

APPENDIX C

HYDROLOGY REPORT

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Hydrologic and Hydraulic Analysis

of

Box Springs Dam

Prepared for:
SDH & Associates, Inc.

March 30, 2015

Prepared by:



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TORY R. WALKER ENGINEERING

RELIABLE SOLUTIONS IN WATER RESOURCES

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CHAPTER 1 - BACKGROUND

1.1 Introduction

Box Springs Dam is a flood control detention basin located about one mile west of the intersection of Central Avenue and Interstate 215 in Riverside, California. This flood control dam receives runoff from a catchment area of approximately 2,570 acres is located east of the dam (see Figure 1). Box Springs Dam has a bottom elevation of 1098 feet above sea level and a spillway at 1132 feet.

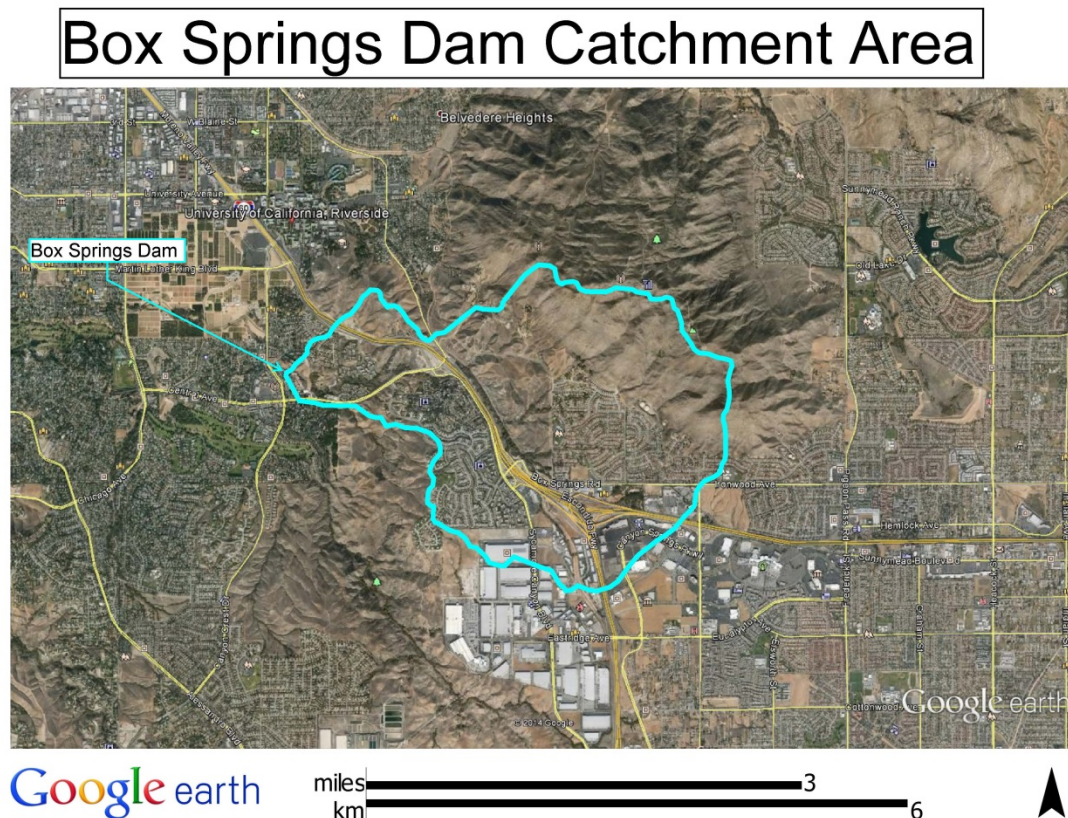


Figure 1. Approximate Dam Location

The primary purpose of this study is to determine what, if any, impact the proposed Quail Run project will have on the hydraulic capacity of the Box Springs Dam. Towards that end, this study analyzes the current condition 2-year, 10-year and 100-year 6-hour and 24-hour storms to determine peak flowrates to the Box Springs Dam. Per County of Riverside drainage criteria, the Unit Hydrograph method should be used to determine peak design flowrates when the contributing drainage area is greater than 1.0 square mile. The contributing drainage area to Box Springs Dam is approximately 4 square miles.

Methodology used for the computation of design rainfall events, loss rates, and rainfall intensity values are consistent with criteria set forth in the Riverside County Flood Control and Water Conservation District (RCFC&WCD) Hydrology Manual. A more detailed explanation of the methodology used for this analysis is given in Chapter 2.

1.2 – Summary of Existing Conditions

The existing 2,568 acre (4.01 square-miles) catchment area makes its way to Box Springs Dam through two main types of conveyance systems, natural creeks and improved channels and underground drainage systems. This tributary area to Box Springs Dam consists of different land uses, including residential, commercial, industrial and natural covers, with natural cover and residential cover being the predominant land uses. Table 1 below summarizes each land use type. The catchment area also has varied slopes and is composed of all four (4) soil types A, B, C and D, but it is predominantly types C and D. Table 2 shows the distribution of soil types.

TABLE 1 – Land Use Summary

Landuse	Area (ac)	% Area
Commercial	334.16	13.0%
Industrial	258.27	10.1%
Residential	1053.63	41.0%
Natural	921.95	35.9%
Total	2568.00	100%

TABLE 2 – Soil Type Summary

Soil Type	Area (ac)	% Area
A	81.11	3.2%
B	162.28	6.3%
C	548.79	21.4%
D	1775.82	69.2%
Total	2568.00	100%

CHAPTER 2 – HYDROLOGIC ANALYSIS

2.1 – Methodology

2.1.1 Design Storms

The 2-year, 10-year and 100-year 6-hour and 24-hour design storms were determined using the Synthetic Unit Hydrograph Method from Section B of the RCFC&WCD Hydrology Manual. These 6 storms were then routed through Box Springs Dam. Rainfall distributions are listed in Appendix 2.

2.1.2 Losses

Catchment losses and effective rainfall were computed using the Curve Number Method as described in Section C of the RCFC&WCD Hydrology Manual. This method requires the determination of soil and cover type parameters for the catchment. Curve Numbers (CN) in this report reflect the assumption of Antecedent Moisture Condition III (AMC III), which is required for the 100-year return period storm and AMC II, for the 10-year and 2-year return period storms. For detailed information and maps on soil type, cover type, and CN selection, refer to Section 2.2 and Appendix 2 of this study.

2.1.3 Unit Hydrograph Method

The Unit Hydrograph Method for Catchment Runoff Hydrographs, as described in the RCFC&WCD Hydrology Manual, was used to generate hydrographs for this project. Two S-Curves were developed, one for the 6-hour storm events and another for the 24-hour storm events. The S-Curves were then multiplied by the effective rain in order to obtain unit hydrographs for each storm event. The unit hydrographs were then convoluted with the effective rainfall for each catchment to determine the runoff hydrographs.

2.2 – Summary of Hydrologic Analysis

2.2.1 Soil Type, Cover Type, and CN Selection

The watershed being analyzed consists of soil types A, B, C and D. However, hydrologic soil types D and C dominate the watershed, with only small patches of type B soil in some areas (refer to Appendix 2 for Soil Type Maps). Both type D and type C soils have slow infiltration rates when saturated. This is especially true for D soils, which consist chiefly of clay soils with a high swelling potential, clay pan or clay layer at or near the surface or shallow soils over nearly impervious materials. Type D soils have a very slow rate of water transmission. As a result, losses due to infiltration will be relatively low for the catchment.

The cover type for the watershed consists of approximately 41% residential, 36% natural cover, 13% commercial and 10% industrial. Areas with natural cover were classified as “Chaparral, Narrow Leaf”. Residential areas within the study were best represented as Single Family Residential (7,200-10,000 S.F. Lots) with 60% impervious cover and 40% Residential Landscaping per the RCFC&WCD Hydrology Manual. Commercial and industrial areas were assigned an impervious value of 90% and 87 % respectively, with the remaining 10% and 13% being urban landscaping per the RCFC&WCD Hydrology Manual.

After determining the distribution of soil and cover types in the catchment, CN's were selected based on the values given in the RCFC&WCD Hydrology Manual. A table showing the breakdown of soil group, cover type, and CN selection is presented in the Appendix 2.

2.2.2 Peak Flow Determination

Peak flows for the 2,570 acre (4.01 mile) catchment tributary to Box Springs Dam obtained from the runoff hydrographs are presented in Table 3.

TABLE 3 – Peak Flows per Storm Event

Storm Event	Peak Flow (cfs)
2-year 6-hour	1049.6
2-year 24-hour	459.60
10-year 6-hour	1553.6
10-year 24-hour	805.9
100-year 6-hour	2461.6
100-year 24-hour	1425.7

CHAPTER 3 – ANALYSIS OF BOX SPRINGS DAM

3.1 – Detention Basin Routing Summary

The lowest elevation behind Box Springs Dam is 1098 feet. The maximum elevation of the dam is 1138 feet, at which the storage capacity of the dam is 660.74 ac-ft. Box Springs Dam discharges flows in two ways. The first is by a 30-inch gated outlet with an invert elevation at 1106 feet, and the second is by a spillway at elevation 1132 feet (Details are shown in Appendix 3).

The runoff hydrographs calculated for each of the six (6) storms were routed through Box Springs Dam with HEC-HMS to determine peak flow out and the maximum water surface elevation behind the dam. A summary of the results is provided in Table 4 below.

TABLE 4 – Box Springs Dam Routing Summary

Storm Event	Peak Flow In (cfs)	Peak Flow Out (cfs)	Elevation (feet)
2-year 6-hour	1049.6	6.1	1116.2
2-year 24-hour	459.60	13.3	1117.8
10-year 6-hour	1553.6	31.9	1120.9
10-year 24-hour	805.9	69.2	1125.5
100-year 6-hour	2461.6	134.7	1131.3
100-year 24-hour	1425.7	1098.5	1134.5

3.2- Stage-Storage Relationship

The stage-storage data used for Box Springs Dam in this drainage study is based on 2008 topo. The 1959 stage-storage data was not used, as the 2008 stage-storage data more accurately reflects the storage capacity of Box Springs Dam.

Additionally, the differences between the existing and proposed (with the project) stage-storage data are very minimal. A comparison of the three different stage-storage curves is shown on Figure 2 below.

