6852.14	6856.95	6857.157	6859.587	685
6881.283	6850.217	6838.1	6861.783	6855.917	6862.517	6864.65	6865.85	6869.95	6864.967	6878.467	6852.45	6857.3	6857.517	6860.033	685
6880.833	6850.1	6837.833	6862.05	6856.15	6862.75	6864.75	6866.01	6870.083	6865.067	6878.133	6852.333	6857.5	6857.733	6860.183	685
6880.577	6850.113	6837.613	6862.347	6856.387	6862.683	6864.99	6866.06	6870.047	6865.367	6878.194	6852.317	6857.713	6857.94	6860.31	685
6880.17	6849.95	6837.42	6862.21	6855.81	6862.81	6864.68	6866	6869.85	6865.08	6877.87	6852.25	6857.6	6857.75	6859.98	685
6879.78	6849.9	6837.3	6862.08	6856.12	6862.55	6864.6	6865.76	6869.75	6864.81	6877.85	6852	6857.33	6857.52	6859.9	68
6879.36	6849.61	6836.79	6861.98	6856.07	6861.34	6864.48			6864.89	6877.27	6852.06	6857.39	6857.61	6859.88	685
6879.09	6849.72	6836.52	6862.11	6856.27	6861.54	6864.63	6866	6869.81	6865.02	6877.26	6851.96	6857.49	6857.81	6859.98	685
6878.81	6849.7	6836.5	6862.04	6856.35	6861.49	6864.01	6865.56	6869.4	6864.94	6877.11	6851.96	6857.48	6857.66	6859.91	685
6878.52	6849.72	6836.43	6861.84	6855.82	6861.2	6864.22	6865.37	6869.2	6864.67	6876.91	6852	6857.1	6857.34	6859.68	685
6877.96	6849.6	6836.28	6861.76	6856.04	6861.21	6864.16	6865.65	6869.4	6864.6	6876.67	6851.91	6857.22	6857.47	6859.72	685
6877.89	6849.67	6836.24	6862.09	6856.07	6861.39	6864.43	6865.61	6869.32	6864.98	6876.75	6852	6857.39	6857.63	6859.94	685
6877.38	6849.52	6835.89	6861.69	6855.86	6861.15	6864.08	6865.35	6869.1	6864.56	6876.27	6851.77	6857.16	6857.41	6859.61	685
6877.03	6849.34	6835.97	6861.41	6855.47	6860.76	6863.76	6865.08	6868.84	6864.17	6876.01	6851.62	6856.79	6857	6859.21	685
6876.74	6849.37	6836.02	6861.6	6855.82	6860.89	6863.88	6864.93	6868.64	6864.32	6875.97	6851.81	6856.96	6857.13	6859.48	685
6876.54	6849.37	6835.55	6861.45	6855.77	6861	6863.99	6865.04	6868.73	6864.5	6875.94	6851.54	6856.94	6857.29	6859.64	685
6876.04	6849.17	6835.37	6861.37	6855.42	6860.64	6863.59	6864.81	6868.45	6864.03	6875.53	6851.38	6856.75	6856.92	6859.1	685
6875.84	6849.02	6835.48	6861.11	6855.15	6860.41	6863.27	6864.53	6868.23	6863.82	6875.41	6851.35	6856.53	6856.6	6858.9	68
6875.35	6848.93	6835.12	6860.99	6855.08	6860.26	6863.1	6864.65	6868.26	6863.57	6874.95	6851.18	6856.66	6856.61	6858.86	685
6875.04	6848.92	6835.02	6861.04	6855.22	6860.24	6863.08	6864.29	6867.88	6863.57	6874.81	6851.18	6856.51	6856.71	6858.93	685
6874.74	6848.92	6834.87	6860.79	6854.87	6860.04	6862.83	6864.3	6867.88	6863.32	6874.56	6851.03	6856.21	6856.36	6858.63	685
6874.54	6848.93	6834.82	6860.67	6855.19	6859.94	6862.68	6864.04	6867.65	6863.22	6874.41	6851.03	6856.13	6856.26	6858.55	685
6874.05	6848.88	6834.77	6860.61	6854.77	6859.87	6862.58	6863.98	6867.55	6863.07	6874.03	6851.14	6856.31	6856.44	6858.54	685
6873.82	6849.02	6835.02	6860.87	6854.82	6860.04	6862.78	6864.13	6867.66	6863.37	6874.31	6851.25	6856.44	6856.61	6858.9	685
6873.69	6848.67	6834.67	6860.59	6854.52	6859.74	6862.48	6863.7	6867.27	6863.07	6873.91	6850.88	6856.11	6856.26	6858.43	685
6873.39	6848.67	6834.55	6860.32	6854.29	6859.48	6862.11	6863.5	6867.1	6862.7	6873.59	6850.86	6855.91	6855.99	6858.13	685
6872.94	6848.62	6834.77	6860.29	6854.17	6859.39	6861.93	6863.5	6867.05	6862.53	6873.21	6850.98	6856.01	6855.96	6858.13	685
6873.04	6849.12	6834.72	6860.49	6854.47	6859.69	6862.33	6863.65	6867.2	6862.97	6873.51	6851.28	6856.16	6856.31	6858.53	685
6872.84	6848.67	6834.47	6860.29	6854.22	6859.34	6861.98	6863.5	6867.2	6862.72	6873.21	6850.78	6855.91	6856.01	6858.18	685
6872.54	6848.42	6833.99	6859.79	6853.82	6858.94	6861.58	6862.77	6866.42	6862.47	6872.96	6850.4	6855.56	6855.56	6857.68	685
6872.19	6848.27	6834.22	6859.74	6853.77	6858.89	6861.43	6862.75	6866.3	6862.07	6872.46	6850.48	6855.46	6855.51	6857.73	685
6871.84	6848.22	6834.02	6859.64	6853.57	6858.79	6861.23	6862.85	6866.4	6861.87	6872.21	6850.23	6855.41	6855.46	6857.48	685
6871.84	6848.07	6834.02	6859.59	6853.47	6858.69	6861.23	6862.5	6865.85	6861.87	6872.21	6850.18	6855.31	6855.41	6857.48	685
6871.74	6847.77	6834.02	6859.09	6852.97	6858.24	6860.88	6862	6865.5	6861.37	6872.21	6849.88	6855.01	6854.86	6856.98	685
6871.24	6847.57	6833.82	6858.94	6852.82	6857.99	6860.48	6862	6865.6		6871.56		6854.66	6854.81	6856.93	
6871.24	6847.72	6833.67	6859.09	6852.92	6858.09	6860.68	6861.8	6865.35	6861.32	6871.66	6849.68	6854.485	6854.91	6857.13	685
6870.94	6847.52	6833.57	6858.79	6852.67	6857.84	6860.33	6861.7	6865.1	6861.02	6871.31	6849.48	6854.46	6854.71	6856.83	68
6870.79	6847.37	6833.47	6858.59	6852.32	6857.54	6860.03	6861.3	6864.7	6860.77	6871.11	6849.38	6853.71	6854.41	6856.48	68
6870.59	6847.22	6833.42	6858.392	6852.17	6857.437	6859.982	6860.89	6864.52	6860.67	6870.912	6849.183	6854.261	6854.31	6856.48	68
6870.14	6847.1	6833.32	6858.312	6852.04	6857.317	6859.672	6861	6864.64	6860.39	6870.462	6849.153	6854.161	6854.19	6856.18	68
6870.09	6846.97	6833.17	6858.162	6851.87	6857.137	6859.582	6860.7	6864.3	6860.27	6870.362	6848.963	6854.171	6854.07	6856.19	68

10 D	0011 D	0012 D	0013 D	0014 D	0036 D	0037 D	0106 D	0107 D	0118 D	0121	0123	0125	0126	0127	[illegible]	0202	
															[illegible]	6951.327	
															[illegible]	6939.927	
20.7	6934.2	6923.94	6916.08	6942.725	6946.1		6923.425	6944.95	6892.275						6946.086	6944.338	
1.314	6933.114	6924.523	6920.171	6942.214	6945.886		6923.764	6944.171	6904.693	6919.439	6922.415	6894.138	6903.546	6895.9	6946.75	6945.617	
2.203	6931.013	6927.119	6923.884	6941.626	6945.48	6945.677	6924.488	6942.092	6906.075	6920.193	6922.871	6895.129	6904.564	6897.036	6942.96	6942	
2.173	6931.117	6926.921	6923.578	6940.39	6944.886	6945.126	6924.111	6940.045	6906.208	6920.516	6922.535	6896.187	6904.794	6897.669	6940.269	6938.95	68
1.555	6929.744	6926.61	6923.461	6938.5	6944.252	6944.443	6923.514	6939.297	6896.28	6920.167	6922.323	6896.839	6903.751	6896.835	6939.259	6937.827	6
1.264	6929.416	6927.1	6924.042	6937.084	6943.884	6944.06	6923.705	6939.442	6901.467	6919.804	6922.883	6896.977	6901.277	6893.741	6939.273	6937.871	6
21.55	6929.85	6928.55	6924.647		6943.969	6944.017	6924.191	6939.971	6904.6	6920.107	6923.311	6897.02	6903.52	6895.61	6940.11	6938.33	68
2.233	6930.467	6932.233			6945.8	6945.667	6924.467			6920.492	6923.467				6942.633	6940.667	6
22.85	6931.75	6934.25			6949.2	6949.25	6925.1		6907.5	6920.775	6923.95				6947.6	6944.533	
3.867	6932.533	6933.95	6926.745		6950.521	6950.615	6926.367	6933.783	6907.5	6921.615	6925.033	6898.8	6905.7	6898.9	6956.028	6943.332	6
		6935.1	6927.508		6952.362	6952.358		6934.508	6909.2	6922.1	6927.843	6900.025	6908.473	6900	6949.044	6943.637	
25.7	6934.3	6936.123	6928.054		6952.95	6952.936	6928.9	6934.743	6912	6922.4	6928.554	6900.94	6909.353	6902.7	6949.592	6944.067	6
26.9		6936.82	6928.07		6953.39	6953.33		6934.54	6911.9	6924.7	6928.908	6901.592	6909.969	6902.667	6949.545	6943.927	
927	6935.4	6936.688	6928.275		6954	6953.85	6930	6934.45	6912		6929.471	6902.315	6910.379	6902.7	6947.94	6943.656	6
4.684	6935.988	6937.396	6929.33		6954.5	6954.418	6928.587	6934.61	6913.283	6924.02	6929.887	6903.164	6910.828	6904.117	6947.433	6943.967	
1.614	6935.58	6937.294	6929.789		6954.713	6954.625	6926.36	6934.162	6912.685	6921.406	6928.362	6903.03	6910.587	6903.665	6948.444	6943.7	6
0.671	6935.386	6937.243					6925.779		6912.292	6920.362	6927.488	6902.865	6909.994	6905.615	6947.65	6943.15	
20.1	6934.992	6936.55	6929.8		6953.8	6953.8	6925.183	6932.8	6911.992	6919.842	6927.164	6902.807	6910.557	6903.583	6947.1	6942.233	6
9.462	6888.808	6936.315					6926.285		6912.886	6919.2	6927.715	6902.885	6911.515	6904.086	6946.133	6941.533	
9.34	6934.64	6936.02	6928.8		6952.2	6952.4	6925	6931.1	6912.76	6918.86	6926.8	6902.95	6911.521	6904.24	6944.475	6940.6	6
9.933	6934.233	6935.533					6927.767		6912.267	6918.567	6926.362	6904.179	6912.043	6903.967	6950.433	6940	
18.1	6933.767	6934.557	6929.608		6950.323	6950.531	6923.767	6929.115	6911.9	6918.3	6925.721	6902.7	6911.136	6903.867	6950.862	6939.123	6
18.5	6933.6	6934.371	6927.977		6949.869	6950.2	6924.233	6928.892	6912.667	6918.233	6926.1	6902.892	6912.092	6904.433	6948.464	6938.85	
8.067	6933.533	6933.6	6927		6948.633	6948.833	6923.367	6927.267	6912.7	6918.767	6925.792	6902.985	6911.792	6904.267	6941.525	6937.65	6
7.467	6933.3	6934.1	6924.933		5614.867	6948.333	6922.333	6926.1	6911.533	6918.6	6923.75	6902.583	6910.833	6904.1	6941.233	6936.667	
6.867	6931.9	6933.25	6927.45		6947.8	6948	6921.167	6925.25	6910.267		6922.25	6902.5	6909.9	6903.267	6945.8	6935.8	
15.2					6947.9		6919.5		6910.2		6920.6	6902	6908.9	6902.3			
5.05	6931.2	6932.8	6928.7		6948.3	6948.5	6919	6924	6908.1		6919.7	6902	6908	6902.1	6943.7	6934.4	
914	6930.3	6931.3	6928.3		6949.1	6949.5	6918.7	6924.3	6907.4			6901.1	6907.3	6903.7	6951.5	6934.05	
13.5	6930	6930.8	6933.7		6948.4	6948.4	6917.5	6923.2	6906.6		6917.8	6900.7	6906.4	6901.4	6946.7	6933.8	
13.4	6930	6930.1	6933.6		6948.1	6948.3	6915.8	6922.9	6905.5		6916.5	6900.3	6905.4	6900.25	6943.3	6933.5	
11.6	6929.5	6929.9	6933		6947.4	6947.6	6914.6	6922.2	6904.6		6915.6	6900	6904.6	6899.4	6938.2	6932.9	
10.9	6928.7	6929.3	6932.2		6946.6	6947.1	6913.6	6921.4	6903.2		6913.7	6989.9	6903.2	6898.1	6936.1	6932.3	
910	6928.1	6928.6	6931.5		6946.3	6946.5	6912.55	6920.6	6902.5		6912.7	6898.6	6902.5	6902.5	6941.1	6931.6	
							6912										
	6927.2						6910.8									6931	
	6926.7						6910.5									6931	
							6909.1										
							6906.8										
							6905.9										
							6904.2						6888.5				
							6903.2						6887.5				

10 D	0011 D	[illegible]2 D	0013 D	0014 D	0036 D	0037 D	0106 D	0107[illegible]	0118 D	0121	0123	0125	0126	0127	[illegible]	0202
							6902.3						6887.8			
							6902.4						6888.9			
							6903						6889.7			
							6901.9						6885			
							6901.3						6880.6			
							6899.3						6882.1			
							6899.5						6882.6			
													6877.1			
													6875.9			
													6877.4			
							6910									
													6873.9			
													6872.8			
							6910						6873.4			
							6910						6873.9			
							6910						6871.3			
							6910						6870.6			
													6869.9			
							6910						6869.2			
							6910						6869.9			
							6910						6866			

422	0423	[illegible]24	0426	0427	0428	0429	0430	043[illegible]	0432	0433	0434	0436	0437	0438	[illegible]	0440	
												6864.7					
												6860.7					
86.7	6884.133						6924.9										
7.658	6877.993	6867.45	6880.857	6879.628	6875.586	6872.7	6869.446		6886.969	6863.966	6880.031	6874.053	6869.527			6865.286	68
5.652	6868.082	6845.078	6871.049	6870.223	6866.826	6863.365	6861.465		6878.712	6849.433	6870.379	6863.465	6861.612			6858.65	68
81.4	6879.862	6884.54	6885.171	6881.786	6877.714	6872.343	6868.371		6891.871	6887.58	6886	6873.786	6869.586			6863.571	68
88.1	6886	6890.2	6890.7	6887.9	6884.05	6879.4	6876.9		6896	6893.3	6891.6	6881	6877.1			6871.7	6
88.6	6896.6	6891.2	6891.3	6888.5	6884.8	6880.2	6876.6		6896.3	6893.8	6892.1	6881.6	6877.9			6872.5	
91.2	6889	6893.8	6893.7	6891	6887.3	6882.5	6878.8		6898.5	6896.6	6894.5	6884	6871.9			6875	6
		6895.4															
94.3	6890.8	6895.4	6895.3	6892.7	6898.9	6884.3	6880.8		6900.4	6897.8	6896.1	6884.6	6881.9			6876.1	6
	6892.6	6896.8	6896.7	6893.2	6901.3	6886.1	6883			6897.175		6886.4	6883.9	6882.067			
									6902.2	6899.285				6882.008			
94.6	6892.7	6896.8	6896.9	6894.3	6890.8	6886.2	6883.7	6879.8	6902	6898.833	6897.7	6887.8	6884.1	6879.583	6880.7	6878.3	6
										6899.985				6882.777			
95.8	6892.8	6898	6898.1	6895.5	6892.1	6887.6	6885.1	6881.1	6903.2	6900.04	6898.8	6888.9	6885.5	6883.08	6880.7	6879.3	
										6899.9				6883.167			
94.8	6893.4	6897.2	6897.6	6894.9	6896.7	6887.4	6885	6881	6902.6	6899.967	6898.3	6888.6	6885.4	6883.133	6881.5	6788.2	6
										6900.433				6883.833			
94.2	6894.2	6898	6898	6895.6	6892.4	6888	6886.1	6881.7	6903.1	6900.8	6899	6889.2	6886.3	6884.133	6882.4	6788.6	6
										6900.133				6884.467			
										6898.65				6883.2			
										6897.4				6882.6			
										6896.6				6881.8			
										6895.8				6881.3			
										6895				6880.8			
										6894.2				6880.3			
										6893.3				6879.5			
										6892.2				6878.6			
										6890.8				6877.6			
										6890				6876.9			

422	0423	24	0426	0427	0428	0429	0430	043	0432	0433	0434	0436	0437	0438	[illegible]	0440	

447	0449	1 B	0502 B	0503 B	0504 B	0505 B	0505 C	0507	0507 C	0508 B	0508 C	0517	0518	0523		0608	
		6883.813	6892.769	6891.25	6859.642	6915.475	6913.3	6929.486	6929.392	6927.45	6930.375						
		6881.925	6892.75	6891.167	6861.767	6915.7	6916.625	6929.367	6929.333	6929.8	6929.6						
						6915.923			6928.6		6929.6	6908.509	6904.713				
		6883.5		6893.5		6916.373						6907.185	6904.733				
		6884	6894.1	6893.8	6866.5	6918.573						6909.071	6906.056				
		6898.4	6895.4		6871.3	6920.12	6920.7	6930.1				6911.875	6907.56				
		6886.9	6896.8	6896.3		6920.921						6913.622	6908.533				
		6886.9	6896.8	6896.3	6869.3	6921.564	6923.3	6930.3				6913.763					
		6888.773	6898.18	6897.836	6870.855	6920.13	6924.688					6912.92	6908.85		6915.633	6922.8	6
		6889.538	6898.046	6897.9	6871.423	6917.97	6924.171					6910.719	6906.5	6922.9			6
		6890.271	6897.993	6897.993	6871.754	6917.461	6923.454					6910.493	6906.3	6922.043			6
76.1		6882.975	6895.358	6892.55	6872.017	6917.193	6923.133	6931	6932.5	6933.4	6933.1	6910.725	6906.308	6921.333			69
		6898.029	6898.357	6898.357	6872.629	6917.723	6923.7					6911.354	6906.6	6922.008			69
79.7		6891.3	6898.825	6898.38	6873.24	6917.54	6923.58	6931	6932.6	6933	6933	6910.46	6910.28	6922.14			69
		6891.867	6898.467	6898.3	6873.267	6917.107	6923.1					6909.833	6906.267	6922.167			69
76.5		6892.233	6898.6	6898.267	6873.133	6916.65	6922.533	6929.6	6931.5	6932	6932	6909.567	6906.3	6920.667			
		6894.033	6899.05	6898.567	6873.767	6917.625	6923.033					6911	6907.133	6921.233			69
77.2		6892.7	6899	6898.533	6873.8	6917.215	6922.9	6930.2	6932.5	6932.1	6932.2	6909.8	6906.867	6920.3			6
		6892.833	6898.933	6898.733	6874	6915.858	6922.3					6909.533	6906.4	6919.4			
		6892.425	6899.533	6898.1	6873.966	6914.867	6920.9	6924.8		6927.1		6910	6905.933	6918.45			6
		6892.4	6897.9	6898.9	6873.2	6912.9		6922.6		6924.8		6908.9	6904.2				6
		6892.8	6898.05	6898	6873.3	6912.4	6918.4	6921.8		6924			6904.1	6917.4			6
	6910.4	6892.1	6897.2	6897.3	6872.7	6911.9	6917.7	6920.3		6922.6		6908.3	6903.2	6925.2			6
		6892.1	6897	6897.1	6872.5	6910.5	6917.4	6919.5		6921.7		6907.4	6902.8	6918.2			6
		6892.2	6896.433	6896.6	6871.8	6910.5	6915.7	6919.4		6920.6		6905.7	6902.1	6917.7			6
		6892.1	6896	6896.4	6871.7	6908.4	6915.5	6917.5		6919.7		6904.8	6901.7	6917.5			
		6891.05	6894.65	6895.4	6870.95	6907	6913.3	6916.4		6918.6		6903.65	6900.4	6917.7			6
	6916.1	6891.1	6894.7	6895.1	6870.2	6906.6	6912.1	6915.2		6917.4		6902.6	6899.95	6917.4			
		6890.5	6894.1		6869.7							6901.6	6899.2				
		6890.1	6893.5		6869.3		6910.5					6901.3	6898.7	6917.4			
		6889.7	6893.1		6868.9		6909.7					6901.1	6898.4	6917.8			
		6889	6892.4		6868.1							6899.7	6897.2				
		6887.9	6888.1		6867.3							6893.2	6892.9				
		6885.3	6885.7		6865.9							6894.8	6890.2				
		6884.6	6883.9		6864.6							6892.6	6888.2				
		6883.3	6882.7		6863.5							6892.9	6886.8				

447	0449	[illegible]1 B	0502 B	0503 B	0504 B	0505 B	0505 C	0507[illegible]	0507 C	0508 B	0508 C	0517	0518	0523	[illegible]	0608
		[illegible].3	6881.4		6862.7							6892.6	6885.6			
		6881.4	6880.6		6862.7							6893.6	6885.1			
		6880.7	6880		6861.7							6894.5	6887.3			
		6879.9	6879.2		6860.7							6891.6	6885.6			
		6879.4	6878.1		6857.3							6887.6	6883.9			
		6878.8	6876.7		6855.4							6888.8	6884.1			
		6878.4	6875.7		6855.9							6888.8	6885.1			
		6877.9	6874.5		6855.8							6884.7	6881.6			
		6877.5	6873.1		6851.7							6882.6	6879.7			
		6877.1	6870.1		6849.9							6883.2	6882.5			
		6876.9	6870.2		6849.9							6884.2	6883.5			
		6876.2	6869.3		6848.4							6882.1	6879.8			
		6873.1	6865.4		6844.7							6880.1	6876			
		6874.9	6867.2		6847							6880	6880.4			6882.9
		6874.9	6867.2		6846.5							6879.7	6881.3			6883
		6874.9	6867.2		6846.3							6878.6	6881.3			6882.7
		6874.2	6867.2		6846.3							6878	6881.4			6882.2
			6866.5		6844.8							6877.2	6880.9			6882.1
		6873.6	6866.4		6845							6876.8	6880.9			6882.1
		6873.9	6866.1		6845.1							6875.9	6880.3			6882
		6873.9	6866.1		6844.1							6875.1	6880.2			6881.8
			6866.1		6843.3							6874.4	6880.1			6881.7
			6865.7		6843.1							6874	6880.2			6881.7
			6865.4		6842.7							6873.8	6879.5			6881.9
			6865.5		6842.2							6873.6	6879.2			6881.2
			6865.7		6843.9							6873.5	6879.7			6881.4
			6864.8		6842.1							6873.3	6878.8			6881
			6864.4		6841.3							6872.7	6878.4			6880.9
			6865		6841.7							6872.6	6878.4			6880.9
			6864.2		6841.2							6872.4	6878.3			6880
			6864.3		6841							6872.5	6878.3			6881.3
			6864.9		6841							6872.4	6877.9			6879.4
			6865.1		6841.2							6872.2	6877.8			6879.4
			6863.9		6841							6871.8	6877.76			6879.5
			6864		6841.2							6870.9	6877.86			6879.5
			6863.3		6840.81							6871.32	6877.28			6878.7
			6863.7		6841.4							6869.1	6877.26			6879.3
			6863.9		6841.5							6870.8	6877.36			6881

0703	071[illegible]	0712	0713	0714	0715	EPA 01	EPA 03	EPA 06	EPA 09	EPA 10	EPA 11	EPA 12	EPA 13	EPA 14	EPA 15	EPA 1[illegible]
							6900.9	6915.1		6844.9	6859.7	6868.4			6899.5	6884.7
												6868.4				
						6806.2	6900.5	6915.1	6911.3	6843.8	6859.4	6868.6	6882.9	6904.5	6897.5	
						6805.6	6899.8	6914.8	6911.2	6843.8	6858.9	6868.4	6882.8	6904.6	6897	6885.7
						6805.4	6899.2	6914	6811.1	6841.8	6858.3	6868.1	6882.7	6902.5	6895.8	6886.1
						6805.067	6897.933	6913.7	6911.1	6840.8	6856.8	6867.367	6882.267	6899.9	6923.767	6886.06
													6882.1	6899.1	6893.2	
						6804.7	6897		6910.9		6856	6866.7	6881.9	6898.3	6892.7	6886.7
						6804.4	6896.8		6911		6855.4	6866.4	6881.9	6897.7	6892.2	6886.6
						6804.3	6896.1		6910.9		6854.9	6866.1	6881.5	6896.7	6891.2	6886.7
						6804.3	6895.6		6911		6854.6	6865.9	6881.3	6895.9	6890.2	6886.6
						6804.5	6894.9		6911.2		6854.2	6865.8	6880.4	6891.1	6883.5	6887
						6804.2	6892.8		6911.2		6853	6864.8	6878.5	6889.5	6881.5	6886.3
						6803.8	6891.7		6911.1		6852	6863.9	6877.7	6888.2	6880.3	6886.2
						6803.1	6890.5		6910.8		6850.9	6862.8	6876.8	6886.6	6879.1	6886

0703	071[illegible]	0712	0713	0714	0715	EPA 01	EPA 03	[illegible]06	EPA 09	EPA 10	EPA 11	EPA 12	EPA 13	EPA 14	EPA 15	EPA 1[illegible]
						6802.9	6889.5		6910.9			6862.2	6876.1	6886.[illegible]	[illegible]879.8	6885.9
						6802.3	6888.8		6910.7			6861.4	6875.2	6886.5	6878.8	6885.6
						6802.2	6888.3		6910.9			6861	6874.8	6886.9	6879.2	6885.4
						6801.8	6887.7		6910.7			6860.4	6876.3	6883.9	6876	6885.1
						6801.4	6887		6910.8			6859.7	6876.1	6875.1	6871.1	6885
						6801	6886.1		6911.6			6858.4	6875.52	6880.2	6873.5	6884.7
						6800.5	6887.3		6910.6			6857.5	6875.22	6880.2	6873.8	6884.5
						6799.1			6909.7			6856	6874	6870.3	6866.9	6884.4
						6798.6			6909.7				6873.5	6870.6	6866.2	6884.2
						6798.1			6909.5				6873	6875.3	6869	
						6797.9			6909.6			6840.7	6872	6872.2	6869.4	6912.5
						6797.5			6909.8			6840.9	6872.1	6866.9	6864.6	6883.6
						6796.3			6907			6843.2	6869.8	6865.6	6860.7	6884.2
6888.4	6865.8	6858.1	6855.2	6871.7	6882.2	6796.9			6908				6871.6	6871	6864.2	
6890	6865.7	6858.7	6855.9	6880.5	6873.5	6796.5			6908.7			6841.2	6871.6	6868.4	6863.9	6883.5
6890.6	6865.4	6857.6		6879.1	6870.3	6797.4			6909.5			6841.2	6871.6	6866.1	6862.2	6883.2
6890.7	6865.3	6857.5		6878.3	6870	6795.9			6908.4			6841.1	6870.4	6866.1	6861.6	6883
6890.7	6864.3	6856.9		6879	6870.6	6795.6			6908.2				6869.9	6867.8	6861.7	
6890.9	6864	6856.6		6877.7	6870.3	6795.9			6908.6			6840	6870.2	6867.6	6861.9	6883.2
6891	6863.4	6856		6876.7	6867.8	6795.3			6907.9			6840	6869.4	6863.4	6860.3	6883.1
6891	6863.1	6855.8		6876.1	6867	6795.2			6908			6840	6869.3	6863.6	6859.7	6883
6890.8	6862.3	6854.9		6875.2	6874.6	6794.9			6907.6				6868.9	6861.8	6858.5	
6890.9	6862.1	6854.9		6874.7	6865.5	6794.8			6907.6				6867.3	6861.2		
6890.7	6861.5	6854.5		6874.6	6865.3	6794.7			6907.4				6868.7	6861	6860.9	
6890.7	6861.1	6854.2		6873.2	6863.9	6794.5			6907.4				6868.5	6861.1	0	
6890.9	6861.1	6854.4		6872.9	6864.3	6794.5			6912.3				6868.2	6861.6	6860.9	
6890.6	6860.5	6853.9		6872.4	6863.2	6801.2			6907.2				6868	6861.9	6856.4	
6890.6	6860	6853.7		6871.9	6861.8	6801			6906.8				6868	6858.5		
6890.5	6859.8	6853.7		6871.4	6862.9	6794.8			6906.7				6867.5	6859.1		
6890.7	6859.8	6853.4		6871.9	6862.1	6794.2			6907.1				6867.8	6863.5		
6890.6	6859.6	6853.1		6871.6	6861	6793.3			6906.8				6867.6	6858		
6890.7	6859.4	6852.9		6871.4	6860.6	6794.2			6906.6				6867.4	6857.4		
6890.7	6859.3	6852.9		6871.2	6860.8	6792.9			6907.9				6868.5	6861.2		
6890.6	6859	6852.9		6870.7	6859.7	6797.3			6917.5				6868.2	6858.1		
6890.8	6859.1	6852.9		6870.9	6860.2				6907.8				6868.1	6857.8		
6890.5	6858.5	6852.5		6870	6858				6907.51				6868.02	6857.41		
6890.5	6858.3	6852.6		6870	6857.9				6907.4				6867.9	6857.4		
6890.5	6858.9	6852.7		6863.5	6859				6907.8				6868.4	6857.1		

24	0446	[illegible]B	0517	0613	0701	0702	0703	0705	0706	0707	0708	0709	0710	0711	07[illegible]	0713	0
.23	6836.4	[illegible]4	6871.6	6884.6	6880.2	6894.1			[illegible]862.3	6855.6			6858.8	6863.55	6[illegible]	6861	68
.23	6840.1	6841.3	6871.3	6883.7	6879.9	6894.2			6862.3	6856.1			6858.7	6863.5	6852.4	6860.9	68
.23	6840.85	6841.4	6871.55	6885	6879.6	6894.1			6862.4	6857.05			6858.9	6863.65	6852.8	6861	68
.38	6841.3	6841.8	6871.75	6883.5	6879.5	6894.05			6862.4	6857.55	6863.85		6859.1	6863.85	6853	6861.1	68
.15		6841.8	6871.75	6883.65	6879.5	6893.8			6862.35	6857.75	6864.2		6859.2	6863.85	6853.2	6860.9	68
53	6841	6841.7	6871.45	6883.5	6879.4	6893.75			6862.25	6857.6	6863.9		6859	6863.5	6853	6860.7	68
3.2	6841.3	6841.85	6871.45	6883.5	6879.7	6893.8			6862.35	6857.95	6864.25		6859.15	6863.65	6853.2	6861.05	68
2.9	6841.45	6841.6	6871.35	6883.45	6879.5	6893.7			6862.5	6857.9	6864.4		6859	6863.75	6853.3	6860.9	6
.75	6841.47	6841.855	6871.4	6883.4	6879.05	6893.95			6862.2	6857.7	6864.3		6859.15	6863.55	6853.4	6861	68
.35	6841.3	6841.755	6871.45	6883.23	6878.8	6893.7			6862.1	6857.4	6864.1		6859	6863.46	6853.05	6860.75	68
2.2	6842.05	6841.662	6871.2	6883.3	6878.5	6893.7			6861.95	6857.35	6863.93		6859	6863.49	6853.2	6860.85	68
		6841.485	6870.77	6882.69							6863.61			6863.1			
.78	6841.56	6841.677	6870.68	6882.54	6878.08	6893.55			6861.67	6857.04	6863.88		6858.9	6863.46	6852.92	6860.81	68
.13	6841.51	6841.37	6870.55	6882.75	6878.75	6892.35			6861.27	6856.51	6863.48		6858.57	6863.13	6852.65	6860.48	68
.78	6840.71	6841.1	6870.44	6882.97	6877.71	6893.35			6861.17	6856.28	6851.39		6858.62	6863.08	6852.57	6860.33	68
.38	6841.71	6840.977	6870.25	6882.61	6877.78	6893.32			6861.1	6856.06	6863.13		6858.42	6862.83	6852.46	6860.38	68
.71	6840.83	6840.873	6870.23	6882.66	6877.42	6893.15			6860.82	6855.77	6863.37		6858.47	6862.97	6852.47	6860.28	68
9.5	6840.94	6841.027	6869.94	6882.67	6877.44	6893.08			6860.76	6855.36	6863.06		6858.19	6862.93	6852.3	6860.28	68
.01	6840.91	6840.525	6870.03	6882.21	6877.31	6893.19	6889.87		6860.57	6855.31	6863.04		6858.42	6862.94	6852.59	6860.43	68
.31	6840.62	6840.513	6869.86	6882.66	6877.3	6893.1			6860.32	6854.73	6863		6858.29	6863.14	6852.17	6860.22	68
.348	6840.98	6840.09	6869.62	6881.78	6877.03	6892.95		6866.578	6860.033	6854.077	6862.37	6851.793	6857.716	6862.81	6850.9	6859.664	686
.553	6839.56	6839.687	6869.32	6882.27	6876.93	6892.95			6860.023	6853.21	6862.177	6850.815	6857.377	6862.6	6849.94	6859.653	686
.113	6839.01	6839.55	6869.52	6882.39	6876.84	6892.95			6859.88	6852.93	6862.157	6850.415	6857.113	6862.66	6849.287	6859.483	68
.02	6839.16	6838.98	6869.38	6882.16	6876.8	6892.88			6860.26	6852.86	6861.91		6857.04	6862.43	6849.02	6859.65	68
.39	6838.51	6838.71	6869.43	6882.14	6876.59	6892.77			6859.82	6852.24	6861.9		6856.78	6862.4	6848.53	6859.17	68
4.9	6837.96	6838.23	6869.04	6882.19	6876.54	6892.85			6859.87	6852.06	6861.66		6856.42	6862.34	6848.44	6859.23	68
.45	6837.86	6837.89		6882.14	6876.33	6892.65			6859.77	6851.78	6861.45		6856.32	6862.28	6848.27	6859.18	68
.73	6837.51	6837.51		6882.04	6876.81	6892.63			6859.49	6851.21	6861.3		6856.15	6862.15	6847.87	6858.88	68
.31	6837.41	6836.83	6869.18	6882.04	6877.08	6892.56			6859.56	6851.21	6861.13		6855.8	6862.14	6847.77	6858.86	68
.83	6836.81	6836.81	6869.02	6882.04	6877.07	6892.6			6859.37	6850.86	6860.73		6855.69	6861.85	6847.97	6858.88	68
.48	6836.69	6836.233	6868.92	6881.72	6877.03	6892.49			6859.31	6850.51	6860.48		6855.6	6861.68	6847.93	6858.83	68
.95	6837.55	6835.95	6869.25	6882.4	6877.15	6892.55			6859.2	6850.25	6860.6		6855.7	6862.05	6848.7	6859	68
.51	6837.21	6835.96	6868.97	6881.94	6877.81	6892.35	6889.24		6858.97	6849.93	6860.28		6855.42	6861.5	6848.73	6858.67	68
.13	6836.31	6835.41	6868.62	6881.79	6878.68	6892.6	6889.12		6859.27	6849.86	6859.98		6855.27	6861.125	6848.77	6858.63	68
.68	6837.21	6835.11	6869.02	6881.74	6878.18	6892.25	6889.14		6858.81	6849.4	6859.84	6848.19	6855.24	6861.075	6848.67	6858.48	68
.92	6836.71	6834.86	6868.49	6881.79	6877.88	6892.1			6858.57	6849.06	6859.18		6854.71	6860.675	6848.71	6858.09	68
.72	6837.26	6834.86	6868.84	6881.84	6877.78	6892.2	6889.07		6858.77	6849.36	6859.33		6854.91	6861.3	6848.36	6858.39	68
.32	6836.91	6834.51	6868.49	6881.99	6877.48	6892.05	6888.97		6858.72	6848.76	6858.98		6854.46	6861.2	6847.41	6857.89	68
.02	6836.81	6834.36	6868.69	6881.74	6877.33	6892	6888.92		6858.72	6848.71	6859.08	6847.24	6854.41	6861.3	6847.06	6857.84	68
.87	6837.46	6834.41	6868.29	6881.79	6877.28	6891.95			6858.92	6848.46	6858.48		6853.96	6860.325	6846.86	6857.79	68
.52	6838.21	6833.66	6868.44	6881.89	6876.93	6892.1			6858.72	6848.21	6858.53		6853.91	6860.525	6846.46	6857.69	68
.37	6835.91	6833.21	6868.09	6881.79	6876.93	6891.9			6858.47	6847.86	6858.18		6853.61	6860.225	6846.26	6857.54	68
.17	6836.41	6833.41	6868.24	6881.84	6876.88	6891.9	6888.82		6858.62	6847.51	6858.38	6846.29	6853.46	6860.475	6845.56	6857.29	68
.87	6837.63		6868.043	6881.44	6876.78	6891.77			6858.34	6847.45	6857.801		6853.49	6860.75	6845.87	6857.19	68
.66	6836.88		6868.083	6881.59	6876.85	6891.7			6858.32	6847.35	6857.631		6853.36	6860.6	6846.11	6857.39	68
.82	6836.55		6867.593	6881.59	6876.8	6891.7			6858.12	6846.9	6857.431		6852.96	6860.4	6845.84	6857.19	68
.973	6836.7		6867.763	6881.58	6876.48	6891.65	6888.42		6857.659	6846.81	6857.421	6844.966	6852.803	6860.57	6845.755	6856.958	68

20	EPA 09	EPA 13	EPA 14	IW-A	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	NBL-01	NBL-02	NW-1	NW-2	NW-3	NW-4	N
	6907.9	[illegible]3	6857.4														
	6907.8	6868.1	6859.3														
	6907.8	6868.1	6861														
	6907.85	6868.1	6860.5														
	6907.6	6867.9	6860.7														
	6907.5	6867.6	6860.4								6823.168						
	6907.7	6867.8	6860.35								6822.958						
	6907.7	6867.9	6860.2								6822.768						
	6907.25	6867.67	6860.4								6822.888						
	6907.03	6867.63	6859.8								6822.713						
	6906.96	6867.52	6859.4								6822.578						
		6867.41	6858.66								6822.563						
	6906.81	6867.62	6858.37								6822.305						
	6906.77	6867.52	6858.13								6822.021						
	6906.73	6867.48	6857.56								6821.875						
	6906.62	6867.57	6857.21								6821.571						
	6906.66	6867.54	6856.84								6821.435						
	6906.66	6867.45	6856.29								6821.028						
	6907.15	6867.36	6856.01								6820.798						
	6906.99	6867.57	6856.11								6820.501						
.862	6907.01	6866.307	6854.28		6845.587	6832.52	6825.251	6822.826			6819.92						
.415	6907.01	6874.64	6853.63		6844.23	6830.607	6823.43	6820.571			6818.695						
.96	6907.16	6866.417	6853.076		6843.335	6829.995	6822.48	6819.575			6817.829						
	6906.83	6867.28	6852.62		6842.62	6829.36	6821.86	6819.41			6816.878						
	6906.91	6867.08	6853.48								6816.078						
	6906.11	6867.12	6851.96								6815.408						
	6906.86	6866.95	6851.39								6814.988						
	6906.51	6866.72	6850.61								6814.308						
	6906.79	6866.7	6850.35								6813.788						
	6906.86	6866.62	6849.86								6813.258						
	6906.46	6866.42	6849.38								6812.611						
	6906.75	6866.5	6848.85								6811.891	6819.903					
	6906.46	6866.37	6848.61								6811.575	6819.913					
	6906.46	6866.37	6848.11								6810.715	6819.353					
.71	6906.46	6866.23	6847.51		6841.24	6823.81	6819.04	6813.74			6810.159	6818.923					
	6907.21	6864.81	6847.61					6813.51			6809.149	6818.393	6800.88	6804.995	6808.072	6804.816	680
	6906.36	6865.01	6847.36								6808.564	6817.95	6799.141	6803.936	6807.301	6806.022	680
	6906.36	6864.76	6847.16								6807.935	6817.46	6798.645	6803.296	6806.467	6805.161	680
.13	6906.51	6864.96	6846.61		6839.74	6822.71	6819.01	6812.01			6807.417	6817.286	6799.221	6802.062	6806.192	6803.394	680
	6906.16	6864.51	6846.66								6807.13	6817.073	6799.5	6802.769	6806.519	6795.297	680
	6906.36	6864.66	6846.31								6807.055	6816.36	6797.456	6802.052	6806.43	6794.737	68
	6906.26	6864.46	6845.71	6802.597				6810.81	6802.698	6804.55	6806.625	6816.203	6798.552	6803.084	6805.873	6799.293	680
.78	6906.56	6864.76	6846.11		6838.49	6821.46	6821.01	6809.71			6806.42	6816.025	6807.32	6801.85	6805.875	6800.61	68
	6906.49	6864.227	6845.61								6806.108	6815.46	6797.36	6802.6	6804.94	6789.76	68
	6906.2	6864.157	6845.41								6805.908	6815.21	6796.46	6800.67	6805.14	6791.85	68
	6906.2	6864.157	6845.03						6801.44	6802.12	6805.428	6814.61	6798.11	6800.9	6804.79	6798.66	68
.181	6906.412	6863.297	6844.71		6837.29	6819.36		6809.36	6801.57	6802.03	6805.158	6814.36	6801.36	6801.2	6804.19	6801.01	68

DATE	PB-04	RW-11	RW-12	RW-13	RW-1[illegible]	RW-15	RW-16	RW-17	RW-A	Z3 M-01	Z3 M-02
4/15/2000											
7/15/2000											
10/15/2000											
1/15/2001											
4/15/2001											
7/15/2001											
10/15/2001											
1/15/2002											
4/15/2002											
7/15/2002	6823.99										
10/15/2002	6823.893										
1/15/2003	6823.815										
4/15/2003	6823.505										
7/15/2003	6823.327										
10/15/2003	6823.075										
1/15/2004	6822.643										
4/15/2004	6822.733										
7/15/2004	6822.377										
10/15/2004	6822.19									6928.13	6932.34
1/15/2005	6821.85										
4/15/2005	6821.246	6820.413	6826.137	6822.583	6827.25	6841.668	6846.16	6844.526			
7/15/2005	6819.918				6826.135		6843.13				
10/15/2005	6818.257	6810.23		6819.34	6825.2	6850.16	6828.73	6837.08			
1/15/2006	6817.33	6810.43	6815.57	6822.727		6849.87	6828.18	6836.05			
4/15/2006				6819.296		6828.2					
7/15/2006											
10/15/2006											
1/15/2007		6810.23					6827.313	6836.363			
4/15/2007											
7/15/2007											
10/15/2007	6813.323							6842.95			
1/15/2008	6815.387	6811.7							6812.795		
4/15/2008	6812.813						6842		6812.557	6927.99	6931.97
7/15/2008	6811.7								6810.697	6928.89	6931.81
10/15/2008	6811.207	6823.59		6817.01		6793.77	6840.78	6844.78	6815.797	6928.84	6931.83
1/15/2009	6810.487							6845.05	6818.467		
4/15/2009	6809.815								6817.767	6928.49	6932.01
7/15/2009	6809.586								6816.663	6928.39	6931.86
10/15/2009	6808.693	6818.18				6844.22	6831.28	6834.88	6808.03	6928.19	6931.86
1/15/2010	6808.306								6807.963		
4/15/2010	6808.082								6807.057		
7/15/2010	6807.815								6800.847		
10/15/2010	6805.54	6815.23		6817.81		6823.67	6827.23	6835.38	6812.245	6928.34	6931.81
1/15/2011									6807.78		
4/15/2011	6806.56								6818.03		
7/15/2011	6806.18								6810.83		
10/15/2011	6806.04	6822.68					6830.43	6835.28	6809.74	6928.04	6931.46

		6888.433	6891.725	6879.15	6879.775	6927.767	6[illegible]17	6904.967	6912.7					
	69[illegible]246	6890.879	6895.25	6879.879	6881.264	6933.854	69[illegible]023	6905.123	6913.143	6867.558				
	6906.319	6895.036	6896.893	6882.386	6883.043	6935.714	6926.836	6907.471	6915.367	6869.438		6765.7	6756.867	6755.05
	6909.925	6896.012	6897.8	6883.5	6884.287	6936.329	6927.237	6907.943	6915.83	6871.018		6763.825	6757.677	6755.404
	6913.787	6897.114	6898.3	6884.28	6885	6936.607	6927.533	6908.5	6915.015	6872.567		6753.28	6757.925	6756.731
	6916.586	6898.214	6899.429	6884.85	6885.629	6936.979	6927.814	6909.5	6915.446	6874.95		6735.785	6758.138	6756.969
	6918.3	6898.98	6900.98	6885.16	6885.98	6937.3	6928.04	6910.54	6916.054	6876.9		6753.5	6757.75	6754.7
	6921.5								6917	6878.623		6759.2		
		6901.9	6903						6916.4	6879.643				
6913.8	6923.2	6894.3	6902.6	6885.8	6886.7	6938.4	6928.7	6914.8	6917.833	6880.938			6760.4	6758.5
										6881.8				
6917.9	6925.3	6907.2	6897.1	6884.1	6884.7	6939.4	6929.3	6917.8	6920.1	6884.65	6870.1	6767.7	6761.7	6759.9
										6885.6	6876.4			
6920.7	6926.2	6906.4	6896.3	6883.3	6884.5	6940.4	6929.6		6920.3	6886.7	6879.6	6768.4	6762.5	6761
										6887.337	6881.511			
6920.7	6927.7	6904.8	6894.6	6882.5	6883.5		6930.3		6922.6	6883.811	6883.18			
										6882.657	6884.586			
	6927.7	6894.5	6894.3		6883.2	6941.4	6930.7	6922.2	6921.2	6882.642	6885.567	6770.5	6764.6	6762.6
										6885.064	6886.185			
6924	6928.2	6893.7	6893.5	6884.4	6882.9	6941.9	6931.3	6923.4	6921.1	6885.04	6886.72	6770.9	6765.3	6763.7
										6883.733	6887			
6924.2	6928.1	6892.5	6892.3	6882	6883.4	6942.4	6932.2	6924.2	6919.6	6883.533	6887.1	6771.6	6765.3	6764
										6884.6	6887.733			
6925	6928.4	6892	6892	6881.5	6882	6943.1	6932	6930	6920.1	6885.2	6887.833	6773.2	6765.5	6763.6
										6885	6887.033			
	6928.1				6881.6		6933.1			6885.5	6886.3	6772.3	6766.7	6764.8
	6928.2				6881.2		6933.9			6883.7	6885.9	6772.4	6766.9	6764.8
	6928.4				6881.1		6935.1			6882.55	6885.3	6772.6	6767.85	6765.2
	6928.1				6881.1		6935.6			6881.4	6884.1	6772.6	6767.2	6765.4
	6927.9				6880.9		6936.2			6880.1	6883.1	6772.7	6767	6765.1
	6928.1				6880.7		6936.7			6879.7	6882.6	6772.7	6766.9	6765
	6928.1				6880.6		6936.9			6879	6882.6	6773.5	6767.2	6765.3
	6928				6880.5		6936.8			6878.9	6881.9	6773.1	6767	6765.1
	6928				6880.2		6937			6878	6882	6773.1	6766.8	6765
	6928				6879.6		6937.2							6765.4
	6928				6879.7		6937.3							6765.2
					6879.4									6765.1
					6879.1									6765.5
					6878.4									6765.2

														6765.2
					0									6764.9
					6877.4									6764.9
					6877									6764.9
					6876.8									6764.9
					6876.2									6764.6
					6875.4									6766.7
					6875									6770.8
					6874.8									6772.1
					6873.5									6772.8
					6872.3									6774.2
					6872.1									6775.1
					6872.2									6775.9
					6865.9									6776.5
					6868.3									6776.8
					6870.3									6775.7
					6870.2									6778.3
					6869.5									6778.7
					6869.1									6779.2
					6869									6779.6
					6868.7									6780.1
					6868.1									6780.3
					6867.5									6780.5
														6781
														6781.3
														6781.5
														6781.6
														6782.3
														6782.3
														6782.2
														6782.5
														6782.9
														6783.2
														6783.2
														6783.2
														6783.6
														6782.9
														6783.54
														6783.3
														6780.5

		6940.21	6895.58												
		6[illegible]47	6901.797												
	6895.622	69[illegible]49	6910.972												
:5	6904.482	6917.84	6920.221	6930.2	6920.9	6860.65			6939.773	6940.761	6935.787		6940.723		
03	6907.917	6920.334	6920.586	6923.1	6923.024	6863.745			6937.614	6938.505	6934.465		6938.506	6796.29	6813.13
04	6909.673	6915.355	6919.995	6922.8	6922.994	6865.618			6937.206	6938.181	6934.398		6938.038	6795.083	6822.495
5	6910.612	6913.035	6921.282		6923.596	6868.28			6937.6	6938.66	6933.044		6938.336	6795.867	6829.329
2	6911.978	6918.93	6923.94	6925.75	6924.979	6870.774			6937.483	6939.75	6929.65		6939.206	6796.471	6822.257
	6913.783	6924.783	6926.633	6926.817	6926.55	6874.683			6919.367	6940.467	6925.6		6944.4	6801.3	6814.5
	6915.027	6926.525	6927.955	6927.625	6927.93	6878.175			6920.15	6942.5	6925.3		6947.6		
	6915.633	6927.6	6929.1	6929.05	6928.955	6882.75			6920.975	6942.52	6924.675		6946.835	6798.6	6827.9
	6916.612	6929.4	6930.169	6930.267	6930.323	6884.5			6922.014	6943.543	6924.977		6948.785		
	6917.35	6930.4	6930.518	6929.356	6929.456	6891.6			6922.827	6944.108	6925.5		6949.777	6799.8	6818.6
	6917.109	6929.867	6930.345	6929.008	6928.97	6891.85			6922.89	6944.37	6925.411		6949.79		
	6916.867	6937.75	6930.1	6928.692	6928.743	6892.4			6922.912	6944.3	6925.425		6950.15	6801.8	6814.7
	6917.13	6930.933	6928.108	6928.821	6928.827	6895.1			6923.822	6944.764	6926.709		6947.5		
	6917.387	6933.95	6927.5	6929.092	6929.05				6924.113	6945.557	6926.914		6943.9	6803.5	6797.1
	6917.95	6925.35	6930.4	6929.071	6929.2	6896.3	6919.5								
	6916.918	6927.739	6929.144	6929.2	6929.15	6898.6	6918.9							6804	6799.2
	6912.527	6926.11	6925.637				6918.7								
	6908.733	6918.713	6922.407				6917.2							6805.7	6815.7
	6907.729	6922.679	6922.16				6918								
	6907.683	6922.9	6422.233				6914.567	6920.967	6923.117	6943.04		6927.684		6805.3	6797.8
	6906.833	6922.233	6922.1			6896.2	6916.009	6920.831	6922.231			6922.915			
	6906.775	6921.5	6921.225			6894.8	6916.125	6920.967	6920.067			6915.033		6806	6795.2
	6908.175	6921.3	6920.05			6894.4	6915.733	6923.267	6919.067			6920.133			
						6893.1	6915	6922.35	6918.8			6921.45		6806.4	6812.2
						6892.5								6806.2	6783.2
						6890.7	6913.5	6920.5	6916.2			6911.1		6806.7	6783.5
	6906.9	6925	6921.9			6889.3	6913.2	6921.9	6915.1			6910.2		6806.3	6783.6
	6907.5	6927.5	6923.2			6888.5	6911.8	6921.7	6914.6	6952.1		6911		6806.1	6783.6
	6908.4	6928.8	6924.2			6887.8	6911.4	6921.2	6914.6	6952.1		6913.8		6805.8	
	6909.6					6888	6911.6	6921.4	6915.3			6911.8		6806	6782.4
						6887.6	6911.6	6920.4	6914.2			6911.8		6805.8	6783
	6913					6887.6	6911.5	6919.7	6914.1			6912.1		6805.3	6783.9
															6782.7
	6910.4						6911.4	6917.1							
	6912.6						6911.8	6916.7							

		6902.6													
	6859.042	6904.475	6906.4	6905.075	6901.443	6915.356	6918.1								
	6859.06	6903.825	6905.5	6903.95	6901.85	6915.033	6909.767								
						6919.364	6912.186	6916.672	6925.668						
						6920.155	6912.933	6916.808	6926.889						
						6921.671	6913.347	6918.712	6927.535						
	6863.3	6909.6	6908.3		6897.3	6922.7	6913.819	6921.223	6928.053						
	6866.1	6910.4	6909.3			6923.157	6913.914	6921.292	6928.118						
	6866.1	6910.5			6896.6	6923.623	6913.527	6922.514	6928.533						
2	6865.719	6912.863				6924.1	6913.557	6923.058	6928.592	6925.333			6873.5	6865.6	6874.6
	6859.654	6912.738				6924.2	6913.708	6921.088	6928.625	6920.3			6861.32		
6	6858.223	6912.129				6923.925	6914.213	6917.2	6928.7	6919.75			6860.638	6916.4	
	6857.7	6911.882		6908.4	6894.6	6924.239	6914.318	6923.013	6928.581	6919.092	6918.813	6922.936	6869.325		
9	6860.408	6912.485				6923.109	6914.156	6921.596	6927.714	6919.185	6911.859	6921.407	6868.669		
2	6860.725	6912.14		6908.7	6893.8	6920.536	6910.5		6925.285	6918.95	6906.6	6918.423	6863.975		
7	6859.7	6911.333				6919.862	6908.936		6924.407	6918.333	6909.357	6918.314	6862.367		
7	6859.733	6910.533	6905	6908	6892.5	6919.593	6908.75		6924.833	6917.633	6908.843	6918.129	6866		
7	6861	6911.433				6919.346	6908.777		6924.667	6917.933	6907.15	6918.5	6865.267		
	6862.367	6910.933	6904.6	6908.2	6892.1	6918.946	6908.692		6924.4	6918.367	6906.767	6917	6866		
	6863.1	6910.033	6904.6	6906.2		6918.5	6908.95		6924.633	6917.233	6907.967	6916.833	6868.033	6861.4	
7	6863.967	6907.333	6905.9	6905.5	6891.5	6918.05	6909.25		6924.967	6917.8	6913	6915.867	6870.933		
	6862.2	6905.6	6904	6903.6	6890.9	6917.6	6910.5		6925.7			6915.9	6865		
	6860.9	6905	6903.4	6903.3	6891.1	6918.1	6911.5		6927.3		6911	6916.4	6864.1		
	6860.5	6903.8	6902.1	6902.2	6890.8	6918.2	6911.9		6928.5		6913.1	6916.7	6863.4		
	6859.4	6903	6901.4	6901.7	6890.5	6918.1	6913.5		6930.8		6913.5	6917.1	6863.8		
	6859.8	6901.8	6900.2	6900.6	6889.4	6918.7	6916		6932.6		6924	6918.1	6863.7		
	6858.9	6900.9	6899.4	6900.1	6890.3	6920.1	6917.4		6933.3		6917.1	6919.3	6862.2		
	6858.4	6899.8	6898.6	6899.5	6890.1	6919.65	6918.6		6933.4		6917.6	6918.95	6861.4		
	6857.8	6898.7	6897.6	6898.8	6889.7	6920.1	6918.8		6933.4		6919	6919.55	6860.6		
						6921.1	6919.1					6920.1			
						6920.5	6919.1				6918.4	6919.8	6860.1		
						6920.2	6919.1				6918.2	6919.3	6859.2		
						6920.5	6918.7					6919.2			
						6920.8	6918.5					6919.1			
						6919.6	6917.8					6917.8			

					6918.8	6917.4					6917.2			
					6918.1	6916.4					6916.4			
					6917.8	6915.6					6915.8			
					6916.9	6915.1					6914.9			
					6916.6	6914.4					6914.6			
					6916.5	6913.8					6914.8			
					6916.2	6911.4					6914.3			
					6916.1	6913.2					6914.5			
					6916.2	6912.9					6914.4			
					6915.8	6912.4					6914.4			
					6915.7	6912.2					6914.2			
					6915.6	6912.1					6914.1			
					6915.6	6911.8					6914			
					6915	6911.2					6913.5			
					6914.8	6910.5					6913.3			
					6914.7	6910.7					6913.1			
					6914.4	6910.2					6912.8			
					6913.9	6906.8					6912.3			
					6914	6909.5					6912.4			
					6913.7	6909.1					6912.1			
					6913.4	6908.8					6911.9			
					6912.9	6903.9					6911.4			
					6912.9	6903.7					6911.5			
					6912.7	6908.2					6911.2			
					6912.4	6904.1					6911.3			
					6912.2	6904.2					6910.6			
					6912	6903.8					6910.3			
					6911.9	6903.7					6910.2			
					6911.7	6902.2					6909.9			
					6911.2	6902.1					6910			
					6911.2	6901.4					6909.6			
					6911	6902.5					6910.4			
					6911	6901.4					6909.7			
					6910.9	6902.1					6908.9			
					6910.5	6902.1					6908.9			
					6910	6902.2					6908.9			
					6910.1	6902.4					6908.4			
					6909.88	6901.04					6907.8			
					6910	6900					6908.6			
					6910.4	6899.6					6908.2			

11.323	6892.985	6894.269													
08.969	6891.207	6894.469													
905.4	6889.954	6891.438													
04.443	6890.6	6891.854													
904.2	6890.383	6891.833													
04.033	6921.067	6892.433													
03.633	6889.667	6891.467													
04.067	6889.467	6891.2											6839.7	6866.6	
904.85	6888.65	6891.333										6931.9			
		6890.8										6831.5			
6905	6887.2	6890.1										6831.5	6840.6	6868	6892
904.2	6886.1	6889										6931	6840.6	6868	6892
904.3	6885	6888.3										6930.7			
905.1	6884.8	6887.9										6930.8	6841.1	6867.8	6892
905.9	6884.7	6888										6930.7			
6906	6884.5	6887.55										6930.4	6842.233	6868.1	6894.
906.7	6884.3	6887.55										6930.1			
		6887.6											6842.5	6868.3	6894
6907	6884.7	6887.7										6929.7	6843.1	6868.5	6894
907.1	6884.7	6887.9											6843.3	6868.4	6895
		6888.1											6843.9	6868.8	6895
		6888.2											6844.3	6869.1	6895
		6887.6											6844.8	6869.4	6895

		6887.6											6845	6869.3	6895
		6887											6844.9	6869.1	6895
		6886.9											6845.1	6869.1	689
		6887.2											6845.3	6869	6894
		6887.6											6845.8	6869.5	6894
		6888.1											6846	6869.6	6894
		6888.5											6846.5	6870.2	6894
		6888.6											6846.7	6870.5	6894
		6888.6											6847.1	6870.5	6894
		6888.7											6846.5	6869.7	6894
		6889											6846.7	6869.8	6894
		6889.3											6847	6870	6894
		6889.7											6847.5	6870.5	6894
		6889.6											6848.2	6871.1	6894
		6889.5											6845.5	6868.8	689
		6889.8											6847.8	6869.5	689
		6889.7											6847.9	6870.5	6893
		6889.5											6848.1	6870.4	6893
		6889.7	6920.9	6910.9	6903	6894.5	6916.1	6894.7	6904.1	6898.2	6900.1		6848	6870.3	6893
		6889.5											6848.1	6870.4	6893
		6889.4											6848.5	6870.6	6894
		6888											6848.4	6870.3	6893
		6888.9											6842.6	6870.4	6893
		6888.8											6848.5	6870.3	6893
		6888.6											6842.7	6870.2	6893
		6888.3											6848.5	6870.2	689
		6888.1											6848.7	6870.1	6892
		6888.5											6848.7	6870.1	6892
		6887.8											6848.7	6869.9	6892
		6887.4											6848.5	6869.5	6892
		6887.3											6848.5	6869.4	689
		6887.2											6849.2	6870.3	6892
		6887.1											6848.9	6869.5	6892
		6886.7											6848.7	6869.2	6891
		6887											6849.5	6871.8	6897
		6886.2											6849.3	6869.5	689
		6886.4											6849.5	6869.8	6892
		6885.69											6849.19	6869.5	6891.
		6885.6											6849.3	6869.2	6891
		6885.6											6849.5	6869.5	6891

/2000	6780.7		6793.9	6837.7	6832.2	6798	6851.3	6910.6	6909	6914.6	6850.1	6869.1	6891.8	6902.5	686
/2000	6780.5		6793.9	6837.6	6832.1	6797.9	6851	6910.3	6908.8	6914.4	6849.9	6868.9	6891.	6902.2	686
5/2000	6780.6	6780.4	6794.25	6837.7	6832.15	6798.2	6851	6910.4	6908.9	6914.15	6849.95	6868.9	6891.6	6902.3	686
/2001	6781.2	6780.6	6794.3	6837.75	6832.15	6798.4	6850.8	6910.4	6909	6914	6850	6868.95	6891.6	6902.4	6863
/2001	6781.3	6780.85	6794.5	6837.9	6832.3	6798.6	6850.7	6910.3	6908.9	6913.7	6850.1	6868.8	6891.4	6902.05	686
/2001	6781.05	6780.65	6794.2	6837.5	6831.8	6798.35	6850.1	6909.9	6908.45	6913.35	6849.6	6868.25	6891	6901.7	686
5/2001	6781.2	6780.95	6794.55	6837.8	6832.05	6798.8	6850.2	6910	6908.5	6913.2	6849.75	6868.3	6891.1	6901.75	686
/2002	6781.15	6781.2	6794.75	6837.9	6832.15	6799	6850.2	6909.85	6908.4	6913	6849.8	6868.25	6891.1	6901.75	686
/2002	6781.69	6781.35	6794.9	6837.9	6832.1	6799.1	6849.9	6910	6908.1	6912.9	6849.36	6867.9	6890.74	6901.36	686
/2002	6781.6	6781.15	6794.8	6837.75	6831.9	6799.05	6849.5	6909.3	6908.02	6912.4	6849.45	6867.85	6890.78	6901.25	686
5/2002	6781.53	6781.33	6794.97	6837.93	6832.08	6799.3	6849.48	6910.87	6907.87	6912.3	6849.16	6867.7	6890.63	6901.17	6862
/2003	6781.66							6909.16	6908.03	6912.06	6849.13	6867.38	6890.29	6901.09	
/2003	6781.98	6781.69	6795.29	6838.04	6832.1	6799.6	6849.18	6908.81	6908	6911.76	6849.54	6867.44	6890.24	6900.86	6862
/2003	6781.85	6781.59	6795.01	6837.64	6831.6	6799.27	6848.5	6908.68	6907.72	6911.61	6849.09	6867.14	6890.01	6900.68	686
5/2003	6782.14	6781.69	6795.19	6837.54	6831.6	6799.38	6848.4	6908.8	6907.76	6911.63	6848.8	6866.96	6890.07	6900.61	6862
/2004	6782	6781.98	6795.59	6837.73	6831.7	6799.64	6848.22	6909.85	6907.7	6911.41	6848.87	6866.8	6891.44	6900.43	6862
/2004	6782.4	6781.97	6795.35	6837.68	6831.65	6799.72	6848.33	6908.45	6907.5	6911.37	6848.76	6866.82	6889.95	6900.39	6861
/2004	6782.17	6781.91	6795.38	6836.94	6831.55	6799.74	6847.72	6908.21	6907.05	6911.01	6848.67	6866.61	6889.7	6900.08	6862
5/2004	6782.35	6782.09	6795.49	6837.7	6831.6	6800.02	6847.6	6908.21	6907.05	6911.04	6848.79	6866.64	6889.67	6900.09	6862
/2005	6782.41	6782	6795.26	6838.42	6831.3	6799.79	6847.12	6908.03	6907.04	6911.01	6848.91	6866.93	6889.91	6900.32	686
/2005	6782.45	6782.14	6795.36	6837.57	6831.4	6800	6847.1	6907.6	6906.6	6910.6	6848.66	6866.3	6889.52	6899.87	686
/2005	6782.4	6781.98	6795.15	6837.39	6831.17	6799.93	6846.67	6907.49	6906.4	6910.51	6847.89	6866.15	6889.05	6899.62	6862
5/2005	6782.69	6782.02	6795.13	6837.38	6831.18	6800.03	6846.57	6907.48	6906.5	6910.58	6848.28	6866.02	6889.14	6899.66	6862
/2006	6782.66	6782.09	6795.11	6837.47	6831.26	6800.22	6846.55	6907.55	6906.34	6910.48	6848.01	6865.81	6888.87	6899.29	6862
/2006	6782.62	6781.99	6794.83	6837.14	6830.91	6799.97	6845.98	6907.45	6906.4	6910.28	6848.22	6865.71	6888.84	6899.29	6862
/2006	6782.43	6781.68	6794.89	6837.21	6830.95	6800.09	6845.84	6906.83	6905.7	6910.01	6848.04	6865.55	6889.04	6899.12	6862
5/2006	6782.55	6781.96	6794.96	6837.19	6829.94	6800.15	6845.7	6907	6905.67	6909.93	6847.9	6865.45	6888.64	6899.06	6862
/2007	6782.42	6782.02	6794.86	6836.99	6830.69	6800.07	6845.33	6906.88	6905.69	6909.94	6847.64	6865.28	6888.32	6898.84	686
/2007	6782.6	6782.12	6794.81	6837.26	6830.89	6800.37	6845.54	6906.77	6905.64	6909.94	6847.81	6865.2	6888.47	6898.96	6862
/2007	6782.3	6781.94	6794.71	6836.94	6830.61	6800.22	6845.15	6906.38	6905.1	6909.56	6847.44	6864.75	6888.04	6898.16	686
5/2007	6782.23	6782.04	6794.66	6836.98	6830.7	6800.27	6845.1	6906.33	6905.13	6909.49	6847.26	6864.52	6888.03	6898.26	6861
/2008	6781.9	6782.09	6794.71	6836.54	6830.65	6800.37	6845.1	6906.43	6905.15	6909.66	6847.49	6864.8	6887.99	6898.51	6861
/2008	6782.55	6782.19	6794.56	6836.59	6830.5	6800.25	6844.93	6906.43	6905.15	6909.61	6847.09	6864.5	6887.59	6898.01	686
/2008	6782.15	6781.64	6794.41	6836.59	6830.25	6800.12	6844.75	6905.93	6904.6	6909.11	6846.99	6864.3	6887.49	6897.96	686
5/2008	6782.2	6781.99	6794.32	6836.41	6830.11	6799.97	6844.65	6905.73	6904.48	6908.91	6846.54	6864.08	6887.34	6897.84	686
/2009	6782.1	6780.99	6794.31	6836.44	6830.2	6800.12	6844.8	6905.73	6904.3	6908.81	6846.79	6863.7	6886.99	6897.56	6861
/2009	6782.5	6781.89	6794.76	6836.94	6830.7	6800.62	6845.25	6905.68	6904.4	6908.91	6846.84	6863.9	6887.14	6897.56	686
/2009	6782.2	6780.84	6794.31	6836.29	6830.1	6800.07	6844.6	6905.33	6904	6908.61	6846.64	6863.6	6886.94	6897.46	686
5/2009	6782.3	6781.74	6794.41	6836.44	6830.2	6800.27	6844.6	6905.43	6904.05	6908.71	6846.74	6863.7	6886.94	6897.51	686
/2010	6782.1	6781.84	6794.56	6836.44	6830.3	6800.42	6844.6	6905.13	6903.8	6908.46	6845.99	6863.3	6886.54	6897.11	686
/2010	6782.4	6781.89	6794.51	6836.49	6830.25	6800.32	6844.45	6904.88	6903.6	6908.21	6846.165	6863.5	6886.69	6897.11	686
/2010	6782.15	6782.64	6794.41	6836.14	6830.05	6800.27	6844.2	6904.43	6903.45	6908.06	6845.84	6863.2	6886.44	6897.01	686
5/2010	6782.2	6782.3	6794.31	6836.04	6829.7	6800.07	6843.9	6904.58	6903.35	6908.06	6845.515	6863.35	6886.59	6897.16	686
/2011	6782.1	6782.05	6794.4	6836.13	6830.1	6800.45	6843.78	6904.43	6903.25	6908.3	6846.135	6863.348	6886.544	6897.122	686
/2011	6782.3	6781.95	6794.59	6836.38	6830.17	6800.6	6844	6904.48	6903.32	6907.96	6846.165	6862.898	6886.124	6896.712	686
/2011	6782.05	6782.45	6794.35	6836.1	6829.81	6800.4	6843.6	6904.23	6903.08	6907.51	6845.985	6862.798	6885.994	6896.512	686
5/2011	6782.1	6781.69	6794.07	6835.86	6829.61	6800.21	6843.2	6904.26	6903.1	6907.85	6846.105	6862.898	6886.124	6896.662	6860.

final calibrated mo... top to early models at bottom.
refer to areas show... gures 15B to 15F in model report (Chester Engineers, Oct. 2012)
kh (horizontal hydraulic conductivity, ft/d), kv (vertical hydraulic conductivity, ft/d), Ah (horizontal anisotropy ratio), Av (vertical anisotropy ratio)
Sy (specific yield), Dis (dispersivity - not used in model), Por (porosity ratio)
n differences of model predicted and measured heads at observation wells over the simulation stess period range (listed to right of error statistics)

ge multiplier in north pond) — error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	Z3_M5	head	Alluv	Zone 3
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	0.377	mean	-3.98	7.80
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	0.0189	absolute		
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1	0.67	1	root mean :	9.65	15.89
3	20	10	20	10	20	10	20	20	20	12	10	20	flow		
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	0.0008	mean		
).25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06	0.06	0.06	absolute		
0	0	0	0	0	0	0	0	0	0	0	0	0	root mean square		
).25	0.06	0.18	0.12	0.1	0.06	0.08	0.06	0.06	0.06	0.1	0.1	0.06			

harge same as model 108, porosities increased to 0.12 in several zone 3 materials,, 5x recharge multiplier in north pond) — error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	Z3_M5	head	Alluv	Zone 3
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	0.377	mean	-13.28	5.65
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	0.0189	absolute		
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1	0.67	1	root mean :	17.18	15.70
3	20	10	20	10	20	10	20	20	20	12	10	20	flow		
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	0.0008	mean		
).25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06	0.06	0.06	absolute		
0	0	0	0	0	0	0	0	0	0	0	0	0	root mean square		
).25	0.06	0.06	0.12	0.12	0.06	0.12	0.06	0.06	0.06	0.1	0.1	0.06			

harge stage 0.037 except 0.025 in poly 25 and 0.07 in poly 32,, 5x recharge multiplier in north pond) — error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	Z3_M5	head	Alluv	Zone 3
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	0.377	mean	-13.37	6.10
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	0.0189	absolute		
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1	0.67	1	root mean :	17.19	15.54
3	20	10	20	10	20	10	20	20	20	12	10	20	flow		
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	0.0008	mean		
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	0.06	absolute		
0	0	0	0	0	0	0	0	0	0	0	0	0	root mean square		
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	0.06			

harge stage 0.05, 5x recharge multiplier in north pond) — error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	Z3_M5	head	Alluv	Zone 3
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	0.377	mean	-14.01	4.38
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	0.0189	absolute		
1	1	0.1	1	0.5	1	0.35	1	1	0.67	1	0.67	1	root mean :	18.01	16.75
3	20	10	20	10	20	10	20	20	20	12	10	20	flow		
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	0.0008	mean		
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	0.06	absolute		
0	0	0	0	0	0	0	0	0	0	0	0	0	root mean square		
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	0.06			

harge stage 0.025 [illegible] charge multiplier in north pond) error

lluv2	Dilco_M1	[illegible]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2[illegible]	Z2_M2	Z1_M1	Z1_M2	Z3_M5	head	[illegible]	Zone 3
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	0.377	mean	-12.38	7.58
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	0.0189	absolute		
1	1	0.1	1	0.5	1	0.35	1	1	0.67	1	0.67	1	root mean :	16.21	16.60
3	20	10	20	10	20	10	20	20	20	12	10	20	flow		
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	0.0008	mean		
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	0.06	absolute		
0	0	0	0	0	0	0	0	0	0	0	0	0	root mean square		
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	0.06			

ove most of recharge strip north of Section 36 boundary

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-12.56	5.27	0.99	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.67	1	0.67	root mean square	17.50	16.47	14.54	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

: recharge strips along pipeline arroyo start only after mine discharge ends

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-12.36	4.12	1.45	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.67	1	0.67	root mean square	17.34	15.67	14.70	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

ce river segments with recharge strips at 0.07 runoff percentage, recharge strip removed from dilco cut

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-12.58	4.91	-0.22	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.67	1	0.67	root mean square	17.48	16.70	14.35	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

ce river segments [illegible] charge strips at 0.07 runoff percentage, recharge strip added to dilco[illegible]

												error				
lluv2	Dilco_M1	[illegible]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2[illegible]	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Z[illegible]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-12.63	5.54	-0.09	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.67	1	0.67	root mean square	17.43	18.54	14.38	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

ce river segments with recharge strips at 0.1 runoff percentage, return to river-3_83 mats

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-13.18	2.03	-1.13	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.67	1	0.67	root mean square	18.15	16.71	15.01	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

ce river segments with recharge strips at 0.05 runoff percentage, return to river-3_83 mats

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-11.27	7.79	1.89	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.67	1	0.67	root mean square	16.04	16.47	14.14	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency) return to river-3_83 mats, increase stage & conductance or

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean				
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.67	1	0.67	root mean square				
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments an[illegible]ning calcs - 0.2 run off with 3X multiplier of frequency) return to river-3[illegible]ats, return alluvium, reduce Kh in Z2_ error

lluv2	Dilco_M1	[illegible]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2[illegible]	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Z[illegible]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-9.07	10.24	4.15	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.25	1	0.25	1	1	0.35	1	0.35	root mean square	13.69	17.89	14.14	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency) return to river_3_83 mats, convert alluvium to rock beneath error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-9.04	12.53	9.44	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	13.39	19.03	18.93	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency) didn't work error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean				
90625	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.5	1	0.35	1	0.35	1	1	1	1	1	root mean square				
8	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency) error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-9.11	13.21	2.79	
90625	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.5	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	13.66	22.99	13.45	
8	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments an[illegible]ning calcs - 0.2 run off with 3X multiplier of frequency)

error

lluv2	Dilco_M1	[illegible]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2[illegible]	Z2_M2	Z1_M1	Z1_M2	head	Alluv	[illegible]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-7.18	11.22	3.91	
7125	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.5	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	12.51	18.17	13.88	
10	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency)

error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-8.84	13.66	3.16	
'8125	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.5	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	13.55	23.19	13.44	
4	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency)

error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-8.95	13.20	3.54	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.5	1	0.5	1	0.5	1	1	0.67	1	0.67	root mean square	13.61	22.93	13.88	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency)

error

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-8.89	13.27	3.64	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.5	1	0.5	1	1	0.67	1	0.67	root mean square	13.60	22.45	13.75	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments an[redacted]ning calcs - 0.2 run off with 3X multiplier of frequency, reduce Zone 3b[redacted]rial in layer 4, larger initial dry areas)

												error				
lluv2	Dilco_M1	[redacted]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_[redacted]	Z2_M2	Z1_M1	Z1_M2	head	Alluv	[redacted]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean				
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square				
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency, expand Zone 3b material in layer 4)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-9.12	12.75	2.41	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	13.72	22.15	13.37	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 3X multiplier of frequency)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-9.28	11.57	2.29	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	13.81	21.68	13.63	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off with 4X multiplier of frequency)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-9.0	11.90	3.10	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	14.3	22.15	14.04	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments an[illegible]ning calcs - 0.2 run off with 2x multiplier of frequency)

												error				
lluv2	Dilco_M1	[illegible]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_[illegible]	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Z[illegible]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-7.5	15.06	4.93	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	12.4	23.53	14.44	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.2 run off)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-5.6	15.43	6.01	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	11.2	21.34	14.94	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.15 run off)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-5.8	15.14	4.17	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	11.4	23.89	13.86	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs - 0.10 run off)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-6.0	14.26	1.87	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	11.5	22.98	13.82	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments an[illegible]ning calcs -0.05 run off)

lluv2	Dilco_M1	[illegible]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2[illegible]	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Z[illegible]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-5.6	14.27	1.65	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	11.4	23.43	13.33	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

river segments and manning calcs)

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-14.4	-2.48	-0.2	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	20.0	24.30	15.0	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

ase river conductance and head next to tailings cells)

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-6.6	13.72	-0.6	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	12.0	22.93	12.7	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.18	0.18	0.12	0.12	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

al river conductances in upgradient reaches) alluvium sy of .3 causes blow out

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-5.2	13.81	2.7	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	11.6	20.00	13.4	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
0.3	0.18	0.18	0.09	0.09	0.06	0.06	0.06	0.12	0.12	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
0.3	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

le river conductan[illegible] upgradient reaches)

												error				
lluv2	Dilco_M1	[illegible]_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_[illegible]	Z2_M2	Z1_M1	Z1_M2	head	Alluv	[illegible]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-7.3	8.1	-7.1	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	12.7	15.5	15.1	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

le river conductances in upgradient reaches)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.05	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-7.0	12.9	-4.0	
.375	0.0005	0.003333	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.2	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	12.4	19.9	13.1	
3	20	15	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.05	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-7.1	12.7	-4.2	
.375	0.0005	0.003333	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.2	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	12.5	19.9	13.0	
3	20	15	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

of river stage time series after 1986)

												error				
lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-7.3	8.9	-7.0	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	12.6	16.6	14.9	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

p to modflow more [redacted] e matching of wells, river to grid)

lluv2	Dilco_M1	[redacted] _M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2 [redacted]	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	[redacted]	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-11.6	0.8	-8.6	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	15.8	12.6	16.6	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

ı refinement beneath and north of ponds

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Zone 1	str
.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-11.7	3.7	-7.2	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	15.9	17.0	16.1	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Zone 1	str
4.25	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-11.9	2.2	-8.7	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	16.0	13.2	17.0	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

lluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Zone 1	str
4.25	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-11.6	3.5	-7.3	
.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				
1	1	0.1	1	0.35	1	0.35	1	1	0.67	1	0.67	root mean square	16.0	13.6	16.6	
3	20	10	20	10	20	10	20	20	20	12	10	flow				
.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).25	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	0	root mean square				
).25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

e as 58 with noted [illegible]ial changes)

co_M1	Dilco_M2	[illegible]_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_[illegible]	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Z[illegible]	tress periods
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	-12.49857995	-2.0	-8.3	4/1/1969
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				1/15/2005
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	16.60854373	14.3	20.5	
20	10	20	10	20	10	20	20	20	12	10	flow				
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				
).06	0.06	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				
0	0	0	0	0	0	0	0	0	0	0	root mean square				
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	problem in i76 j38 k2-6 Alluv	Zone 3	Zone 1	str
).01	0.05	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.8	1.2	mean		7.0		-1.5
0005	0.005	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.066667	0.12	absolute				14.0
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean square		15.7		17.7
20	10	20	10	20	10	20	20	20	12	10	flow				
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				11983.0
).18	0.18	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				29236.0
0	0	0	0	0	0	0	0	0	0	0	root mean square				45716.0
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	problem in i76 j38 k2-6 Alluv	Zone 3	Zone 1	str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.63675	0.955125	mean	-12.27565222	3.0	-7.1	-2.5
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.053063	0.095513	absolute				14.3
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	16.43248994	13.6	17.8	19.0
20	10	20	10	20	10	20	20	20	12	10	flow				
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				12432.0
).18	0.18	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				29432.0
0	0	0	0	0	0	0	0	0	0	0	root mean square				46078.0
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

h increases of K in layers 4-6 to reduce i76 j38 blow up-inusfficient effect,)

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	problem in i76 j38 k2-6 Alluv	Zone 3	Zone 1	str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean		3.6		-1.6
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute				14.6
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean square		13.9		19.3
20	10	20	10	20	10	20	20	20	12	10	flow				
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				12882.0
).18	0.18	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute				29398.0
0	0	0	0	0	0	0	0	0	0	0	root mean square				45961.0
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

e as 59 with startin[illegible]ds set to 1 ft beneath river in layers 2-4, and east of column i=68 in la[illegible]

											error	problem in i76 j38 k2-6					
)o_M1	Dilco_M2	[illegible]_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2[illegible]	Z1_M1	Z1_M2	head	Alluv		Zone 3	Z[illegible]		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean		-12.48777354	3.8	-3.9	-1.2	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute					14.7	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ		16.95934232	14.0	17.8	19.5	
20	10	20	10	20	10	20	20	20	12	10	flow						
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean					12935.0	
).18	0.18	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute					29408.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square					46077.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1							

e as 59 with starting heads set to 1 ft beneath river in layers 2-4)

											error	problem in i76 j38 k2-6					
)o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv		Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean		8.88	-5.4	-3.3	-0.9	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute		16.09	17.1	18.7	15.2	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ		20.52	22.4	26.3	20.1	
20	10	20	10	20	10	20	20	20	12	10	flow						
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean					14014.0	
).18	0.18	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute					30738.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square					48141.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1							

											error						
)o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv		Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean		7.75	-13.8	-15.1	6.2	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute		15.82	21.3	21.6	17.6	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ		20.17	27.0	33.6	24.6	
20	10	20	10	20	10	20	20	20	12	10	flow						
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean					12862.0	
).18	0.18	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute					29373.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square					46443.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1							

											error	problem in i76 j38 k2-6					
)o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv		Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean		7.23	-8.9	-14.5	5.1	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute		16.09	18.7	22.3	17.2	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ		21.08	24.6	33.9	24.3	
20	10	20	10	20	10	20	20	20	12	10	flow						
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean					13925.0	
).06	0.06	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	absolute					29303.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square					46533.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1							

											error	problem in i76 j38 k2-6				
:o_M1	Dilco_M2	[illegible]_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_[illegible]	Z1_M1	Z1_M2	head	Alluv	Zone 3	Z[illegible]		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	7.36	-10.4	-22.7	9.1	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute	15.86	20.1	26.7	19.8	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	20.38	26.2	38.6	28.3	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				15954.0	
).06	0.06	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				29351.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				46610.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

											error	problem in i76 j38 k2-6				
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245	0.63675	mean	7.04	-9.1	-19.9	7.1	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375	0.063675	absolute	16.47	20.7	24.5	18.2	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.72	27.2	35.7	25.9	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				15533.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				28898.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				46360.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

											error	problem in i76 j38 k2-6				
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.283	0.4245	mean	7.04	-9.1	-25.2	10.0	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.023583	0.04245	absolute	16.35	19.4	28.8	20.6	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.47	25.1	40.7	29.2	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016	0.0016	mean				16543.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				29180.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				46520.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

nod 52 with dry cell starting heads in layers 2-6)

											error	problem in i76 j38 k2-6				
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.283	0.4245	mean	7.07	-7.8	-26.3	9.6	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.023583	0.04245	absolute	16.43	19.3	28.2	20.0	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.73	25.2	40.3	28.5	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				15932.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				28832.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				46314.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

nod 52 with dry ce[illegible]ing heads in layers 2-5)

											error	problem in i76 j38 k2-6				
:o_M1	Dilco_M2	[illegible]_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2[illegible]	Z1_M1	Z1_M2	head	Alluv	Zone 3	[illegible]		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.283	0.4245	mean	7.87	-5.3	-21.7	6.7	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.023583	0.04245	absolute	16.67	18.8	25.2	18.0	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.91	24.5	35.4	25.2	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				14860.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				28695.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				46220.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

nod 47 with material changes)

											error	problem in i75 j45 k3 and i76 j38 k2-6				
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.283	0.4245	mean	8.05	-4.5	-18.4	5.4	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.023583	0.04245	absolute	16.69	18.2	23.2	17.1	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.98	23.7	32.3	23.8	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				12340.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				28541.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				45937.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

nod 47 with material changes)

											error	problem in i75 j45 k3				
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.8	1.2	mean	-7.72	-6.6	-11.3	3.0	
0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.066667	0.12	absolute	16.15	18.2	17.5	14.5	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	20.91	23.4	25.4	20.0	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				9100.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				22417.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				37607.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

:ase pond recharge by 20%)

											error					
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.2	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	-7.34	-0.7	-7.3	-1.2	
0005	0.02	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	18.08	19.9	18.1	13.2	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	25.15	26.0	25.2	17.5	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				10962.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				34454.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				51620.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

ease alluv, dilco_li uctances, increase river conductance and stage by 20%)

co_M1	Dilco_M2	_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2	Z1_M1	Z1_M2	error head	Alluv	Zone 3			str
).01	0.2	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	6.67	-1.1	-9.1	0.0	
0005	0.02	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	17.2	19.9	18.8	13.6	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	22.69	26.4	25.8	17.9	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				11089.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				34733.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				51812.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

nod 42 properties, increase river conductance and stage by 20%)

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	problem in i75 j45 k3 Alluv	Zone 3	Zone 1		str
).01	0.1	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	7.05	-6.6	-11.7	3.0	
0005	0.01	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	16.71	18.7	18.9	14.6	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.88	24.0	26.2	19.4	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				11997.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				33842.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				51310.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

nod 42 properties, increase river stage by 10%)

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	problem in i75 j45 k3 Alluv	Zone 3	Zone 1		str
).01	0.1	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	6.56	-6.0	-10.5	2.6	
0005	0.01	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	16.52	18.2	18.0	14.1	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	22.03	23.2	25.7	18.9	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				11613.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				31358.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				47626.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

nod 42 properties, reduce river bed conductance by .5)

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error head	Alluv	Zone 3	Zone 1		str
).01	0.1	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	6.34	-9.1	-13.9	4.2	
0005	0.01	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	15.71	19.5	18.9	14.3	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	20.26	24.5	27.3	18.8	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				8405.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				20817.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				35730.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