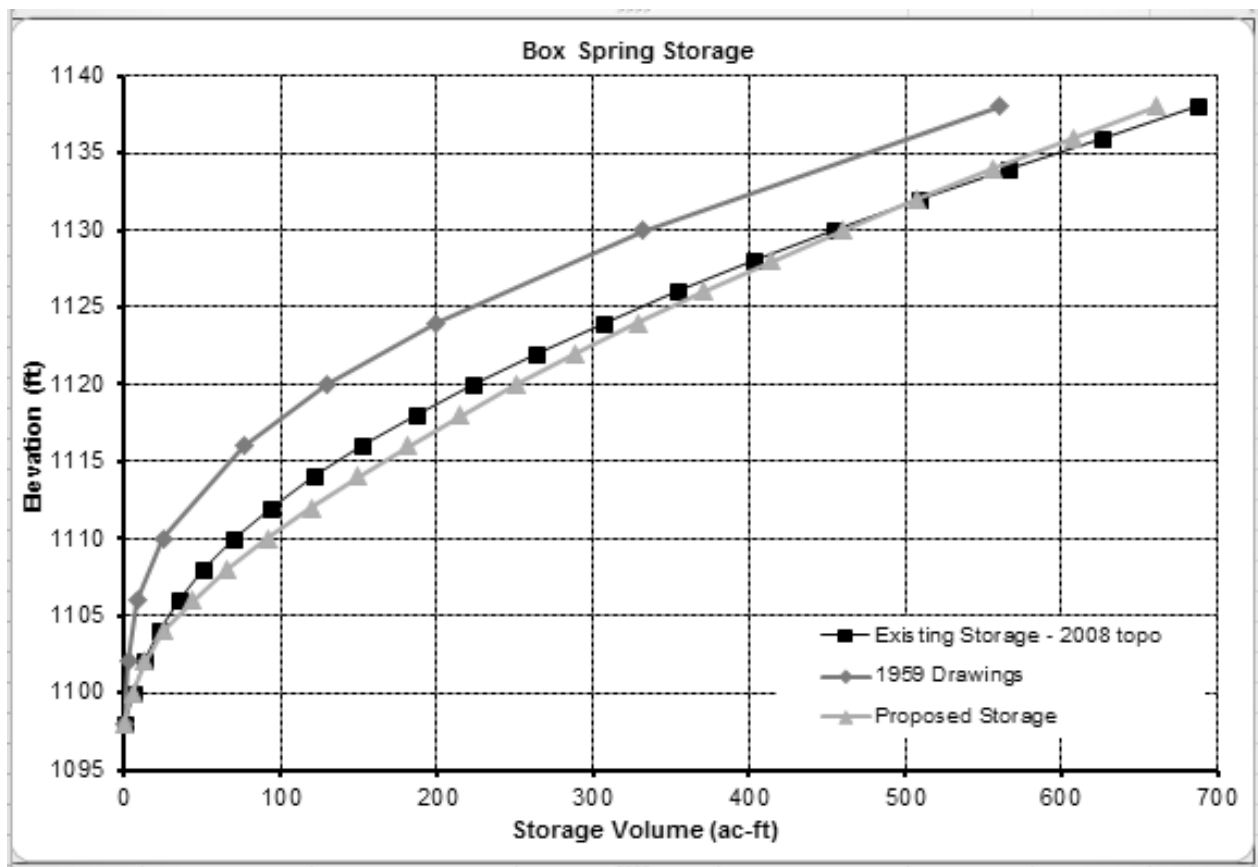


Figure 2. Box Springs Storage

3.3 - Stage Discharge Relationship

As previously stated, Box Springs Dam discharges by two means, one through a 30-inch gated outlet at an invert elevation at 1106 feet and the second is by a spillway at elevation 1132 feet. Since the gated outlet is at an elevation of 1106 feet, it was assumed that all the storage below that elevation is dead storage. Furthermore, the gated outlet is not always open, as it has a gate valve that is controlled (either onsite or remotely) as a function of the depth of the water in the dam. A Table describing the gate opening as a function of the depth of the water in the dam is provided in Appendix 3.

The stage discharge curve used in the HEC-HMS model takes into account the opening of the culvert as a function of the depth of the water behind the dam. Please see Appendix 3.

3.4 – Summary of Results

Table 5 shows a comparison of HEC-HMS results after routing the hydrographs with the existing and proposed stage-storage data. As can be seen in Table 5, the difference in results is minimal, and in fact using the proposed stage-storage curve yields conservative results.

TABLE 5 – Proposed vs Existing Stage-Storage Results

Storm Event	Proposed Stage Storage		Existing Stage Storage	
	Peak Discharge	Peak Elevation	Peak Discharge	Peak Elevation
	(cfs)	(ft)	(cfs)	(ft)
2yr-6hr	6.1	1116.2	10.7	1117.3
2yr-24hr	13.3	1117.8	21.3	1118.8
10yr-6hr	31.9	1120.9	32.3	1121.8
10yr-24hr	69.2	1125.5	72.7	1125.8
100yr-6hr	134.7	1131.3	130.4	1131.0
100yr-24hr	1098.5	1134.5	1045.1	1134.4

CHAPTER 4 – CONCLUSION

This study demonstrates that the proposed Quail Run project will not have a measurable impact on the operations or functioning of Box Springs Dam. The proposed grading of the project around the perimeter of the ponded area will actually prevent flows from escaping by any means other than the spillway. This study also demonstrates that 100-year peak flows do not overtop the dam. In fact the highest elevation the water reaches in the dam is 1134.5 feet for the 100yr-24hr storm, which leaves a freeboard of close to 3.5 feet.

References

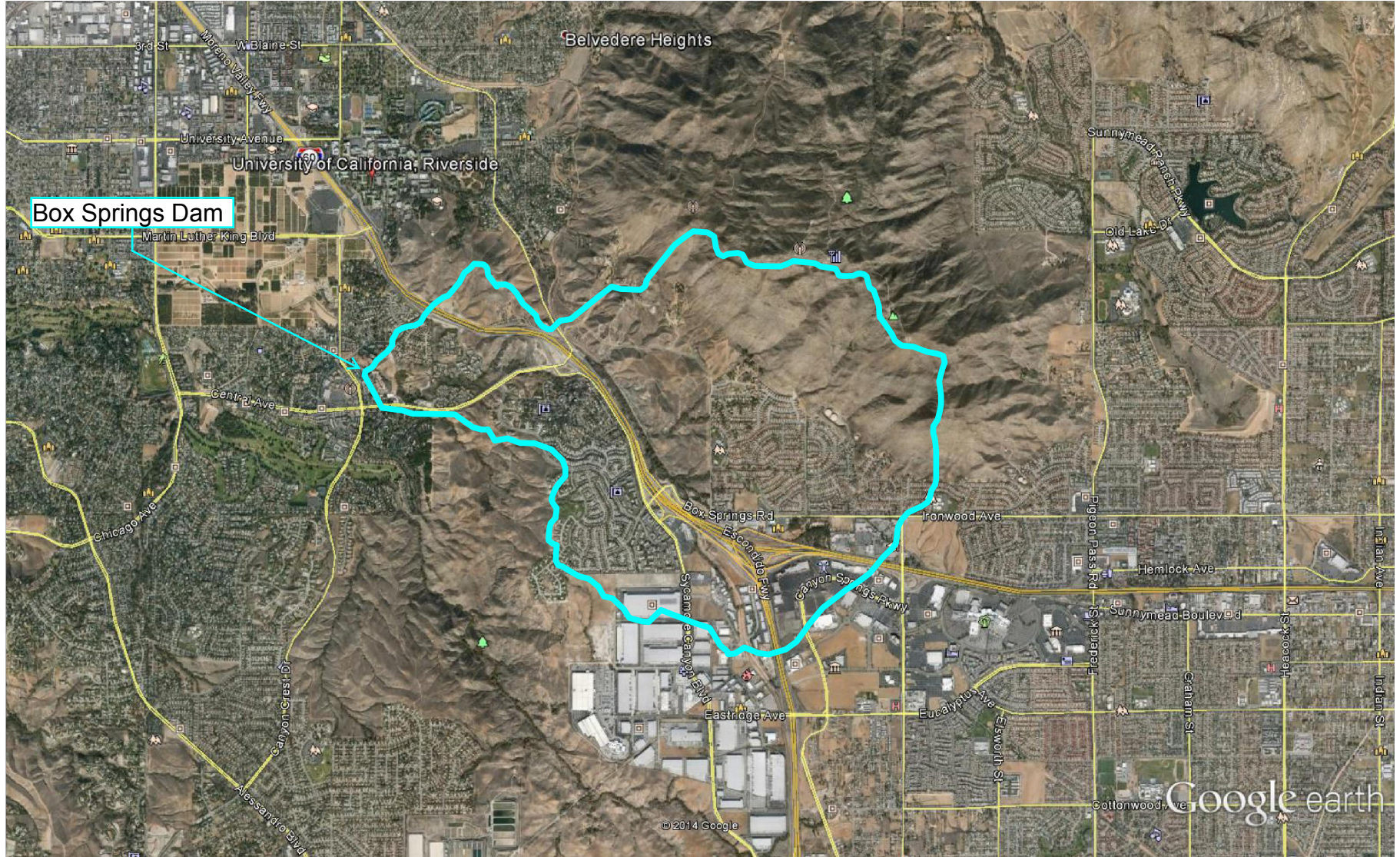
1978 Riverside County Flood Control and Water Conservation District Hydrology
Manual

USDA Web Soil Survey

APPENDIX 1

Site Plans

Box Springs Dam Catchment Area



Google earth

miles
km

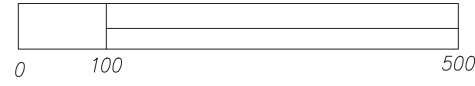


PROPOSED SITE EXHIBIT

TOPOGRAPHIC SOURCE:
1. Arrowhead Mapping Corporation – NOV 2014 – NAVD88



MAP SCALE 1" = 100'



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NOV 2014



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APPROVED CHANGES			
No.	Description	Approved By	Date

BENCH MARK
Description: _____
Location: _____
Record From: _____
Elev: _____ Datum: _____

SHEET 1	CITY OF RIVERSIDE	1 SHEETS
PROPOSED CONDITIONS EXHIBIT FOR: QUAIL RUN		
Approved _____		
ENGINEER OF WORK ENGINEER RCE	Checked by Approval date	

APPENDIX 2

Rainfall, Curve Number, and Unit Hydrograph Calculations



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Project Name.....
Project No.....
Str. Name.....
Design by.....

Quail-Run
156-14
9/17/2014
TRWE

Area Summary

Soil Type	Area (acres)	Land Use	Imp %*	% Soil Type
A	31.31	Commercial	90	0.09
B	0.00	Commercial	90	0.00
C	277.93	Commercial	90	0.83
D	24.92	Commercial	90	0.07
Total	334.16			1.00

*Plate E-6.3

Soil Type	Area (acres)	Land Use	Imp %*	% Soil Type
A	4.90	Industrial	87	0.02
B	0.00	Industrial	87	0.00
C	163.00	Industrial	87	0.63
D	90.36	Industrial	87	0.35
Total	258.27			1.00

Soil Type	Area (acres)	Land Use	Imp %*	% Soil Type
A	29.58	Residential	60	0.03
B	119.75	Residential	60	0.11
C	100.33	Residential	60	0.10
D	803.97	Residential	60	0.76
Total	1053.63			1.00

Soil Type	Area (acres)	Land Use	% Area	**CN Number	Weighted
A	15.32	Natural	0.017	55.00	0.91
B	42.53	Natural	0.046	72.00	3.32
C	7.52	Natural	0.008	81.00	0.66
D	856.57	Natural	0.929	86.00	79.90
Total	921.95		1.00	CN Weighted:	84.8

**Chaparral, Narrowleaf
(Chamise and redshank)
Fair Conditions
Plate
E-6.3

Soil Type Summary

Soil Type	Area (ac)	% Area
A	81.11	3.2%
B	162.28	6.3%
C	548.79	21.4%
D	1775.82	69.2%
Total	2568.00	

Landuse Summary

Landuse	Area (ac)	% Area
Commercial	334.16	13.0%
Industrial	258.27	10.1%
Residential	1053.63	41.0%
Natural	921.95	35.9%
Total	2568.00	

Impervious vs Pervious Summary

Imp Area	Perv Area	Total Area	% Imp	% Perv
(acres)	(acres)	(acres)		
1158	1410	2568	45.1%	54.9%

Developed Pervious Area CN Number

Soil Type	Area (acres)	Perv A (acres)	% Area Perv	***CN Number	Weighted	Landuse	*** Urban Covers
A	31.3	3.1	0.6%	32	0.21	Commercial	Residential or Commercial
B	0.0	0.0	0.0%	56	0.00	Commercial	Landscaping
C	277.9	27.8	5.7%	69	3.93	Commercial	Plate
D	24.9	2.5	0.5%	75	0.38	Commercial	E-6.3
A	4.9	0.6	0.1%	32	0.04	Industrial	
B	0.0	0.0	0.0%	56	0.00	Industrial	
C	163.0	21.2	4.3%	69	2.99	Industrial	
D	90.4	11.7	2.4%	75	1.80	Industrial	
A	29.6	11.8	2.4%	32	0.78	Residential	
B	119.8	47.9	9.8%	56	5.49	Residential	
C	100.3	40.1	8.2%	69	5.67	Residential	
D	804.0	321.6	65.8%	75	49.38	Residential	
	Total	488.4		CN Weighted:	70.7		

Pervious Area Runoff Number

Landuse	Area	CN	% Area	Weighted
Urban Cover	488.4	70.7	0.35	24.47
Natural	921.9	84.8	0.65	55.43
Total	1410.4		CN Weighted:	79.90



F and FP Calculations

100yr-24hr AMC III
100yr-6hr AMC III

*Fp:	0.11	inches/hour	*Per Plate E-6.2
A _i :	0.451	decimal percent	
F:	0.065	inches/hour	

10yr-24hr AMC II
2yr--24hr AMC II
10yr-6hr AMC II
2yr-6hr AMC II

*Fp:	0.24	inches/hour	*Per Plate E-6.2
A _i :	0.451	decimal percent	
F:	0.143	inches/hour	

Precipitation

2YR-24HR	2.5	Per Plate E-5.5
2YR-6HR	1.4	Per Plate E-5.3
10YR-24HR	3.6	Per Plate E-5.7
10YR-6HR	1.9	Per Plate E-5.7
100YR-24HR	5	Per Plate E-5.6
100YR-6HR	2.6	Per Plate E-5.4



Lag Time Calculations

Lag : $24 * \bar{\eta} * [(L * L_{ca}) / S^{0.5}]^{0.38}$

A: Drainage Area in square miles

L: Length of longest watercourse in miles

L_{ca} : Length along the longest watercourse, measured upstream to a point opposite the centroid of the area in miles.

H: Difference in elevation between the concentration point and the most remote poin of the basin in feet.

S: Overall slope of longest watercourse between headwaters and concentration point in feet per mile

$\bar{\eta}$: The visually estimated mean of the $\bar{\eta}$ (Mannings formula) values of all collection streams and channels within the watershed.

A: 4.01 square-miles

L: 3.93 miles

L_{ca} : 1.97 miles

H: 1480 feet

S: 376 feet/mile

$\bar{\eta}$: 0.03165

Lag : 0.536 hours

Lag : 32.16 minutes



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Project Name.....
Project No.....
Str. Name.....
Design by.....

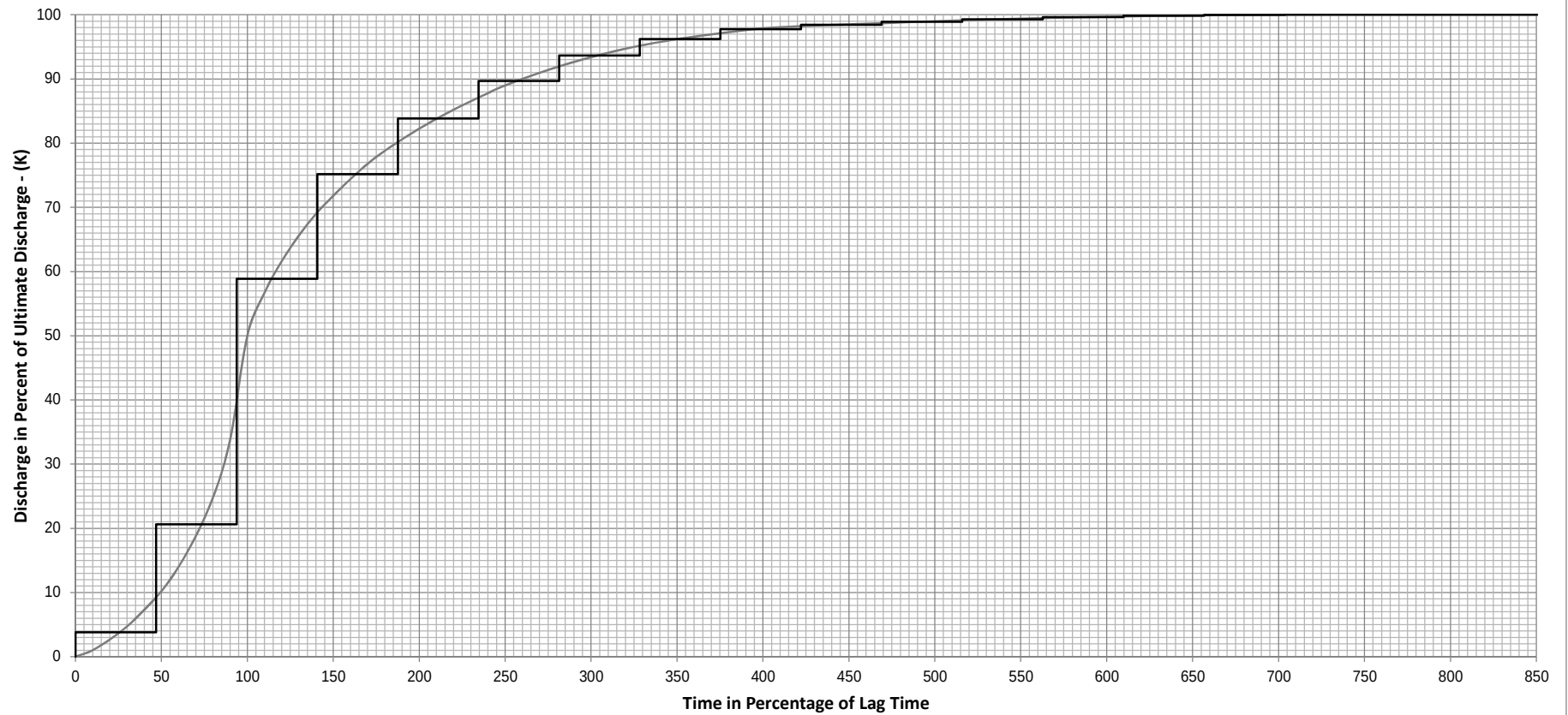
Quail-Run
156-14
9/9/2014
TRWE

Calculation of weighted Mannings coefficient

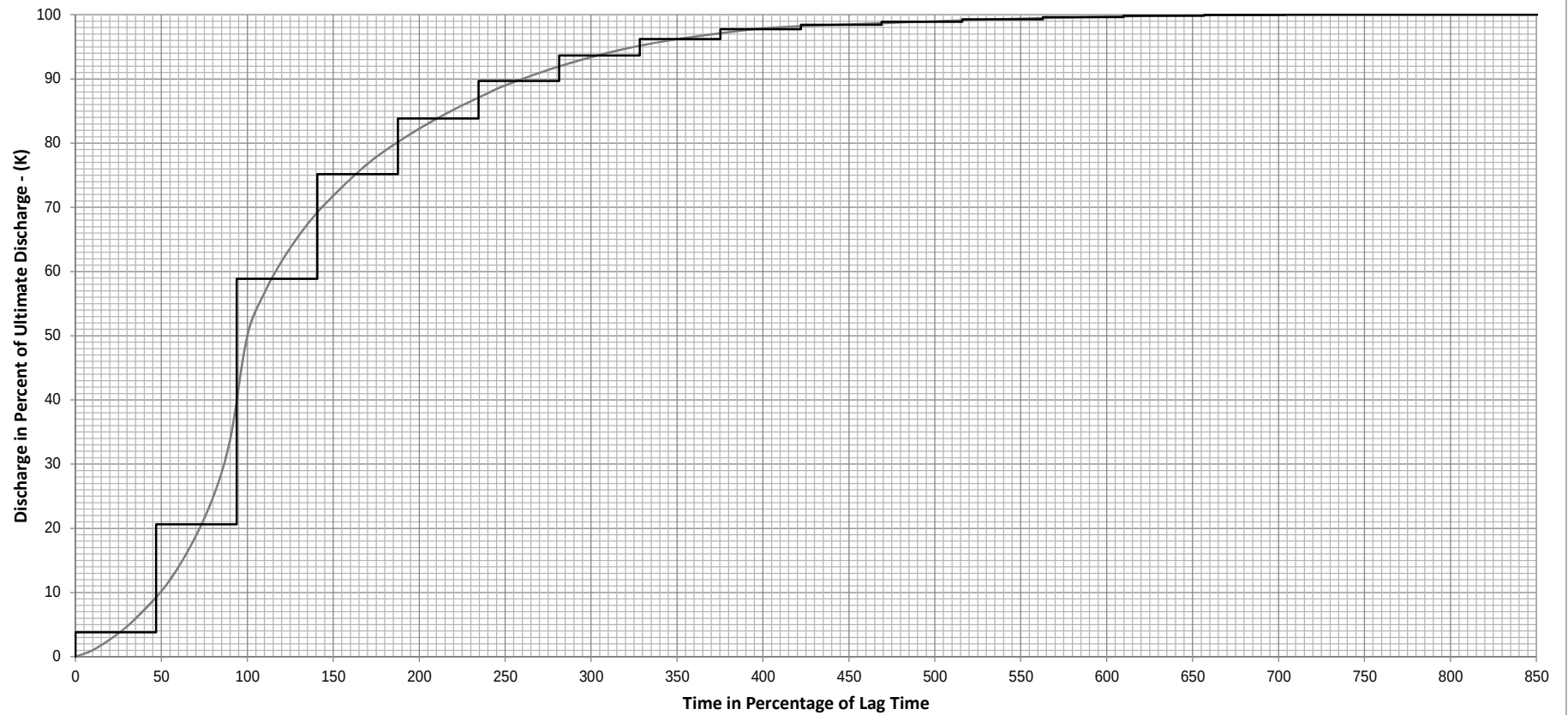
Conveyance Type	Mannings	Length (ft)	% of Total
River	0.04	28060	67%
Underground SD	0.015	14072	33%
Total		42132	
Mannings ¹ :	0.03165		

¹Visually estimated Mean of the n (Manning's Formula)
values of all the Channels within an area
Plate E-3

TOTAL AREA, Existing: S-GRAPH FOR FOOT HILL AREAS (RCFC & WCDHM). $\Delta t/t_{lag} = 0.313$



TOTAL AREA, Existing: S-GRAPH FOR FOOT HILL AREAS (RCFC & WCDHM). $\Delta t/t_{lag} = 0.469$