ıble river bed cond[illegible]ces)

											error					
:o_M1	Dilco_M2	[illegible]_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2[illegible]	Z1_M1	Z1_M2	head	Alluv	Zone 3	[illegible]	all	str
).01	0.1	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	6.65	-7.7	-11.2	3.5	
0005	0.01	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	15.87	18.6	16.6	13.3	
1	0.5	1	0.5	1	0.5	0.5	1	0.5	1	0.2	root mean squ	20.47	23.6	24.1	17.9	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				10525.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				34109.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				50673.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

ove anisotropy except in fracture zones)

											error					
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	6.22	-8.4	-13.4	4.5	
0005	0.01	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	15.67	18.9	17.9	13.8	
1	0.5	1	0.5	1	0.5	0.5	1	0.5	1	0.2	root mean squ	20.19	23.6	25.8	18.3	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				8543.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				30819.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				47177.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

											error	problem in i75 j45 k3				
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	6.55	-7.6	-11.3	3.0	
0005	0.01	0.0595	0.952	0.0418	0.119	0.01885	0.0005	0.00075	0.066667	0.12	absolute	16.25	19.3	18.5	14.3	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.54	24.6	26.0	19.2	
20	10	20	5	20	20	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				13047.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				32205.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				49238.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

ɜ Zone 3 into two model layers

											error					
:o_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1	Z1_M2	head	Alluv	Zone 3	Zone 1		str
).01	0.1	1.19	4.76	0.836	2.38	0.377	0.01	0.015	0.8	1.2	mean	6.45	-7.3	-11.3	2.5	
0005	0.01	0.0595	0.476	0.0418	0.238	0.01885	0.0005	0.00075	0.066667	0.12	absolute	16.43	18.9	18.3	13.8	
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean squ	21.84	24.1	26.0	18.2	
20	10	20	10	20	10	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				15272.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				34181.0	
0	0	0	0	0	0	0	0	0	0	0	root mean square				51480.0	
).06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

									error		problem in i75 j45 k3			
co_M1	Dilco_M2	_M1	Z3_M2	Z3_M4	Z2_M1	Z2_M2	Z1_M1	Z1_	head	Alluv	Zone 3	Zone 1		stres ods
.01	0.1	1.19	4.76	0.142	0.01	0.015	0.8	1.2	mean	6.66	-8.79	-11.78	3.9	25294.0
0005	0.01	0.0595	0.238	0.0071	0.0005	0.00075	0.066667	0.12	absolute	16.08	19.28	18.05	14.4	38367.0
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	20.92	24.55	26.1	19.5	
20	10	20	20	20	20	20	12	10	flow					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004	mean				14788.0	
.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1	absolute				34864.0	
0	0	0	0	0	0	0	0	0	t mean square				52079.0	
.06	0.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1						

								error				
co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
.01	0.1	1.19	4.76	0.01	0.015	0.8	1.2	mean	6.47	-5.94	-10.91	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.066667	0.12	absolute	16.66	19.77	18.68	1/15/2005
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	22.15	25.25	25.96	
20	10	20	20	20	20	12	10					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004					
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

								error				
co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
.01	0.1	1.19	4.76	0.01	0.015	0.8	1.2	mean	6.76	-8.4	-10.88	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.066667	0.12	absolute	15.73	20.45	18	1/15/2005
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	20.41	25.82	25.43	
20	10	20	20	20	20	12	10					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.004	0.004					
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

								error				
co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
.01	0.1	1.19	4.76	0.01	0.015	0.8	1.2	mean	6.85	-7.78	-11.61	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.066667	0.12	absolute	16.07	19.62	18.51	1/15/2005
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	20.89	24.86	26.07	
20	10	20	20	20	20	12	10					
0008	0.0008	0.0004	0.0004	0.0008	0.0008	0.004	0.004					
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	er	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	0.8	12	mean	10.77	0.73	-24.51	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.066667	1.2	absolute	15.96	15.88	27.77	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	20.21	19.26	37.24	
20	10	20	20	20	20	12	10					
0008	0.0008	0.0004	0.0004	0.0008	0.0008	0.004	0.004					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	0.666667	1	mean	10.92	1.8	-25.16	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.066667	0.1	absolute	16.11	16.68	28.71	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	20.17	20.18	37.94	
20	10	20	20	20	20	10	10					
0008	0.0008	0.0004	0.0004	0.0008	0.0008	0.004	0.004					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

materials, except in Zone 1)

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	1	1.5	mean	10.33	-0.294	-23.12	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.1	0.15	absolute	16	16.91	26.74	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	20.62	20.75	35.97	
20	10	20	20	20	20	10	10					
0008	0.0008	0.0004	0.0004	0.0008	0.0008	0.004	0.004					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	1	1.5	mean	10.66	3.71	-24.76	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.05	0.075	absolute	16.56	16.71	28.04	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	21.53	21.12	36.76	
20	10	20	20	20	20	20	20					
0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.004	0.004					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.02	1	1.5	mean	10.71	3.36	-23.67	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.001	0.05	0.075	absolute	16.36	16.72	27.6	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	21.22	21.08	36.48	
20	10	20	20	20	20	20	20					
0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.004	0.004					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

er

co_M1	Dilco_M2	_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	1	1.5	mean	10.7	4.59	-22.96	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.05	0.075	absolute	16.48	16.46	26.74	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	21.46	20.78	36.04	
20	10	20	20	20	20	20	20					
0004	0.0004	0.0004	0.0004	0.0008	0.0008	0.004	0.004					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

error

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	1	1.5	mean	10.57	0.97	-24.04	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.05	0.075	absolute	15.92	16.79	27.09	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	20.16	20.3	36.3	
20	10	20	20	20	20	20	20					
0008	0.0008	0.0004	0.0004	0.0008	0.0008	0.004	0.004					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

error

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	1	1.5	mean	9.98	0.283	-27.09	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.05	0.075	absolute	16.12	17.02	29.16	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	21.22	20.57	38.51	
20	10	20	20	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.008	0.008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

error

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	1	1.5	mean	10.31	2.03	-16.01	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.05	0.075	absolute	16.76	16.63	25.75	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	22.2	20.48	34.3	
20	10	20	20	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

error

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2		Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	4.76	0.01	0.015	1	1.5	mean	4.278	-7.75	-20.32	4/1/1969
0005	0.01	0.0595	0.238	0.0005	0.00075	0.05	0.075	absolute	17.115	19.08	24.84	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	t mean squ	23.09	24.98	33.31	
20	10	20	20	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					

co_M1	Dilco_M2	_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	3.57	0.01	0.02	1	2	mean	4.44	-6.36	-18.37	4/1/1969
0005	0.01	0.0595	0.1785	0.0005	0.001	0.05	0.1	absolute	17.12	18.06	24.19	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean :	23.07	23.74	32.49	
20	10	20	20	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	2.975	0.01	0.02	1	2	mean	1.997	-6.29	-18.05	4/1/1969
.001	0.01	0.0595	0.2975	0.0005	0.001	0.05	0.1	absolute	18.41	17.93	24.12	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean :	26.17	23.89	32.62	
10	10	20	10	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	2.975	0.01	0.05	1	2.5	mean	1.85	-7.84	-14.95	4/1/1969
.001	0.01	0.0595	0.2975	0.0005	0.0025	0.05	0.125	absolute	18.11	18.19	23.69	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean :	25.95	23.36	31.75	
10	10	20	10	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	2.975	0.01	0.05	1	2.5	mean	3.79	-7.38	-15.63	4/1/1969
.001	0.01	0.119	0.2975	0.0005	0.0025	0.05	0.125	absolute	16.84	18.17	23.99	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean :	22.96	23.74	31.96	
10	10	10	10	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					
0	0	0	0	0	0	0	0					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2	error	Alluv	Zone 3	Zone 1	stress periods
).01	0.1	1.19	2.975	0.01	0.05	1	2.5	mean	3.2	-8.67	-16.18	4/1/1969
.001	0.01	0.0595	0.2975	0.0005	0.0025	0.05	0.125	absolute	17.08	18.61	24.06	1/15/1987
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	root mean :	23.54	24.18	32.01	
10	10	20	10	20	20	20	20					
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008					
).06	0.06	0.06	0.06	0.06	0.06	0.1	0.1					

o_M1	Dilco_M2	[illegible]_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	0.1	0.836	2.09	0.01	0.05	0.5	1.25
.001	0.01	0.0418	0.209	0.0005	0.0025	0.025	0.0625
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2
10	10	20	10	20	20	20	20
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1
0	0	0	0	0	0	0	0
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	stress periods
mean	4.47	-8.46	-23.79	4/1/1969
absolute	17.54	19.61	27.9	1/15/1987
root mean	23.98	25.67	35.81	

o_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	0.1	0.836	2.09	0.01	0.05	1	2.5
.001	0.01	0.0418	0.209	0.0005	0.0025	0.05	0.125
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2
10	10	20	10	20	20	20	20
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1
0	0	0	0	0	0	0	0
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	stress periods
mean	3.74	-9.3	-16.42	4/1/1969
absolute	17.4	19.13	23.79	1/15/1987
root mean	23.98	24.9	31.96	

o_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	0.1	0.836	2.09	0.01	0.05	0.283	0.7075
.001	0.01	0.0418	0.209	0.0005	0.0025	0.01415	0.0354
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2
10	10	20	10	20	20	20	20
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1
0	0	0	0	0	0	0	0
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	stress periods
mean	-1.65	-6.36	-40.49	4/1/1969
absolute	28.96	20.55	49.52	1/15/1987
root mean	39.14	28.95	61.23	

o_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	0.1	0.836	2.09	0.01	0.05	0.283	0.7075
.001	0.01	0.0418	0.209	0.0005	0.0025	0.01415	0.0354
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2
10	10	20	10	20	20	20	20
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1
0	0	0	0	0	0	0	0
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	stress periods
mean	4.18	-7.74	-30.02	4/1/1969
absolute	18.06	19.63	33.13	1/15/1987
root mean	25.02	27.09	40.09	

o_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	0.1	1.19	2.975	0.01	0.05	1	2.5
.001	0.01	0.0595	0.2975	0.0005	0.0025	0.05	0.125
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2
10	10	20	10	20	20	20	20
0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	0.06	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	
mean	2.87	-9.09	-17.37	4/1/1969
absolute	17.08	18.43	24.83	7/15/1986
root mean	23.94	23.88	32.82	

co_M1	Dilco_M2	_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	N/A	2.38	5.94	0.01	0.05	1	2.5
0005	N/A	0.238	0.297	0.0005	0.0025	0.05	0.125
0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.2
20	N/A	10	20	20	20	20	20
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1
0	N/A	0	0	0	0	0	0
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	
mean	1.75	-20.98	-18.54	4/1/1969
absolute	17.52	25.25	23.8	7/15/1986
root mean :	24.52	30.89	32.42	

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	N/A	2.38	5.94	0.01	0.05	1	2.5
0005	N/A	0.238	0.297	0.0005	0.0025	0.05	0.125
0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.2
20	N/A	10	20	20	20	20	20
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1
0	N/A	0	0	0	0	0	0
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	
mean	-3.65	-20.718	-6.36	4/29/1978
absolute	16.74	24.78	15.91	4/15/1999
root mean :	22.99	29.97	20.66	

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	N/A	2.38	5.94	0.01	0.05	1	2.5
0005	N/A	0.238	0.297	0.0005	0.0025	0.05	0.125
0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.2
20	N/A	10	20	20	20	20	20
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1
0	N/A	0	0	0	0	0	0
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	
mean	1.96	-21.59	-15.1	4/30/1978
absolute	15.63	25.41	20.68	11/14/1985
root mean :	21.44	30.43	25.98	

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	N/A	2.38	5.94	0.01	0.05	1	2.5
0005	N/A	0.238	0.297	0.0005	0.0025	0.05	0.125
0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.2
20	N/A	10	20	20	20	20	20
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1
0	N/A	0	0	0	0	0	0
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1

error	Alluv	Zone 3	Zone 1	
mean	1.56	-20.43	-14.67	4/30/1978
absolute	16.45	24.36	20.79	11/14/1985
root mean :	23.43	29.23	26.11	

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
.01	N/A	2.38	5.94	0.01	0.05	1	2.5
0005	N/A	0.119	0.297	0.0005	0.0025	0.05	0.125
0.5	N/A	0.75	0.5	0.5	0.5	0.5	0.2
20	N/A	20	20	20	20	20	20
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
.06	N/A	0.06	0.06	0.06	0.06	0.1	0.1
0	N/A	0	0	0	0	0	0

error	Alluv	Zone 3	Zone 1	
mean	-3.72	-21.8	-30.64	12/1/1969
absolute	20.57	25.48	33.46	10/15/1983
root mean :	31.54	30.68	42.11	

co_M1	Dilco_M2	[illegible]_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
).01	N/A	2.38	5.94	0.01	0.05	1	2.5
0005	N/A	0.119	0.297	0.0005	0.0025	0.05	0.125
0.5	N/A	0.5	0.5	0.5	0.5	0.5	0.2
20	N/A	20	20	20	20	20	20
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06
0	N/A	0	0	0	0	0	0
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06

error	Alluv	Zone 3	Zone 1	
mean	-2.95	-19.79	-21.32	12/1/1969
absolute	19.82	23.8	27.99	10/15/1983
root mean :	29.79	28.88	37.37	

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
).01	N/A	1.188	2.97	0.01	0.05	1	2.5
.001	N/A	0.1188	0.297	0.001	0.005	0.1	0.25
0.5	N/A	0.5	0.2	0.5	0.5	0.5	0.2
10	N/A	10	10	10	10	10	10
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06
0	N/A	0	0	0	0	0	0
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06

error	Alluv	Zone 3	Zone 1	
mean	-1.81	-22.98	-18.72	12/1/1969
absolute	19.68	26.26	26.77	10/15/1983
root mean :	29.87	31.71	36.92	

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
).01	N/A	1.188	2.97	0.01	0.05	1	2.5
.001	N/A	0.1188	0.297	0.001	0.005	0.1	0.25
0.5	N/A	0.5	0.2	0.5	0.5	0.5	0.2
10	N/A	10	10	10	10	10	10
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06
0	N/A	0	0	0	0	0	0
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06

error	Alluv	Zone 3	Zone 1	
mean	-2.14	-22.44	-18.87	12/1/1969
absolute	20.3	25.78	27.31	10/15/1983
root mean :	31.68	31.13	38.42	

co_M1	Dilco_M2	Z3_M1	Z3_M2	Z2_M1	Z2_M2	Z1_M1	Z1_M2
).01	N/A	1.188	2.97	0.01	0.05	1	2.5
.001	N/A	0.1188	0.297	0.001	0.005	0.1	0.25
0.5	N/A	0.5	0.2	0.5	0.5	0.5	0.2
10	N/A	10	10	10	10	10	10
0008	N/A	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06
0	N/A	0	0	0	0	0	0
).06	N/A	0.06	0.06	0.06	0.06	0.06	0.06

error	Alluv	Zone 3	Zone 1	
mean	-0.96	-24.44	-17.99	3/15/1969
absolute	19.55	27.97	26.12	10/15/1983
root mean :	29.46	33.62	35.78	

TABLE 3B

Ranges of Values Assigned to Property Zone Hydraulic Parameters During the Development and Calibration Process

UNC Church Rock Site, Church Rock, New Mexico

	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
.25	0.01	.05 to .2	.836 to 2.38	2.09 to 5.94	.418 to .836	1.19 to 2.38	.142 to .377	0.01	.015 to 0.05	0.283 to 1.0
75	0.0005 to 0.001	0.00333 to 0.02	0.0418 to 0.238	0.1785 to 0.952	0.0209 to 0.418	0.119 to 0.238	0.0071 to .01885	0.0005 to 0.001	0.00075 to 0.005	0.01415 to 0.
	0.5 to 1	0.1 to 0.67	0.5 to 1	0.2 to 0.5	0.5 to 1	0.25 to 0.67	0.5 to 1	0.5 to 1	0.35 to 1	0.5 to 1
	10 to 20	10 to 15	10 to 20	10 to 20	20	10 to 20	20	10 to 20	10 to 20	10 to 20
033	0.004 to 0.0008	0.004 to 0.0008	0.004 to 0.0008	0.004 to 0.0008	0.0008	0.0008	0.0008	0.0004 to 0.0008	0.0004 to 0.0008	0.004 to 0.00(
3	0.06 to 0.18	0.06 to 0.18	0.06 to 0.12	0.06 to 0.12	0.06	0.06 to 0.12	0.06	0.06 to 0.12	0.06 to 0.12	0.06 to 0.1

TABLE 4A Model Water Balance for 1986

1/15/1986-2/11/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 39

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	578128832.0000	STORAGE =	122580.0859
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793486400.0000	RIVER LEAKAGE =	4248.1899
RECHARGE =	105209888.0000	RECHARGE =	33541.1289
TOTAL IN =	1476825088.0000	TOTAL IN =	160369.4062
OUT:		OUT:	
STORAGE =	1105047936.0000	STORAGE =	115719.7422
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	3675918.5000	WELLS =	4183.7476
DRAINS =	57241616.0000	DRAINS =	10612.0059
RIVER LEAKAGE =	256787232.0000	RIVER LEAKAGE =	11524.9492
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1422752640.0000	TOTAL OUT =	142040.4375
IN - OUT =	54072448.0000	IN - OUT =	18328.9688
PERCENT DISCREPANCY =	3.73	PERCENT DISCREPANCY =	12.12

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 39

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.40550E+06	40092.	668.19	27.841	7.62257E-02
STRESS PERIOD TIME	2.40550E+06	40092.	668.19	27.841	7.62257E-02
TOTAL TIME	5.32297E+08	8.87161E+06	1.47860E+05	6160.8	16.867

2/11/1986-3/13/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 39

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	581036544.0000	STORAGE =	99465.3828
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000

TABLE 4A Model Water Balance for 1986

RIVER LEAKAGE =	793618368.0000	RIVER LEAKAGE =	4514.0361
RECHARGE =	106190416.0000	RECHARGE =	33541.1289
TOTAL IN =	1480845312.0000	TOTAL IN =	137520.5469
OUT:		OUT:	
----		----	
STORAGE =	1108132864.0000	STORAGE =	105528.7266
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	3798121.5000	WELLS =	4180.2373
DRAINS =	57560916.0000	DRAINS =	10922.3418
RIVER LEAKAGE =	257024912.0000	RIVER LEAKAGE =	8130.4043
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1426516864.0000	TOTAL OUT =	128761.7109
IN - OUT =	54328448.0000	IN - OUT =	8758.8359
PERCENT DISCREPANCY =	3.74	PERCENT DISCREPANCY =	6.58

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 39

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.52577E+06	42096.	701.60	29.233	8.00369E-02
STRESS PERIOD TIME	4.93127E+06	82188.	1369.8	57.075	0.15626
TOTAL TIME	5.34822E+08	8.91371E+06	1.48562E+05	6190.1	16.948

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3/13/1986-4/12/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 39

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
---		---	
STORAGE =	583994944.0000	STORAGE =	96379.9922
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793762176.0000	RIVER LEAKAGE =	4684.2041
RECHARGE =	107219968.0000	RECHARGE =	33541.1289
TOTAL IN =	1484977152.0000	TOTAL IN =	134605.3281
OUT:		OUT:	
----		----	
STORAGE =	1111198976.0000	STORAGE =	99888.7109
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	3926542.2500	WELLS =	4183.7476
DRAINS =	57899948.0000	DRAINS =	11045.1045
RIVER LEAKAGE =	257239696.0000	RIVER LEAKAGE =	6997.1343
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1430265216.0000	TOTAL OUT =	122114.6953

TABLE 4A Model Water Balance for 1986

IN - OUT =	54711936.0000	IN - OUT =	12490.6328
PERCENT DISCREPANCY =	3.75	PERCENT DISCREPANCY =	9.73

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 39

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.65206E+06	44201.	736.68	30.695	8.40388E-02
STRESS PERIOD TIME	7.58334E+06	1.26389E+05	2106.5	87.770	0.24030
TOTAL TIME	5.37475E+08	8.95791E+06	1.49298E+05	6220.8	17.032

4/12/1986-5/15/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 4 IN STRESS PERIOD 39

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	587080832.0000	STORAGE =	95745.9766
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	4801.3916
RECHARGE =	108300992.0000	RECHARGE =	33541.1289
TOTAL IN =	1489298688.0000	TOTAL IN =	134088.5000
OUT:		OUT:	
STORAGE =	1114581120.0000	STORAGE =	104936.6094
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	4061384.0000	WELLS =	4183.7476
DRAINS =	58248588.0000	DRAINS =	10817.2188
RIVER LEAKAGE =	257439920.0000	RIVER LEAKAGE =	6212.4077
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1434331008.0000	TOTAL OUT =	126149.9844
IN - OUT =	54967680.0000	IN - OUT =	7938.5156
PERCENT DISCREPANCY =	3.76	PERCENT DISCREPANCY =	6.10

TIME SUMMARY AT END OF TIME STEP 4 IN STRESS PERIOD 39

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.78466E+06	46411.	773.52	32.230	8.82407E-02
STRESS PERIOD TIME	1.03680E+07	1.72800E+05	2880.0	120.00	0.32854
TOTAL TIME	5.40259E+08	9.00432E+06	1.50072E+05	6253.0	17.120

TABLE 4A Model Water Balance for 1986

5/15/1986-6/13/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 40

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	590226048.0000	STORAGE =	105700.5625
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	109294776.0000	RECHARGE =	33397.6328
TOTAL IN =	1493437696.0000	TOTAL IN =	139098.1875
OUT:		OUT:	
STORAGE =	1117916288.0000	STORAGE =	112081.5000
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	4191513.7500	WELLS =	4373.2129
DRAINS =	58543136.0000	DRAINS =	9898.7295
RIVER LEAKAGE =	257597584.0000	RIVER LEAKAGE =	5298.4717
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1438248576.0000	TOTAL OUT =	131651.9062
IN - OUT =	55189120.0000	IN - OUT =	7446.2812
PERCENT DISCREPANCY =	3.77	PERCENT DISCREPANCY =	5.50

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 40

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.57093E+06	42849.	714.15	29.756	8.14677E-02
STRESS PERIOD TIME	2.57093E+06	42849.	714.15	29.756	8.14677E-02
TOTAL TIME	5.42830E+08	9.04717E+06	1.50786E+05	6282.8	17.201

6/13/1986-7/15/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 40

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	592924800.0000	STORAGE =	86376.7578
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	110338248.0000	RECHARGE =	33397.6328

TABLE 4A Model Water Balance for 1986

TOTAL IN =	1497180032.0000	TOTAL IN =	119774.3906
OUT:		OUT:	
STORAGE =	1120685056.0000	STORAGE =	88616.0469
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	4328064.5000	WELLS =	4370.4829
DRAINS =	58857872.0000	DRAINS =	10073.5625
RIVER LEAKAGE =	257752016.0000	RIVER LEAKAGE =	4942.8374
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1441623040.0000	TOTAL OUT =	108002.9297
IN - OUT =	55556992.0000	IN - OUT =	11771.4609
PERCENT DISCREPANCY =	3.78	PERCENT DISCREPANCY =	10.34

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 40

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.69947E+06	44991.	749.85	31.244	8.55411E-02
STRESS PERIOD TIME	5.27040E+06	87840.	1464.0	61.000	0.16701
TOTAL TIME	5.45530E+08	9.09216E+06	1.51536E+05	6314.0	17.287

7/15/1986-8/13/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 41

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	595595776.0000	STORAGE =	91524.6328
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	111297984.0000	RECHARGE =	32886.6406
TOTAL IN =	1500810752.0000	TOTAL IN =	124411.2734
OUT:		OUT:	
STORAGE =	1123609728.0000	STORAGE =	100216.8594
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	4466077.5000	WELLS =	4729.1978
DRAINS =	59137516.0000	DRAINS =	9582.3672
RIVER LEAKAGE =	257887952.0000	RIVER LEAKAGE =	4658.2593
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1445101312.0000	TOTAL OUT =	119186.6875
IN - OUT =	55709440.0000	IN - OUT =	5224.5859
PERCENT DISCREPANCY =	3.78	PERCENT DISCREPANCY =	4.29

TABLE 4A Model Water Balance for 1986

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 41

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.52143E+06	42024.	700.40	29.183	7.98992E-02
STRESS PERIOD TIME	2.52143E+06	42024.	700.40	29.183	7.98992E-02
TOTAL TIME	5.48051E+08	9.13418E+06	1.52236E+05	6343.2	17.367

8/13/1986-9/12/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 41

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	598579136.0000	STORAGE =	97360.5703
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	112305704.0000	RECHARGE =	32886.6406
TOTAL IN =	1504801792.0000	TOTAL IN =	130247.2109
OUT:		OUT:	
STORAGE =	1126484992.0000	STORAGE =	93832.4609
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	4610613.0000	WELLS =	4716.8550
DRAINS =	59431168.0000	DRAINS =	9583.2246
RIVER LEAKAGE =	258024656.0000	RIVER LEAKAGE =	4461.1338
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1448551424.0000	TOTAL OUT =	112593.6719
IN - OUT =	56250368.0000	IN - OUT =	17653.5391
PERCENT DISCREPANCY =	3.81	PERCENT DISCREPANCY =	14.54

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 41

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.64750E+06	44125.	735.42	30.642	8.38942E-02
STRESS PERIOD TIME	5.16893E+06	86149.	1435.8	59.826	0.16379
TOTAL TIME	5.50699E+08	9.17831E+06	1.52972E+05	6373.8	17.451

9/12/1986-10/15/1986

TABLE 4A Model Water Balance for 1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 41

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	601465920.0000	STORAGE =	89722.8750
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	113364664.0000	RECHARGE =	32913.0742
TOTAL IN =	1508747520.0000	TOTAL IN =	122635.9531
OUT:		OUT:	
STORAGE =	1129546496.0000	STORAGE =	95153.8984
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	4762684.5000	WELLS =	4726.4678
DRAINS =	59737584.0000	DRAINS =	9523.5283
RIVER LEAKAGE =	258161648.0000	RIVER LEAKAGE =	4257.9375
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1452208384.0000	TOTAL OUT =	113661.8281
IN - OUT =	56539136.0000	IN - OUT =	8974.1250
PERCENT DISCREPANCY =	3.82	PERCENT DISCREPANCY =	7.60

10/15/1986-11/13/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 42

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	604505856.0000	STORAGE =	104168.0312
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	114311128.0000	RECHARGE =	32431.7051
TOTAL IN =	1512733952.0000	TOTAL IN =	136599.7344
OUT:		OUT:	
STORAGE =	1132427904.0000	STORAGE =	98734.6875
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	4890336.0000	WELLS =	4374.1440
DRAINS =	59992380.0000	DRAINS =	8730.9590
RIVER LEAKAGE =	258280592.0000	RIVER LEAKAGE =	4075.5708
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1455591168.0000	TOTAL OUT =	115915.3594

IN - OUT =	57142784.0000	IN - OUT =	20684.3750
PERCENT DISCREPANCY =	3.85	PERCENT DISCREPANCY =	16.38

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 42

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.52143E+06	42024.	700.40	29.183	7.98992E-02
STRESS PERIOD TIME	2.52143E+06	42024.	700.40	29.183	7.98992E-02
TOTAL TIME	5.56000E+08	9.26666E+06	1.54444E+05	6435.2	17.619

11/13/1986-12/13/1986

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 42

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	607372224.0000	STORAGE =	93542.2812
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	115304912.0000	RECHARGE =	32431.7051
TOTAL IN =	1516594048.0000	TOTAL IN =	125973.9844
OUT:		OUT:	
STORAGE =	1135516416.0000	STORAGE =	100794.1641
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	5024370.0000	WELLS =	4374.1440
DRAINS =	60263492.0000	DRAINS =	8847.6758
RIVER LEAKAGE =	258399712.0000	RIVER LEAKAGE =	3887.3516
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1459203968.0000	TOTAL OUT =	117903.3359
IN - OUT =	57390080.0000	IN - OUT =	8070.6484
PERCENT DISCREPANCY =	3.86	PERCENT DISCREPANCY =	6.62

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 42

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.64750E+06	44125.	735.42	30.642	8.38942E-02
STRESS PERIOD TIME	5.16893E+06	86149.	1435.8	59.826	0.16379

TOTAL TIME 5.58647E+08 9.31079E+06 1.55180E+05 6465.8 17.702

12/13/1986-1/15/1987

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 42

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	609772736.0000	STORAGE =	74609.4297
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	793916928.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	116348384.0000	RECHARGE =	32431.7051
TOTAL IN =	1520038016.0000	TOTAL IN =	107041.1328
OUT:		OUT:	
STORAGE =	1138304640.0000	STORAGE =	86658.3125
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	5165080.0000	WELLS =	4373.3398
DRAINS =	60546372.0000	DRAINS =	8792.0479
RIVER LEAKAGE =	258519088.0000	RIVER LEAKAGE =	3710.4072
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1462535168.0000	TOTAL OUT =	103534.1094
IN - OUT =	57502848.0000	IN - OUT =	3507.0234
PERCENT DISCREPANCY =	3.86	PERCENT DISCREPANCY =	3.33

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 42

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.77987E+06	46331.	772.19	32.174	8.80889E-02
STRESS PERIOD TIME	7.94880E+06	1.32480E+05	2208.0	92.000	0.25188
TOTAL TIME	5.61427E+08	9.35712E+06	1.55952E+05	6498.0	17.791

TABLE 4B Model Water Balance for 2011

10/15/2010-11/13/2010

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 138

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	960605120.0000	STORAGE =	17167.7676
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	210516384.0000	RECHARGE =	8433.9785
TOTAL IN =	1971706368.0000	TOTAL IN =	25601.7461
OUT:		OUT:	
STORAGE =	1507495808.0000	STORAGE =	22428.7734
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36130048.0000	WELLS =	230.0048
DRAINS =	97494648.0000	DRAINS =	2748.3201
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1878213376.0000	TOTAL OUT =	25407.0977
IN - OUT =	93492992.0000	IN - OUT =	194.6484
PERCENT DISCREPANCY =	4.86	PERCENT DISCREPANCY =	0.76

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 138

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.52143E+06	42024.	700.40	29.183	7.98992E-02
STRESS PERIOD TIME	2.52143E+06	42024.	700.40	29.183	7.98992E-02
TOTAL TIME	1.31339E+09	2.18898E+07	3.64830E+05	15201.	41.619

11/13/2010-12/13/2010

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 138

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	961154240.0000	STORAGE =	17920.7871
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	210774816.0000	RECHARGE =	8433.9785
TOTAL IN =	1972513920.0000	TOTAL IN =	26354.7656

TABLE 4B Model Water Balance for 2011

OUT:		OUT:	
STORAGE =	1508212480.0000	STORAGE =	23386.8867
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36141600.0000	WELLS =	376.9938
DRAINS =	97573656.0000	DRAINS =	2578.4883
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1879020544.0000	TOTAL OUT =	26342.3691
IN - OUT =	93493376.0000	IN - OUT =	12.3965
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	0.05

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 138

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.64750E+06	44125.	735.42	30.642	8.38942E-02
STRESS PERIOD TIME	5.16893E+06	86149.	1435.8	59.826	0.16379
TOTAL TIME	1.31603E+09	2.19339E+07	3.65565E+05	15232.	41.703

12/13/2010-1/15/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 138

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	961744320.0000	STORAGE =	18339.3789
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	0.0000	WELLS =	0.0000
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	211046176.0000	RECHARGE =	8433.9785
TOTAL IN =	1973375360.0000	TOTAL IN =	26773.3574
OUT:		OUT:	
STORAGE =	1508972800.0000	STORAGE =	23629.4785
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36149000.0000	WELLS =	230.0048
DRAINS =	97654112.0000	DRAINS =	2500.6169
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1879868800.0000	TOTAL OUT =	26360.0996
IN - OUT =	93506560.0000	IN - OUT =	413.2578
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	1.56

TABLE 4B Model Water Balance for 2011

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 138

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.77987E+06	46331.	772.19	32.174	8.80889E-02
STRESS PERIOD TIME	7.94880E+06	1.32480E+05	2208.0	92.000	0.25188
TOTAL TIME	1.31881E+09	2.19802E+07	3.66337E+05	15264.	41.791

1/15/2011-2/13/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 139

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	962353856.0000	STORAGE =	21350.0430
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	56.3797	WELLS =	1.9749
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	211286960.0000	RECHARGE =	8433.9785
TOTAL IN =	1974225792.0000	TOTAL IN =	29785.9961
OUT:		OUT:	
STORAGE =	1509647232.0000	STORAGE =	23623.8711
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36160800.0000	WELLS =	413.2889
DRAINS =	97732648.0000	DRAINS =	2751.0371
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1880633472.0000	TOTAL OUT =	26788.1973
IN - OUT =	93592320.0000	IN - OUT =	2997.7988
PERCENT DISCREPANCY =	4.86	PERCENT DISCREPANCY =	10.60

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 139

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.46661E+06	41110.	685.17	28.549	7.81623E-02
STRESS PERIOD TIME	2.46661E+06	41110.	685.17	28.549	7.81623E-02
TOTAL TIME	1.32128E+09	2.20214E+07	3.67023E+05	15293.	41.869

2/13/2011-3/15/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 139

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T

TABLE 4B Model Water Balance for 2011

IN:		IN:	
STORAGE =	962909696.0000	STORAGE =	18541.8457
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	115.5784	WELLS =	1.9749
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	211539776.0000	RECHARGE =	8433.9785
TOTAL IN =	1975034496.0000	TOTAL IN =	26977.7988
OUT:		OUT:	
STORAGE =	1510355072.0000	STORAGE =	23615.3379
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36171988.0000	WELLS =	373.2236
DRAINS =	97809936.0000	DRAINS =	2578.3123
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1881429888.0000	TOTAL OUT =	26566.8730
IN - OUT =	93604608.0000	IN - OUT =	410.9258
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	1.53

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 139

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.58994E+06	43166.	719.43	29.976	8.20704E-02
STRESS PERIOD TIME	5.05656E+06	84276.	1404.6	58.525	0.16023
TOTAL TIME	1.32387E+09	2.20645E+07	3.67742E+05	15323.	41.951

3/15/2011-4/15/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 139

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	963484416.0000	STORAGE =	18259.3652
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	177.7370	WELLS =	1.9749
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	211805232.0000	RECHARGE =	8433.9785
TOTAL IN =	1975874688.0000	TOTAL IN =	26695.3184
OUT:		OUT:	
STORAGE =	1511091456.0000	STORAGE =	23396.7891
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000

WELLS =	36181128.0000	WELLS =	290.3687
DRAINS =	97888600.0000	DRAINS =	2499.2603
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1882254080.0000	TOTAL OUT =	26186.4180
IN - OUT =	93620608.0000	IN - OUT =	508.9004
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	1.92

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 139

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.71944E+06	45324.	755.40	31.475	8.61739E-02
STRESS PERIOD TIME	7.77600E+06	1.29600E+05	2160.0	90.000	0.24641
TOTAL TIME	1.32659E+09	2.21098E+07	3.68497E+05	15354.	42.037

4/15/2011-5/13/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 140

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	964044992.0000	STORAGE =	19419.5117
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	5142.2104	WELLS =	171.9835
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	212048688.0000	RECHARGE =	8433.9785
TOTAL IN =	1976683776.0000	TOTAL IN =	28025.4746
OUT:		OUT:	
STORAGE =	1511761152.0000	STORAGE =	23201.6738
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36192420.0000	WELLS =	391.1206
DRAINS =	97966656.0000	DRAINS =	2704.1753
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1883013120.0000	TOTAL OUT =	26296.9707
IN - OUT =	93670656.0000	IN - OUT =	1728.5039
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	6.36

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 140

TABLE 4B Model Water Balance for 2011

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.49402E+06	41567.	692.78	28.866	7.90307E-02
STRESS PERIOD TIME	2.49402E+06	41567.	692.78	28.866	7.90307E-02
TOTAL TIME	1.32908E+09	2.21514E+07	3.69190E+05	15383.	42.116

5/13/2011-6/12/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 140

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	964558336.0000	STORAGE =	16936.6777
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	10354.9072	WELLS =	171.9835
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	212304320.0000	RECHARGE =	8433.9785
TOTAL IN =	1977457920.0000	TOTAL IN =	25542.6406
OUT:		OUT:	
STORAGE =	1512453632.0000	STORAGE =	22847.7520
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36200908.0000	WELLS =	280.0246
DRAINS =	98044048.0000	DRAINS =	2553.5293
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1883791360.0000	TOTAL OUT =	25681.3066
IN - OUT =	93666560.0000	IN - OUT =	-138.6660
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	-0.54

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 140

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.61872E+06	43645.	727.42	30.309	8.29823E-02
STRESS PERIOD TIME	5.11274E+06	85212.	1420.2	59.175	0.16201
TOTAL TIME	1.33170E+09	2.21951E+07	3.69918E+05	15413.	42.199

6/12/2011-7/15/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 140

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	965187712.0000	STORAGE =	19775.7012

TABLE 4B Model Water Balance for 2011

CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	15828.2393	WELLS =	171.9835
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	212572736.0000	RECHARGE =	8433.9785
TOTAL IN =	1978361216.0000	TOTAL IN =	28381.6641
OUT:		OUT:	
STORAGE =	1513243776.0000	STORAGE =	24829.1445
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36213356.0000	WELLS =	391.1206
DRAINS =	98123072.0000	DRAINS =	2483.0762
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1884673024.0000	TOTAL OUT =	27703.3418
IN - OUT =	93688192.0000	IN - OUT =	678.3223
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	2.42

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 140

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.74966E+06	45828.	763.79	31.825	8.71314E-02
STRESS PERIOD TIME	7.86240E+06	1.31040E+05	2184.0	91.000	0.24914
TOTAL TIME	1.33445E+09	2.22409E+07	3.70681E+05	15445.	42.286

7/15/2011-8/12/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 141

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	965728320.0000	STORAGE =	18524.9902
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	20395.4453	WELLS =	156.5013
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	212818864.0000	RECHARGE =	8433.9785
TOTAL IN =	1979152512.0000	TOTAL IN =	27115.4707
OUT:		OUT:	
STORAGE =	1513937792.0000	STORAGE =	23781.0957
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36223468.0000	WELLS =	346.4905
DRAINS =	98201688.0000	DRAINS =	2693.9214
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000

TOTAL OUT =	1885455744.0000	TOTAL OUT =	26821.5078
IN - OUT =	93696768.0000	IN - OUT =	293.9629
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	1.09

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 141

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.52143E+06	42024.	700.40	29.183	7.98992E-02
STRESS PERIOD TIME	2.52143E+06	42024.	700.40	29.183	7.98992E-02
TOTAL TIME	1.33697E+09	2.22829E+07	3.71382E+05	15474.	42.366

8/12/2011-9/12/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 141

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	966316480.0000	STORAGE =	19194.9785
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	25191.0117	WELLS =	156.5013
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	213077296.0000	RECHARGE =	8433.9785
TOTAL IN =	1980003840.0000	TOTAL IN =	27785.4590
OUT:		OUT:	
STORAGE =	1514664960.0000	STORAGE =	23732.2383
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36231420.0000	WELLS =	259.4725
DRAINS =	98279632.0000	DRAINS =	2543.6382
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1886268800.0000	TOTAL OUT =	26535.3496
IN - OUT =	93735040.0000	IN - OUT =	1250.1094
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	4.60

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 141

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.64750E+06	44125.	735.42	30.642	8.38942E-02
STRESS PERIOD TIME	5.16893E+06	86149.	1435.8	59.826	0.16379
TOTAL TIME	1.33962E+09	2.23270E+07	3.72117E+05	15505.	42.450

TABLE 4B Model Water Balance for 2011

9/12/2011-10/15/2011

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 141

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	966872768.0000	STORAGE =	17289.6289
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	30226.3574	WELLS =	156.5013
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	213348656.0000	RECHARGE =	8433.9785
TOTAL IN =	1980836608.0000	TOTAL IN =	25880.1094
OUT:		OUT:	
STORAGE =	1515401728.0000	STORAGE =	22898.7812
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	36243740.0000	WELLS =	382.8939
DRAINS =	98359216.0000	DRAINS =	2473.4290
RIVER LEAKAGE =	237092832.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	1887097472.0000	TOTAL OUT =	25755.1035
IN - OUT =	93739136.0000	IN - OUT =	125.0059
PERCENT DISCREPANCY =	4.85	PERCENT DISCREPANCY =	0.48

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 141

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.77987E+06	46331.	772.19	32.174	8.80889E-02
STRESS PERIOD TIME	7.94880E+06	1.32480E+05	2208.0	92.000	0.25188
TOTAL TIME	1.34240E+09	2.23734E+07	3.72889E+05	15537.	42.538

TABLE 4C Model Water Balance for 2026

10/15/2025-11/13/2025

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 198

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1121257344.0000	STORAGE =	13091.5645
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	664666.3125	WELLS =	100.4350
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	256726176.0000	RECHARGE =	8433.9785
TOTAL IN =	2179233024.0000	TOTAL IN =	21625.9785
OUT:		OUT:	
STORAGE =	1648278144.0000	STORAGE =	19258.7812
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37330924.0000	WELLS =	201.8877
DRAINS =	109923672.0000	DRAINS =	2000.1257
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2032651136.0000	TOTAL OUT =	21460.7949
IN - OUT =	146581888.0000	IN - OUT =	165.1836
PERCENT DISCREPANCY =	6.96	PERCENT DISCREPANCY =	0.77

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 198

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.52143E+06	42024.	700.40	29.183	7.98992E-02
STRESS PERIOD TIME	2.52143E+06	42024.	700.40	29.183	7.98992E-02
TOTAL TIME	1.78677E+09	2.97795E+07	4.96325E+05	20680.	56.619

11/13/2025-12/13/2025

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 198

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1121652608.0000	STORAGE =	12899.4180
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	667743.8750	WELLS =	100.4350
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	256984608.0000	RECHARGE =	8433.9785

TABLE 4C Model Water Balance for 2026

TOTAL IN =	2179889920.0000	TOTAL IN =	21433.8320
OUT:		OUT:	
STORAGE =	1648861312.0000	STORAGE =	19029.5410
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37336188.0000	WELLS =	171.8127
DRAINS =	109981352.0000	DRAINS =	1882.2712
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2033297280.0000	TOTAL OUT =	21083.6250
IN - OUT =	146592640.0000	IN - OUT =	350.2070
PERCENT DISCREPANCY =	6.96	PERCENT DISCREPANCY =	1.65

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 198

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.64750E+06	44125.	735.42	30.642	8.38942E-02
STRESS PERIOD TIME	5.16893E+06	86149.	1435.8	59.826	0.16379
TOTAL TIME	1.78942E+09	2.98236E+07	4.97061E+05	20711.	56.703

12/13/2025-1/15/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 198

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1122122752.0000	STORAGE =	14613.6328
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	670975.3125	WELLS =	100.4350
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	257255968.0000	RECHARGE =	8433.9785
TOTAL IN =	2180634624.0000	TOTAL IN =	23148.0469
OUT:		OUT:	
STORAGE =	1649481856.0000	STORAGE =	19285.9316
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37341716.0000	WELLS =	171.8127
DRAINS =	110040032.0000	DRAINS =	1823.7883
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2033982080.0000	TOTAL OUT =	21281.5332
IN - OUT =	146652544.0000	IN - OUT =	1866.5137
PERCENT DISCREPANCY =	6.96	PERCENT DISCREPANCY =	8.40

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 198

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.77987E+06	46331.	772.19	32.174	8.80889E-02
STRESS PERIOD TIME	7.94880E+06	1.32480E+05	2208.0	92.000	0.25188
TOTAL TIME	1.79220E+09	2.98700E+07	4.97833E+05	20743.	56.791

1/15/2026-2/12/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 199

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1122530432.0000	STORAGE =	14280.5176
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	673824.6875	WELLS =	99.8081
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	257496752.0000	RECHARGE =	8433.9785
TOTAL IN =	2181285888.0000	TOTAL IN =	22814.3047
OUT:		OUT:	
STORAGE =	1650051968.0000	STORAGE =	19970.2617
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37346588.0000	WELLS =	170.6048
DRAINS =	110096744.0000	DRAINS =	1986.3876
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2034613760.0000	TOTAL OUT =	22127.2539
IN - OUT =	146672128.0000	IN - OUT =	687.0508
PERCENT DISCREPANCY =	6.96	PERCENT DISCREPANCY =	3.06

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 199

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.46661E+06	41110.	685.17	28.549	7.81623E-02
STRESS PERIOD TIME	2.46661E+06	41110.	685.17	28.549	7.81623E-02
TOTAL TIME	1.79467E+09	2.99111E+07	4.98518E+05	20772.	56.870

2/12/2026-3/14/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 199

TABLE 4C Model Water Balance for 2026

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1122930560.0000	STORAGE =	13346.9619
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	676816.5625	WELLS =	99.8081
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	257749568.0000	RECHARGE =	8433.9785
TOTAL IN =	2181941760.0000	TOTAL IN =	21880.7480
OUT:		OUT:	
STORAGE =	1650641280.0000	STORAGE =	19658.1270
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37351704.0000	WELLS =	170.6048
DRAINS =	110152824.0000	DRAINS =	1870.6975
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2035264256.0000	TOTAL OUT =	21699.4297
IN - OUT =	146677504.0000	IN - OUT =	181.3184
PERCENT DISCREPANCY =	6.96	PERCENT DISCREPANCY =	0.83

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 199

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.58994E+06	43166.	719.43	29.976	8.20704E-02
STRESS PERIOD TIME	5.05656E+06	84276.	1404.6	58.525	0.16023
TOTAL TIME	1.79726E+09	2.99542E+07	4.99238E+05	20802.	56.952

3/14/2026-4/15/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 199

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1123381760.0000	STORAGE =	14336.5840
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	679958.0000	WELLS =	99.8081
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	258015024.0000	RECHARGE =	8433.9785
TOTAL IN =	2182661632.0000	TOTAL IN =	22870.3711

TABLE 4C Model Water Balance for 2026

OUT:		OUT:	
STORAGE =	1651334528.0000	STORAGE =	22024.4570
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37355368.0000	WELLS =	116.3682
DRAINS =	110209840.0000	DRAINS =	1811.5533
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2036018176.0000	TOTAL OUT =	23952.3789
IN - OUT =	146643456.0000	IN - OUT =	-1082.0078
PERCENT DISCREPANCY =	6.95	PERCENT DISCREPANCY =	-4.62

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 199

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.71944E+06	45324.	755.40	31.475	8.61739E-02
STRESS PERIOD TIME	7.77600E+06	1.29600E+05	2160.0	90.000	0.24641
TOTAL TIME	1.79997E+09	2.99996E+07	4.99993E+05	20833.	57.038

4/15/2026-5/13/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 200

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1123848192.0000	STORAGE =	16160.4512
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	682821.0625	WELLS =	99.1846
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	258258480.0000	RECHARGE =	8433.9785
TOTAL IN =	2183374336.0000	TOTAL IN =	24693.6152
OUT:		OUT:	
STORAGE =	1651952896.0000	STORAGE =	21421.1172
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37360256.0000	WELLS =	169.4034
DRAINS =	110266792.0000	DRAINS =	1973.0824
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2036698368.0000	TOTAL OUT =	23563.6035
IN - OUT =	146675968.0000	IN - OUT =	1130.0117
PERCENT DISCREPANCY =	6.95	PERCENT DISCREPANCY =	4.68

TABLE 4C Model Water Balance for 2026

TIME SUMMARY AT END OF TIME STEP 1 IN STRESS PERIOD 200

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.49402E+06	41567.	692.78	28.866	7.90307E-02
STRESS PERIOD TIME	2.49402E+06	41567.	692.78	28.866	7.90307E-02
TOTAL TIME	1.80247E+09	3.00411E+07	5.00686E+05	20862.	57.117

5/13/2026-6/13/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 2 IN STRESS PERIOD 200

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1124352384.0000	STORAGE =	16632.8652
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	685827.2500	WELLS =	99.1846
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	258514112.0000	RECHARGE =	8433.9785
TOTAL IN =	2184137216.0000	TOTAL IN =	25166.0293
OUT:		OUT:	
STORAGE =	1652566528.0000	STORAGE =	20245.3887
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37365392.0000	WELLS =	169.4034
DRAINS =	110323048.0000	DRAINS =	1856.1052
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2037373440.0000	TOTAL OUT =	22270.8965
IN - OUT =	146763776.0000	IN - OUT =	2895.1328
PERCENT DISCREPANCY =	6.95	PERCENT DISCREPANCY =	12.21

TIME SUMMARY AT END OF TIME STEP 2 IN STRESS PERIOD 200

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.61872E+06	43645.	727.42	30.309	8.29823E-02
STRESS PERIOD TIME	5.11274E+06	85212.	1420.2	59.175	0.16201
TOTAL TIME	1.80509E+09	3.00848E+07	5.01413E+05	20892.	57.200

6/13/2026-7/15/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 200

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T

TABLE 4C Model Water Balance for 2026

IN:		IN:	
STORAGE =	1124819328.0000	STORAGE =	14672.8105
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	688983.7500	WELLS =	99.1846
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	258782528.0000	RECHARGE =	8433.9785
TOTAL IN =	2184875776.0000	TOTAL IN =	23205.9746
OUT:		OUT:	
STORAGE =	1653204096.0000	STORAGE =	20035.1191
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37370784.0000	WELLS =	169.4034
DRAINS =	110380288.0000	DRAINS =	1798.6190
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2038073600.0000	TOTAL OUT =	22003.1406
IN - OUT =	146802176.0000	IN - OUT =	1202.8340
PERCENT DISCREPANCY =	6.95	PERCENT DISCREPANCY =	5.32

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 200

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.74966E+06	45828.	763.79	31.825	8.71314E-02
STRESS PERIOD TIME	7.86240E+06	1.31040E+05	2184.0	91.000	0.24914
TOTAL TIME	1.80784E+09	3.01306E+07	5.02177E+05	20924.	57.287

7/15/2026-8/13/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 1 IN STRESS PERIOD 201

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1125224960.0000	STORAGE =	13899.0566
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	691859.8750	WELLS =	98.5543
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	259028656.0000	RECHARGE =	8433.9785
TOTAL IN =	2185530368.0000	TOTAL IN =	22431.5898
OUT:		OUT:	
STORAGE =	1653777664.0000	STORAGE =	19652.1016
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000

TABLE 4C Model Water Balance for 2026

```
           WELLS =    37374128.0000                  WELLS =        114.5547
          DRAINS =   110437496.0000                 DRAINS =       1960.2899
   RIVER LEAKAGE =   237118448.0000          RIVER LEAKAGE =          0.0000
        RECHARGE =           0.0000               RECHARGE =          0.0000

       TOTAL OUT =  2038707712.0000              TOTAL OUT =      21726.9453

        IN - OUT =   146822656.0000               IN - OUT =        704.6445

PERCENT DISCREPANCY =          6.95    PERCENT DISCREPANCY =          3.19




       TIME SUMMARY AT END OF TIME STEP    1 IN STRESS PERIOD  201
                    SECONDS     MINUTES      HOURS       DAYS        YEARS
                    -----------------------------------------------------------
   TIME STEP LENGTH 2.52143E+06  42024.      700.40      29.183     7.98992E-02
 STRESS PERIOD TIME 2.52143E+06  42024.      700.40      29.183     7.98992E-02
         TOTAL TIME 1.81036E+09 3.01726E+07 5.02877E+05  20953.      57.367

8/13/2026-9/13/2026

  VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP  2 IN STRESS PERIOD 201
  ------------------------------------------------------------------------------

     CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
     ------------------                 ------------------------

           IN:                                      IN:
           ---                                      ---
             STORAGE =  1125627008.0000              STORAGE =      13122.3760
       CONSTANT HEAD =           0.0000        CONSTANT HEAD =          0.0000
               WELLS =      694879.8125                WELLS =         98.5543
              DRAINS =           0.0000               DRAINS =          0.0000
       RIVER LEAKAGE =   800584896.0000        RIVER LEAKAGE =          0.0000
            RECHARGE =   259287088.0000             RECHARGE =       8433.9785

            TOTAL IN =  2186193920.0000             TOTAL IN =      21654.9082

          OUT:                                     OUT:
          ----                                     ----
             STORAGE =  1654365440.0000              STORAGE =      19179.9297
       CONSTANT HEAD =           0.0000        CONSTANT HEAD =          0.0000
               WELLS =    37379280.0000                WELLS =        168.1888
              DRAINS =   110493992.0000               DRAINS =       1843.6387
       RIVER LEAKAGE =   237118448.0000        RIVER LEAKAGE =          0.0000
            RECHARGE =           0.0000             RECHARGE =          0.0000

           TOTAL OUT =  2039357184.0000            TOTAL OUT =      21191.7578

            IN - OUT =   146836736.0000             IN - OUT =        463.1504

 PERCENT DISCREPANCY =             6.95  PERCENT DISCREPANCY =          2.16




       TIME SUMMARY AT END OF TIME STEP    2 IN STRESS PERIOD  201
```

TABLE 4C Model Water Balance for 2026

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.64750E+06	44125.	735.42	30.642	8.38942E-02
STRESS PERIOD TIME	5.16893E+06	86149.	1435.8	59.826	0.16379
TOTAL TIME	1.81301E+09	3.02168E+07	5.03613E+05	20984.	57.451

9/13/2026-10/15/2026

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP 3 IN STRESS PERIOD 201

CUMULATIVE VOLUMES	L**3	RATES FOR THIS TIME STEP	L**3/T
IN:		IN:	
STORAGE =	1126095232.0000	STORAGE =	14552.5957
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	698050.7500	WELLS =	98.5543
DRAINS =	0.0000	DRAINS =	0.0000
RIVER LEAKAGE =	800584896.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	259558448.0000	RECHARGE =	8433.9785
TOTAL IN =	2186936576.0000	TOTAL IN =	23085.1289
OUT:		OUT:	
STORAGE =	1654960512.0000	STORAGE =	18495.4922
CONSTANT HEAD =	0.0000	CONSTANT HEAD =	0.0000
WELLS =	37384692.0000	WELLS =	168.1888
DRAINS =	110551456.0000	DRAINS =	1785.9924
RIVER LEAKAGE =	237118448.0000	RIVER LEAKAGE =	0.0000
RECHARGE =	0.0000	RECHARGE =	0.0000
TOTAL OUT =	2040015104.0000	TOTAL OUT =	20449.6738
IN - OUT =	146921472.0000	IN - OUT =	2635.4551
PERCENT DISCREPANCY =	6.95	PERCENT DISCREPANCY =	12.11

TIME SUMMARY AT END OF TIME STEP 3 IN STRESS PERIOD 201

	SECONDS	MINUTES	HOURS	DAYS	YEARS
TIME STEP LENGTH	2.77987E+06	46331.	772.19	32.174	8.80889E-02
STRESS PERIOD TIME	7.94880E+06	1.32480E+05	2208.0	92.000	0.25188
TOTAL TIME	1.81579E+09	3.02631E+07	5.04385E+05	21016.	57.539

Parameter	/ 5	/ 2.5	base	* 2.5	* 5
kh row, kv, kh col	2.11	3.92	6.38	12.22	9.13
av	8.[illegible]	7.17	6.38	6.10	7.16
ah	5.[illegible]	5.02	6.38	12.75	16.27
kh row, kv, kh col	7.22	9.61	6.38	6.44	9.13
kh row, kv, kh col	7.52	5.39	6.38	9.15	11.75
av	8.64	9.69	6.38	10.72	7.73
ah	6.83	6.57	6.38	7.60	11.16
kh row, kv, kh col	7.97	7.51	6.38	8.70	10.57
kh row, kv, kh col	6.53	7.42	6.38	6.43	7.81
kh row, kv, kh col	8.47	8.31	6.38	8.97	5.93
av	5.70	7.44	6.38	7.51	7.27
kh row, kv, kh col	6.10	6.76	6.38	12.13	17.13
av	5.88	6.71	6.38	10.58	7.21
kh row, kv, kh col	19.17	12.59	6.38	5.08	4.37
av		6.89	6.38	8.88	7.06
kh row, kv, kh col	8.37	6.96	6.38	5.73	5.92
av	7.78	6.30	6.38	7.62	6.38
conductance	25.41	15.29	6.38	5.24	5.17
flux	17.53	16.12	6.38	-6.35	-23.39
		without	with		
		8.27	6.38		

Material Zone	Parameter	/ 5	/ 2.5	base	* 2.5	* 5
Z3_M1	kh row, kv, kh col	15.5[illegible]	16.46	15.95	17.90	15.13
Z3_M1	av	15[illegible]	[illegible]6.15	15.95	15.33	16.67
Z3_M1	ah	15.[illegible]	[illegible]5.42	15.95	18.61	21.87
Z3_M2	kh row, kv, kh col	16.78	17.40	15.95	14.17	15.13
Z3_M3	kh row, kv, kh col	15.92	15.13	15.95	17.01	19.18
Z3_M3	av	15.90	17.29	15.95	16.17	16.88
Z3_M3	ah	15.61	16.01	15.95	15.92	18.35
Z3_M4	kh row, kv, kh col	18.72	17.80	15.95	15.43	16.08
Z3_M6	kh row, kv, kh col	15.97	16.21	15.95	14.97	16.57
Z2_M1	kh row, kv, kh col	17.18	16.17	15.95	18.17	15.49
Z2_M1	av	15.16	15.91	15.95	16.91	17.69
Z1_M1	kh row, kv, kh col	18.03	17.48	15.95	17.75	21.17
Z1_M1	av	14.99	15.69	15.95	17.55	15.20
alluv_M1	kh row, kv, kh col	28.90	21.21	15.95	13.81	12.07
alluv_M1	av		15.73	15.95	15.78	15.54
Dilco_M1	kh row, kv, kh col	16.45	16.38	15.95	15.19	15.72
Dilco_M1	av	16.40	15.16	15.95	16.37	15.10
river cells	conductance	31.48	23.04	15.95	14.27	14.57
recharge cells	flux	22.10	21.50	15.95	19.37	35.23
			without	with		
no lineament			20.14	15.95		

Material Zone	Parameter	/ 5	/ 2.5	base	* 2.5
Z3_M1	kh row, kv, kh col	7814	[illegible]32	7476	713
Z3_M1	av	7212	[illegible]5	7476	812
Z3_M1	ah	7291	[illegible]5	7476	709
Z3_M2	kh row, kv, kh col	6796	[illegible]626	7476	808
Z3_M3	kh row, kv, kh col	7384	8097	7476	695
Z3_M3	av	7238	6979	7476	723
Z3_M3	ah	7327	7756	7476	731
Z3_M4	kh row, kv, kh col	6605	7294	7476	779
Z3_M6	kh row, kv, kh col	6985	7846	7476	800
Z2_M1	kh row, kv, kh col	7171	7130	7476	804
Z2_M1	av	8776	7865	7476	766
Z1_M1	kh row, kv, kh col	7145	7200	7476	690
Z1_M1	av	7979	7872	7476	702
alluv_M1	kh row, kv, kh col	4724	6588	7476	810
alluv_M1	av		7347	7476	716
Dilco_M1	kh row, kv, kh col	7457	7384	7476	812
Dilco_M1	av	7746	8345	7476	744
river cells	conductance	1473	5609	7476	827
recharge cells	flux	5530	5795	7476	923
			without	with	
no lineament			5438	7476	

Sensitivity of Zone 1 Mean Error to Parameters

Parameter	/ 5	/ 2.5	base	* 2.5	* 5
kh row, kv, kh col	-1.00	-1.20	-0.91	0.90	-1.02
av	2.32	0.34	-0.91	-1.78	0.03
ah	0.40	-1.75	-0.91	2.28	4.71
kh row, kv, kh col	1.22	2.80	-0.91	-1.69	-1.02
kh row, kv, kh col	0.05	-1.52	-0.91	0.55	2.09
av	1.49	3.03	-0.91	2.87	-0.43
ah	1.61	-0.67	-0.91	0.53	1.40
kh row, kv, kh col	1.26	0.91	-0.91	0.28	0.04
kh row, kv, kh col	1.42	0.22	-0.91	-0.84	-0.90
kh row, kv, kh col	8.56	4.85	-0.91	-4.49	-10.27
av	-9.64	-3.95	-0.91	4.14	6.86
kh row, kv, kh col	8.69	4.89	-0.91	2.93	6.34
av	-3.01	-1.91	-0.91	5.28	5.65
kh row, kv, kh col	7.44	3.06	-0.91	-0.17	-1.10
av		0.58	-0.91	2.81	1.15
kh row, kv, kh col	0.86	0.74	-0.91	-1.83	-0.74
av	0.57	-1.19	-0.91	0.12	0.51
conductance	21.15	9.66	-0.91	-2.56	-4.32
flux	10.93	9.45	-0.91	-11.42	-23.47
		without	with		
		5.76	-0.91		

Sensitivity of Zone 1 Root Mean Squared Error to Parameters

Material Zone	Parameter	/ 5	/ 2.5	base	* 2.5	* 5
Z3_M1	kh row, kv, kh col	13.99	13.78	13.80	13.07	13.73
Z3_M1	av	13.51	13.48	13.80	14.19	13.42
Z3_M1	ah	14.00	14.03	13.80	13.37	13.78
Z3_M2	kh row, kv, kh col	13.18	13.64	13.80	13.94	13.73
Z3_M3	kh row, kv, kh col	13.72	14.75	13.80	13.18	13.16
Z3_M3	av	13.26	13.80	13.80	13.65	13.80
Z3_M3	ah	14.45	14.01	13.80	13.34	12.91
Z3_M4	kh row, kv, kh col	13.68	13.67	13.80	13.09	13.62
Z3_M6	kh row, kv, kh col	13.42	14.05	13.80	13.81	13.66
Z2_M1	kh row, kv, kh col	16.27	14.47	13.80	14.43	17.95
Z2_M1	av	17.47	14.54	13.80	14.59	15.69
Z1_M1	kh row, kv, kh col	21.47	17.34	13.80	13.48	16.93
Z1_M1	av	13.80	14.20	13.80	14.80	16.04
alluv_M1	kh row, kv, kh col	15.96	14.05	13.80	14.07	14.32
alluv_M1	av		13.45	13.80	13.26	13.69
Dilco_M1	kh row, kv, kh col	13.63	13.65	13.80	14.45	13.78
Dilco_M1	av	13.87	15.40	13.80	13.18	13.75
river cells	conductance	27.01	17.11	13.80	14.17	14.10
recharge cells	flux	18.74	17.14	13.80	20.33	31.33
			without	with		
no lineament			15.42	13.80		

Sensitivity of Zone 1 Residual Comparisons to Parameters

Material Zone	Parameter	/ 5	/ 2.5	base	* 2.5
Z3_M1	kh row, kv, kh col	8906	8846	8847	886
Z3_M1	av	8802	8731	8847	890
Z3_M1	ah	8898	8857	8847	887
Z3_M2	kh row, kv, kh col	8793	8887	8847	887
Z3_M3	kh row, kv, kh col	8826	8800	8847	883
Z3_M3	av	8838	8787	8847	877
Z3_M3	ah	8889	8722	8847	890
Z3_M4	kh row, kv, kh col	8738	8875	8847	883
Z3_M6	kh row, kv, kh col	8760	8881	8847	889
Z2_M1	kh row, kv, kh col	8781	8883	8847	879
Z2_M1	av	8840	8911	8847	882
Z1_M1	kh row, kv, kh col	8369	8525	8847	874
Z1_M1	av	8798	8797	8847	887
alluv_M1	kh row, kv, kh col	8668	8688	8847	880
alluv_M1	av		8800	8847	885
Dilco_M1	kh row, kv, kh col	8886	8892	8847	883
Dilco_M1	av	8775	8725	8847	882
river cells	conductance	8476	8645	8847	883
recharge cells	flux	8006	8404	8847	893
			without	with	
no lineament			8679	8847	

Sensitivity of Alluvium Mean Error to Parameters

Parameter	/ 5	/ 2.5	base	* 2.5	* 5
kh row, kv, kh col	-5.16	-4.79	-4.35	-3.19	-3.53
av	-1.98	-4.08	-4.35	-4.50	-4.48
ah	-2.54	-4.73	-4.35	-1.47	-0.87
kh row, kv, kh col	-4.57	-2.07	-4.35	-3.95	-3.53
kh row, kv, kh col	-2.54	-4.62	-4.35	-3.78	-2.83
av	-2.24	-2.09	-4.35	1.95	-4.29
ah	-2.20	-4.59	-4.35	-3.91	-3.22
kh row, kv, kh col	-4.93	-4.79	-4.35	-3.56	-2.80
kh row, kv, kh col	-4.31	-4.10	-4.35	-4.46	-4.42
kh row, kv, kh col	-1.92	-1.86	-4.35	-4.76	-5.12
av	-5.10	-4.46	-4.35	-4.03	-3.76
kh row, kv, kh col	-6.82	-5.87	-4.35	-0.49	3.38
av	-4.54	-4.35	-4.35	-1.50	-3.83
kh row, kv, kh col	-1.02	-5.60	-4.35	-1.14	1.67
av		-4.31	-4.35	-2.05	-4.33
kh row, kv, kh col	-2.24	-4.30	-4.35	-4.40	-4.49
av	-2.75	-3.89	-4.35	-4.20	-4.29
conductance	16.70	-0.94	-4.35	-4.65	-5.14
flux	-0.79	-1.89	-4.35	-9.11	-14.86
		without	with		
		-4.70	-4.35		

Sensitivity of Alluvium Root Mean Squared Error to Parameters

Material Zone	Parameter	/ 5	/ 2.5	base	* 2.5	* 5
Z3_M1	kh row, kv, Kh col	10.55	10.33	9.88	9.34	9.41
Z3_M1	av	9.46	9.85	9.88	10.13	9.99
Z3_M1	ah	9.69	10.26	9.88	9.43	9.52
Z3_M2	kh row, kv, kh col	10.16	9.54	9.88	9.70	9.41
Z3_M3	kh row, kv, kh col	10.02	10.18	9.88	9.55	9.19
Z3_M3	av	9.52	9.43	9.88	11.77	10.01
Z3_M3	ah	9.63	10.15	9.88	9.55	9.38
Z3_M4	kh row, kv, kh col	10.55	10.20	9.88	9.34	9.03
Z3_M6	kh row, kv, kh col	9.98	9.78	9.88	10.02	9.97
Z2_M1	kh row, kv, kh col	9.73	9.71	9.88	10.15	10.27
Z2_M1	av	10.34	9.92	9.88	9.83	9.83
Z1_M1	kh row, kv, kh col	11.93	11.01	9.88	9.13	11.77
Z1_M1	av	10.01	9.86	9.88	9.48	9.81
alluv_M1	kh row, kv, kh col	11.66	10.52	9.88	10.43	12.40
alluv_M1	av		9.95	9.88	9.39	9.76
Dilco_M1	kh row, kv, kh col	9.55	9.84	9.88	9.92	10.05
Dilco_M1	av	9.77	9.74	9.88	9.83	9.90
river cells	conductance	23.10	8.79	9.88	10.20	10.46
recharge cells	flux	9.15	8.99	9.88	14.66	24.15
			without	with		
no lineament			10.35	9.88		

Sensitivity of Alluvium Residual Comparisons to Parameters

Material Zone	Parameter	/ 5	/ 2.5	base	* 2.5
Z3_M1	kh row, kv, kh col	6957	6915	6842	674
Z3_M1	av	6576	6788	6842	692
Z3_M1	ah	6656	6955	6842	658
Z3_M2	kh row, kv, kh col	6928	6607	6842	685
Z3_M3	kh row, kv, kh col	6580	6851	6842	683
Z3_M3	av	6610	6550	6842	615
Z3_M3	ah	6655	6784	6842	688
Z3_M4	kh row, kv, kh col	6887	6917	6842	690
Z3_M6	kh row, kv, kh col	6850	6862	6842	688
Z2_M1	kh row, kv, kh col	6669	6670	6842	689
Z2_M1	av	6849	6896	6842	688
Z1_M1	kh row, kv, kh col	6979	6878	6842	654
Z1_M1	av	6808	6798	6842	659
alluv_M1	kh row, kv, kh col	6727	6825	6842	656
alluv_M1	av		6792	6842	662
Dilco_M1	kh row, kv, kh col	6681	6912	6842	688
Dilco_M1	av	6584	6689	6842	691
river cells	conductance	3891	6520	6842	682
recharge cells	flux	6416	6565	6842	716
			without	with	
no lineament			6877	6842	

r to areas shown in[illegible]es 15B to 15F in model report (Chester Engineers, Oct. 2012)
'horizontal hydraulic conductivity, ft/d), kv (vertical hydraulic conductivity, ft/d), Ah (horizontal anisotropy ratio), Av (vertical anisotropy ratio)
specific yield)

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	0.238	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.0238	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	0.476	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.0476	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	5.95	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.595	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	2.975	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.2975	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.1045	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	4	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.05225	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	8	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	100	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00836	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	50	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	0.2	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	0.4	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	5	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	2.5	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0025	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	4	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.00125	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	8	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0001	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	100	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0002	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	50	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.002	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0001	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.004	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0002	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.05	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0025	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.025	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.00125	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0025	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	4	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.00125	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	8	10	20	10	20	10	20	20	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0001	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	100	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0002	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	50	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.176875
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	2.4
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.0884375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	4.8
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.007075
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	60
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.01415
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	30

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.0849
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.007075
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.1698
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.01415
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	2.1225
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.176875
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	1.06125
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.0884375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.002	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0001	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.004	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0002	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.05	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0025	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.025	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.00125	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
5.9375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
1.2	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
0.2375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
30	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
0.475	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
15	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
0.95	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
7.5	20	10	20	10	20	10	20	20	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	0.2	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	0.4	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	5	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	2.5	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.209	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	4	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.1045	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	8	10	20	10	20	20	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.00836	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	100	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.01672	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	50	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	0.476	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.0476	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	0.952	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.0952	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	11.9	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	1.19	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	5.95	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.595	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
1.425	0.01	0.1	0.836	2.38	0.0836	1.19	0.142	0.01	0.015	0.4245
0.475	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
2.85	0.01	0.1	0.836	2.38	0.0836	1.19	0.142	0.01	0.015	0.4245
0.95	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
35.625	0.01	0.1	0.836	2.38	0.0836	1.19	0.142	0.01	0.015	0.4245
11.875	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
17.8125	0.01	0.1	0.836	2.38	0.0836	1.19	0.142	0.01	0.015	0.4245
5.9375	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.0836	1.19	0.0284	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.00142	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.0836	1.19	0.0568	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.00284	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.0836	1.19	0.71	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.0355	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.0836	1.19	0.355	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.01775	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.0836	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00418	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.1672	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.00836	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	2.09	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.1045	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	1.045	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.05225	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.1672	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.00836	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.3344	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.01672	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	4.18	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.209	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	2.09	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.1045	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

Alluv2	Dilco_M1	Dilco_M2	Z3_M1	Z3_M2	Z3_M3	Z3_M4	Z3_M6	Z2_M1	Z2_M2	Z1_M1
7.125	0.01	0.1	0.836	2.38	0.418	1.19	0.142	0.01	0.015	0.4245
2.375	0.0005	0.01	0.0418	0.238	0.0209	0.119	0.0071	0.0005	0.00075	0.035375
1	1	0.67	1	0.5	1	0.67	1	1	0.67	1
3	20	10	20	10	20	10	20	20	20	12
0.001	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0016
0.25	0.18	0.18	0.12	0.12	0.06	0.12	0.06	0.12	0.12	0.06

FIGURES

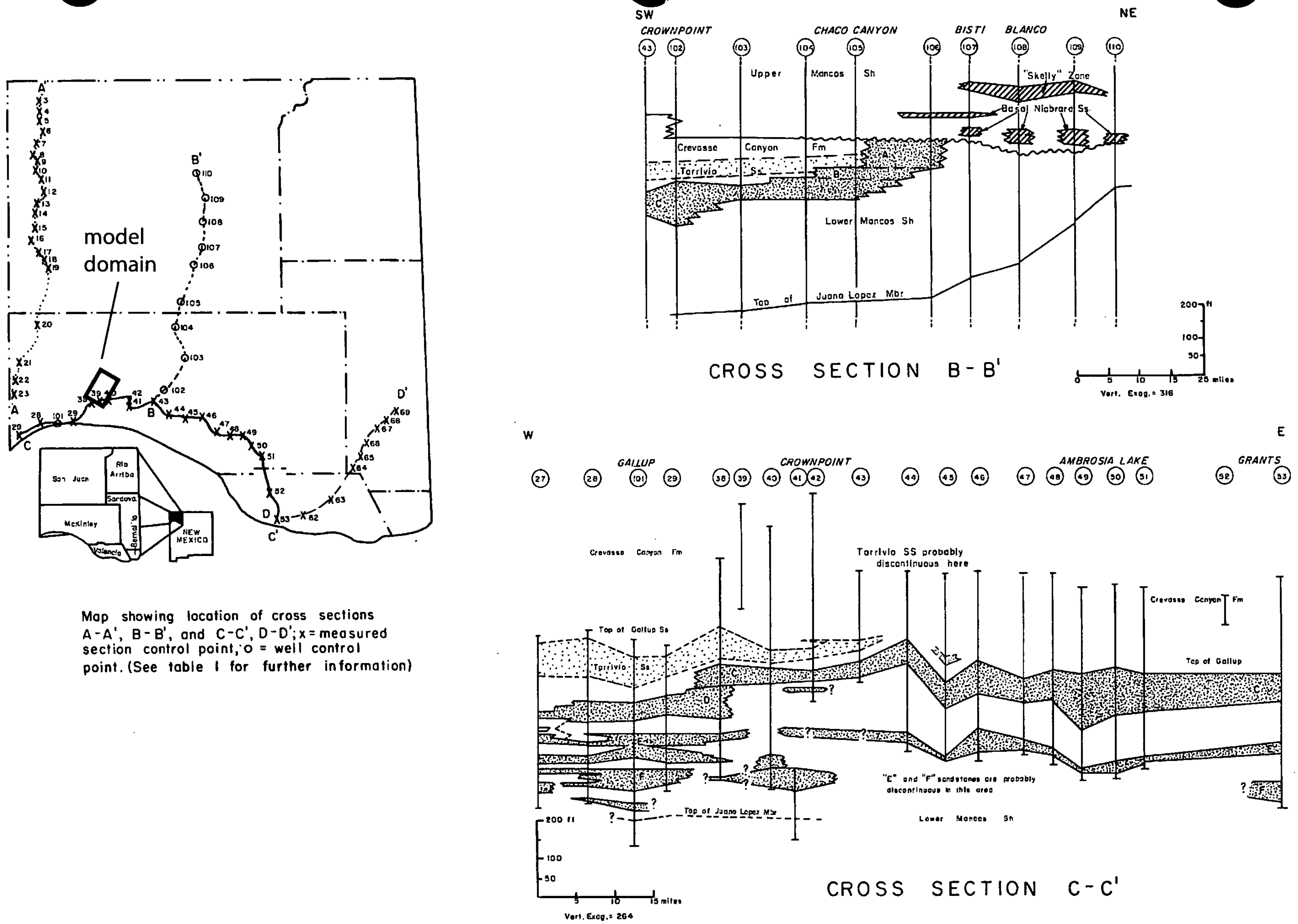
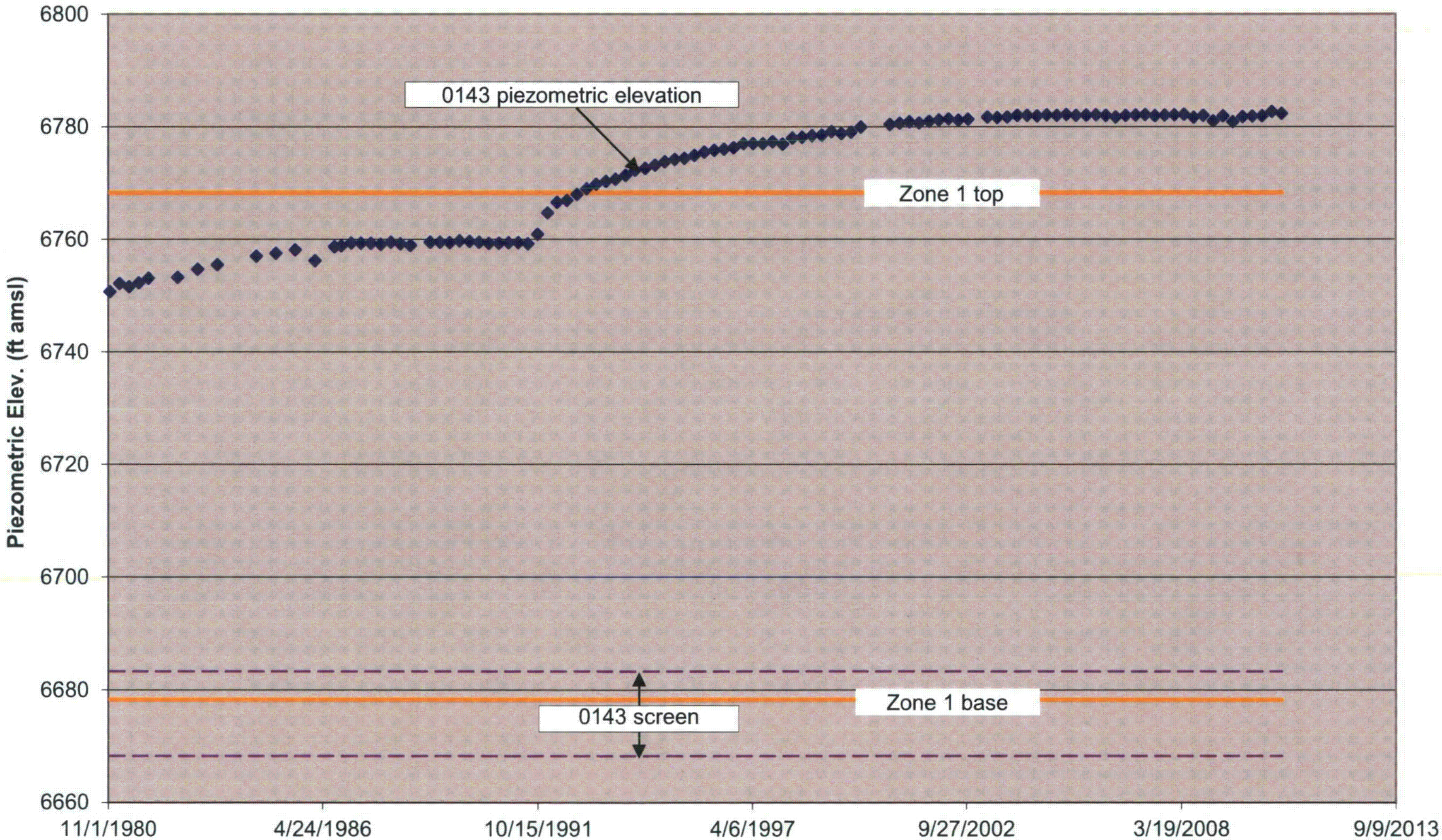


FIGURE 1

Cross sections showing stratigraphic relationships of sandstone bodies (stippled) in the Gallup Sandstone (after Mizell and Stone, 1979)

Figure 2
Relationship of Zone 1 Well 0143 screen and piezometric elevations to Zone 1 top and bottom



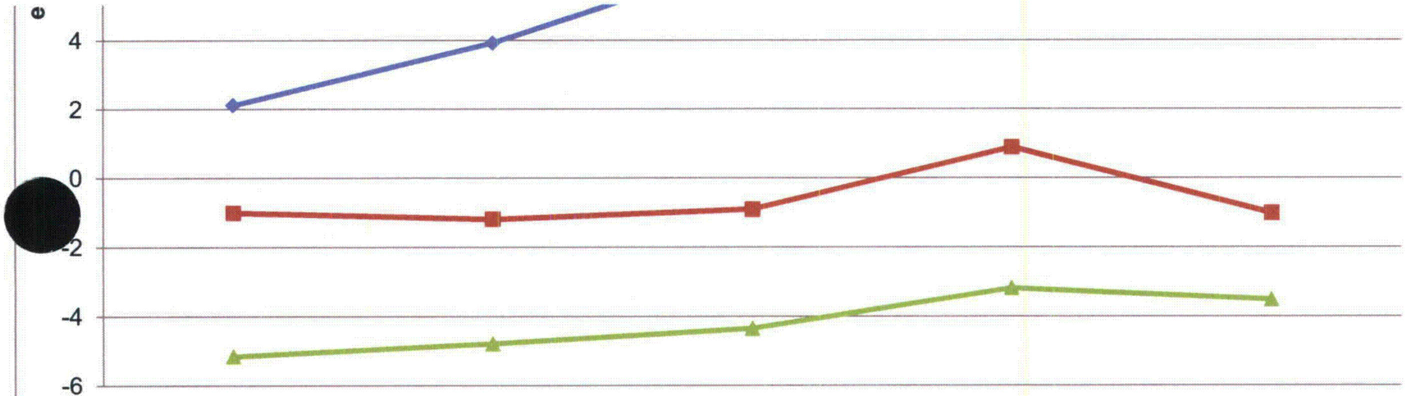


Figure 3A
Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M1

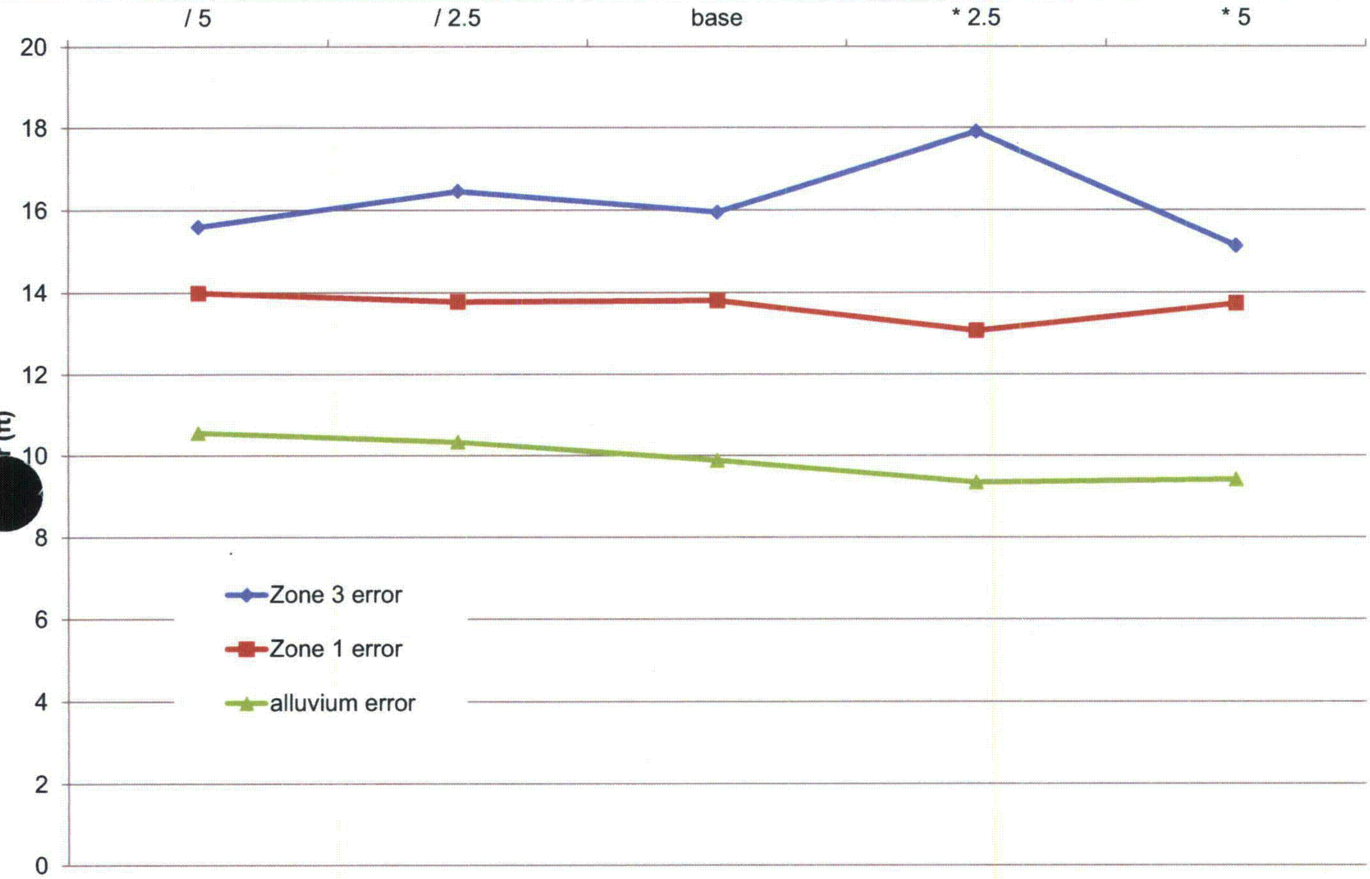
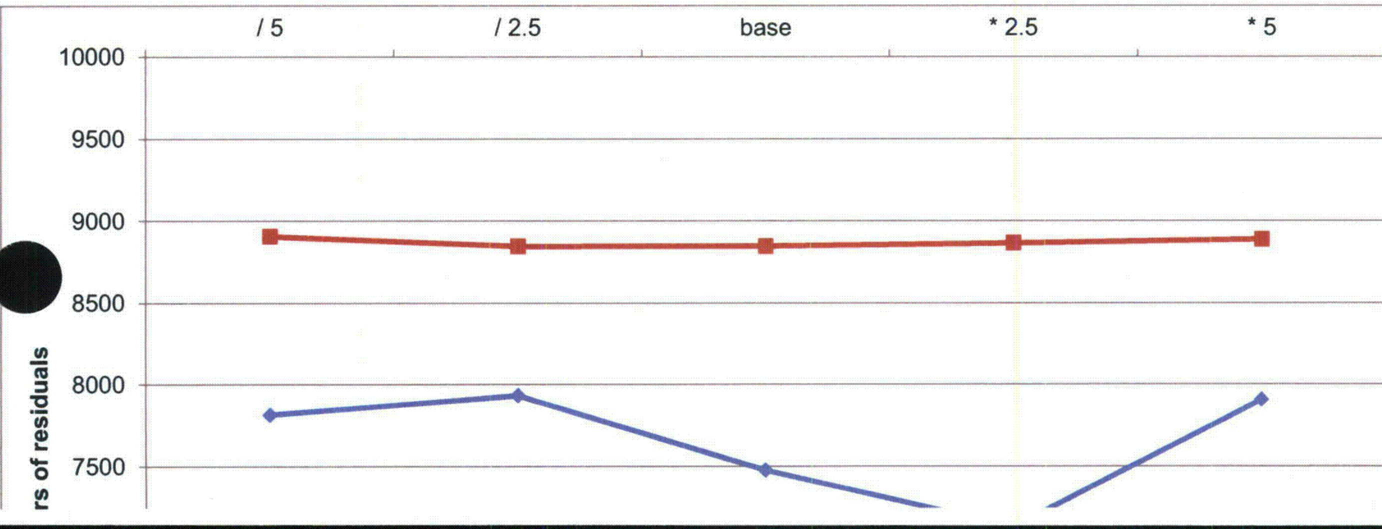