R C F C & W C D HYDROLOGY MANUAL	"SHORTCUT METHOD" SYNTHETIC UNIT HYDROGRAPH METHOD Unit Hydrograph and Effective Rain Calculation Form				Project				Sheet	
					By _____ TRWE _____ Date _____ 09/9/2014 _____				Quail-Run - Existing	
					Checked _____ Date _____				1 1	
[1] CONCENTRATION POINT	1				[2] AREA DESIGNATION	---				
[3] DRAINAGE AREA-ACRES	2568.00				[4] ULTIMATE DISCHARGE-CFS-HRS/IN (645*[3])	1656360				
[5] UNIT TIME-MINUTES	10				[6] LAG TIME-MINUTES	32				
[7] UNIT TIME-PERCENT OF LAG (100*[5]/[6])	31.25				[8] S-CURVE	Foothill				
[9] STORM FREQUENCY & DURATION	2-YR, 6-HR				[10] TOTAL ADJUSTED STORM RAIN-INCHES	1.4				
[11] VARIABLE LOSS RATE (AVG)-INCHES/HOUR	---				[12] MINIMUM LOSS RATE (FOR VAR. LOSS)-IN/HR	---				
[13] CONSTANT LOSS RATE-INCHES/HOUR	0.143				[14] LOW LOSS RATE-PERCENT	85				
	UNIT HYDROGRAPH				EFFECTIVE RAIN				FLOOD HYDROGRAPH	
	[15] UNIT TIME PERIOD m	[16] TIME PERCENT OF LAG [7]*[15]	[17] CUMULATIVE AVERAGE PERCENT OF ULTIMATE DISCHARGE (S-GRAPH)	[18] DISTRIB GRAPH PERCENT [17]m-[17]m-1	[19] UNIT HYDROGRAPH CFS-HRS/IN [4]*[18] 100.000	[20] PATTERN PERCENT (PL E-5.9)	[21] STORM RAIN IN/HR 60[10][20] 100[5]	[22] LOSS RATE IN/HR MAXLOW	[23] EFFECTIVE RAIN IN/HR [21]-[22]	[24] FLOW CFS
1	31	2.130	2.130	35280.468	1.1	0.092	0.1430.079	0.014	35.89	
2	63	9.570	7.440	123233.184	1.2	0.101	0.1430.086	0.015	39.15	
3	94	24.850	15.280	253091.808	1.3	0.109	0.1430.093	0.016	42.41	
4	125	55.000	30.150	499392.540	1.4	0.118	0.1430.100	0.018	45.68	
5	156	68.920	13.920	230565.312	1.4	0.118	0.1430.100	0.018	45.68	
6	188	77.030	8.110	134330.796	1.5	0.126	0.1430.107	0.019	48.94	
7	219	82.690	5.660	93749.976	1.6	0.134	0.1430.114	0.020	52.20	
8	250	87.070	4.380	72548.568	1.6	0.134	0.1430.114	0.020	52.20	
9	281	90.490	3.420	56647.512	1.6	0.134	0.1430.114	0.020	52.20	
10	313	93.110	2.620	43396.632	1.6	0.134	0.1430.114	0.020	52.20	
11	344	95.110	2.000	33127.200	1.6	0.134	0.1430.114	0.020	52.20	
12	375	96.530	1.420	23520.312	1.7	0.143	0.1430.121	0.021	55.46	
13	406	97.590	1.060	17557.416	1.7	0.143	0.1430.121	0.021	55.46	
14	438	98.200	0.610	10103.796	1.8	0.151	0.1430.129	0.023	58.73	
15	469	98.530	0.330	5465.988	1.8	0.151	0.1430.129	0.023	58.73	
16	500	98.840	0.310	5134.716	1.8	0.151	0.1430.129	0.023	58.73	
17	531	99.130	0.290	4803.444	2.0	0.168	0.1430.143	0.025	65.25	
18	563	99.370	0.240	3975.264	2.0	0.168	0.1430.143	0.025	65.25	
19	594	99.570	0.200	3312.720	2.1	0.176	0.1430.150	0.033	86.49	
20	625	99.740	0.170	2815.812	2.2	0.185	0.1430.157	0.042	108.24	
21	656	99.860	0.120	1987.632	2.5	0.210	0.1430.179	0.067	173.49	
22	688	99.940	0.080	1325.088	2.8	0.235	0.1430.200	0.092	238.74	
23	719	100.000	0.060	993.816	3.0	0.252	0.1430.214	0.109	282.24	
24					3.2	0.269	0.1430.228	0.126	325.75	
25			100.000	1656360.000	3.5	0.294	0.1430.250	0.151	391.00	
26					3.9	0.328	0.1430.278	0.185	478.00	
27					4.2	0.353	0.1430.300	0.210	543.26	
28					4.5	0.378	0.1430.321	0.235	608.51	
29					4.8	0.403	0.1430.343	0.260	673.76	
30					5.1	0.428	0.1430.364	0.285	739.01	
31					6.7	0.563	0.1430.478	0.420	1087.03	
32					8.1	0.6				

R C F C & W C D HYDROLOGY MANUAL		"SHORTCUT METHOD" SYNTHETIC UNIT HYDROGRAPH METHOD Unit Hydrograph and Effective Rain Calculation Form			Project				Sheet	
					Quail-Run - Existing				1	
					By <u>TRWE</u>		Date <u>09/9/2014</u>		1	
Checked _____		Date _____								
[1] CONCENTRATION POINT	1				[2] AREA DESIGNATION	---				
[3] DRAINAGE AREA-ACRES	2568.00				[4] ULTIMATE DISCHARGE-CFS-HRS/IN (645*[3])	1656360				
[5] UNIT TIME-MINUTES	15				[6] LAG TIME-MINUTES	32				
[7] UNIT TIME-PERCENT OF LAG (100*[5]/[6])	46.875				[8] S-CURVE	Foothill				
[9] STORM FREQUENCY & DURATION	2-YR, 24-HR				[10] TOTAL ADJUSTED STORM RAIN-INCHES	2.5				
[11] VARIABLE LOSS RATE (AVG)-INCHES/HOUR	0.143				[12] MINIMUM LOSS RATE (FOR VAR. LOSS)-IN/HR	0.0715				
[13] CONSTANT LOSS RATE-INCHES/HOUR	---				[14] LOW LOSS RATE-PERCENT	85				
		UNIT HYDROGRAPH				EFFECTIVE RAIN				FLOOD HYDROGRAPH
[15] UNIT TIME PERIOD m	[16] TIME PERCENT OF LAG [7]*[15]	[17] CUMULATIVE AVERAGE PERCENT OF ULTIMATE DISCHARGE (S-GRAPH)	[18] DISTRIB GRAPH PERCENT [17]m-[17]m-1	[19] UNIT HYDROGRAPH CFS-HRS/IN [4]*[18] 100.000	[20] PATTERN PERCENT (PL E-5.9)	[21] STORM RAIN IN/HR 60[10]/[20] 100[5]	[22] LOSS RATE IN/HR		[23] EFFECTIVE RAIN IN/HR [21]-[22]	[24] FLOW CFS
							MAX	LOW		
1	47	3.790	3.790	62776.044	0.2	0.020	0.253	0.017	0.003	7.77
2	94	20.600	16.810	278434.116	0.3	0.030	0.250	0.026	0.005	11.65
3	141	58.870	38.270	633888.972	0.3	0.030	0.247	0.026	0.005	11.65
4	188	75.150	16.280	269655.408	0.4	0.040	0.244	0.034	0.006	15.54
5	234	83.840	8.690	143937.684	0.3	0.030	0.241	0.026	0.005	11.65
6	281	89.690	5.850	96897.060	0.3	0.030	0.238	0.026	0.005	11.65
7	328	93.650	3.960	65591.856	0.3	0.030	0.235	0.026	0.005	11.65
8	375	96.200	2.550	42237.180	0.4	0.040	0.232	0.034	0.006	15.54
9	422	97.760	1.560	25839.216	0.4	0.040	0.230	0.034	0.006	15.54
10	469	98.460	0.700	11594.520	0.4	0.040	0.227	0.034	0.006	15.54
11	516	98.920	0.460	7619.256	0.5	0.050	0.224	0.043	0.008	19.42
12	563	99.310	0.390	6459.804	0.5	0.050	0.221	0.043	0.008	19.42
13	609	99.620	0.310	5134.716	0.5	0.050	0.219	0.043	0.008	19.42
14	656	99.830	0.210	3478.356	0.5	0.050	0.216	0.043	0.008	19.42
15	703	99.960	0.130	2153.268	0.5	0.050	0.213	0.043	0.008	19.42
16	750	100.000	0.040	662.544	0.6	0.060	0.210	0.051	0.009	23.30
17					0.6	0.060	0.208	0.051	0.009	23.30
18			100.000	1656360.000	0.7	0.070	0.205	0.060	0.011	27.19
19					0.7	0.070	0.202	0.060	0.011	27.19
20					0.8	0.080	0.200	0.068	0.012	31.07
21					0.6	0.060	0.197	0.051	0.009	23.30
22					0.7	0.070	0.195	0.060	0.011	27.19
23					0.8	0.080	0.192	0.068	0.012	31.07
24					0.8	0.080	0.190	0.068	0.012	31.07
25					0.9	0.090	0.187	0.077	0.014	34.96
26					0.9	0.090	0.185	0.077	0.014	34.96
27					1.0	0.100	0.182	0.085	0.015	38.84
28					1.0	0.100	0.180	0.085	0.015	38.84
29					1.0	0.100	0.177	0.085	0.015	38.84
30					1.1	0.110	0.175	0.094	0.017	42.73
31					1.2	0.120	0.172	0.102	0.018	46.61
32					1.3	0.130	0.170	0.111	0.020	50.49
33					1.5	0.150	0.168	0.128	0.023	58.26
34					1.5	0.150	0.165	0.128	0.023	58.26
35					1.6	0.160	0.163	0.136	0.024	62.15
36					1.7	0.170	0.161	0.145	0.026	66.03
37					1.9	0.190	0.158	0.162	0.032	81.72
38					2.0	0.200	0.156	0.170	0.044	113.45
39					2.1	0.210	0.154	0.179	0.056	145.13
40					2.2	0.220	0.152	0.187	0.068	176.75
41					1.5	0.150	0.150	0.128	0.023	58.26
42					1.5	0.150	0.147	0.128	0.023	58.26
43					2.0	0.200	0.145	0.170	0.055	141.81
44					2.0	0.200	0.143	0.170	0.057	147.31
45					1.9	0.190	0.141	0.162	0.049	126.87
46					1.9	0.190	0.139	0.162	0.051	132.25
47					1.7	0.170	0.137	0.145	0.033	85.80
48					1.8	0.180	0.135	0.153	0.045	116.96
49					2.5	0.250	0.133	0.213	0.117	303.43
50					2.6	0.260	0.131	0.221	0.129	334.47
51					2.8	0.280	0.129	0.238	0.151	391.35
52					2.9	0.290	0.127	0.247	0.163	422.28
53					3.4	0.340	0.125	0.289	0.215	556.71
54					3.4	0.340	0.123	0.289	0.217	561.62
55					2.3	0.230	0.121	0.196	0.109	281.63

56					2.3	0.230	0.119	0.196	0.111	286.40
57					2.7	0.270	0.118	0.230	0.152	394.69
58					2.6	0.260	0.116	0.221	0.144	373.45
59					2.6	0.260	0.114	0.221	0.146	378.03
60					2.5	0.250	0.112	0.213	0.138	356.65
61					2.4	0.240	0.111	0.204	0.129	335.21
62					2.3	0.230	0.109	0.196	0.121	313.69
63					1.9	0.190	0.107	0.162	0.083	214.43
64					1.9	0.190	0.106	0.162	0.084	218.67
65					0.4	0.040	0.104	0.034	0.006	15.54
66					0.4	0.040	0.102	0.034	0.006	15.54
67					0.3	0.030	0.101	0.026	0.005	11.65
68					0.3	0.030	0.099	0.026	0.005	11.65
69					0.5	0.050	0.098	0.043	0.008	19.42
70					0.5	0.050	0.096	0.043	0.008	19.42
71					0.5	0.050	0.095	0.043	0.008	19.42
72					0.4	0.040	0.093	0.034	0.006	15.54
73					0.4	0.040	0.092	0.034	0.006	15.54
74					0.4	0.040	0.091	0.034	0.006	15.54
75					0.3	0.030	0.089	0.026	0.005	11.65
76					0.2	0.020	0.088	0.017	0.003	7.77
77					0.3	0.030	0.087	0.026	0.005	11.65
78					0.4	0.040	0.086	0.034	0.006	15.54
79					0.3	0.030	0.085	0.026	0.005	11.65
80					0.2	0.020	0.083	0.017	0.003	7.77
81					0.3	0.030	0.082	0.026	0.005	11.65
82					0.3	0.030	0.081	0.026	0.005	11.65
83					0.3	0.030	0.080	0.026	0.005	11.65
84					0.2	0.020	0.079	0.017	0.003	7.77
85					0.3	0.030	0.078	0.026	0.005	11.65
86					0.2	0.020	0.077	0.017	0.003	7.77
87					0.3	0.030	0.077	0.026	0.005	11.65
88					0.2	0.020	0.076	0.017	0.003	7.77
89					0.3	0.030	0.075	0.026	0.005	11.65
90					0.2	0.020	0.074	0.017	0.003	7.77
91					0.2	0.020	0.074	0.017	0.003	7.77
92					0.2	0.020	0.073	0.017	0.003	7.77
93					0.2	0.020	0.073	0.017	0.003	7.77
94					0.2	0.020	0.072	0.017	0.003	7.77
95					0.2	0.020	0.072	0.017	0.003	7.77
96					0.2	0.020	0.072	0.017	0.003	7.77
TOTALS					100.0				3.29	8521.12

EFFECTIVE RAIN = 0.82 INCHES
TOTAL RUNOFF VOLUME = 176.06 AC-FT

EFFECTIVE RAIN = 1.08 INCHES
TOTAL RUNOFF VOLUME = 231.04 AC-FT

R C F C & W C D HYDROLOGY MANUAL	"SHORTCUT METHOD" SYNTHETIC UNIT HYDROGRAPH METHOD Unit Hydrograph and Effective Rain Calculation Form				Project Quail-Run - Existing				Sheet 1 1	
					By <u>TRWE</u>		Date <u>09/9/2014</u>			
					Checked _____		Date _____			

[1] CONCENTRATION POINT	1	[2] AREA DESIGNATION	---
[3] DRAINAGE AREA-ACRES	2568.00	[4] ULTIMATE DISCHARGE-CFS-HRS/IN (645*[3])	1656360
[5] UNIT TIME-MINUTES	15	[6] LAG TIME-MINUTES	32
[7] UNIT TIME-PERCENT OF LAG (100*[5]/[6])	46.875	[8] S-CURVE	Foothill
[9] STORM FREQUENCY & DURATION	10-YR, 24-HR	[10] TOTAL ADJUSTED STORM RAIN-INCHES	3.6
[11] VARIABLE LOSS RATE (AVG)-INCHES/HOUR	0.143	[12] MINIMUM LOSS RATE (FOR VAR. LOSS)-IN/HR	0.0715
[13] CONSTANT LOSS RATE-INCHES/HOUR	---	[14] LOW LOSS RATE-PERCENT	85

UNIT HYDROGRAPH					EFFECTIVE RAIN				FLOOD HYDROGRAPH	
[15] UNIT TIME PERIOD m	[16] TIME PERCENT OF LAG [7]*[15]	[17] CUMULATIVE AVERAGE PERCENT OF ULTIMATE DISCHARGE (S-GRAPH)	[16] DISTRIB GRAPH PERCENT [17]m-[17]m-1	[17] UNIT HYDROGRAPH CFS-HRS/IN [4]*[18] 100.000	[20] PATTERN PERCENT (PL E-5.9)	[21] STORM RAIN IN/HR 60[10][20] 100[5]	[22] LOSS RATE IN/HR		[23] EFFECTIVE RAIN IN/HR [21]-[22]	[24] FLOW CFS
							MAX	LOW		
1	47	3.790	3.790	62776.044	0.2	0.029	0.253	0.024	0.004	11.19
2	94	20.600	16.810	278434.116	0.3	0.043	0.250	0.037	0.006	16.78
3	141	58.870	38.270	633888.972	0.3	0.043	0.247	0.037	0.006	16.78
4	188	75.150	16.280	269655.408	0.4	0.058	0.244	0.049	0.009	22.37
5	234	83.840	8.690	143937.684	0.3	0.043	0.241	0.037	0.006	16.78
6	281	89.690	5.850	96897.060	0.3	0.043	0.238	0.037	0.006	16.78
7	328	93.650	3.960	65591.856	0.3	0.043	0.235	0.037	0.006	16.78
8	375	96.200	2.550	42237.180	0.4	0.058	0.232	0.049	0.009	22.37
9	422	97.760	1.560	25839.216	0.4	0.058	0.230	0.049	0.009	22.37
10	469	98.460	0.700	11594.520	0.4	0.058	0.227	0.049	0.009	22.37
11	516	98.920	0.460	7619.256	0.5	0.072	0.224	0.061	0.011	27.97
12	563	99.310	0.390	6459.804	0.5	0.072	0.221	0.061	0.011	27.97
13	609	99.620	0.310	5134.716	0.5	0.072	0.219	0.061	0.011	27.97
14	656	99.830	0.210	3478.356	0.5	0.072	0.216	0.061	0.011	27.97
15	703	99.960	0.130	2153.268	0.5	0.072	0.213	0.061	0.011	27.97
16	750	100.000	0.040	662.544	0.6	0.086	0.210	0.073	0.013	33.56
17					0.6	0.086	0.208	0.073	0.013	33.56
18			100.000	1656360.000	0.7	0.101	0.205	0.086	0.015	39.15
19					0.7	0.101	0.202	0.086	0.015	39.15
20					0.8	0.115	0.200	0.098	0.017	44.74
21					0.6	0.086	0.197	0.073	0.013	33.56
22					0.7	0.101	0.195	0.086	0.015	39.15
23					0.8	0.115	0.192	0.098	0.017	44.74
24					0.8	0.115	0.190	0.098	0.017	44.74
25					0.9	0.130	0.187	0.110	0.019	50.34
26					0.9	0.130	0.185	0.110	0.019	50.34
27					1.0	0.144	0.182	0.122	0.022	55.93
28					1.0	0.144	0.180	0.122	0.022	55.93
29					1.0	0.144	0.177	0.122	0.022	55.93
30					1.1	0.158	0.175	0.135	0.024	61.52
31					1.2	0.173	0.172	0.147	0.026	67.12
32					1.3	0.187	0.170	0.159	0.028	72.71
33					1.5	0.216	0.168	0.184	0.048	125.16
34					1.5	0.216	0.165	0.184	0.051	131.21
35					1.6	0.230	0.163	0.196	0.067	174.50
36					1.7	0.245	0.161	0.208	0.084	217.73
37					1.9	0.274	0.158	0.233	0.115	298.19
38					2.0	0.288	0.156	0.245	0.132	341.32
39					2.1	0.302	0.154	0.257	0.148	384.39
40					2.2	0.317	0.152	0.269	0.165	427.40
41					1.5	0.216	0.150	0.184	0.066	172.07
42					1.5	0.216	0.147	0.184	0.069	177.68
43					2.0	0.288	0.145	0.245	0.143	369.68
44					2.0	0.288	0.143	0.245	0.145	375.18
45					1.9	0.274	0.141	0.233	0.133	343.34
46					1.9	0.274	0.139	0.233	0.135	348.73
47					1.7	0.245	0.137	0.208	0.108	279.48
48					1.8	0.259	0.135	0.220	0.124	322.04
49					2.5	0.360	0.133	0.306	0.227	588.26
50					2.6	0.374	0.131	0.318	0.244	630.70
51					2.8	0.403	0.129	0.343	0.274	710.37
52					2.9	0.418	0.127	0.355	0.291	752.68
53					3.4	0.490	0.125	0.416	0.365	944.09
54					3.4	0.490	0.123	0.416	0.366	948.99
55					2.3	0.331	0.121	0.282	0.210	543.67

56					2.3	0.331	0.119	0.282	0.212	548.45
57					2.7	0.389	0.118	0.330	0.271	702.32
58					2.6	0.374	0.116	0.318	0.259	669.68
59					2.6	0.374	0.114	0.318	0.260	674.26
60					2.5	0.360	0.112	0.306	0.248	641.49
61					2.4	0.346	0.111	0.294	0.235	608.65
62					2.3	0.331	0.109	0.282	0.222	575.74
63					1.9	0.274	0.107	0.233	0.166	430.90
64					1.9	0.274	0.106	0.233	0.168	435.14
65					0.4	0.058	0.104	0.049	0.009	22.37
66					0.4	0.058	0.102	0.049	0.009	22.37
67					0.3	0.043	0.101	0.037	0.006	16.78
68					0.3	0.043	0.099	0.037	0.006	16.78
69					0.5	0.072	0.098	0.061	0.011	27.97
70					0.5	0.072	0.096	0.061	0.011	27.97
71					0.5	0.072	0.095	0.061	0.011	27.97
72					0.4	0.058	0.093	0.049	0.009	22.37
73					0.4	0.058	0.092	0.049	0.009	22.37
74					0.4	0.058	0.091	0.049	0.009	22.37
75					0.3	0.043	0.089	0.037	0.006	16.78
76					0.2	0.029	0.088	0.024	0.004	11.19
77					0.3	0.043	0.087	0.037	0.006	16.78
78					0.4	0.058	0.086	0.049	0.009	22.37
79					0.3	0.043	0.085	0.037	0.006	16.78
80					0.2	0.029	0.083	0.024	0.004	11.19
81					0.3	0.043	0.082	0.037	0.006	16.78
82					0.3	0.043	0.081	0.037	0.006	16.78
83					0.3	0.043	0.080	0.037	0.006	16.78
84					0.2	0.029	0.079	0.024	0.004	11.19
85					0.3	0.043	0.078	0.037	0.006	16.78
86					0.2	0.029	0.077	0.024	0.004	11.19
87					0.3	0.043	0.077	0.037	0.006	16.78
88					0.2	0.029	0.076	0.024	0.004	11.19
89					0.3	0.043	0.075	0.037	0.006	16.78
90					0.2	0.029	0.074	0.024	0.004	11.19
91					0.2	0.029	0.074	0.024	0.004	11.19
92					0.2	0.029	0.073	0.024	0.004	11.19
93					0.2	0.029	0.073	0.024	0.004	11.19
94					0.2	0.029	0.072	0.024	0.004	11.19
95					0.2	0.029	0.072	0.024	0.004	11.19
96					0.2	0.029	0.072	0.024	0.004	11.19
TOTALS					100.0				6.40	16577.02

EFFECTIVE RAIN = 1.60 INCHES
TOTAL RUNOFF VOLUME = 342.50 AC-FT

EFFECTIVE RAIN = 2.21 INCHES
TOTAL RUNOFF VOLUME = 472.94 AC-FT

R C F C & W C D HYDROLOGY MANUAL	"SHORTCUT METHOD" SYNTHETIC UNIT HYDROGRAPH METHOD Unit Hydrograph and Effective Rain Calculation Form				Project Quail-Run - Existing				Sheet 1 1	
					By <u>TRWE</u>		Date <u>09/9/2014</u>			
					Checked _____		Date _____			

[1] CONCENTRATION POINT	1	[2] AREA DESIGNATION	---
[3] DRAINAGE AREA-ACRES	2568.00	[4] ULTIMATE DISCHARGE-CFS-HRS/IN (645*[3])	1656360
[5] UNIT TIME-MINUTES	15	[6] LAG TIME-MINUTES	32
[7] UNIT TIME-PERCENT OF LAG (100*[5]/[6])	46.875	[8] S-CURVE	Foothill
[9] STORM FREQUENCY & DURATION	100-YR, 24-HR	[10] TOTAL ADJUSTED STORM RAIN-INCHES	5
[11] VARIABLE LOSS RATE (AVG)-INCHES/HOUR	0.065	[12] MINIMUM LOSS RATE (FOR VAR. LOSS)-IN/HR	0.0325
[13] CONSTANT LOSS RATE-INCHES/HOUR	---	[14] LOW LOSS RATE-PERCENT	85