Figure 3B
Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M1



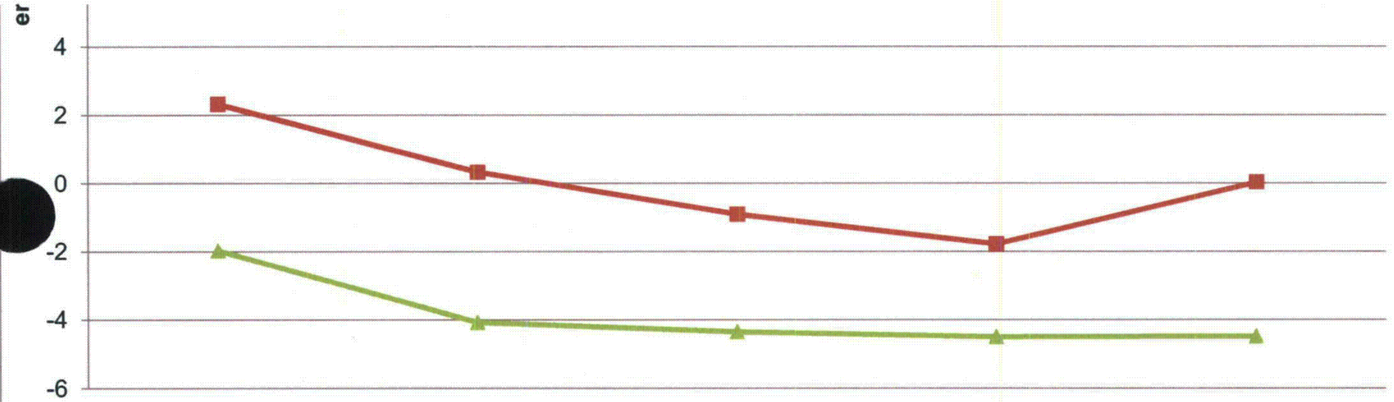


Figure 4A
Mean error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z3_M1

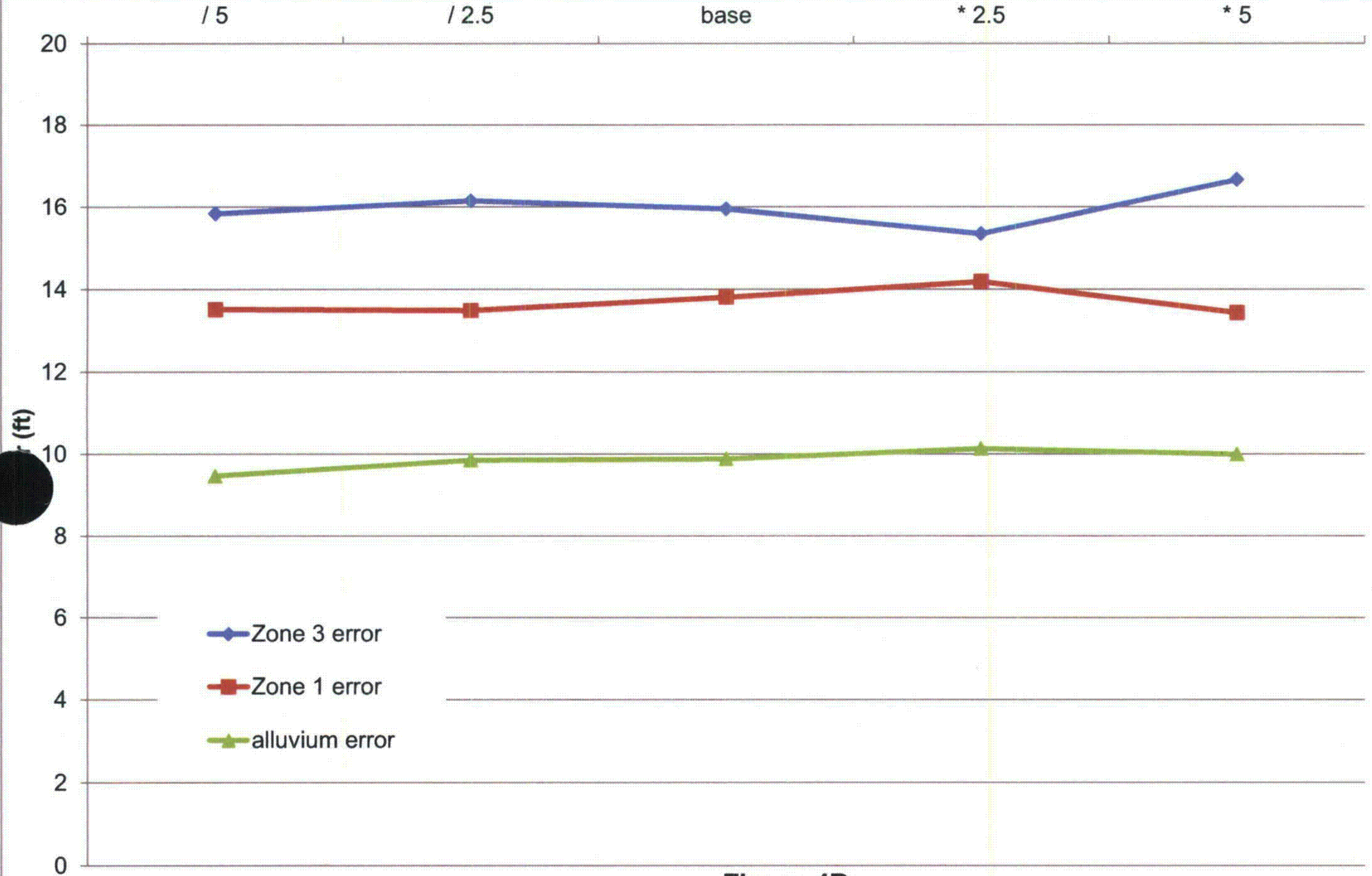
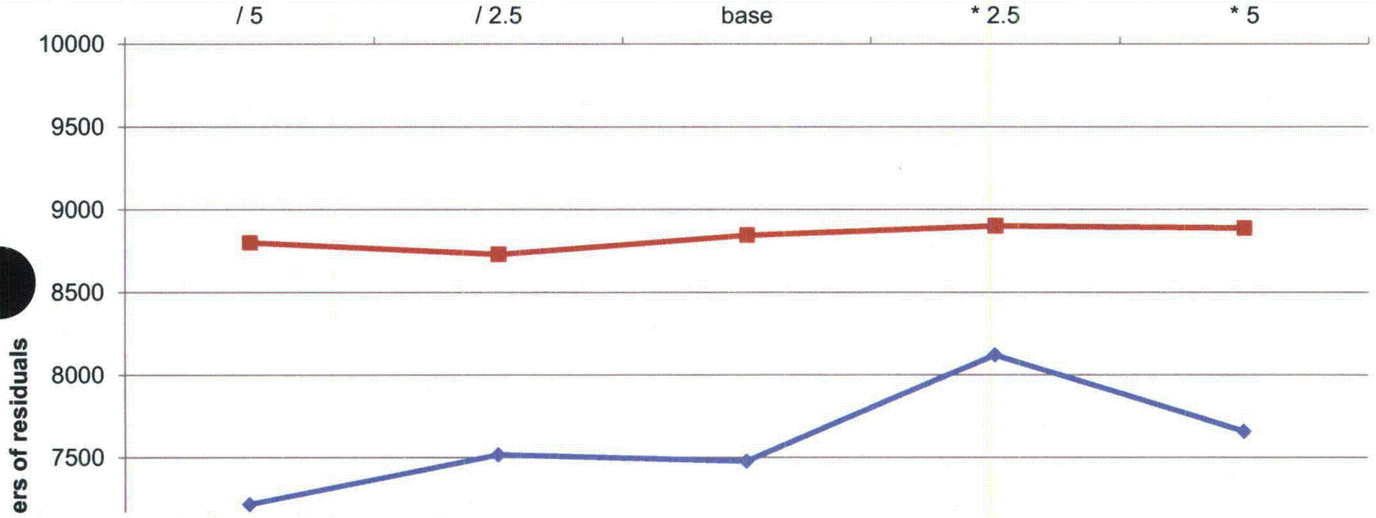


Figure 4B
Root mean squared error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z3_M1



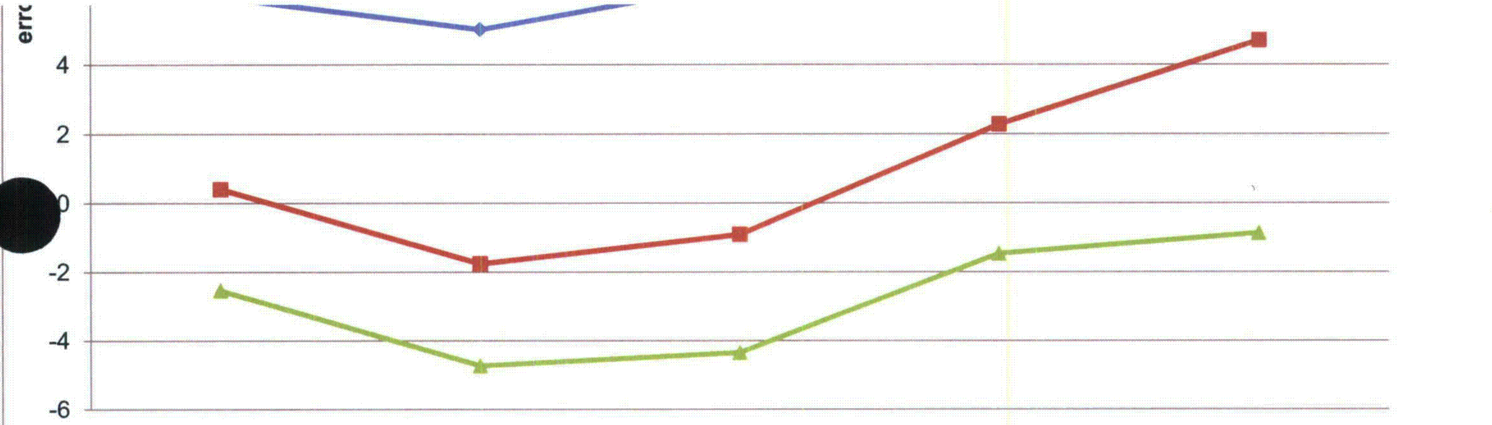


Figure 5A
Mean error statistics resulting from adjustments of horizontal conductivity anisotropy ratio in property zone Z3_M1

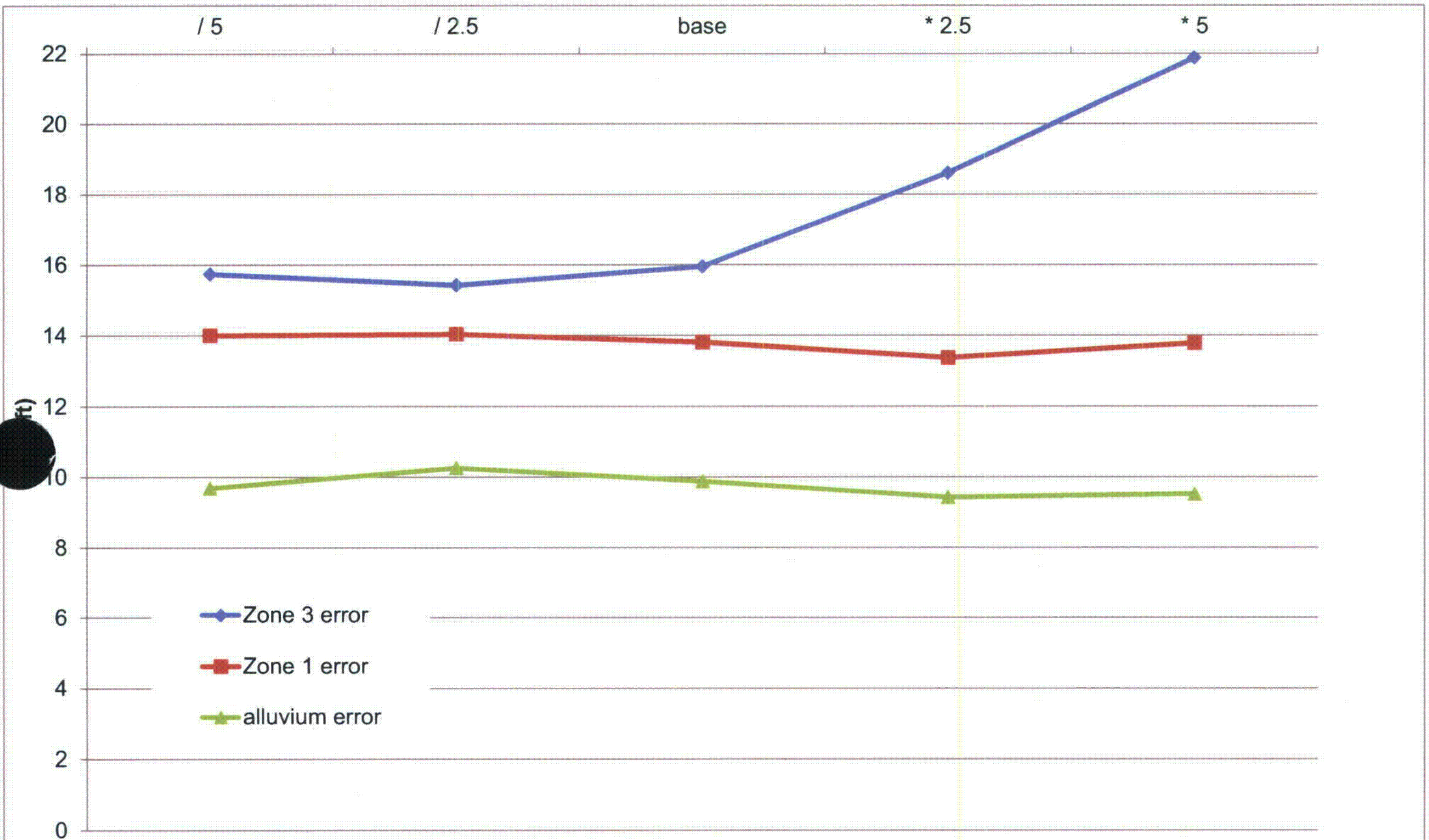
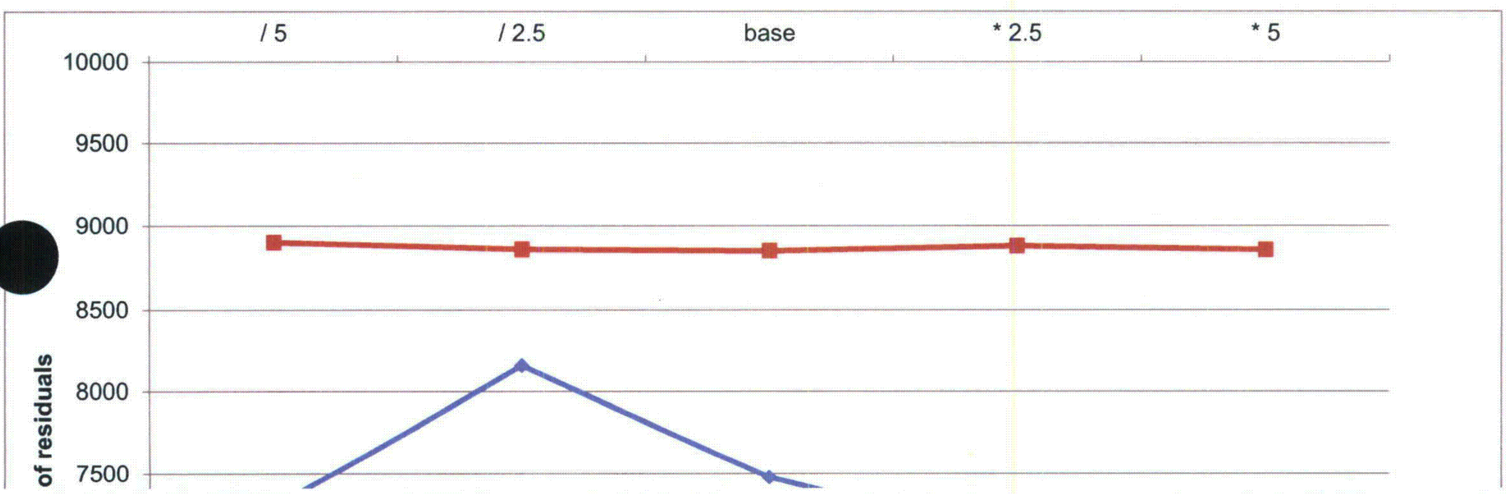


Figure 5B
Root mean squared error statistics resulting from adjustments of horizontal conductivity anisotropy ratio in property zone Z3_M1



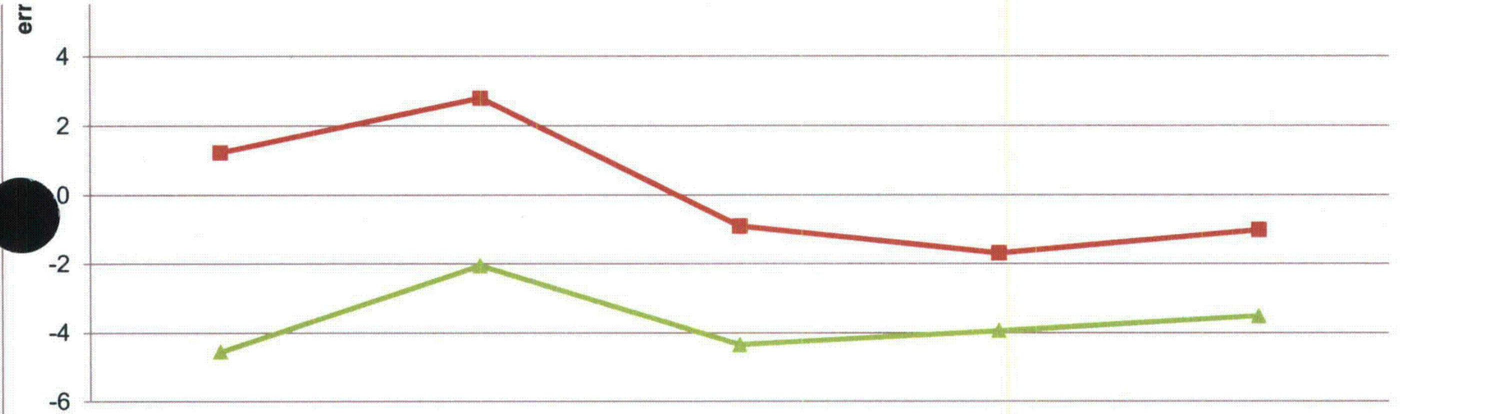


Figure 6A
Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M2

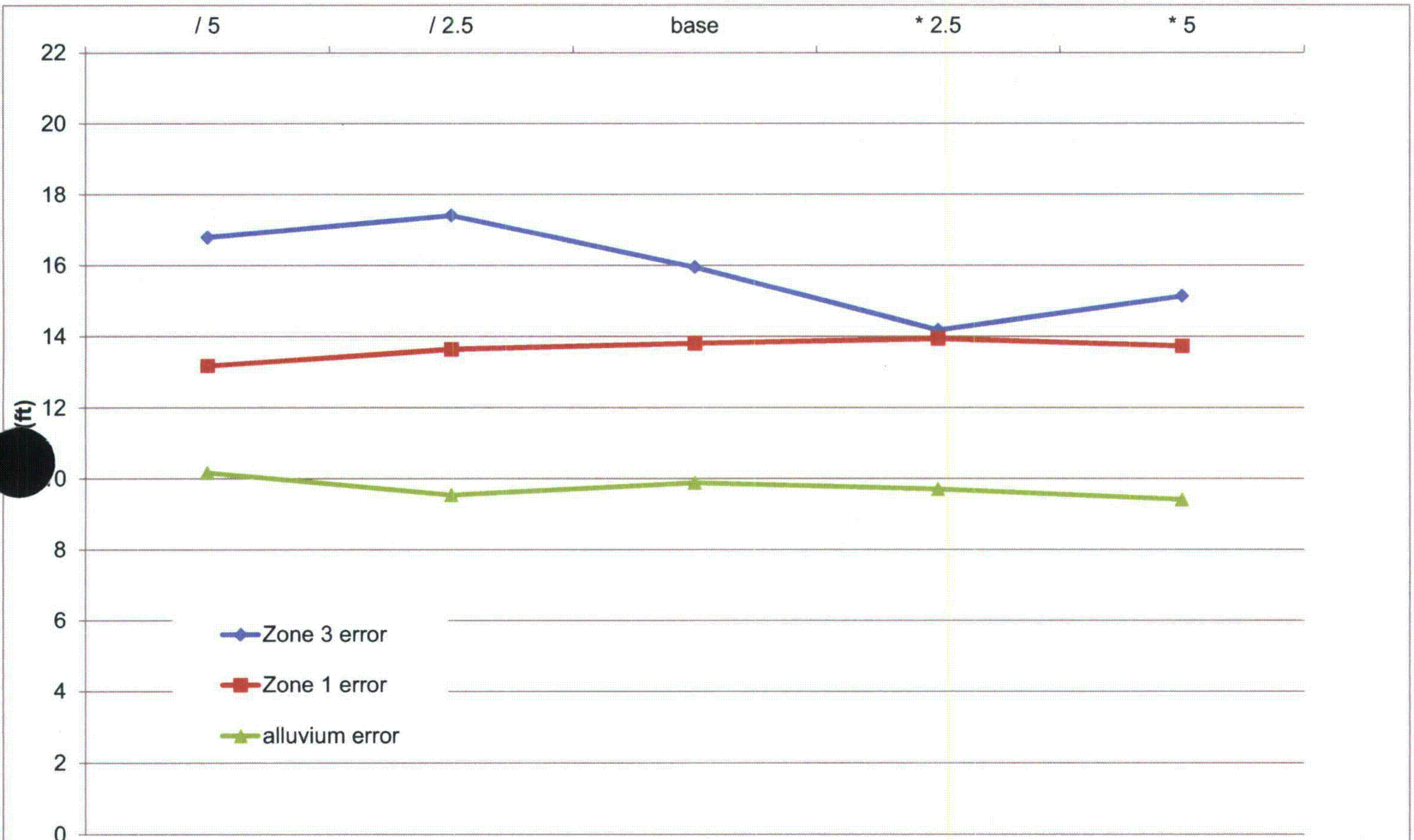
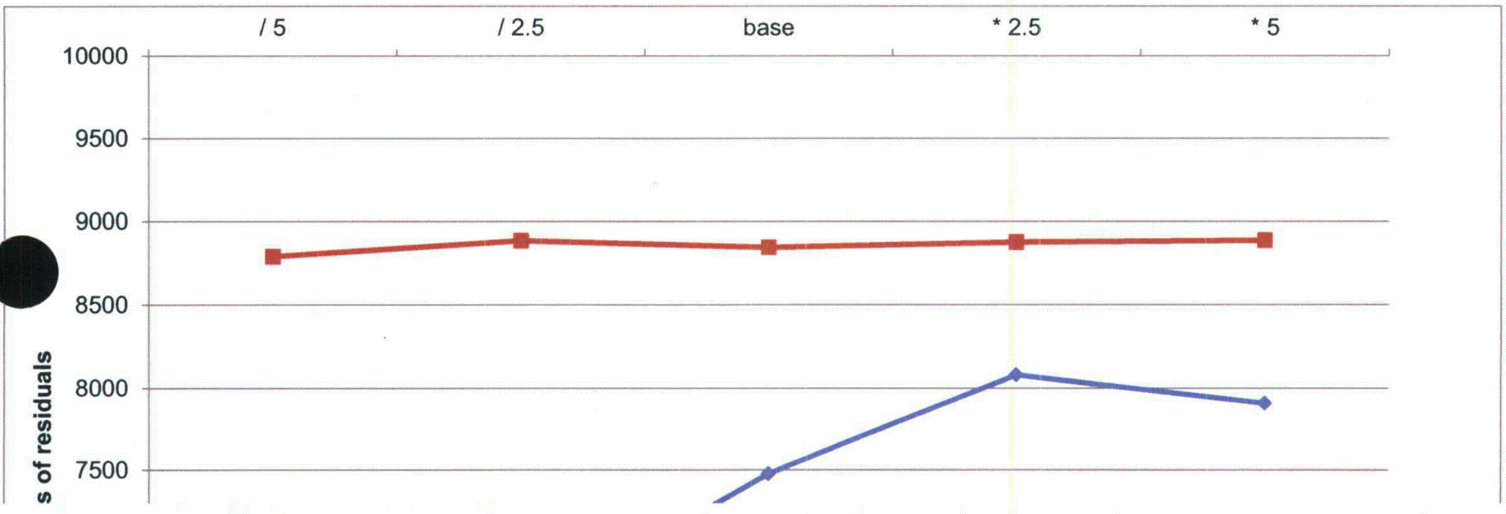


Figure 6B
Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M2



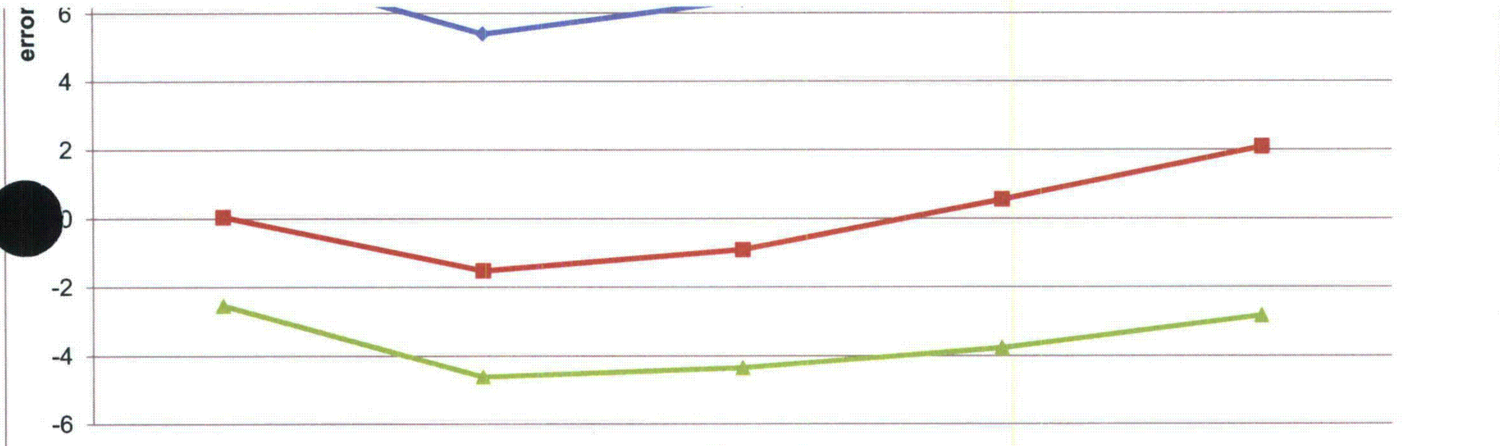


Figure 7A

Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M3

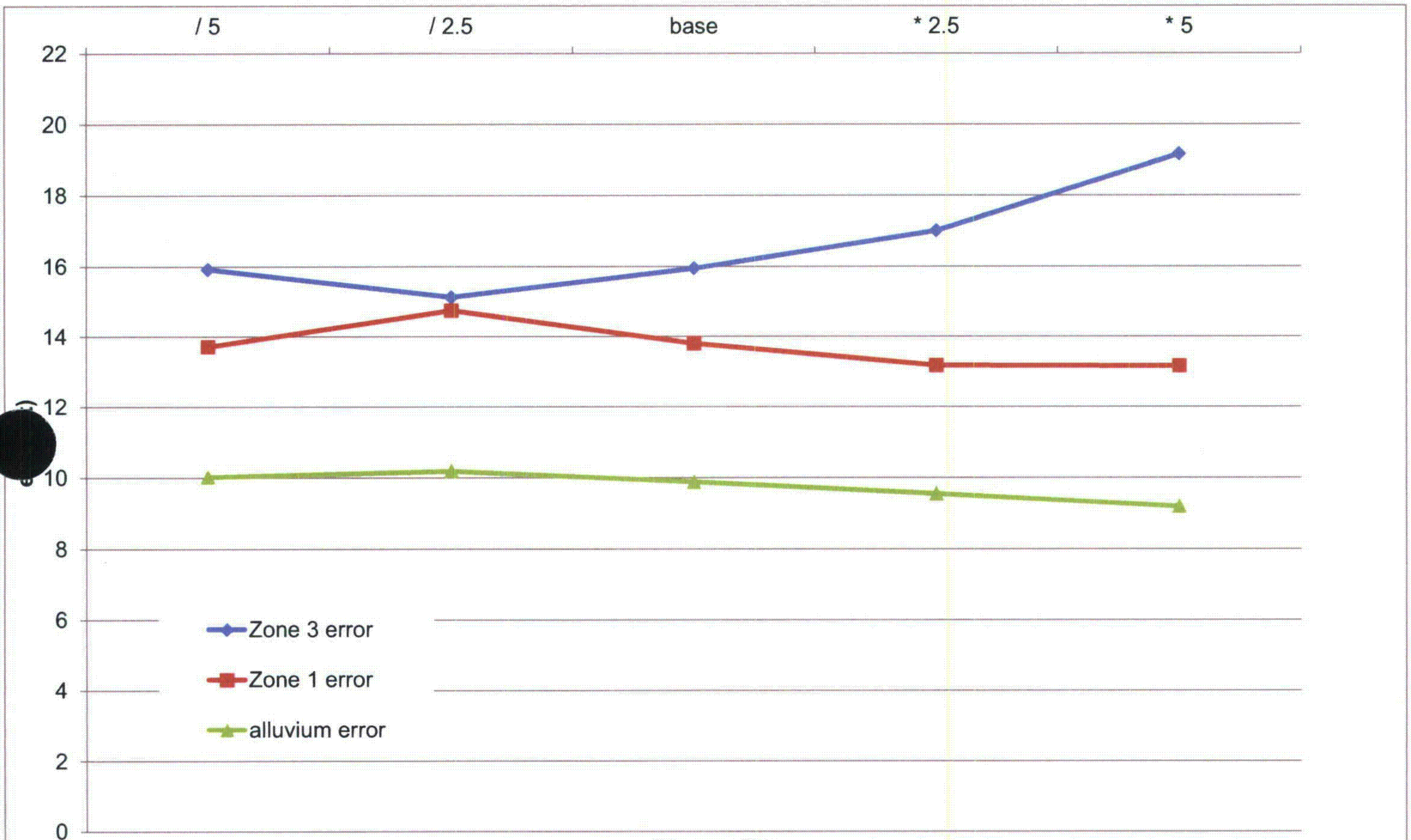
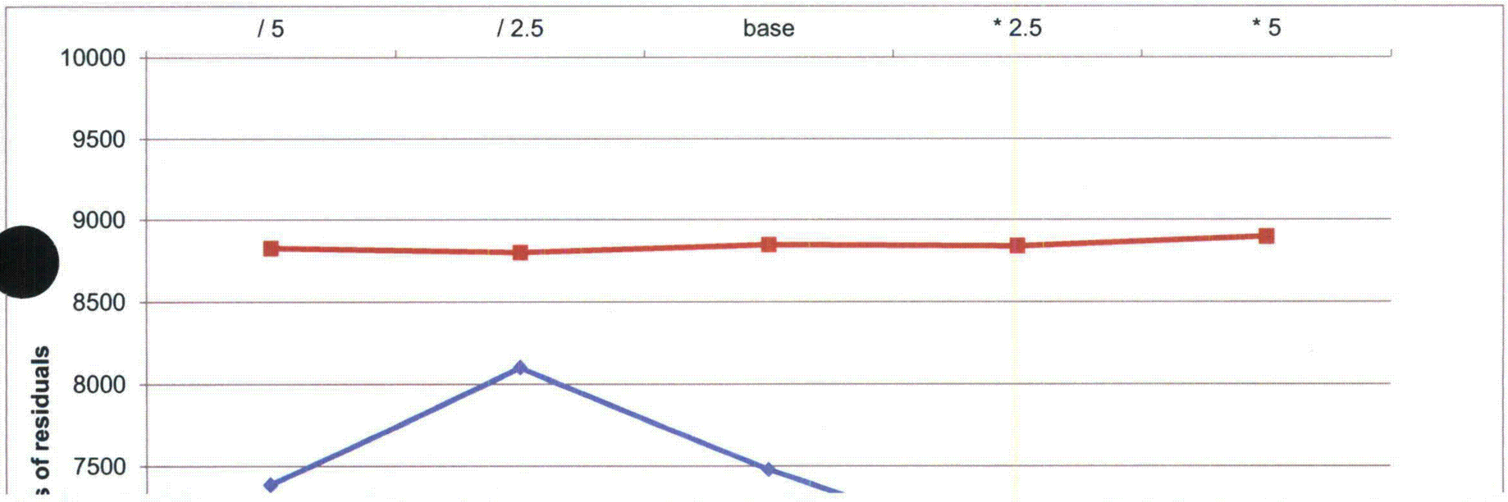


Figure 7B

Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M3



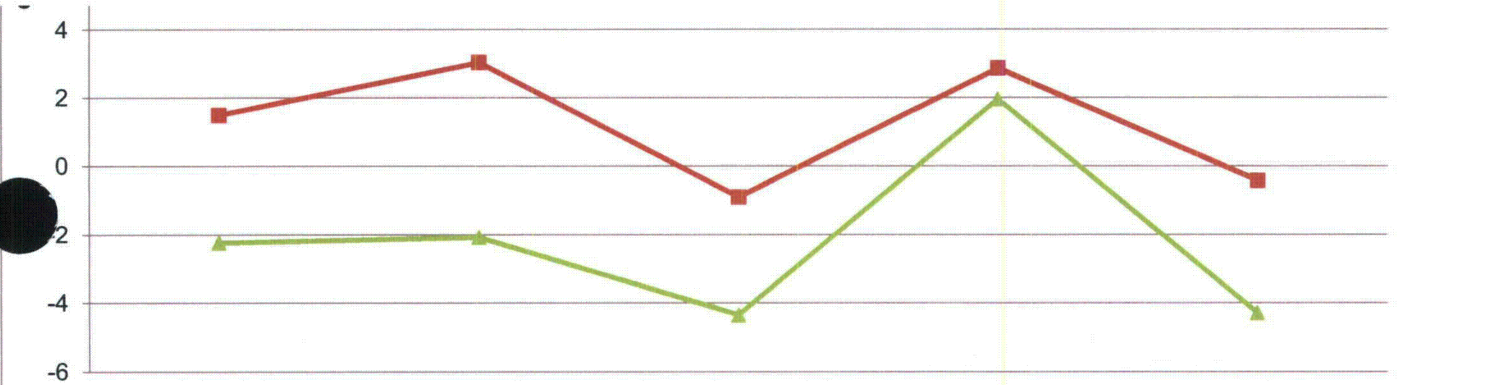


Figure 8A
Mean error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z3_M3

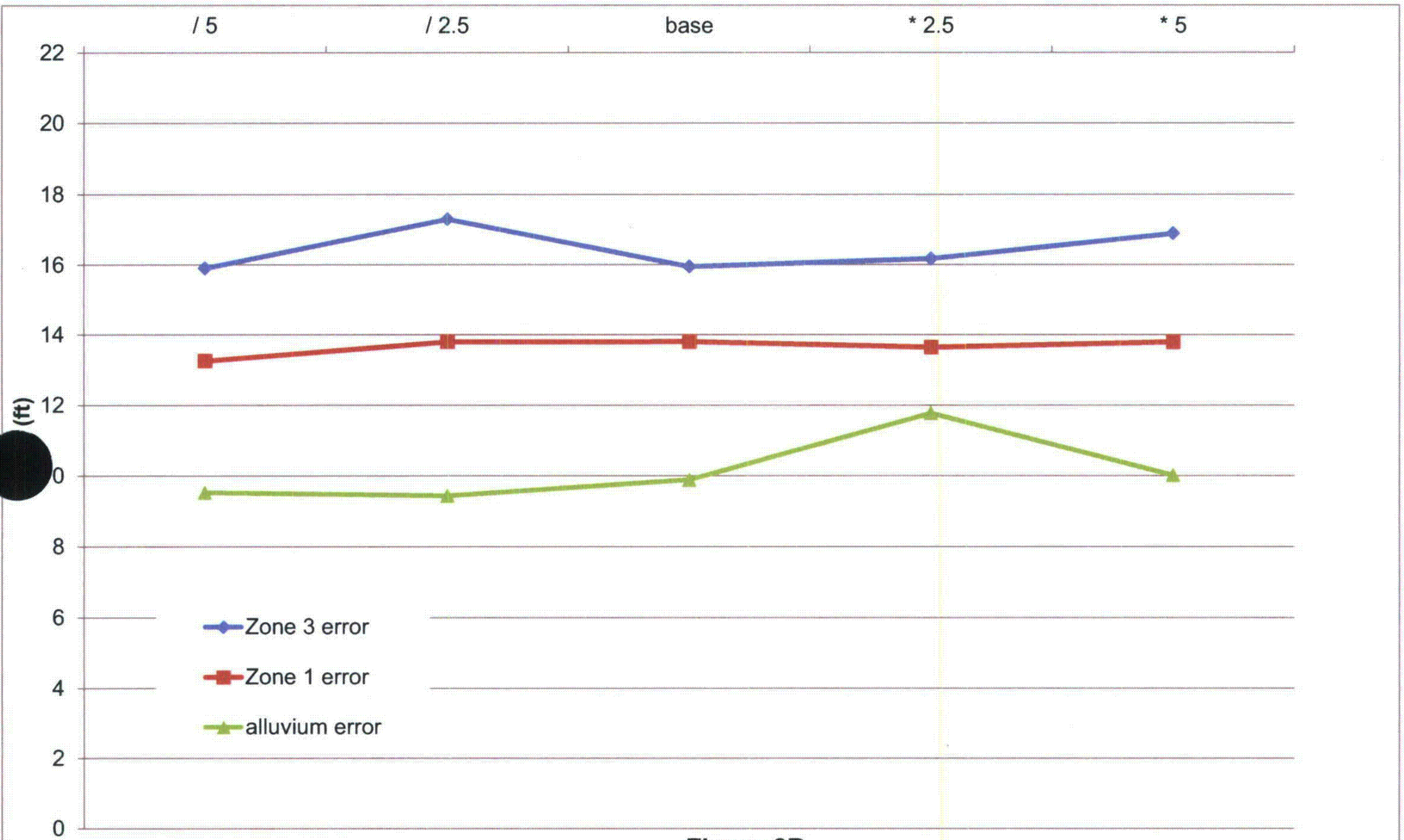
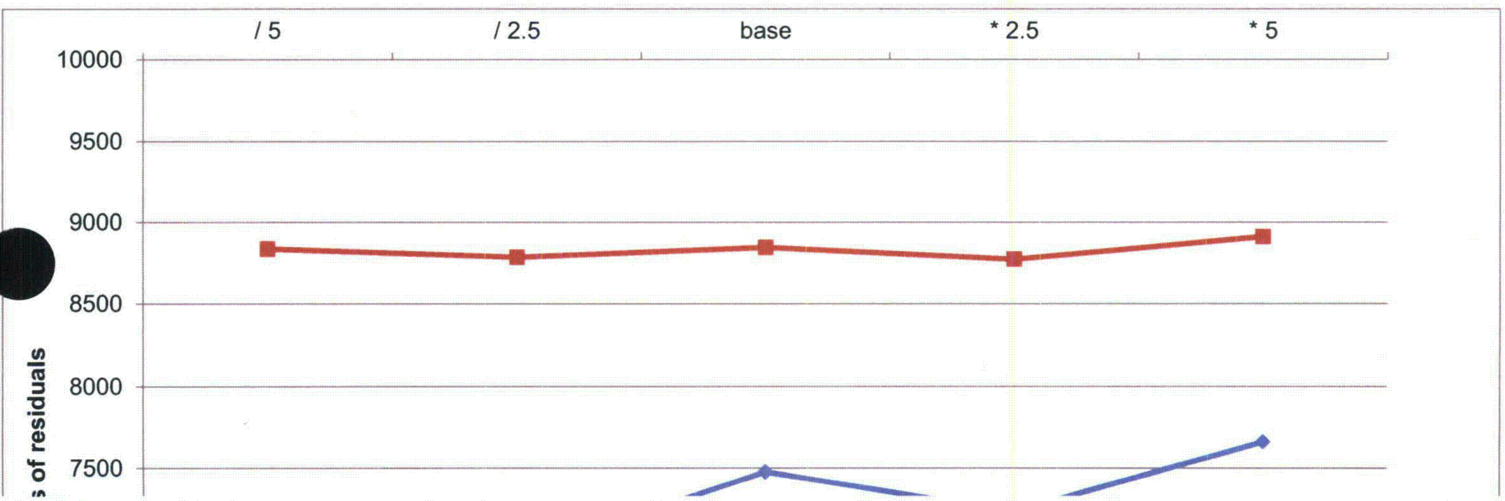


Figure 8B
Root mean squared error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z3_M3



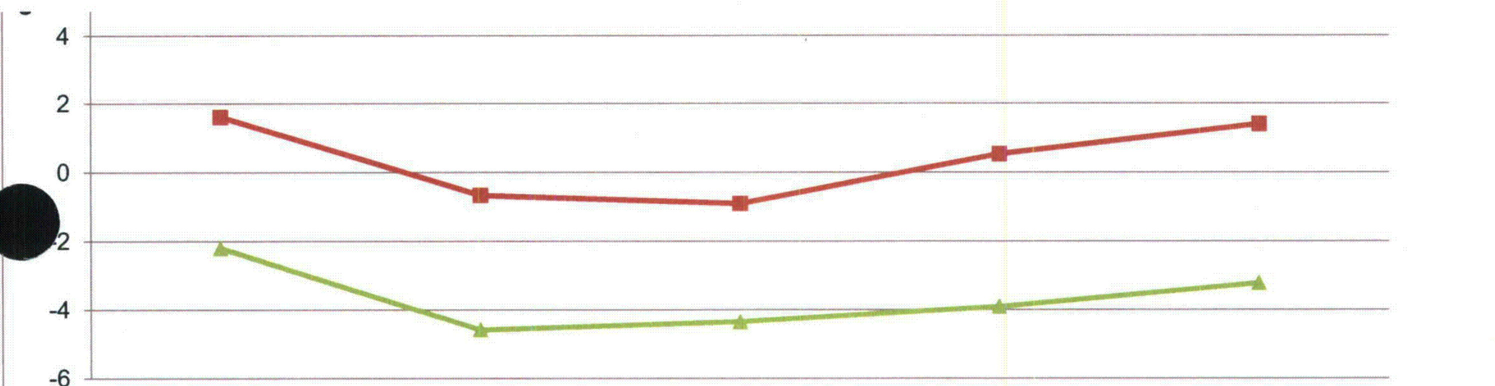


Figure 9A
Mean error statistics resulting from adjustments of horizontal conductivity anisotropy ratio in property zone Z3_M3

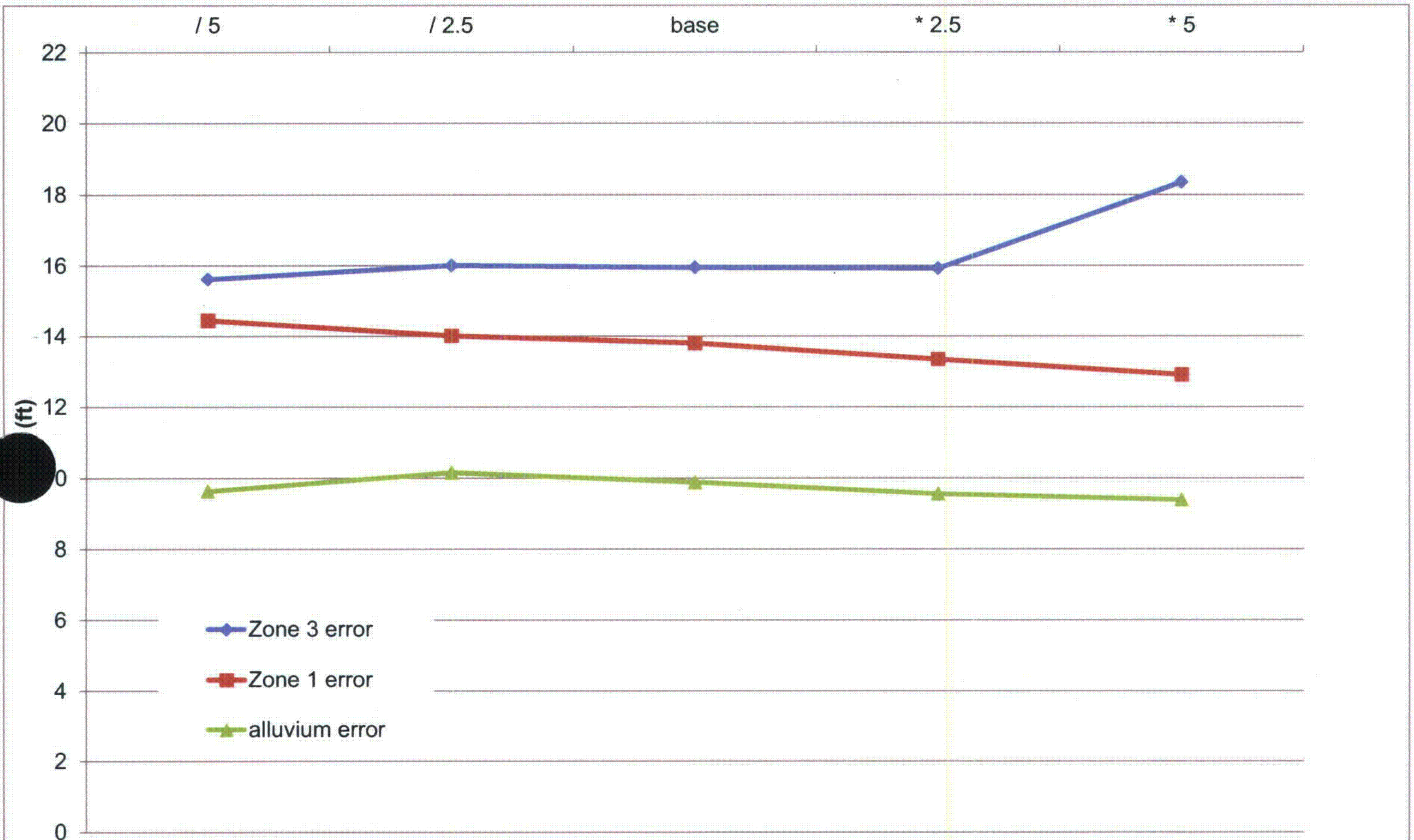
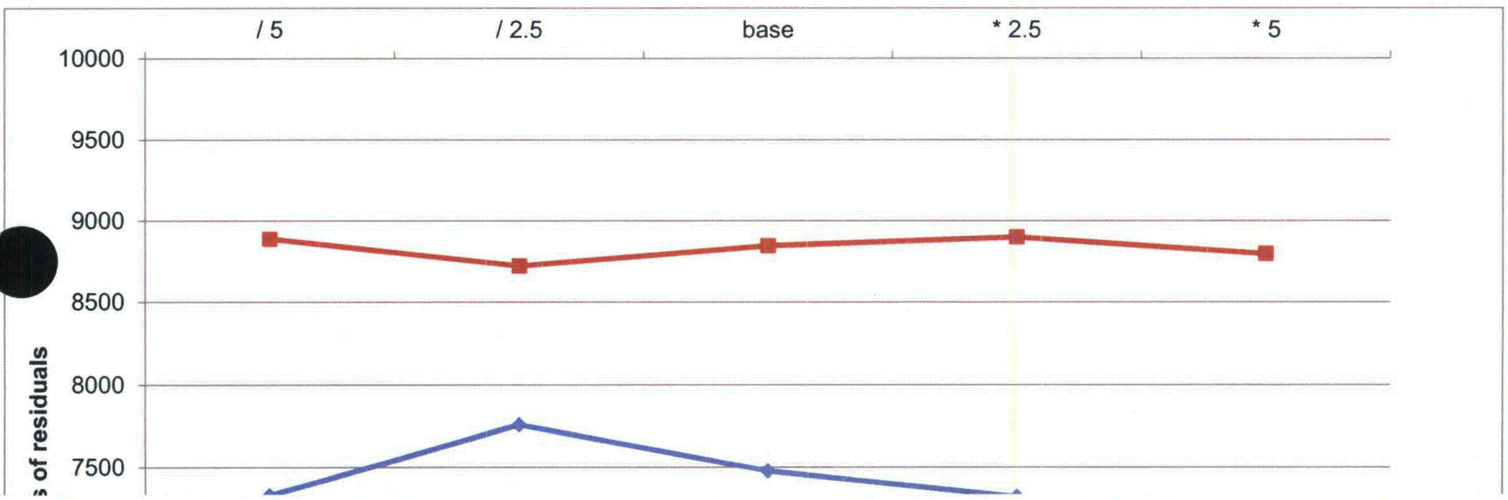


Figure 9B
Root mean squared error statistics resulting from adjustments of horizontal conductivity anisotropy ratio in property zone Z3_M3



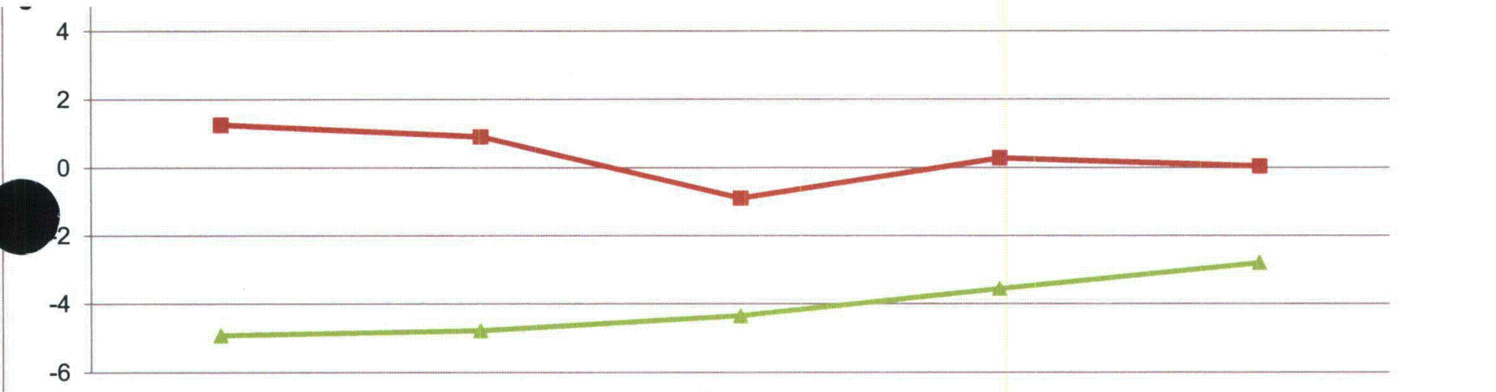


Figure 10A
Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M4

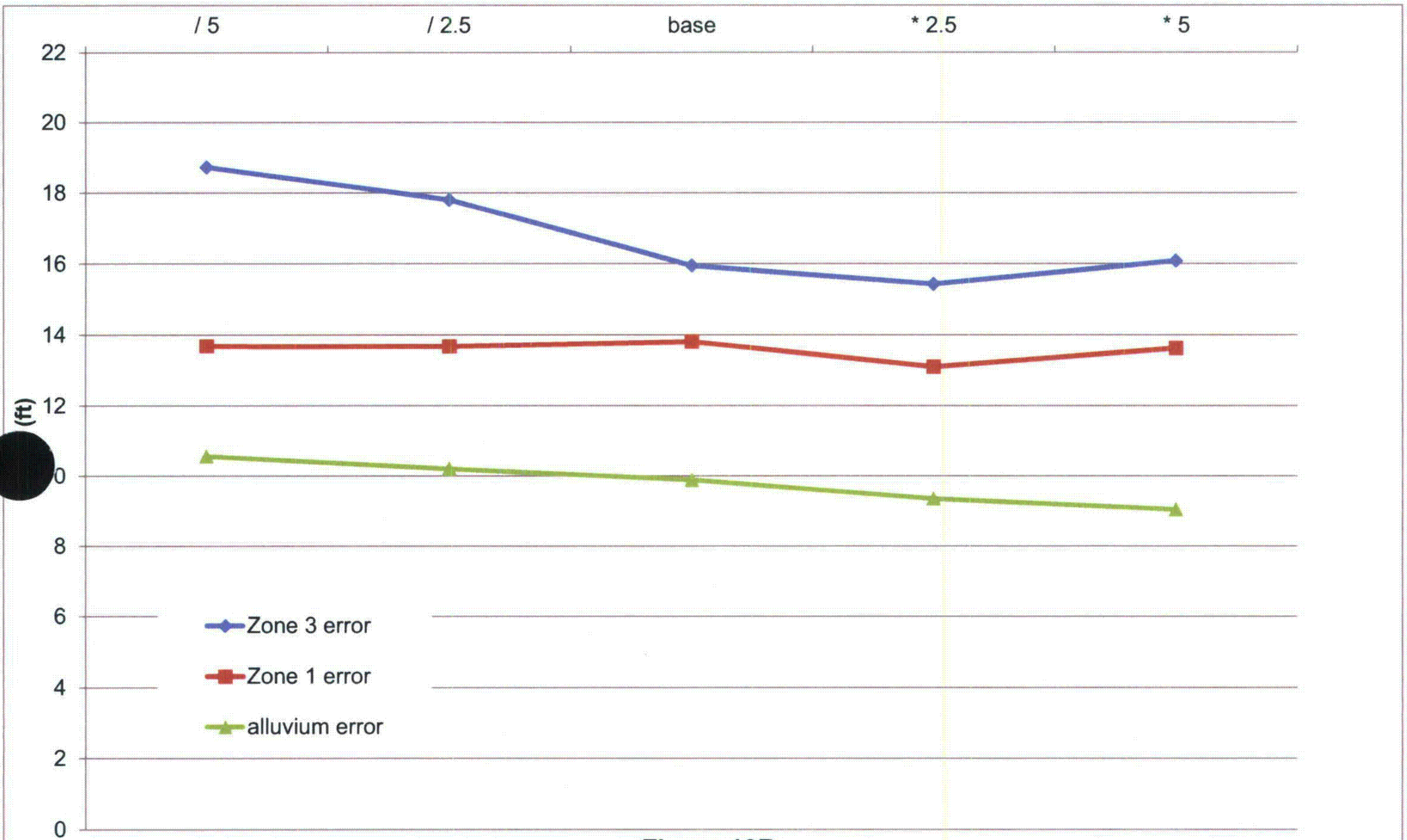
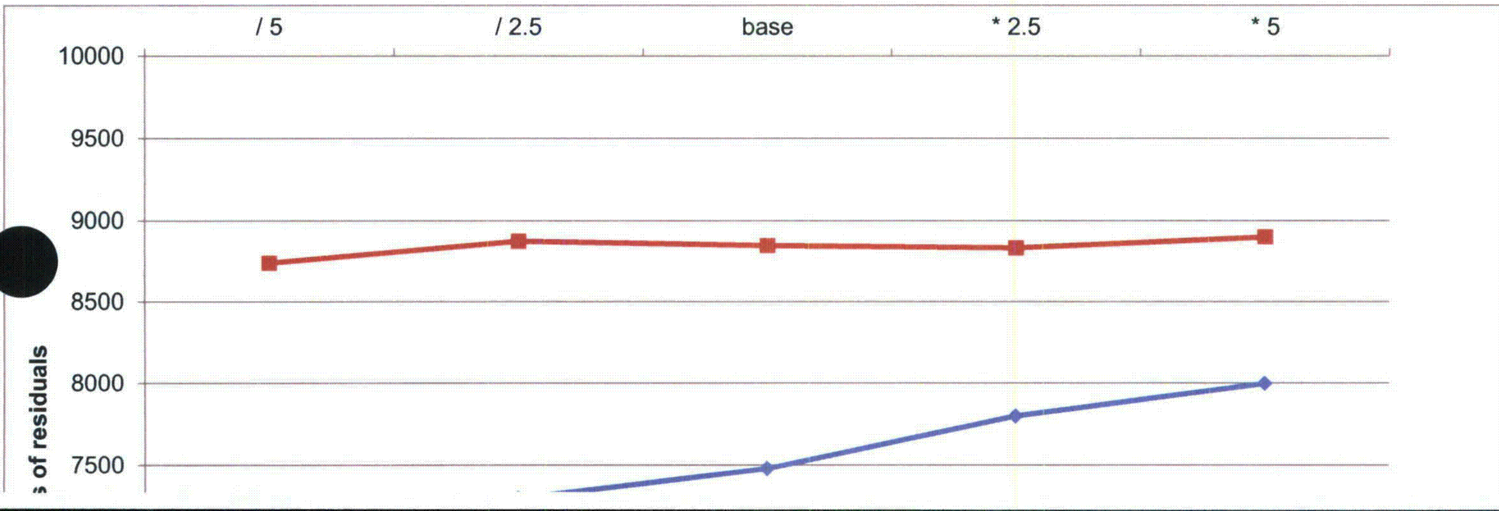


Figure 10B
Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M4



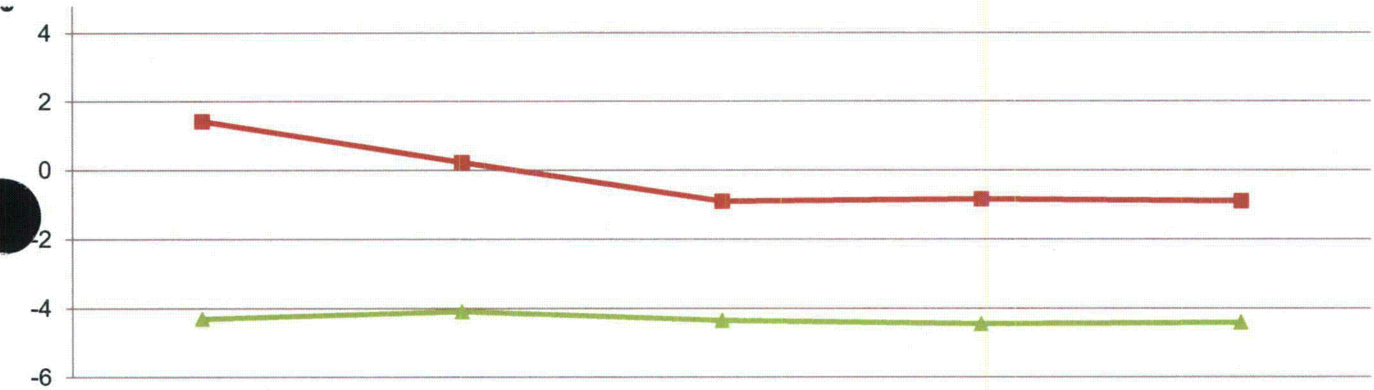


Figure 11A
Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M6

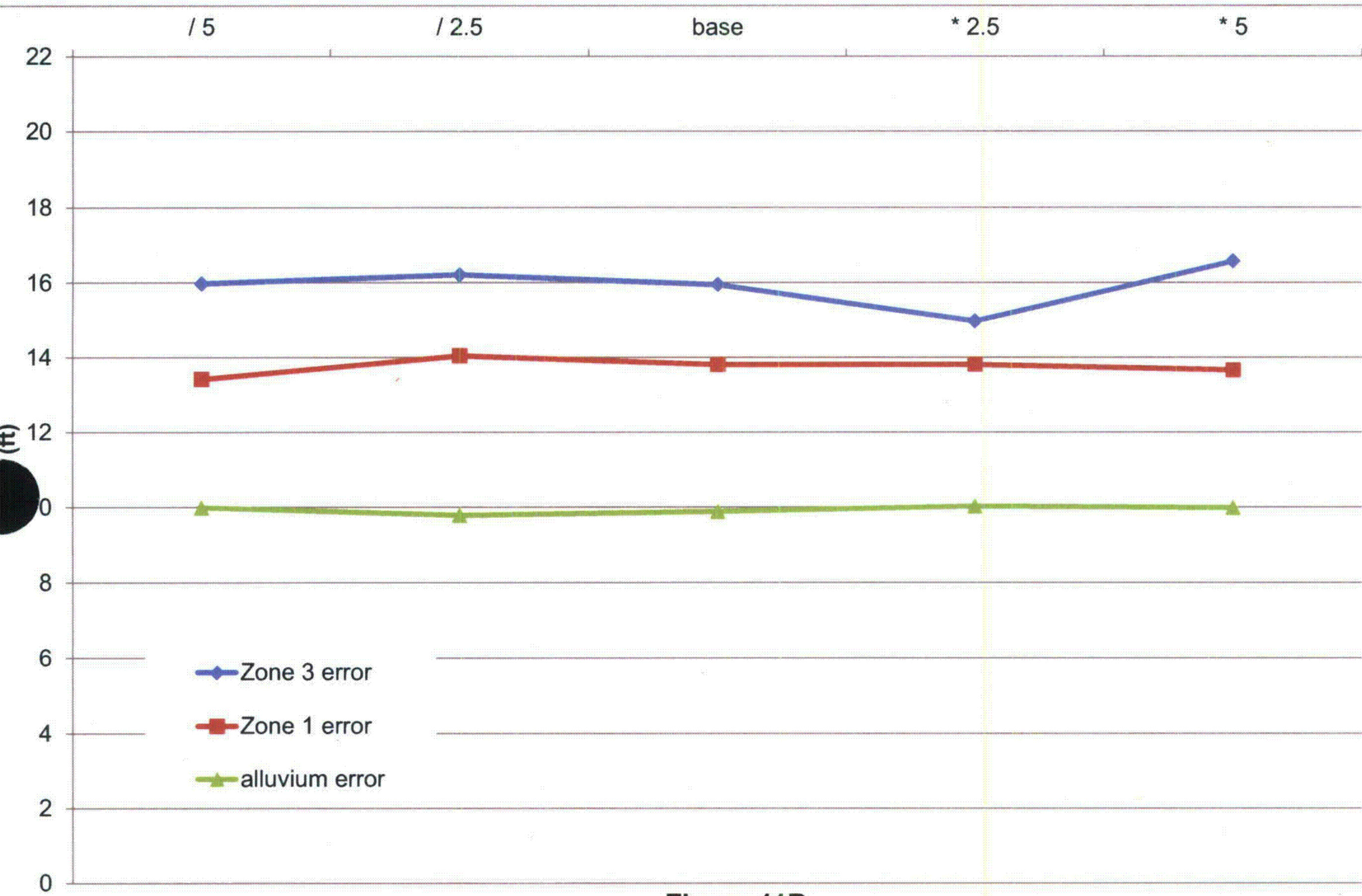
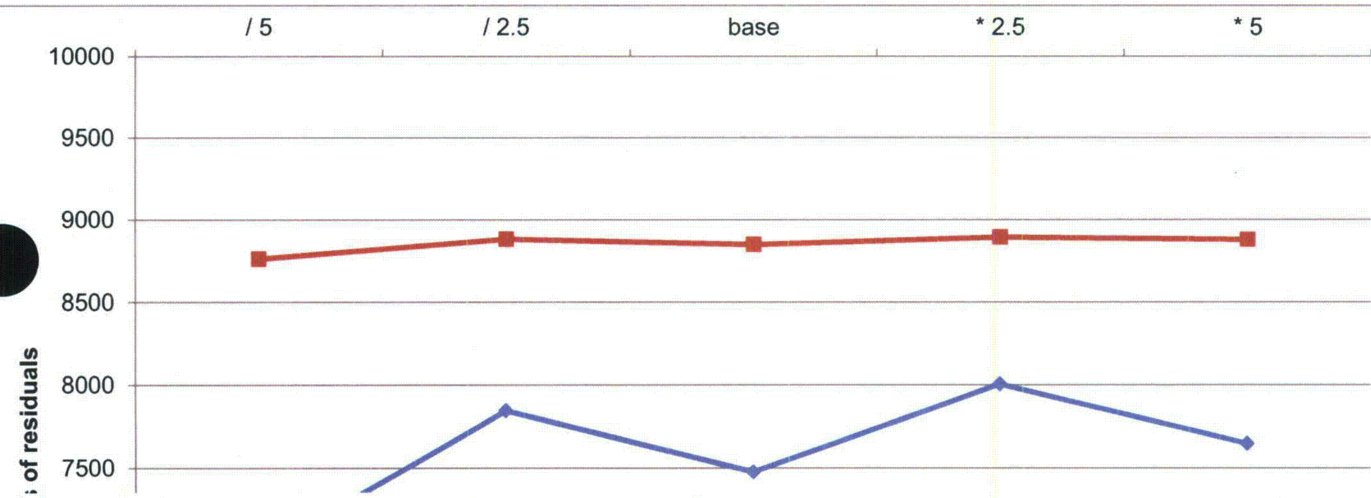


Figure 11B
Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Z3_M6



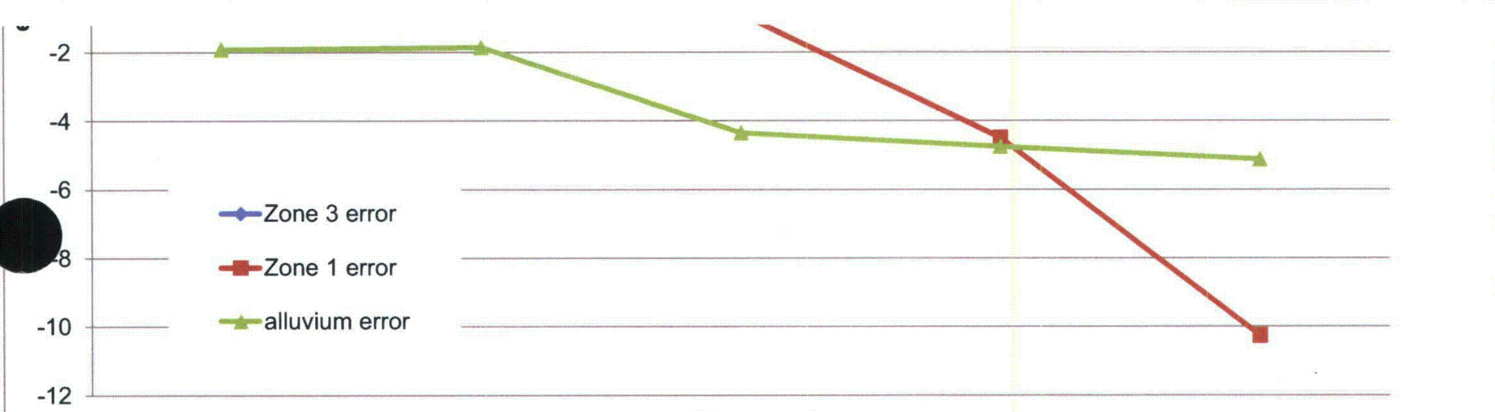


Figure 12A

Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Z2_M1

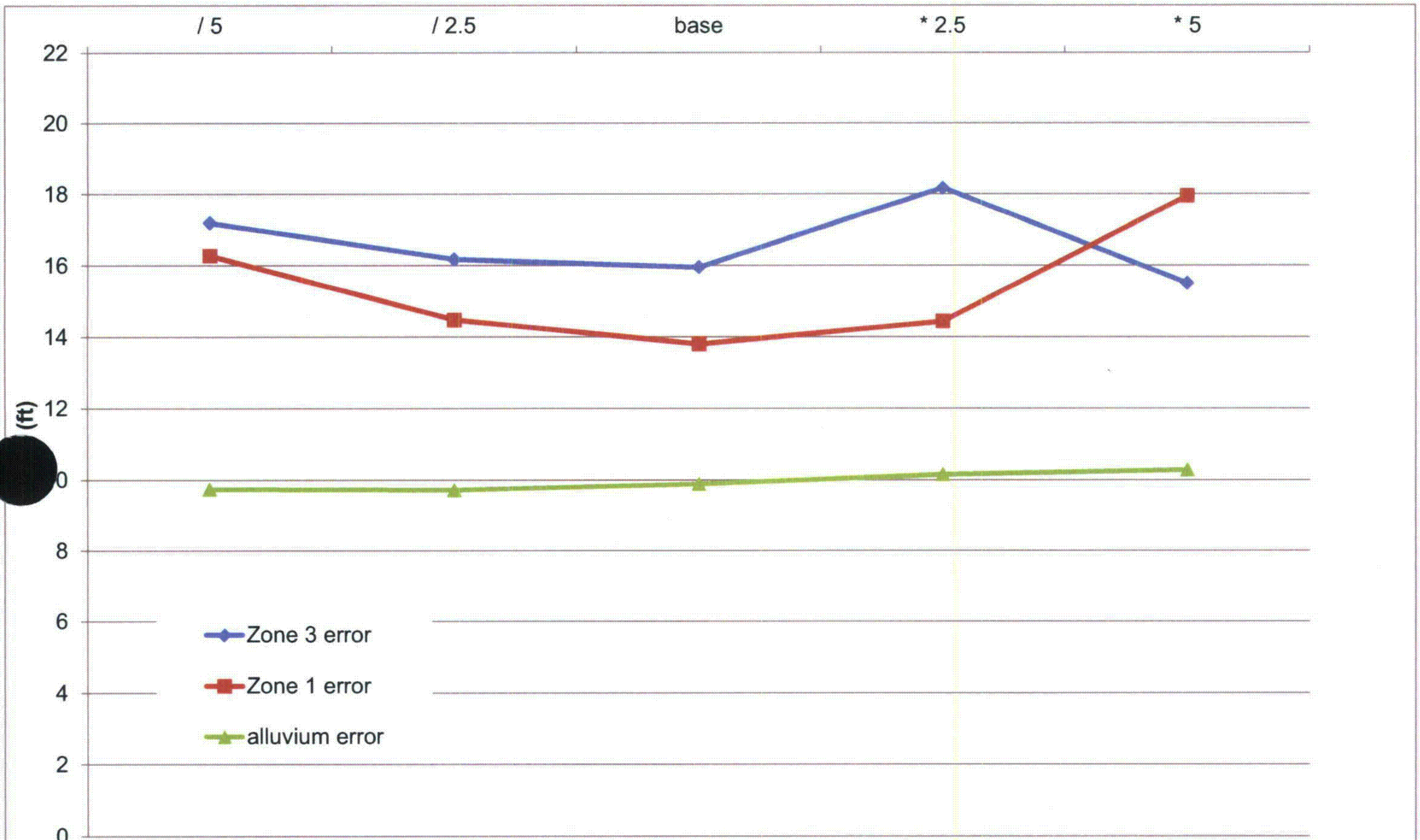
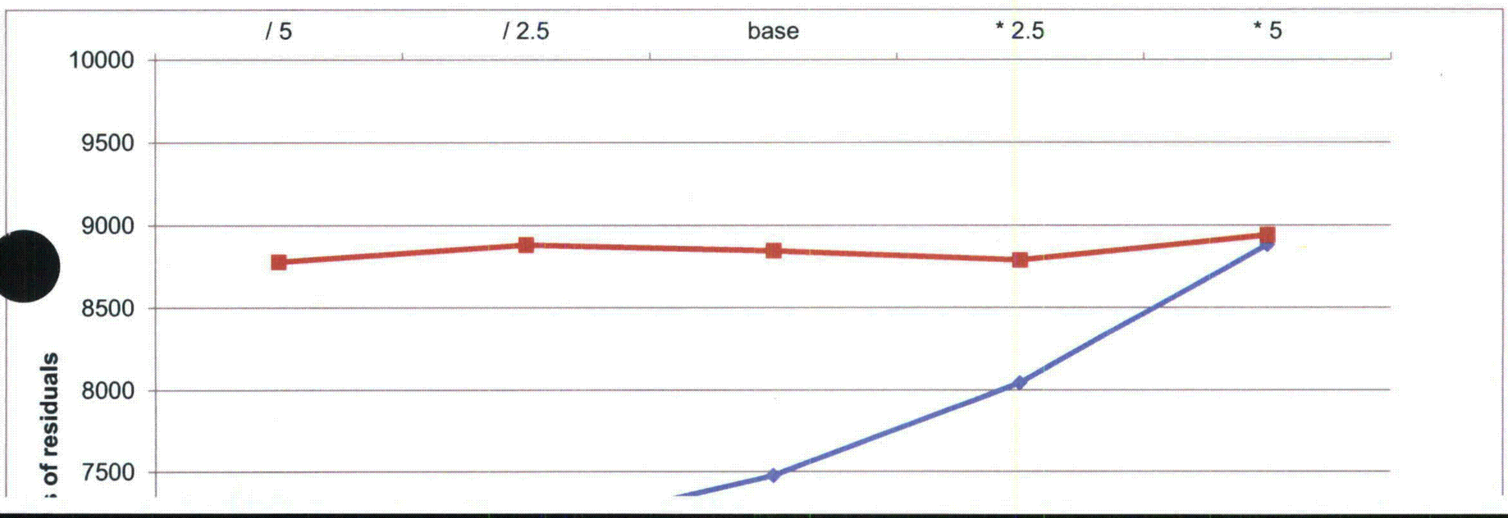


Figure 12B

Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Z2_M1



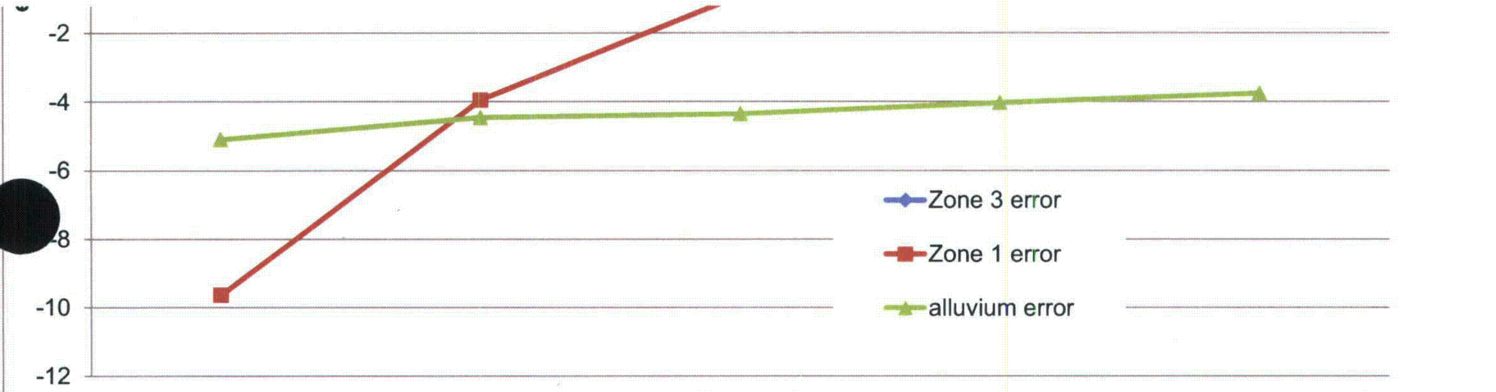


Figure 13A
Mean error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z2_M1

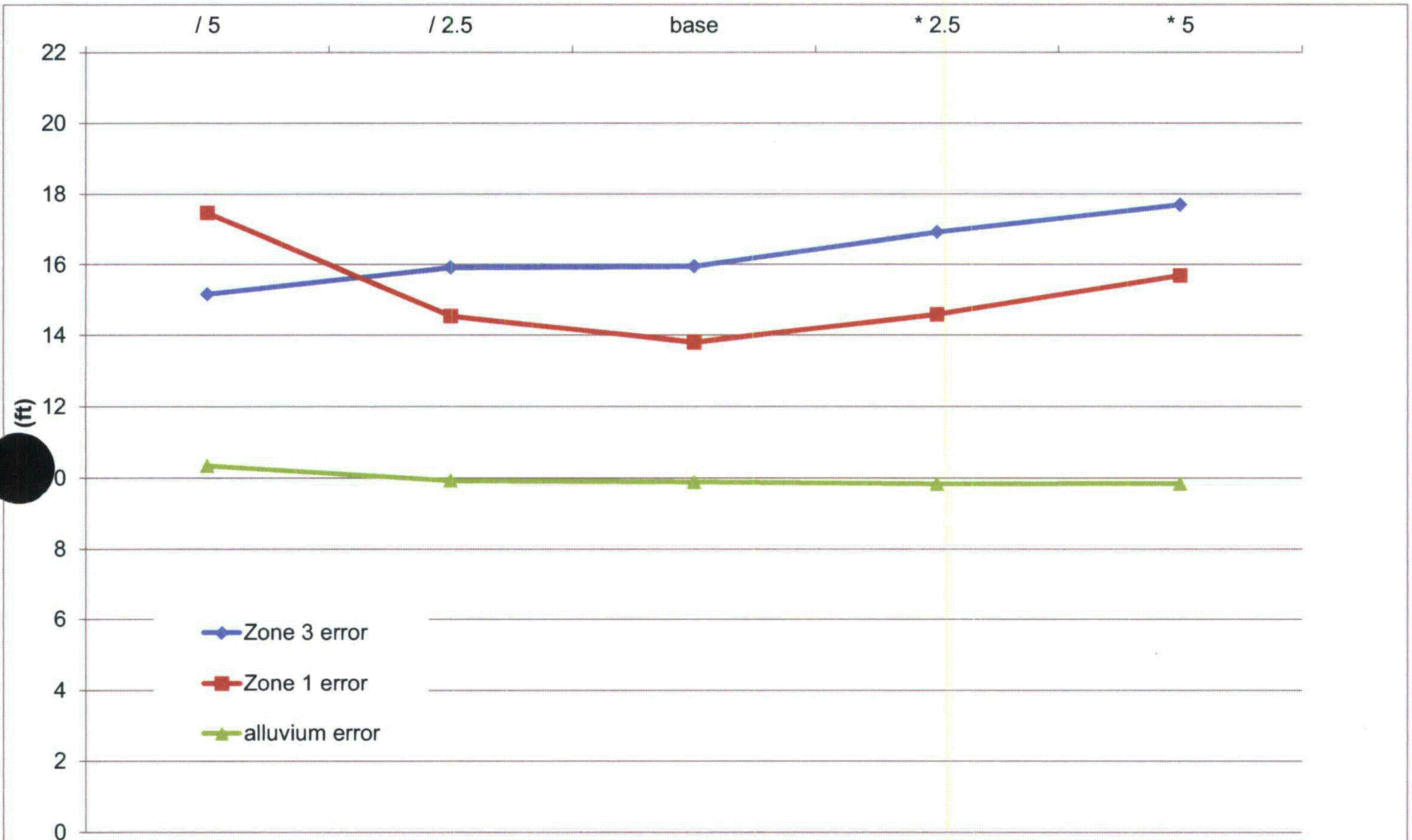
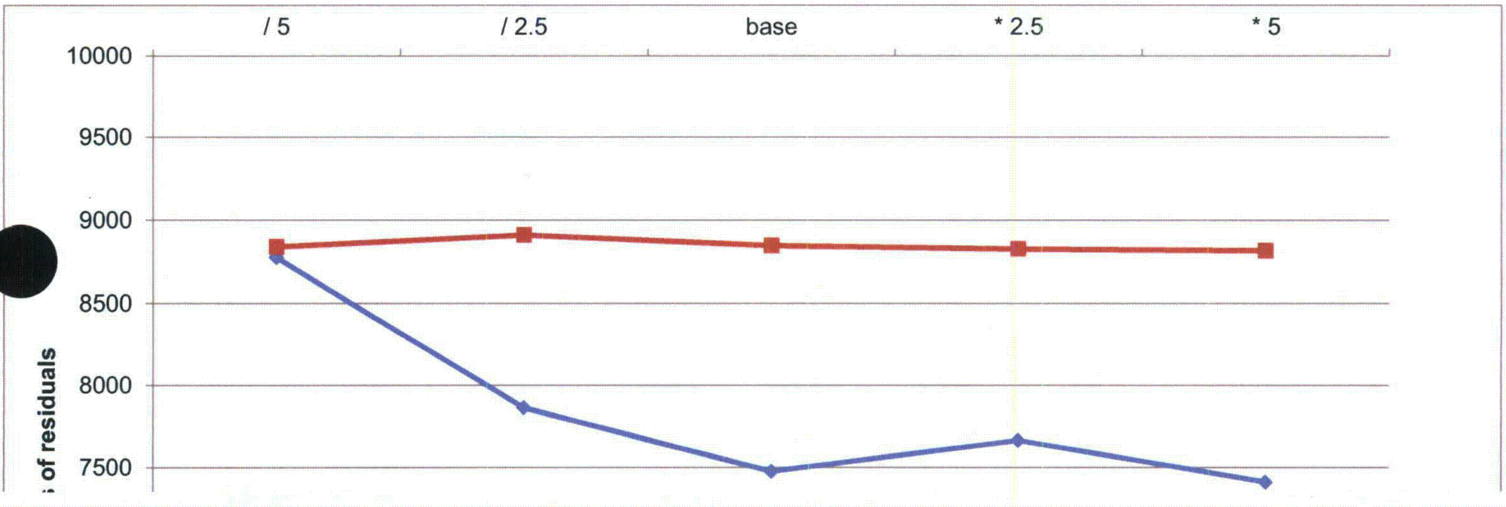


Figure 13B
Root mean squared error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z2_M1



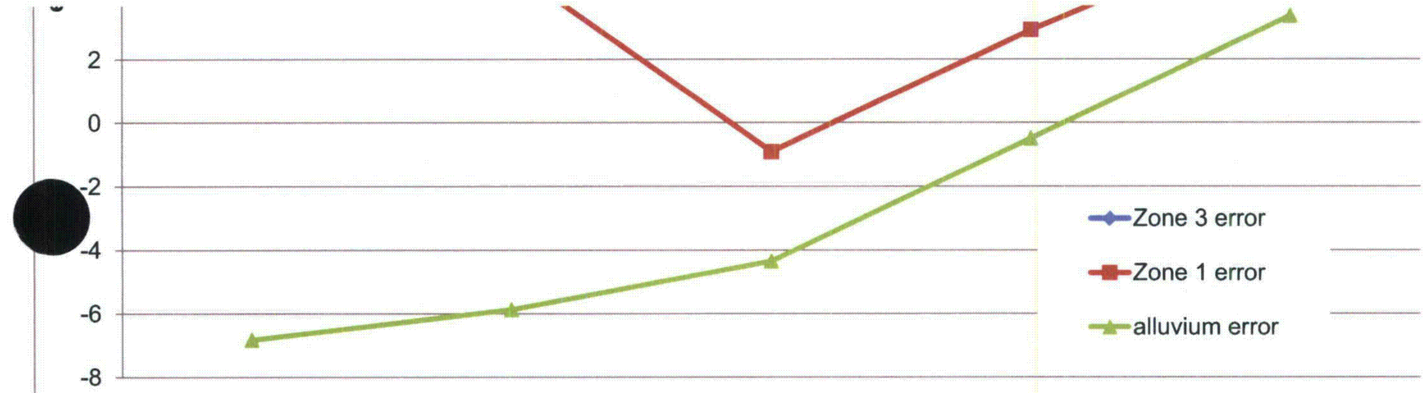


Figure 14A
Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Z1_M1

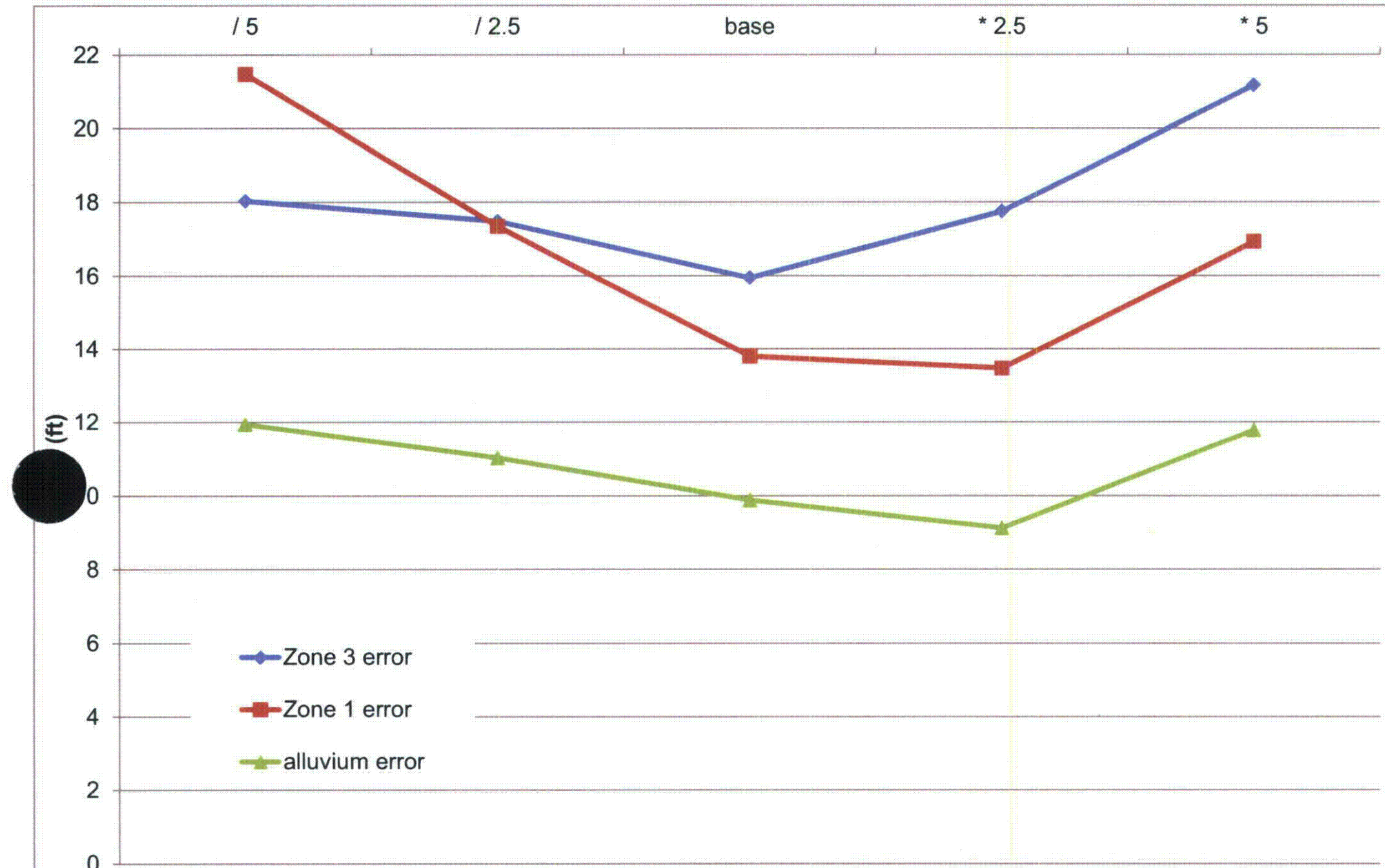
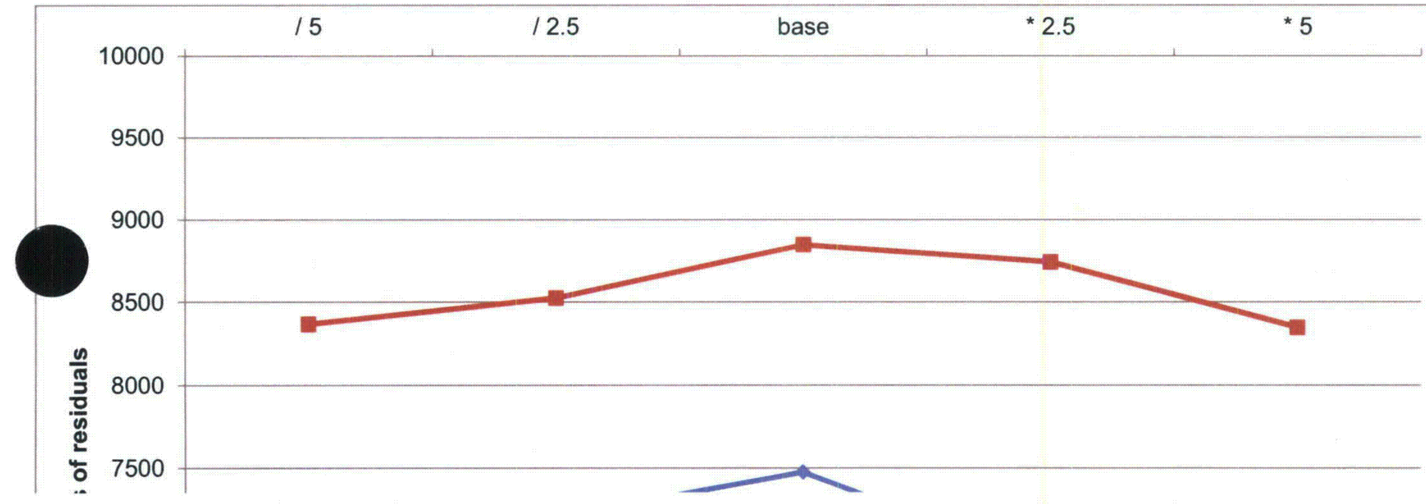