[15] UNIT TIME PERIOD m	UNIT HYDROGRAPH				EFFECTIVE RAIN				[24] FLOOD FLOW CFS	
	[16] TIME PERCENT OF LAG [7]*[15]	[17] CUMULATIVE AVERAGE PERCENT OF ULTIMATE DISCHARGE (S-GRAPH)	[18] DISTRIB GRAPH PERCENT [17]m-[17]m-1	[19] UNIT HYDROGRAPH CFS-HRS/IN [4]*[18] 100.000	[20] PATTERN PERCENT (PL E-5.9)	[21] STORM RAIN IN/HR 60[10][20] 100[5]	[22] LOSS RATE IN/HR			[23] EFFECTIVE RAIN IN/HR [21]-[22]
							MAX	LOW		
1	47	3.790	3.790	62776.044	0.2	0.040	0.115	0.034	0.006	15.54
2	94	20.600	16.810	278434.116	0.3	0.060	0.113	0.051	0.009	23.30
3	141	58.870	38.270	633888.972	0.3	0.060	0.112	0.051	0.009	23.30
4	188	75.150	16.280	269655.408	0.4	0.080	0.111	0.068	0.012	31.07
5	234	83.840	8.690	143937.684	0.3	0.060	0.110	0.051	0.009	23.30
6	281	89.690	5.850	96897.060	0.3	0.060	0.108	0.051	0.009	23.30
7	328	93.650	3.960	65591.856	0.3	0.060	0.107	0.051	0.009	23.30
8	375	96.200	2.550	42237.180	0.4	0.080	0.106	0.068	0.012	31.07
9	422	97.760	1.560	25839.216	0.4	0.080	0.104	0.068	0.012	31.07
10	469	98.460	0.700	11594.520	0.4	0.080	0.103	0.068	0.012	31.07
11	516	98.920	0.460	7619.256	0.5	0.100	0.102	0.085	0.015	38.84
12	563	99.310	0.390	6459.804	0.5	0.100	0.101	0.085	0.015	38.84
13	609	99.620	0.310	5134.716	0.5	0.100	0.099	0.085	0.015	38.84
14	656	99.830	0.210	3478.356	0.5	0.100	0.098	0.085	0.015	38.84
15	703	99.960	0.130	2153.268	0.5	0.100	0.097	0.085	0.015	38.84
16	750	100.000	0.040	662.544	0.6	0.120	0.096	0.102	0.024	63.09
17					0.6	0.120	0.094	0.102	0.026	66.22
18			100.000	1656360.000	0.7	0.140	0.093	0.119	0.047	121.13
19					0.7	0.140	0.092	0.119	0.048	124.22
20					0.8	0.160	0.091	0.136	0.069	179.08
21					0.6	0.120	0.090	0.102	0.030	78.55
22					0.7	0.140	0.088	0.119	0.052	133.37
23					0.8	0.160	0.087	0.136	0.073	188.16
24					0.8	0.160	0.086	0.136	0.074	191.15
25					0.9	0.180	0.085	0.153	0.095	245.90
26					0.9	0.180	0.084	0.153	0.096	248.83
27					1.0	0.200	0.083	0.170	0.117	303.54
28					1.0	0.200	0.082	0.170	0.118	306.43
29					1.0	0.200	0.081	0.170	0.119	309.30
30					1.1	0.220	0.079	0.187	0.141	363.93
31					1.2	0.240	0.078	0.204	0.162	418.54
32					1.3	0.260	0.077	0.221	0.183	473.13
33					1.5	0.300	0.076	0.255	0.224	579.48
34					1.5	0.300	0.075	0.255	0.225	582.23
35					1.6	0.320	0.074	0.272	0.246	636.74
36					1.7	0.340	0.073	0.289	0.267	691.23
37					1.9	0.380	0.072	0.323	0.308	797.49
38					2.0	0.400	0.071	0.340	0.329	851.93
39					2.1	0.420	0.070	0.357	0.350	906.35
40					2.2	0.440	0.069	0.374	0.371	960.74
41					1.5	0.300	0.068	0.255	0.232	600.80
42					1.5	0.300	0.067	0.255	0.233	603.35
43					2.0	0.400	0.066	0.340	0.334	864.82
44					2.0	0.400	0.065	0.340	0.335	867.32
45					1.9	0.380	0.064	0.323	0.316	818.01
46					1.9	0.380	0.063	0.323	0.317	820.46
47					1.7	0.340	0.062	0.289	0.278	719.30
48					1.8	0.360	0.061	0.306	0.299	773.49
49					2.5	0.500	0.060	0.425	0.440	1138.37
50					2.6	0.520	0.059	0.442	0.461	1192.50
51					2.8	0.560	0.059	0.476	0.501	1298.39
52					2.9	0.580	0.058	0.493	0.522	1352.47
53					3.4	0.680	0.057	0.578	0.623	1613.66
54					3.4	0.680	0.056	0.578	0.624	1615.89
55					2.3	0.460	0.055	0.391	0.405	1048.43

56					2.3	0.460	0.054	0.391	0.406	1050.60
57					2.7	0.540	0.053	0.459	0.487	1259.89
58					2.6	0.520	0.053	0.442	0.467	1210.22
59					2.6	0.520	0.052	0.442	0.468	1212.30
60					2.5	0.500	0.051	0.425	0.449	1162.57
61					2.4	0.480	0.050	0.408	0.430	1112.80
62					2.3	0.460	0.049	0.391	0.411	1063.00
63					1.9	0.380	0.049	0.323	0.331	857.81
64					1.9	0.380	0.048	0.323	0.332	859.74
65					0.4	0.080	0.047	0.068	0.033	84.81
66					0.4	0.080	0.047	0.068	0.033	86.68
67					0.3	0.060	0.046	0.051	0.014	36.72
68					0.3	0.060	0.045	0.051	0.015	38.51
69					0.5	0.100	0.044	0.085	0.056	143.85
70					0.5	0.100	0.044	0.085	0.056	145.57
71					0.5	0.100	0.043	0.085	0.057	147.27
72					0.4	0.080	0.042	0.068	0.038	97.13
73					0.4	0.080	0.042	0.068	0.038	98.75
74					0.4	0.080	0.041	0.068	0.039	100.33
75					0.3	0.060	0.041	0.051	0.019	50.08
76					0.2	0.040	0.040	0.034	0.006	15.54
77					0.3	0.060	0.040	0.051	0.020	53.05
78					0.4	0.080	0.039	0.068	0.041	106.26
79					0.3	0.060	0.038	0.051	0.022	55.86
80					0.2	0.040	0.038	0.034	0.006	15.54
81					0.3	0.060	0.037	0.051	0.023	58.49
82					0.3	0.060	0.037	0.051	0.023	59.74
83					0.3	0.060	0.036	0.051	0.024	60.94
84					0.2	0.040	0.036	0.034	0.006	15.54
85					0.3	0.060	0.036	0.051	0.024	63.20
86					0.2	0.040	0.035	0.034	0.006	15.54
87					0.3	0.060	0.035	0.051	0.025	65.25
88					0.2	0.040	0.034	0.034	0.006	15.54
89					0.3	0.060	0.034	0.051	0.026	67.08
90					0.2	0.040	0.034	0.034	0.006	16.11
91					0.2	0.040	0.033	0.034	0.007	16.87
92					0.2	0.040	0.033	0.034	0.007	17.55
93					0.2	0.040	0.033	0.034	0.007	18.15
94					0.2	0.040	0.033	0.034	0.007	18.67
95					0.2	0.040	0.033	0.034	0.007	19.08
96					0.2	0.040	0.033	0.034	0.007	19.36
TOTALS					100.0				14.37	37210.52

EFFECTIVE RAIN = 3.59 INCHES
TOTAL RUNOFF VOLUME = 768.81 AC-FT

Quail-Run - 2yr-6hr Convolution

Area (acres)		Effective Rain	
2568			

Time (min)	Total Hydrograph	S-Curve
0	0	2.13
10	0.764	7.44
20	3.504	15.28
30	9.300	30.15
40	20.931	13.92
50	27.652	8.11
60	32.569	5.66
70	36.615	4.38
80	39.831	3.42
90	43.133	2.62
100	45.950	2.00
110	47.727	1.42
120	49.018	1.06
130	50.165	0.61
140	51.353	0.33
150	52.996	0.31
160	54.276	0.29
170	55.919	0.24
180	57.241	0.20
190	59.252	0.17
200	63.674	0.12
210	71.147	0.08
220	87.887	0.06
230	113.705	
240	152.671	
250	195.973	
260	239.208	
270	287.044	
280	343.809	
290	407.503	
300	469.896	
310	538.617	
320	628.048	
330	761.715	
340	942.375	
350	1049.553	
360	1014.094	

0.014	0.015	0.016	0.018	0.018	0.019	0.020	0.020	0.020	0.020	0.020	0.021	0.021	0.023	0.023	0.023	0.025	0.025	0.033	0.042	0.067	0.092	0.109
0.126	0.151	0.185	0.210	0.235	0.260	0.285	0.420	0.537	0.722	0.092	0.014	0.006										

0.764																							
2.670	0.834																						
5.484	2.913	0.903																					
10.821	5.982	3.156	0.973																				
4.996	11.804	6.481	3.398	0.973																			
2.911	5.450	12.788	6.979	3.398	1.042																		
2.031	3.175	5.904	13.772	6.979	3.641	1.112																	
1.572	2.216	3.440	6.358	13.772	7.478	3.884	1.112																
1.227	1.715	2.401	3.704	6.358	14.755	7.977	3.884	1.112															
0.940	1.339	1.858	2.585	3.704	6.812	15.739	7.977	3.884	1.112														
0.718	1.026	1.451	2.001	2.585	3.969	7.267	15.739	7.977	3.884	1.112													
0.510	0.783	1.111	1.562	2.001	2.770	4.234	7.267	15.739	7.977	3.884	1.181												
0.380	0.556	0.848	1.197	1.562	2.144	2.955	4.234	7.267	15.739	7.977	4.127	1.181											
0.219	0.415	0.602	0.914	1.197	1.674	2.286	2.955	4.234	7.267	15.739	8.475	4.127	1.251										
0.118	0.239	0.450	0.649	0.914	1.282	1.785	2.286	2.955	4.234	7.267	16.723	8.475	4.369	1.251									
0.111	0.129	0.259	0.484	0.649	0.979	1.368	1.785	2.286	2.955	4.234	7.721	16.723	8.974	4.369	1.251								
0.104	0.121	0.140	0.279	0.484	0.695	1.044	1.368	1.785	2.286	2.955	4.498	7.721	17.706	8.974	4.369	1.390							
0.086	0.114	0.131	0.151	0.279	0.519	0.741	1.044	1.368	1.785	2.286	3.139	4.498	8.175	17.706	8.974	4.855	1.390						
0.072	0.094	0.123	0.142	0.151	0.299	0.553	0.741	1.044	1.368	1.785	2.429	3.139	4.763	8.175	17.706	9.971	4.855	1.842					
0.061	0.078	0.102	0.132	0.142	0.162	0.318	0.553	0.741	1.044	1.368	1.897	2.429	3.324	4.763	8.175	19.674	9.971	6.435	2.305				
0.043	0.067	0.085	0.110	0.132	0.152	0.172	0.318	0.553	0.741	1.044	1.453	1.897	2.572	3.324	4.763	9.083	19.674	13.215	8.053	3.695			
0.029	0.047	0.072	0.091	0.110	0.142	0.162	0.172	0.318	0.553	0.741	1.109	1.453	2.008	2.572	3.324	5.292	9.083	26.076	16.539	12.908	5.085		
0.022	0.031	0.051	0.078	0.091	0.117	0.151	0.162	0.172	0.318	0.553	0.788	1.109	1.539	2.008	2.572	3.693	5.292	12.039	32.633	26.509	17.762	6.012	
6.938	0.023	0.034	0.055	0.078	0.098	0.125	0.151	0.162	0.172	0.318	0.588	0.788	1.175	1.539	2.008	2.858	3.693	7.014	15.067	52.307	36.480	20.999	
24.236	8.328	0.025	0.037	0.055	0.083	0.104	0.125	0.151	0.162	0.172	0.338	0.588	0.834	1.175	1.539	2.232	2.858	4.895	8.778	24.150	71.981	43.127	
49.774	29.090	10.181	0.027	0.037	0.059	0.089	0.104	0.125	0.151	0.162	0.183	0.338	0.623	0.834	1.175	1.710	2.232	3.788	6.126	14.070	33.233	85.097	
98.213	59.745	35.563	11.571	0.027	0.039	0.063	0.089	0.104	0.125	0.151	0.172	0.183	0.358	0.623	0.834	1.305	1.710	2.958	4.741	9.820	19.362	39.288	
45.344	117.886	73.039	40.418	12.961	0.029	0.042	0.063	0.089	0.104	0.125	0.161	0.172	0.194	0.358	0.623	0.927	1.305	2.266	3.702	7.599	13.513	22.890	
26.418	54.427	144.118	83.010	45.273	14.351	0.031	0.042	0.063	0.089	0.104	0.133	0.161	0.182	0.194	0.358	0.692	0.927	1.730	2.836	5.933	10.457	15.975	
18.437	31.710	66.538	163.792	92.980	50.128	15.741	0.031	0.042	0.063	0.089	0.111	0.133	0.170	0.182	0.194	0.398	0.692	1.228	2.165	4.545	8.165	12.362	
14.268	22.131	38.766	75.621	183.465	102.951	54.983	23.154	0.031	0.042	0.063	0.094	0.111	0.141	0.170	0.182	0.215	0.398	0.917	1.537	3.470	6.255	9.653	
11.141	17.126	27.055	44.058	84.704	203.139	112.921	80.875	29.640	0.031	0.042	0.067	0.094	0.117	0.141	0.170	0.202	0.215	0.528	1.147	2.464	4.775	7.395	
8.535	13.372	20.937	30.748	49.350	93.788	222.813	166.098	103.531	39.832	0.031	0.044	0.067	0.100	0.117	0.141	0.189	0.202	0.285	0.660	1.839	3.390	5.645	
6.515	10.244	16.348	23.795	34.442	54.642	102.871	327.740	212.628	139.133	5.085	0.033	0.044	0.070	0.100	0.117	0.157	0.189	0.268	0.357	1.058	2.531	4.008	
4.626	7.820	12.524	18.579	26.653	38.135	59.934	151.315	419.550	285.746	17.762	0.764	0.033	0.047	0.070	0.100	0.131	0.157	0.251	0.336	0.573	1.456	2.992	
3.453	5.552	9.560	14.233	20.811	29.511	41.828	88.158	193.703	563.825	36.480	2.670	0.347	0.035	0.047	0.070	0.111	0.131	0.208	0.314	0.538	0.788	1.722	