Figure 14B
Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Z1_M1



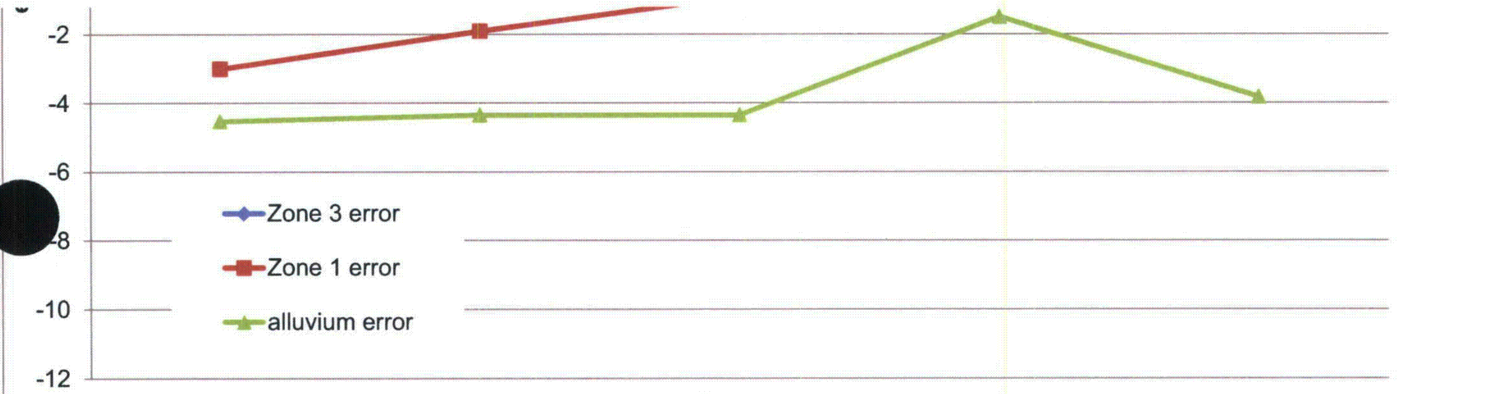


Figure 15A
Mean error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z1_M1

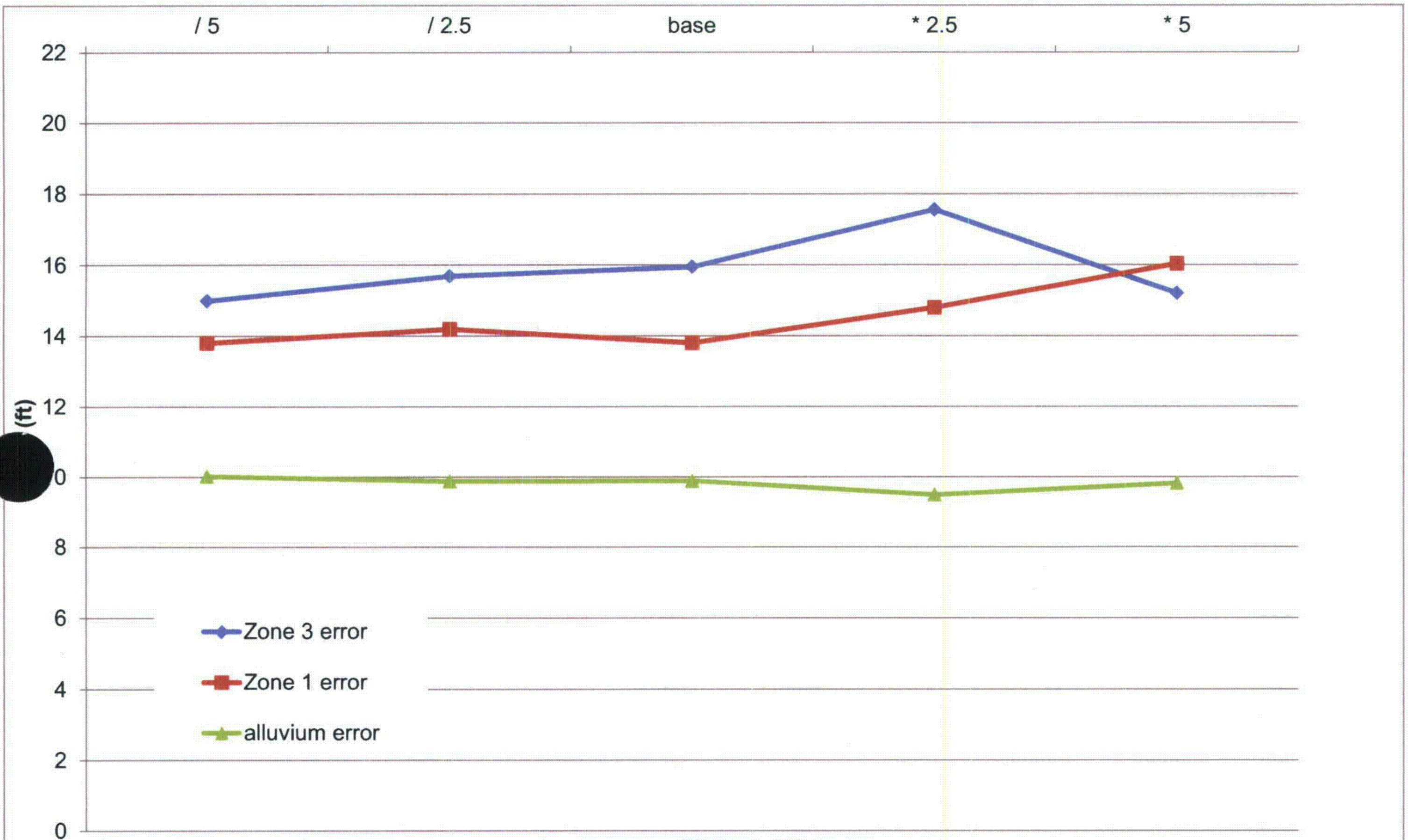
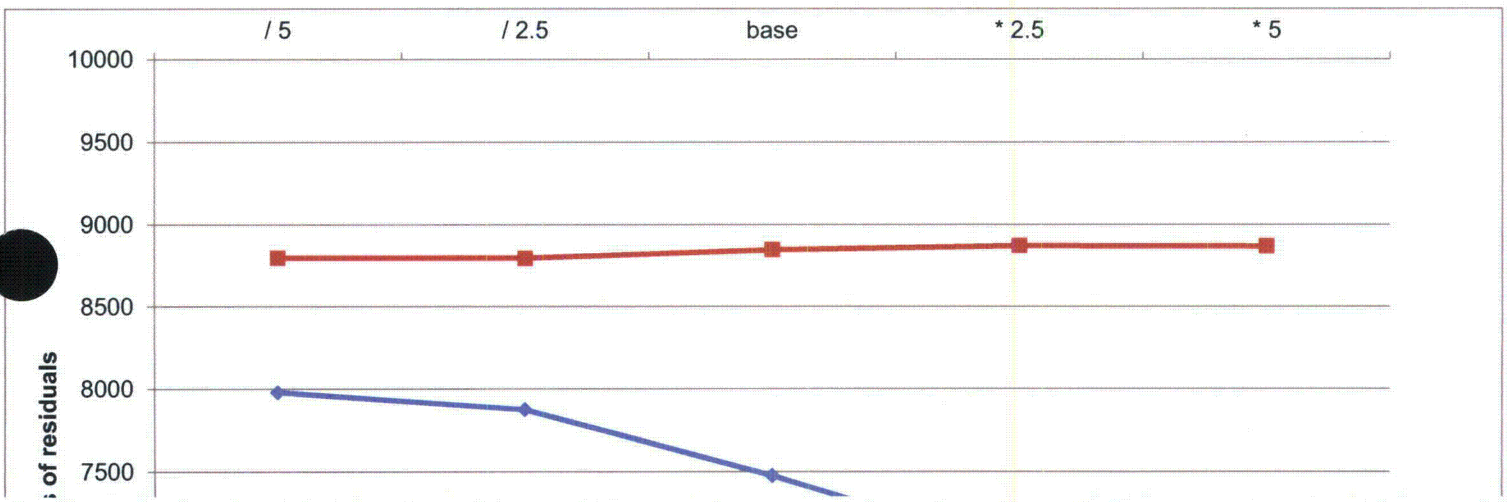


Figure 15B
Root mean squared error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Z1_M1



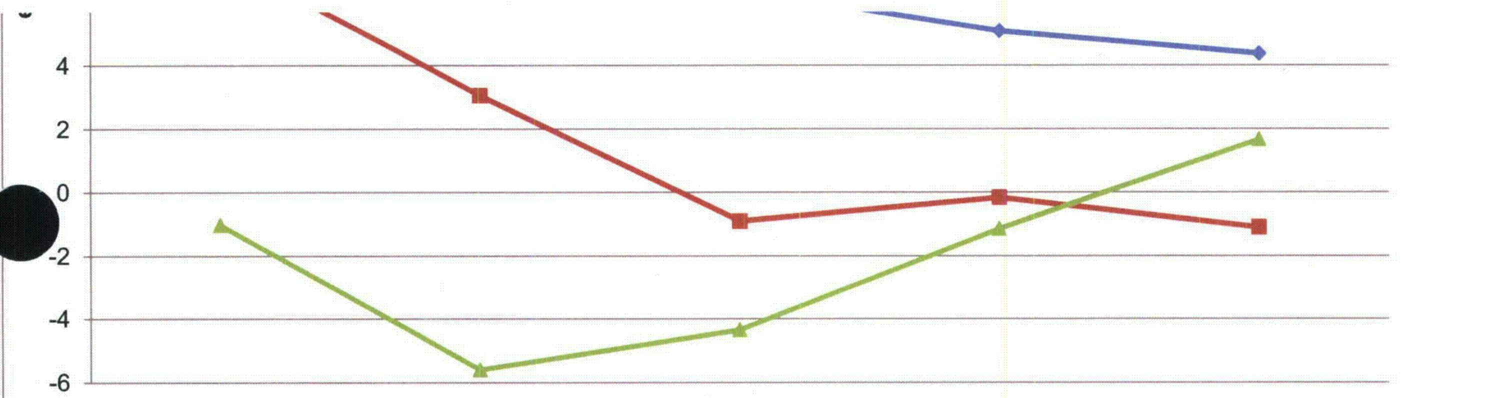


Figure 16A

Mean error statistics resulting from adjustments of hydraulic conductivity in property zone alluv_M1

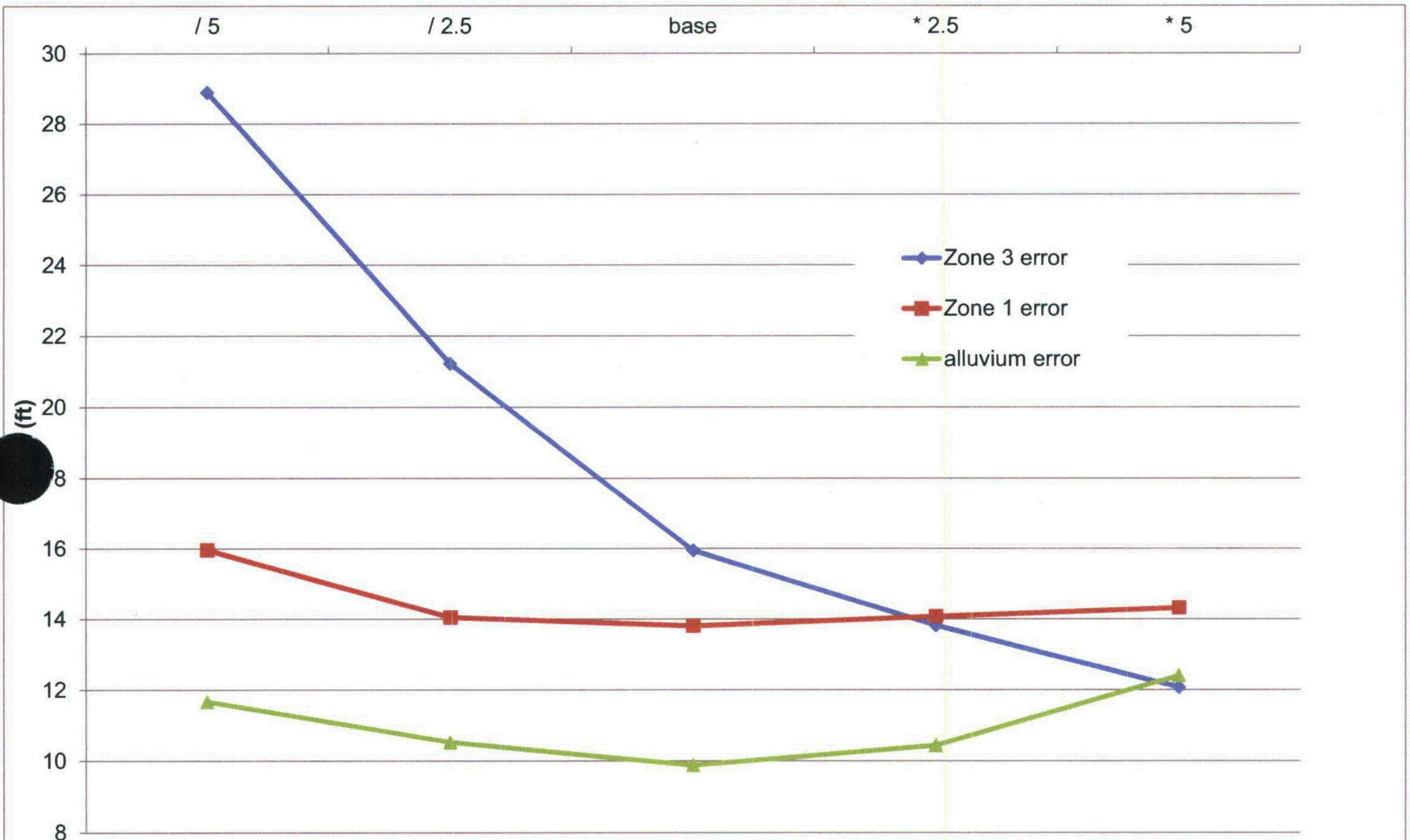
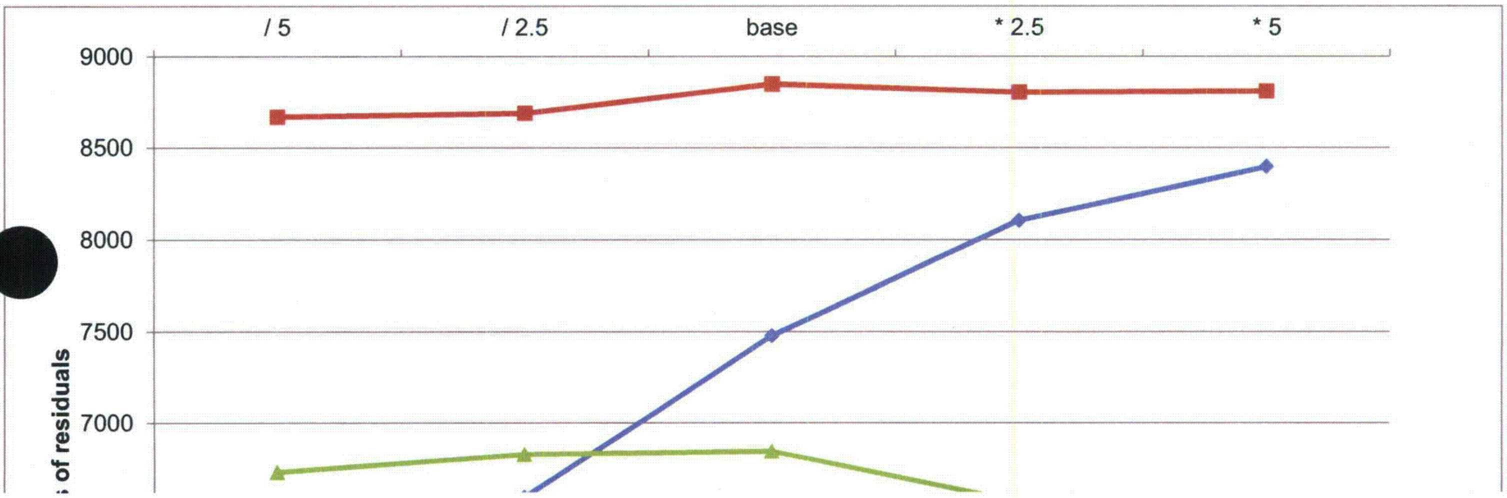


Figure 16B

Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone alluv_M1



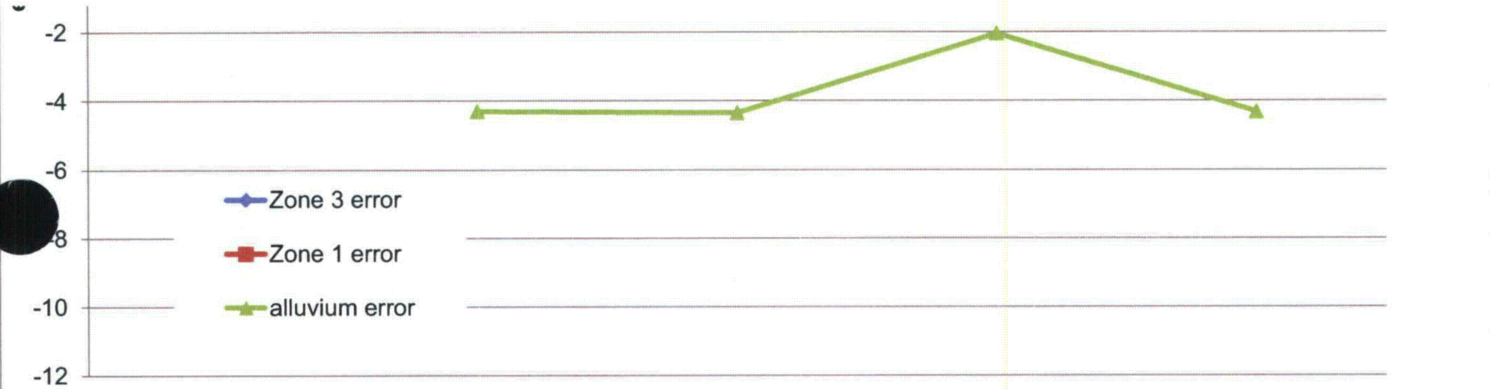


Figure 17A
Mean error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone alluv_M1

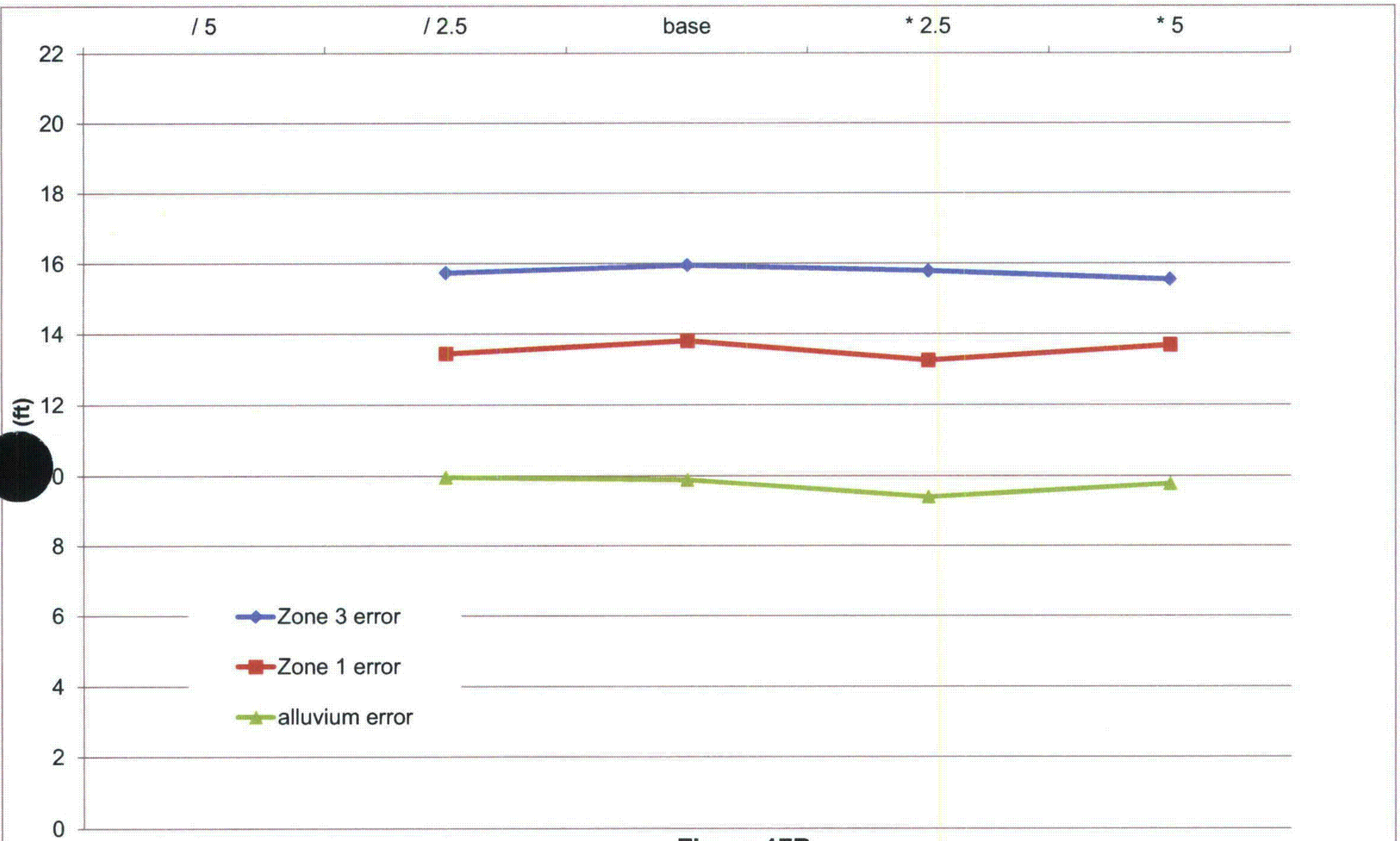
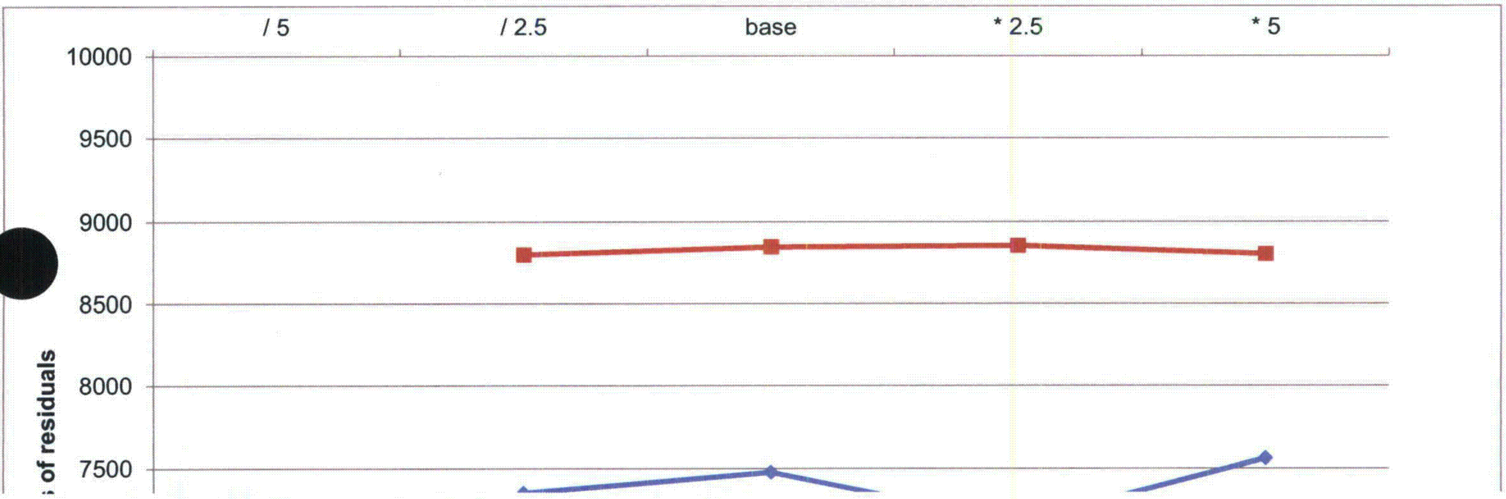


Figure 17B
Root mean squared error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone alluv_M1



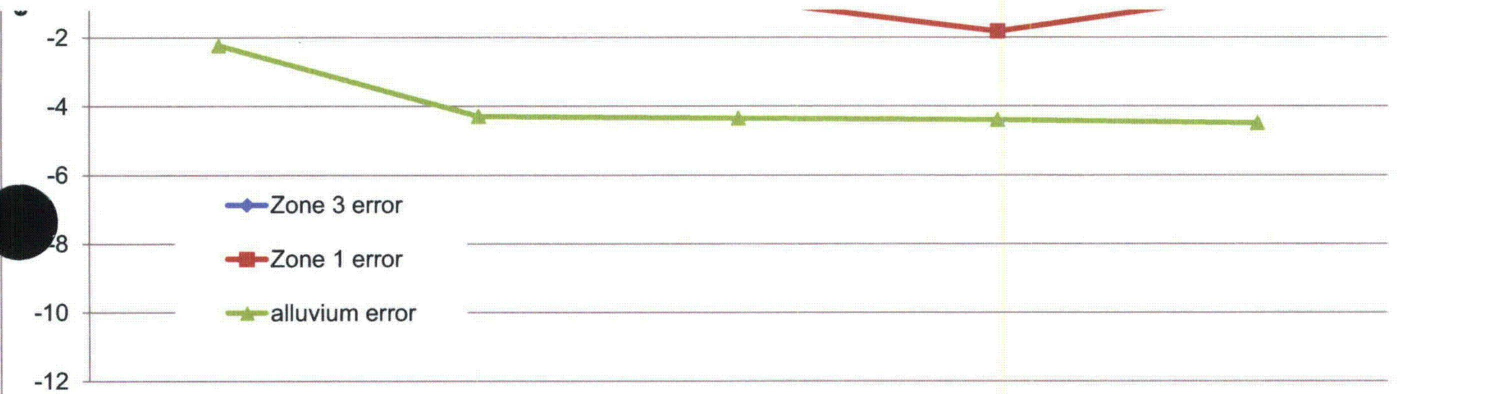


Figure 18A
Mean error statistics resulting from adjustments of hydraulic conductivity in property zone Dilco_M1

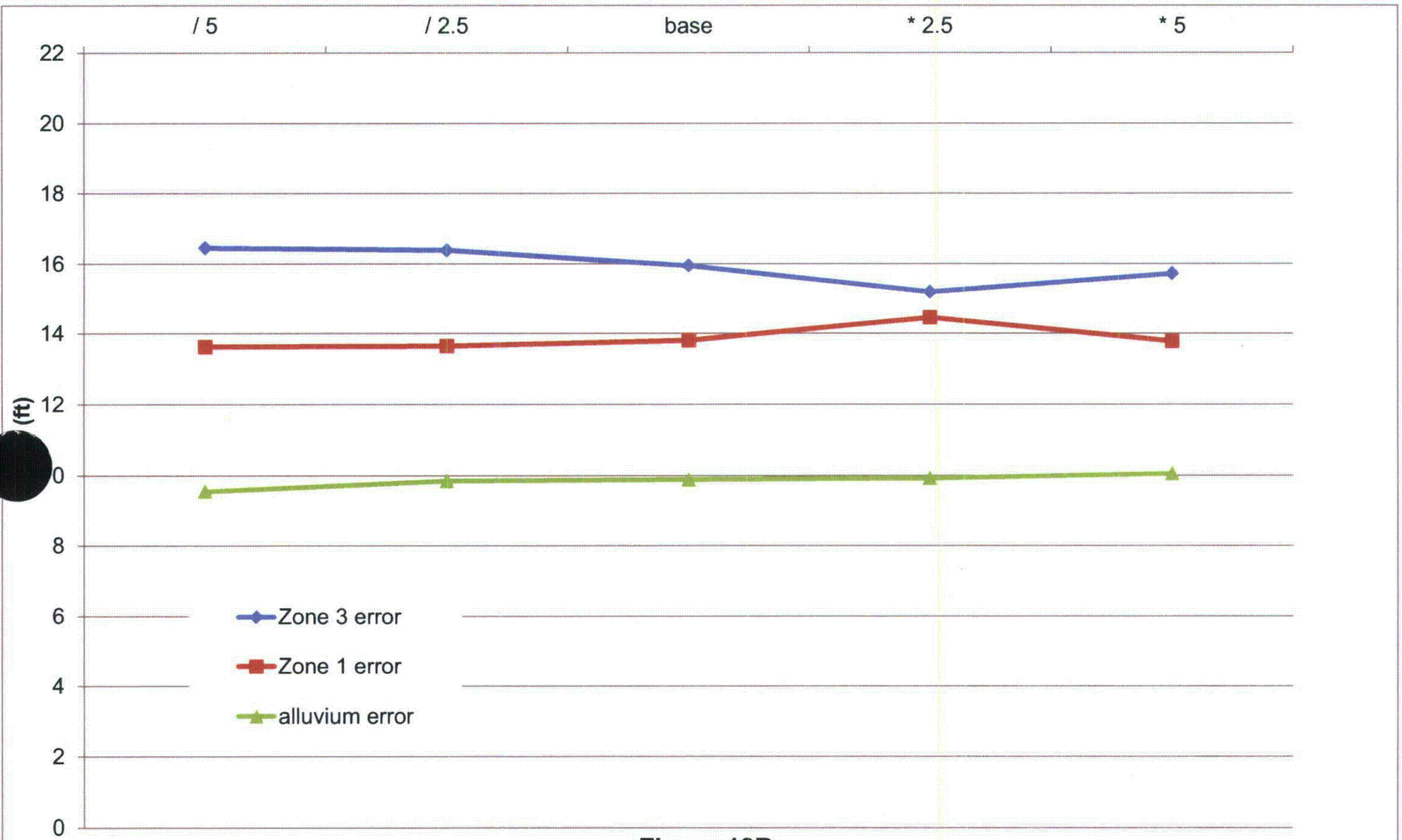


Figure 18B
Root mean squared error statistics resulting from adjustments of hydraulic conductivity in property zone Dilco_M1

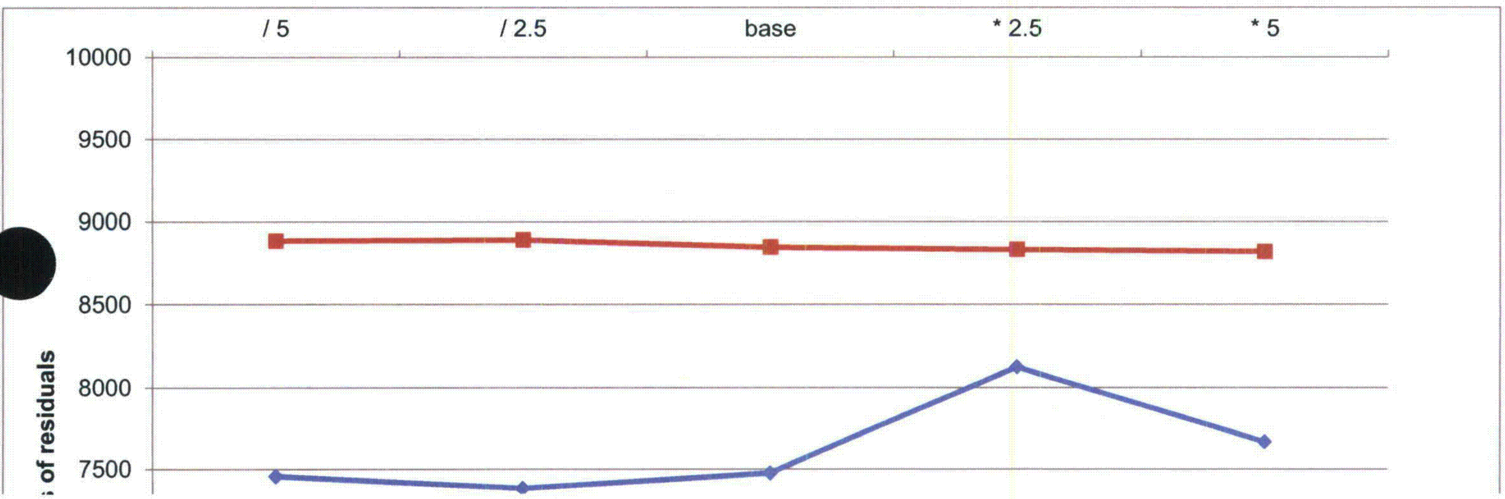


Figure 19A
Mean error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Dilco_M1

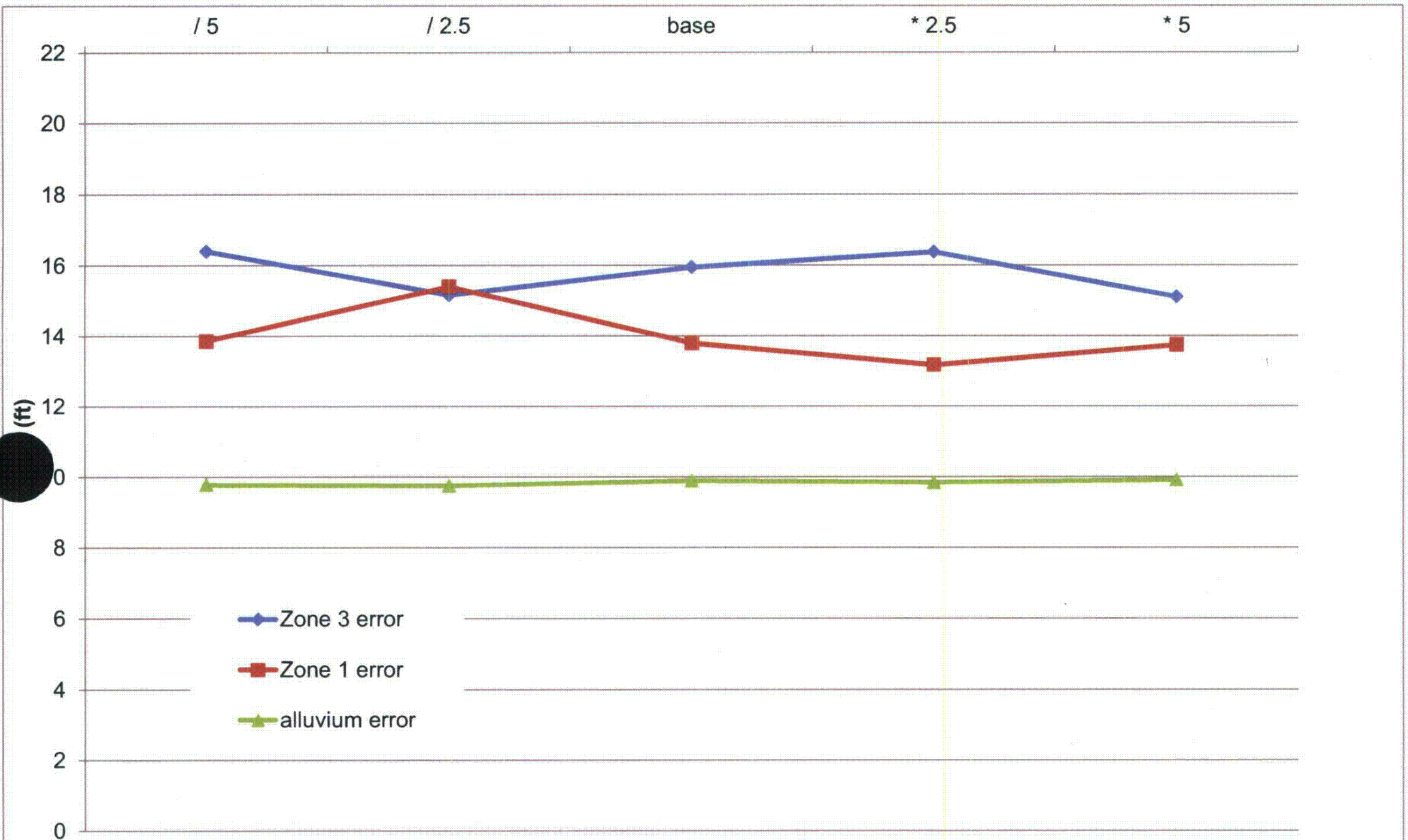
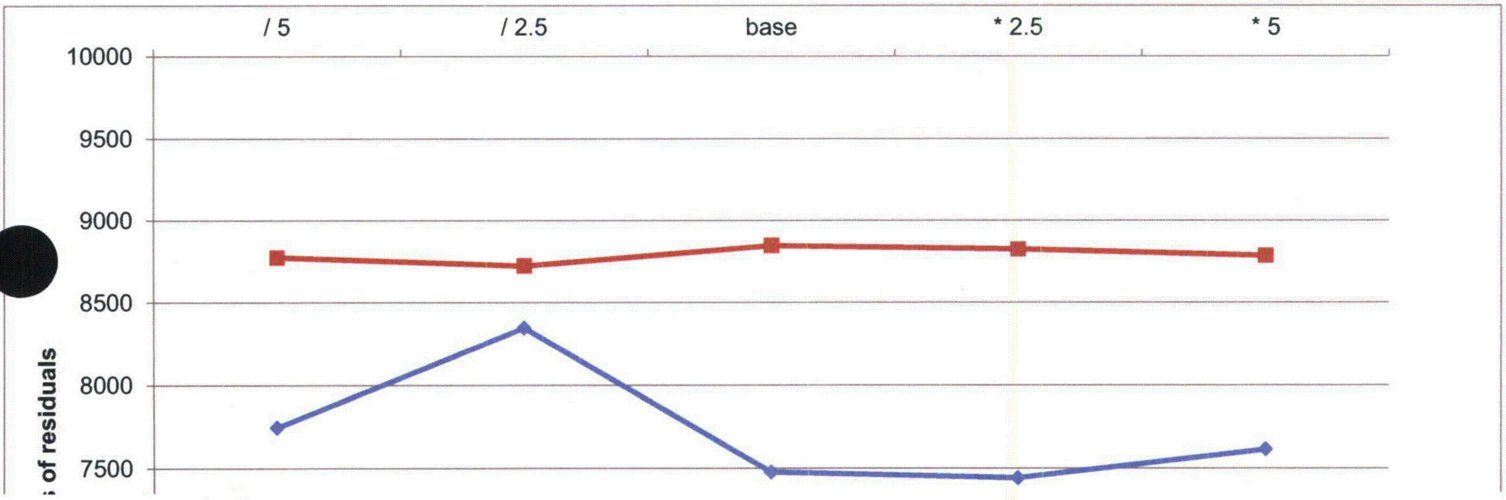


Figure 19B
Root mean squared error statistics resulting from adjustments of vertical conductivity anisotropy ratio in property zone Dilco_M1



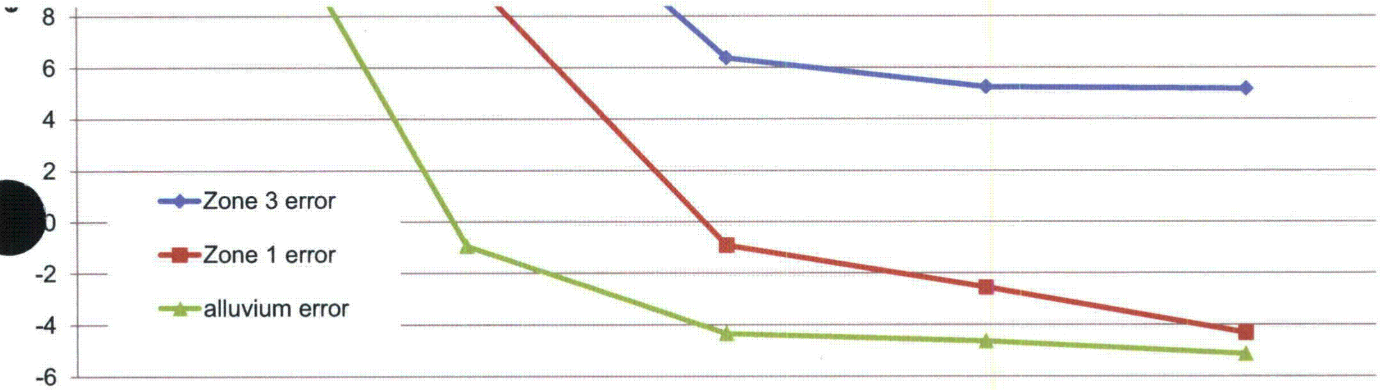


Figure 20A
Mean error statistics resulting from adjustments of bed conductances in river cells

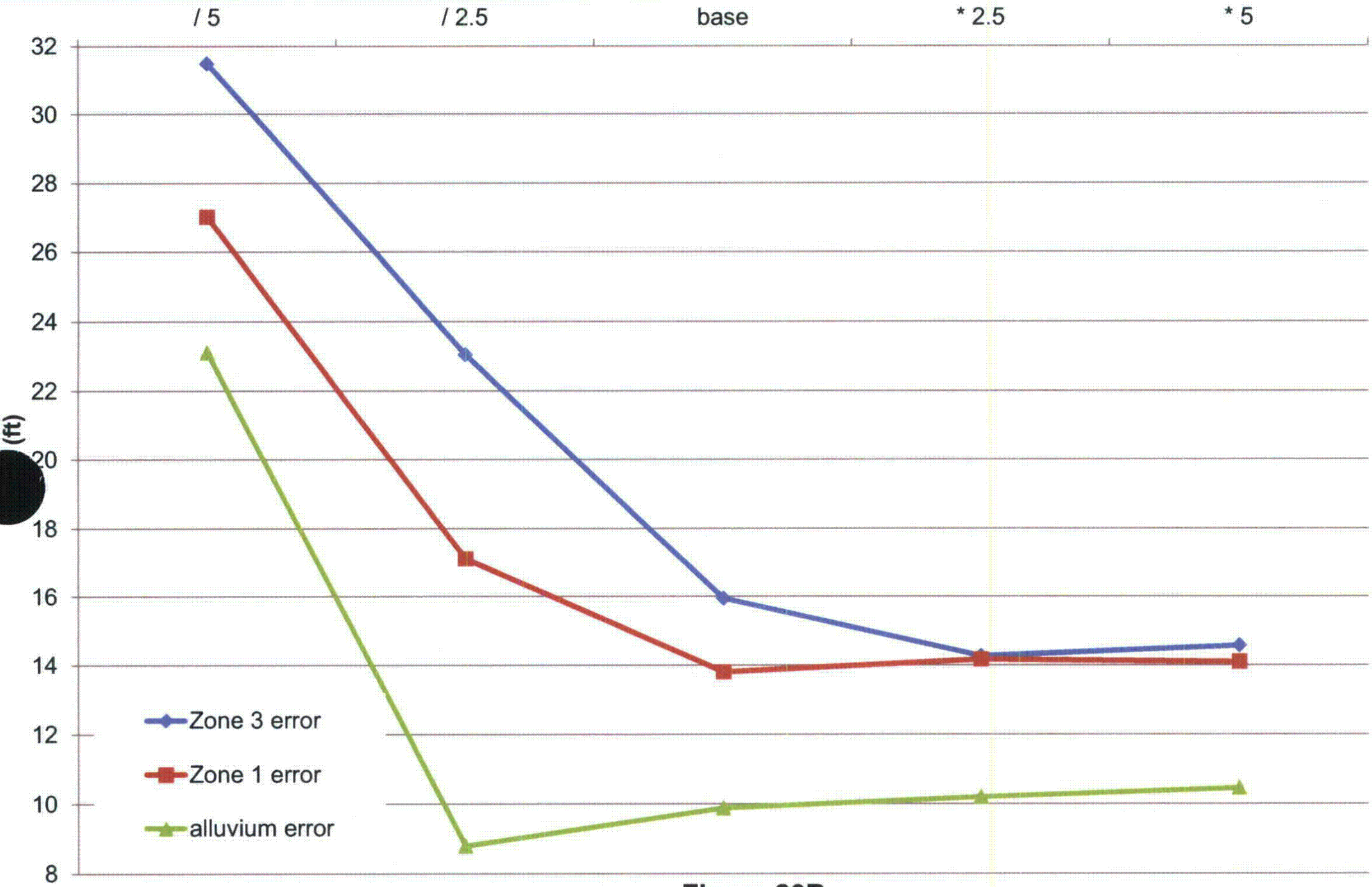
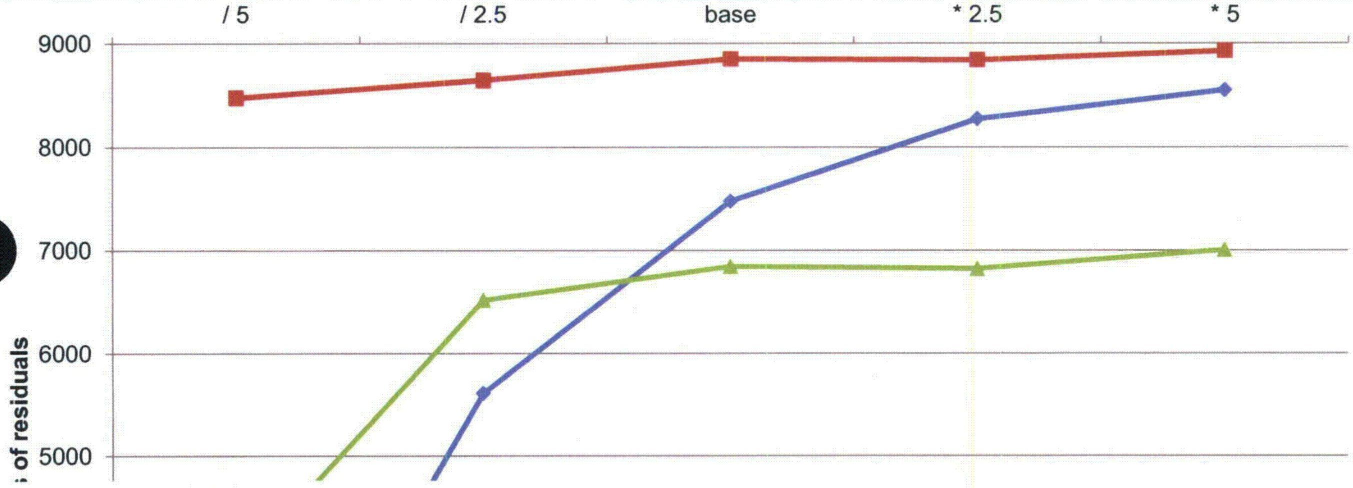


Figure 20B
Root mean squared error statistics resulting from adjustments of bed conductances in river cells



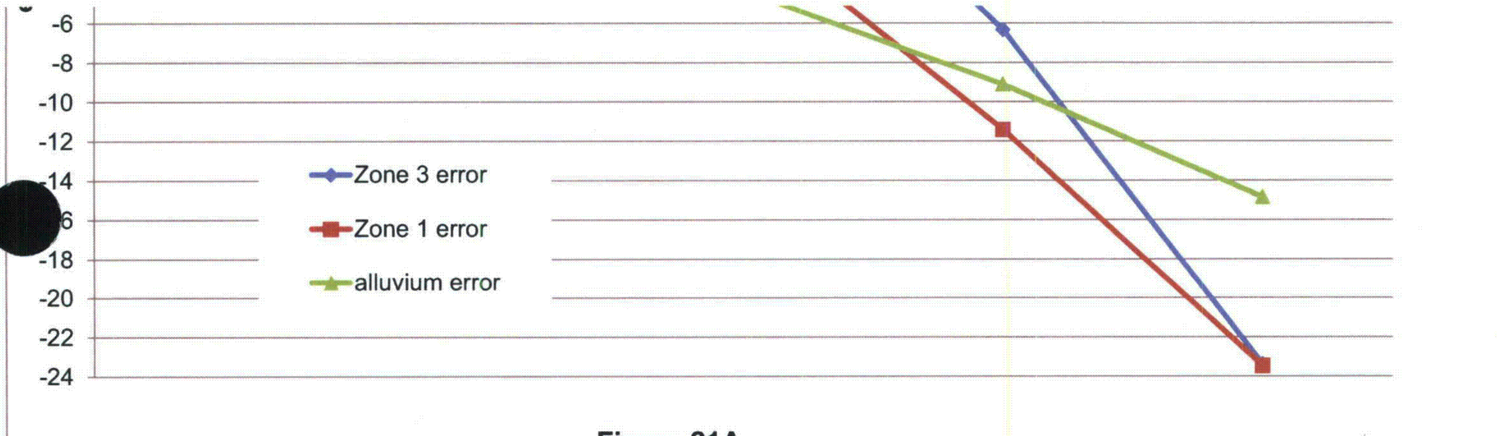


Figure 21A
Mean error statistics resulting from adjustments of fluxes in recharge cells

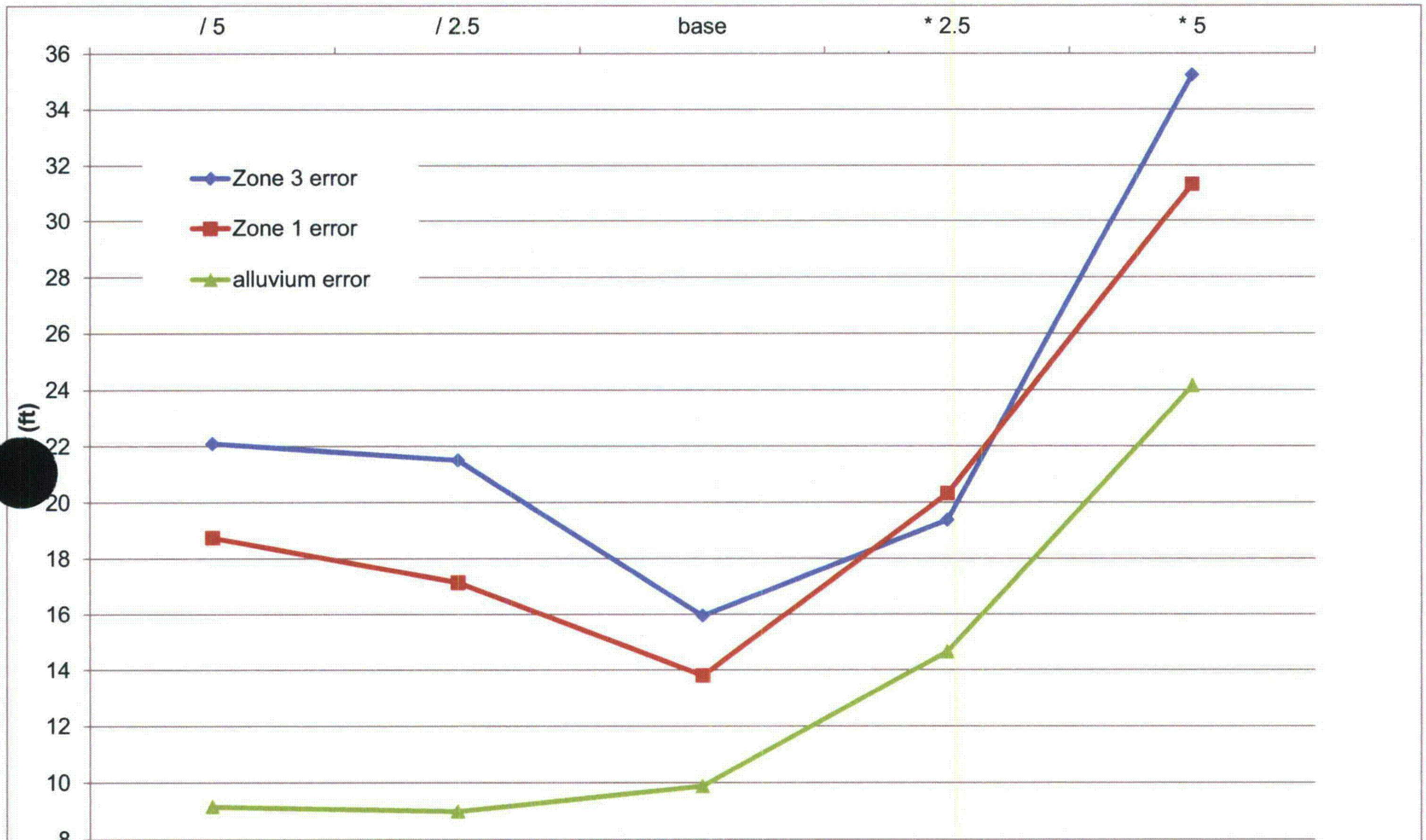
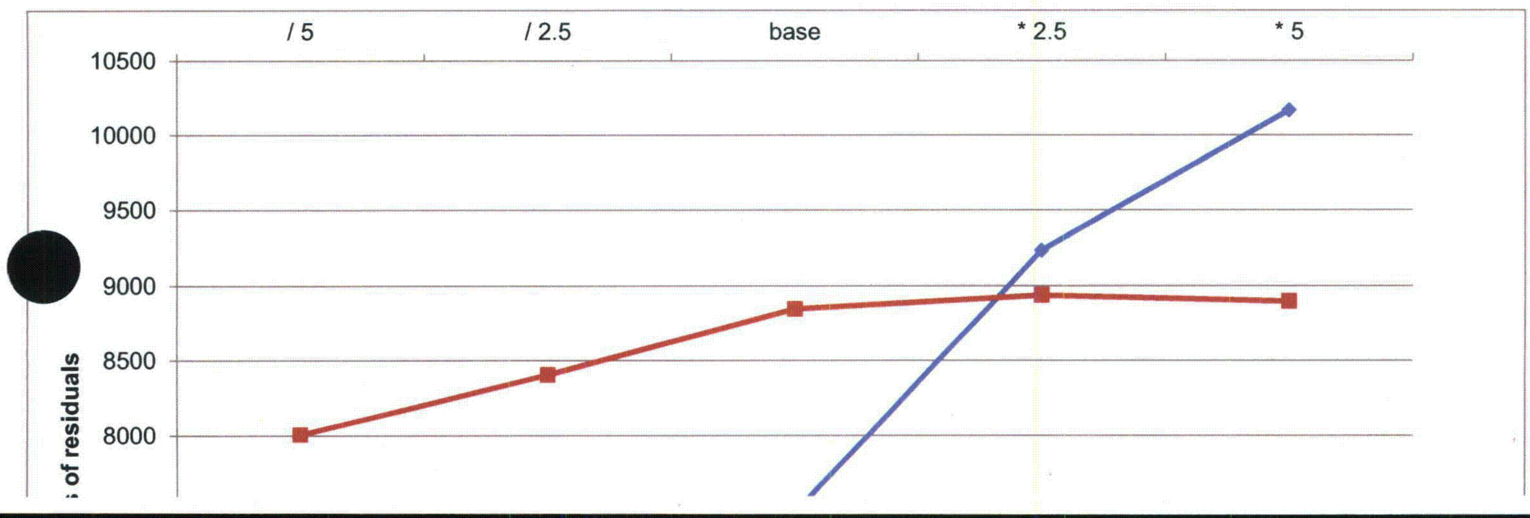


Figure 21B
Root mean squared error statistics resulting from adjustments of fluxes in recharge cells



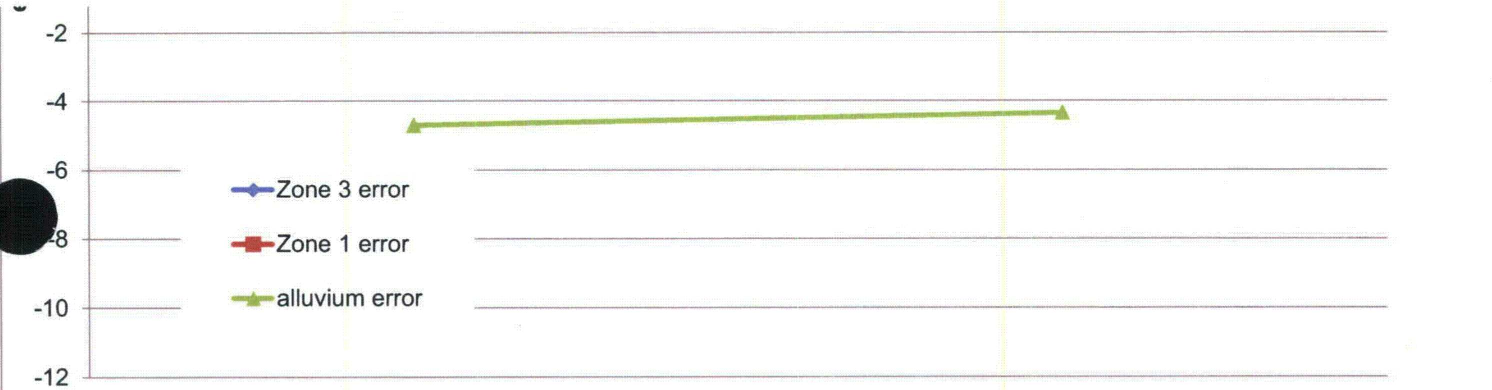


Figure 22A
Mean error statistics resulting from removal of property zones associated with Pipeline lineament

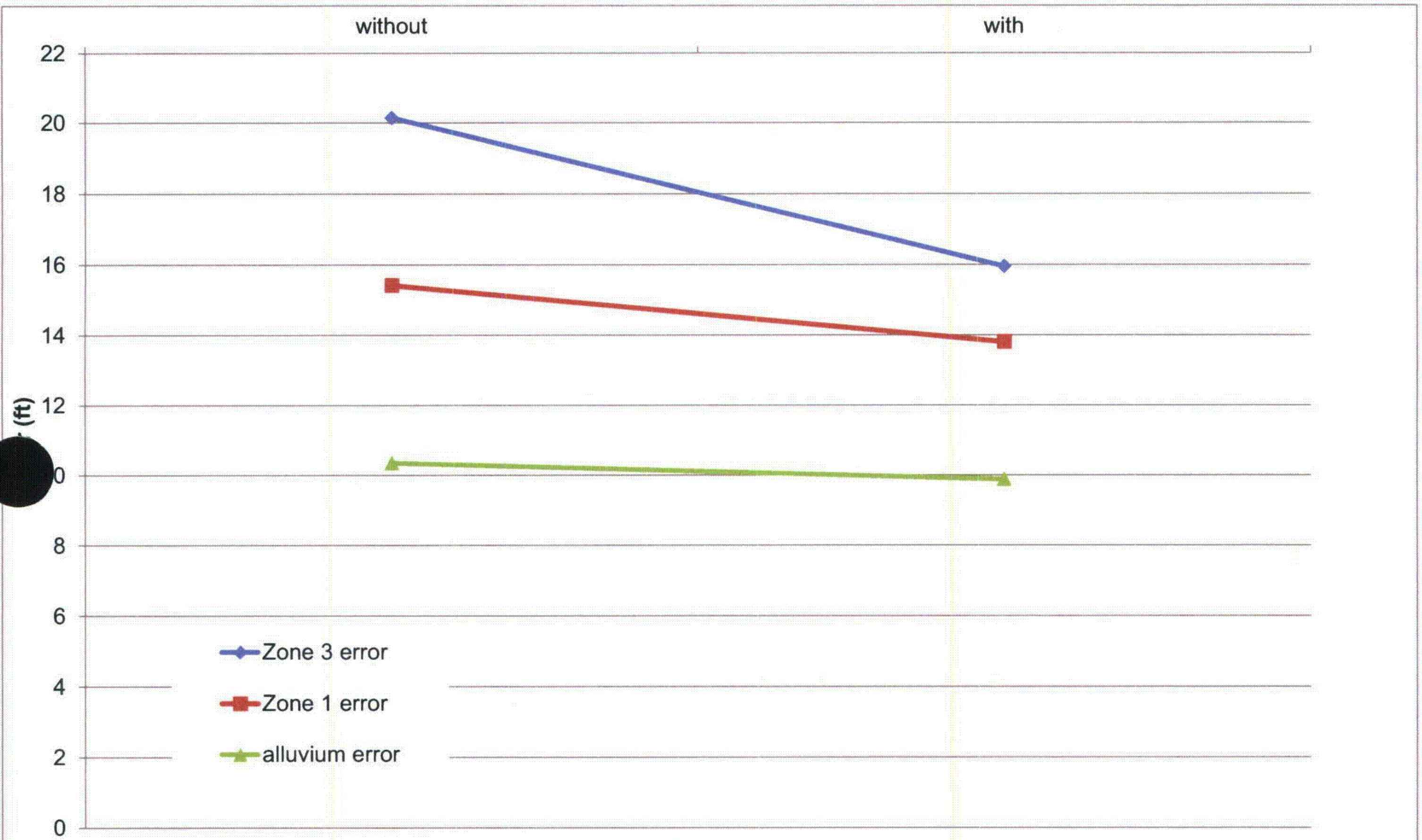


Figure 22B
Root mean squared error statistics resulting from removal of property zones associated with Pipeline lineament

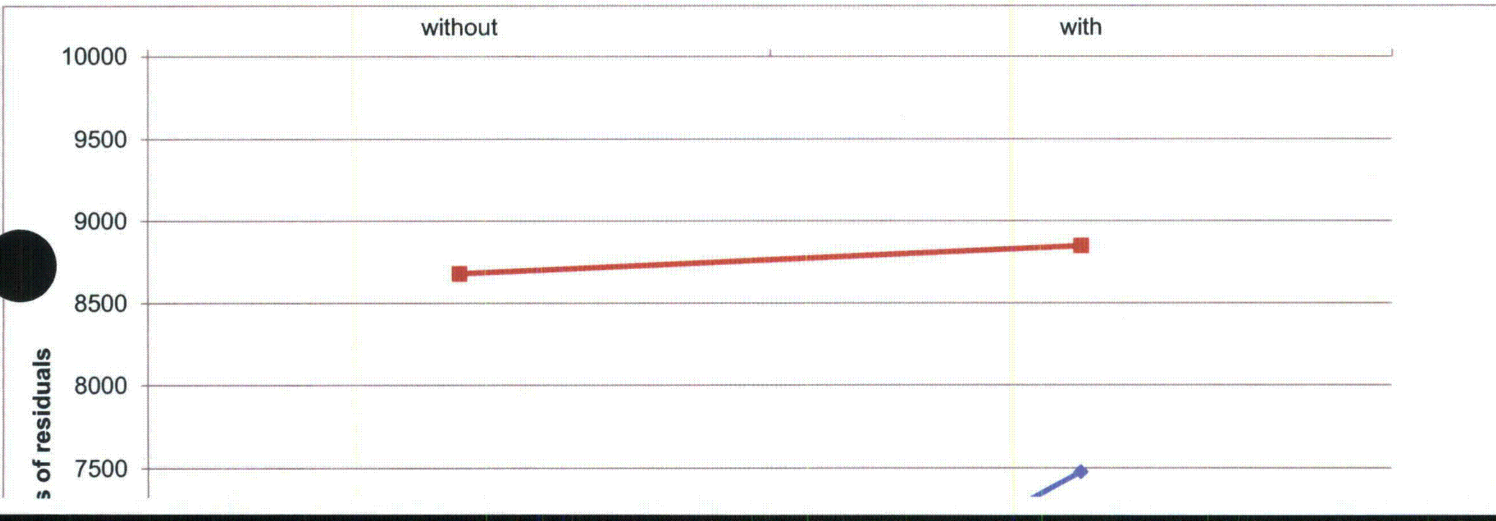


Figure 23A
Mean error statistics resulting from revision of Zone 1 base elevation

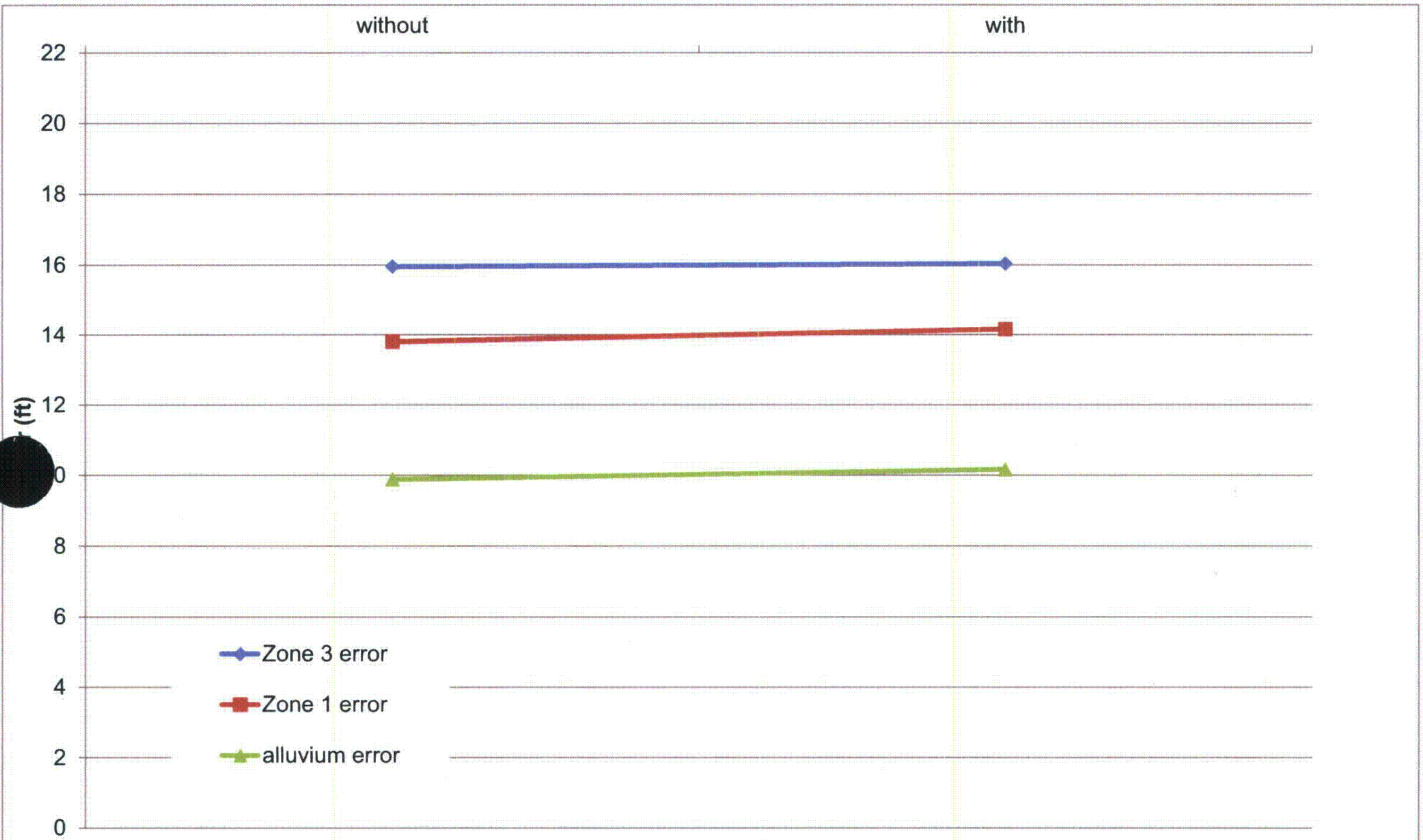


Figure 23B
Root mean squared error statistics resulting from revision of the Zone 1 base elevation

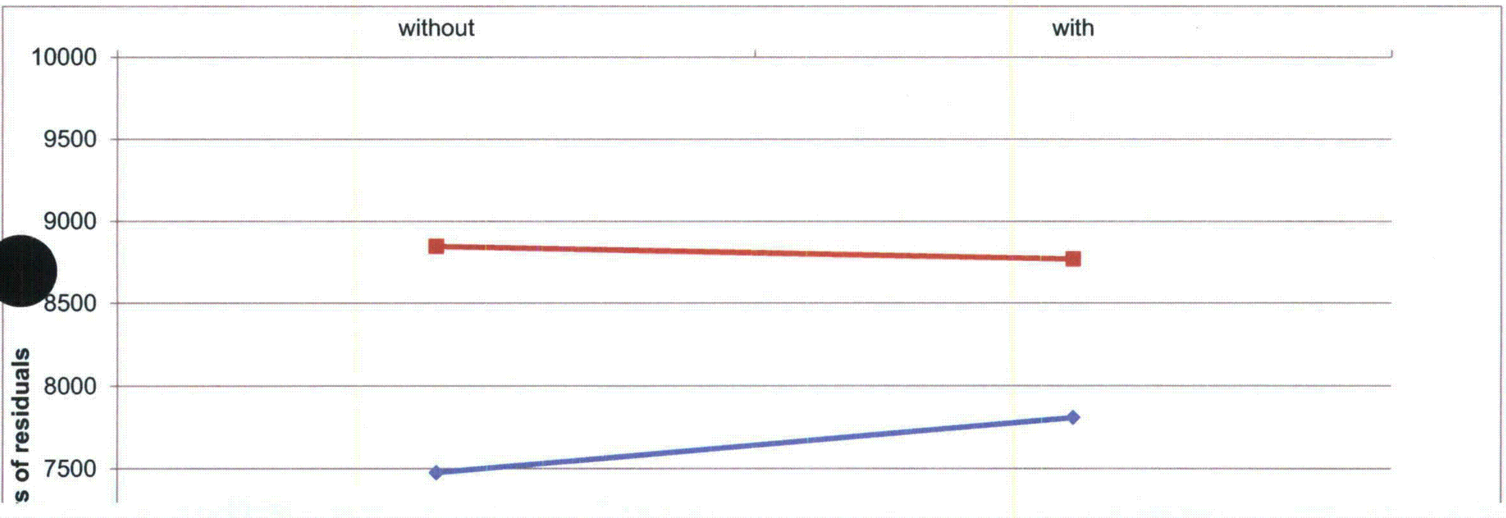
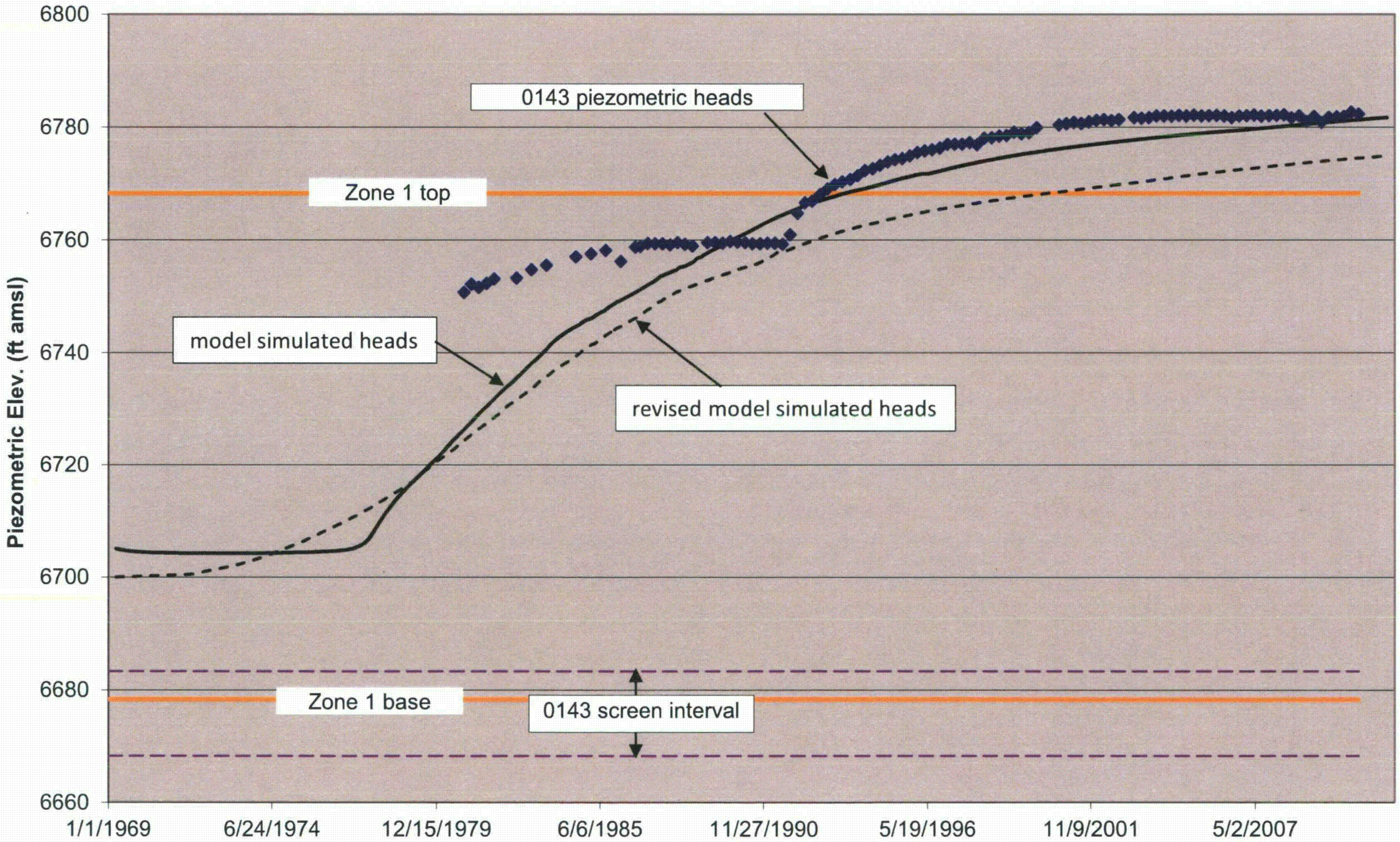
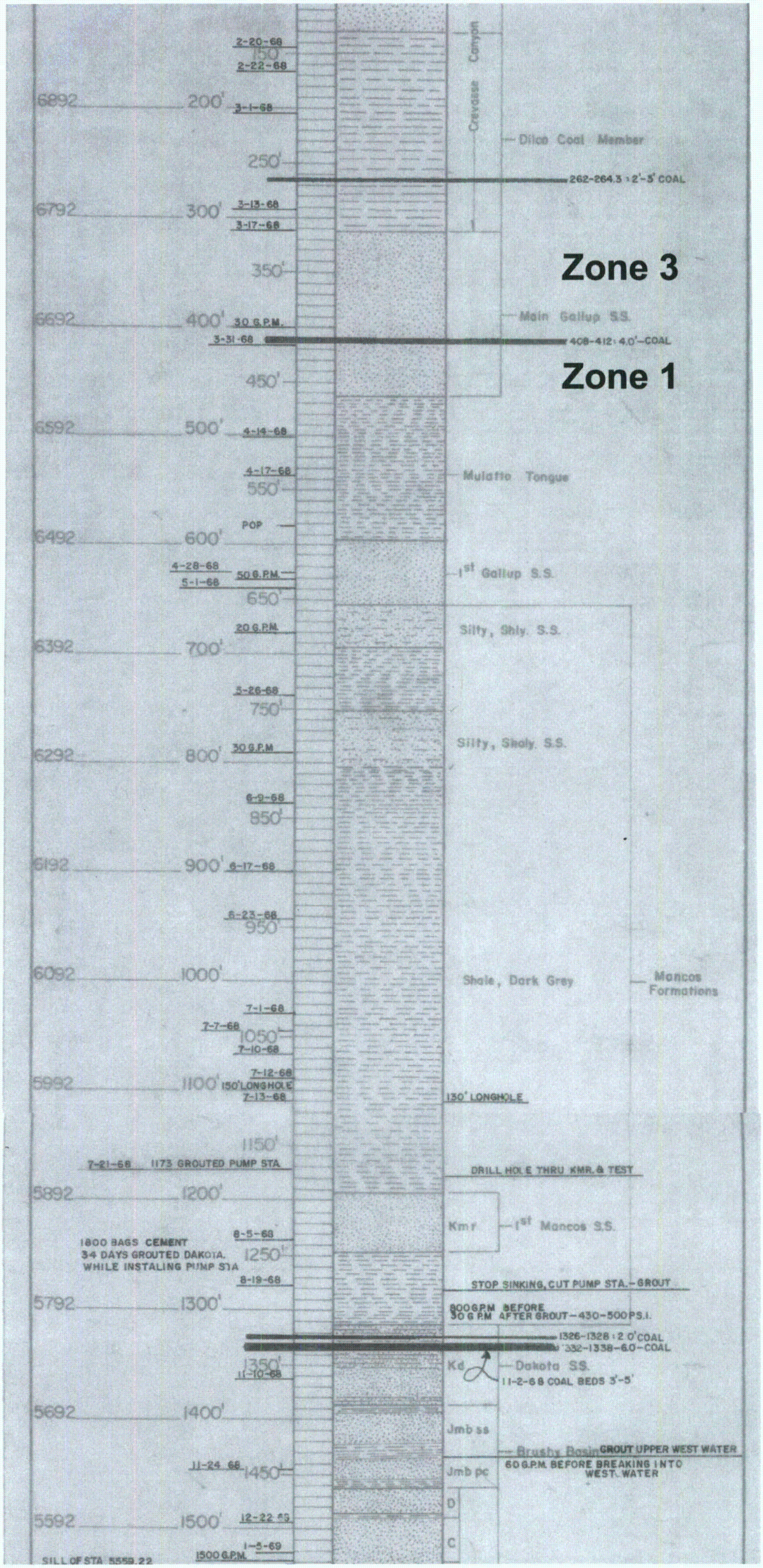


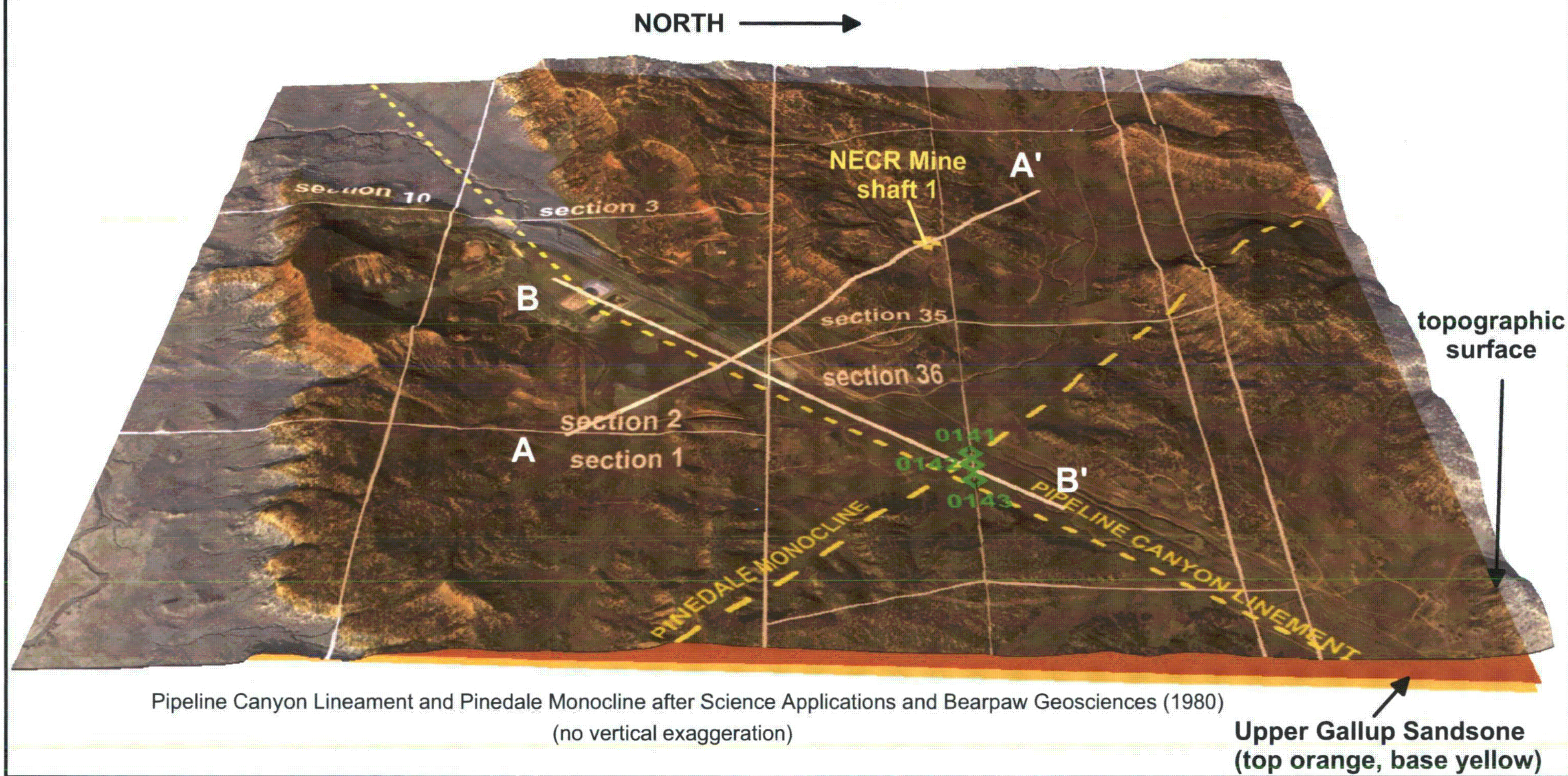
Figure 24
Comparison of Model-simulated and measured heads in Zone 1 Well 0143



REVISED GROUNDWATER MODELING REPORT FIGURES



Zone 3
Zone 1
2-20-68
2-22-68
6892
200'
3-1-68
Crevasse Canyon
Dilco Coal Member
250'
262-264.3 : 2'-3' COAL
6792
300'
3-13-68
3-17-68
350'
6692
400'
30 G.P.M.
Main Gallup S.S.
3-31-68
408-412 : 4.0'-COAL
450'
6592
500'
4-14-68
4-17-68
550'
Mulatto Tongue
POP
6492
600'
4-28-68
50 G.P.M.
5-1-68
1st Gallup S.S.
650'
20 G.P.M.
Silty, Shly. S.S.
6392
700'
5-26-68
750'
6292
800'
30 G.P.M.
Silty, Shaly S.S.
6-9-68
850'
6192
900'
6-17-68
6-23-68
950'
6092
1000'
Shale, Dark Grey
Mancos Formations
7-1-68
7-7-68
1050'
7-10-68
7-12-68
5992
1100'
150' LONGHOLE
7-13-68
130' LONGHOLE
1150'
7-21-68
1173 GROUTED PUMP STA.
DRILL HOLE THRU KMR. & TEST
5892
1200'
Kmr
1st Mancos S.S.
1800 BAGS CEMENT
34 DAYS GROUTED DAKOTA
WHILE INSTALING PUMP STA
8-5-68
1250'
8-19-68
STOP SINKING, CUT PUMP STA.-GROUT
5792
1300'
800 G.P.M. BEFORE
30 G.P.M. AFTER GROUT-430-500 P.S.I.
1326-1328 : 2.0' COAL
1332-1338-6.0-COAL
1350'
11-10-68
Kd
Dakota SS.
11-2-68 COAL BEDS 3'-5'
5692
1400'
Jmb ss
Brushy Basin
GROUT UPPER WEST WATER
11-24-68
1450'
Jmb pc
60 G.P.M. BEFORE BREAKING INTO WEST. WATER
D
5592
1500'
12-22-68
C
1-5-69
1500 G.P.M.
SILL OF STA. 5559.22



Pipeline Canyon Lineament and Pinedale Monocline after Science Applications and Bearpaw Geosciences (1980)

(no vertical exaggeration)

FIGURE 10

West-looking perspective view of topographic surface and north-dipping Upper Gallup Sandstone, showing locations of Pipeline Canyon Lineament, Pinedale Monocline, cross sections A-A', B-B' and associated features. Surface imagery (NAIP 2009 orthophoto) rendered semi-transparent to show underlying Upper Gallup Sandstone.

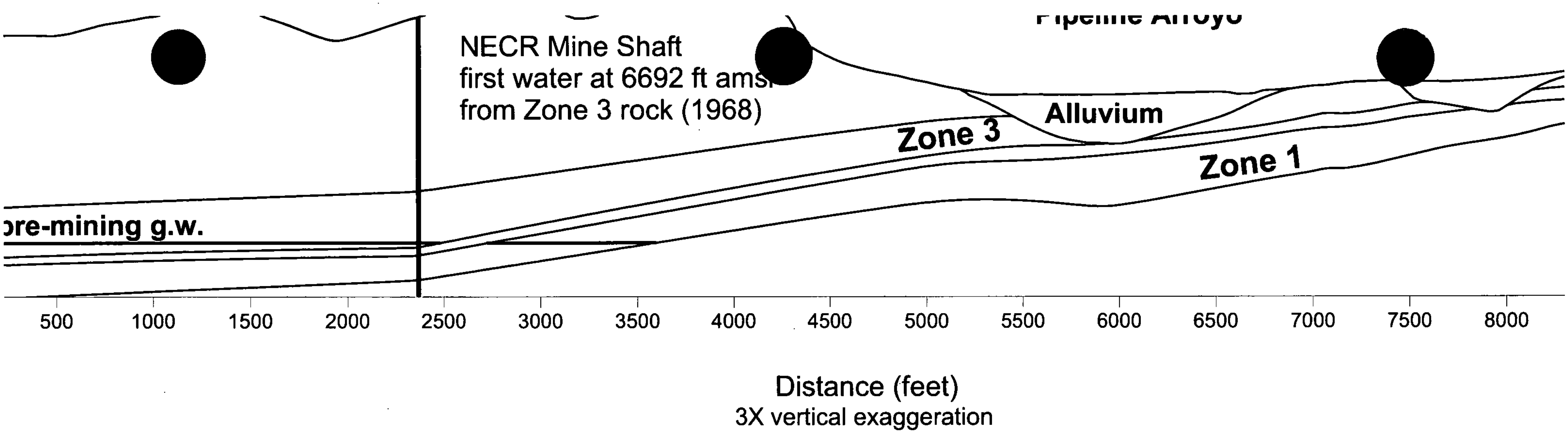


FIGURE 11A

Northeast-looking view of cross section A-A' (see Figure 10 for location)

Pre-mining water table shown in Zone 3 where encountered in NECR mine shaft in 1968 (at elevation 6692 ft amsl). Elevation of pre-mining water table shown in Zone 1 is interpreted by analogy, but is also consistent with sample data from Zone 1 monitoring wells.

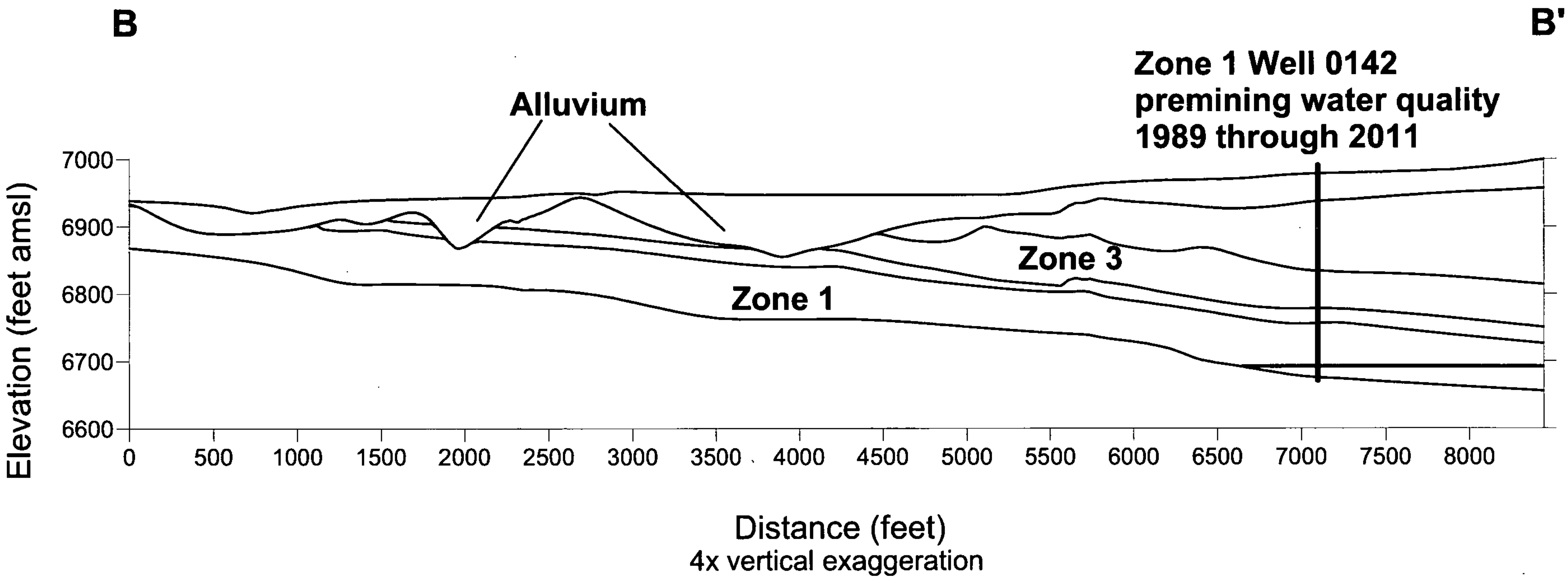


FIGURE 11B

Northwest-looking view of cross section B-B' (see Figure 10 for location)

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GEOCHEMISTRY OF GROUND WATER IN THE GALLUP, DAKOTA, AND MORRISON AQUIFERS, SAN JUAN BASIN, NEW MEXICO

By William L. Dam

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 94-4253

A Contribution of the Regional Aquifer-System Analysis Program

Albuquerque, New Mexico
1995

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, *Secretary*

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, *Director*

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U.S. Geological Survey
Water Resources Division
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Albuquerque, New Mexico 87110

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ILLUSTRATIONS

ILLUSTRATIONS--Concluded

TABLES

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY TERMS

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon (gal)	3.785	liter (L)
gallon per minute (gal/min)	0.06309	liter per second (L/s)

Temperature in degrees Celsius (°C) can be converted to temperature in degrees Fahrenheit (°F) by using the equation:

$$^{\circ}F = 1.8 \times {}^{\circ}C + 32$$

Sea level: In this report, sea level refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Al	Aluminum, in micrograms per liter
Ag	Silver, in micrograms per liter
Ar	Argon, in milligrams per liter
As	Arsenic, in micrograms per liter
B	Boron, in micrograms per liter
Ba	Barium, in micrograms per liter
Be	Beryllium, in micrograms per liter
Br^-	Bromide, in milligrams per liter
$\delta^{13}C$	Carbon-13/carbon-12 ratio, in per mil PDB (Peedee belemnite, Cretaceous Peedee Formation of South Carolina)
^{14}C	Carbon-14, in uncorrected percent modern carbon
$CaCO_3$	Calcium carbonate, in milligrams per liter
Ca^{2+}	Calcium, in milligrams per liter
Cd	Cadmium, in micrograms per liter
Cl^-	Chloride, in milligrams per liter
$^{36}Cl/10^{15}Cl$	Atomic ratio of ^{36}Cl atoms to 10^{15} atoms of Cl^{35} and Cl^{37}
Co	Cobalt, in micrograms per liter
CO_2	Carbon dioxide, in milligrams per liter
CO_3^{2-}	Carbonate, in milligrams per liter
Cr	Chromium, in micrograms per liter
Cu	Copper, in micrograms per liter
D	Deuterium
DO	Dissolved oxygen, in milligrams per liter
F^-	Fluoride, in milligrams per liter
Fe	Iron, in micrograms per liter
g	Gram
δD	Deuterium/hydrogen ratio, in per mil V-SMOW (Vienna-Standard Mean Ocean Water)
^3H	Tritium, in tritium units
HCO_3^-	Bicarbonate, in milligrams per liter
Hg	Mercury, in micrograms per liter
T	
HS^-	Bisulfide
I^-	Iodide, in milligrams per liter
K^+	Potassium, in milligrams per liter
Li	Lithium, in micrograms per liter
Mg^{2+}	Magnesium, in milligrams per liter
meq/L	Milliequivalents per liter
mg/L	Milligrams per liter
mmol/L	Millimoles per liter
Mn	Manganese, in micrograms per liter
Mo	Molybdenum, in micrograms per liter
N	Nitrogen, in milligrams per liter

Na^+	Sodium, in milligrams per liter
Ni	Nickel, in micrograms per liter
NO_3^-	Nitrate, in milligrams per liter
NO_2^-	Nitrite, in milligrams per liter
$\delta^{18}O$	Oxygen-18/oxygen-16 ratio, in per mil V-SMOW (Vienna-Standard Mean Ocean Water)
P	Phosphorus, in milligrams per liter
Pb	Lead, in micrograms per liter
pCi/L	Picocuries per liter
pCO_2	Partial pressure of carbon dioxide
pH	Negative log activity of hydrogen ion
PO_4	Phosphorous, in milligrams per liter
$\delta^{34}S$	Sulfur-34/sulfur-32 ratio, in per mil Canyon Diablo meteorite standard
SiO_2^0	Silica, in milligrams per liter
SO_4^{2-}	Sulfate, in milligrams per liter
Se	Selenium, in micrograms per liter
Sr^{2+}	Strontium, in micrograms per liter
µg/L	Micrograms per liter
µm	Micron
V	Vanadium, in micrograms per liter
Zn	Zinc, in micrograms per liter

GEOCHEMISTRY OF GROUND WATER IN THE GALLUP, DAKOTA, AND MORRISON AQUIFERS, SAN JUAN BASIN, NEW MEXICO

By William L. Dam

ABSTRACT

Ground water was sampled from wells completed in the Gallup, Dakota, and Morrison aquifers in the San Juan Basin, New Mexico, to examine controls on solute concentrations. Samples were collected from 38 wells primarily from the Morrison aquifer (25 wells) in the northwestern part of the basin. A series of samples was collected along ground-water flow paths; dissolved constituents varied horizontally and vertically.

The understanding of the flow system changed as a result of the geochemical analyses. The conceptual model of the flow system in the Morrison aquifer prior to the study reported here assumed the Westwater Canyon Member of the Morrison aquifer as the only significant regional aquifer; flow was assumed to be two dimensional; and vertical leakage was assumed to be negligible. The geochemical results indicate that the Westwater Canyon Member is not the only major water-yielding zone and that the flow system is three dimensional. The data presented in this report suggest an upward component of flow into the Morrison aquifer. The entire section above and below the Morrison aquifer appears to be controlled by a three-dimensional flow regime where saline brine leaks near the San Juan River discharge area.

Predominant ions in the Gallup aquifer were calcium bicarbonate in recharge areas and sodium sulfate in discharge areas. In the Dakota aquifer, predominant ions were sodium bicarbonate and sodium sulfate. Water in the Morrison aquifer was predominantly sodium bicarbonate in the recharge area, changing to sodium sulfate downgradient.

Chemical and radioisotopic data indicate that water from overlying and underlying units mixes with recharge water in the Morrison aquifer. Recharge water contained a large ratio of chlorine-36 to chlorine and a small ratio of bromide to chloride. Approximately 10 miles downgradient, samples from four wells completed in the Morrison aquifer were considerably different in composition compared to recharge samples. Oxygen stable isotopes decreased by 2.8 per mil and deuterium decreased 26 per mil, relative to recharge. Carbon-14 radioisotope activities were not detectable. Chloride-36 radioisotope ratios were small and bromide to chloride concentration ratios were large. These results suggest two potentially viable processes: ion filtration or trapping of ancient dilute water recharged under a humid climate. For water samples near the San Juan River, pH decreased to about 8.0, chloride concentrations increased to more than 100 milligrams per liter, and ratios of chlorine-36 to chlorine and bromide to chloride were small. Leakage of deep basin brine into the fresher water of the Morrison aquifer appears to control ion concentrations.

INTRODUCTION

In October 1984, the U.S. Geological Survey (USGS) began a regional assessment of the San Juan structural basin aquifer systems in New Mexico, Colorado, Arizona, and Utah as part of its national Regional Aquifer-System Analysis (RASA) program (Bennett, 1979).

The San Juan Basin is located in New Mexico, Colorado, Arizona, and Utah, covering an area of approximately 21,600 mi^2 (fig. 1). The basin, a structural depression in the eastern part of the Colorado Plateau, is approximately 140 mi wide by 200 mi long, and land-surface altitudes range from about 4,500 ft in the northwest to about 11,000 ft in the southeast.

The San Juan Basin is an arid region where development of energy and water resources is essential to the economy. Surface-water resources are fully allocated, so ground-water resources are vital to industries, municipalities, and ranchers.

Purpose and Scope

This report presents geochemical and isotopic data used in examining sources of solutes and hydrologic and chemical controls that affect the concentration and distribution of solutes in aquifers in the San Juan Basin. The Gallup, Dakota, and Morrison aquifers were chosen for detailed geochemical analysis because of available water wells having known completion data, ground-water modeling results, and mineralogical analyses. These aquifers are equivalent stratigraphically to the Gallup Sandstone, Dakota Sandstone, and Morrison Formation. These aquifers are used extensively as water supplies for industry, communities, and livestock.

The report examines in detail the geochemistry of the three aquifers. The scope is constrained primarily to the northwestern part of the basin due to limited areal distribution of wells completed in a single aquifer and disturbances to the natural ground-water system by mining and petroleum industries in other parts of the basin. The main focus of this report is on the Morrison aquifer from the communities of Sanostee to Shiprock. Data for the Gallup and Dakota aquifers are provided for purposes of comparison and examination of vertical changes in flow and water quality. Hydrologic and water-quality data for the underlying Entrada Sandstone also are evaluated for the effects that water from this unit may have had on the Morrison aquifer.

Previous Studies

The hydrogeology of the San Juan Basin was described comprehensively by Stone and others (1983). USGS Hydrologic Investigations Atlases (HA 720-A through 720-J) have been published for 10 major aquifers in the basin (Craigg and others, 1989, 1990; Kernodle and others, 1989, 1990; Dam and others, 1990a, b; Levings and others, 1990a, b; and Thorn and others, 1990a, b). Data are presented on maps and in tables to describe the geology, hydrology, and water quality for each aquifer.

The only previous study that examined the regional San Juan Basin ground-water geochemistry of Jurassic and Cretaceous aquifers was performed by Berry (1959). He collected physical and chemical data from water wells, producing oil or gas wells, and drill-stem tests.

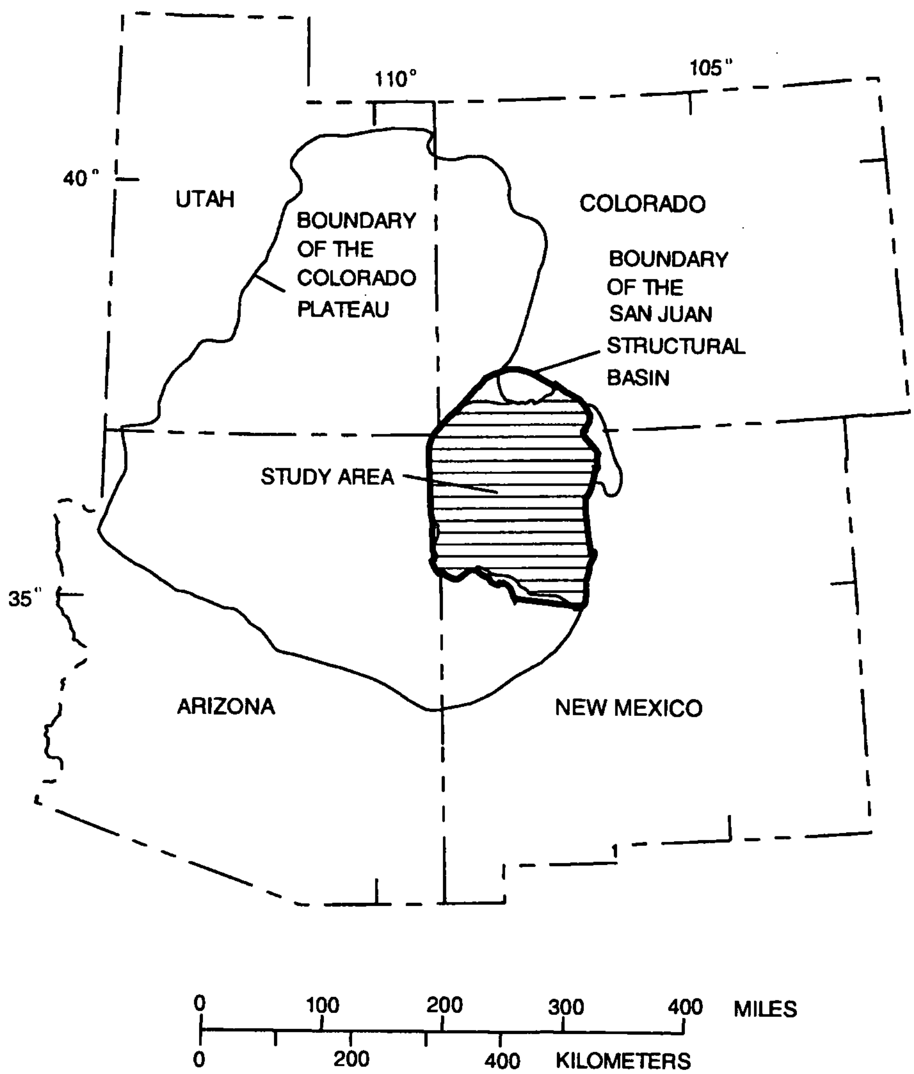


Figure 1.--Location of the San Juan structural basin, Colorado Plateau, and study area.

The direction of ground-water flow in Jurassic and Cretaceous aquifers, according to Berry (1959), was predominantly toward the lowest outcrop in the northwestern part of the basin. Normal hydrodynamic conditions existed along the flanks of the San Juan Basin. Conversely, in the central San Juan Basin, referred to by Berry as the "Inner Basin," hydraulic-pressure sinks and increased salinities were observed in all Cretaceous aquifers. Berry hypothesized that saline water containing dissolved-solids concentrations ranging from 30,000 to 270,000 parts per million entered the Entrada Sandstone from dissolved evaporite minerals such as halite contained in the overlying Todilto Limestone Member of the Wanakah Formation. The saline water in the Entrada Sandstone moved to the west and was trapped on the western side of the central basin due to the synclinal structures of the basin. Saline water in the Entrada Sandstone and freshwater in the Dakota aquifer were separated by the Brushy Basin Member of the Morrison Formation; this shale, acting as a semipermeable membrane, created an osmotic pressure system. Osmotic pressure, Berry proposed, caused the relatively dilute water from the Dakota aquifer to pass through the Brushy Basin Member. This caused a decrease in hydraulic pressure and left behind solutes that increased the salinity in the Dakota. The dilute water flowed into sandstones of the Morrison aquifer and Entrada Sandstone, increasing the hydraulic pressure and decreasing the dissolved-solids concentration. Similar osmotic-pressure phenomena for all Cretaceous sequences of sandstones and shales in this basin were observed (Berry, 1959).

Phillips and others (1986b) evaluated stable and radioactive isotopic data obtained from the Ojo Alamo and Nacimiento aquifers (in rocks of Paleocene age) in the central San Juan Basin. They found that waters collected from the two aquifers were of Pleistocene age and contained lighter oxygen and deuterium isotopes than modern precipitation and ground water. They proposed trends of decreased mean annual temperature and increased winter precipitation as factors affecting the stable-isotope contents.

Acknowledgments

The author acknowledges the people of the Navajo Nation who allowed and assisted in collection of water samples from their wells. Officials with ARCO Oil and Gas Company and El Paso Natural Gas Company also permitted access to wells, and Exxon Company, USA supplied well information. The Bureau of Land Management and the National Park Service provided access and information on selected wells. Information on oil and gas injection wells was obtained from the New Mexico Oil Conservation Division. Dr. Fred Phillips and Geoff Jones provided chlorine-36 results through a cooperative agreement with the New Mexico Institute of Mining and Technology. Several professors at the University of New Mexico provided assistance and technical advice in data collection and interpretation, including Drs. Laura Crossey, Douglas Brookins, and Crayton Yapp.

GEOLOGY AND HYDROLOGY

The San Juan Basin is a northwest-trending, asymmetric structural depression formed during the Laramide orogeny (Late Cretaceous-early Tertiary age) at the eastern edge of the Colorado Plateau (fig. 1). In many places, structural boundaries of the basin are well defined, whereas in other places, the basin merges gradually into adjacent depressions or uplifts (Kelley, 1951, p. 124-127). The structural boundaries consist principally of large, elongate, domal uplifts; low, marginal platforms; and abrupt monoclines as shown in figure 2. Faulting is common especially in the southeastern part of the basin. Maximum structural relief in the basin is about 10,000 ft. The Hogback Monocline, Nacimento Uplift, and Chaco Slope bound the central San Juan Basin.

The San Juan Basin contains a thick sequence of nearly horizontal beds of sedimentary rocks, ranging in age from Cambrian through Tertiary, but principally from Pennsylvanian through Tertiary (fig. 3). The maximum thickness of this sequence of rocks is about 14,000 ft at the trough-like structural center of the basin (Fassett and Hinds, 1971, p. 4). The sedimentary rocks, primarily sandstone and shale, dip from the basin margins toward the center of the basin. Volcanic rocks of Tertiary age and various deposits of Quaternary age also are present in the basin.

Ground-water flow directions for Jurassic and Cretaceous aquifers are shown in a generalized areal form in figure 2. Recharge occurs along outcrops in mountainous regions along the basin boundaries; ground water circulates toward major discharge areas in the northwestern, southwestern, and southeastern parts of the basin (Frenzel and Lyford, 1982, p. 7).

A diagrammatic hydrogeologic section showing major aquifers, confining layers, and direction of ground-water flow is shown in figure 4. Major aquifers include the rocks of Tertiary age, undivided; Kirtland Shale and Fruitland Formation; Pictured Cliffs Sandstone; Mesaverde Group, undivided; Gallup Sandstone; Dakota Sandstone; Morrison Formation; Entrada Sandstone; and San Andres Limestone and Glorieta Sandstone. Thick shale beds act as confining layers between the sandstone aquifers. Ground water generally flows from the recharge areas at the outcrops downdip through permeable zones. Vertical leakage between aquifers is known to occur; however, the magnitude is not known and leakage rates through intervening shale beds probably are small in most areas (Stone and others, 1983, p. 23). Large upward vertical leakage rates are thought to occur along the Hogback Monocline in the northwestern part of the basin and in the Puerco Fault Zone in the southeastern part of the basin (fig. 2) (Stone and others, 1983, p. 23).

The geology and hydrology of the Gallup, Dakota, and Morrison aquifers are described briefly, including the structure, stratigraphy, depositional environment, petrology, mineralogy, ground-water flow patterns, water levels, and hydraulic characteristics. Additional information can be found in Stone and others (1983); Craigg and others (1989); Kernodle and others (1989); and Dam and others (1990a).

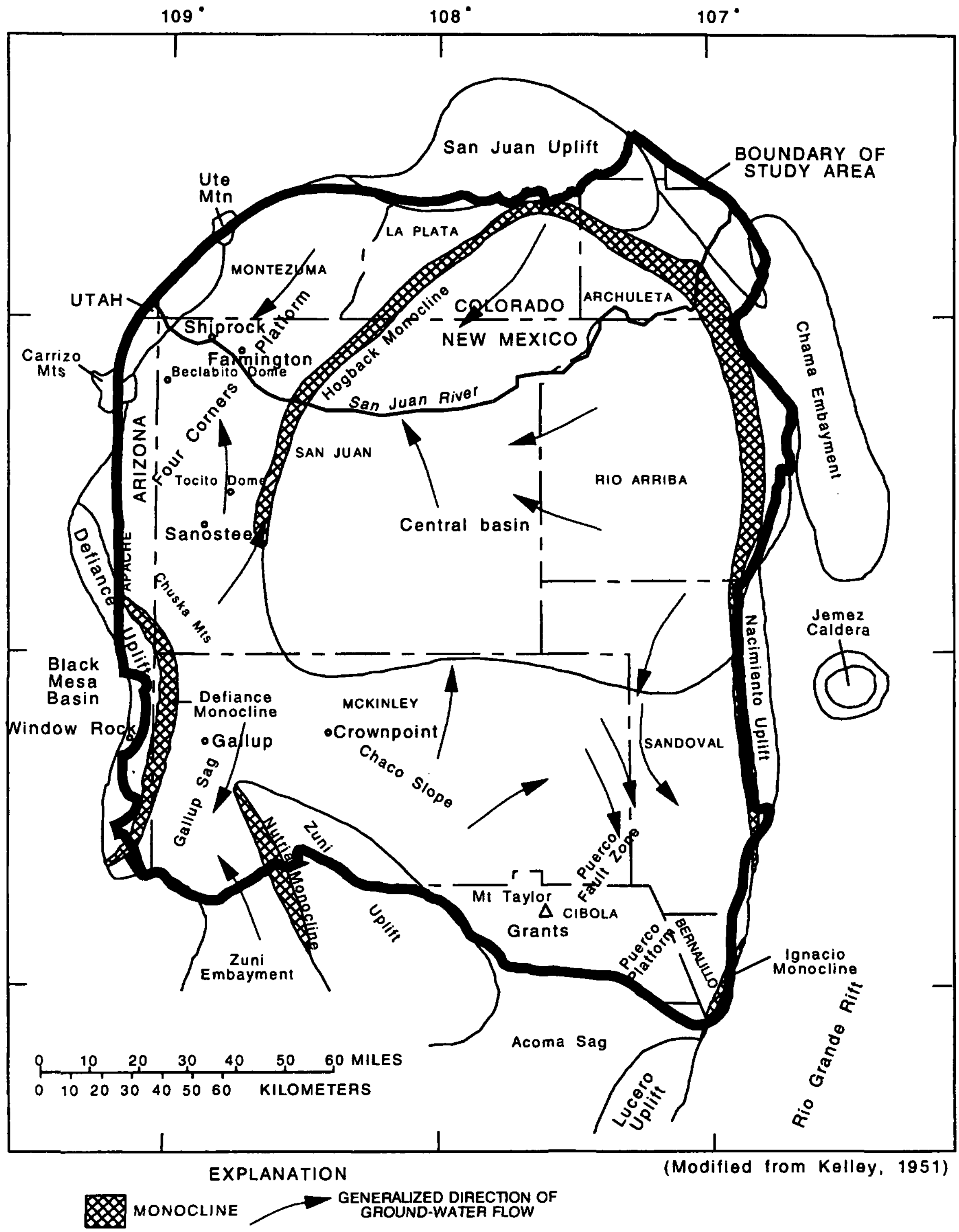
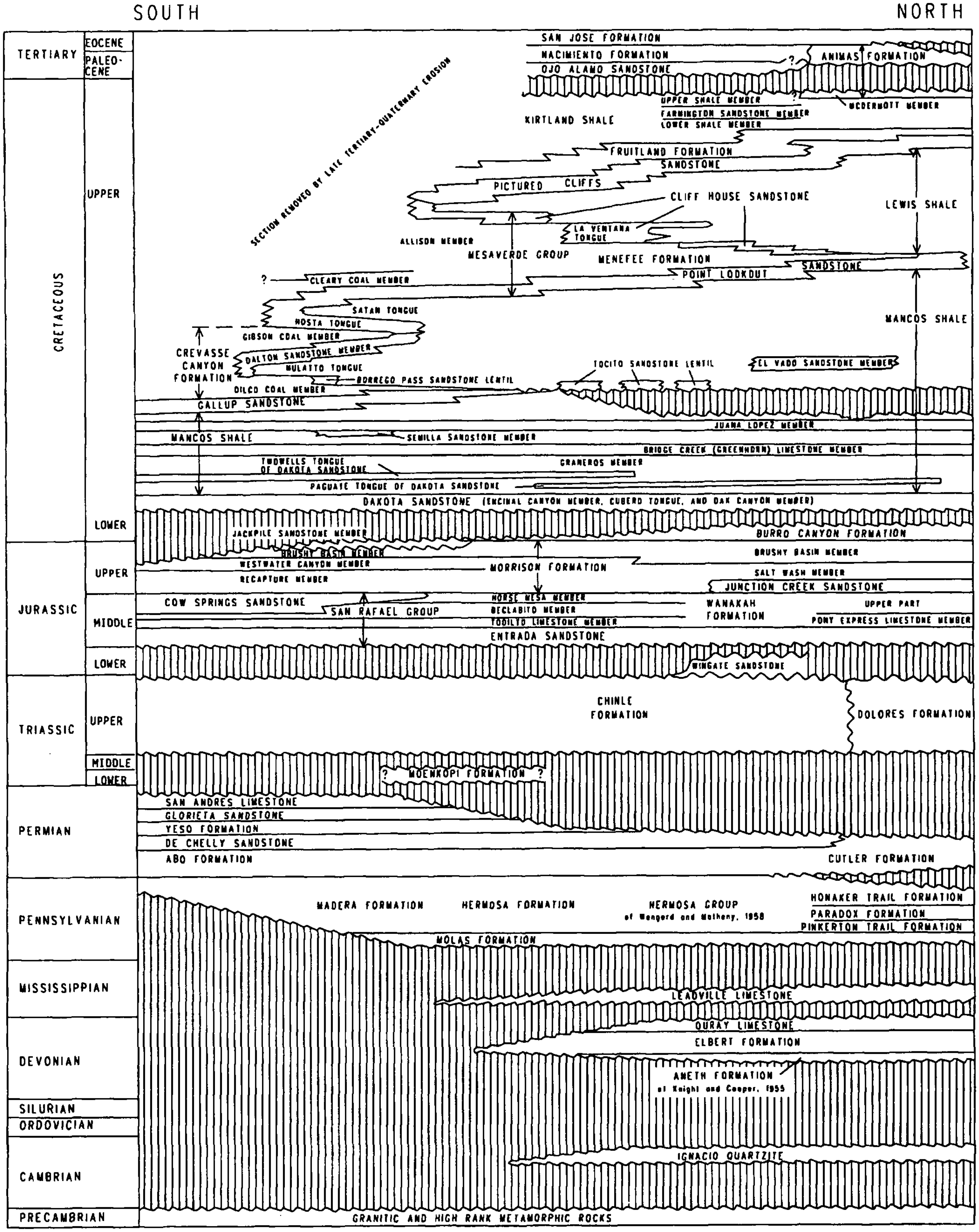


Figure 2.--Structural elements of the San Juan structural basin and adjacent areas and generalized pattern of ground-water flow in rocks of Jurassic and Cretaceous age.



(Modified from Molenaar, 1977a,b, and 1989)

Figure 3.--Time- and rock-stratigraphic framework and nomenclature. Ruled lines indicate a hiatus in the sequence of beds.

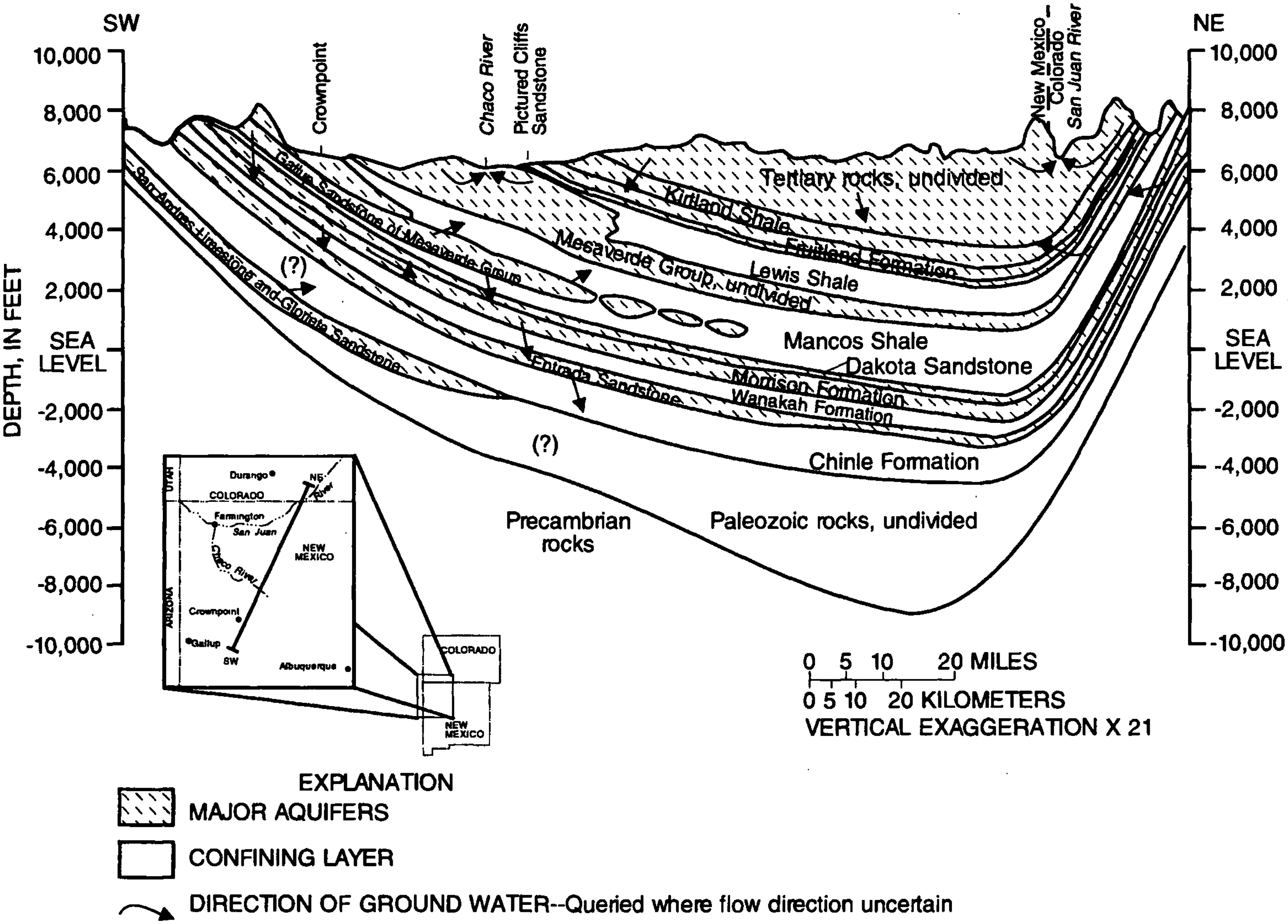


Figure 4.--Diagrammatic hydrogeologic section of the San Juan Basin (modified from Stone and others, 1983).

Gallup Aquifer

The Gallup aquifer is a hydrogeologic unit corresponding to the Gallup Sandstone. The Gallup Sandstone is of Late Cretaceous age (Molenaar, 1973, 1974). The unit has a smaller areal extent than the other major Upper Cretaceous sandstones in the San Juan structural basin and occurs only in New Mexico and a small part of Arizona. The Gallup crops out in an arcuate pattern around the western and southern margin of the basin where it typically forms erosion-resistant cliffs and dip slopes. Thickness of the Gallup decreases from about 600 ft near the outcrops along the margin of the basin to zero along the northwest-trending pre-Niobrara erosion limit. Depth to the top of the Gallup Sandstone ranges from zero in areas of outcrop to about 4,500 ft in an area about 20 mi south of the town of Farmington (Kernodle and others, 1989). The altitude of the top of the Gallup decreases from a maximum of about 7,500 ft northeast of Window Rock, Arizona, to about 1,500 ft above sea level southwest of Farmington. The Gallup represents the first major regression of the Upper Cretaceous sea in the San Juan structural basin and also represents deposition in marine and nonmarine environments. As originally defined by Sears (1925) and discussed in detail by Dane and others (1957), the Gallup consists of various rocks including sandstone (the predominant rock type), conglomerate, shale, carbonaceous shale, and coal. Minerals found in the Gallup include quartz (70-90 percent), feldspar (5-25 percent), glauconite, chlorite, sericite, chert, zircon, tourmaline, hematite, limonite, magnetite, ilmenite, dolomite, and ankerite (Kaharoeddin, 1971).

The Gallup aquifer is a source of water for domestic, livestock, municipal, and industrial uses. Recharge to the aquifer is from infiltration of precipitation and streamflow on outcrops and from vertical leakage of water through confining beds. Areas of recharge are in the southwestern and northeastern parts of the basin. Ground-water flow from these areas moves generally toward the central part of the basin and to the west, northwest, and southeast parts (fig. 2). However, the remaining body of the Gallup aquifer is cut off in a northwest-southeast pattern such that flow of water is not continuous throughout the entire basin (fig. 3). The Gallup aquifer occurs under both water-table and artesian conditions. Water wells generally are near the western and southern margins of the basin and primarily in McKinley County; flowing wells are mostly in the northern part of the county. The reported or measured discharge from 32 water wells completed in the Gallup aquifer ranges from 1 to 645 gal/min and the median is 30 gal/min (Kernodle and others, 1989). Water levels significantly below land surface were found in the Grants mineral belt near Crownpoint and near Gallup, New Mexico, and Window Rock, Arizona.

Dakota Aquifer

The Dakota aquifer is a hydrogeologic unit corresponding to the Dakota Sandstone. The Dakota Sandstone generally is thought to be of earliest Late Cretaceous age, although the lowermost part may be of latest Early Cretaceous age (Fassett, 1977, p. 225). The Dakota crops out around the basin margins where it typically caps mesas and forms erosion-resistant dip slopes and hogbacks. The Dakota Sandstone unconformably overlies the Morrison Formation (Late Jurassic age) throughout much of the basin; however, it unconformably overlies the Burro Canyon Formation (Early Cretaceous age) in the northern part of the basin (fig. 3). The upper contact of the Dakota is conformable with the Mancos Shale, and intertonguing of these two units is common near the contact. Stratigraphy of the Dakota is complex. The unit consists of a main sandstone body in the north, which branches into various members and tongues depending on location in the San Juan Basin. Thickness of the Dakota generally ranges from a few tens of feet to about 500 ft; Stone and others (1983, p. 37) reported that a range of 200 to 300 ft probably is common. Data reported by Molenaar (1977b, p. 160-161) and Stone and others (1983, fig. 66) and data obtained from Petroleum Information Corporation, Denver, Colorado, indicate that the thickness of the Dakota generally increases from the western, northwestern, and northern margins of the basin toward the eastern, southeastern, and southern margins. Depth to the Dakota ranges from zero in areas of outcrop to about 8,500 ft in the northeastern part of the basin. The top of the Dakota decreases from a maximum altitude of about 9,500 ft along the northern basin margin to about 1,500 ft below sea level in the northeastern part of the study area (Craigg and others, 1989).

The Dakota was deposited on an erosional surface in this region; the strata represent a transition from nonmarine alluvial-plain deposition in the lower part of the aquifer to marine shorezone deposition in the upper part. Marine and nonmarine depositional environments were interpreted by Walters and others (1987); the primary depositional area for nonmarine rocks was along the west side of the present basin. The Dakota contains three principal lithologies in different parts of the basin. It typically consists of a sequence of buff to brown, crossbedded, poorly sorted, coarse-grained conglomeratic sandstone and moderately sorted, medium-grained sandstone in the lower part; dark-gray carbonaceous shale with brown siltstone and lenticular sandstone beds in the middle part; and yellowish-tan, fine-grained sandstone interbedded with gray shale in the upper part (Owen, 1973, p. 39-48; Merrick, 1980, p. 45-47). Mineralogy, in mean percentage, as determined by Walters and others (1987, p. 269), for the marine (first number) and nonmarine (second number) deposits consists of the following: quartz (28 percent, 26 percent), illite (22 percent, 32 percent), kaolinite (16 percent, 22 percent), calcite (8.3 percent, 0.87 percent), dolomite (7.3 percent, 0.42 percent), mixed clay (5.7 percent, 9.8 percent), smectite (4.4 percent, 2.9 percent), potassium feldspar (4.2 percent, 4.7 percent), chlorite (2.7 percent, 0.29 percent), and plagioclase (2.4 percent, 1.3 percent).

The Dakota aquifer is a source of water for domestic, livestock, and industrial uses, and water wells generally are near the margins of the basin. Water in the Dakota aquifer occurs under both water-table and artesian conditions. Recharge to the aquifer is from infiltration of precipitation and streamflow on outcrops and from vertical leakage of water through confining beds. Within the basin, areas of stress from ground-water development in the Dakota aquifer are localized. These areas may represent oil or gas production, injection for disposal of brine, secondary recovery or repressurization of producing zones, or uranium-mine dewatering of the underlying Morrison aquifer that induces downward flow in the Dakota. The reported or measured discharge from 29 water wells completed in the Dakota aquifer ranged from 1 to 200 gal/min and the median is 13 gal/min (Craigg and others, 1989). Water levels in numerous wells were several hundred feet below land surface. Only one well, in the northwestern part of the basin, was flowing.

Morrison Aquifer

The Morrison aquifer is a hydrogeologic unit corresponding to the Morrison Formation. The Morrison Formation is of Late Jurassic age (Cadigan, 1967, p. 6) and crops out around the basin margins. Major sandstones in the Morrison typically form erosion-resistant cliffs and dip slopes, whereas shale units form topographic saddles. The Morrison is present throughout the San Juan Basin (Green and Pierson, 1977, p. 151) and conformably overlies the Wanakah Formation or Cow Springs Sandstone of Late Jurassic age (Condon and Peterson, 1986, p. 24) throughout most of the basin. In the northern part of the basin, the Morrison conformably overlies and probably intertongues with the Junction Creek Sandstone of Late Jurassic age (fig. 3). In the San Juan Basin, the Morrison Formation consists of five members (Gregory, 1938; Craig and others, 1955; Cadigan, 1967; Green and Pierson, 1977; Owen, 1984). These members, in ascending order, are: the Salt Wash Member, Recapture Member, Westwater Canyon Member, Brushy Basin Member, and Jackpile Sandstone Member. The thickness of the Morrison ranges from about 200 ft near Grants to about 1,100 ft in the northwestern part of the basin (Dam and others, 1990a). Depth to the top of the Morrison ranges from zero in areas of outcrop to about 8,500 ft in the northeastern part of the basin (Dam and others, 1990a). The top of the Morrison decreases from a maximum altitude of about 10,000 ft along the northern basin margin to about 1,500 ft below sea level in the northeastern part of the basin. Morrison Formation strata were deposited in various continental environments including eolian, stream channels, flood plains, and lakes (Green and Pierson, 1977, p. 151; Turner-Peterson and others, 1986). A semiarid to arid climate existed during deposition of the Morrison (Turner-Peterson and Fishman, 1989).

The Morrison Formation generally consists of yellowish-tan to pink, fine- to coarse-grained, locally conglomeratic sandstones, which are interbedded with sandy siltstones and green to reddish-brown shales and claystones; minor limestone beds also are in the aquifer (Woodward and Schumacher, 1973, p. 3-5; Green and Pierson, 1977, p. 151; Stone and others, 1983, p. 38). The Salt Wash Member was deposited by meandering and braided streams and consists of very fine to medium-grained sandstone interbedded with mudstone (Hansley, 1990, p. H4). The Recapture Member was deposited in fluvial, lacustrine, and eolian environments; lithology consists of very fine to fine-grained sandstones interbedded with mudstones and claystones. The Westwater Canyon Member was deposited by braided streams draining source areas in the western and southwestern parts of the basin. Sandstones are fine to medium grained and locally conglomeratic; interbedded mudstones and claystones are bentonitic (Hansley, 1990). The Brushy Basin Member consists of thick bentonitic to zeolitic mudstones interbedded with thin fluvial sandstones that were deposited in a saline, alkaline lake. The Jackpile Sandstone Member was deposited in the southeastern part of the basin by braided streams; sandstones are fine to medium grained and locally conglomeratic.

Hansley (1986 and 1990) described in detail the mineralogy and diagenesis of members of the Morrison Formation. Minerals from core samples in the southern part of the basin and from outcrop samples along the rim of the basin include amorphous silica, potassium feldspar, albite, calcite, anhydrite, barite, hematite, pyrite, garnet, staurolite, and zeolite. Whitney and Northrop (1987, p. 357) examined clay mineralogy and found smectite, interstratified illite/smectite, chlorite, and kaolinite. Crossey (1989) recognized two groups of clay minerals on the basis of grain size in the Westwater Canyon Member: (1) coarse-grained lithologies contain a mixed-layer illite/smectite that is highly expandable, kaolinite, and chlorite; and (2) fine-grained lithologies contain a more illitic mixed-layer illite/smectite with traces of chlorite.

The initial interpretation of the ground-water flow system in the Morrison aquifer is based on work by Kelly (1977), Frenzel and Lyford (1982), Stone and others (1983), and data from the files of the U.S. Geological Survey, Albuquerque, New Mexico. The conceptual model of the flow system in the Morrison aquifer assumed the Westwater Canyon Member to be the only significant regional aquifer (Kelly, 1977); the other members were considered important only as local aquifers. The Brushy Basin and Recapture Members were thought to serve as semiconfining layers above and below the Westwater Canyon throughout the basin except in the southwestern part where the Brushy Basin is absent.

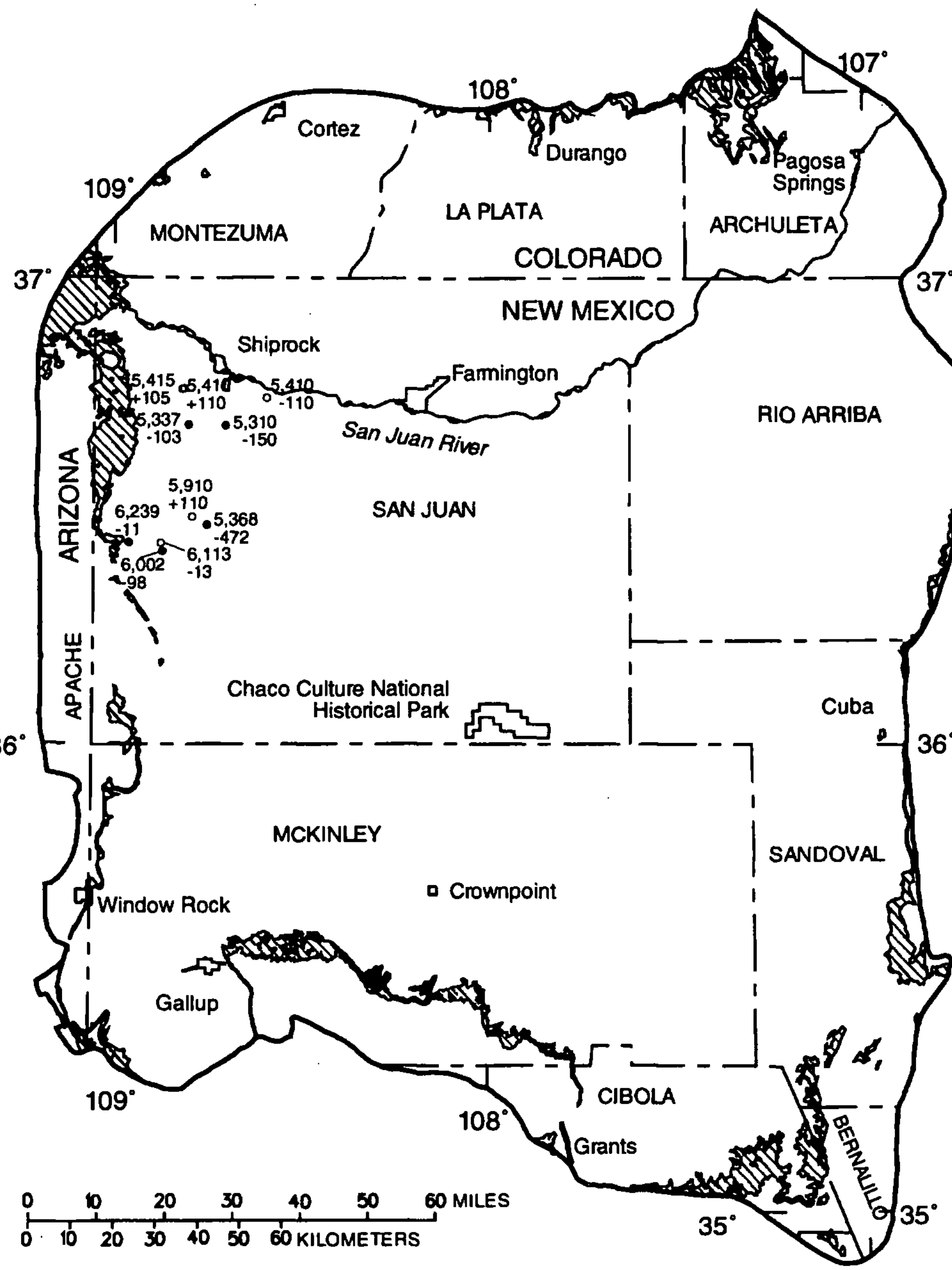
Flow in the Morrison aquifer previously was assumed to be two dimensional. Vertical leakage into the Morrison from above or below was unknown and assumed to be negligible (Stone and others, 1983, p. 23). Minimal hydraulic-head data not representing a single time period were available for units overlying and underlying the Morrison to determine vertical flow components. Data for the Dakota and Morrison aquifers were for 1985-86 and data for the Entrada Sandstone were pre-1959. Figure 5 shows a comparison of hydraulic heads for the Dakota aquifer and the Entrada relative to the Morrison aquifer. Hydraulic heads for the Dakota aquifer and Entrada were measured in the well, whereas hydraulic heads for the Morrison aquifer were interpolated from the Morrison potentiometric-surface map for that well site. The heads for wells in the Dakota (for 1985-86) generally are lower than those interpolated from the Morrison potentiometric surface.

Underlying the Morrison aquifer is the Wanakah Formation; however, no hydraulic-head data were available for this formation. The Entrada Sandstone underlies the Wanakah Formation. The only head data available for the Entrada were obtained from a dissertation by Berry (1959), which contains a potentiometric-surface map of the Entrada with five data points. The dates of measurement for these wells are unknown, but they were made prior to 1959. The head values for the Entrada indicate a northerly flow direction similar to the Morrison aquifer. Figure 5 shows the estimated hydraulic-head differences between the Entrada Sandstone and the Morrison aquifer at the locations of five wells. Comparison of heads in the Entrada (pre-1959) with those in the Morrison (1985-86) (fig. 5) shows that the Entrada heads in four wells were from 13 to 110 higher than in the Morrison. Because hydraulic-head values in the Morrison had declined, pre-1985 water levels in the Morrison were sought for comparison with pre-1959 water levels. Hydrographs for three wells completed in the Morrison aquifer that span the period 1957-90 were used to determine water-level trends in the Morrison during this time. These hydrographs, shown in figure 6, indicate a decline in hydraulic head in the Morrison during this period. The declines range from approximately 4 feet to more than 70 feet. Although the declines in the Morrison are shown for almost a 30-year period, the declines are believed to have occurred after the mid- to late 1970's when uranium test drilling was conducted and many of the test holes were completed as wells in the Morrison aquifer and allowed to flow continuously. On the basis of these tentative comparisons, even with the declines in the Morrison of as much as 70 feet, the head in the Entrada would still be several tens of feet higher than the head in the Morrison. Therefore, an upward component of flow into the Morrison aquifer is assumed.

The potentiometric contours shown in figure 7 indicate that recharge to the Morrison aquifer north of the Chuska Mountains along the New Mexico-Arizona State line has a significant component that is north, parallel to the north-trending outcrop. Along the north flanks of the Chuska Mountains, the Morrison dips primarily to the east, but northward the easterly dip flattens and a northerly dip develops toward the Four Corners Platform (fig. 2). This change in dip accounts for the much larger outcrop area, and recharge in this area moves north parallel to the outcrop to the discharge area near Four Corners.

The discharge areas for the Morrison are considered to be in the northwestern part of the area near Four Corners where the San Juan River has breached the Morrison aquifer, the southwestern part of the area southwest of Gallup, and the southeastern part of the area northeast of Grants (see fig. 2 for general areas of discharge as indicated by converging arrows). In the northwestern part of the basin north of the Chuska Mountains, the general gradient is to the north (fig. 7); in the area northeast of the city of Gallup, areas of localized dewatering for uranium mining have resulted in substantial head declines.

The reported or measured discharge from 53 water wells completed in the Morrison aquifer ranges from 1 to 401 gal/min; the median discharge is 32 gal/min (Dam and others, 1990a). Heads of wells completed in the Morrison Formation are typically above land surface in San Juan County and below land surface in McKinley and Cibola Counties.



EXPLANATION

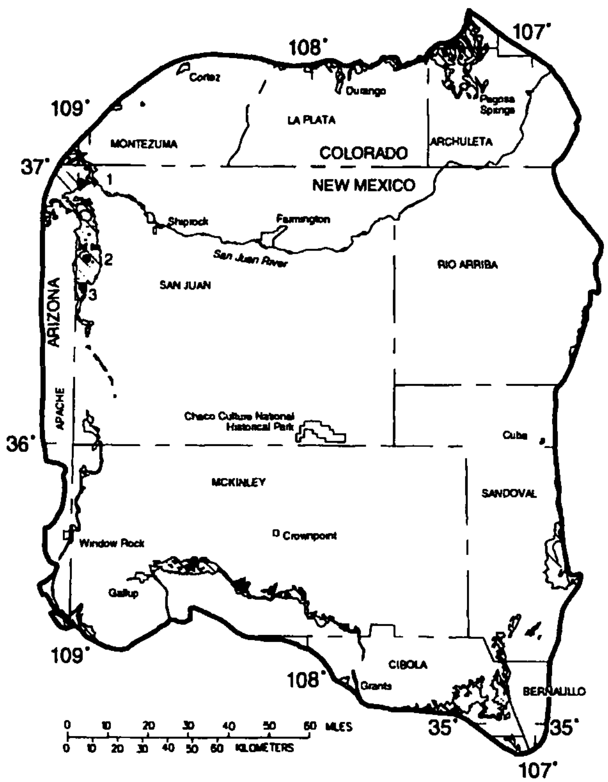
OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP-- From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

● 5,310 -150 WATER WELL--Upper number is altitude of potentiometric surface in Dakota aquifer, in feet above sea level. Lower number is difference between altitude of potentiometric surfaces in the Dakota and Morrison aquifers

○ 5,410 -110 WATER WELL--Upper number is altitude of potentiometric surface in Entrada Sandstone, in feet above sea level. Lower number is difference between altitude of potentiometric surfaces in the Entrada Sandstone and Morrison aquifers

Figure 5.--Hydraulic heads in the Dakota aquifer and Entrada Sandstone relative to the Morrison aquifer, 1985-86.



EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP-- From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

● 1 WATER WELL AND HYDROGRAPH NUMBER

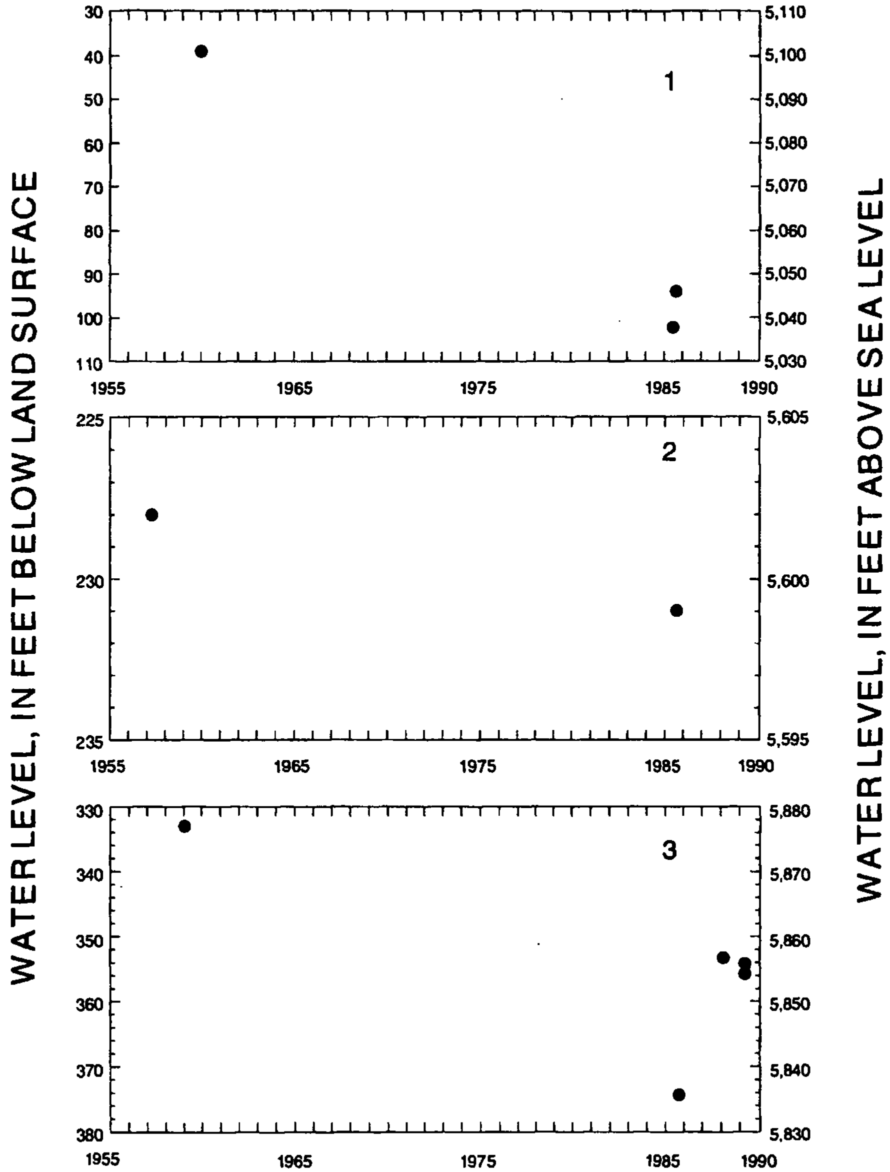


Figure 6.--Water-level hydrographs for three wells completed in the Morrison aquifer, 1957-87.

EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

6400 POTENTIOMETRIC CONTOUR--Shows altitude at which water level would have stood in tightly cased wells. Contour interval 100 feet. Datum is sea level

DIRECTION OF GROUND-WATER FLOW

6,466 1974 WATER WELL--Upper number is altitude of water level, in feet above sea level. Lower number is year water level was measured or reported

Figure 7.--Potentiometric surface of the Morrison aquifer, 1985-86.

GEOCHEMISTRY OF GALLUP, DAKOTA, AND MORRISON AQUIFERS

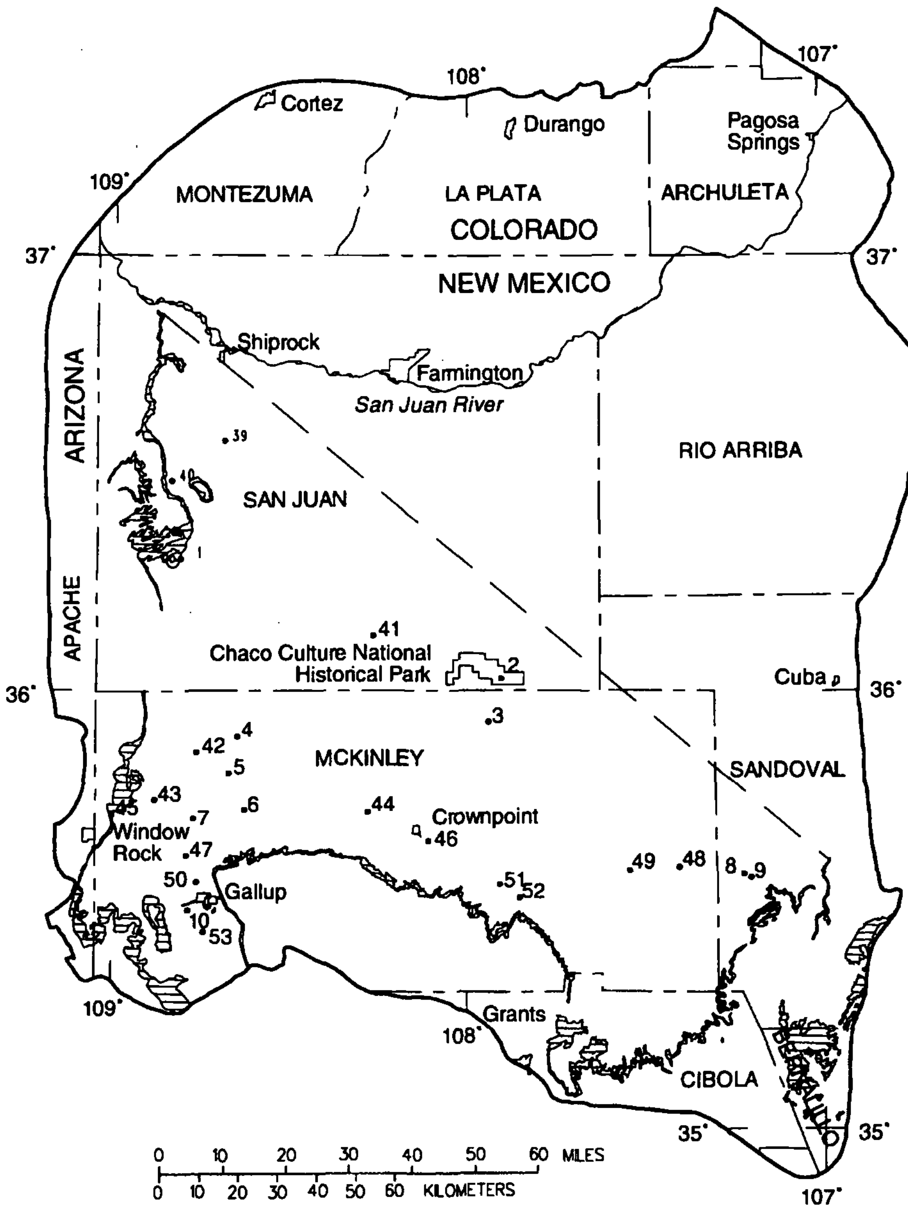
This section describes the methods used to collect the data including essential water well information. Geochemical data are discussed by type of constituent including major, minor, and trace elements; gases; and isotopes. Physical and geochemical processes controlling solute concentrations then are evaluated.

Methods

The field sampling methods used to collect the geochemical data are detailed in Dam (1988) and follow standard USGS procedures (Claassen, 1982; Knapton, 1985). Nonflowing wells were pumped for a sufficient duration to remove at least three borehole volumes of water. Field techniques were used to measure specific conductance, pH, temperature, DO, alkalinity, and sulfide. Alkalinity was used to calculate HCO_3^- and CO_3. Samples were collected and preserved for analysis of major, minor, and trace elements; stable and radioactive isotopes; and dissolved-organic carbon. Dissolved gases were collected in the field using double-chamber glass tubes under a vacuum. Carbon-14 samples were collected onsite by precipitation of strontium carbonate in a stainless-steel tank as described in Dam (1988). Chloride-36 samples were treated with nitric acid and silver nitrate to precipitate silver chloride and stored in light-proof brown bottles. An anion-exchange resin was used to concentrate chloride when chloride concentration was less than 10 mg/L. Preparation of the ^{36}Cl samples for analysis (primarily to remove interfering sulfur-36) is described in Jones and Phillips (1990).

All samples collected for laboratory analysis of major, minor, and trace elements were analyzed at the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado. Gas samples were kept on ice and sent to the USGS laboratory in Reston, Virginia, for analysis. These samples were analyzed for N, oxygen, Ar, CO_2, methane, and ethane. Rapid analysis was necessary to ensure that loss of vacuum did not result in sample contamination from the air. Stable isotopes of oxygen and hydrogen and the radioisotope ^{3}H were analyzed at the USGS laboratory in Reston, Virginia. Carbon-13/carbon-12 and sulfur-34/sulfur-32 stable isotopes were analyzed by Global Geochemistry, and ^{14}C isotopes were analyzed by Kruger, Inc. These laboratories are under contract to the NWQL. The University of Rochester, in Rochester, New York, analyzed ^{36}Cl isotopes using a tandem accelerator mass spectrometer.

Geochemical data for analysis and interpretation were obtained by sampling 38 wells and using analyses from the USGS NWIS (National Water Information System) data base for 21 wells (figs. 8-10). Locations of water wells sampled for geochemical data are shown in figure 8 for the Gallup aquifer (wells 1-10), in figure 9 for the Dakota aquifer (wells 11-13), and in figure 10 for the Morrison aquifer (wells 14-38). The abundance of wells completed in the Morrison aquifer is a result of uranium exploration (without development or mining) in the early 1980's. Additional chemical analyses obtained from the NWIS data base augmented the geochemical data for the Gallup (15 wells) and Dakota (6 wells) aquifers.



EXPLANATION

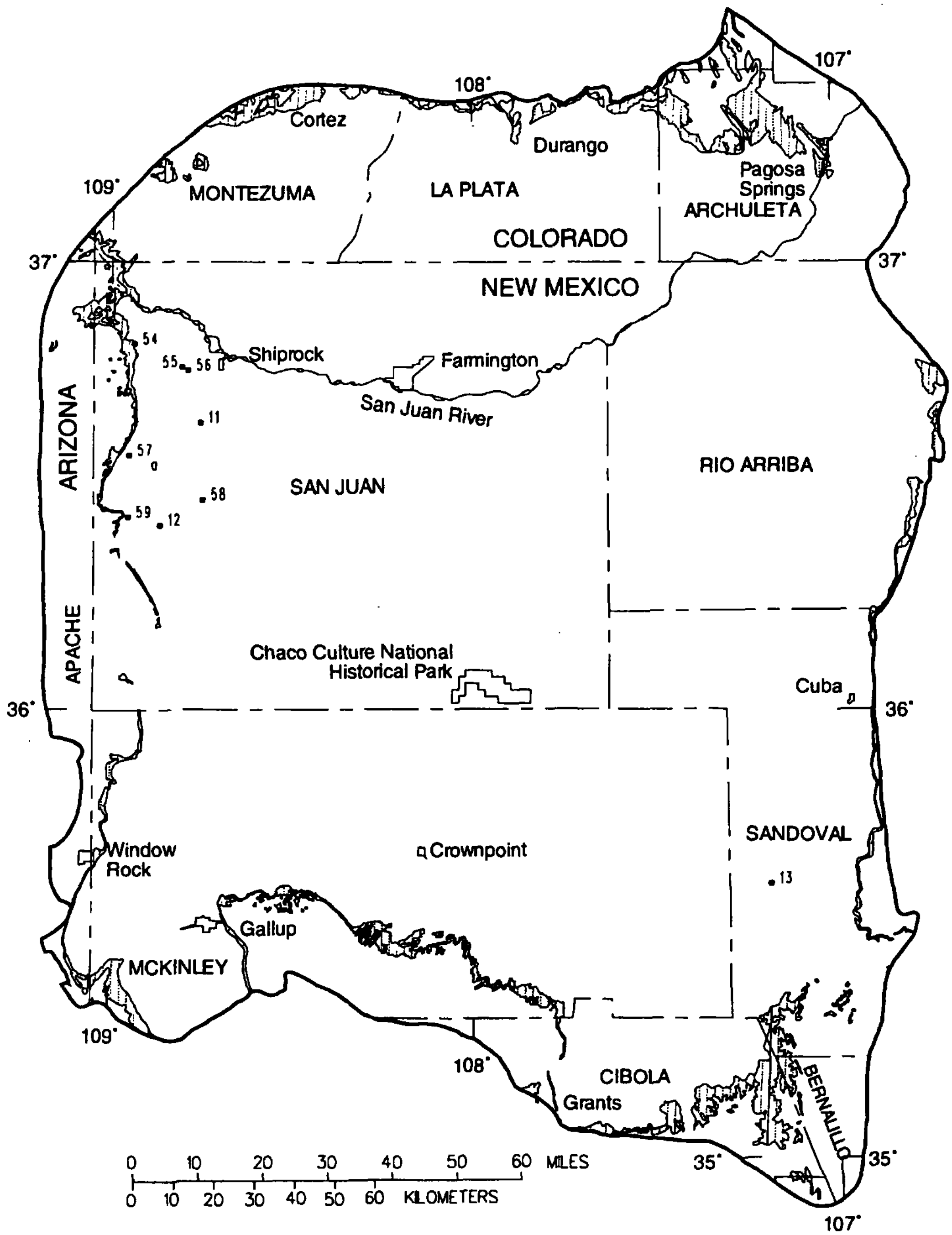
OUTCROP OF GALLUP AQUIFER--In Arizona includes Pescado Tongue of Mancos Shale. In southeastern part of the study area mapped as part of the Mesaverde Group, undivided. From Dane and Bachman, 1965, and Hackman and Olson, 1977

APPROXIMATE SUBSURFACE EXTENT OF GALLUP AQUIFER--From Molenaar, 1973

BOUNDARY OF STUDY AREA

• 1 WATER WELL--Wells 1-10 were sampled from 1986 to 1989; wells 39-53 were sampled prior to 1986 and the analyses are from the National Water Information System data base

Figure 8.--Location of sampled water wells completed in the Gallup aquifer.



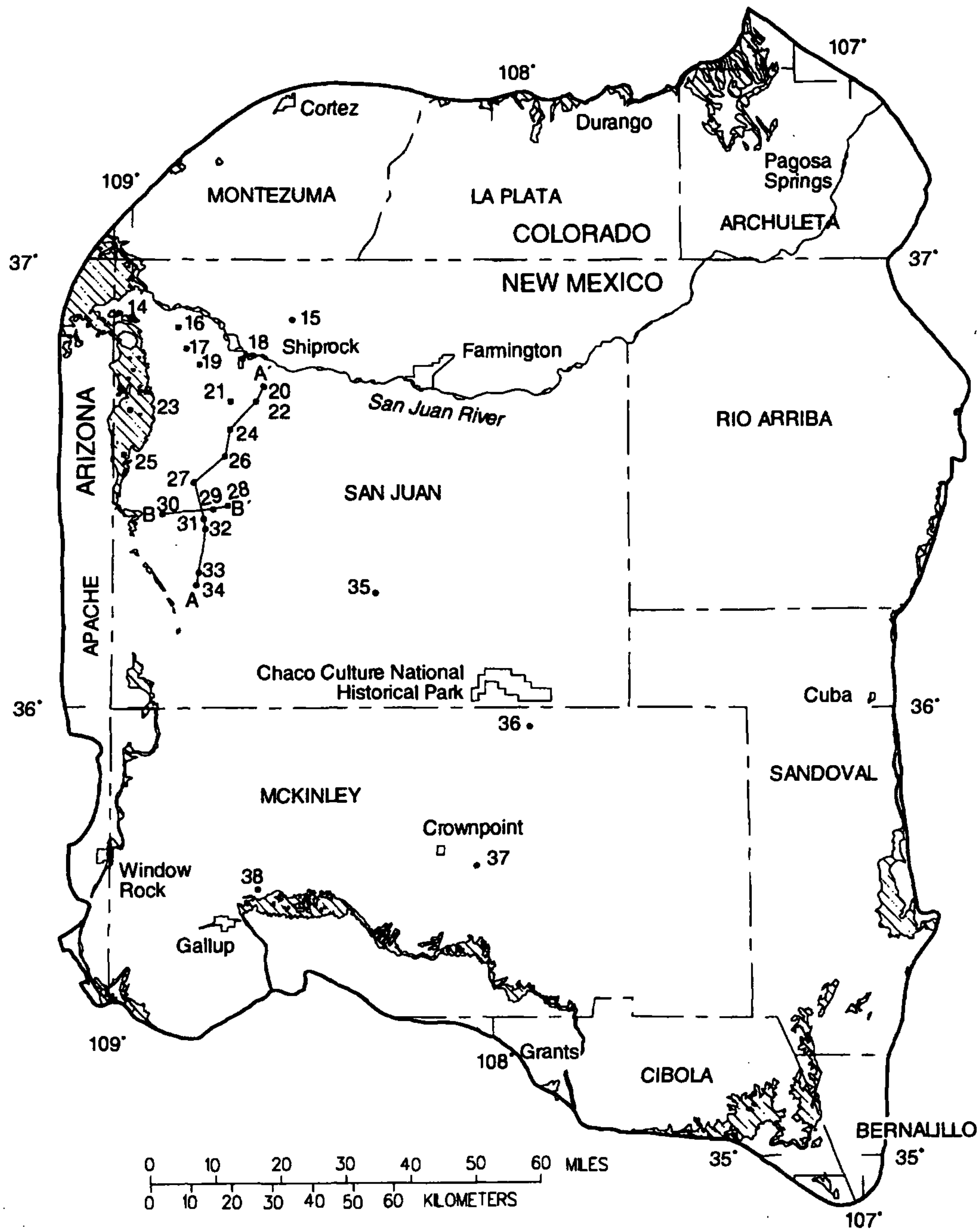
EXPLANATION

OUTCROP OF DAKOTA AQUIFER, MANCOS SHALE, AND BURRO CANYON FORMATION--From Dane and Bachman, 1965; Wilson and others, 1969; and Tweto, 1979

BOUNDARY OF STUDY AREA

•11 WATER WELL--Wells 11-13 were sampled from 1986 to 1989; wells 54-59 were sampled prior to 1986 and the analyses are from the National Water Information System data base

Figure 9.--Location of sampled water wells completed in the Dakota aquifer.



EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

A —— A' LINE OF GEOHYDROLOGIC SECTION--See figure 11

• 14 WATER WELL--Wells 14-38 were sampled from 1986 to 1989

Figure 10.--Locations of sampled water wells completed in the Morrison aquifer and of geohydrologic sections.

Table 1 provides data pertaining to the 38 wells sampled from 1986 to 1989. Well depths range from 150 to 5,250 ft. The part of the Gallup, Dakota, or Morrison aquifer that was sampled, as shown in table 1, is the thickness of the interval open to the aquifer; the interval thickness ranges from 31 to 876 ft. Most wells sampled were completed as open holes, so water was obtained from the entire open interval as opposed to one or more perforated intervals in the casing. Eight wells were completed with multiple perforated intervals so the well was open to selected zones; the perforated intervals were summed to determine the total thickness of the interval open to the aquifer that was sampled (table 1). Two geohydrologic sections for 12 wells completed in the Morrison aquifer are shown in figure 11. Section A-A' depicts nine wells in a north-trending line. Well 32 is the only well open solely to the Westwater Canyon Member; the other wells are open to varying combinations of the Westwater Canyon, Recapture, or Salt Wash Members of the Morrison Formation. Several wells are completed below the Morrison aquifer and open to the Wanakah Formation. Section B-B' depicts three wells in an east-trending line. Wells 29 and 30 are completed solely in the Morrison aquifer, whereas well 28 extends 155 feet into the Wanakah Formation. Flowing, artesian conditions occurred at most wells, facilitating sample collection. Most of these wells (22 of 29) (table 1) had the capacity to be shut in for a head measurement and therefore could be turned off after sampling was completed. However, seven wells (7, 11, 18, 20, 21, 32, and 33) could not be shut in for a head measurement or turned off to prevent continuous discharge. Six wells were equipped with windmills with positive-displacement piston pumps and three wells were equipped with submersible pumps. These data are listed in table 1.

Table 1.--Data for wells sampled from 1986 to 1989

[See figures 8-10 for location of wells. Type of lift: F, natural flow; P, piston; S, submersible. --, not reported]

Well number	Aquifer	Altitude of land surface (feet above sea level)	Depth of well (feet below land surface)	Thickness of interval open to aquifer (feet)	Type of lift	Shut-in capacity for flowing wells
1	Gallup	5,890	150	--	F	Yes
2	Gallup	6,195	3,090	60	F	Yes
3	Gallup	6,401	--	--	F	Yes
4	Gallup	5,990	1,239	80	F	Yes
5	Gallup	6,048	1,743	160	F	Yes
6	Gallup	6,379	1,082	502	P	--
7	Gallup	6,365	1,850	225	F	No
8	Gallup	6,430	969	64	F	Yes
9	Gallup	6,165	602	120	F	Yes
10	Gallup	6,515	667	64	S	--
11	Dakota	5,342	1,464	555	F	No
12	Dakota	6,035	521	147	P	--
13	Dakota	6,130	1,840	55	F	Yes
14	Morrison	5,545	604	342	P	--
15	Morrison	5,440	2,736	430	S	--
16	Morrison	5,120	2,000	782	F	Yes
17	Morrison	5,100	2,035	691	F	Yes
18	Morrison	4,941	1,777	295	F	No
19	Morrison	5,270	2,013	280	F	Yes
20	Morrison	5,060	2,300	788	F	No
21	Morrison	5,290	2,597	770	F	No
22	Morrison	5,139	2,520	747	F	Yes
23	Morrison	5,831	555	60	P	--
24	Morrison	5,270	2,682	876	F	Yes
25	Morrison	6,206	702	149	P	--
26	Morrison	5,522	1,992	247	F	Yes
27	Morrison	5,735	1,912	526	F	Yes
28	Morrison	5,595	2,034	834	F	Yes
29	Morrison	5,670	1,912	505	F	Yes
30	Morrison	6,090	1,751	275	F	Yes
31	Morrison	5,840	2,125	613	F	Yes
32	Morrison	5,830	1,691	410	F	No
33	Morrison	5,905	2,349	858	F	No
34	Morrison	6,010	2,518	768	F	Yes
35	Morrison	5,750	5,250	250	F	Yes
36	Morrison	6,330	3,988	31	F	Yes
37	Morrison	6,795	2,605	400	S	--
38	Morrison	6,825	410	110	P	--

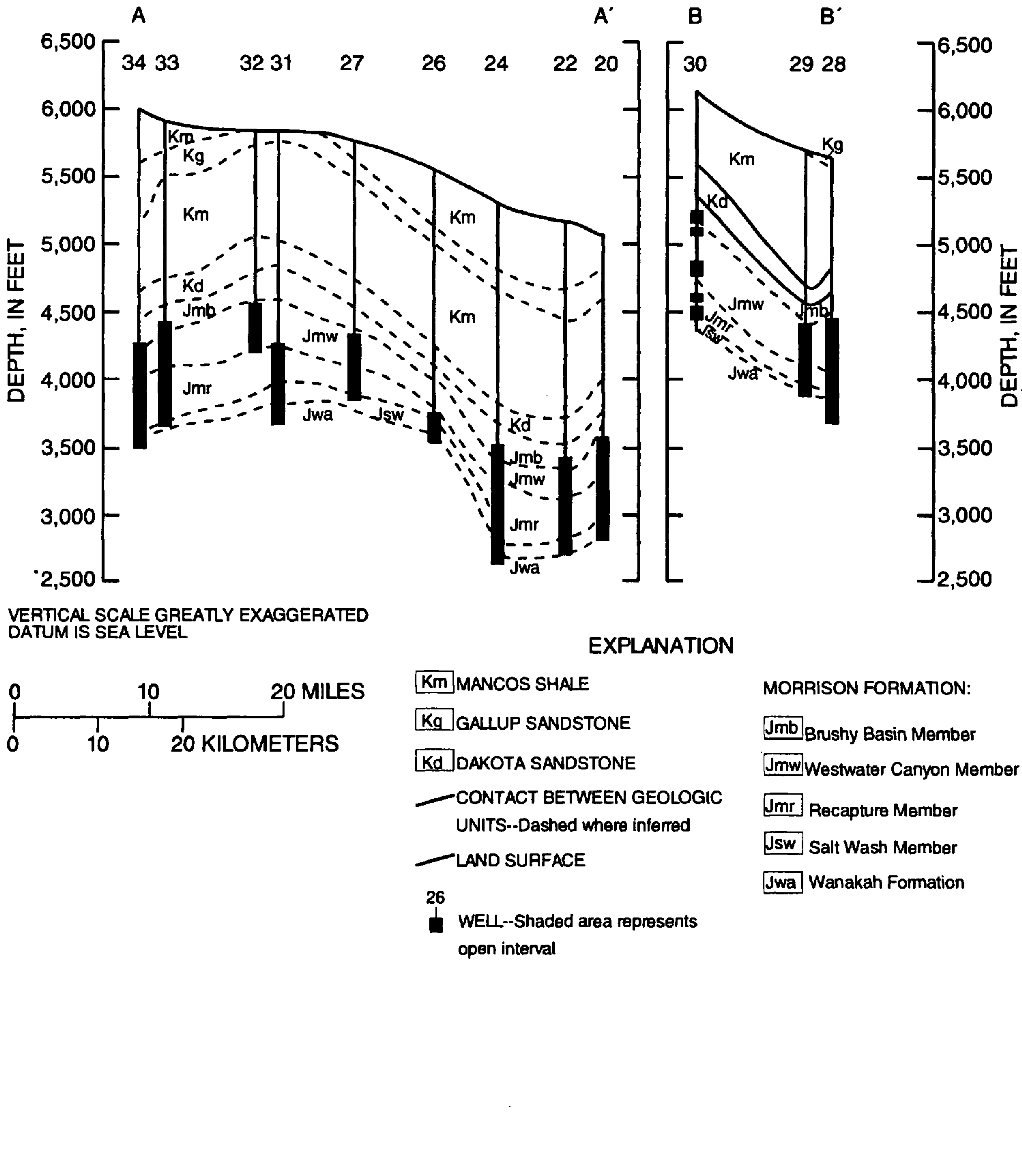


Figure 11.--Geohydrologic sections showing well completion in the Morrison aquifer. Lines of section are shown in figure 10 (modified from Dam, 1988).

Major Constituents and pH

Chemical analyses are shown for 61 water samples collected during 1986 through 1989 from 38 wells completed in the Gallup (table 2), Dakota (table 3), and Morrison aquifers (table 4). In addition, data from NWIS are presented for the Gallup aquifer (15 wells) and the Dakota aquifer (6 wells). Several wells, particularly wells completed in the Morrison aquifer, were sampled more than once during 1986 through 1989 to supplement the initial suite of constituents collected and to identify a possible change of constituent concentrations with time.

Concentrations of major ions (Ca^{2+}, Mg^{2+}, Na^+, K^+, HCO_3^-, CO_3^{2-}, SO_4^{2-}, and Cl^-) generally were found to be reproducible in samples collected from the Gallup and Dakota aquifers. Concentrations of major ions were found to change over time for samples collected from several wells completed in the Morrison aquifer.

Three of 10 wells in the Gallup aquifer were sampled twice between 1986 and 1987. Major ion concentrations differed by less than 10 percent for Na^+, alkalinity, and SiO_2^0 (table 2). Only one of three wells completed in the Dakota aquifer that were sampled during the investigation was sampled twice (table 3). Differences greater than 10 percent were detected between Ca^{2+}, Mg^{2+}, Na^+, and K^+ concentrations from two analyses for well 13. However, SO_4^{2-}, Cl^-, and several other properties and constituents differed by less than 10 percent between the two analyses. Three of six chemical analyses obtained from the NWIS data base for the Dakota aquifer indicated that major ion concentrations were within 10 percent (table 3).

Fifteen of 25 wells completed in the Morrison aquifer were sampled more than once between 1986 and 1989 (table 4). Concentrations of major ions in water samples collected from 9 of the 15 wells were reproducible within 10 percent. Thus, concentrations of several major ions in samples collected from 6 of 15 wells differed by more than 10 percent. Concentrations of Ca^{2+}, HCO_3^-, and Cl^- varied between sampling periods for wells 18, 20, 22, 25, 28, and 33, and Mg^{2+}, Na^+, and SO_4^{2-} concentrations varied by more than 10 percent in samples from wells 20 and 28. Because major ion concentrations in water from well 30 were nearly identical except for Cl^-, which changed from 4.7 to 2.7 mg/L, and for K^+, which changed from 2.3 to 1.9 (table 4), well 30 was not included with the six wells.

Several factors may contribute to the non-reproducibility of the samples with time. These include discharge of large volumes of water between sampling periods, a large open interval, and pump type--such as piston, which can introduce oxygen into the water resulting in chemical reactions. The range in discharge at wells 18, 20, 22, and 33 was 16 to 65 gal/min. At a discharge rate of only 20 gal/min over the minimum duration of 354 days between the 1986 and 1987 sampling dates, more than 10 million gal of water would have been discharged at each of these four wells. However, well 32 flowed continuously for the 3 years of sample collection, 1986-88, yet analytical results were reproducible within 10 percent. A smaller open interval for well 32 (410 ft) compared with well 33 (858 ft) may account for the difference in analytical results. Well 28 was constructed with a large open interval (834 ft) (table 1). Well 25 was constructed with a relatively small open interval (149 ft) (table 1); however, a windmill piston pump was used to obtain the water sample.