Quail-Run - 2yr-24hr Convolution

Area
(acres)
2568

Effective Rain	

Time	Total
(min)	Hydrograph
0	0
15	0.294
30	1.747
45	5.373
60	8.272
75	10.085
90	11.710
105	11.391
120	11.595
135	12.358
150	13.886
165	14.674
180	15.674
195	17.393
210	18.199
225	18.651
240	19.091
255	19.922
270	21.670
285	23.027
300	25.036
315	26.280
330	27.120
345	25.919
360	27.354
375	29.303
390	30.705
405	32.738
420	34.296
435	36.302
450	37.449
465	38.818
480	41.462
495	44.762
510	48.666

S-Curve

3.79
16.81
38.27
16.28
8.69
5.85
3.96
2.55
1.56
0.70
0.46
0.39
0.31
0.21
0.13
0.04

0.003	0.005	0.005	0.006	0.005	0.005	0.005	0.006	0.006	0.006	0.008	0.008	0.008	0.008	0.008	0.009
0.009	0.011	0.011	0.012	0.009	0.011	0.012	0.012	0.014	0.014	0.015	0.015	0.015	0.017	0.018	0.020
0.023	0.023	0.024	0.026	0.032	0.044	0.056	0.068	0.023	0.023	0.055	0.057	0.049	0.051	0.033	0.045
0.117	0.129	0.151	0.163	0.215	0.217	0.109	0.111	0.152	0.144	0.146	0.138	0.129	0.121	0.083	0.084
0.006	0.006	0.005	0.005	0.008	0.008	0.008	0.006	0.006	0.006	0.005	0.003	0.005	0.006	0.005	0.003
0.005	0.005	0.005	0.003	0.005	0.003	0.005	0.003	0.005	0.003	0.003	0.003	0.003	0.003	0.003	0.003

0.294															
1.306	0.442														
2.973	1.959	0.442													
1.265	4.459	1.959	0.589												
0.675	1.897	4.459	2.612	0.442											
0.454	1.013	1.897	5.946	1.959	0.442										
0.308	0.682	1.013	2.529	4.459	1.959	0.442									
0.198	0.461	0.682	1.350	1.897	4.459	1.959	0.589								
0.121	0.297	0.461	0.909	1.013	1.897	4.459	2.612	0.589							
0.054	0.182	0.297	0.615	0.682	1.013	1.897	5.946	2.612	0.589						
0.036	0.082	0.182	0.396	0.461	0.682	1.013	2.529	5.946	2.612	0.736					
0.030	0.054	0.082	0.242	0.297	0.461	0.682	1.350	2.529	5.946	3.265	0.736				
0.024	0.045	0.054	0.109	0.182	0.297	0.461	0.909	1.350	2.529	7.432	3.265	0.736			
0.016	0.036	0.045	0.071	0.082	0.182	0.297	0.615	0.909	1.350	3.162	7.432	3.265	0.736		
0.010	0.024	0.036	0.061	0.054	0.082	0.182	0.396	0.615	0.909	1.688	3.162	7.432	3.265	0.736	
0.003	0.015	0.024	0.048	0.045	0.054	0.082	0.242	0.396	0.615	1.136	1.688	3.162	7.432	3.265	0.883
0.883	0.005	0.015	0.033	0.036	0.045	0.054	0.109	0.242	0.396	0.769	1.136	1.688	3.162	7.432	3.918
3.918	1.030	0.005	0.020	0.024	0.036	0.045	0.071	0.109	0.242	0.495	0.769	1.136	1.688	3.162	8.919
8.919	4.570	1.030	0.006	0.015	0.024	0.036	0.061	0.071	0.109	0.303	0.495	0.769	1.136	1.688	3.794
3.794	10.405	4.570	1.178	0.005	0.015	0.024	0.048	0.061	0.071	0.136	0.303	0.495	0.769	1.136	2.025
2.025	4.426	10.405	5.223	0.883	0.005	0.015	0.033	0.048	0.061	0.089	0.136	0.303	0.495	0.769	1.363
1.363	2.363	4.426	11.892	3.918	1.030	0.005	0.020	0.033	0.048	0.076	0.089	0.136	0.303	0.495	0.923
0.923	1.591	2.363	5.059	8.919	4.570	1.178	0.006	0.020	0.033	0.060	0.076	0.089	0.136	0.303	0.594
0.594	1.077	1.591	2.700	3.794	10.405	5.223	1.178	0.006	0.020	0.041	0.060	0.076	0.089	0.136	0.364
0.364	0.693	1.077	1.818	2.025	4.426	11.892	5.223	1.325	0.006	0.025	0.041	0.060	0.076	0.089	0.163
0.163	0.424	0.693	1.230	1.363	2.363	5.059	11.892	5.876	1.325	0.008	0.025	0.041	0.060	0.076	0.107
0.107	0.190	0.424	0.792	0.923	1.591	2.700	5.059	13.378	5.876	1.472	0.008	0.025	0.041	0.060	0.091
0.091	0.125	0.190	0.485	0.594	1.077	1.818	2.700	5.691	13.378	6.529	1.472	0.008	0.025	0.041	0.072
0.072	0.106	0.125	0.218	0.364	0.693	1.230	1.818	3.038	5.691	14.864	6.529	1.472	0.008	0.025	0.049
0.049	0.084	0.106	0.143	0.163	0.424	0.792	1.230	2.045	3.038	6.323	14.864	6.529	1.619	0.008	0.030
0.030	0.057	0.084	0.121	0.107	0.190	0.485	0.792	1.384	2.045	3.375	6.323	14.864	7.182	1.766	0.009
0.009	0.035	0.057	0.096	0.091	0.125	0.218	0.485	0.891	1.384	2.272	3.375	6.323	16.351	7.835	1.914
2.208	0.011	0.035	0.065	0.072	0.106	0.143	0.218	0.545	0.891	1.538	2.272	3.375	6.956	17.837	8.488
9.794	2.208	0.011	0.040	0.049	0.084	0.121	0.143	0.245	0.545	0.990	1.538	2.272	3.713	7.588	19.324

525	53.073
540	55.909
555	59.835
570	66.586
585	80.607
600	102.707
615	122.752
630	124.121
645	92.551
660	93.915
675	119.985
690	128.249
705	124.666
720	120.061
735	116.022
750	154.105
765	234.592
780	287.7
795	341.0
810	398.6
825	459.6
840	448.7
855	366.8
870	353.2
885	376.0
900	374.9
915	370.8
930	358.3
945	339.727
960	310.799
975	259.869
990	207.048
1005	118.342
1020	77.292
1035	53.653
1050	39.570
1065	32.500
1080	27.358
1095	23.433
1110	20.375
1125	18.535
1140	16.544
1155	13.670
1170	11.776
1185	12.460
1200	13.094
1215	11.683

22.297	9.794	2.355	0.012	0.030	0.057	0.096	0.121	0.161	0.245	0.606	0.990	1.538	2.499	4.050	8.220
9.485	22.297	10.447	2.503	0.009	0.035	0.065	0.096	0.136	0.161	0.272	0.606	0.990	1.692	2.727	4.388
5.063	9.485	23.783	11.100	3.097	0.011	0.040	0.065	0.108	0.136	0.179	0.272	0.606	1.089	1.846	2.954
3.408	5.063	10.117	25.270	13.737	4.300	0.012	0.040	0.073	0.108	0.151	0.179	0.272	0.667	1.189	2.000
2.307	3.408	5.400	10.750	31.275	19.071	5.500	0.012	0.045	0.073	0.120	0.151	0.179	0.299	0.727	1.288
1.486	2.307	3.636	5.738	13.304	43.418	24.396	6.699	0.014	0.045	0.082	0.120	0.151	0.197	0.326	0.788
0.909	1.486	2.461	3.863	7.102	18.470	55.541	29.712	2.208	0.014	0.050	0.082	0.120	0.167	0.214	0.353
0.408	0.909	1.585	2.615	4.781	9.859	23.627	67.643	9.794	2.208	0.016	0.050	0.082	0.132	0.182	0.232
0.268	0.408	0.969	1.684	3.236	6.637	12.612	28.775	22.297	9.794	5.375	0.016	0.050	0.090	0.144	0.197
0.227	0.268	0.435	1.030	2.084	4.493	8.490	15.360	9.485	22.297	23.838	5.583	0.016	0.056	0.098	0.157
0.181	0.227	0.286	0.462	1.275	2.893	5.747	10.340	5.063	9.485	54.271	24.764	4.808	0.017	0.061	0.106
0.122	0.181	0.242	0.304	0.572	1.770	3.701	6.999	3.408	5.063	23.087	56.377	21.326	5.012	0.019	0.066
0.076	0.122	0.193	0.258	0.376	0.794	2.264	4.507	2.307	3.408	12.323	23.983	48.552	22.232	3.252	0.020
0.023	0.076	0.131	0.205	0.319	0.522	1.016	2.757	1.486	2.307	8.296	12.802	20.654	50.613	14.422	4.433
11.500	0.023	0.081	0.139	0.253	0.442	0.668	1.237	0.909	1.486	5.616	8.618	11.025	21.531	32.834	19.661
51.006	12.677	0.025	0.086	0.172	0.352	0.566	0.813	0.408	0.909	3.616	5.834	7.422	11.493	13.967	44.760
116.122	56.225	14.832	0.026	0.106	0.238	0.450	0.689	0.268	0.408	2.212	3.757	5.024	7.737	7.456	19.041
49.398	128.003	65.786	16.004	0.033	0.147	0.305	0.548	0.227	0.268	0.993	2.298	3.235	5.237	5.019	10.164
26.368	54.452	149.771	70.985	21.099	0.045	0.189	0.371	0.181	0.227	0.652	1.031	1.979	3.372	3.397	6.842
17.751	29.066	63.712	161.605	93.584	21.285	0.058	0.230	0.122	0.181	0.553	0.678	0.888	2.063	2.188	4.632
12.016	19.567	34.009	68.746	213.054	94.408	10.674	0.071	0.076	0.122	0.440	0.575	0.584	0.926	1.338	2.982
7.737	13.245	22.894	36.696	90.633	214.931	47.341	10.855	0.023	0.076	0.298	0.457	0.495	0.608	0.601	1.825
4.733	8.529	15.498	24.703	48.378	91.432	107.779	48.145	14.959	0.023	0.184	0.309	0.393	0.516	0.395	0.819
2.124	5.218	9.979	16.722	32.568	48.805	45.849	109.607	66.348	14.154	0.057	0.192	0.266	0.410	0.335	0.538
1.396	2.341	6.105	10.768	22.046	32.855	24.473	46.627	151.050	62.777	14.327	0.059	0.165	0.278	0.266	0.456
1.183	1.539	2.739	6.588	14.196	22.240	16.475	24.889	64.256	142.919	63.547	13.517	0.051	0.172	0.180	0.363
0.941	1.304	1.800	2.956	8.685	14.321	11.152	16.755	34.299	60.798	144.673	59.954	12.704	0.053	0.112	0.246
0.637	1.037	1.526	1.942	3.897	8.761	7.181	11.342	23.090	32.453	61.544	136.492	56.349	11.889	0.034	0.152
0.394	0.702	1.213	1.647	2.561	3.931	4.393	7.303	15.630	21.847	32.851	58.063	128.284	52.732	8.127	0.047
0.121	0.435	0.822	1.309	2.171	2.583	1.971	4.468	10.065	14.789	22.115	30.993	54.572	120.051	36.046	8.288
0.589	0.134	0.509	0.887	1.726	2.190	1.295	2.005	6.157	9.523	14.970	20.864	29.130	51.070	82.062	36.759
2.612	0.589	0.157	0.549	1.169	1.741	1.098	1.317	2.763	5.826	9.640	14.124	19.610	27.260	34.909	83.685
5.946	2.612	0.442	0.169	0.724	1.179	0.873	1.117	1.816	2.614	5.897	9.095	13.274	18.351	18.634	35.600
2.529	5.946	1.959	0.442	0.223	0.730	0.591	0.888	1.539	1.718	2.646	5.564	8.548	12.422	12.544	19.002
1.350	2.529	4.459	1.959	0.736	0.225	0.366	0.601	1.224	1.456	1.739	2.497	5.229	7.999	8.491	12.792
0.909	1.350	1.897	4.459	3.265	0.736	0.113	0.372	0.829	1.158	1.474	1.641	2.346	4.894	5.468	8.659
0.615	0.909	1.013	1.897	7.432	3.265	0.736	0.115	0.513	0.784	1.172	1.391	1.542	2.196	3.345	5.576
0.396	0.615	0.682	1.013	3.162	7.432	3.265	0.589	0.158	0.485	0.794	1.106	1.307	1.443	1.501	3.411
0.242	0.396	0.461	0.682	1.688	3.162	7.432	2.612	0.589	0.149	0.491	0.749	1.039	1.223	0.986	1.531
0.109	0.242	0.297	0.461	1.136	1.688	3.162	5.946	2.612	0.589	0.151	0.464	0.704	0.972	0.836	1.006
0.071	0.109	0.182	0.297	0.769	1.136	1.688	2.529	5.946	2.612	0.442	0.143	0.436	0.659	0.665	0.853
0.061	0.071	0.082	0.182	0.495	0.769	1.136	1.350	2.529	5.946	1.959	0.294	0.134	0.408	0.450	0.678
0.048	0.061	0.054	0.082	0.303	0.495	0.769	0.909	1.350	2.529	4.459	1.306	0.442	0.125	0.279	0.459
0.033	0.048	0.045	0.054	0.136	0.303	0.495	0.615	0.909	1.350	1.897	2.973	1.959	0.589	0.086	0.284
0.020	0.033	0.036	0.045	0.089	0.136	0.303	0.396	0.615	0.909	1.013	1.265	4.459	2.612	0.442	0.087
0.006	0.020	0.024	0.036	0.076	0.089	0.136	0.242	0.396	0.615	0.682	0.675	1.897	5.946	1.959	0.294
0.442	0.006	0.015	0.024	0.060	0.076	0.089	0.109	0.242	0.396	0.461	0.454	1.013	2.529	4.459	1.306