Table 2.--Selected properties of and constituents in water from the Gallup aquifer

[See figure 8 for location of wells; pH, standard units; °C, degrees Celsius; concentrations in milligrams per liter; <, less than; --, not reported]

Well number	Date of sample	Field pH	Temperature (°C)	Dissolved oxygen	Sulfide (H_2S+HS^-)	Calcium (Ca^{2+})	Magnesium (Mg^{2+})	Sodium (Na^+)	Sodium plus potassium (Na^++K^+)	Potassium (K^+)	Bicarbonate (HCO_3^-)	Carbonate (CO_3^{2-})	Alkalinity (as $CaCO_3$)	Sulfate (SO_4^{2-})	Chloride (Cl^-)	Fluoride (F^-)	Bromide (Br^-)	Iodide (I^-)	Silica (SiO_2^0)	Dissolved solids
1	07-01-88	7.90	16.7	1.2	<0.05	42	17	96	--	6.4	310	0	254	120	7.8	0.30	0.074	0.006	14	455
2	04-22-86	8.20	32.8	--	--	10	2.1	630	--	3.3	380	0	307	910	46	1.6	.18	.004	17	1,799
	10-21-87	8.33	32.9	--	.14	7.4	2.4	670	--	3.2	334	10	290	1,100	49	1.6	.066	.005	16	2,000
3	04-21-86	8.60	32.7	--	--	7.0	1.2	669	--	2.3	240	10	213	1,000	81	.70	.16	.004	17	1,900
4	07-15-88	8.57	24.4	--	.15	1.2	.28	220	--	1.1	451	14	394	84	4.1	1.2	.034	.005	12	559
5	06-30-87	8.81	26.0	--	--	3.8	.18	400	--	1.0	295	22	277	530	44	1.2	.15	.006	12	1,200
	06-28-88	8.81	25.0	--	.14	3.6	.15	400	--	.90	288	17	264	550	45	1.1	--	--	12	--
6	06-30-88	8.99	19.9	--	--	1.7	.62	230	--	.70	336	22	311	180	5.0	.70	.054	.005	11	639
7	06-28-88	9.00	20.7	--	.11	2.3	.29	140	--	.70	222	14	206	84	9.5	.30	.056	.005	13	374
8	12-03-87	8.73	18.4	--	.05	5.2	2.0	630	--	2.4	252	10	224	1,200	23	.60	.11	.004	12	2,000
9	04-29-86	9.10	18.0	--	--	1.4	.03	129	--	.80	259	20	244	31	4.3	.50	.044	.008	12	330
	08-11-87	8.83	18.0	--	.12	1.3	.31	130	--	.70	293	26	244	35	3.3	.70	--	--	13	330
10	06-30-88	9.20	16.9	--	--	.28	.06	170	--	.70	290	17	266	85	20	.80	.068	.005	9.9	444
39	05-26-64	7.8	18.5	--	--	33	6.7	--	1,000	--	410	0	336	1,700	180	3.5	--	--	12	3,200
40	07-03-74	8.0	--	--	--	400	120	150	--	2.0	170	13	161	1,500	20	.4	--	--	--	2,700
41	10-29-74	8.5	--	--	--	4.2	.7	580	--	3.6	520	19	457	480	240	3.0	--	--	16	1,600
42	10-14-64	7.8	--	--	--	37	11	--	25	--	200	0	167	19	2.8	.4	--	--	14	210
43	09-08-69	8.2	--	--	--	74	15	37	--	2.0	240	7	209	95	9.9	.3	--	--	--	390
44	01-28-72	8.2	--	--	--	12	4.8	120	--	2.0	190	0	156	140	4.6	.6	--	--	--	430
45	01-20-71	8.0	--	--	--	92	17	36	--	2.0	260	0	213	140	7.1	.5	--	--	--	450
46	03-10-70	7.8	--	--	--	80	26	87	--	5.0	270	0	221	260	8.9	.4	--	--	--	650
47	07-31-70	8.4	32.0	--	--	11	3.0	270	--	2.7	280	6	243	310	50	.8	--	--	16	810
48	09-19-62	8.2	24.5	--	--	9.5	2.1	720	--	3.0	310	0	254	1,200	42	.8	--	--	13	2,190
49	10-02-62	7.9	24.0	--	--	9.4	5.0	360	--	3.0	280	0	230	560	12	.8	--	--	14	1,100
50	10-14-64	8.5	--	--	--	12	3.6	--	220	--	250	7	205	270	21	.5	--	--	16	680
51	07-18-73	8.1	--	--	--	100	36	180	--	3.1	210	10	189	580	7.1	.7	--	--	--	1,100
52	09-18-62	8.8	20.0	--	--	3.1	.9	400	--	1.8	350	18	315	440	73	1.2	--	--	15	1,100
53	08-30-57	8.4	15.5	--	--	11	3.3	--	440	--	610	8	500	200	180	4.4	--	--	10	1,200

Table 3.--Selected properties of and constituents in water from the Dakota aquifer

[See figure 9 for location of wells; pH, standard units; °C, degrees Celsius; concentrations in milligrams per liter; --, not reported; >, greater than]

Well number	Date of sample	Field pH	Temperature (°C)	Sulfide (H_2S+HS^-)	Calcium (Ca^{2+})	Magnesium (Mg^{2+})	Sodium (Na^+)	Sodium plus potassium (Na^++K^+)	Potassium (K^+)	Bicarbonate (HCO_3^-)	Carbonate (CO_3^{2-})	Alkalinity (as $CaCO_3$)	Sulfate (SO_4^{2-})	Chloride (Cl^-)	Fluoride (F^-)	Bromide (Br^-)	Iodide (I^-)	Silica (SiO_2^0)	Dissolved solids
11	07-23-87	8.47	18.1	0.05	21	11	390	--	3.8	277	10	241	640	57	0.90	0.16	0.006	8.6	1,300
12	06-29-88	8.78	18.1	--	2.0	.16	100	--	1.1	215	10	192	25	2.6	.30	.038	.005	12	262
13	04-29-86	8.90	19.5	--	2.3	1.1	700	--	1.7	390	30	376	910	85	1.5	.24	.005	10	1,900
	12-03-87	8.91	19.5	>1.5	170	95	270	--	2.2	--	--	--	980	78	1.6	--	--	11	--
54	04-27-60	7.6	15.5	--	24	.5	780	--	3	280	0	230	1,100	260	2.2	--	--	8.5	2,320
55	09-21-66	8.0	--	--	53	10	1,300	--	11	360	12	315	1,600	720	8.2	--	--	--	3,780
56	06-27-52	--	--	--	19	3.1	--	690	--	170	6	149	980	280	1.3	--	--	13	2,080
	09-21-66	8.4	--	--	19	2.4	690	--	9	140	12	135	1,000	290	2.0	--	--	--	2,060
57	07-22-70	8.6	--	--	7.0	--	320	--	--	260	12	233	480	15	.3	--	--	--	961
	09-24-74	8.6	--	--	6.0	1.2	360		2	250	23	243	470	18	.4	--	--	8.7	1,040
58	06-08-67	9.4	--	--	2.0	1.2	120		--	160	26	175	70	15	.3	--	--	--	302
	01-08-70	9.4	--	--	1.0	--	130		2	180	34	204	68	12	.3	--	--	--	310
59	07-03-74	8.2	--	--	54	7.3	120		2	300	13	268	130	11	.2	--	--	9.8	512

Table 4.--Selected properties of and constituents in water from the Morrison aquifer

[See figure 10 for location of wells; pH, standard units; °C, degrees Celsius; concentrations in milligrams per liter; --, not reported; <, less than detection limit]

Well number	Date of sample	Field pH	Temperature (°C)	Dissolved oxygen	Sulfide ($H_2S + HS^-$)	Calcium (Ca^{2+})	Magnesium (Mg^{2+})	Sodium (Na^+)	Potassium (K^+)	Bicarbonate (HCO_3^-)	Carbonate (CO_3^{2-})	Alkalinity (as $CaCO_3$)	Sulfate (SO_4^{2-})	Chloride (Cl^-)	Fluoride (F^-)	Bromide (Br^-)	Iodide (I^-)	Silica (SiO_2^0)	Dissolved solids
14	06-10-88	7.56	17.0	--	--		13	42	1.3	286	0	234	79	11	0.60	0.135	0.008	28	361
15	07-21-87	7.52	39.9	--	35	50	28	1,700	18	305	0	250	3,800	210	1.6	.38	.033	33	6,000
16	06-24-86	9.20	19.9	--	--	1.1	.08	130	1.0	244	29	247	33	10	2.0	.050	.006	17	350
	06-08-88	9.37	20.1	--	.07	1.2	.06	140	.90	273	14	248	33	11	2.8	--	--	17	350
17	07-02-86	8.50	23.0	--	--	40	3.4	810	3.6	124	4	110	1,700	61	1.6	.13	.015	13	2,700
18	06-16-86	8.00	31.0	--	--	58	14	800	7.7	58	0	49	1,600	110	2.0	.13	.015	14	2,600
	06-09-87	8.03	31.1	--	<.05	110	14	810	7.2	71	0	60	2,100	57	1.9	--	--	14	3,200
19	07-14-87	7.74	29.1	--	.24	33	12	1,300	9.0	383	0	310	1,500	750	8.0	.05	.073	18	3,800
20	06-19-86	7.60	33.0	--	--	78	31	1,400	19	158	0	130	3,200	190	2.1	.20	.035	16	5,000
	06-10-87	7.80	31.0	--	.18	160	15	890	10	81	0	68	2,500	120	2.1	--	--	14	3,800
21	06-18-86	8.30	--	--	--	39	3	770	4.6	128	0	105	1,600	67	1.1	.15	.021	14	2,600
22	06-19-86	8.00	28.8	--	--	98	25	740	8.2	51	0	48	1,900	60	1.9	.12	.016	16	2,900
	06-10-87	8.03	30.5	--	.07	160	23	690	8.2	57	0	45	2,000	83	2.0	--	--	16	3,000
23	06-10-88	9.65	17.1	--	--	1.3	.06	120	.70	176	26	188	37	23	.80	.235	.018	11	308
24	07-01-86	8.10	18.0	--	--	14	8.1	290	2.7	327	0	265	390	38	1.3	.12	.005	12	920
25	06-09-88	8.87	16.9	5.0	--	14	5.9	54	2.1	156	7	140	21	10	.50	.074	.004	16	213
	04-25-89	9.12	16.0	--	--	5.0	1.6	60	1.0	117	10	112	23	8.3	.40	--	--	10	167
26	06-17-86	9.30	27.2	--	--	1.0	.04	110	.40	143	30	166	52	4.2	.40	.019	.002	19	300
	07-22-87	9.39	27.6	--	.16	2.6	.16	110	.60	176	34	200	35	4.1	.40	--	--	18	290
	07-01-88	9.33	27.1	--	.19	.98	.09	120	.40	159	43	202	48	3.9	.30	--	--	18	310
27	06-18-86	9.40	23.9	--	--	.80	.04	81	.30	156	34	182	9.8	1.1	.30	.014	.002	17	220
	06-11-88	9.65	23.9	--	--	.90	<.01	88	.30	166	29	184	10	.80	.30	--	--	18	230
28	06-30-86	9.33	22.0	--	--	1.8	.20	130	.90	170	36	199	71	28	.40	.032	.006	19	370
	07-17-87	9.45	21.3	--	<.05	3.1	.46	190	1.2	164	38	197	170	64	.90	--	--	17	570
	07-01-88	9.26	21.3	--	--	2.1	.37	160	.90	171	34	196	90	37	.60	--	--	18	430
29	06-29-88	9.51	23.3	--	--	.73	.03	110	.40	200	36	224	24	2.5	.80	.030	.003	16	290
	11-22-88	9.41	20.9	--	--	.86	<.01	120	.50	193	38	222	22	3.0	.70	--	--	17	297
30	07-23-87	8.37	24.0	1.0	<.05	11	.89	68	2.3	200	0	163	13	4.7	2.0	.010	<.001	18	220
	01-05-89	8.58	16.1	--	--	11	.89	70	1.9	200	0	164	13	2.7	.80	--	--	18	216
31	01-05-89	9.06	22.0	--	--	1.3	.06	66	.70	134	22	146	3.0	1.6	.20	--	--	16	174
32	06-24-86	9.05	21.9	--	--	1.0	.07	71	.60	151	14	147	5.6	1.6	.20	.018	.001	19	190
	07-15-87	9.31	22.4	<1.0	.10	.93	.05	72	.60	144	19	148	4.8	1.5	.30	--	--	19	190
	06-11-88	9.42	23.6	--	--	.95	.06	71	.50	149	19	154	5.2	1.1	.30	--	--	18	190
33	07-15-87	9.52	26.6	<	--	.85	.04	120	.50	168	34	194	38	12	.60	--	--	18	290
	06-29-88	9.53	--	--	--	.66	.01	110	.60	164	34	190	36	8.4	.50	--	--	19	290
	11-23-88	9.25	21.3	--															
34	07-16-87	8.96	25.5	<1.0	.71	1.8	.17	190	1.2	301	17	270	130	7.1	1.7	--	--	15	509
	11-22-88	8.88	23.9	--	--	1.9	.19	190	1.0	295	19	274	130	7.8	1.9	.062	.005	14	510
35	06-11-87	7.88	51.8	--	<.05	27	.42	240	2.3	173	0	142	430	19	1.2	.10	.009	35	840
36	04-24-86	8.20	42.2	--	--	12	.09	359	2.1	190	6	165	560	14	1.5	.16	.009	25	1,099
	10-22-87	8.31	37.4	--	.12	13	.15	340	2.0	188	5	162	580	17	1.6	.081	.012	25	1,100
37	10-02-87	9.05	30.5	--	.07	1.4	.32	200	.90	308	22	288	150	6.5	.40	.035	.006	14	550
38	07-01-87	7.64	15.0	4.3-5.0	--	49	17	180	2.6	344	0	282	290	7.9	.30	.10	.006	--	720
	07-14-88	7.64	15.4	--	--	51	17	180	2.4	344	0	282	310	7.2	.20	--	--	17	750

Values of pH were reproducible at most wells, and all samples were alkaline (above 7.0). Values of pH in water samples from the Gallup and Dakota aquifers were typically below 9.0 (figs. 12 and 13). Values of pH in water samples from the Morrison aquifer ranged from 7.52 to 9.65; water from 10 wells exceeded a pH of 9.0, indicating highly alkaline conditions. The areal distribution of pH in water from the Morrison aquifer indicates that highly alkaline water in the northwestern part of the basin generally is neutralized as it moves in a northerly direction (fig. 14). The pH in water along Morrison outcrop areas was typically below 9.0 except for one sample that had the highest pH value measured at 9.65. The pH of samples from wells located near Shiprock was typically below 8.0.

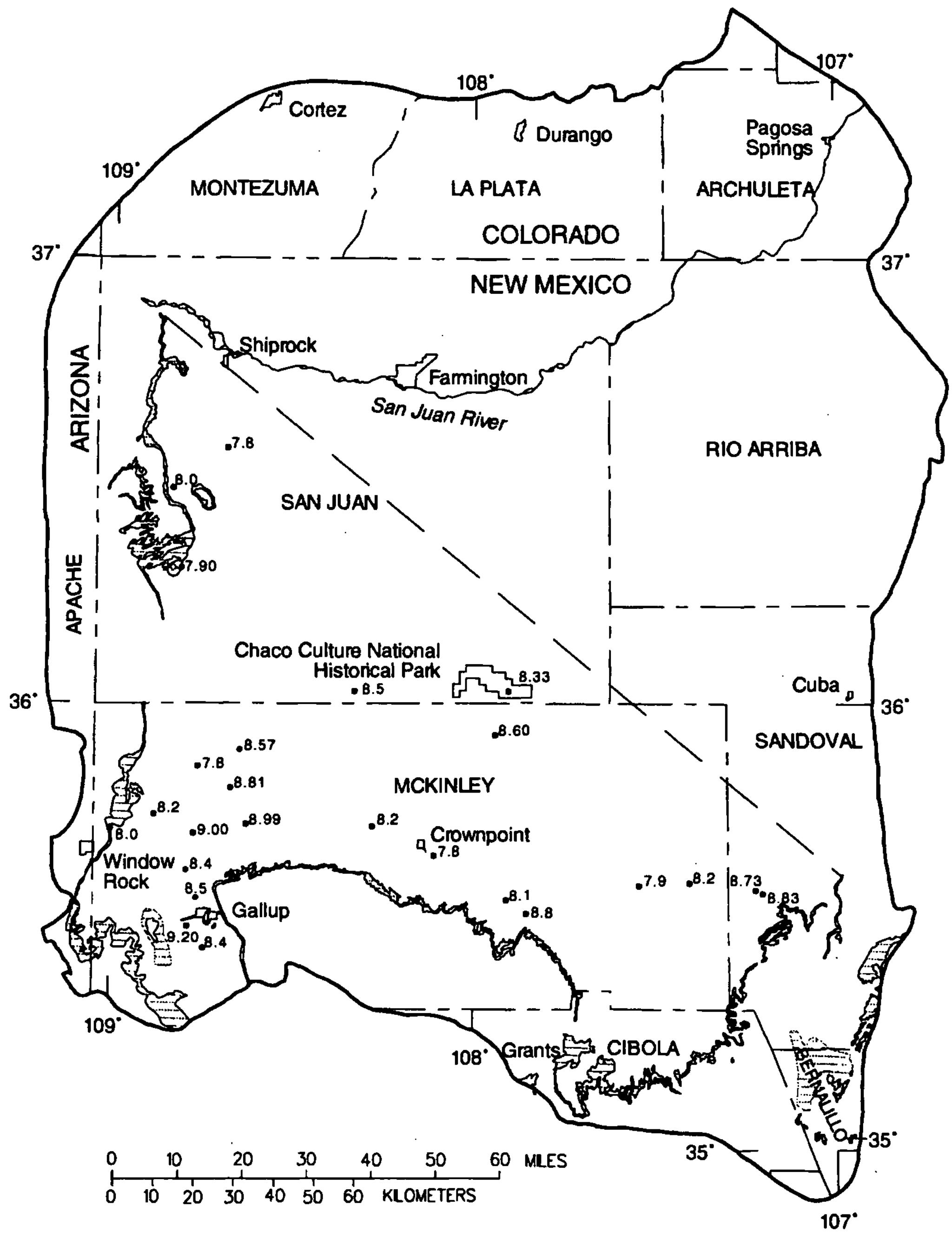
The distribution of major cations and anions found in water from the three aquifers is shown in figures 15 through 20. Two types of diagrams were used to depict ion concentrations: (1) chemical-constituent diagrams modified from Stiff (1951) to indicate spatial variations in ion concentrations, and (2) trilinear diagrams developed by Piper (1944) to relate variations in the relative percentage of ion concentrations.

Predominant ions in water from the three aquifers generally were Ca^{2+}, Na^{+}, HCO_3^-, and SO_4^{2-}, as shown in figures 15-17. Bicarbonate represents part of the alkalinity value in these figures. Major ions in water from the Gallup aquifer were predominantly Ca^{2+}-HCO_3^- in the southwestern outcrop area and Na^+-HCO_3^- in the northwestern outcrop area. The majority of samples were predominantly Na^+-HCO_3^- in the southwestern area of the basin and Na^+-SO_4^{2-} in the southeastern and central parts of the basin (fig. 15).

Predominant ions in water in the Dakota aquifer were Na^+-HCO_3^- for three samples located farthest south in the northwestern part of the basin. Predominant ions were Na^+-SO_4^{2-}, with minor HCO_3^-, for samples to the north and one sample in the southeastern part of the basin (fig. 16).

Distinct chemical groups of major ion distribution were observed in samples from wells completed in the Morrison aquifer (fig. 17). Chemical changes were observed in well samples from south to north in the general direction of flow. For one sample near the outcrop located near Gallup, New Mexico, Na^+-HCO_3^--SO_4^{2-} were predominant ions. Predominant ions near Crownpoint consisted of Na^+-HCO_3^- and predominant ions south and northwest of Chaco Culture National Historical Park consisted of Na^+-SO_4^{2-}. In the northwestern part of the basin, the predominant ions in 10 samples from the southern and outcrop areas were Na^+-HCO_3^- and in 8 samples from the northern area were Na^+-SO_4^{2-}. Predominant ions in two samples near Four Corners consisted of Ca^{2+}-HCO_3^- and Na^+-HCO_3^-. In the western part of the basin, water is dilute and ion concentrations progressively increased northward toward Shiprock.

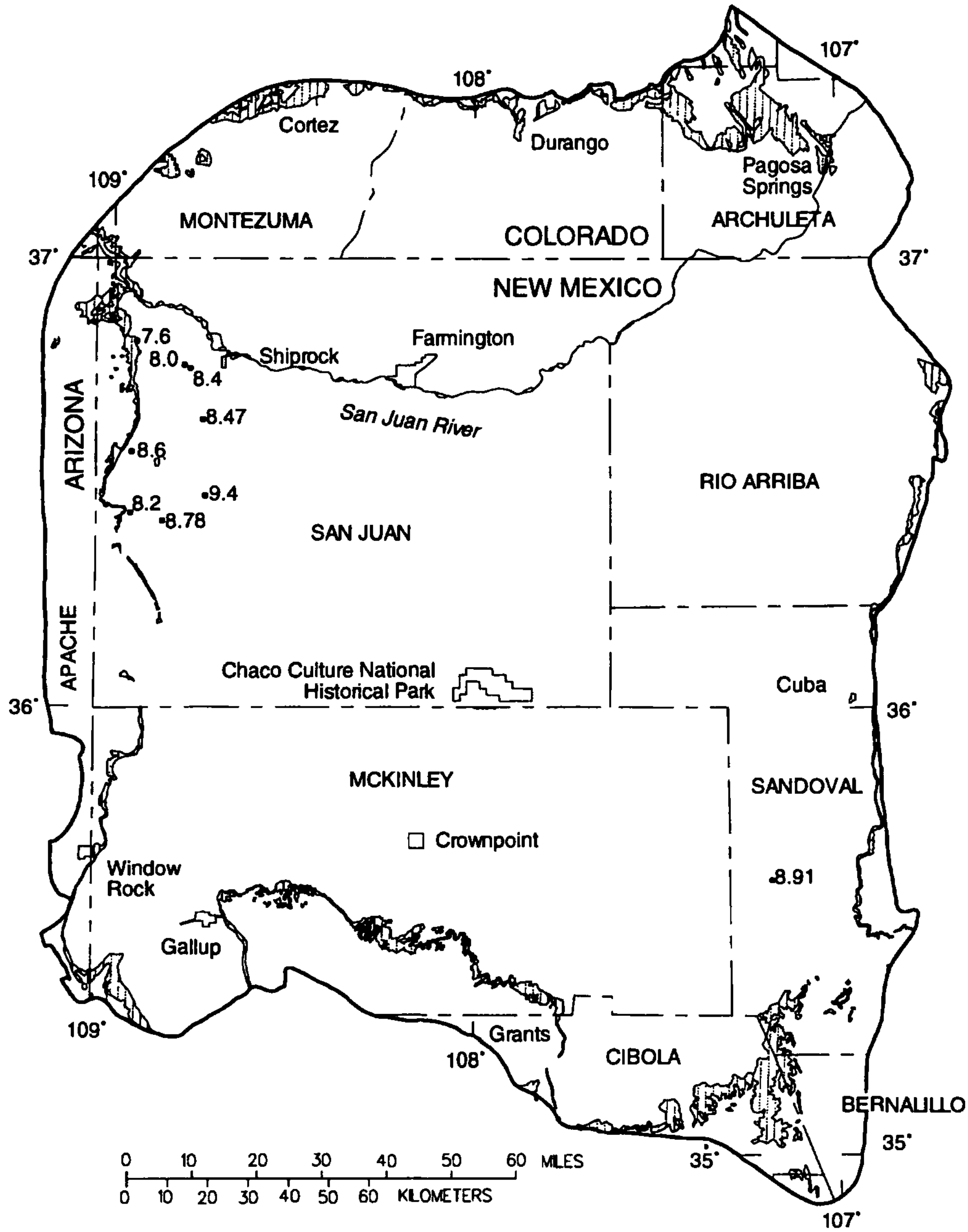
Points in figures 18-20 represent the percentage of a cation, in meq/L, relative to the total sum of cations and the percentage of an anion, in meq/L, relative to the total sum of anions. The intersection of the two percentages is depicted in the quadrangular portion of the trilinear diagram. Calcium concentrations constitute approximately 0 to 35 percent of the total cations in the Gallup, Dakota, and Morrison aquifers (figs. 18-20).



EXPLANATION

[outcrop pattern]	OUTCROP OF GALLUP AQUIFER--In Arizona includes Pescado Tongue of Mancos Shale. In the southeastern part of the study area mapped as part of the Mesaverde Group, undivided. From Dane and Bachman, 1965; and Hackman and Olson, 1977
— —	APPROXIMATE SUBSURFACE EXTENT OF GALLUP AQUIFER--From Molenaar, 1973
———	BOUNDARY OF STUDY AREA
• 7.8	WATER WELL--Number is pH, in standard units

Figure 12.--Values of pH for water from water wells completed in the Gallup aquifer.



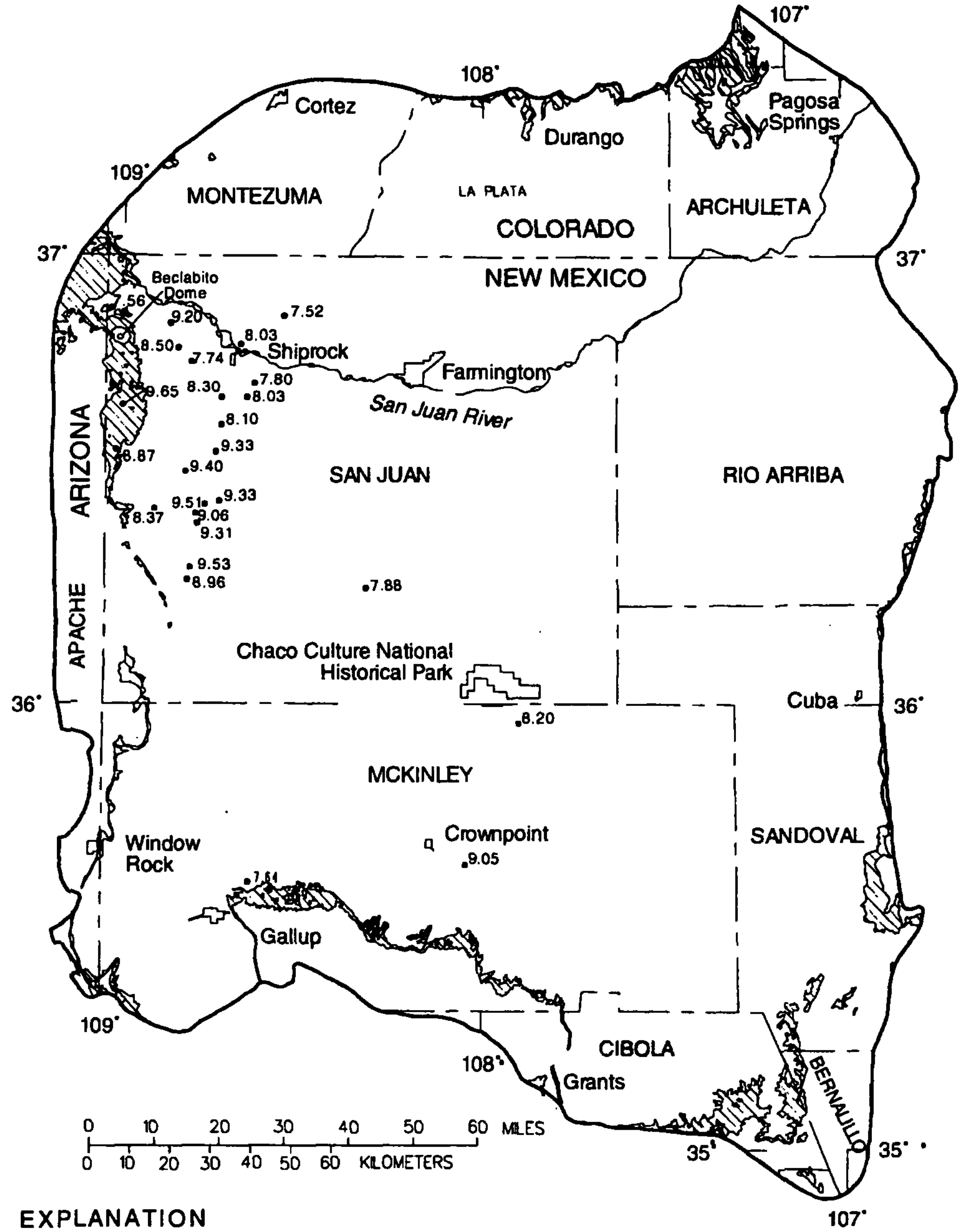
EXPLANATION

OUTCROP OF DAKOTA AQUIFER, MANCOS SHALE, AND BURRO CANYON FORMATION-- From Dane and Bachman, 1965; Wilson and others, 1969; and Tweto, 1979

BOUNDARY OF STUDY AREA

• 9.4 WATER WELL--Number is pH, in standard units

Figure 13.--Values of pH for water from water wells completed in the Dakota aquifer.



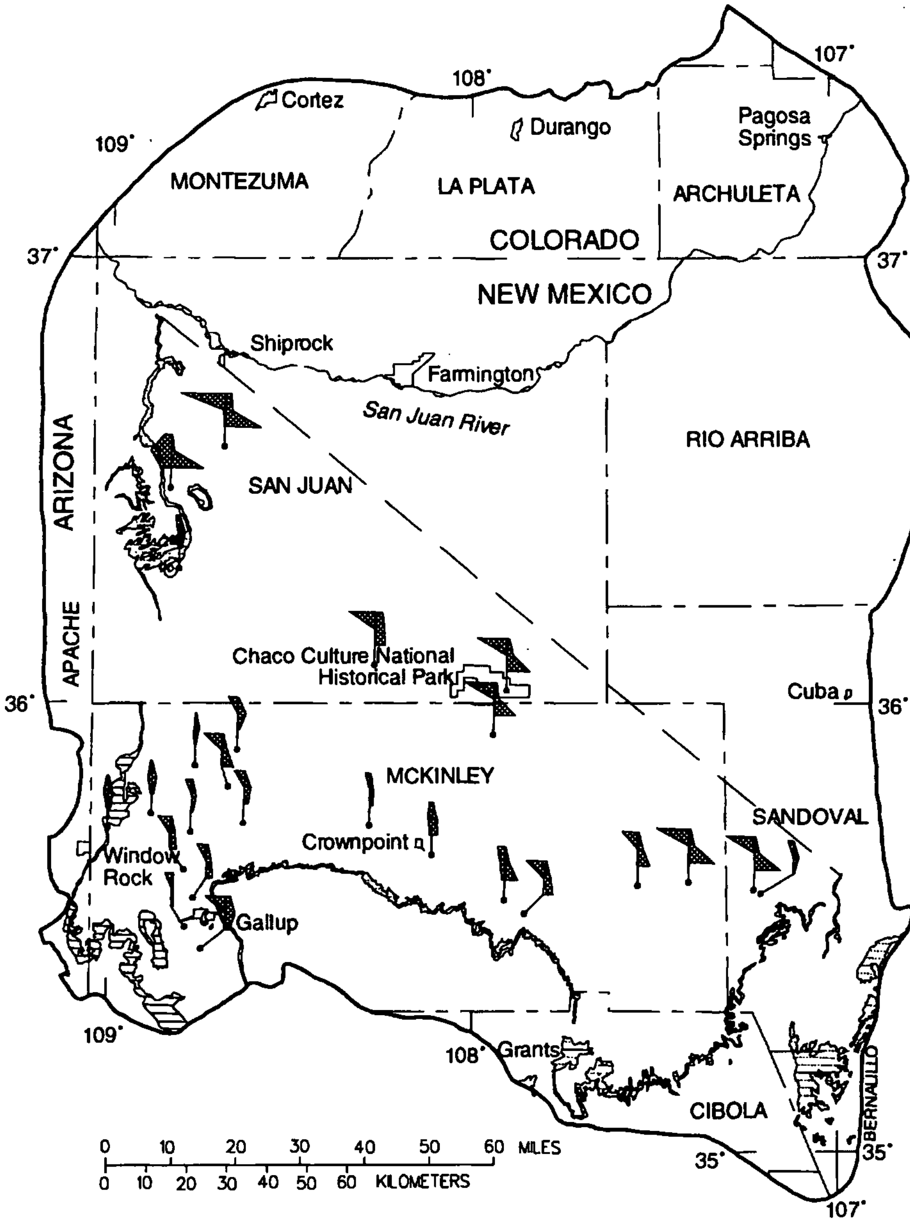
EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

•9.05 WATER WELL--Number is pH, in standard units

Figure 14.--Values of pH for water from water wells completed in the Morrison aquifer.



EXPLANATION

OUTCROP OF GALLUP AQUIFER--In Arizona includes Pescado Tongue of Mancos Shale. In the southeastern part of the study area mapped as part of the Mesaverde Group, undivided. From Dane and Bachman, 1965; and Hackman and Olson, 1977

APPROXIMATE SUBSURFACE EXTENT OF GALLUP AQUIFER--From Molenaar, 1973

BOUNDARY OF STUDY AREA

WATER WELL

CHEMICAL-CONSTITUENT DIAGRAM (modified from Stiff, 1951)

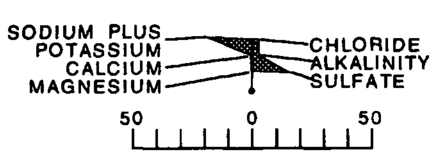


Figure 15.--Chemical-constituent diagrams of water from water wells completed in the Gallup aquifer.

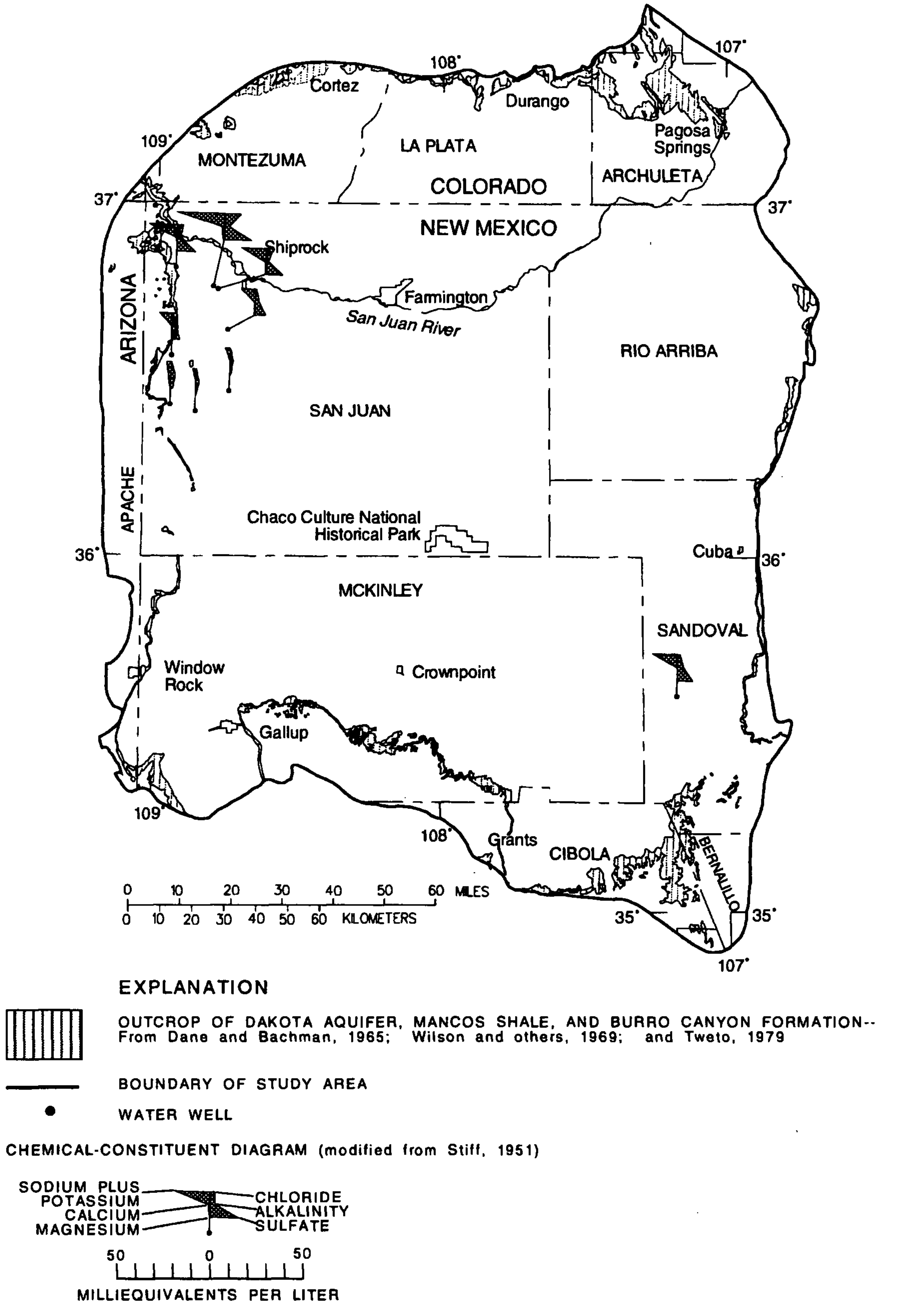
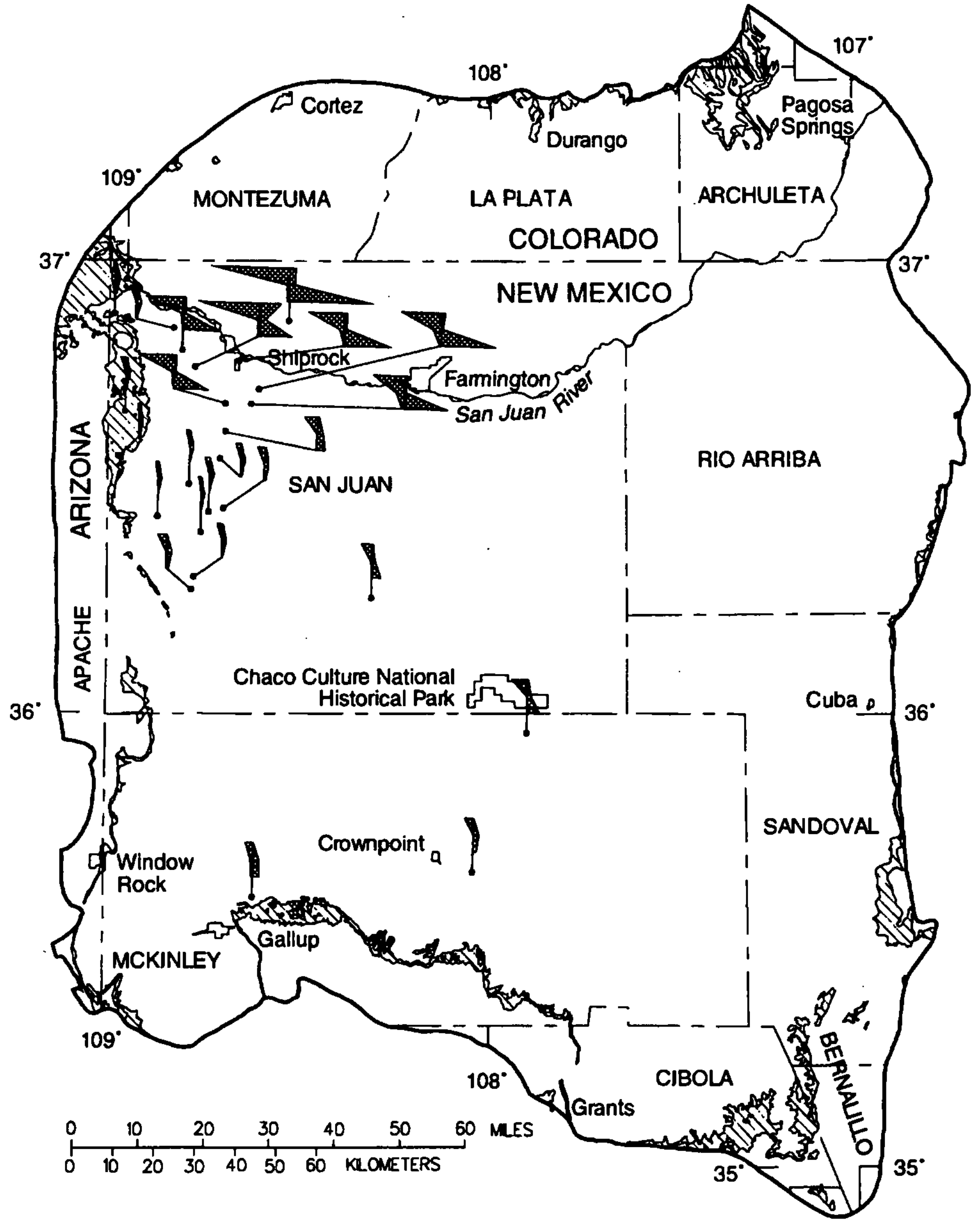


Figure 16.--Chemical-constituent diagrams of water from water wells completed in the Dakota aquifer.



EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

● WATER WELL

CHEMICAL-CONSTITUENT DIAGRAM (modified from Stiff, 1951)

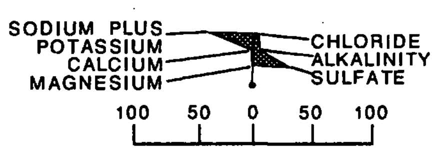


Figure 17.--Chemical-constituent diagrams of water from water wells completed in the Morrison aquifer.

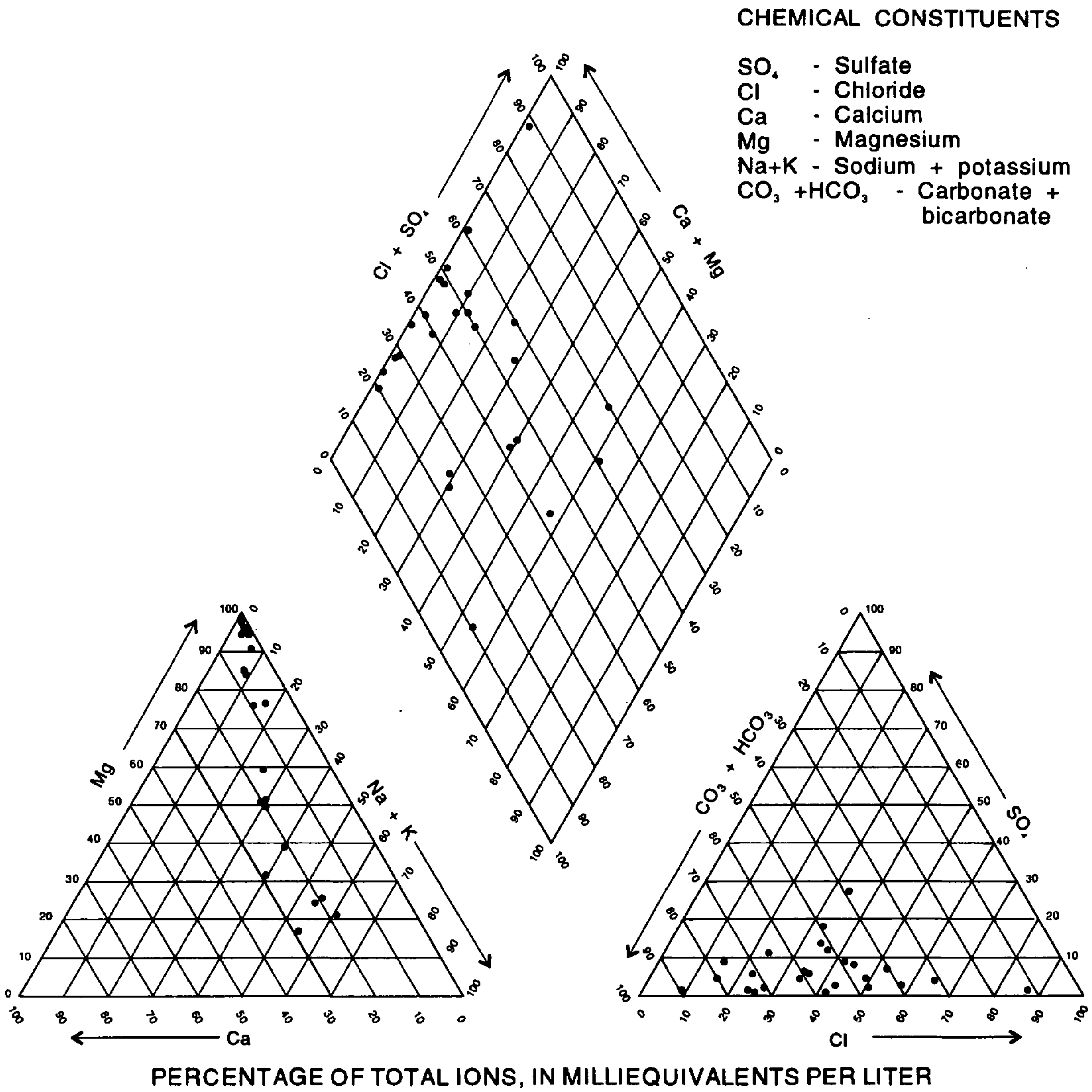


Figure 18.--Trilinear diagram of major ion chemistry from water wells completed in the Gallup aquifer.

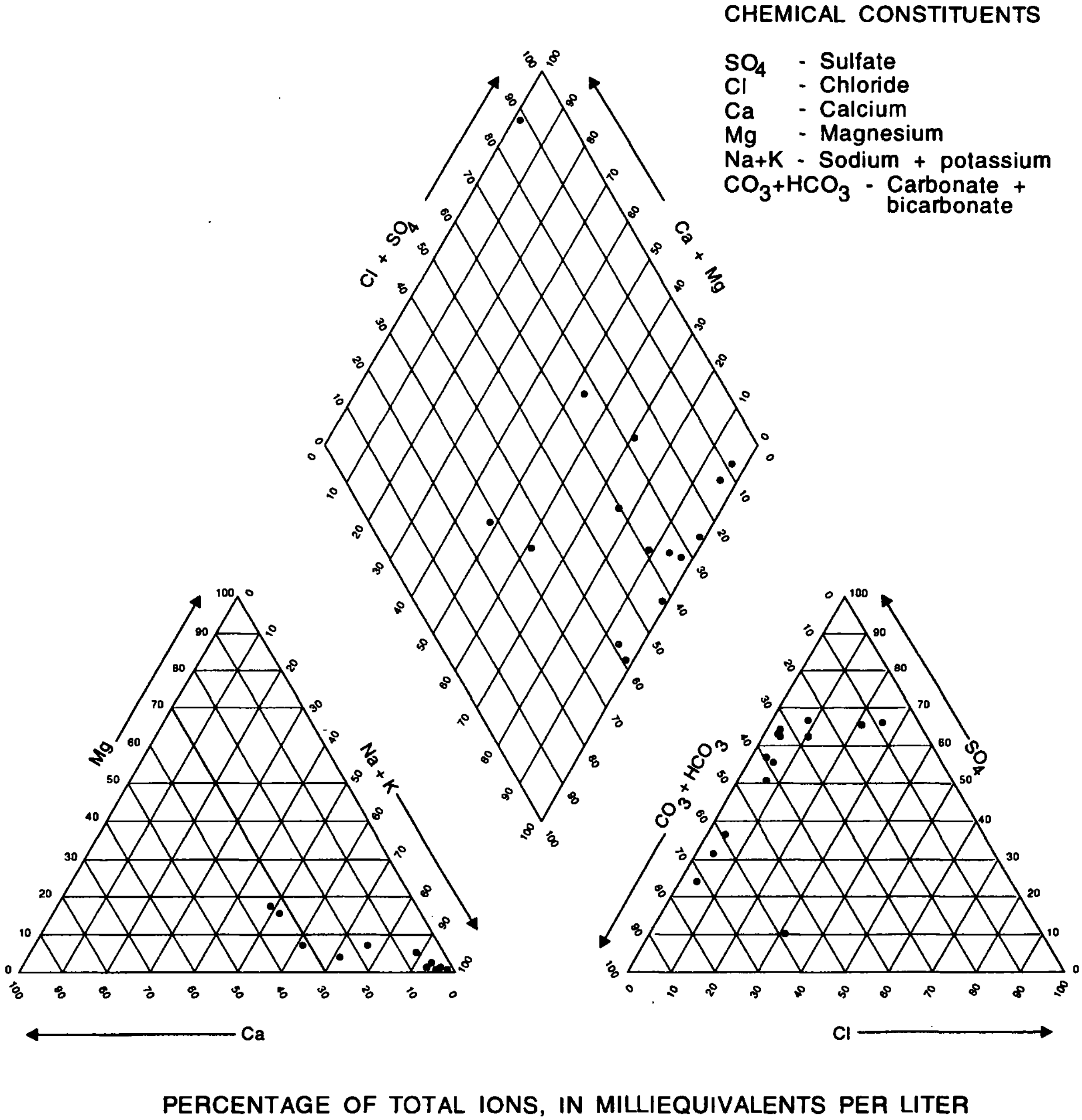


Figure 19.--Trilinear diagram of major ion chemistry from water wells completed in the Dakota aquifer.

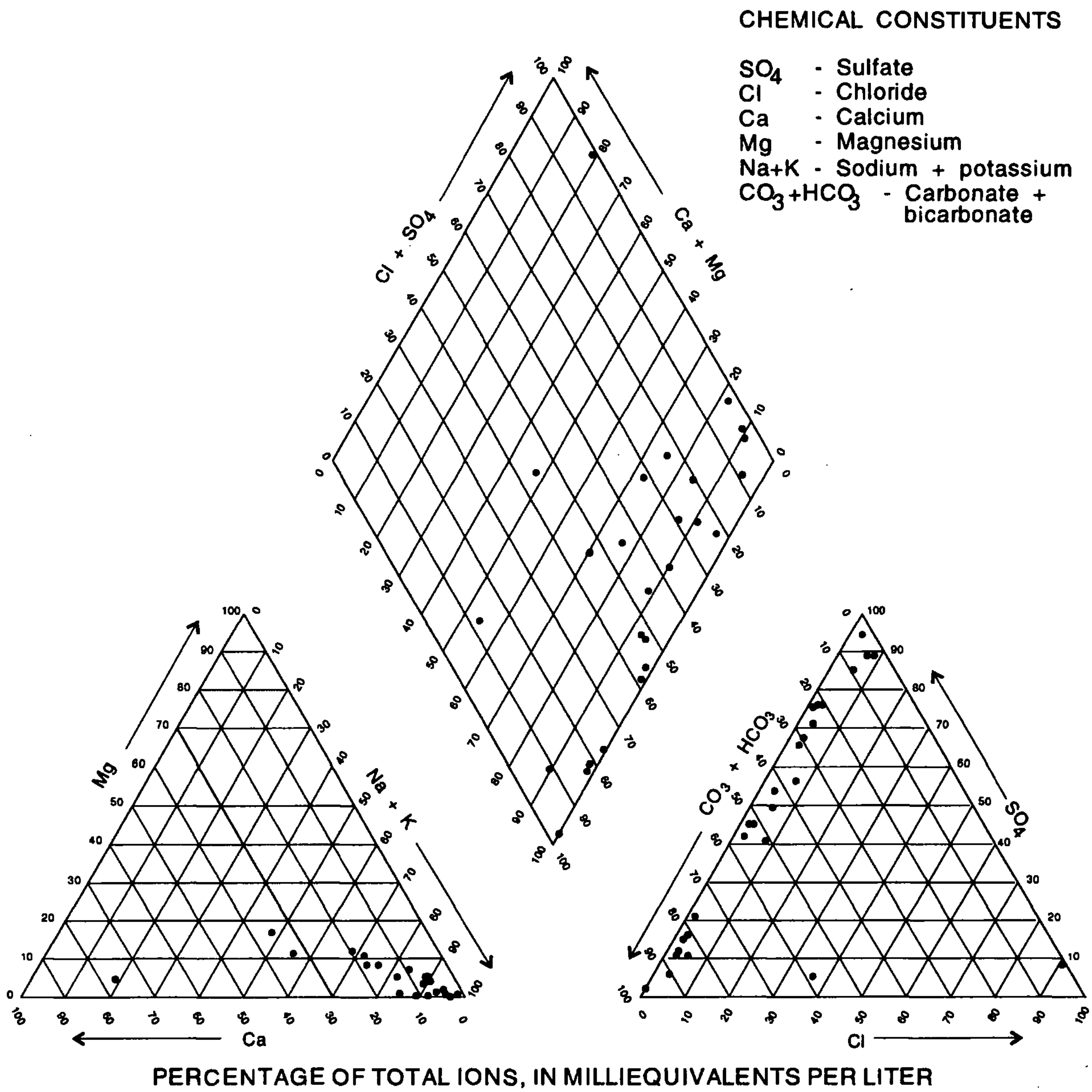


Figure 20.--Trilinear diagram of major ion chemistry from water wells completed in the Morrison aquifer.

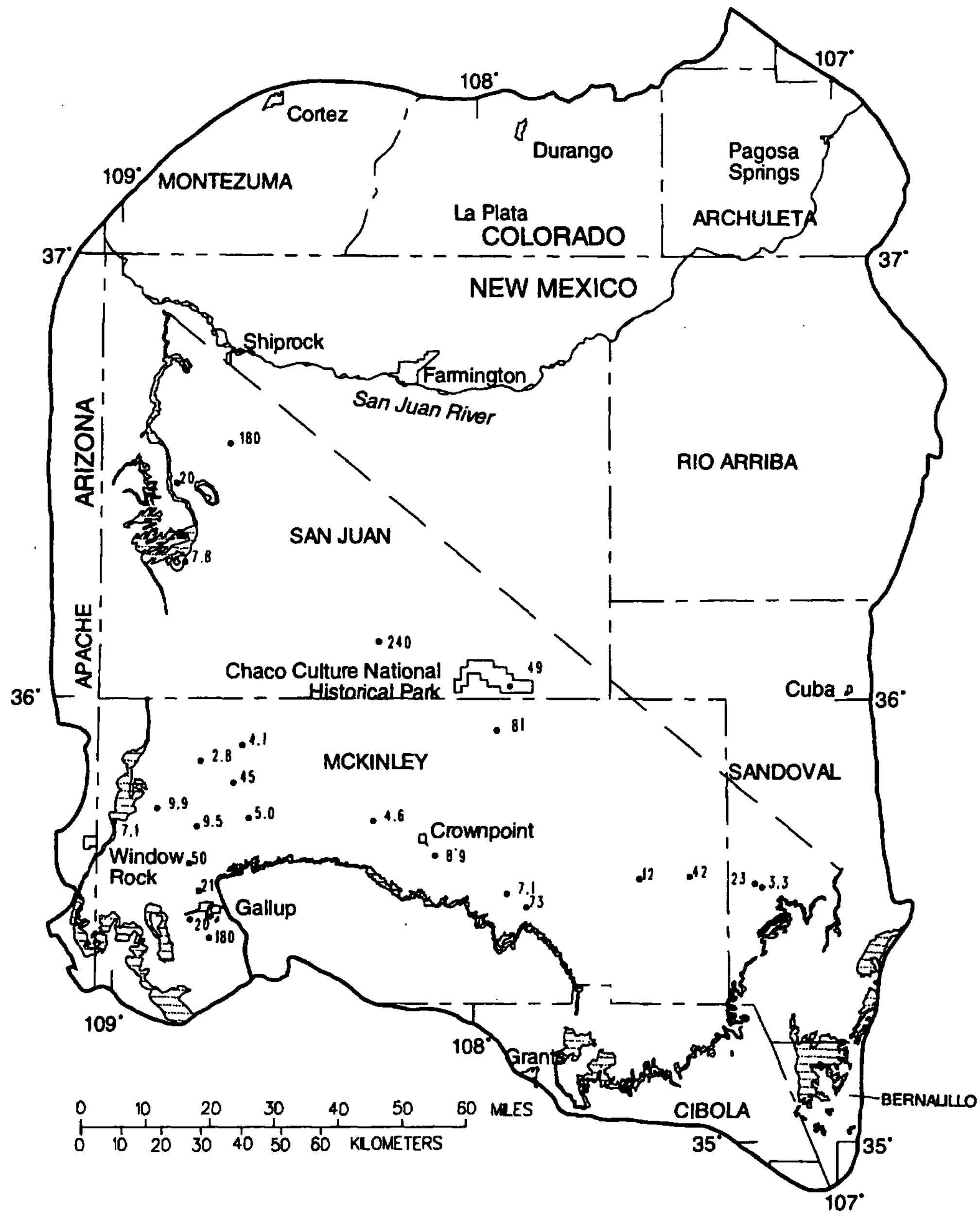
Chloride concentrations were small (less than 25 mg/L) in samples on or near recharge areas for the three aquifers (figs. 21-23). Downgradient, chloride concentrations generally increased by one to two orders of magnitude. Two samples from wells completed in the outcrop area of the Gallup aquifer contained less than 8 mg/L of Cl^- (fig. 21). Chloride concentrations ranged from 2.8 to 180 mg/L in samples downgradient from the western outcrop areas. For three water samples from the Gallup aquifer in the northwestern area, chloride concentrations ranged from 7.8 to 180 mg/L, increasing to the north in the general direction of ground-water flow (fig. 21). Similar trends were observed for the Dakota aquifer (fig. 22). Chloride concentrations were less than 20 mg/L for four samples and increased to the north toward Shiprock to a maximum of 720 mg/L. In outcrop areas of the Morrison aquifer, small chloride concentrations (less than 25 mg/L) as well as large increases (750 mg/L) toward Shiprock were observed (fig. 23). However, six samples at and downgradient from Sanostee contained extremely low chloride values ranging from 0.80 to 3.9 mg/L.

Minor and Trace Constituents

Concentrations of selected minor and trace constituents are shown for the Gallup, Dakota, and Morrison aquifers (tables 2-4, respectively). Dissolved oxygen and sulfide data were used to establish the redox (oxidation-reduction) potential of the water samples. The occurrence of DO in water along outcrop areas generally is anticipated although difficult to measure precisely. Wells sampled on or near outcrops were equipped with piston pumps that can transfer oxygen from the air to the water. For example, at well 38 the DO concentration in water ranged from 4.3 to 5.0 mg/L (table 4), increasing as the rate of pumping decreased. Therefore, values of DO shown in tables 2 and 4 are very approximate. Sulfide was detected in water from several wells downgradient from the outcrop area; this indicates reducing conditions. However, sulfide did not consistently increase to the north toward Shiprock, suggesting that localized conditions, such as the presence of organic matter or availability of reactive iron, may have affected sulfate reduction reactions. Sulfide consists largely of hydrogen sulfide gas (H_2S) and the bisulfide (HS^-) ion. Above a pH of 7.0, sulfide will occur predominantly as HS^- (Stumm and Morgan, 1981, p. 443). Therefore, the alkaline water found in the three aquifers indicates that HS^- was the predominant sulfide species.

Fluoride concentrations generally are small in water samples from the three aquifers (tables 2-4); however, a larger percentage of F^- concentrations were greater than 2 mg/L in samples from wells completed in the Dakota aquifer. The F^- concentration exceeded 2 mg/L for samples from 3 of 25 wells completed in the Gallup aquifer, 2 of 9 wells completed in the Dakota aquifer, and 3 of 25 wells completed in the Morrison aquifer. The 2-mg/L value is the recommended maximum contaminant level set by the U.S. Environmental Protection Agency (1986). The Dakota aquifer commonly contains elevated concentrations of F^- in the San Juan Basin (Craigg and others, 1989) and in other parts of the Western United States (Lawton and others, 1984, p. 227).

To further define geochemical and hydrologic processes within the aquifers, samples were analyzed for Br^- and I^- concentrations (tables 2-4). Bromide solid phases are highly soluble, and concentrations of bromide in most natural water are not affected by redox reactions, sorption, or precipitation reactions (Whittemore, 1988). Bromide concentrations ranged from 0.010 mg/L in water from well 30 to 0.38 mg/L in water from well 15. Both wells were completed in the Morrison aquifer, and bromide concentrations for the Gallup and Dakota aquifers were within this range (tables 2-4). For water from downgradient wells northeast of well 30 where chloride decreased in concentration, Br^- concentrations increased only slightly (as much as three times higher) relative to the Br^- concentration at well 30.



EXPLANATION

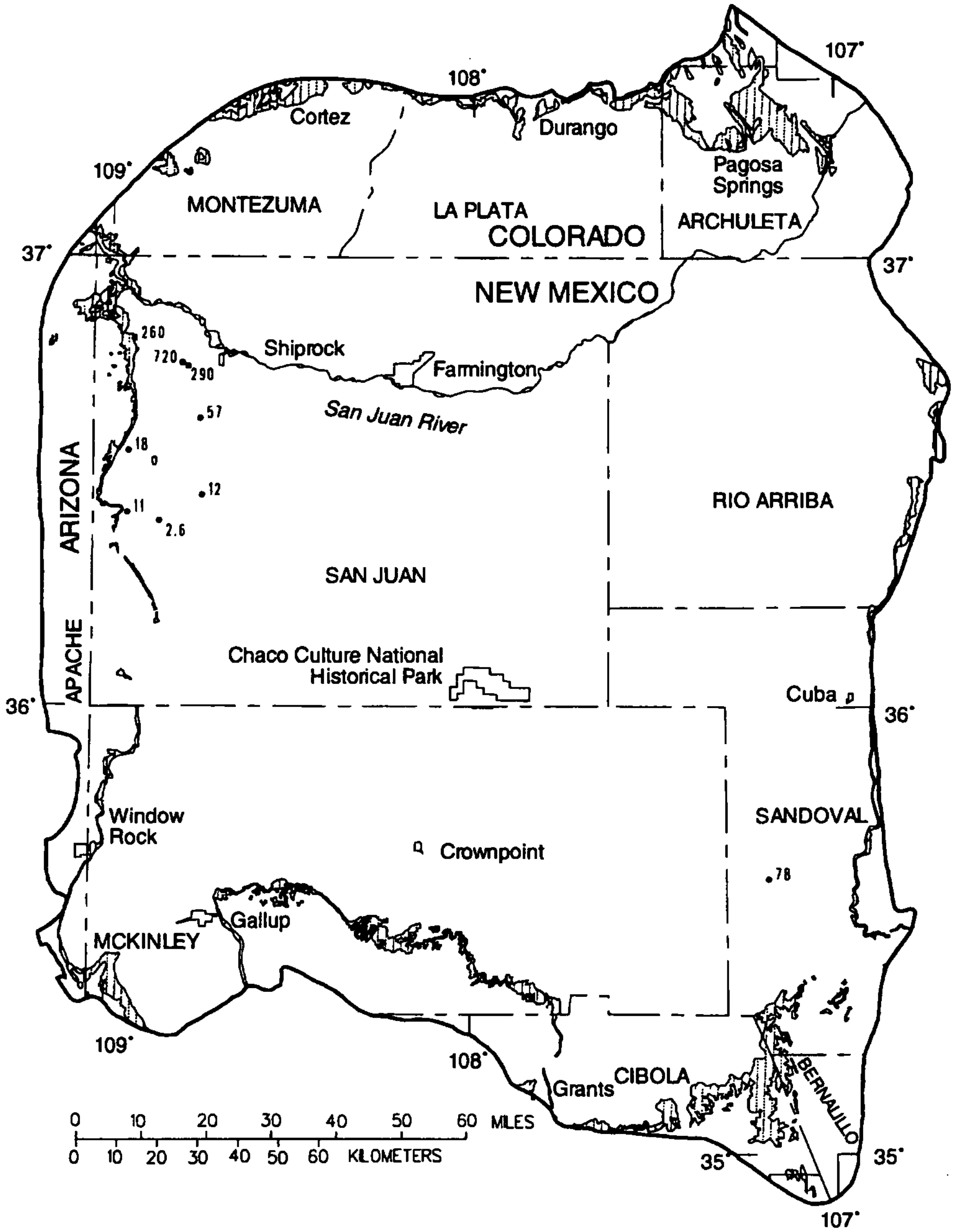
OUTCROP OF GALLUP AQUIFER--In Arizona includes Pescado Tongue of Mancos Shale. In the southeastern part of the study area mapped as part of the Mesaverde Group, undivided. From Dane and Bachman, 1965; and Hackman and Olson, 1977

APPROXIMATE SUBSURFACE EXTENT OF GALLUP AQUIFER--From Molenaar, 1973

BOUNDARY OF STUDY AREA

• 81 WATER WELL--Number is concentration of chloride, in milligrams per liter

Figure 21.--Concentration of chloride in water from water wells completed in the Gallup aquifer.



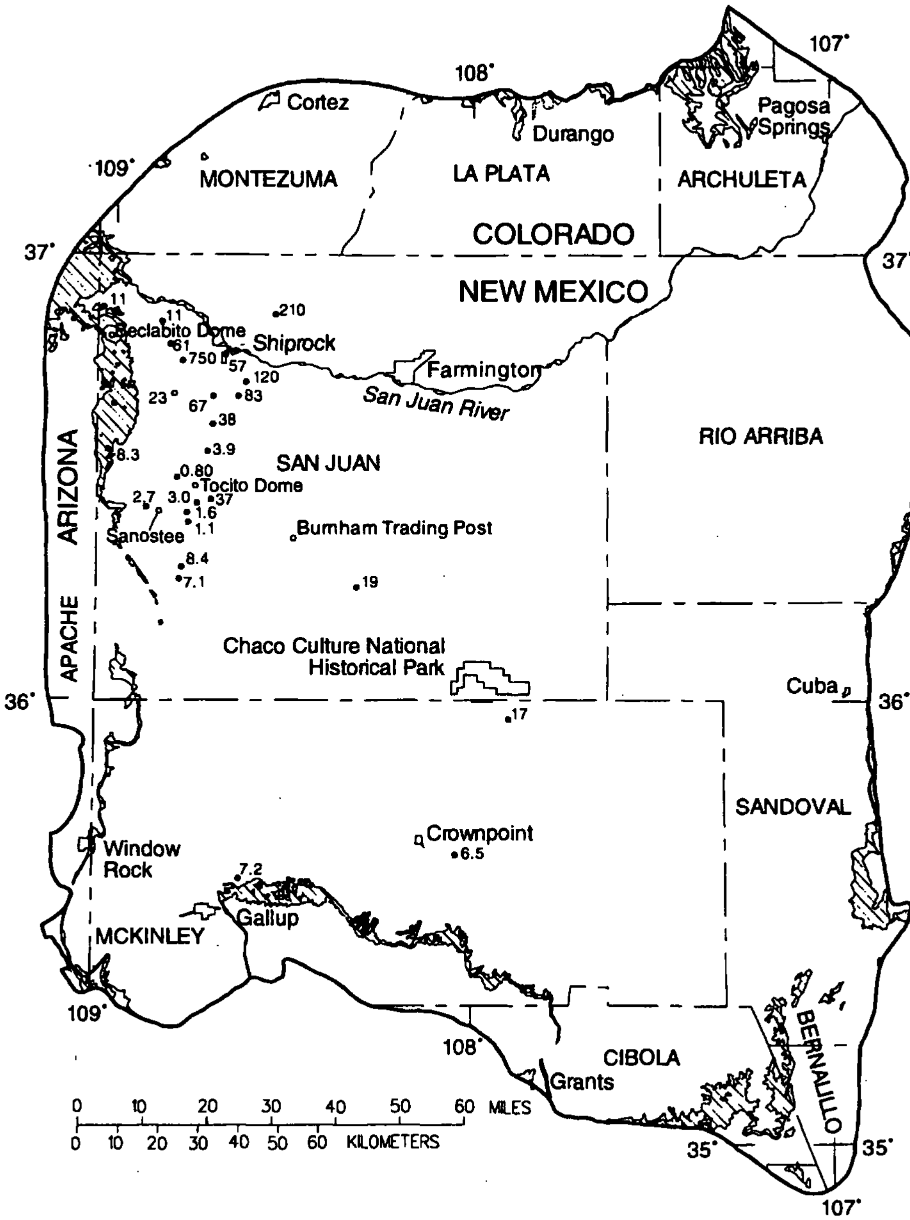
EXPLANATION

OUTCROP OF DAKOTA AQUIFER, MANCOS SHALE, AND BURRO CANYON FORMATION--From Dane and Bachman, 1965; Wilson and others, 1969; and Tweto, 1979

BOUNDARY OF STUDY AREA

•78 WATER WELL--Number is concentration of chloride, in milligrams per liter

Figure 22.--Concentration of chloride in water from water wells completed in the Dakota aquifer.



EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

• 6.5 WATER WELL--Number is concentration of chloride, in milligrams per liter

Figure 23.--Concentration of chloride in water from water wells completed in the Morrison aquifer.

Concentrations of silica ranged from 8.5 to 35 mg/L in the three aquifers (tables 2-4). Median SiO_2^0 concentrations in samples from the Gallup, Dakota, and Morrison aquifers were 13, 9.8, and 17 mg/L, respectively.

Data for dissolved nutrients and dissolved organic carbon in the three aquifers are shown in table 5. Nitrate was detected in samples from only four wells. Two wells located in the outcrop area of the Morrison aquifer contained NO_3^- concentrations greater than 0.2 mg/L. Ammonium was not detected in samples near outcrops, but a concentration of 0.520 mg/L was measured in well 20 in the Morrison aquifer south of Shiprock.

Trace-constituent data for samples collected from the three aquifers are presented in table 6. Constituent concentrations generally found to be below the minimum reporting level were Al, Be, Cd, Cr, Co, Cu, Pb, Hg, Mo, Ni, Se, Ag, and V. Trace-element concentrations generally found to be above the minimum reporting level included As, Ba, B, Fe, Li, Mn, and Sr. The minimum reporting levels differ for some elements due to the requested level of detection.

Twenty-three samples were filtered with both a 0.10-µm filter and a 0.45-µm filter (table 6). Of these 23 samples, 11 in which the 0.45-µm filter was used were larger or equal in concentration to the samples in which the 0.10-µm filter was used. This suggests that some Fe colloids passing through a 0.45-µm filter are removed with a 0.10-µm filter as described by Kennedy and others (1974). Iron concentrations in the 0.10-µm filtered samples that were greater than concentrations in the 0.45-µm filtered samples (12 of 23) may be caused by analytical uncertainties or field-collection techniques. There are no apparent systematic areal patterns of Fe concentrations in the Gallup aquifer. Iron concentrations in samples from the Dakota aquifer indicate a general increase in the direction of ground-water flow to the north. Iron concentrations in the Morrison aquifer were generally less than 12 µg/L in the recharge area and increased to a maximum value of 980 µg/L in a sample from a well near the San Juan River discharge area.

Arsenic concentration was less than 1 µg/L in 12 of 14 samples collected from the Gallup and Dakota aquifers, but was less than 1 µg/L in only 4 of 23 samples from the Morrison aquifer (table 6).

Concentrations of Li generally were larger in the Morrison aquifer than in the other two aquifers and increased in the direction of ground-water flow. Lithium concentrations in the Morrison aquifer increased from less than 50 µg/L in samples collected from wells in the recharge area to 540 µg/L in a sample collected from well 20 near the San Juan River.

Strontium concentrations in samples generally increased in the direction of ground-water flow in the three aquifers. In the Gallup aquifer, Sr^{2+} concentrations were 360 µg/L or less except for one concentration that was 920 µg/L (table 6). In the Dakota aquifer, Sr^{2+} concentrations were variable both spatially and in samples from the same well. Strontium concentrations ranged from 140 to 3,300 µg/L in four samples from three wells completed in the Dakota aquifer. Water from well 13 on two different dates contained Sr^{2+} concentrations of 350 and 3,300 µg/L, suggesting a problem in reproducibility and a need for additional sampling to verify Sr^{2+} concentrations. Strontium concentrations in the Morrison aquifer ranged from 38 to 12,000 µg/L and were substantially larger than in the other two aquifers.

Table 5.--Concentrations of dissolved nutrients and dissolved organic carbon in water from the Gallup, Dakota, and Morrison aquifers

[See figures 8-10 for location of wells. Wells 1-10 are completed in the Gallup aquifer, wells 11 and 13 in the Dakota aquifer, and wells 14-38 in the Morrison aquifer. Concentrations in milligrams per liter; --, not reported; <, less than detection limit]

Well number	Date of sample	Nitrite, as N	Nitrite plus nitrate, as N	Nitrogen ammonia, as N	Nitrogen ammonia plus organic, as N	Phosphorus, as P	Phosphorus ortho-phosphate, as P	Organic carbon
1	07-01-88	<0.010	<0.100	0.220	0.40	0.010	<0.010	--
2	04-22-86	--	--	--	--	--	--	1.3
	10-21-87	<0.010	<.100	.460	2.2	<.010	.021	.6
3	04-21-86	--	--	--	--	--	--	1.1
4	07-15-88	--	--	--	--	--	--	1.6
5	06-30-87	<.010	<.100	.041	1.9	.010	.010	.9
6	06-30-88	<.010	<.100	.180	.50	.021	.021	--
7	06-28-88	.021	.130	.041	.20	.021	.030	--
8	12-03-87	<.010	<.100	.060	<.20	.010	<.010	.8
9	04-29-86	--	--	--	--	--	--	1.1
	08-11-87	<.010	<.100	.030	<.20	.021	.010	--
10	06-30-88	<.010	<.100	.070	.30	.120	.120	.8
11	07-23-87	<.010	<.100	.120	.40	.010	<.010	--
13	04-29-86	--	--	--	--	--	--	1.0
	12-03-87	<.010	<.100	.730	.80	.010	<.010	--
14	06-10-88	.010	<.100	.041	<.20	<.010	<.010	--
15	06-24-86	--	--	--	--	--	--	.4
	07-21-87	<.010	<.100	.760	1.0	.010	<.010	1.8
17	07-02-86	--	--	--	--	--	--	.1
18	06-16-86	--	--	--	--	--	--	.2
	06-09-87	<.010	<.100	.540	1.3	.010	<.010	--
19	06-19-86	--	--	--	--	--	--	.2
	07-14-87	<.010	<.100	.140	.80	.010	<.010	1.8
20	06-10-87	<.010	<.100	.520	1.1	.010	<0.010	--
21	06-18-86	--	--	--	--	--	--	0.1
22	06-19-86	--	--	--	--	--	--	.2
	06-10-87	<.010	<.100	.450	1.3	.010	<.010	--
23	06-10-88	.021	.230	.010	<.20	.010	<.010	--
24	07-01-86	--	--	--	--	--	--	.6
25	06-09-88	<.010	.220	.010	<.20	<.010	<.010	.6
26	07-22-87	<.010	<.100	<.010	.90	<.010	<.010	--
	06-17-86	--	--	--	--	--	--	.2
27	06-18-86	--	--	--	--	--	--	.2
28	06-30-86	--	--	--	--	--	--	.2
	07-17-87	<.100	<.100	.021	.60	.010	<.010	--
30	07-23-87	<.010	<.100	<.010	.50	<.010	<.010	1.7
32	06-24-86	--	--	--	--	--	--	.2
	07-15-87	.021	.110	<.010	.20	.041	.021	--
33	07-15-87	<.010	<.100	<.010	.40	.030	.030	1.9
34	07-16-87	<.010	<.100	<.010	.30	.010	<.010	1.7
35	06-11-87	<.010	<.100	.110	.50	.010	<.010	4.1
36	04-24-86	--	--	--	--	--	--	.5
	10-22-87	<.010	<.100	.021	<.20	<.010	.021	.3
37	10-02-87	<.010	<.100	.090	.30	.010	.021	--
	07-01-87	<.010	<.100	.110	.30	.010	<.010	1.1
38	07-01-87	<.010	<.100	.110	.30	.010	<.010	1.1

Table 6.--Concentration of dissolved trace constituents in water from the Gallup, Dakota, and Morrison aquifers

[See figure 8-10 for location of wells; wells 1-10 are completed in the Gallup aquifer, wells 11-13 in the Dakota aquifer, and wells 14-38 in the Morrison aquifer; concentrations in micrograms per liter; --, not reported; <, concentration less than detection limit; samples filtered with a 0.45-micron filter except Al.1, Fe.1, and Mn.1 where a 0.10-micron filter was used]

Well number	Date of sample	Aluminum (Al)	Aluminum (Al.1)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Boron B	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Iron (Fe.1)
1	07-01-88	<10	--	2	33	<.05	--	<1	<1	<3	<1	330	--
2	04-22-86	<10	<10	<1	17	<17	--	<3	<1	<1	2	309	160
	10-21-87	<10	--	<1	<100	<10	--	<1	<1	2	1	250	--
3	04-21-86	10	10	<1	100	<10	--	<1	<1	<1	1	40	50
4	07-15-88	<10	--	<1	26	<.5	--	<1	<1	<3	2	22	--
5	06-30-87	<10	<20	<1	<34	<.5	--	<1	<1	<10	<10	<21	40
	06-28-88	<10	--	--	--	--	110	--	--	--	--	30	--
6	06-30-88	<10	--	<1	31	<.5	--	<1	2	<3	1	17	--
7	06-28-88	<10	--	<1	38	<.5	--	<1	1	<3	5	16	--
8	12-03-87	<10	--	<1	<100	<10	--	<1	<1	<1	<1	430	--
9	04-29-86	<10	<10	<1	7	<5	--	<1	<1	<3	1	10	10
	08-11-87	<10	--	--	--	--	90	--	--	--	--	<3	--
10	06-30-88	<10	--	<1	14	<.5	--	<1	<1	<3	44	640	--
11	07-23-87	<10	--	<1	10	<.5	--	<1	<1	<3	<1	680	--
12	06-29-88	<10	--	1	24	<.5	--	<1	<1	<3	1	53	--
13	04-29-86	<10	<10	<1	<100	<10	--	<1	<1	1	2	70	30
	12-03-87	<10	--	--	--	--	200	--	--	--	--	17	--
14	06-10-88	<10	--	1	19	<.5	--	<1	3	<3	6	440	--
15	07-21-87	20	10	1	<100	<10	--	<1	<1	<1	<1	300	230
16	06-24-86	<10	20	21	17	<.5	--	<1	<1	<3	<1	7	10
	06-08-88	<10	--	--	--	--	180	--	--	--	--	12	--
17	07-02-86	<10	--	12	<100	<10	--	<1	<1	<1	<1	30	--
18	06-16-86	<10	<10	<1	100	<10	--	<1	<1	<1	<1	170	160
	06-09-87	<10	--	--	--	--	150	--	--	--	--	170	--
19	07-14-87	--	<10	--	--	--	1,600	--	--	--	--	980	1,000
20	06-19-86	<10	--	13	100	<10	--	<1	<1	<1	<1	990	--
	06-10-87	<10	--	--	--	--	300	--	--	--	--	470	--
21	06-18-86	<10	10	1	100	<10	--	<1	<1	<1	1	540	540
22	06-19-86	<10	10	2	100	<10	--	<1	<1	<1	<1	140	150
	06-10-87	<10	--	--	--	--	150	--	--	--	--	240	--
23	06-10-88	<10	--	3	26	<0.5	--	<1	1	<3	<1	140	--
24	07-01-86	<10	<10	<1	10	<.5	--	<1	<1	<3	2	159	180
25	06-09-88	<10	--	2	120	<.5	--	<1	1	<3	1	85	--
	04-25-89	<10	--	--	--	--	30	--	--	--	--	180	--
26	06-17-86	20	20	4	36	<.5	--	<1	<1	<3	<1	6	<10
	07-22-87	20	--	--	--	--	30	--	8	--	--	15	--
	07-01-88	10	--	--	--	--	30	--	--	--	--	3	--
27	06-18-86	20	10	3	25	<.5	--	<1	<1	<3	1	<3	<10
	06-11-88	20	--	--	--	--	20	--	--	--	--	7	--
28	06-30-89	10	10	3	15	<.5	--	<1	<1	<3	1	3	<10
	07-17-87	10	6	--	--	--	--	--	--	--	--	--	--
	07-01-88	<10	--	--	--	--	100	--	--	--	--	>3	--
29	06-29-88	20	--	2	9	<.5	--	<1	1	<3	<1	8	--
	11-22-88	20	--	--	--	--	--	--	--	--	--	--	<3
30	07-23-87	<10	<10	11	61	<.5	--	<1	<1	<3	3	11	<10
	01-05-89	<10	--	--	--	--	--	--	--	--	--	--	11
31	01-05-89	10	--	--	--	--	--	--	--	--	--	--	8
32	06-24-86	20	20	2	24	<.5	--	<1	1	<3	1	7	<10
	07-15-87	30	--	--	--	--	10	--	--	--	--	34	--
	06-11-88	30	--	--	--	--	20	--	--	--	--	--	19
33	07-15-87	--	20	--	--	--	--	--	--	--	--	<10	--
	06-29-88	20	--	--	--	--	110	--	--	--	--	6	--
	11-23-88	<10	--	--	--	--	70	--	--	--	--	<3	--
34	07-16-87	<10	10	4	43	.5	--	1	<1	<3	<1	14	<10
	11-22-88	<10	--	--	--	--	--	--	--	--	--	8	--
35	06-11-87	20	20	5	46	<.5	--	<1	<1	<3	<1	140	120
36	04-24-86	<10	<10	6	30	<.5	--	<1	<1	<3	1	159	250
	10-22-87	<10	10	6	42	<.5	--	<1	<1	<3	<1	100	70
37	10-02-87	<10	<10	<1	34	<.5	--	<1	<1	<3	1	14	<10
38	07-01-87	<10	<10	<1	12	<.5	--	<1	<1	<3	<1	680	1,900
	07-14-88	<10	--	--	--	--	120	--	--	--	--	620	--

Table 6.— Concentration of dissolved trace constituents in water from the Gallup, Dakota, and Morrison aquifers--Concluded

Well number	Date of sample	Lead (Pb)	Lithium (Li)	Manganese (Mn)	Manganese (Mn.1)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Strontium (Sr)	Vanadium (V)	Zinc (Zn)
1	07-01-88	<5	46	150	--	<0.1	<10	<1	<1	<1	920	<6	31
2	04-22-86	1	98	8	10	<.1	<1	<1	<1	<1	350	1	<9
	10-21-87	<5	120	<10	--	<.1	<1	5	<1	<1	350	<1	<10
3	04-21-86	<1	70	20	20	<.1	<1	1	<1	<1	280	<1	<10
4	07-15-88	<5	14	4	--	<.1	<10	<1	<1	1	97	<6	5
5	06-30-87	<10	<4	<5	<10	.1	<10	1	<1	1	89	<6	<100
	06-28-88	--	--	5	--	--	--	--	--	--	85	--	--
6	06-30-88	<5	12	6	--	.1	<10	1	<1	<1	89	<6	19
7	06-28-88	5	<4	4	--	<.1	<10	4	<1	<1	52	<6	<3
8	12-03-87	<5	100	20	--	.1	3	<1	<1	<1	360	<1	<10
9	04-29-86	<1	23	2	<10	<.1	<10	1	<1	<1	26	<6	<3
	08-11-87	--	--	2	--	--	--	--	--	--	26	--	--
10	06-30-88	<5	10	20	--	<.1	<10	<1	10	<1	18	<6	590
11	07-23-87	<5	140	30	--	.1	<10	<1	<1	<1	930	<6	4
12	06-29-88	<5	24	7	--	<.1	<10	<1	<1	1	140	<6	34
13	04-29-86	1	100	60	10	<.1	<1	<1	<1	<1	350	2	<10
	12-03-87	--	--	<3	--	--	--	--	--	--	3,300	--	--
14	06-10-88	<5	15	61	--	<.1	<10	5	<1	<1	1,100	<6	150
15	07-21-87	<5	840	130	140	<.1	<1	<1	<1	<1	6,700	3	40
16	06-24-86	<5	61	<1	<10	<.1	<10	<1	<1	<1	62	<6	6
	06-08-88	--	--	<1	--	--	--	--	--	--	66	--	--
17	07-02-86	<5	270	70	--	.1	1	<1	<1	<1	7,500	<1	<10
18	06-16-86	<5	300	100	90	<.1	1	<1	<1	<1	12,000	<1	10
	06-09-87	--	--	87	--	--	--	--	--	--	11,000	--	--
19	07-14-87	--	--	30	30	--	--	--	--	--	--	--	--
20	06-19-86	<5	540	110	16	<.1	13	<1	<1	<1	10,000	2	10
	06-10-87	--	--	87	--	--	--	--	--	--	9,000	--	--
21	06-18-86	<5	270	70	70	<.1	2	1	<1	<1	7,500	<1	<10
22	06-19-86	<5	220	160	160	<.1	3	<1	<1	<1	11,000	<1	<10
	06-10-87	--	--	9	--	--	--	--	--	--	9,800	--	--
23	06-10-88	<5	33	3	--	<0.1	<10	6	3	<1	100	<6	27
24	07-01-86	<5	88	3	<10	<.1	<10	1	<1	<1	469	<6	8
25	06-09-88	<1	37	2	--	<.1	<10	5	27	<1	1,100	6	94
	04-25-89	--	--	3	--	--	--	--	--	--	380	--	--
26	06-17-86	<5	20	3	<10	.3	<10	<1	<1	<1	70	<6	9
	07-22-87	--	--	4	--	--	--	--	--	--	63	--	--
	07-01-88	--	--	<1	--	--	--	--	--	--	71	--	--
27	06-18-86	<5	40	<1	<10	<.1	<10	<1	<1	<1	67	<6	7
	06-11-88	--	--	<1	--	--	--	--	--	--	76	--	--
28	06-30-89	<5	38	<1	<10	<.1	<10	<1	<1	<1	260	<6	10
	07-17-87	--	--	2	--	--	--	--	--	--	650	--	--
	07-01-88	--	--	<1	--	--	--	--	--	--	380	--	--
29	06-29-88	<1	15	2	--	<.1	<10	<1	5	<1	47	<6	<3
	11-22-88	--	--	1	--	--	--	--	--	--	56	--	--
30	07-23-87	<5	35	<1	<10	<.1	<10	<1	2	<1	810	14	51
	01-05-89	--	--	2	--	--	--	--	--	--	780	--	--
31	01-05-89	--	--	<1	--	--	--	--	--	--	47	--	--
32	06-24-86	<5	41	3	<10	<.1	<10	<1	2	<1	42	14	10
	07-15-87	--	--	2	--	--	--	--	--	--	39	--	--
	06-11-88	--	--	<1	--	--	--	--	--	--	41	--	--
33	07-15-87	--	--	--	<10	--	--	--	--	--	--	--	--
	06-29-88	--	--	3	--	--	--	--	--	--	45	--	--
	11-23-88	--	--	3	--	--	--	--	--	--	38	--	--
34	07-16-87	<5	42	13	10	.1	<10	<1	<1	<1	130	--	--
	11-22-88	--	--	12	--	--	--	--	--	--	140	--	--
35	06-11-87	6	70	19	20	.1	<10	<1	<1	1	1,100	<6	6
36	04-24-86	1	109	8	20	.1	30	<1	<1	<1	2,400	<6	<3
	10-22-87	<5	110	10	<10	<.1	30	1	<1	<1	2,200	<6	<3
37	10-02-87	<5	33	7	<10	<.1	<10	1	<1	<1	100	<6	5
38	07-01-87	<5	60	140	150	<.1	<10	3	<1	<1	2,000	6	200
	07-14-88	--	--	130	--	--	--	--	--	--	2,100	--	--

Dissolved Gases

Direct measurement of gas composition is useful for correcting pH values of water that loses carbon dioxide gas (Pearson and others, 1978). Results of four gas analyses for the Morrison aquifer are shown in table 7. The samples appear to be representative of dissolved-gas compositions expected from the aquifer.

Table 7.--Concentrations of dissolved gases in water from the Morrison aquifer
[See figures 8-10 for location of wells; concentration in milligrams per liter; nd, not detected]

Well number	Date of sample	Nitrogen (N_2)	Oxygen (O_2)	Argon (Ar)	Carbon dioxide (CO_2)	Methane (CH_4)	Ethane (C_2H_6)
18	06-09-87	1.48	0.004	0.015	0.0007	0.008	nd
20	06-10-87	1.34	.007	.014	.001	.051	0.002
22	06-10-87	1.42	.010	.015	.0007	.018	nd
35	06-11-87	1.08	.009	.014	.003	.001	nd

Stable Isotopes

To evaluate hydrologic and geochemical processes, the stable isotopes of $\delta^{18}O$, δD, $\delta^{13}C$, and $\delta^{34}S$ were determined. Data for the first three isotopes are presented in the text. Stable-isotopic ratios are expressed in units of parts per thousand (per mil, $^0/_{00}$) relative to a standard:

$$\delta_x = \left[\frac{R_x}{R_s} - 1\right] \times 1,000 \qquad (1)$$

where δ is delta;
R is the ratio of heavier to lighter isotope;
x is the sample; and
s is the standard.

For an example of deriving the delta (δ) notation, hydrogen isotopes are the ratio of deuterium (D = ^2H) to hydrogen (H):

$$\delta D = \left[\frac{\frac{D}{H_x}}{\frac{D}{H_{V-SMOW}}} - 1\right] \times 1,000 \qquad (2)$$

where V-SMOW is Vienna-Standard Mean Ocean Water.

Oxygen and hydrogen isotopes can be ideal tracers of water movement because they compose the water. Isotopic variations in precipitation (atmospheric deposition) result from changes in temperature, altitude, and other factors. For example, winter precipitation is depleted in heavy isotopes (D, ^{18}O) relative to summer precipitation. Because high-latitude precipitation is depleted, the isotopic ratio is lighter than low-latitude precipitation. The mixing of recharge water tends to average the isotopic variations of precipitation. At low temperatures (as compared to geothermal regimes) associated with most aquifers, no hydrogen isotopes are exchanged between water and solid phases. Thus, the isotopic composition of water changes only as a function of physical and chemical processes in the aquifer such as evaporation or mineral dissolution.

Isotopic ratios are shown in table 8, and a plot of the δD and $\delta^{18}O$ ratios for 36 samples collected from the Gallup, Dakota, and Morrison aquifers is shown in figure 24. A line defined by Craig (1961) as $\delta D = 8\delta^{18}O + 10$ represents samples collected from various localities in the world. Vuataz and Goff (1986) defined a local meteoric water line for northern New Mexico as $\delta D = 8\delta^{18}O + 12$, which is parallel to and slightly left of the world meteoric line. This local meteoric line was applied to the San Juan Basin study area by Phillips and others (1986b) in their report on the Ojo Alamo aquifer. However, most of the isotopic ratios plot to the right of the world meteoric line in figure 24. This suggests a different local meteoric water line for these samples or evaporation during infiltration of precipitation, which is common in semiarid environments (Phillips and others, 1986b, p. 181).

Phillips and others (1986b, p. 181) calculated the mean isotopic ratio for modern precipitation in the central San Juan Basin as -12.8 $^0/_{00}$ for $\delta^{18}O$ and as -90 $^0/_{00}$ for δD. Recharge water of Pleistocene age averaged 3.0 $^0/_{00}$ lighter in $\delta^{18}O$ and 25 $^0/_{00}$ lighter in δD than modern recharge water. During the Pleistocene, climatic changes such as a decrease in mean annual temperature and an increase in winter precipitation may have accounted for the shift to lighter isotopic ratios (Phillips and others, 1986b, p. 183).

The areal distribution of δD is shown for the Morrison aquifer in figure 25. Heavier isotopic ratios ($\delta^{18}O$ = -14.2 $^0/_{00}$ and δD = -103.5 $^0/_{00}$) were found in samples at well 30 in the recharge area near Sanostee than in samples collected from wells 10 mi downgradient to the east and northeast. Water in an area encompassing four wells in the Morrison aquifer had light values of $\delta^{18}O$ (-15.0 $^0/_{00}$ to -15.6 $^0/_{00}$) and δD (-114 $^0/_{00}$ to -116 $^0/_{00}$). Comparing data for these four wells to modern precipitation calculated by Phillips and others (1986a) indicates a depletion of 2.8 $^0/_{00}$ in $\delta^{18}O$ and 26 $^0/_{00}$ in δD, which is similar to Pleistocene samples. The data imply that ground water 10 mi from the outcrop area was recharged during the Pleistocene.

Carbon-13/carbon-12 ratio data were collected to examine sources and sinks of carbon as an aid in determining chemical reactions that control the carbon distribution in the aquifers. In general, soil gas CO_2 contains a $\delta^{13}C$ value of -20 $^0/_{00}$ to -25 $^0/_{00}$, and carbonate minerals have $\delta^{13}C$ values close to 0 $^0/_{00}$ (Drever, 1982, p. 345). Stable carbon isotopic values typically range from -10 $^0/_{00}$ to -12.5 $^0/_{00}$ in samples, as a result of soil gas CO_2 reacting with carbonate minerals. Chemical reactions will affect $\delta^{13}C$ values in water in different ways: calcite dissolution adds carbon so $\delta^{13}C$ values become heavier; calcite precipitation removes carbon so $\delta^{13}C$ values become lighter; feldspar dissolution does not change $\delta^{13}C$ values in a system closed to CO_2. The oxidation of organic matter adds light carbon ($\delta^{13}C$) to the system.

Table 8.--Isotopic ratios of stable isotopes in water from the Gallup, Dakota, and Morrison aquifers

[See figures 8-10 for location of wells; wells 1-10 are completed in the Gallup aquifer, wells 12-13 in the Dakota aquifer, and wells 14-38 in the Morrison aquifer; values are in per mil ($^0/_{00}$); --, not reported]

Well number	Date of sample	Oxygen ($\delta^{18}O$)	Hydrogen (δD)	Carbon ($\delta^{13}C$)	Sulphur, SO_4^{2-} ($\delta^{34}S$)
1	07-01-88	-13.6	-101	-12.3	-14.0
2	04-22-86	-13.5	-113	--	--
	10-21-87	--	--	-9.8	-6.0
3	04-21-86	-14.3	-110	--	--
4	07-15-88	-14.2	-105	-8.0	15.4
5	06-30-87	-13.9	-98	-26.1	--
	06-28-88	--	--	--	-5.4
6	06-30-88	-14.0	-104	-8.6	-6.1
7	06-28-88	-15.0	-111	-11.2	1.6
8	12-03-87	-13.0	-97	--	--
9	04-29-86	-11.8	-87	--	--
	08-11-87	-11.9	-90	-7.6	-10.4
10	06-30-88	-14.3	-106	-12.2	-1.6
12	06-29-88	-14.4	-106	-13.1	-1.3
13	04-29-86	-13.0	-96	--	--
14	06-10-88	-13.0	-96	-8.6	.5
15	07-21-87	-13.6	-101	-19.0	--
16	06-24-86	-14.6	-107	--	9.4
	06-08-88	--	--	-6.5	--
17	07-02-86	-14.1	-103	--	11.7
18	06-16-86	-14.1	-103	-8.8	10.2
	06-09-87	--	-104	--	--
19	07-14-87	-12.7	-97	-3.7	8.6
20	06-19-86	-13.9	-103	--	10.1
21	06-18-86	-14.1	-103	--	9.0
22	06-19-86	-14.0	-104	-9.2	10.1
23	06-10-88	-15.9	-120	-9.1	3.0
24	07-01-86	-12.5	-94	-10.9	-6.1
25	06-09-88	-13.2	-98	-10.3	3.7
26	06-17-86	-15.6	-114	-10.8	10.1
	07-01-88	--	--	-10.5	11.2

Table 8.--Isotopic ratios of stable isotopes in water from the Gallup, Dakota, and Morrison aquifers--Concluded

Well number	Date of sample	Oxygen ($\delta^{18}O$)	Hydrogen (δD)	Carbon ($\delta^{13}C$)	Sulphur, SO_4^{2-} ($\delta^{34}S$)
27	06-18-86	-15.9	-115	-10.0	10.9
28	06-30-86	-15.7	-114	--	--
	07-01-88	--	--	-10.0	14.0
29	06-29-88	-15.6	-116	-10.5	14.9
30	07-23-87	-14.2	-104	-10.9	--
32	06-24-86	-14.6	-107	-13.4	5.0
	07-15-87	--	--	-12.7	--
33	07-15-87	-15.3	-113	-11.7	--
34	07-16-87	-14.1	-104	-10.7	--
35	06-11-87	-14.0	-104	-11.9	--
36	04-24-86	-14.3	-114	--	--
	10-22-87	-14.4	-108	-11.7	12.8
37	10-02-87	-14.5	-108	-12.2	-18.7
38	07-01-87	-11.0	-82	-13.5	-13.0
	07-14-88	--	--	-13.1	-10.3

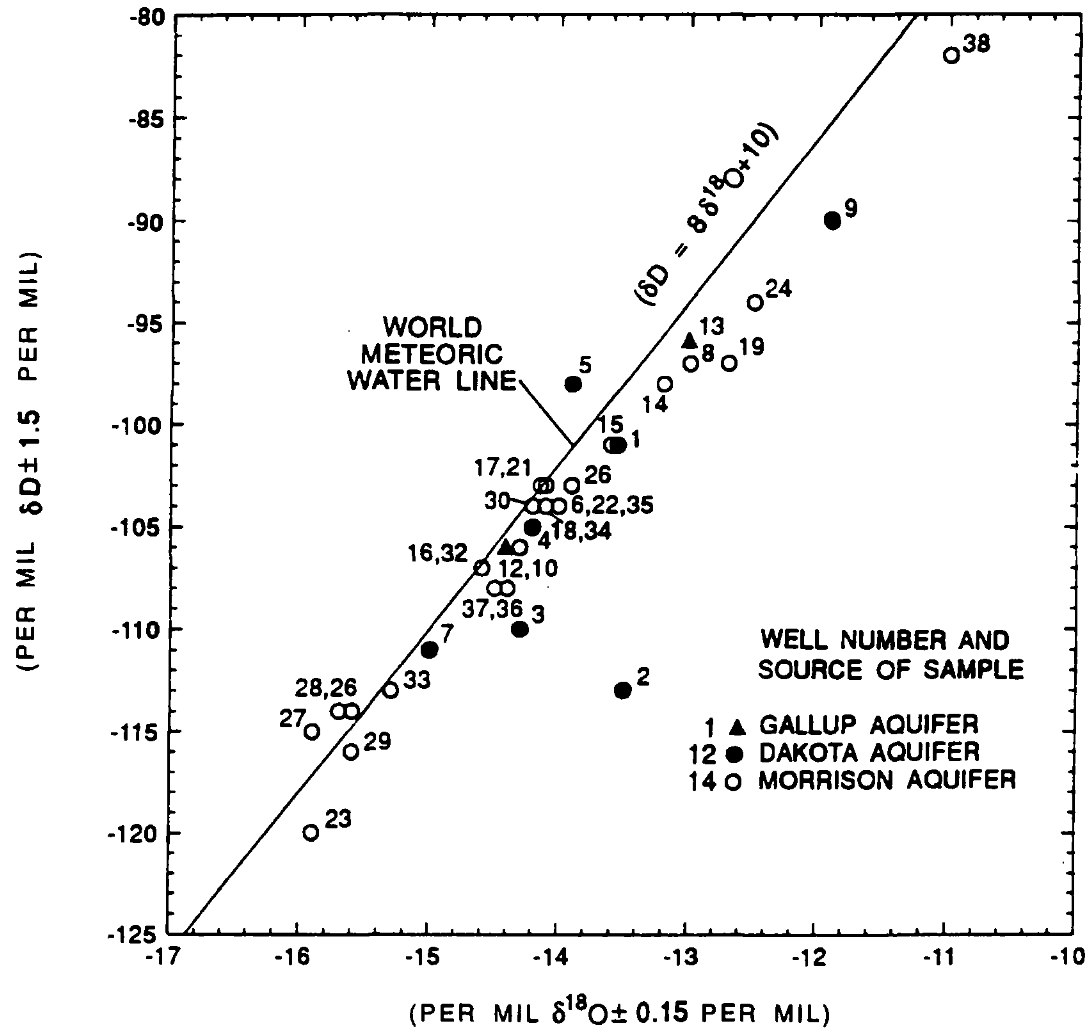
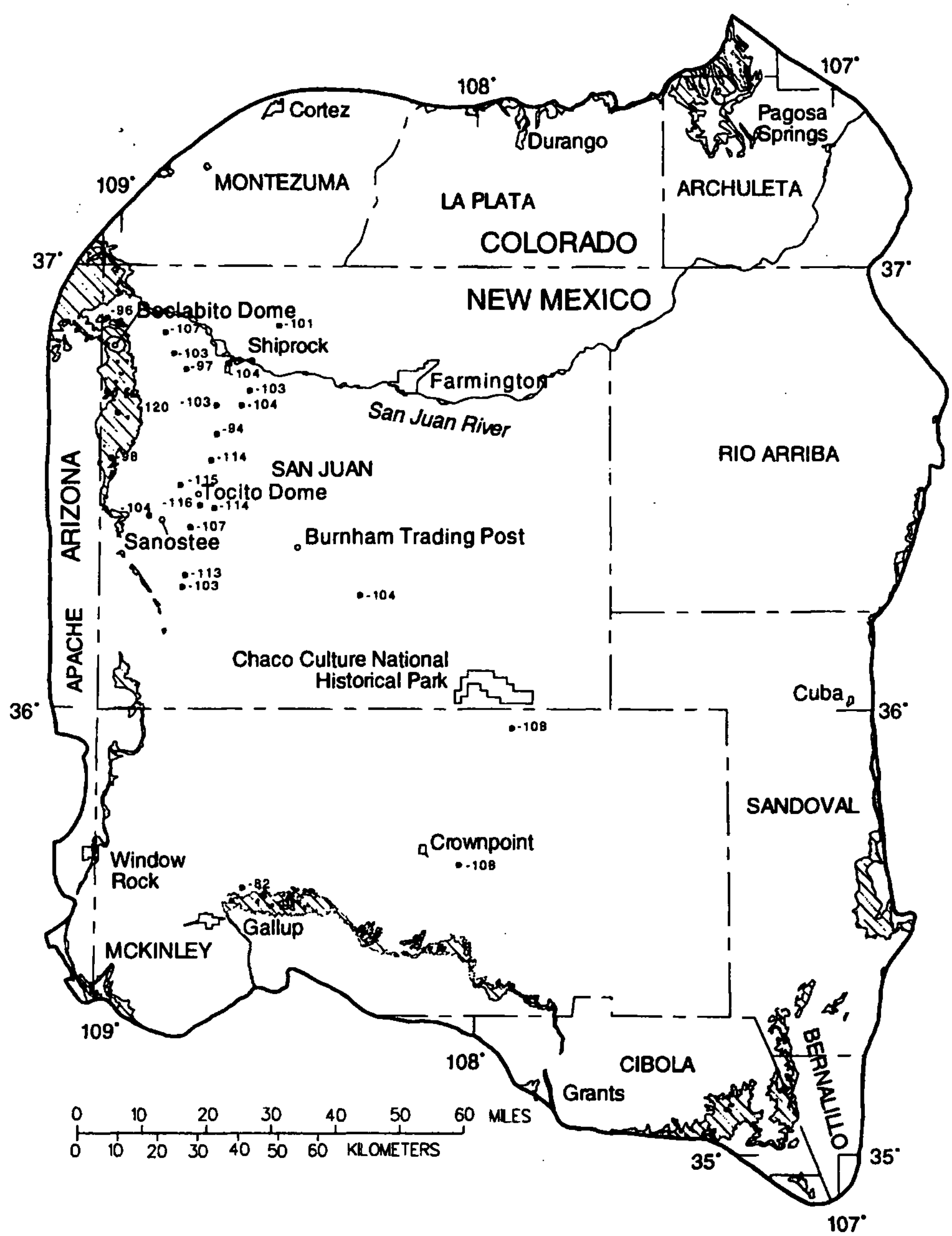


Figure 24.--Oxygen and deuterium isotopic ratios in water from water wells completed in the Gallup, Dakota, and Morrison aquifers. Well locations are shown in figures 8, 9, and 10.



EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

• -104 WATER WELL--Number is deuterium isotopic ratio, in per mil relative to Standard Mean Ocean Water (SMOW)

Figure 25.--Deuterium isotopic ratio in water from water wells completed in the Morrison aquifer.

Stable carbon isotopic data ($\delta^{13}C$) are shown in table 8 and in figure 26 for the Gallup aquifer and figure 27 for the Morrison aquifer. Values of $\delta^{13}C$ for the Gallup aquifer generally were consistent with carbonate minerals reacting with soil gas (-7.6 $^0/_{00}$ to -12.3 $^0/_{00}$) except for one sample that contained very light $\delta^{13}C$ of -26.1 $^0/_{00}$ (fig. 26), suggesting an organic carbon source.

Carbon-13/carbon-12 ratio values for samples from the Morrison aquifer ranged from -3.7 $^0/_{00}$ to -19.0 $^0/_{00}$ (fig. 27). However, 16 of 20 samples had a smaller range of -9.1 $^0/_{00}$ to -13.1 $^0/_{00}$, which coincides with well locations that are more than 10 mi from the San Juan River (fig. 26). The analytical accuracy of the $\delta^{13}C$ analysis was generally $\pm$ 0.3 $^0/_{00}$ (Carol Kendall, U.S. Geological Survey, oral commun., 1989). Thus, the minor variability of the $\delta^{13}C$ values in the samples may be due to chemical reactions involving carbon or may be due to analytical accuracy. For example, a value of -10.5 $^0/_{00}$ $\pm$0.3 $^0/_{00}$ includes three samples (wells 26 and 29) in the northwestern part of the basin (table 8).

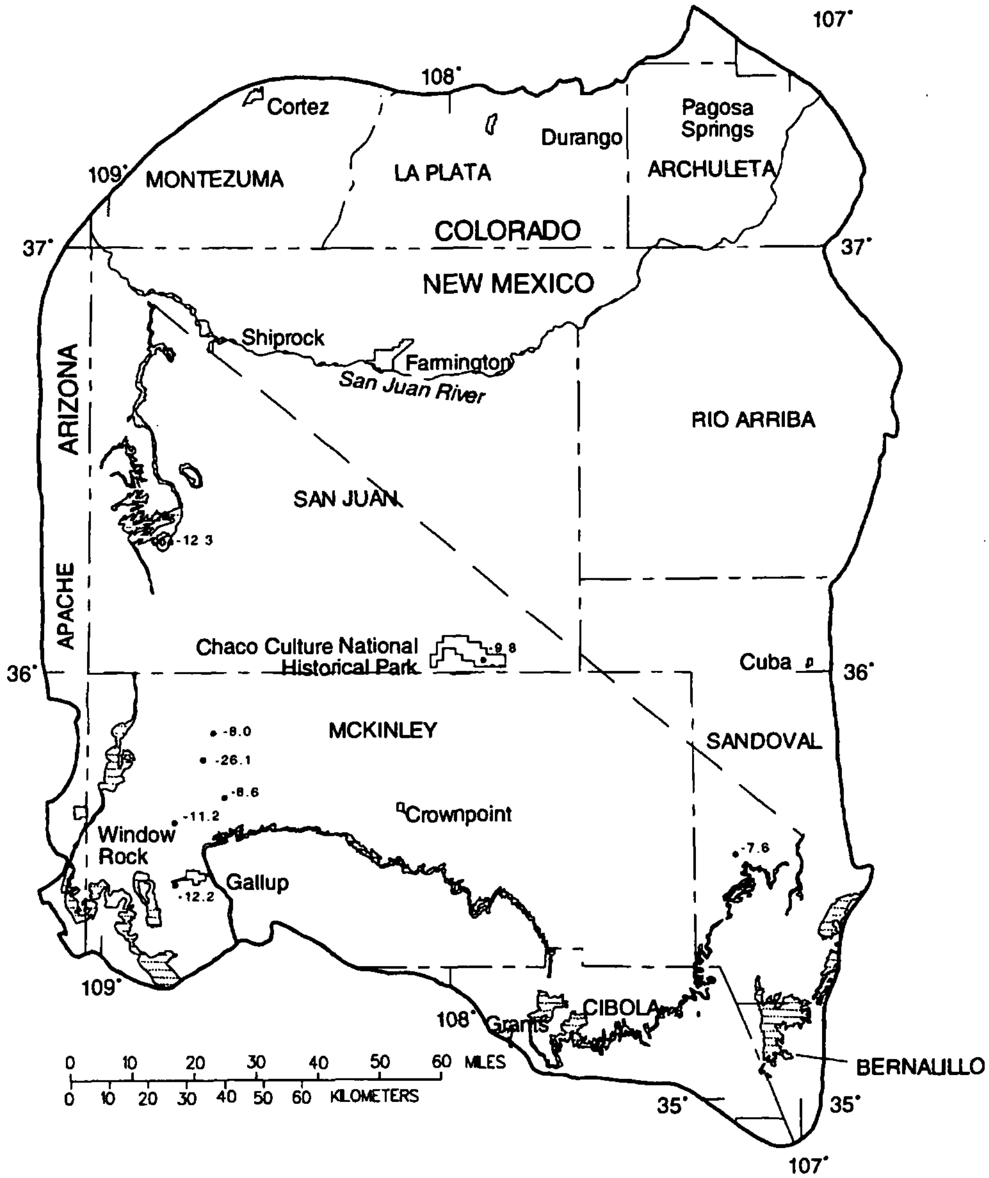
Radioactive Isotopes

The radioactive isotopes ^3H, ^{14}C, and ^{36}Cl were used to determine the residence time that water has been isolated from the atmosphere. Residence times are useful for determination of aquifer characteristics and for geochemical analysis of flow paths. The half-lives of the three radioisotopes are: ^3H = 12.26 years, ^{14}C = 5,730 years, and ^{36}Cl = 301,000 years. Therefore, applications of age dating with the three radioisotopes are significantly different. Tritium is applicable in detecting modern (post-1952) water in the sample. The isotope ^{14}C is applicable in determining ages to approximately 50,000 years (Durrance, 1986). Because of its slow decay, ^{36}Cl is applicable in age determinations of 100,000 to approximately 1 million years (Bentley and others, 1986). Processes that include mixing and ion filtration can be determined using ^{36}Cl radioisotopes as shown by Phillips and others (1986a).

Activities of ^3H in samples from 26 wells generally were less than 1 tritium unit (3.2 pCi/L) as shown in table 9. This indicates that the sampled ground water has not mixed with modern water and has been isolated from the atmosphere at least since 1952.

During the initial collection of radioisotope samples in 1986, samples for ^{14}C analysis were collected from four wells completed in the Morrison aquifer. Of water from wells 18, 22, 26, and 27, only water from well 27, closest to the recharge area, contained measurable ^{14}C (table 9). Therefore, the ^{14}C dating technique could be applied practicably only to water samples near recharge areas in the Morrison aquifer in this part of the study area. Twenty-four ^{14}C samples were analyzed between 1986 and 1989, 12 of which contained detectable ^{14}C.

The ^{14}C technique revealed that samples collected from the Morrison aquifer rapidly increased in apparent age; ^{14}C was not detected downgradient from the recharge areas. Slow flow rates or mixing of modern and ancient waters may have resulted in nondetectable ^{14}C activities. Therefore, in view of the limited application of the ^{14}C data to samples from the Morrison aquifer, Dr. Fred Phillips at New Mexico Institute of Mining and Technology prepared, analyzed, and interpreted results of ^{36}Cl samples. The atmosphere produces ^{36}Cl by cosmic ray spallation of ^{36}Ar and neutron activation of ^{36}Ar (Bentley and others, 1986). Meteroic water contains ^{36}Cl; as precipitation becomes recharge water moving into the subsurface, ^{36}Cl decays exponentially. Chlorine-36 can be added from subsurface sources derived from rock weathering and production of neutrons in uranium radionuclide decay. The application of ^{36}Cl to ground-water hydrology has been demonstrated in two regional aquifers: the Great Artesian Basin in Australia (Bentley and others, 1986) and the Milk River aquifer in Alberta, Canada (Phillips and others, 1986a). Age-dating techniques using ^{36}Cl were substantiated with independent modeling results and provided new insights into hydrochemical processes in the two aquifer systems.



EXPLANATION

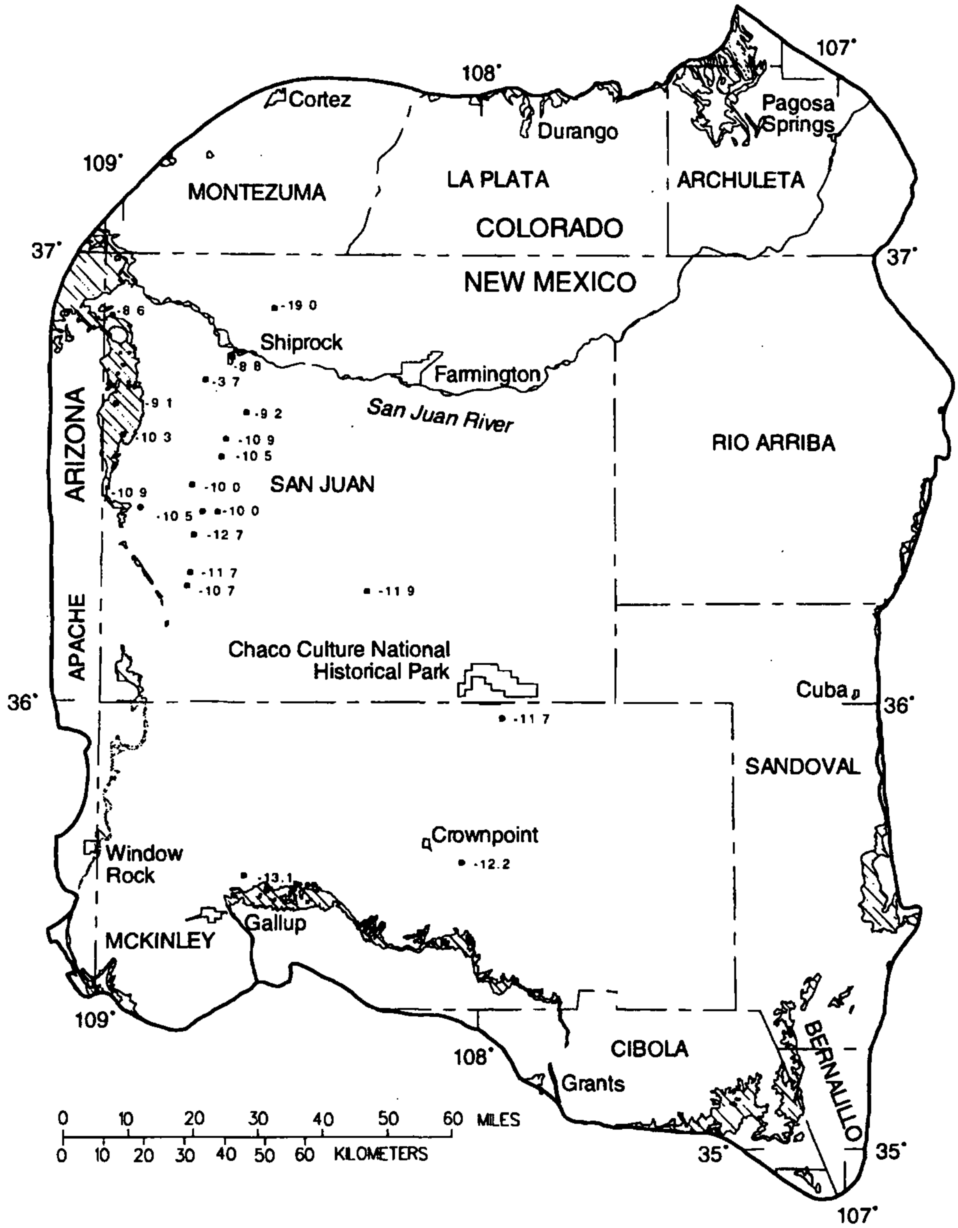
OUTCROP OF GALLUP AQUIFER--In Arizona includes Pescado Tongue of Mancos Shale. In the southeastern part of the study area mapped as part of the Mesaverde Group, undivided. From Dane and Bachman, 1965; and Hackman and Olson, 1977

BOUNDARY OF STUDY AREA

APPROXIMATE SUBSURFACE EXTENT OF GALLUP AQUIFER--From Molenaar, 1973

• -8.0 WATER WELL--Number is carbon-13 isotopic ratio, in per mil relative to Peedee belemnite (PDB)

Figure 26.--Carbon-13 isotopic ratio in water from water wells completed in the Gallup aquifer.



EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

• -11.9 WATER WELL--Number is carbon-13 isotopic ratio, in per mil relative to Peedee belemnite (PDB)

Figure 27.--Carbon-13 isotopic ratio in water from water wells completed in the Morrison aquifer.

Water samples from 34 wells were collected to measure ^{36}Cl, as shown in table 9. Analytical error was less than 10 percent. The primary focus of the ^{36}Cl investigation was a detailed examination of the Morrison aquifer. The $^{36}Cl/10^{15}Cl$ values (unitless atomic ratios of ^{36}Cl atoms per 10^{15} chlorine atoms where chloride is the atomic sum of the stable isotopes ^{35}Cl and ^{37}Cl) ranged from 4 to 2,201. Figure 28 displays the areal distribution of $^{36}Cl/10^{15}Cl$ data for the Morrison aquifer. Multiple samples for the same well location are shown where available. The expected recharge input value for the San Juan Basin area was 700 (Jones and Phillips, 1990). Samples obtained near the southern outcrop (well 38) and western outcrop (well 30) contained ratios of 630 and 573, respectively. The simple interpretation of data shown in figure 28 is that values greater than 700 are a result of buildup of ^{36}Cl and values less than 700 are due to radioactive decay of ^{36}Cl. Repeat sampling for ^{36}Cl at four of five wells indicated that $^{36}Cl/10^{15}Cl$ ratios were not reproducible within 10 percent (fig. 28; table 9). Well construction and open-hole completion opposite multiple sandstones within the Morrison aquifer have a similar effect on the ^{36}Cl data as on the previously discussed water-chemistry data.

Comparison of the ^{14}C data with the ^{36}Cl data was not reliable due to collection of the data on different sampling dates. Chemical concentrations and isotope contents varied in several wells over time as previously described.

Collection and analysis of ^{36}Cl radioisotopes, as well as other constituents, clearly indicated that the original assumptions of the ground-water flow system were inadequate. The flow system was re-evaluated to provide a conceptual model, consistent with the chemical data, with which to interpret the sources of solutes.

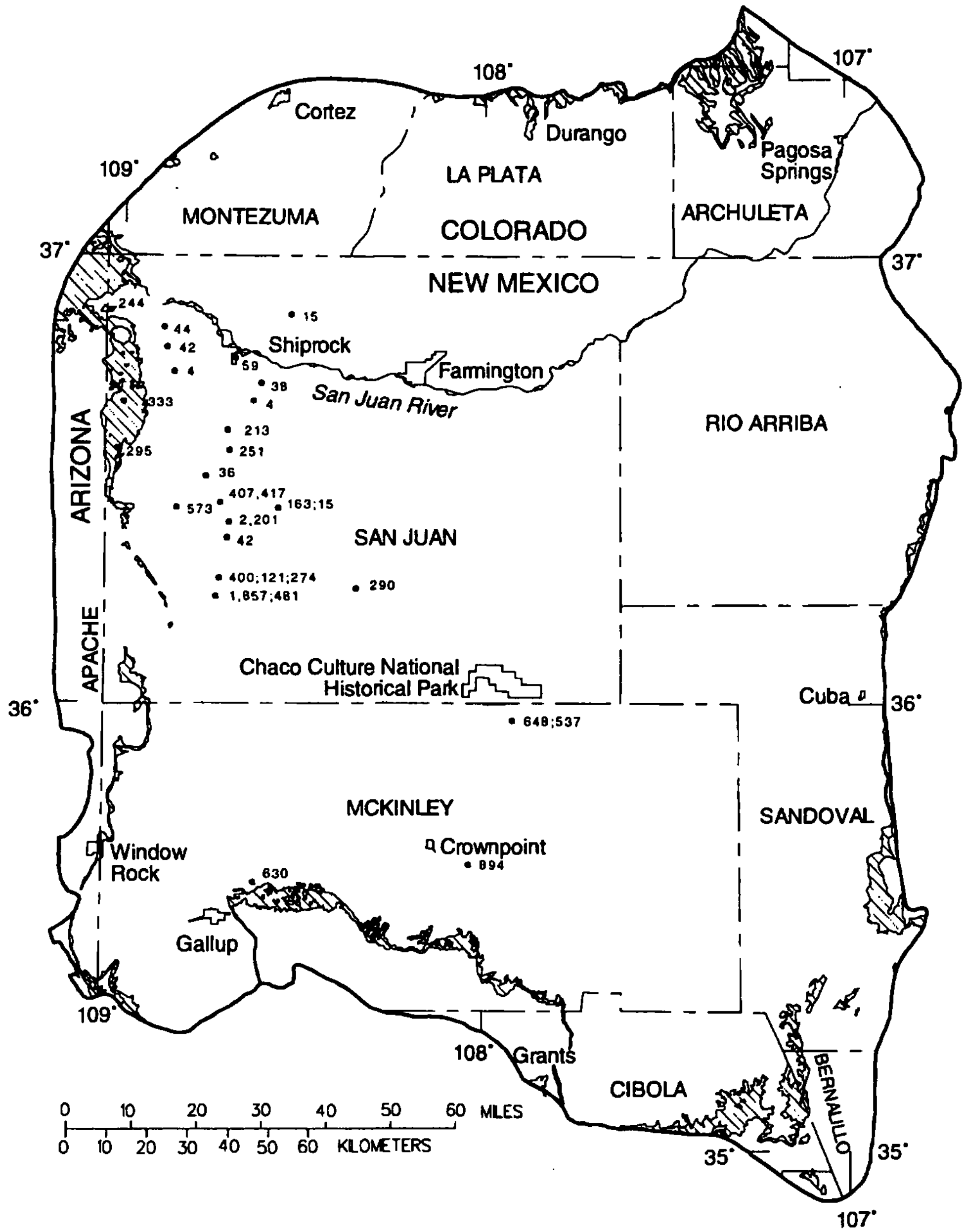
Table 9.—Activities of tritium, carbon-14, and chlorine-36 isotopes in water from the Gallup, Dakota, and Morrison aquifers

[See figures 8-10 for location of wells; wells 1-2 and 4-10 are completed in the Gallup aquifer, wells 11-13 in the Dakota aquifer, and wells 14-38 in the Morrison aquifer; pCi/L, picocuries per liter; <, less than detection limit; --, no data. A, B, and C refer to repeat sampling of wells as shown in figures 31-33]

Well number	Date of sample	Tritium (^3H) (pCi/L)	Carbon-14 (^{14}C) (percent modern)	Chlorine-36 ($^{36}Cl/10^{15}Cl$) (ratio)	Chlorine-36 (^{36}Cl) (atoms/liter)
1	07-01-88	<0.3	--	676	9.0
2	10-21-87	<.3	<0.4	198	16.5
4	07-15-88	<.3	2.2	122	.9
5	06-30-87	<.3	<.4	--	--
	06-28-88	--	--	153	11.7
6	06-30-88	1.5	6.4	22	.2
7	06-28-88	<.3	2.6	569	9.2
8	12-03-87	--	--	537	21.0
9	08-11-87	.4	4.5	--	--
10	06-30-88	<.3	2.8	--	--
11	07-23-87	--	--	169	16.4
12	06-29-88	--	--	730	3.2

Table 9.--Activities of tritium, carbon-14, and chlorine-36 isotopes in water from the Gallup, Dakota, and Morrison aquifers--Concluded

Well number	Date of sample	Tritium (^{3}H) (pCi/L)	Carbon-14 (^{14}C) (percent modern)	Chlorine-36 ($^{36}Cl/10^{15}Cl$) (ratio)	Chlorine-36 (^{36}Cl) (atoms/liter)
13	12-03-87	--	--	149	19.7
14	06-10-88	--	--	244	4.6
15	07-21-87	<0.3	<1.0	15	5.5
16	06-24-86	4.0	--	--	--
	06-08-88	--	<1.1	44	.8
17	07-02-86	--	--	42	4.4
18	06-16-86	--	<1.2	--	--
	06-09-87	<.4	--	59	5.7
19	07-14-87	<.3	<.4	4	5.1
20	06-10-87	1.2	--	38	7.7
22	06-19-86	3.0	<1.2	--	--
	06-10-87	--	--	42	5.9
23	06-10-88	<.3	10.5	333	13.0
24	07-01-86	<.3	--	213	13.8
25	06-09-88	<.3	31.5	295	5.0
26	06-17-86	2.0	<.8	--	--
	07-01-88	--	--	251	1.7
27	06-18-86	1.0	3.1	--	--
	06-11-88	--	--	36	.1
28	06-30-86A	--	--	163	7.8
	07-17-87B	--	--	15	1.6
29	06-29-88B	--	--	417	2.1
30	07-23-87	<.3	15.6	--	--
	01-05-89	--	--	573	2.6
31	01-05-89	<26	--	2,201	6.0
32	06-24-86	3.0	--	--	--
	07-15-87	<.3	11.2	--	--
	06-11-88	--	--	42	.1
33	07-15-87A	<.3	<1.0	400	29.2
	06-29-88B	--	--	121	2.5
	11-23-88C	--	--	274	3.9
34	07-16-87B	<.3	<1.0	1,857	22.4
	11-22-88A	<26	--	481	6.4
35	06-11-87	<1.0	<.4	290	9.4
36	04-24-86A	--	--	648	15.4
	10-22-87B	<.3	<.4	537	15.5
37	10-02-87	<.3	.8	894	9.9
38	07-01-87	.3	14.4	--	--
	07-14-88	--	--	630	7.7



EXPLANATION

OUTCROP OF MORRISON AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

• 333 WATER WELL--Number represents ratio of chlorine-36 to stable chlorine isotopes. Multiple ratios for a well are listed in chronological order

Figure 28.--Ratio of chlorine-36 to stable chlorine isotopes in water from water wells completed in the Morrison aquifer.

Physical and Geochemical Processes

Physical processes of the flow system and geochemical processes controlling rock/water/gas interactions affect the observed chemical concentrations and isotopic contents. Physical processes that are examined include ground-water flow, mixing, evaporation, dilution, and ion filtration. Geochemical processes examined include mineral solubility, ion exchange, and oxidation/reduction. The geochemical data were used to examine these physical and geochemical processes.

The fluctuation in ion concentration among water analyses, particularly for wells containing large open intervals, may be due to the lithology of the Morrison aquifer, which is a sequence of sandstones and shales. Heterogeneity in sandstone properties, such as hydraulic conductivity, may result in variability of ion concentrations contained in the individual sandstone layer if the sandstones are confined between shale layers and no mixing occurs within the Morrison aquifer. Thus, a water sample from a well completed in multiple lithologies in the Morrison aquifer may be a mix of different water chemistries. Changes in ion chemistry in samples collected at a well at different times may be due to changes in hydraulic head. A change in hydraulic head may cause the sandstone layers in the aquifer to contribute different amounts of water to the well bore, which would change the mix of different water chemistries. Wells completed in the Morrison aquifer that flowed continuously during the duration of the field sampling caused a lowering of the hydraulic head, resulting in changes in ion chemistry for samples collected at different times. In large regional aquifer systems such as the San Juan Basin, the water chemistry at a particular location commonly has been assumed to have changed little, if any, over short time periods of a few years. The results determined for six wells completed in the Morrison aquifer and one well in the Dakota aquifer suggest that repeated sampling over time is needed to verify reproducibility of ion chemistry.

Decreases in chloride concentrations 10 mi downgradient from the recharge area may be due to factors including mixing of recharge water with more dilute water within the Morrison aquifer; leakage of more dilute water from above or below the Morrison aquifer; or ion filtration. Another potential cause of low chloride concentrations may be changing rates of recharge in the Morrison aquifer. Large rates of recharge during times of high precipitation would dilute chloride concentrations. Conversely, small rates of recharge during dry periods would likely concentrate chloride in the recharge area by evaporation in the vadose zone.

Ion filtration is a process previously proposed as being active in the San Juan Basin (Berry, 1959) and other basins (such as Phillips and others, 1986b). The ion-filtration hypothesis assumes a semipermeable membrane such as a clay layer or shale separating two zones of higher hydraulic conductivity. Electrochemical and pressure factors can result in exclusion of negatively charged ions, such as chloride, and a decrease in salinity on the low-pressure side of the membrane. Dilute water passes through the membrane to increase the pressure on the "filtrate" side. By applying this hypothesis to the Morrison aquifer, saline water from either the Dakota above the Morrison or the Entrada below the Morrison would be filtered by clay or shale layers and result in the observed low chloride concentrations. Clays or shales of the Brushy Basin and Recapture Members within the Morrison aquifer are the most likely semipermeable membranes within the Dakota-Entrada sequence.

As previously described, δD values in samples from four wells completed in the Morrison aquifer were depleted by $26^0/_{00}$ relative to modern precipitation. These lighter isotopic values may indicate that recharge for these four wells occurred during a time period of cooler mean temperature and wetter conditions than exist today. This would be consistent with average Pleistocene values found for the Ojo Alamo aquifer by Phillips and others (1986b). A second hypothesis explaining the existence of depleted $\delta^{18}O$ and δD values is membrane filtration. The ion filtration process would enrich the heavy isotopes in the residual solution and deplete the heavy isotopes in the solution passing through the shale (Coplen and Hanshaw, 1973).

Increases in chloride concentrations in wells near the San Juan River relative to chloride concentrations in recharge areas may be due to factors including dissolution of halite (NaCl) within the Morrison aquifer; leakage of saline water from above or below the Morrison aquifer; mixing of dilute recharge water with saline, deep-basin water near the discharge area in the Morrison aquifer; or oil-field brine contamination. The large solubility of halite, lack of observed halite, and deposition in a freshwater (nonmarine) environment suggest that NaCl dissolution is an unlikely source of increased chloride concentration. Leakage of saline water into the Morrison aquifer and mixing of dilute and saline water within the aquifer are likely processes controlling chloride concentrations.

Figure 29 compares the ratio for concentrations of Br^-/Cl^- to the concentration of chloride. The log-log plot was developed by Whittemore (1988) to evaluate mixing of brines with dilute water and to differentiate between natural brines and oil-field brines. In general, dilute recharge water has Br^-/Cl^- ratios as low as 10×10^{-4} (concentration ratio). Saline solutions from natural brines increase in chloride and the Br^-/Cl^- ratio decreases. The points plotted in figure 29 represent analyses of water from the three aquifers. The lowest Br^-/Cl^- ratio was for well 19, which contained 750 mg/L Cl^- and 0.05 mg/L Br^-, resulting in a ratio of 0.67×10^{-4} Br^-/Cl^-. By comparison, the lowest Br^-/Cl^- ratio found in a natural salt water was 0.57×10^{-4} (Whittemore, 1988, p. 345). Samples from wells completed in the Morrison aquifer near the San Juan River contain Br^-/Cl^- ratios between values found for recharge-type water and halite brine. This suggests mixing of dilute recharge water with saline water.

To aid in identifying physical processes, sampled wells completed in the Morrison aquifer were grouped by location and sample type by Jones and Phillips (1990). Five groups of wells are shown in figure 30 and were designated as follows: group 1 is wells near the San Juan River with elevated chloride concentrations; group 2 is wells located near the Morrison Formation outcrop; group 3 is wells downgradient from the recharge area; group 4 is wells 33 and 34; and group 5 is wells in the central and southern parts of the basin.

Graphical representation of ^{36}Cl data is useful in delineating processes such as dissolution of radioactively "dead" Cl^-, ion filtration, dilution, evaporation, and decay or buildup of ^{36}Cl from uranium deposits (Bentley and others, 1986; Phillips and others, 1986a; Jones and Phillips, 1990). Figure 31 is a plot of the $^{36}Cl/10^{15}Cl$ ratio data and ^{36}Cl concentrations (in atoms/liter x 10^{-7}) for each sample using the group symbol defined in figure 30. As described in Phillips and others (1986a, p. 2012), the addition of "dead" Cl^- will decrease the $^{36}Cl/10^{15}Cl$ ratio (addition of ^{35}Cl and ^{37}Cl) without changing the ^{36}Cl concentration, resulting in a downward shift of the data points as shown by the diagram in figure 31. Dilution, evaporation, or ion filtration will affect the ^{35}Cl, ^{36}Cl, and ^{37}Cl concentrations; therefore, the $^{36}Cl/10^{15}Cl$ ratio will not change, and points in figure 31 would shift horizontally if these processes occurred. Radioactive decay decreases and buildup increases ^{36}Cl concentrations; these processes are represented by sloped lines in figure 31.

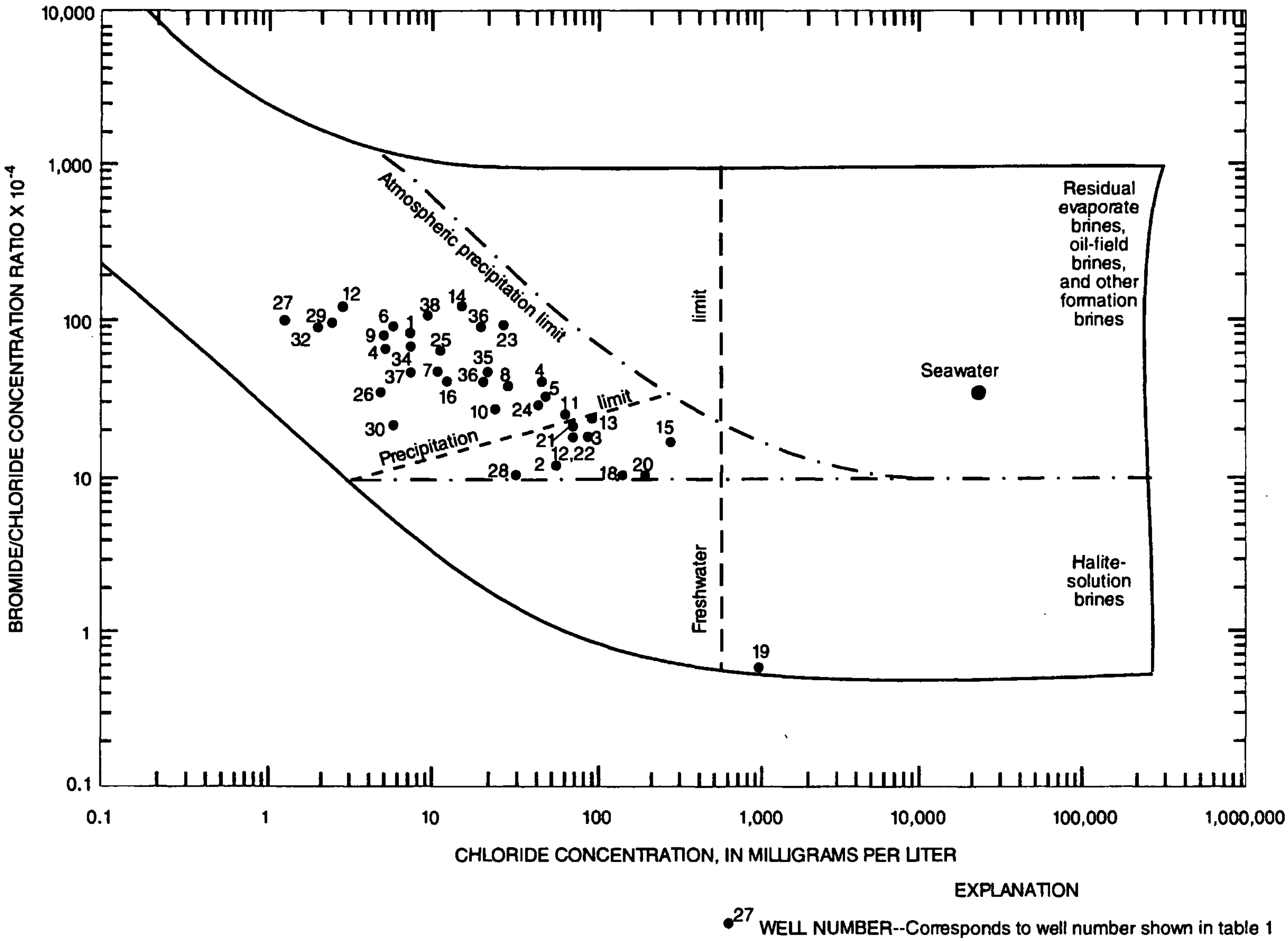
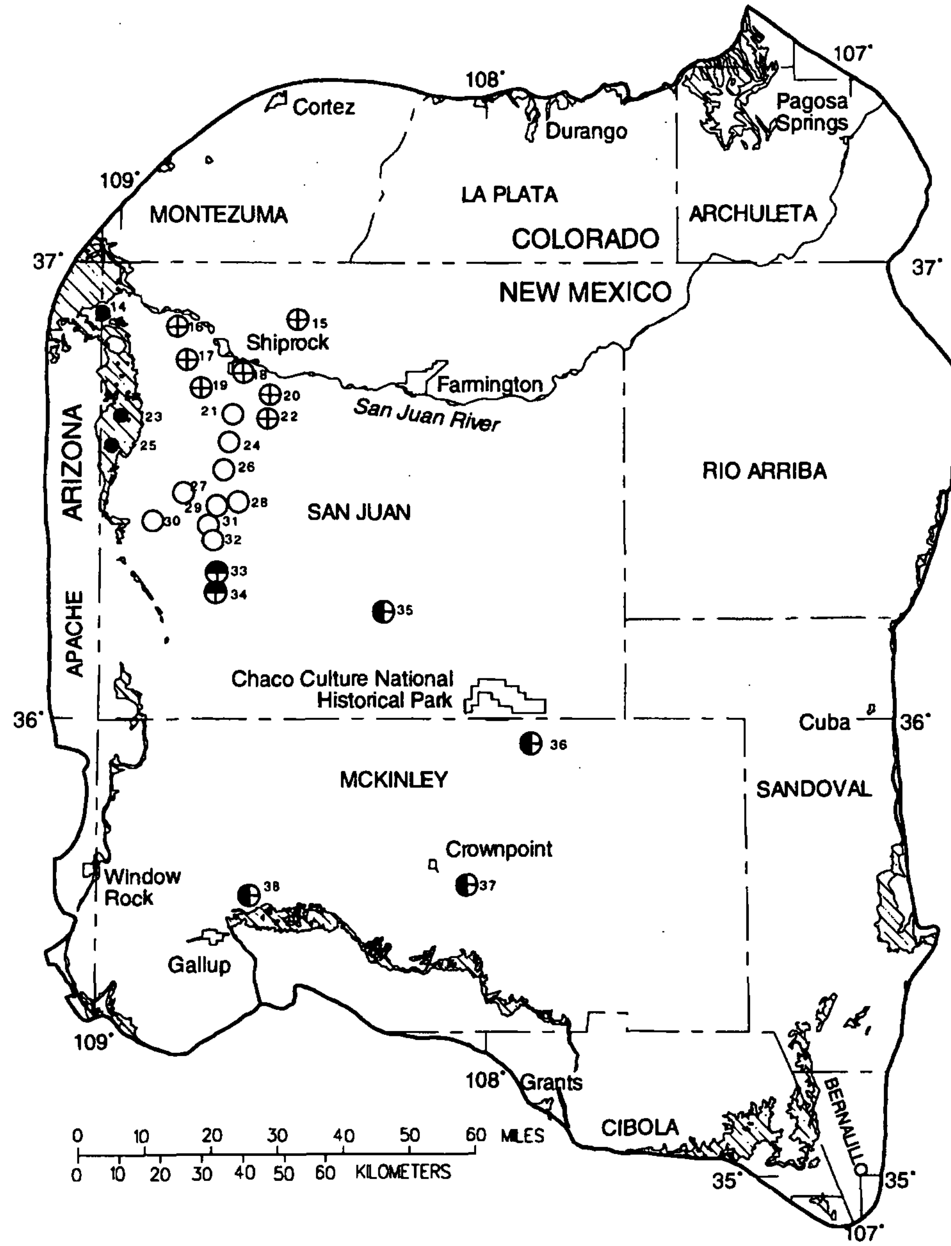


Figure 29.--Ratio of bromide/chloride versus chloride concentrations for water samples from the Gallup, Dakota, and Morrison aquifers.



EXPLANATION

[ ] OUTCROP OF GALLUP AQUIFER, JURASSIC ROCKS, UNDIVIDED; WANAKAH FORMATION; ENTRADA SANDSTONE; AND SAN RAFAEL GROUP--From Dane and Bachman, 1965; Wilson and others, 1969; Tweto, 1979; and Hintze, 1981

BOUNDARY OF STUDY AREA

⊕ 15 WATER WELL--Symbol represents group 1 wells located near the San Juan River with elevated Cl^- concentrations. Number corresponds to well number shown in table 1

● 23 WATER WELL--Symbol represents group 2 wells located near the outcrop of Morrison Formation. Number corresponds to well number shown in table 1

○ 24 WATER WELL--Symbol represents group 3 wells located downgradient from the recharge area. Number corresponds to well number shown in table 1

33 WATER WELL--Symbol represents group 4 wells, wells 33 and 34. Number corresponds to well number shown in table 1

38 WATER WELL--Symbol represents group 5 wells located in the central and southern parts of the basin. Number corresponds to well number shown in table 1

Figure 30.--Location, well number, and group for water wells completed in the Morrison aquifer used in analysis of chlorine-36 data shown in figures 31-33.

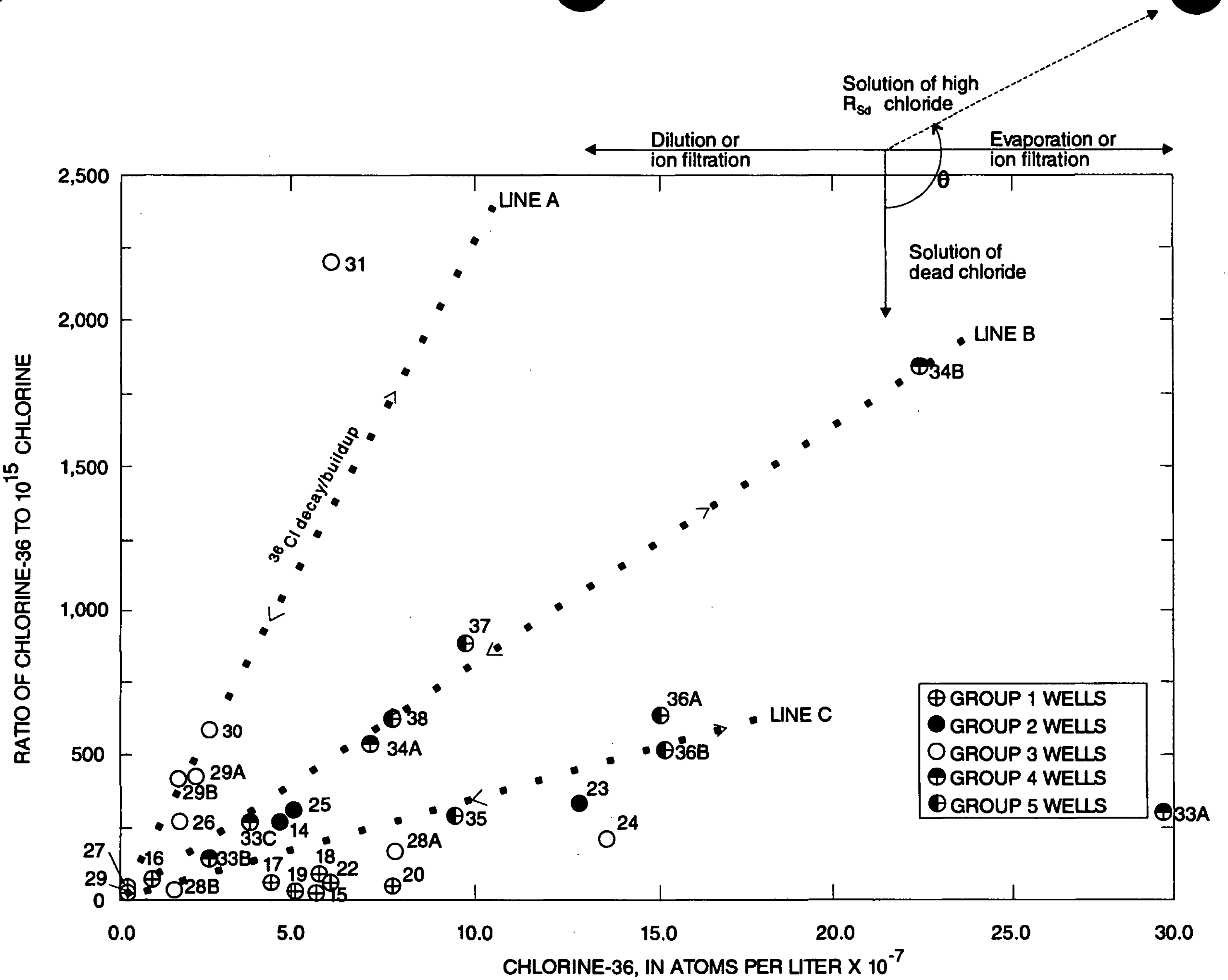


Figure 31.--Chlorine-36/chlorine versus chlorine-36 for water from the Morrison aquifer. The displacement caused by various processes is illustrated (modified from Jones and Phillips, 1990).

Three decay (or buildup) lines were plotted in figure 31 to show samples containing different salinities: line (A) was drawn through sample 30 and the origin for dilute samples; line (B) was drawn through sample 34B and the origin for slightly saline samples; and line (C) was drawn through sample 36B and the origin for saline samples. In general, data points assigned to the well groups defined in figure 30 are described by these three lines. Dilute samples generally followed line A and consisted primarily of group 3 wells: 30, 29, 26, 27, and 31. Samples containing slightly saline values plotted along line B and generally belonged to groups 2 and 5 (outcrop samples and southern San Juan Basin samples). Samples containing saline values plotted along line C and generally consisted of group 5 wells. Wells located near Shiprock and the San Juan River plotted below line C. The buildup of ^{36}Cl due to uranium deposits may have affected samples 31 and 34B (fig. 31).

Chloride mass-balance equations derived by Jones and Phillips (1990) indicate that mixing of waters could be evaluated by plotting the $^{36}Cl/10^{15}Cl$ ratio against the inverse of the chloride concentration in milligrams per liter (figs. 32 and 33). The three lines A, B, and C in figure 31 are shown in figures 32 and 33. Compared to figure 31, lines A, B, and C plot in reverse order in figures 32 and 33 because the chloride concentration decreases away from the origin in figures 32 and 33. Line A represents the ^{36}Cl decay curve and is not affected by other processes such as dilution or ion exchange. Samples that fall on the ^{36}Cl decay curve are 30, 29B, and 26. A decrease in chloride concentration for samples 29A, 32, and 27 results in plots to the right of line A as shown by line D in figure 32. These samples may be the result of dilution or ion filtration of chloride in the Morrison aquifer. Likewise, samples that plotted to the left of line A were concentrated in chloride, possibly due to evaporation or ion filtration on the opposite side of the membrane, as represented by line E.

Dr. Fred Phillips (New Mexico Institute of Mining and Technology, written commun., 1991) compared the $^{36}Cl/Cl$ ratios with Br^-/Cl^- ratio data. The mixing of three end-member sources explains the observed data. The first end member is recharge water having a large $^{36}Cl/Cl$ ratio and large Br^-/Cl^- ratio; chloride concentrations range from 7 to 14 mg/L. The second end member is likely either ion filtrate or very ancient ground water recharged under a more humid climate. This second end member is characterized by a small $^{36}Cl/Cl$ ratio, large Br^-/Cl^- ratio, and is very dilute with chloride concentration less than 5 mg/L. The third end member is upward-leaking deep-basin brine containing small ratios of $^{36}Cl/Cl$ and Br^-/Cl^-; Cl^- concentrations exceed 100 mg/L. Therefore, the mixing of recharge water and an ion filtrate or ancient dilute recharge water with upward-leaking brine dominates the flow regime in the northwestern part of the San Juan Basin. This mixing of ground water affects ion constituent concentrations and precluded quantitative mass-balance calculations of geochemical reactions affecting water chemistry.

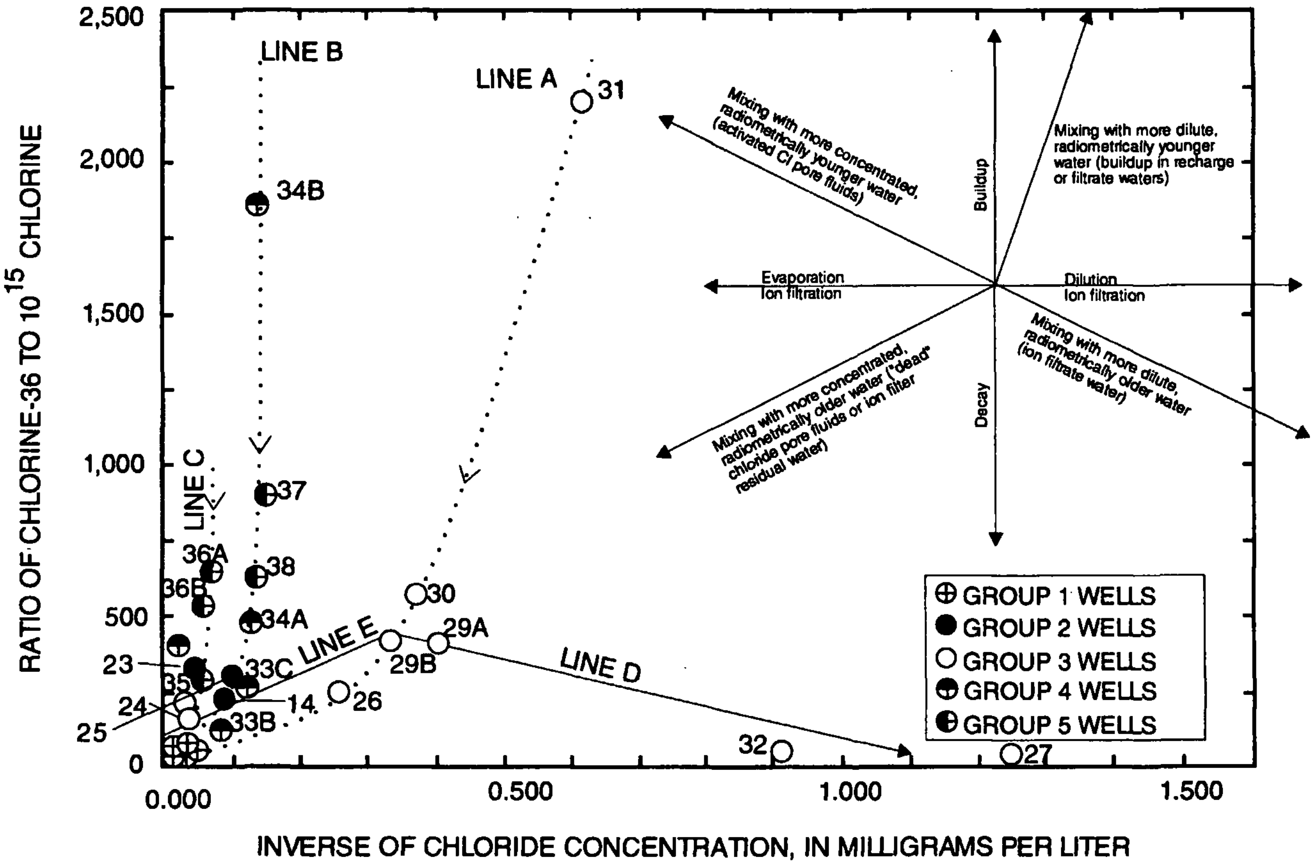


Figure 32.--Chlorine-36/chlorine versus inverse of chloride concentration for water from the Morrison aquifer. Figure 33 provides additional details (modified from Jones and Phillips, 1990).

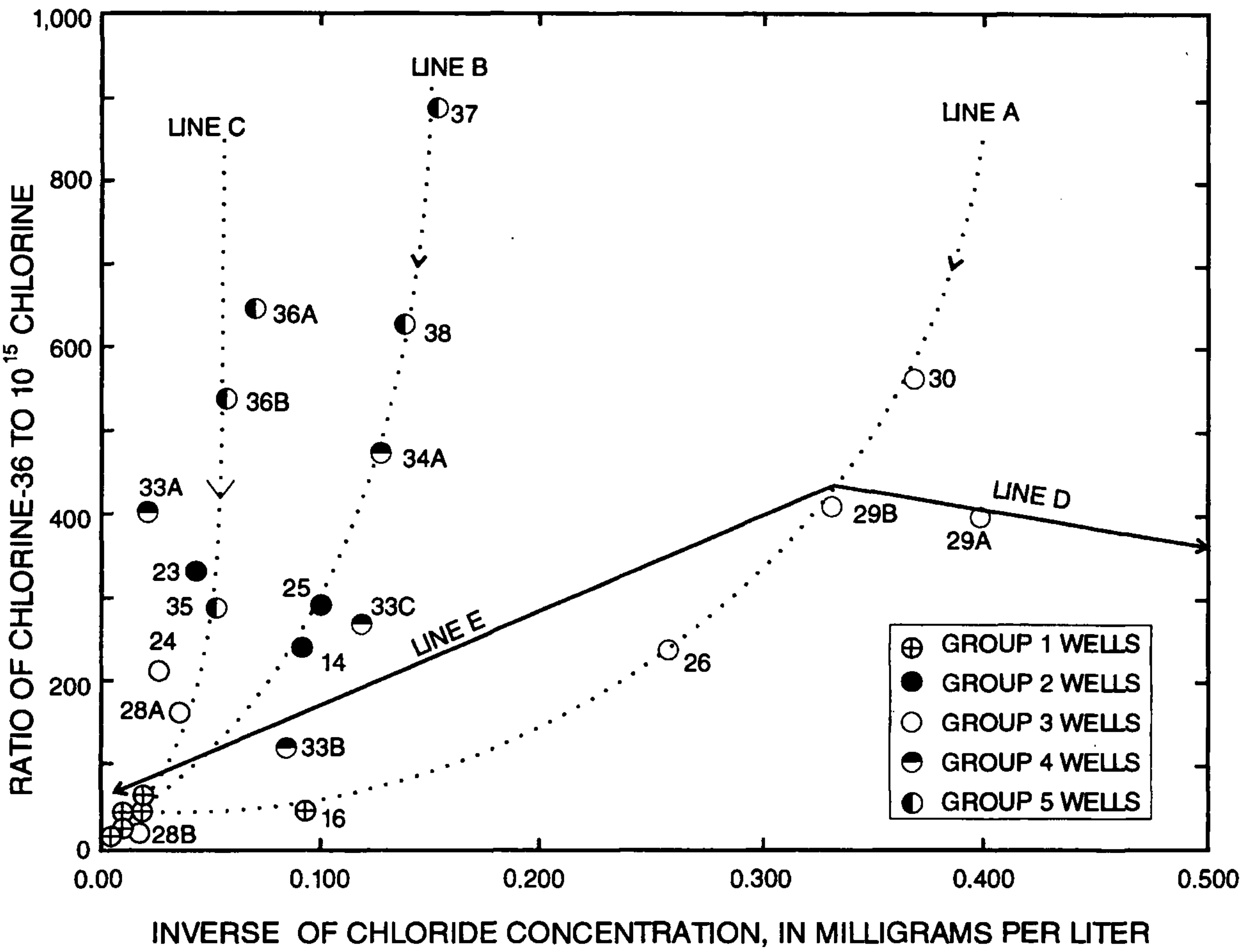


Figure 33.--Chlorine-36/chlorine versus inverse of chloride concentration for water from the Morrison aquifer--expanded scale. Expanded scale shows part of figure 32 in more detail (modified from Jones and Phillips, 1990).

To examine further the possibility of upward leakage into the Morrison aquifer, water-quality analyses were retrieved from the NWIS data base. Single-completion wells in the Wanakah Formation were not available. Chemical analyses for two samples from wells completed in the Entrada Sandstone are shown in table 10. Well Je1 is located on the northwest side of the basin approximately 8 mi west of Morrison well 21, and well Je2 is located approximately 8 mi east of Morrison well 36 (table 10). Sodium, sulfate, and chloride are the predominant major ions in both samples from the Entrada Sandstone. Chloride concentrations are significantly larger in water from the Entrada than in water from the Morrison aquifer. The chloride concentration is 1,100 mg/L in water from well Je1 compared with a chloride concentration of 67 mg/L (table 4) in well 21 from the Morrison aquifer. The chloride concentration is 810 mg/L in water from Entrada well Je2 compared with a chloride concentration of 17 mg/L (table 4) in well 36 from the Morrison. Vertical leakage of water into the Morrison through fractures or other areas of large permeability would increase chloride concentrations in the Morrison aquifer. This finding is generally consistent for samples from wells that have multiple completions in the Morrison and Wanakah Formations. Water from two wells, 26 and 24, completed in the Morrison aquifer, contain chloride concentrations of 3.9 and 38 mg/L (table 4). Well 26 is completed in the Recapture Member and well 24 is completed in the Recapture and Salt Wash Members and in the Wanakah Formation.

Table 10.--Two chemical analyses of water from the Entrada Sandstone
[Concentration in milligrams per liter except where otherwise indicated. --, no data]

	Well identification	
	Je1	Je2
Latitude	364838	360344
Longitude	1085154	1075156
Sample date	09-17-69	03-28-78
Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	9,320	10,000
pH (standard units)	8.20	8.30
Alkalinity (as $CaCO_3$)	410	470
Bicarbonate	570	--
Carbonate	10	2
Calcium	72	70
Manganese	28	8.3
Sodium	2,200	2,800
Potassium	9.0	15
Chloride	1,100	810
Sulfate	2,800	4,300
Fluoride	3.6	5.3
Dissolved solids	6,600	8,300

Physical processes, predominantly leakage and mixing, account for some of the sources and distribution of solutes and isotopes in the three aquifers. Other sources and mechanisms for addition and removal of solutes are controlled by geochemical processes.

Magnesium concentrations were larger in water samples from the Gallup aquifer than from the other two aquifers. This suggests a mineral source of Mg^{2+} in the Gallup aquifer that was not present in the other two aquifers or a sink for Mg^{2+} in the other two aquifers. Dissolution of calcite would contribute Ca^{2+} ions and dissolution of dolomite contributes Ca^{2+} and Mg^{2+} ions as shown in reactions 3 and 4:

$$CaCO_{3(c)} + H^+ = Ca^{2+} + HCO_3^- \quad (3)$$

$$CaMg(CO_3)_{2\,(c)} + 2H^+ = Ca^{2+} + Mg^{2+} + 2HCO_3^- \quad (4)$$

Dolomite, but not calcite, was observed in the Gallup aquifer by Kaharoeddin (1971), suggesting that the source of Ca^{2+} and Mg^{2+} is likely dolomite dissolution reactions.

The small Ca^{2+} and Mg^{2+} concentrations in the Dakota aquifer indicate that either dolomite dissolution is not a major process, cation exchange occurs, or the available data were not representative of the Dakota aquifer. Calcium and magnesium concentrations were also small in the Morrison aquifer. Dolomite minerals have not been observed in the Morrison, and calcite minerals are present but in small amounts (less than 10 percent calcite from two outcrop locations in the northwestern part of the basin according to Hansley, 1990).

The removal of Ca^{2+} and Mg^{2+} and the increase in Na^+ in the Gallup aquifer in the direction of ground-water flow are indicative of ion-exchange reactions with clay minerals (reaction 5):

$$Ca^{2+} + Na_2X = 2Na^+ + CaX; \quad (5)$$

where X = ion-exchange site.

Chlorite and glauconite clay minerals were observed by Kaharoeddin (1971) in the Gallup aquifer. Chlorite has a very low cation-exchange capacity of less than 10 meq/100 g (Drever, 1982, p. 82). Glauconite, an iron-rich variety of illite, has a higher cation-exchange capacity of 10 to 40 meq/100 g (Drever, 1982, p. 74 and 82). This suggests that glauconite rather than chlorite would be more effective in the exchange of the divalent cations (Ca^{2+}, Mg^{2+}) for the monovalent Na^+ cation in the Gallup aquifer.

The presence of small concentrations of Ca^{2+} and Mg^{2+} in samples from the Dakota and Morrison aquifers may be a result of sampling where dissolution of carbonates and cation exchange both occur in the recharge area, possibly in the soil zone or unsaturated zone, prior to reaching the location of the sampled wells. Another possible explanation is that dissolution of carbonates was not a significant process and that silicate hydrolysis was the major process resulting in Na^+ concentrations. The dissolution of albite ($NaAlSi_3O_8$) releases Na^+ as shown in reactions 6 and 7. Albite altering to kaolinite ($Al_2Si_2O_5(OH)_4$) has been observed in core and outcrop samples from the Morrison aquifer (Hansley, 1990).

$$NaAlSi_3O_{8\,(c)} + 8H_2O = Na^+ + Al(OH)_4^- + 3H_4SiO_4^0 \quad (6)$$

$$2NaAlSi_3O_8 + 2CO_2 + 11H_2O = 2Na^+ + Al_2Si_2O_5(OH)_{4\,(c)} + 4H_4SiO_4^0 + 2HCO_3^- \quad (7)$$

Sources of bicarbonate include carbonate dissolution (reactions 3 and 4) and silicate hydrolysis (reaction 7). Dissolution of the carbonate mineral dolomite is a likely source of HCO_3^- in the Gallup aquifer (reaction 6). Silicates hydrolyzing in the presence of CO_2 gas contribute HCO_3^- (reaction 7). Silicate minerals observed in all three aquifers include potassium feldspar, plagioclase feldspar (such as albite), and several clay minerals.

Sources of sulfate include dissolution of sulfate-bearing minerals and oxidation of sulfide minerals. However, for the Gallup aquifer, no sulfate or sulfide minerals were observed by Williams (1956) or Kaharoeddin (1971). The large concentrations of SO_4^{2-} in water analyses shown in table 2 suggest that there is a source of SO_4^{2-} and that the mineralogical data may not be complete for the Gallup aquifer. The Mancos Shale confines the Gallup aquifer and may be a source of SO_4^{2-}.

Sulfate concentrations in the Dakota aquifer do not increase uniformly but rather form two groups of small and large concentrations. No sources of SO_4^{2-} were studied by Walters and others (1987), who were concerned primarily with trace-element concentrations.

Sulfate concentrations increase downgradient in the Morrison aquifer toward Shiprock. Sources of SO_4^{2-} in water from the Morrison aquifer include dissolution of sulfate minerals or oxidation of sulfide minerals. Anhydrite ($CaSO_4$) and pyrite (FeS_2) have been observed in the Morrison aquifer (Hansley, 1990). A dissolution reaction for anhydrite producing SO_4^{2-} is shown in reaction 8. Oxidation of 1 mole of pyrite can release 2 moles of SO_4^{2-} (reaction 9).

$$CaSO_{4(c)} = Ca^{2+} + SO_4^{2-} \tag{8}$$

$$FeS_{2(c)} + 4O_{2\,(g)} + 2H_2O = FeO(OH) + 2SO_4^{2-} + 4H^+ \tag{9}$$

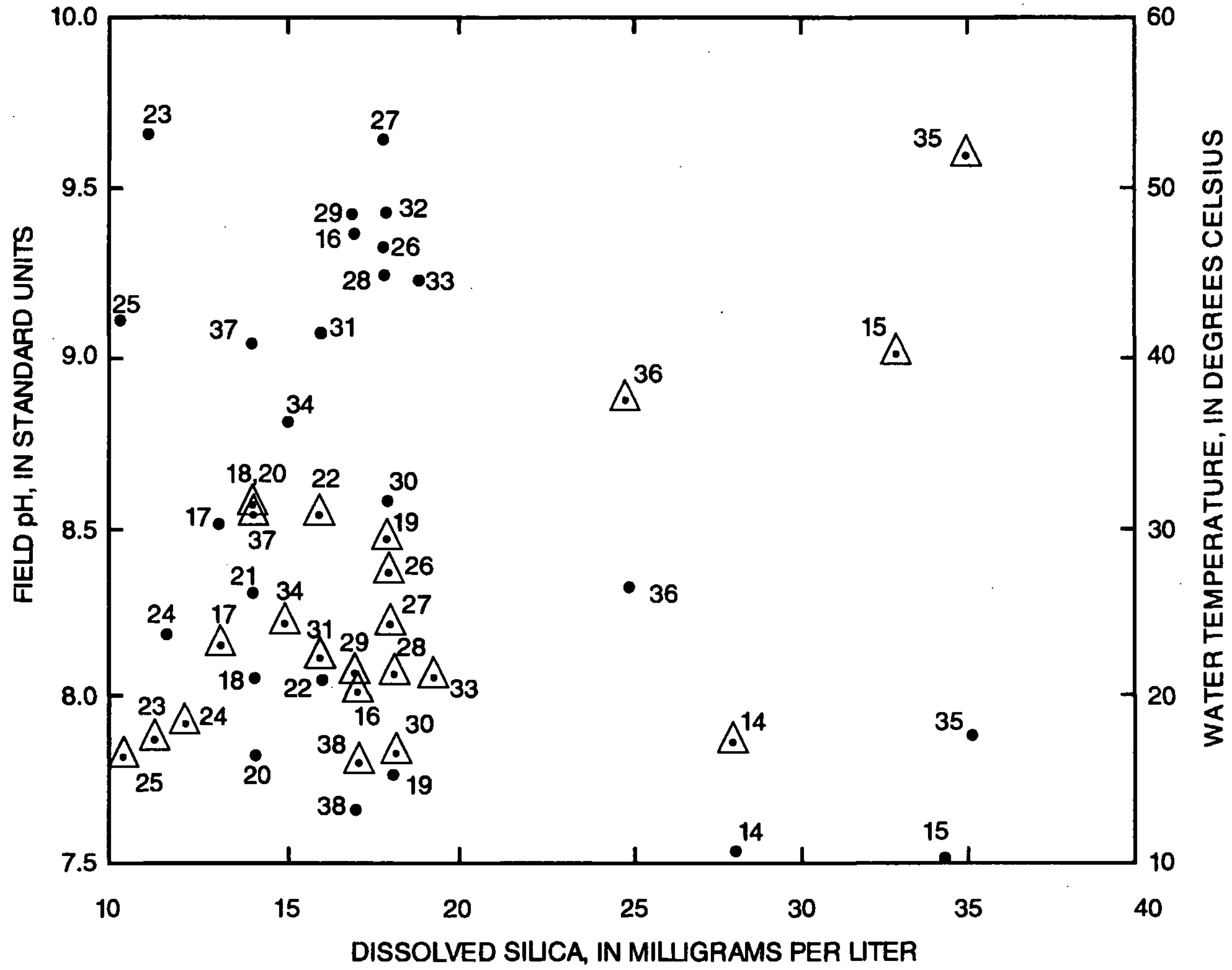
$(Silica)_T$ is the total sum of three ions: $H_4SiO_4^0$, $H_3SiO_4^-$, and $H_2SiO_4^{2-}$. Below a pH of 9, most dissolved $(SiO_2)_T$ exists as $H_4SiO_4^0$. As pH rises above 9, $H_3SiO_4^-$ becomes an important species (Drever, 1982, p. 91-92), followed by $H_2SiO_4^{2-}$ above a pH of 12. Dissolved $(SiO_2)_T$ concentrations would be expected to increase with increasing pH above 9 because both $H_2SiO_4^{2-}$ and $H_3SiO_4^-$ would be in solution. Dissolved $(SiO_2)_T$ is plotted against field pH in figure 34 for water from the Morrison aquifer. No correlation exists for all points; however, a cluster of $(SiO_2)_T$ samples plot in the range of 18 to 20 mg/L with pH values between 9.2 and 9.5. Another control on $(SiO_2)_T$ concentration is temperature (Krauskopf, 1979, p. 169-170). The effects of water temperature on dissolved $(SiO_2)_T$ appear to be significant for values greater than 25 °C (fig. 34). The maximum $(SiO_2)_T$ concentration of 35 mg/L was associated with the warmest water of 51.8 °C.

An oxidation-reduction (redox) reaction controls nitrogen speciation. The denitrification process (reaction10) is shown below:

$$NO_3^- + 2CH_2O + 2H^+ = NH_4^+ + 2CO_{2(g)} + H_2O; \tag{10}$$

where CH_2O = organic matter.

Microbes use the oxygen in nitrate ions to oxidize organic matter to CO_2. The denitrification process in the aquifer probably occurs after oxygen is consumed by the oxygen-reducing microbes.



EXPLANATION

14 WELL NUMBER--Corresponds to well number shown in table 1

• PLOT OF pH

△ PLOT OF TEMPERATURE

Figure 34.--Concentration of dissolved silica versus field pH and temperature of water samples from the Morrison aquifer.

Degrees of mineral saturation were computed with the computer code WATEQF (Plummer and others, 1976) to identify areas where minerals are likely to dissolve, precipitate, or be in thermodynamic equilibrium with the water. Requirements for input into the code include data on the major ions, pH, temperature, SiO_2, Fe, PO_4, Sr, and F. Analytical data for Al and $(SiO_2)_T$ are required for calculating states of saturation for aluminosilicate minerals. A value of 10 µg/L for Al was assumed for values less than the detection limit of 10 µg/L. Redox calculations were made using dissolved oxygen (where detected) or the SO_4/H_2S ratio (H_2S was converted from total sulfide data).

WATEQF modeling provides an estimate of the mineral saturation index (SI) for a suite of minerals for each sample. The definition of SI is:

$$SI = \log \frac{IAP}{K_T} \tag{11}$$

where IAP is ion activity product; and
K is equilibrium constant at temperature T, in degrees Kelvin.

If SI is negative, the solution is undersaturated with respect to the mineral. Conversely, a positive SI indicates supersaturation with respect to the mineral. Where IAP equals K_T, thermodynamic equilibrium is indicated.

Results from WATEQF modeling indicate various states of saturation for minerals in the three sandstone aquifers. Albite, amorphous silica, and gypsum were found to be undersaturated in all samples collected from the three aquifers, suggesting that these minerals would dissolve in ground water where they are present in the aquifer. Values of SI for calcite in the Gallup and Dakota aquifers generally are positive, suggesting conditions suitable for calcite precipitation.

Values of SI for calcite in samples from the Morrison aquifer ranged from positive to negative, indicating both precipitation and dissolution of calcite minerals in some parts of the aquifer. Most samples were supersaturated with respect to calcite, indicating that calcite would precipitate. Several samples, particularly near the San Juan River in the vicinity of Shiprock, were undersaturated with respect to calcite, indicating that calcite would dissolve where present.

Values of SI calculated for dolomite ($CaMg(CO_3)_2$) for samples in the three aquifers have similar patterns to the SI data for calcite. Notable exceptions are three samples from the Gallup aquifer in the central part of the basin that are supersaturated with respect to calcite and undersaturated with respect to dolomite. The difference in SI values for dolomite relative to calcite may be the presence of small Mg^{2+} concentrations detected in several samples from the Gallup aquifer.

SI values were computed for clay minerals including chlorite, kaolinite, illite, and the smectite group of montmorillonite minerals. SI values for chlorite samples from the Gallup aquifer ranged from highly positive (5.0) to highly negative (-4.3). Highly positive SI values indicate that precipitation of chlorite may consume 0.5 mole/liter of Mg from the water. SI values for chlorite in the Morrison aquifer ranged from 3.7 to -6.2. No discernible trends in SI values for chlorite were evident.

Kaolinite minerals were observed in the Dakota and Morrison aquifers. Values of SI for both aquifers show general trends of undersaturation (suggesting dissolution) with respect to kaolinite near the recharge areas and supersaturation (suggesting precipitation) downgradient.

WATEQF calculations for illite minerals indicate predominant undersaturation of the minerals in samples collected from the three aquifers. Exceptions were two samples obtained from wells located in the outcrop area of the Morrison aquifer. Illite has been observed in the Dakota and Morrison aquifers, suggesting the potential for dissolution reactions that would release Mg^{2+}, Al hydroxides, and silicic acid.

Smectite minerals were observed in the Dakota and Morrison aquifers. The thermodynamic data for smectite minerals are not well constrained, creating large uncertainties in the SI calculations. Smectite was found to be supersaturated for all samples from the two aquifers.

SUMMARY AND CONCLUSIONS

Geochemical data were obtained for 38 wells completed in the Gallup, Dakota, and Morrison aquifers to examine sources of solutes and hydrologic controls that affect the concentration and distribution of solutes in the San Juan Basin. The scope was constrained primarily to the northwestern part of the basin because of well availability and disturbances to the natural ground-water system by uranium mining in the southern part of the basin. Although the Gallup, Dakota, and Morrison aquifers were examined, 25 of the 38 wells were completed in the Morrison aquifer, which had the most available wells completed in single aquifers.

Based on a series of samples collected along ground-water flow paths, chemical concentrations were variable depending on vertical sampling interval, well location, and sampling date. Several sandstone units contributed water to wells completed in the Morrison aquifer, suggesting that the Morrison aquifer is not a simple two-dimensional flow system. The data presented in this report indicate an upward component of flow into the Morrison aquifer. The entire section above and below the Morrison aquifer appears to be controlled by a three-dimensional flow regime where saline brine leaks upward near the San Juan River discharge area. Temporal changes in ion constituent concentrations may be a result of changes in hydraulic head in individual sandstone layers that contributed water to the well. The assumption that water chemistry in wells does not change over short periods in a large regional aquifer cannot be made as has been done commonly in previous investigations.

Predominant ions found in the three aquifers were generally Ca^{2+}, Na^{+}, HCO_3^-, and SO_4^{2-}. The Gallup aquifer contained Ca^{2+}-HCO_3^- in recharge areas and Na^{+}-SO_4^{2-} downgradient. The Dakota Sandstone contained Na^{+}-HCO_3^- in recharge areas with the addition of SO_4^{2-} downgradient. Predominant ions in the Morrison aquifer were Na^{+}-HCO_3^- in recharge areas and Na^{+}-SO_4^{2-} downgradient.

Maximum chloride concentrations found in the Gallup, Dakota, and Morrison aquifers were 240, 720, and 750 mg/L, respectively. Median chloride concentrations were 20, 57, and 11 mg/L, respectively. Detectable trace-element concentrations included As, Ba, B, Fe, Li, Mn, and Sr.

Radioactive isotopes were useful in distinguishing sources of water to the Morrison aquifer. The absence of ^{3}H activities confirmed that ground water from all wells sampled has not mixed with modern water and has been isolated from the atmosphere since at least 1952. Of 24 samples analyzed, ^{14}C activities were detected in 12. Age dating with ^{14}C was not meaningful given the different sources of water in the aquifer. The ^{36}Cl radioisotopic data proved most useful in differentiating the sources of water in the Morrison aquifer. Comparing Br^-/Cl^- concentration ratios to $^{36}Cl/Cl$ ratios indicates three major end members of water resulting from different sources. Recharge water had a large $^{36}Cl/Cl$ ratio and small Br^-/Cl^- ratio. Chloride concentrations were between 7 and 14 mg/L. A second end member of water contained small ^{36}Cl ratios, large Br^-/Cl^- ratios, was very dilute, and contained chloride concentrations below 5 mg/L. These results suggest that water may have filtered into the Morrison through zones that trap dissolved solids by the ion-filtration process. A second hypothesis is that this water is very ancient water that was recharged during a humid climatic period. The third end member of water is characterized by upward-leaking, deep-basin brine containing small ratios of $^{36}Cl/Cl$ and Br^-/Cl^- and large chloride concentrations exceeding 100 mg/L.

Chemical and radioisotopic data indicate that water from overlying and underlying units mixes with recharge water in the Morrison aquifer. Recharge water contained a large $^{36}Cl/Cl$ ratio and a small Br^-/Cl^- ratio. Approximately 10 mi downgradient, however, samples from four wells completed in the Morrison aquifer were considerably different in composition compared to recharge samples. Oxygen stable isotopes decreased by 2.8 $^0/_{00}$ and deuterium decreased 26 $^0/_{00}$, relative to recharge. Carbon-14 radioisotope activities were not detectable. Chlorine-36/Cl ratios were small and Br^-/Cl^- ratios were large. These results suggest two potentially viable processes: ion filtration or trapping of ancient dilute water recharged under a humid climate. For water samples near the San Juan River, pH decreased to about 8.0, Cl^- concentrations increased to more than 100 mg/L, and $^{36}Cl/Cl$ ratios and Br^-/Cl^- ratios were small. Leakage of deep basin brine into the fresher water of the Morrison aquifer appears to control ion constituent concentrations.

The mixing of recharge water and an ion filtrate or ancient dilute recharge water with upward-leaking brine dominates the flow regime in the northwestern part of the San Juan Basin. This mixing of ground water controls ion constituent concentrations and precluded quantitative mass-balance calculations of geochemical reactions controlling water chemistry. Geochemical reactions involve dissolution of carbonate, silicate, and sulfate minerals present in the three aquifers, ion-exchange reactions, and oxidation reduction.

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HYDROGEOLOGY AND STEADY-STATE SIMULATION OF GROUND-WATER FLOW IN THE SAN JUAN BASIN, NEW MEXICO, COLORADO, ARIZONA, AND UTAH

By John Michael Kernodle

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 95-4187

REGIONAL AQUIFER-SYSTEM ANALYSIS

Albuquerque, New Mexico
1996

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

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FIGURES--Continued

FIGURES--Continued

FIGURES--Concluded

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
LENGTH		
inch	0.02540	meter
foot	0.3048	meter
mile	1.609	kilometer
foot per day	0.3048	meter per day
AREA		
square mile	2.590	square kilometer
	43,560.	square foot
foot squared per day	0.09290	meter squared per day
VOLUME		
cubic foot	0.02832	cubic meter
	7.48	gallon
acre-foot	1,233	cubic meter
	43,560	cubic foot
cubic foot per second	0.02832	cubic meter per second
	448.8	gallon per minute
gallon per minute	0.00006309	cubic meter per second
gallon per minute per foot	0.2070	liter per second per meter
gallon per day per foot squared	0.04075	meter per day

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:

$$°F = 9/5\ (°C) + 32$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 --a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

HYDROGEOLOGY AND STEADY-STATE SIMULATION OF GROUND-WATER FLOW IN THE SAN JUAN BASIN, NEW MEXICO, COLORADO, ARIZONA, AND UTAH

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ABSTRACT

As part of a multidisciplinary regional aquifer-system analysis, a three-dimensional steady-state ground-water-flow model was constructed for the San Juan Basin in parts of New Mexico, Colorado, Arizona, and Utah. The model simulated ground-water flow in 12 hydrostratigraphic units representing all of the major sources of ground water from aquifers of Jurassic and younger age.

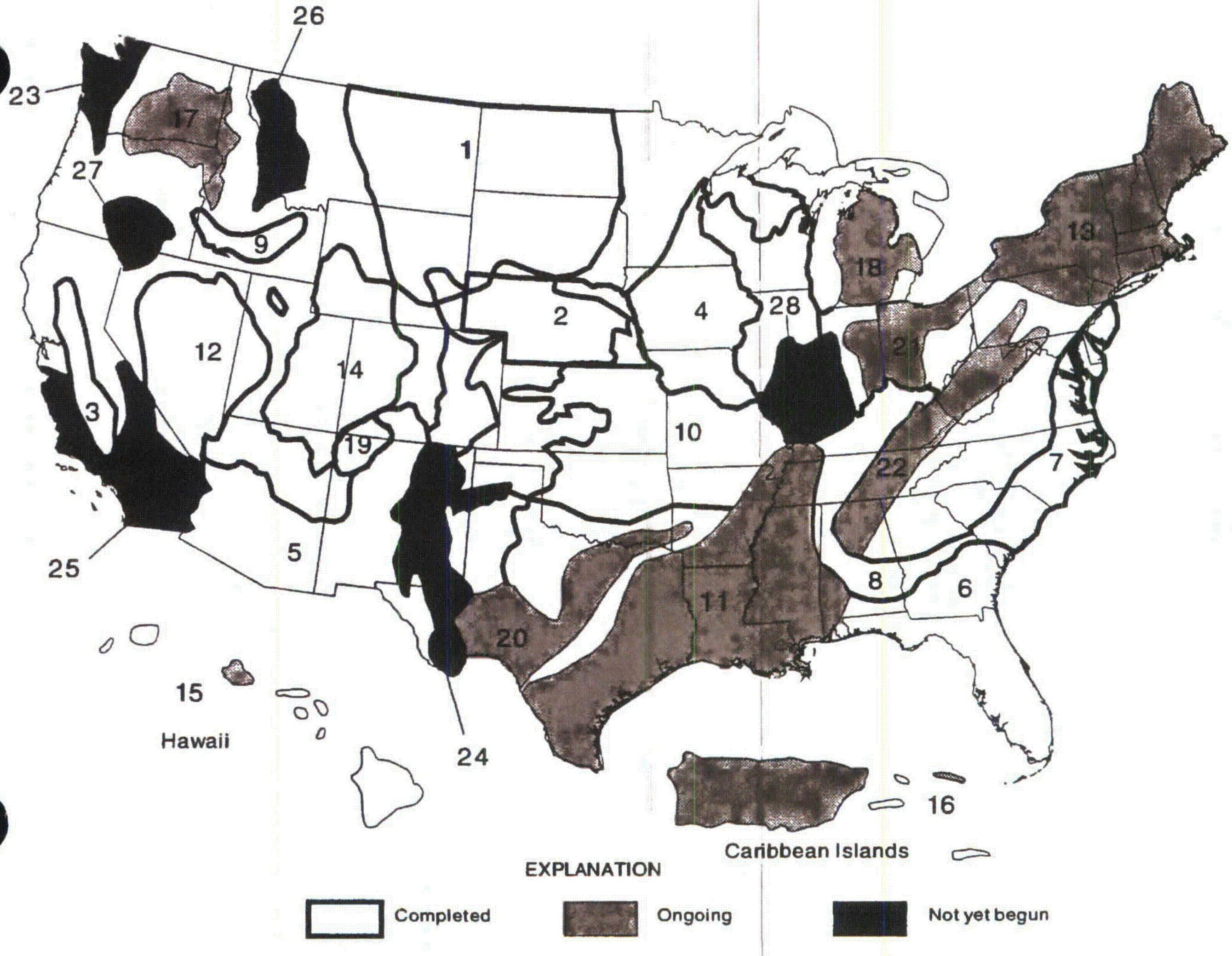
Ten map reports in the U.S. Geological Survey Hydrologic Investigations Atlas 720 series were prepared in conjunction with this investigation. The units that were described in the atlases were the San Jose, Nacimiento, and Animas Formations; Ojo Alamo Sandstone; Kirtland Shale and Fruitland Formation; Pictured Cliffs Sandstone; Cliff House Sandstone; Menefee Formation; Point Lookout Sandstone; Gallup Sandstone; Dakota Sandstone; and Morrison Formation. Additional descriptions of the alluvial and landslide deposits, Chuska and Crevasse Canyon Sandstones, Lewis and Mancos Shales, Wanakah Formation, and Entrada Sandstone are included in this report. Much of the information in the HA-720 series was generated from digital computer data bases that were directly usable by the computer for compilation of input data for the model. In essence, the major components of the ground-water-flow model were described and documented in the series of hydrologic atlases.

The primary finding resulting from the ground-water-flow simulation was that boundary conditions and internal geometry of the aquifers are the major controls of steady-state ground-water flow and hydraulic heads in the San Juan Basin. Another significant finding was that the computed steady-state ground-water flux is a very minor component (about 1 percent) of the total water budget of the basin.

INTRODUCTION

This report is one in a series resulting from the U.S. Geological Survey's Regional Aquifer-System Analysis (RASA) program (Sun, 1986). The program began in 1978 with a study of the Northern Great Plains Basin (fig. 1) and has expanded to include 28 regional aquifer systems nationwide that have been or were planned to be investigated.

The study of the San Juan structural basin began in October 1984. Although the San Juan Basin geologically is a part of the Colorado Plateau and is partly in the Colorado River drainage, which defined the area of a preceding RASA, it was excluded from that study because the ground-water-flow system in the San Juan Basin remains regional in scale and is a classical example of an artesian ground-water-flow system. The isolation of the San Juan Basin as a separate investigation within the Colorado Plateau thus provided the opportunity to derive and focus on information that could be compared with other classical artesian basins.



1. Northern Great Plains
2. High Plains
3. Central Valley California
4. Northern Midwest
5. Southwest alluvial basins
6. Floridian aquifer
7. Northern Atlantic Coastal Plain
8. Southeastern Coastal Plain
9. Snake River Plain
10. Central Midwest
11. Gulf Coastal Plain
12. Great Basin
13. Northeast glacial valleys
14. Upper Colorado River Basin
15. Oahu Island, Hawaii
16. Caribbean Islands
17. Columbia Plateau
18. Michigan Basin
19. San Juan Basin
20. Edwards-Trinity aquifer
21. Ohio/Indiana carbonates and glacial deposits
22. Appalachian Valleys and Piedmont
23. Puget-Willamette Trough
24. Pecos River Basin
25. Southern California alluvial basins
26. Northern Rockies Intermontane Basin
27. Alluvial basins, Oregon, Calif., Nev.
28. Illinois Basin

Figure 1.--Location of the Regional Aquifer-System Analysis areas of investigation.

Purpose and Scope

The purposes of the San Juan Basin RASA (Welder, 1986) are to: (1) define and characterize the aquifer system; (2) assess the effects of past, present, and potential ground-water use on aquifers and streams; and (3) determine the availability and quality of ground water. These broad objectives were reduced to four specific tasks: (1) the geologic framework was described; (2) the geochemical processes in a selected part of the flow system were investigated and described; (3) the flow system was simulated and described (this report); and (4) a summary of the investigation was prepared. This report describes the geohydrology and presents the results of three-dimensional steady-state ground-water-flow simulations of the major aquifers in the San Juan Basin.

Information on the major water-yielding units in the basin presented in the Hydrologic Investigations Atlas 720 Series and additional unpublished information on non-water-yielding units and minor aquifers were used to describe the geohydrology of the basin and to construct the ground-water-flow model. Existing literature and well-completion records provided information on aquifer properties, water levels, potentiometric heads, and well yields. The completed model was used to give an integrated description of the aquifer-system components and their relation to and interaction with surface recharge and discharge.

Description of the Study Area

The San Juan structural basin is located in New Mexico, Colorado, Arizona, and Utah, and has an area of about 21,600 square miles (fig. 2). The structural basin is about 140 miles wide and about 200 miles long. The study area is that part of the structural basin that contains rocks of Triassic and younger age; therefore, the study area is less extensive than the structural basin. Triassic through Tertiary sedimentary rocks are emphasized in this study because these units are the major aquifers in the basin. The study area is about 140 miles wide (about the same as the structural basin), 180 miles long, and has an area of about 19,380 square miles. The study area represents 15,550 square miles in New Mexico, 3,100 square miles in Colorado, 720 square miles in Arizona, and 11 square miles in Utah.

Land-surface altitudes in the study area range from about 4,500 feet above sea level in southeastern Utah to about 11,300 feet in the southeastern part of the basin. The area-weighted mean altitude is about 6,700 feet. Annual precipitation in the high mountainous areas along the north and east margins of the basin is as much as 40 inches, whereas annual precipitation in the lower altitude central basin is generally less than 8 inches. Mean annual area-weighted precipitation in the study area is about 12 inches.

Population and Economy

Data obtained from documents published by the U.S. Bureau of the Census (1980 and 1985) were used to calculate the population of the study area. The population in 1970 was calculated to be about 134,000. The population increased to about 194,000 in 1980, 212,000 in 1982, 221,000 in 1984, and then decreased to about 210,000 in 1985. The economy of the basin is supported by exploration for and development of natural gas, petroleum, coal, and uranium resources; urban enterprise; farming and ranching; tourism; and recreation. The rise and fall in population were related to changes in the economic strength of the minerals, oil, and gas industries and support services. Uranium-mining and -milling activities underwent rapid growth from the 1950's until the late 1970's and early 1980's when most uranium-mining activity came to an abrupt end. Likewise, the oil and gas industry prospered until about 1983 and then declined rapidly.

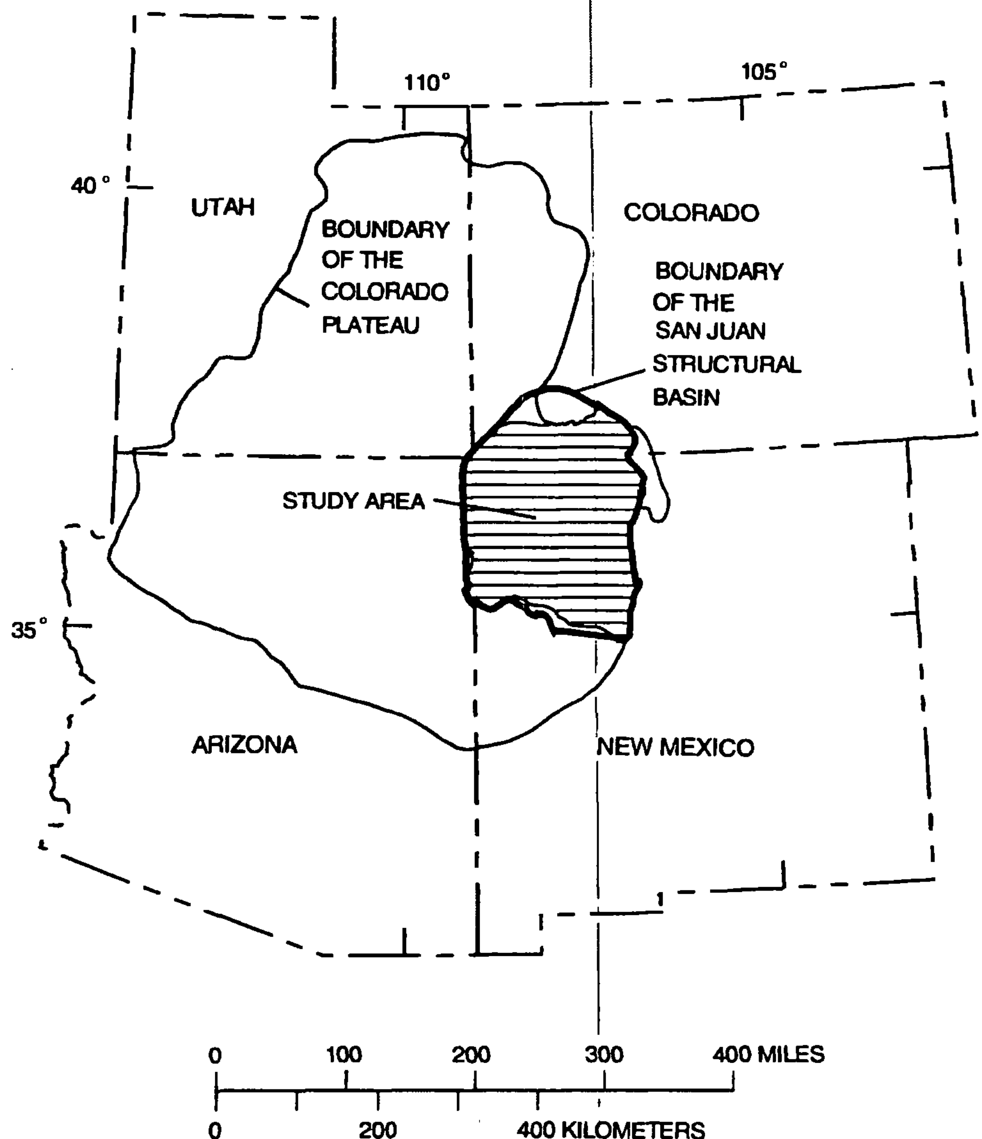


Figure 2.--Location of Colorado Plateau, San Juan structural basin, and study area.

Population density governs the amount of water that is required for private-domestic or municipal supplies. Population density also reflects the distribution or concentration of commercial and industrial facilities that also have water needs. Ranges in estimated population density in the San Juan Basin for 1985 are shown in figure 3.

Previous Investigations

Wright (1979) prepared a bibliographic reference for papers and reports that pertain to geologic and geohydrologic subjects for the San Juan Basin. Her publication listed more than 2,500 manuscripts, including many private consultants' reports. Many other hydrogeologic documents have been published since the release of her compilation, including the citations listed in the next paragraph. In addition, a vast number of archeological, climatic, paleoclimatic, and surface-water reports have information relevant to a study of the ground-water basin.

Stone and others (1983) compiled a fairly comprehensive summary of the hydrogeology of the New Mexico part of the San Juan Basin. That report describes the geohydrologic properties of the Wanakah Formation (later terminology) and younger hydrostratigraphic units. Frenzel (1982) completed a three-dimensional steady-state ground-water-flow model of the San Juan Basin in New Mexico and Colorado. Later (1983), he prepared an uncalibrated transient version of the model to investigate possible effects related to proposed development of Federal coal leases. Other models prepared by the U.S. Geological Survey include those by Hearne (1977) and McLean (1980) of aquifers in the vicinity of Gallup, New Mexico. A three-dimensional steady-state model of the Morrison-Dakota-Gallup aquifer subsystem was completed by Kernodle and Philip (1988). One of the most recent models is of the aquifers in Mesozoic rocks in the Four Corners area (Thomas, 1989). Many other reports and papers are cited in the following sections.

Reports Related to the Investigation

Sun (1986) compiled a summary of RASA investigations. That summary contains detailed information on the overall purpose of the RASA program and the scope and status of the individual investigations, including the San Juan Basin RASA.

A series of Hydrologic Atlases was published in conjunction with this investigation that describe the hydrology, geology, and geochemistry of the major water-yielding hydrostratigraphic units in the study area. Reports in this series describe the hydrogeology of the Dakota Sandstone (Craigg and others, 1989); Gallup Sandstone (Kernodle and others, 1989); Point Lookout Sandstone (Craigg and others, 1990); Morrison Formation (Dam and others, 1990a); Pictured Cliffs Sandstone (Dam and others, 1990b); Kirtland Shale and Fruitland Formation (Kernodle and others, 1990); Menefee Formation (Levings and others, 1990a); San Jose, Nacimiento, and Animas Formations (Levings and others, 1990b); Cliff House Sandstone (Thorn and others, 1990a); and Ojo Alamo Sandstone (Thorn and others, 1990b) in the San Juan structural basin.

The series of atlases was intended to provide information upon which subsequent investigative reports such as this could rely for basic reference material. This report describes a three-dimensional ground-water-flow model of Jurassic and younger hydrostratigraphic units. Levings and others (1996) provided a coherent overview of the multidisciplinary facets of the investigation. The hydrogeochemistry of the Morrison, Dakota, and Gallup aquifers in the northwestern part of the basin was described by Dam (1995). Craigg (in press) describes the geologic framework of the San Juan Basin.

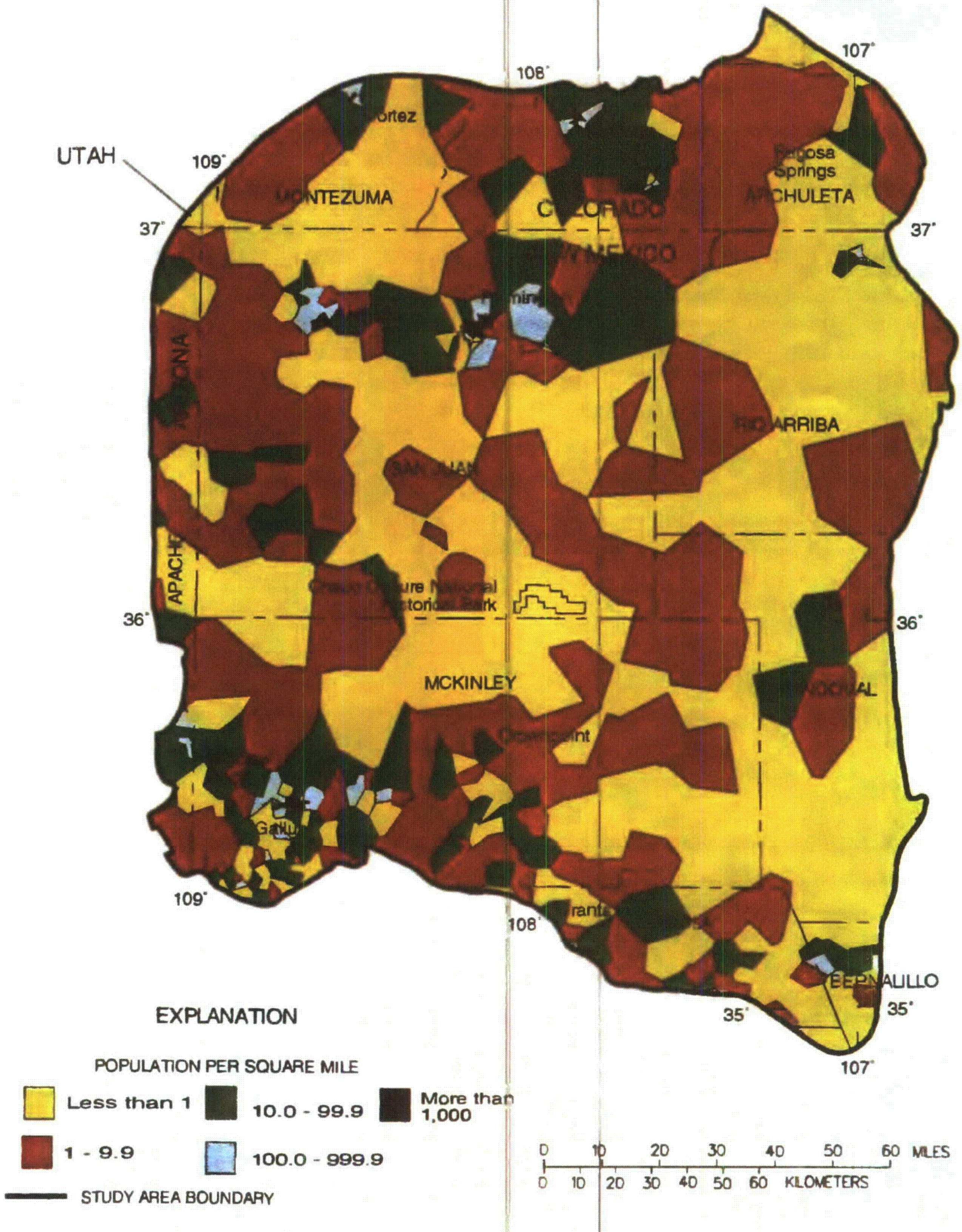


Figure 3.--Estimated 1985 population density in the San Juan Basin (from U.S. Bureau of the Census, 1980 and 1985)

GEOHYDROLOGIC SETTING

Geology

The San Juan structural basin (fig. 4), formed during the Laramide Orogeny (Late Cretaceous-early Tertiary), is an asymmetric syncline that deepens to the northeast. The limits of the basin generally are clearly delineated by faults, uplifts, or monoclines. The clearest example of a fault determining the basin boundary is along the eastern side of the basin where Precambrian granite has been uplifted east of the Nacimiento Fault. The Defiance and Nutria Monoclines also are good examples of basin-bounding features. In some areas, however, the boundary is indistinct and the basin merges across structural saddles with adjacent basins or embayments. Examples of this indistinct boundary between basins are found in the Gallup and Acoma Sags and the Four Corners Platform.

The San Juan structural basin contains a thick sequence of sedimentary rocks ranging in age from Cambrian through Tertiary (fig. 5), but principally from Pennsylvanian through Tertiary. The maximum thickness of the sequence of rocks is about 14,000 feet (Fassett and Hinds, 1971, p. 4). These sedimentary rocks dip basinward from the basin margins toward the troughlike structural center (deepest part of the basin) except where locally interrupted by intrabasinal folds, faults, and domes. Older sedimentary rocks crop out around the basin margins and are successively overlain by younger rocks toward the center of the structural basin (fig. 6). Volcanic rocks of Tertiary age and various deposits of Quaternary age also are present in the basin.

Faulting is common, especially around the northeastern, eastern, and southeastern perimeter of the basin (fig. 7). Faults along the northeastern and eastern perimeter generally are on the platform areas outside the Hogback Monocline. Displacement along these faults is as much as several hundred feet, and along Nacimiento Fault is several thousand feet. Displacement along individual faults in the Puerco Fault Zone in the southeastern part of the basin typically ranges from several tens to a few hundred feet. The basinward side of faults is usually the downthrown side in the Puerco Fault Zone. Fault orientation and displacement in the Crownpoint-Grants, New Mexico, area (also known as the Grants uranium belt) are more disheveled than elsewhere, often leading to some remarkable structures as in the area just south of Crownpoint. When fault displacement and synclinal structure are combined, the maximum structural relief in the basin is about 10,000 feet (Kelley, 1951, p. 126). The present structural elements of the basin largely had developed by middle Tertiary time (Kelley, 1951, p. 130).

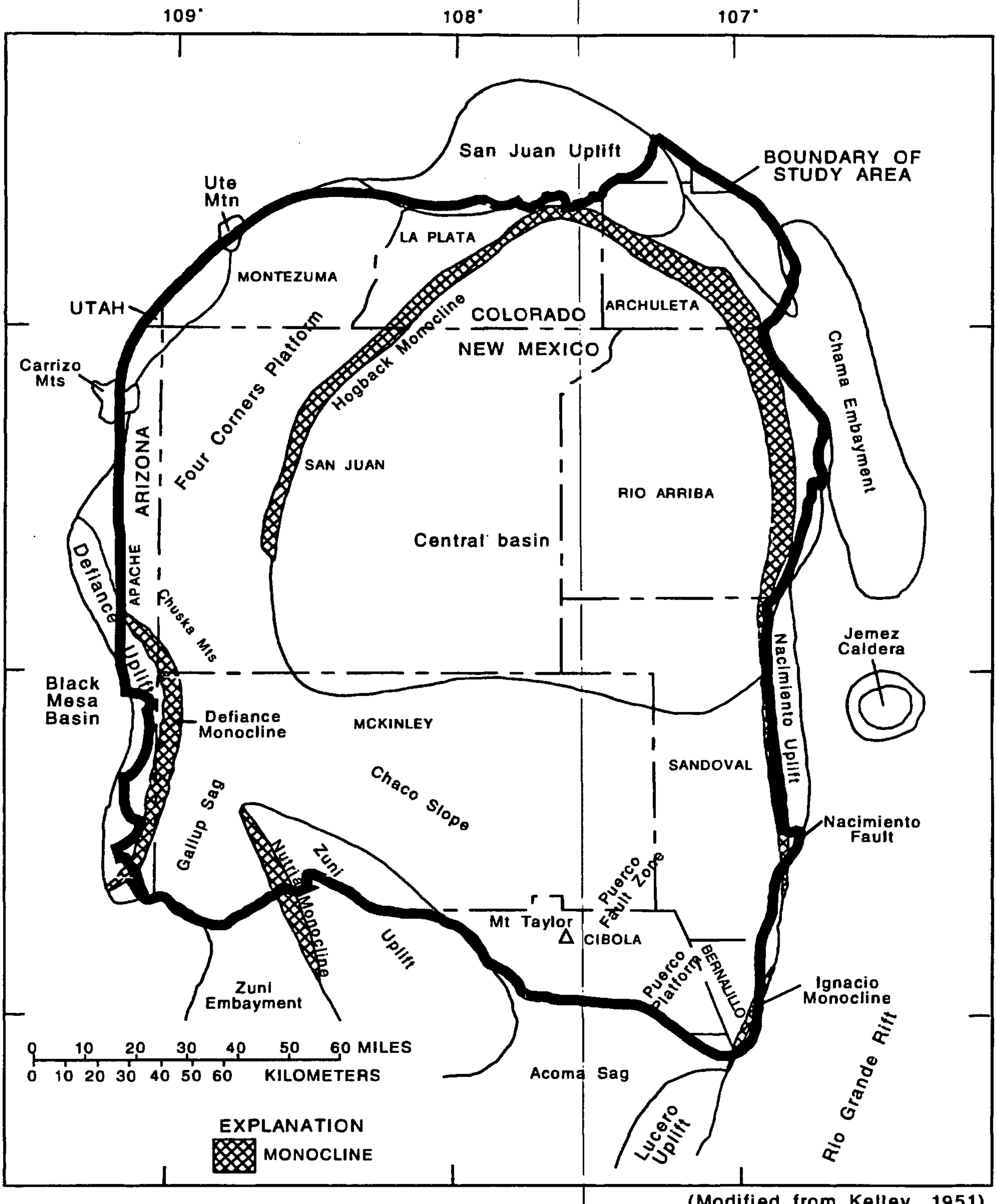
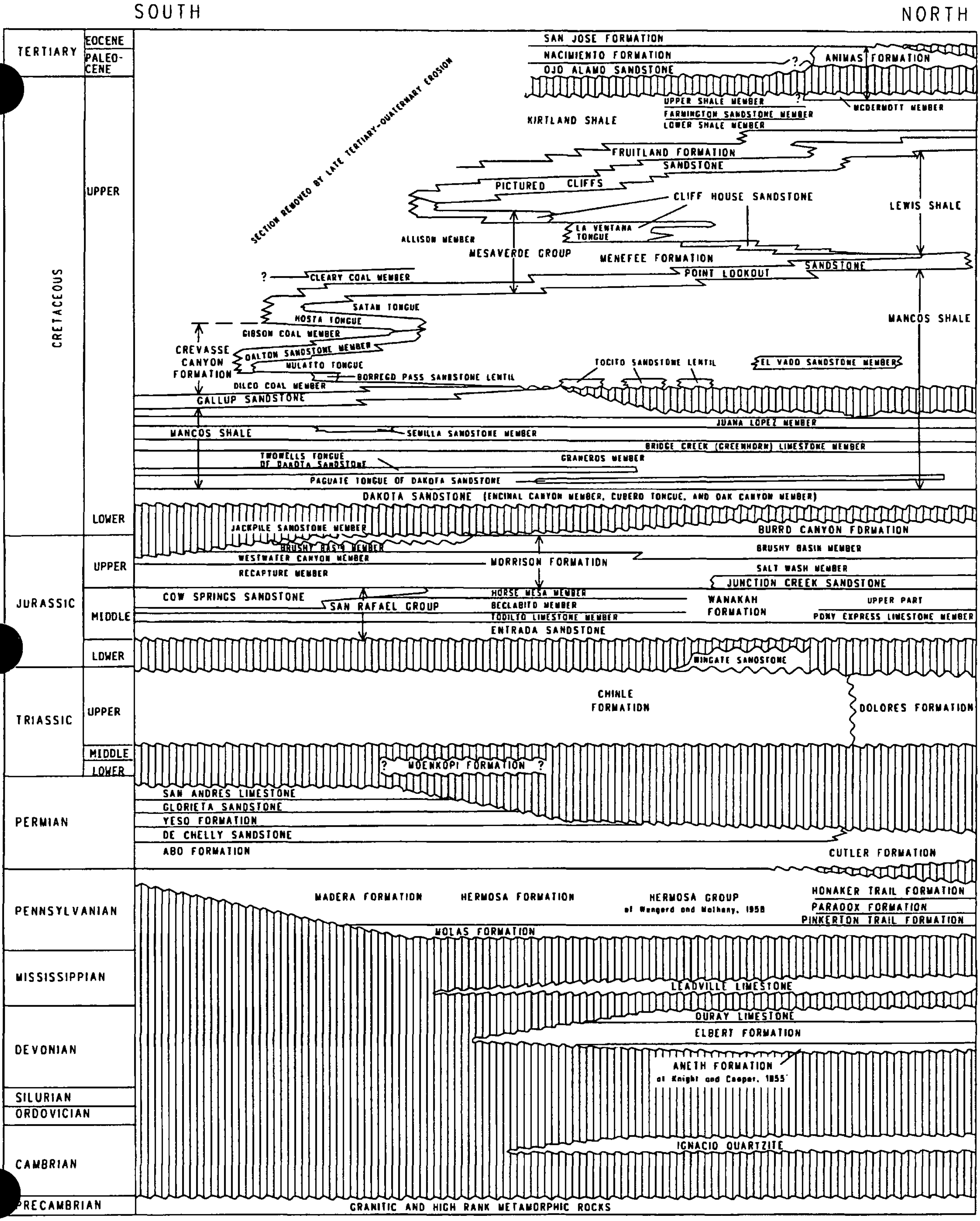


Figure 4.--Structural elements of the San Juan Basin and adjacent areas.



(Modified from Molenaar, 1977a,b, and 1989)

Figure 5.--Time- and rock-stratigraphic framework and nomenclature.

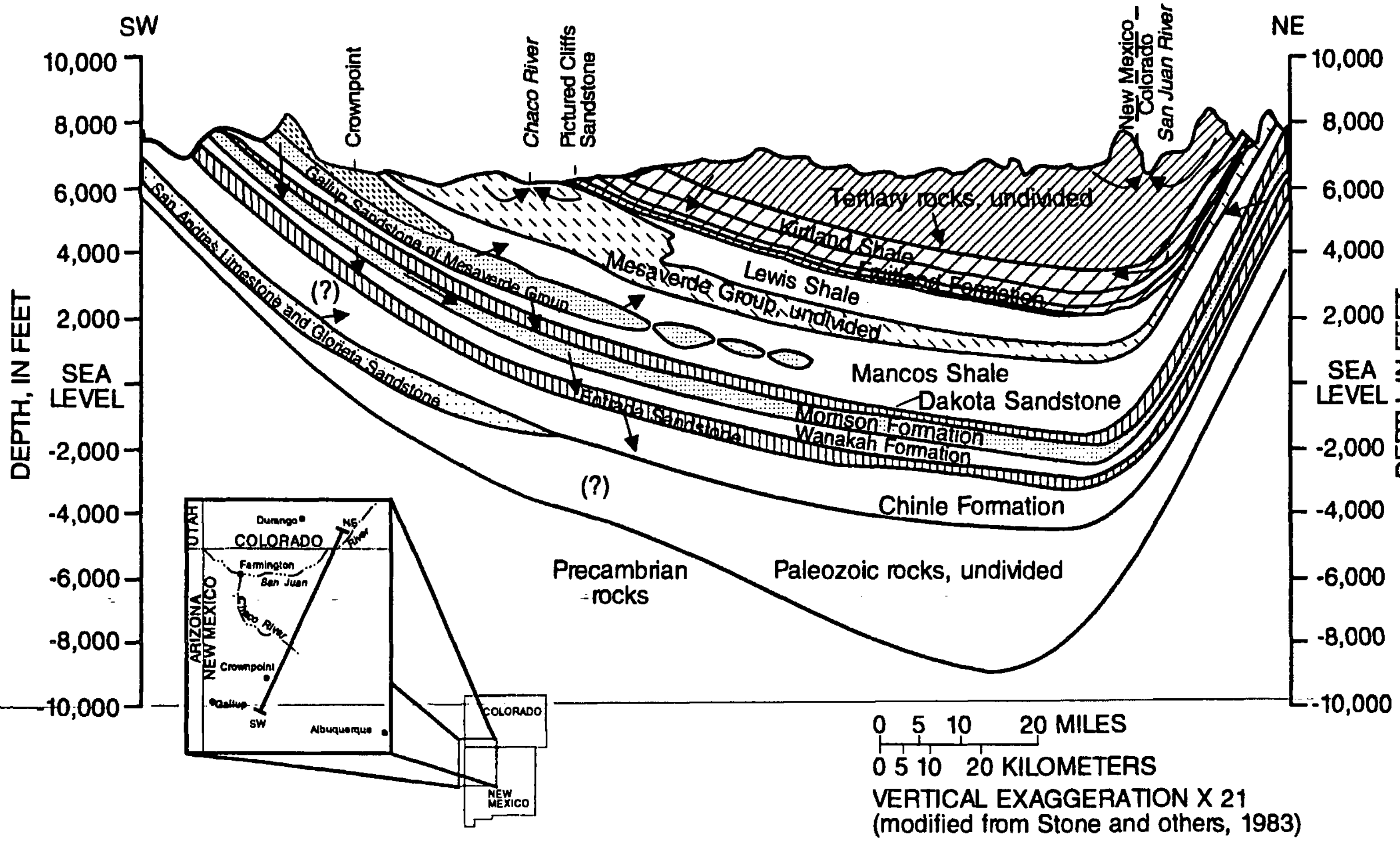


Figure 6.--Generalized hydrogeologic section of San Juan Basin showing major aquifers (stippled), confining beds (blank), and direction of ground-water flow (arrows).

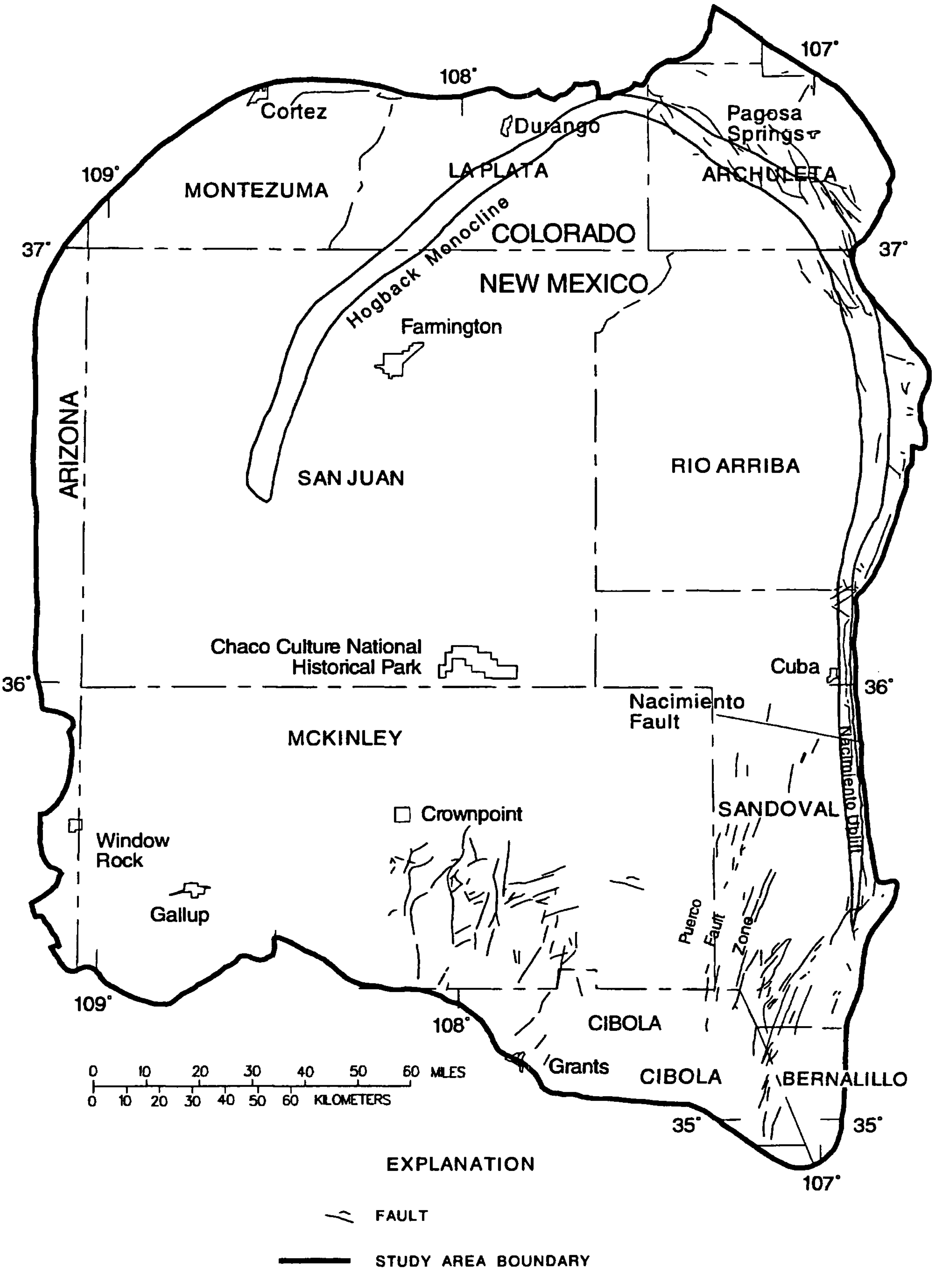


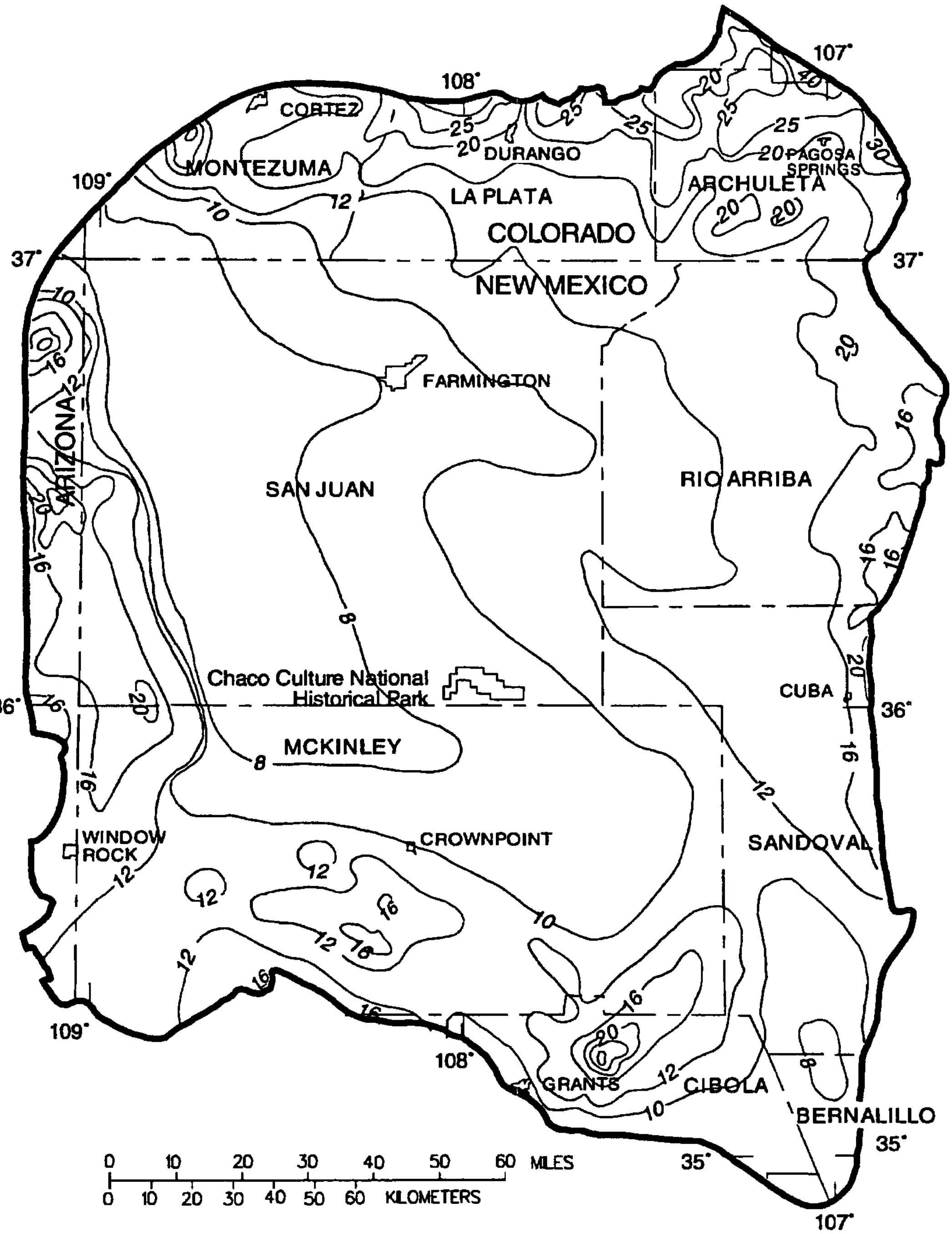
Figure 7.--Major faults in the San Juan Basin.

Climate

The San Juan Basin is located in the arid Southwestern United States and therefore typically has mild winters with periodic cold-front storms; hot, dry, and windy springs and early summers; warm and monsoonal late summers; and cool, clear autumns. However, within the San Juan Basin a wide range of climatic conditions are determined primarily by topographic altitude and somewhat by slope aspect. The low-altitude central and northwestern part of the basin has the warmest temperatures and the least amount of precipitation (upper Sonoran climate). The mountainous regions around most of the northern and eastern perimeter of the basin have the coolest temperatures and receive the most precipitation (Canadian climate zone).

Figures 8 and 9 are maps of mean annual and mean winter precipitation for the period 1931-60. As stated earlier, amounts of annual precipitation range from almost 40 inches in the northeastern part of the study area to less than 8 inches in the lower altitude central basin (U.S. Department of Commerce, no date). Most winter precipitation occurs as snowfall, especially in the higher mountain areas where snowpack typically exceeds 100 inches. Spring runoff from melting mountain snowpacks accounts for most surface water in the basin. Convective summer thunderstorms locally may result in considerable amounts of water in a very brief period, often causing severe and dangerous flash floods.

Potential mean annual evaporation (fig. 10) ranges from a low of less than 40 inches in the northeastern to more than 60 inches in the northwestern part of the study area (National Oceanic and Atmospheric Administration, no date). In only a very small part of the study area does annual precipitation exceed potential evaporation, and throughout most of the area potential evaporation greatly exceeds precipitation. With additional losses due to transpiration, the potential annual water deficit is large throughout most of the area. Because of the timing of rain and snowfall, however, water periodically is available for runoff and ground-water recharge regardless of the annual potential deficit.



EXPLANATION

LINE OF EQUAL MEAN ANNUAL PRECIPITATION--Number indicates mean annual precipitation, in inches. Contour intervals 2, 4, and 5 inches

STUDY AREA BOUNDARY

Figure 8.--Mean annual precipitation for the period 1931-60 (from U.S. Department of Commerce, no date).

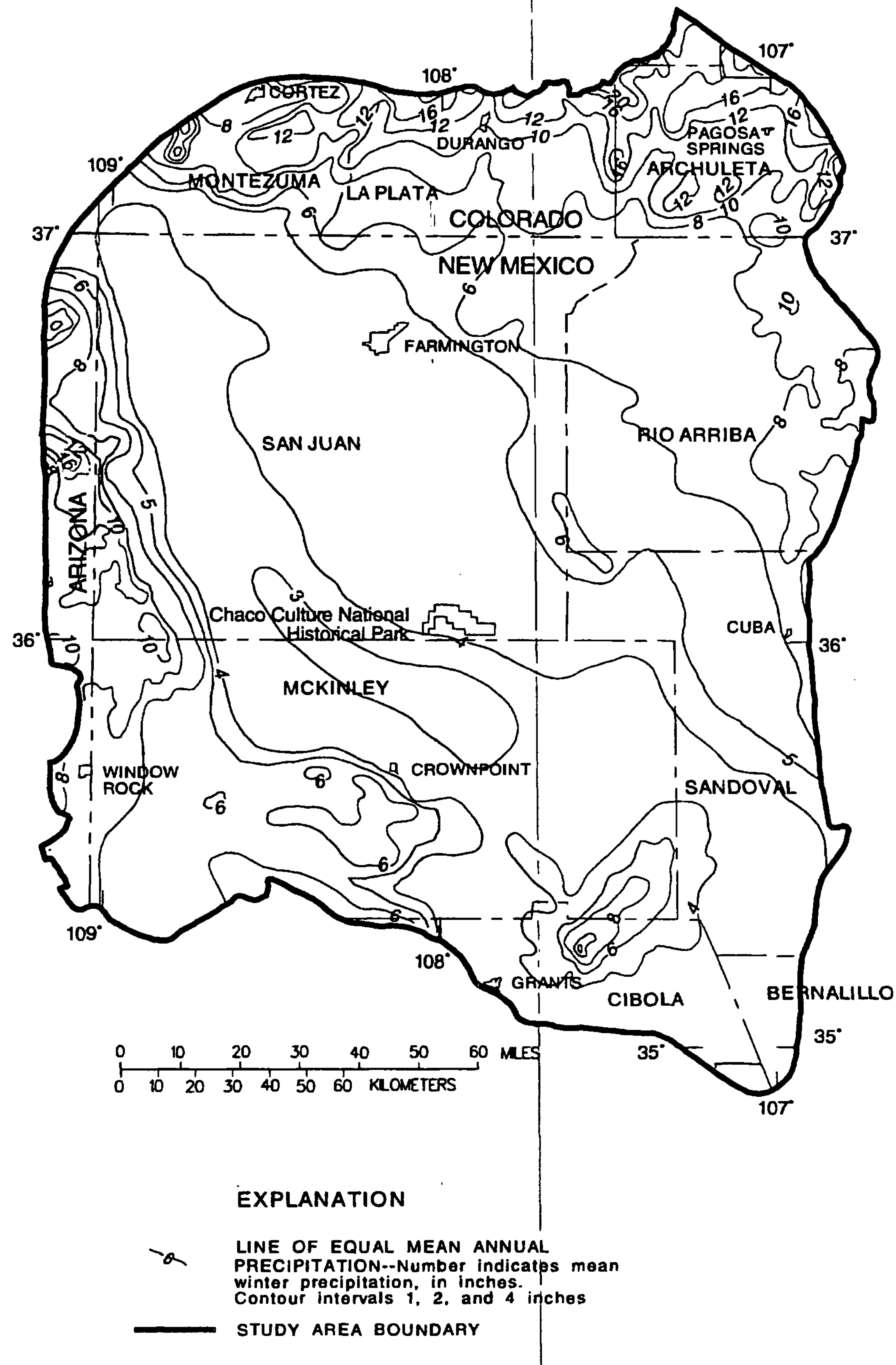
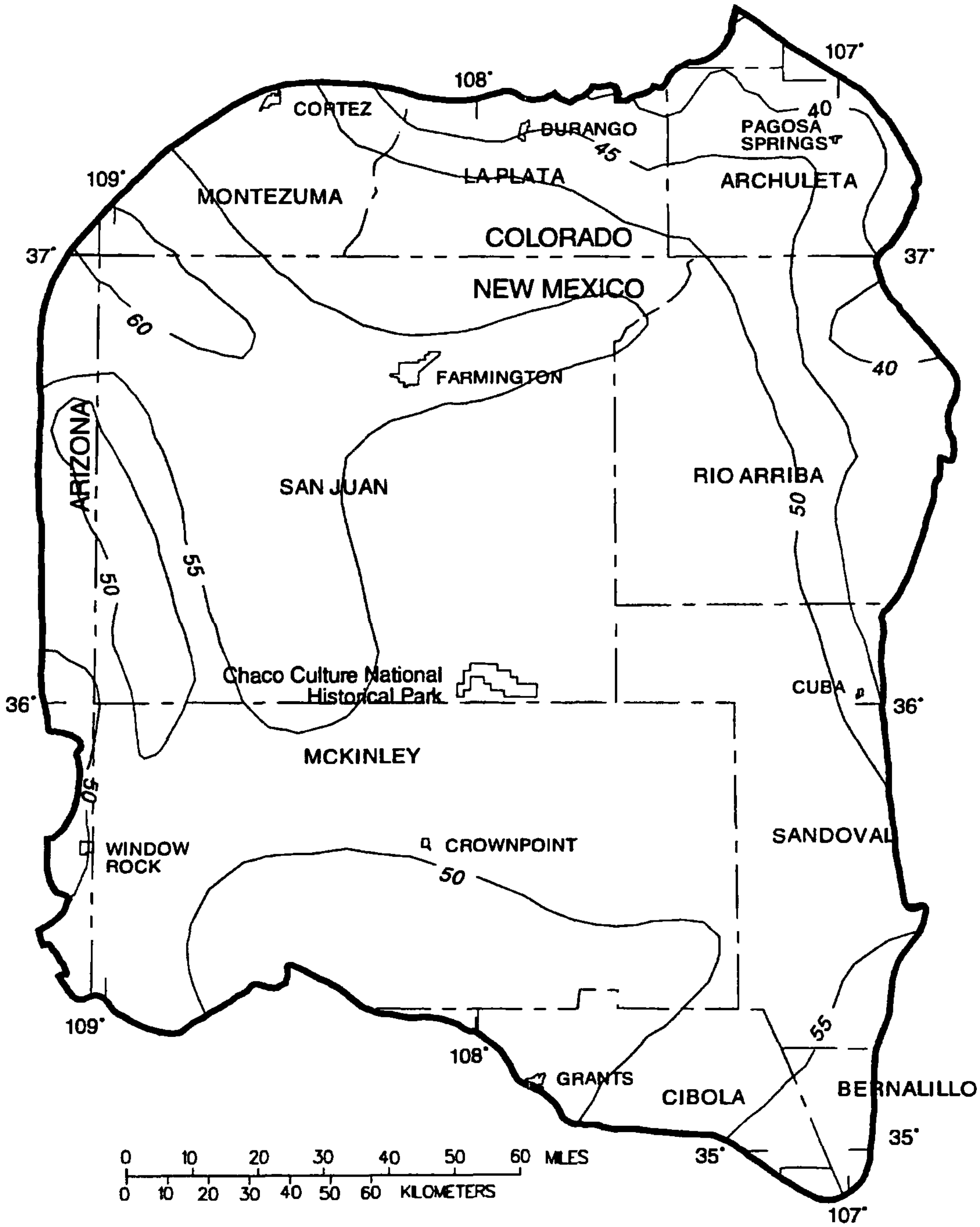


Figure 9.--Mean winter precipitation for the period 1931-60 (from U.S. Department of Commerce, no date).



EXPLANATION

LINE OF EQUAL POTENTIAL MEAN ANNUAL EVAPORATION--Number indicates potential evaporation, in inches per year. Contour interval 5 inches

STUDY AREA BOUNDARY

Figure 10.--Potential mean annual evaporation (from National Oceanic and Atmospheric Administration, no date).

Surface Water

The study area is drained mainly by the San Juan River and its tributaries (fig. 11). The San Juan River is a tributary to the Colorado River. The Puerco River and its tributaries in the southwestern part of the study area are also part of the Colorado River system. East of the Continental Divide the Rio Chama, Rio Salado, Rio Puerco, and Rio San Jose drain to the Rio Grande. A diversion from the headwaters of the San Juan River transfers about 100,000 acre-feet of water per year to the headwaters of the Rio Chama.

Only the San Juan River and its major northern tributaries are naturally perennial in the study area. Portions of some streams are perennial for short reaches downstream from spring or well discharges or discharges of treated municipal wastewater. Other streams are ephemeral or seasonal and many only flow immediately after storms.

Several large reservoirs are in the study area. The largest of these, Navajo Reservoir on the San Juan River, is used for irrigation and municipal water supplies. Water stored in or passed through two other reservoirs in the study area, Heron Lake and El Vado Reservoir on the Rio Chama in New Mexico, is allocated for municipal use by the City of Albuquerque, New Mexico, although much of this water is leased from the City for agricultural use downstream from Albuquerque. Bluewater Lake on the Rio San Jose is used to supply water for irrigation. Lemon and Vallecito Reservoirs, in Colorado just outside the study area, provide flood control and supply water for irrigation within the San Juan Basin. All of these reservoirs offer excellent recreational opportunities.

Ground Water

In a simplified conceptual model of the ground-water-flow system in the San Juan Basin, water enters the ground-water-flow system from precipitation on aquifer outcrops and from stream-channel loss as streams cross the outcrops. Recharge from direct precipitation occurs only after the near-surface demands for moisture are met by the water that does not run off and a residual amount of water is able to reach the zone of saturation in the aquifer. These near-surface demands include evaporation, transpiration, and sublimation.

Once water is in the ground-water-flow system it moves downgradient to areas of natural or artificial discharge, in accordance with Darcy's law (Darcy, 1856) whereby the flow is equal to the ground-water gradient times the aquifer's hydraulic conductivity times the cross-sectional area of the aquifer perpendicular to the direction of flow. Areas of natural discharge include springs and seeps in topographically low parts of the outcrop, discharge from the aquifer outcrop to stream channels, and upward movement across confining units to the surface along fault planes, fractures, and, to a modest extent, along intrusive dikes. Striking examples of spring discharge along fault planes and fractures are at the southern end of the Nacimiento Uplift in the southeastern part of the study area.

Another important mechanism of natural discharge is water moving from one aquifer across a less permeable unit to another aquifer that has relatively lower hydraulic head. Water might also move across a less permeable unit directly to land surface where it would contribute to soil moisture and hence to evaporation or transpiration. Both forms of vertical ground-water movement may be significant in the San Juan Basin.

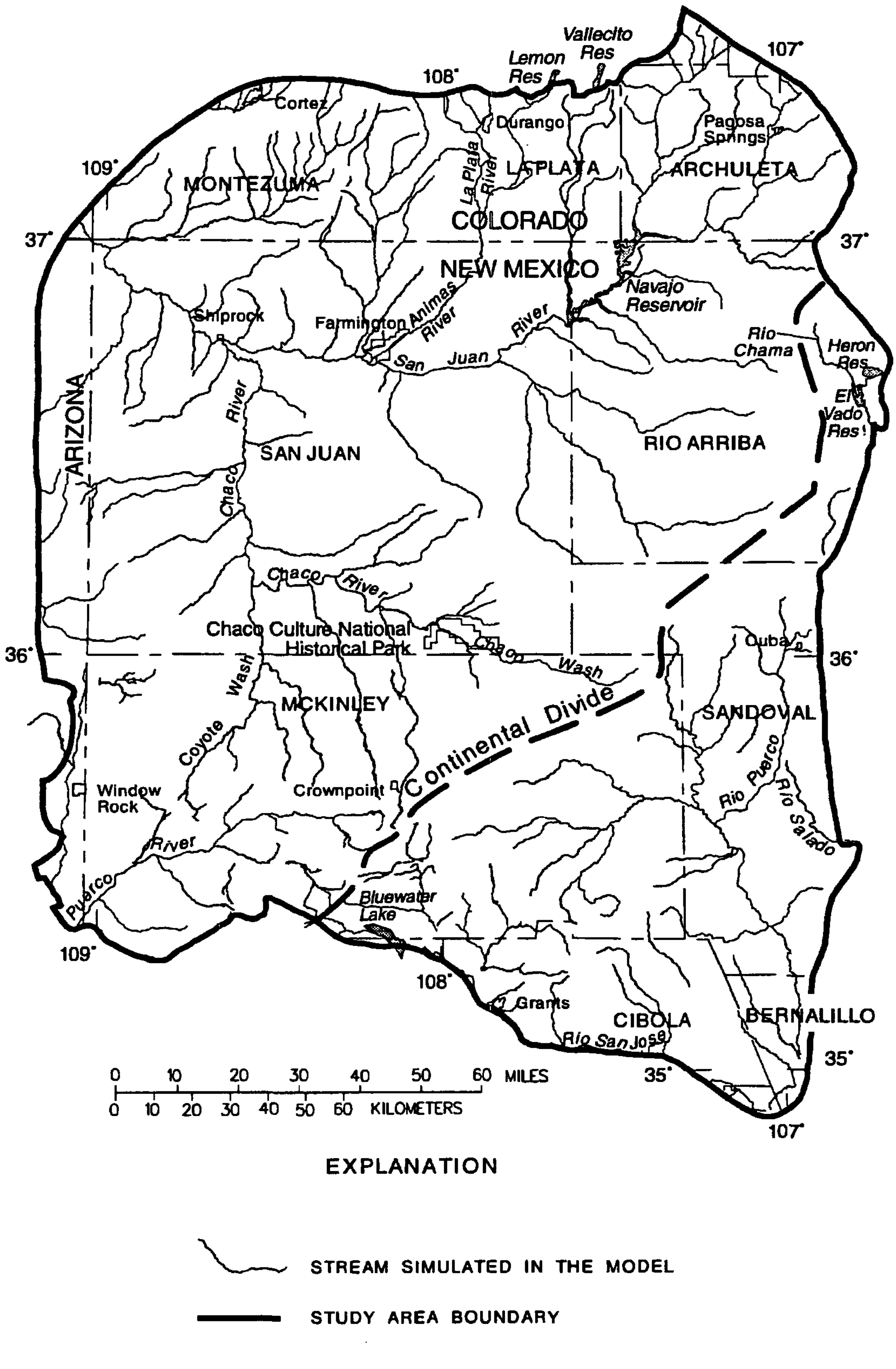


Figure 11.--Location of streams simulated in the model.

Artificial discharge occurs at flowing or pumped wells or in conjunction with open-pit or subsurface mining operations. Free-flowing wells are commonplace in the basin and most of those are completed in multiple aquifers so the percentage of water contributed by each aquifer is unknown. Pumped wells or controlled flowing wells also are common and supply water to satisfy municipal, small-community, private-domestic, and livestock needs. The majority of these wells are windmill powered and small yielding, but some yield large quantities of water. Mine dewatering operations have been a major source of ground-water discharge in the south-central part of the basin. Some mines required the removal of as much as 3 cubic feet per second of ground water to keep the mine from flooding. All of the mines presently are closed, the dewatering has ceased, and ground-water levels are now recovering from head reductions that commonly exceeded 1,000 feet.

Complexities in the flow system arise because of non-uniformity in the aquifers. The aquifers may thin or pinch out, or the composition and hydraulic properties may vary in space. Aquifers also may have preferred directions of ground-water flow that are controlled by the orientation of fracture systems or by a persistent orientation of the aquifer's matrix of sedimentary materials. Other pore-filling liquids or gases may create barriers to the movement of water, or water in parts of an aquifer may be saline enough to create a density barrier to movement of freshwater. All of these conditions are present to some degree in the San Juan Basin.

HYDROSTRATIGRAPHIC UNITS

The San Juan Basin has many hydrostratigraphic units that function either as aquifers or confining units. Other units, such as thin alluvial deposits, may not be hydrologically extensive enough to be classified as major aquifers but potentially are very important in the role they serve in capturing precipitation that eventually becomes recharge to underlying units. Much of the following description of the major hydrostratigraphic units in the San Juan Basin was taken directly from U.S. Geological Survey Hydrologic Investigations Atlases in the HA-720 series (Craigg and others, 1989, 1990; Dam and others, 1990a, b; Kernodle and others, 1989, 1990; Levings and others, 1990a, b; and Thorn and others, 1990a, b).

The structure-contour maps presented in this section are derived from computer-generated and human-edited continuous-surface representations of the tops of the major hydrostratigraphic units. These continuous-surface data layers were generated from the control points shown in the HA-720 series of Hydrologic Investigations Atlases and geographic information system (GIS)-generated outcrop altitudes. The representations were imported into the GIS, which was then used to produce the figures in the atlases and in this report. Much of the information in those atlases also was used directly by the computer for compilation of input data for the model, as described later. In essence, the major components of the ground-water-flow model were documented in the series of hydrologic atlases. In the following section the hydrostratigraphic units are discussed in order of uppermost (youngest) to lowermost (oldest) occurrence.

Alluvium and Other Quaternary Deposits

Quaternary and recent deposits in the San Juan Basin include stream-deposited alluvium and older terrace deposits, landslide deposits, and eolian sand. The areal distribution of these sediments are shown in figure 12. Most Quaternary and younger deposits are unconsolidated and form a thin covering over older bedrock sediments.

Lithology

Stream-deposited alluvium and older terrace deposits are associated with major streams and rivers in the San Juan Basin. The alluvium consists of unconsolidated sediments that range from silt to cobbles in size but predominantly are sand and gravel. Along major streams the alluvium is varied in composition, depending on the mix of material from the various erosional source areas. Alluvial deposits also occur as a thin veneer of fine-grained sediments in the valleys of intermittent streams.

Landslide deposits are mapped on the northeastern flank of the Chuska Mountains and locally in the San Juan Mountains in the northeastern part of the study area. These colluvial deposits consist of material derived from the topographically higher source areas. The landslide material on the flank of the Chuska Mountains consists of reworked sand from the Chuska Sandstone; the deposits in the San Juan Mountains primarily are derived from volcanic or volcaniclastic sources.

Unconsolidated wind-blown deposits are common in the central part of the basin, although they generally are not mapped on small-scale geologic maps. Typically, these deposits are very thin, but local dunes near dry washes, which are excellent sources of fine-grained material, may reach heights of 20 feet. These recent eolian deposits are not known to yield water to wells.

Hydraulic Properties

In the absence of other sources of water, alluvial deposits, where present, commonly are relied upon as a source of water for domestic and livestock use. Along the major rivers and streams, wells are of conventional vertical design, whereas in the valleys of intermittent streams, where the hydraulic conductivities and saturated thickness generally are small, most wells are constructed as galleries of horizontal drains feeding to a central collector. Reported well yields range from less than 1 gallon per minute to as much as 1,100 gallons per minute. The median yield of 48 wells is 15 gallons per minute. The largest reported yields are from wells completed in the alluvium in the Rio San Jose Valley (fig. 11) in the vicinity of Grants, New Mexico. The smaller yields are from gallery wells completed in the alluvium of minor stream valleys.

Hydraulic conductivities of sand and gravel can vary from 10 to 1,000,000 gallons per day per foot squared (roughly 1 to 100,000 feet per day) (Freeze and Cherry, 1979, table 2.2), but a more typical range is from 15 feet per day for fine sand to about 1,000 feet per day for coarse gravel (Lohman, 1972, table 17). Tests along the San Juan River (fig. 11) upstream from Farmington indicate that the hydraulic conductivity of alluvium ranges from 0.006 to 220 feet per day (Peter and others, 1987, p. 29). The thickness of alluvium at this site was reported to range from about 14 to 61 feet, and the saturated thickness was less than 25 feet in all 13 test holes. Water occurs in the alluvium under unconfined conditions. No tests have been made where the storage coefficient of the alluvium was determined. However, a typical specific yield for moderately to well-sorted unconsolidated sediments would be in the range of 0.1 to 0.25.

No known hydraulic data exist for the landslide and recent eolian deposits in the basin. No instances are known where these deposits are used as a source of water.

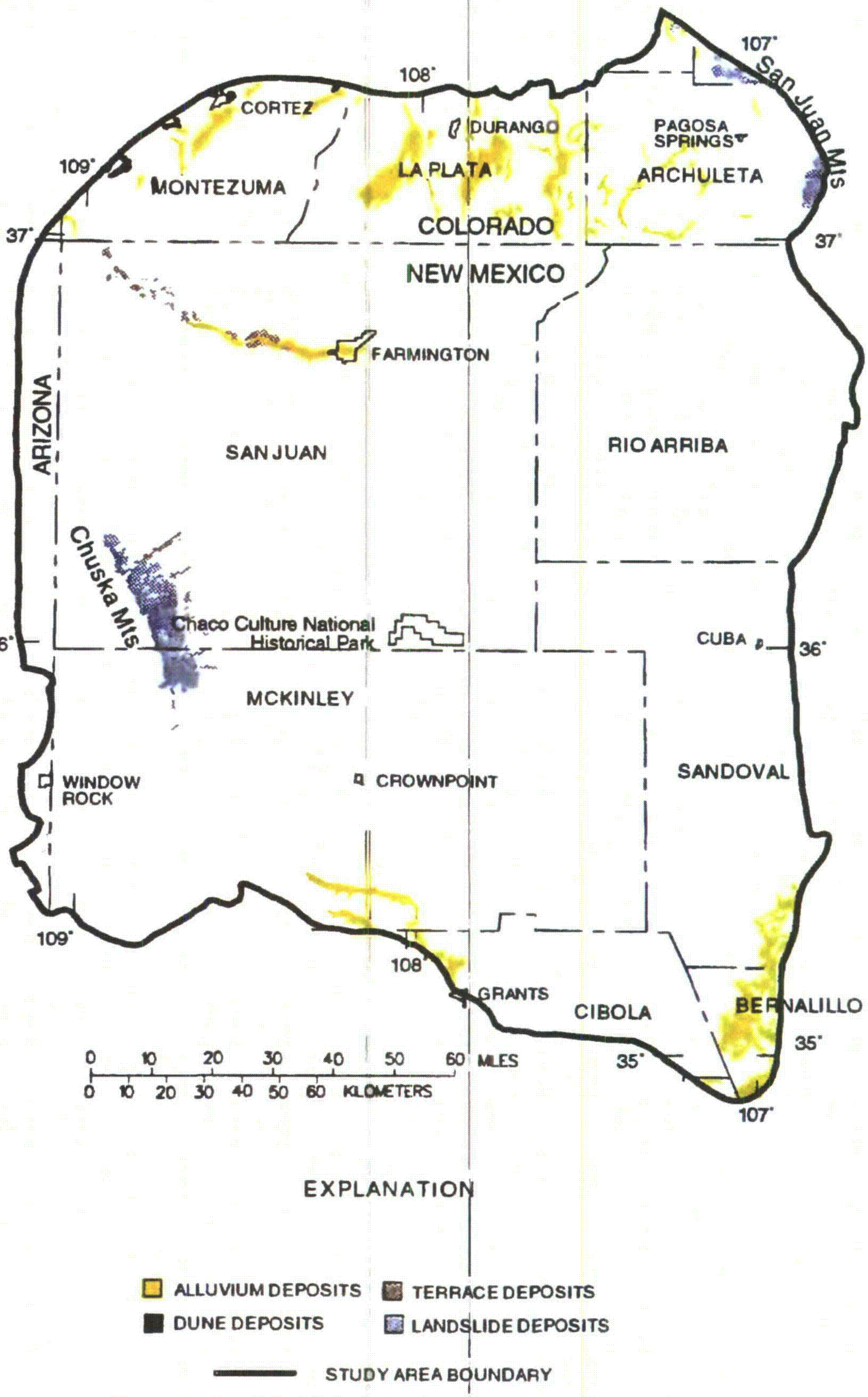


Figure 12.--Distribution of Quaternary deposits.

Chuska Sandstone

The Chuska Mountains (fig. 12) in the western part of the basin primarily are formed from the Chuska Sandstone, a consolidated, windblown sand of Tertiary age that was deposited on upturned and eroded Cretaceous and older sediments. Several moderate-sized intrusive mafic necks form a spine along the ridge of the mountains and, together with associated horizontal lava flows, may have provided the erosional resistance necessary to protect the sandstone from weathering away, as has happened toward its source area to the south-southwest.

Lithology

The Chuska Sandstone is a fine-grained, moderately well sorted sandstone (Harshbarger and Repenning, 1954, p. 6). Cross-bed units typically range from 5 to 15 feet in thickness. Thick zones of silicic cement form resistant ledges at and near the top of the unit, but overall the sandstone is weakly cemented. Cementation is more complete to the southwest, allowing conventional headward erosion of streams. The poorly cemented sand on the northeastern flank of the Chuska Mountains has allowed piping and massive slump failure during pluvial periods in the Pleistocene Epoch. The average thickness of the Chuska Sandstone is about 1,000 feet and the maximum preserved thickness is 1,750 feet (Wright, 1956, p. 416). The Chuska Sandstone conformably overlies a horizontally bedded fluvial sandstone and shale about 250 feet in thickness (the Deza Formation of Wright, 1954).

Hydraulic Properties

No measurements are known of the hydraulic properties of the Chuska Sandstone. However, the unit is water yielding and springs are abundant around the flanks of the Chuska Mountains, usually at the base of the Chuska Sandstone. Most of the springs are undeveloped, but some serve as domestic water supplies. The sandstone is recharged by leakage from the numerous lakes and potholes along the top of the mountains. In addition to the discharge from springs, the sandstone loses water to the underlying Cretaceous and older sediments.

San Jose Formation

The San Jose Formation of Eocene age was defined by Simpson (1948a, b). The San Jose Formation occurs in New Mexico and Colorado, and its outcrop forms the land surface over much of the eastern half of the central basin (fig. 4). It overlies the Nacimiento Formation in the area generally south of the Colorado-New Mexico State line and overlies the Animas Formation in the area generally north of the State line (Fassett, 1974, p. 229). The basal contact of the San Jose varies with location in the basin. This contact is a disconformity along the basin margins and an angular unconformity along the Nacimiento Uplift; the contact is conformable in the central basin (Baltz, 1967, p. 54; Fassett, 1974, p. 229).

Geometry and Lithology

The San Jose Formation was deposited in various fluvial-type environments (Baltz, 1967, p. 44-55). In general, the unit consists of an interbedded sequence of sandstone, siltstone, and variegated shale. The sandstones are buff to yellow and rusty colored, crossbedded, very fine to coarse-grained arkose, which are locally conglomeratic and contain abundant silicified wood (Baltz, 1967, p. 46; Fassett, 1974, p. 229; Anderholm, 1979, p. 23).

Baltz (1967, p. 45) recognized four formal members of the San Jose Formation in the east-central part of the basin; he also identified, but did not name, a fifth member in the northeastern part of the basin. The members and their principal lithology in descending order are Tapicitos Member (shale), Llaves Member (sandstone), Regina Member (shale), and Cuba Mesa Member (sandstone). The stratigraphic relation and subsequent mapability of these members are complicated by extensive intertonguing and pinch-outs (Fassett, 1974, p. 229; Anderholm, 1979, p. 23; Stone and others, 1983, p. 25), and whether the members can be identified throughout the basin has been the subject of some discussion.

Thickness of the San Jose Formation generally increases from west to east. Fassett (1974, p. 229) reported a maximum thickness of 2,400 feet in the east-central part of the basin, and Stone and others (1983, p. 25) reported a range from about 200 feet in the west and south to almost 2,700 feet in the center of the structural basin.

Hydraulic Properties

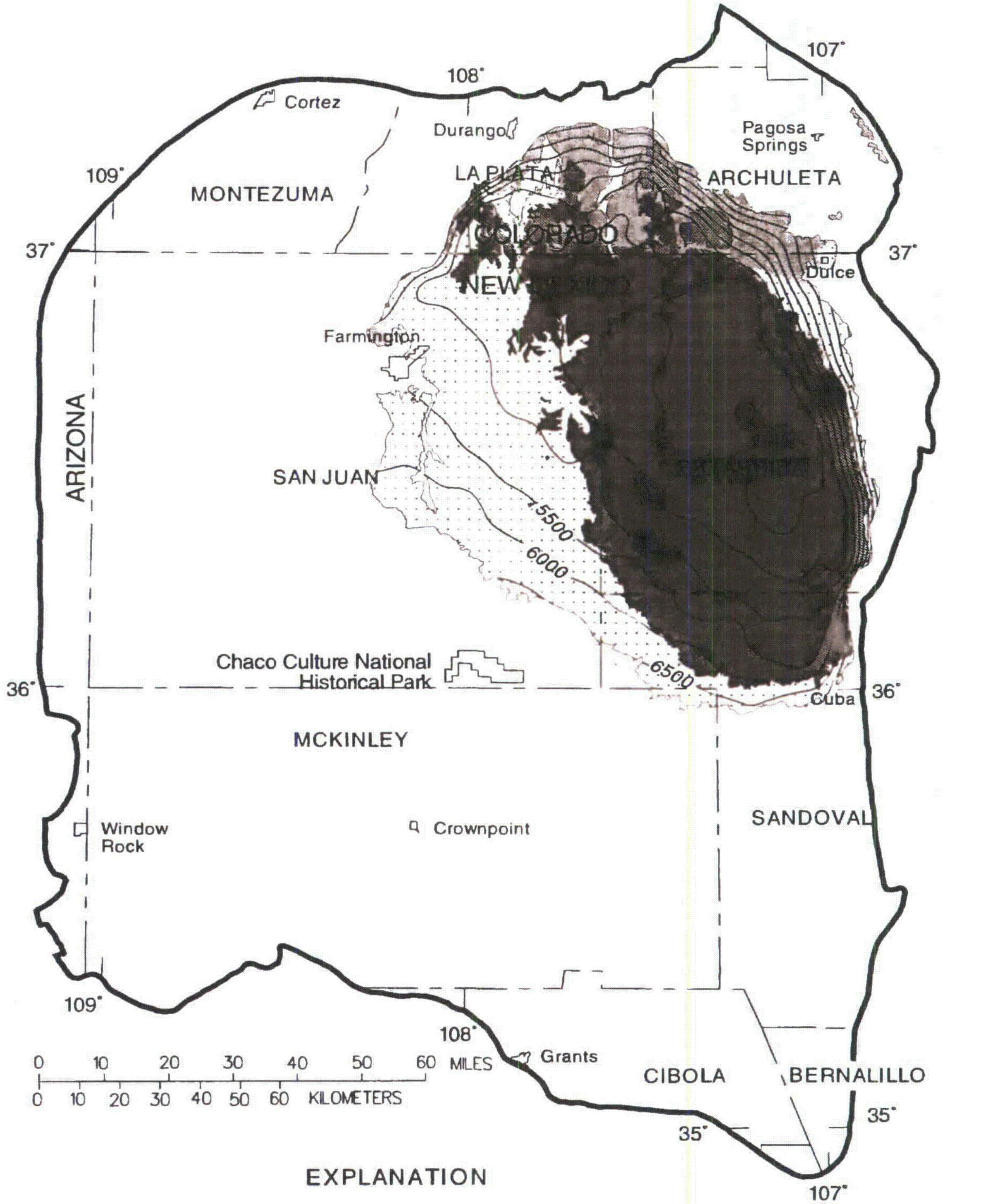
Transmissivity data for the San Jose Formation are minimal. Values of 40 and 120 feet squared per day were determined from two aquifer tests (Stone and others, 1983, table 5).

The reported or measured discharge from 46 water wells completed in the San Jose Formation ranges from 0.15 to 61 gallons per minute and the median is 5 gallons per minute. Most of the wells provide water for livestock and domestic use, but a few provide cooling water for natural gas compression and transmission plants.

The San Jose Formation is a very suitable unit for recharge from precipitation because soils that form on the unit are sandy and highly permeable and therefore readily adsorb precipitation. However, low annual precipitation, relatively high transpiration and evaporation rates, and deep dissection of the San Jose Formation by the San Juan River and its tributaries all tend to reduce the effective recharge to the unit.

Animas and Nacimiento Formations

Most of the Animas Formation is of Paleocene age, but the lower part of the formation is of latest Late Cretaceous age (Barnes and others, 1954). It crops out principally inside the northern margin of the central basin (fig. 4). The Animas is present in only about the northern one-third of the basin, mainly in Colorado; it does not occur south of a line that extends from Dulce, New Mexico, to the La Plata River Valley (fig. 11) near the Colorado-New Mexico State line (fig. 13). Along this line the Animas Formation grades laterally into the Nacimiento Formation (Fassett and Hinds, 1971, p. 33; Fassett, 1974, p. 229), which occupies the same stratigraphic interval (fig. 5). In the north the Animas Formation conformably overlies the Kirtland Shale of Late Cretaceous age; farther south, near the New Mexico-Colorado State line, the unit may unconformably overlie the Ojo Alamo Sandstone of Tertiary age (Fassett and Hinds, 1971, p. 34).



EXPLANATION

AREAS OF FORMATION OUTCROP:

SAN JOSE FORMATION

ANIMAS FORMATION

NACIMIENTO FORMATION

5000 — LINE OF EQUAL ALTITUDE OF THE BASE OF THE ANIMAS AND NACIMIENTO FORMATIONS--Number indicates altitude, in feet. Contour interval 500 feet. Datum is sea level

STUDY AREA BOUNDARY

Figure 13.--Approximate altitude and configuration of the base of the Animas and Nacimiento Formations.

Geometry and Lithology

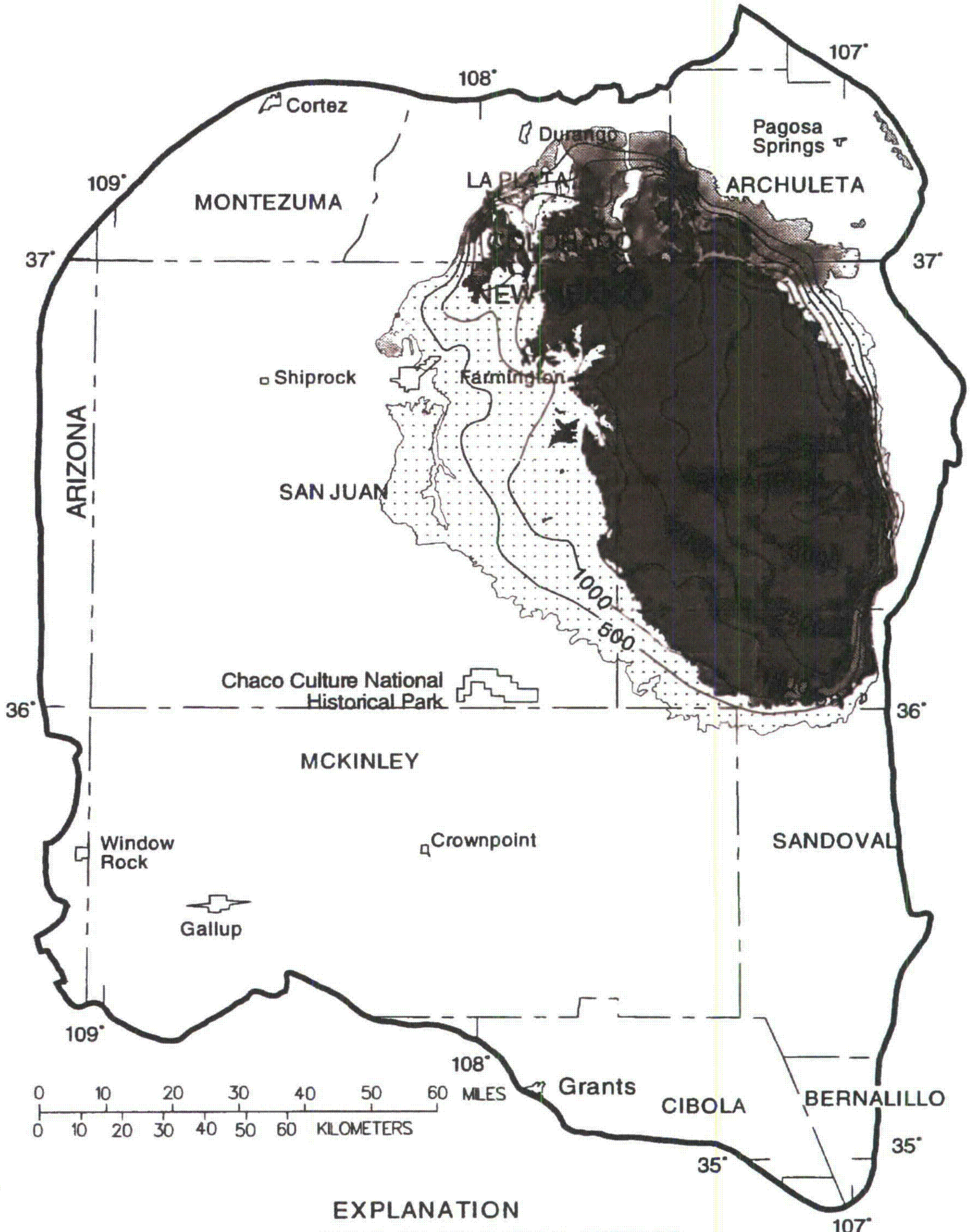
The Animas Formation consists of two members: the unnamed upper member of Paleocene age (Barnes and others, 1954) and the lower McDermott Member of latest Late Cretaceous age. The unnamed upper member disconformably overlies the McDermott Member; this unconformity represents a time gap of about 6 million years (Fassett, 1977). The Animas Formation consists mainly of volcaniclastic deposits; the diagnostic characteristic of the Animas Formation as a whole is the presence of macroscopic volcanic material (Fassett and Hinds, 1971, p. 33). The unnamed upper member consists of varicolored and interbedded tuffaceous sandstone, conglomerate, and shale (Fassett, 1974, p. 229). The McDermott Member consists of varicolored (dominantly purple) tuffaceous sandstone and conglomerate with minor variegated shale (Reeside, 1924, p. 25). Thickness of the Animas Formation ranges from about 230 feet at the type section along the Animas River (fig. 11) at Durango, Colorado (Barnes and others, 1954), to about 2,700 feet near the La Plata-Archuleta County line in Colorado (fig. 14) (Fassett and Hinds, 1971, p. 33).

The Nacimiento Formation is of Paleocene age (Baltz, 1967, p. 35). It crops out in a broad band inside the southern and western margins of the central basin and in a narrow band along the west face of the Nacimiento Uplift (fig. 4). The Nacimiento is a nonresistant unit and typically erodes to low, rounded hills or forms badlands topography.

The Nacimiento Formation occurs in approximately only the southern two-thirds of the basin where it conformably overlies and intertongues with the Ojo Alamo Sandstone (Baltz, 1967, p. 41; Fassett, 1974, p. 229). The Nacimiento Formation grades laterally into the main part of the Animas Formation (Fassett and Hinds, 1971, p. 34; Fassett, 1974, p. 229); thus, in this area the two formations occupy the same stratigraphic interval (fig. 5). The altitude of the base of the Animas and Nacimiento Formations is shown in figure 13.

Strata of the Nacimiento Formation mainly were deposited in lakebeds in the central basin area with lesser deposition in stream channels (Brimhall, 1973, p. 201; Fassett, 1974, p. 229). In general, the Nacimiento consists of drab, interbedded black and gray shale with discontinuous, white, medium- to very coarse grained arkosic sandstone (Fassett, 1974, p. 229; Stone and others, 1983, p. 30). Baltz (1967, p. 39) stated that the percentage of sandstone increases northward. Stone and others (1983, p. 30) indicated that the formation may contain more sandstone than commonly has been reported because some investigators assume the slope-forming strata in the unit are shales, whereas in many places the strata actually are poorly consolidated sandstones.

Total thickness of the Nacimiento Formation ranges from about 500 to 1,300 feet (Molenaar, 1977a). The unit generally thickens from the basin margins toward the basin center (Baltz, 1967, p. 38; Steven and others, 1974; Stone and others, 1983). The sandstone deposits within the Nacimiento Formation are much thinner than the total thickness of the formation because their environment of deposition was localized stream channels (Brimhall, 1973, p. 201). The combined thickness of the combined San Jose, Animas, and Nacimiento Formations ranges from 500 to more than 3,500 feet (fig. 14).



EXPLANATION

AREAS OF FORMATION OUTCROP:

SAN JOSE FORMATION

ANIMAS FORMATION

NACIMIENTO FORMATION

—500— LINE OF EQUAL THICKNESS OF THE SAN JOSE, ANIMAS, AND NACIMIENTO FORMATIONS--Number indicates thickness, in feet. Contour interval 500 feet

STUDY AREA BOUNDARY

Figure 14.--Approximate thickness of the San Jose, Animas, and Nacimiento Formations.