Quail-Run - 10yr-24hr Convolution

Area
(acres)
2568

Effective Rain	

0.004	0.006	0.006	0.009	0.006	0.006	0.006	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.011	0.013
0.013	0.015	0.015	0.017	0.013	0.015	0.017	0.017	0.019	0.019	0.022	0.022	0.022	0.024	0.026	0.028
0.048	0.051	0.067	0.084	0.115	0.132	0.148	0.165	0.066	0.069	0.143	0.145	0.133	0.135	0.108	0.124
0.227	0.244	0.274	0.291	0.365	0.366	0.210	0.212	0.271	0.259	0.260	0.248	0.235	0.222	0.166	0.168
0.009	0.009	0.006	0.006	0.011	0.011	0.011	0.009	0.009	0.009	0.006	0.004	0.006	0.009	0.006	0.004
0.006	0.006	0.006	0.004	0.006	0.004	0.006	0.004	0.006	0.004	0.004	0.004	0.004	0.004	0.004	0.004

Time	Total
(min)	Hydrograph
0	0
15	0.424
30	2.516
45	7.738
60	11.911
75	14.522
90	16.863
105	16.403
120	16.697
135	17.796
150	19.996
165	21.130
180	22.570
195	25.046
210	26.206
225	26.857
240	27.491
255	28.688
270	31.204
285	33.159
300	36.052
315	37.844
330	39.052
345	37.323
360	39.389
375	42.197
390	44.216
405	47.142
420	49.387
435	52.275
450	53.927
465	55.897
480	59.706
495	66.020
510	78.808

S-Curve

3.79
16.81
38.27
16.28
8.69
5.85
3.96
2.55
1.56
0.70
0.46
0.39
0.31
0.21
0.13
0.04

0.424															
1.880	0.636														
4.281	2.821	0.636													
1.821	6.421	2.821	0.848												
0.972	2.732	6.421	3.761	0.636											
0.654	1.458	2.732	8.562	2.821	0.636										
0.443	0.982	1.458	3.642	6.421	2.821	0.636									
0.285	0.664	0.982	1.944	2.732	6.421	2.821	0.848								
0.175	0.428	0.664	1.309	1.458	2.732	6.421	3.761	0.848							
0.078	0.262	0.428	0.886	0.982	1.458	2.732	8.562	3.761	0.848						
0.051	0.117	0.262	0.570	0.664	0.982	1.458	3.642	8.562	3.761	1.060					
0.044	0.077	0.117	0.349	0.428	0.664	0.982	1.944	3.642	8.562	4.701	1.060				
0.035	0.065	0.077	0.157	0.262	0.428	0.664	1.309	1.944	3.642	10.702	4.701	1.060			
0.023	0.052	0.065	0.103	0.117	0.262	0.428	0.886	1.309	1.944	4.553	10.702	4.701	1.060		
0.015	0.035	0.052	0.087	0.077	0.117	0.262	0.570	0.886	1.309	2.430	4.553	10.702	4.701	1.060	
0.004	0.022	0.035	0.069	0.065	0.077	0.117	0.349	0.570	0.886	1.636	2.430	4.553	10.702	4.701	1.272
1.272	0.007	0.022	0.047	0.052	0.065	0.077	0.157	0.349	0.570	1.107	1.636	2.430	4.553	10.702	5.641
5.641	1.484	0.007	0.029	0.035	0.052	0.065	0.103	0.157	0.349	0.713	1.107	1.636	2.430	4.553	12.843
12.843	6.581	1.484	0.009	0.022	0.035	0.052	0.087	0.103	0.157	0.436	0.713	1.107	1.636	2.430	5.463
5.463	14.983	6.581	1.696	0.007	0.022	0.035	0.069	0.087	0.103	0.196	0.436	0.713	1.107	1.636	2.916
2.916	6.374	14.983	7.522	1.272	0.007	0.022	0.047	0.069	0.087	0.129	0.196	0.436	0.713	1.107	1.963
1.963	3.402	6.374	17.124	5.641	1.484	0.007	0.029	0.047	0.069	0.109	0.129	0.196	0.436	0.713	1.329
1.329	2.290	3.402	7.284	12.843	6.581	1.696	0.009	0.029	0.047	0.087	0.109	0.129	0.196	0.436	0.856
0.856	1.550	2.290	3.888	5.463	14.983	7.522	1.696	0.009	0.029	0.059	0.087	0.109	0.129	0.196	0.524
0.524	0.998	1.550	2.618	2.916	6.374	17.124	7.522	1.908	0.009	0.036	0.059	0.087	0.109	0.129	0.235
0.235	0.611	0.998	1.772	1.963	3.402	7.284	17.124	8.462	1.908	0.011	0.036	0.059	0.087	0.109	0.154
0.154	0.274	0.611	1.141	1.329	2.290	3.888	7.284	19.264	8.462	2.120	0.011	0.036	0.059	0.087	0.131
0.131	0.180	0.274	0.698	0.856	1.550	2.618	3.888	8.195	19.264	9.402	2.120	0.011	0.036	0.059	0.104
0.104	0.153	0.180	0.313	0.524	0.998	1.772	2.618	4.374	8.195	21.405	9.402	2.120	0.011	0.036	0.070
0.070	0.121	0.153	0.206	0.235	0.611	1.141	1.772	2.945	4.374	9.106	21.405	9.402	2.332	0.011	0.044
0.044	0.082	0.121	0.175	0.154	0.274	0.698	1.141	1.993	2.945	4.860	9.106	21.405	10.342	2.544	0.013
0.013	0.051	0.082	0.139	0.131	0.180	0.313	0.698	1.284	1.993	3.272	4.860	9.106	23.545	11.282	2.756
4.743	0.016	0.051	0.094	0.104	0.153	0.206	0.313	0.785	1.284	2.215	3.272	4.860	10.016	25.686	12.223
21.039	4.973	0.016	0.058	0.070	0.121	0.175	0.206	0.352	0.785	1.426	2.215	3.272	5.346	10.927	27.826

525	103.391
540	124.271
555	157.440
570	200.274
585	253.475
600	299.981
615	333.341
630	325.904
645	254.973
660	259.300
675	318.507
690	336.816
705	333.536
720	327.547
735	321.552
750	375.687
765	490.203
780	564.6
795	639.2
810	720.1
825	805.9
840	788.2
855	668.1
870	646.4
885	677.2
900	673.5
915	665.5
930	645.6
945	616.867
960	573.259
975	493.510
990	395.718
1005	221.170
1020	142.002
1035	97.203
1050	69.691
1065	54.627
1080	44.083
1095	36.512
1110	31.236
1125	28.013
1140	24.665
1155	20.145
1170	17.162
1185	17.991
1200	18.856
1215	16.823

47.898	22.056	6.613	0.018	0.044	0.082	0.139	0.175	0.232	0.352	0.873	1.426	2.215	3.599	5.832	11.837
20.376	50.214	29.333	8.252	0.013	0.051	0.094	0.139	0.196	0.232	0.392	0.873	1.426	2.436	3.926	6.319
10.876	21.361	66.780	36.600	11.302	0.016	0.058	0.094	0.156	0.196	0.257	0.392	0.873	1.569	2.658	4.254
7.322	11.402	28.408	83.325	50.127	12.936	0.018	0.058	0.106	0.156	0.218	0.257	0.392	0.960	1.711	2.879
4.956	7.676	15.164	35.446	114.119	57.376	14.568	0.018	0.065	0.106	0.173	0.218	0.257	0.431	1.047	1.854
3.192	5.196	10.208	18.921	48.546	130.623	64.616	16.199	0.020	0.065	0.117	0.173	0.218	0.283	0.470	1.134
1.952	3.346	6.910	12.737	25.913	55.567	147.106	71.847	6.521	0.020	0.073	0.117	0.173	0.240	0.309	0.509
0.876	2.047	4.450	8.622	17.444	29.661	62.579	163.568	28.924	6.734	0.022	0.073	0.117	0.191	0.262	0.334
0.576	0.918	2.722	5.552	11.809	19.967	33.403	69.581	65.849	29.868	14.011	0.022	0.073	0.129	0.208	0.284
0.488	0.604	1.221	3.397	7.604	13.516	22.487	37.141	28.012	67.999	62.143	14.219	0.022	0.080	0.141	0.225
0.388	0.512	0.803	1.524	4.652	8.704	15.222	25.003	14.952	28.927	141.476	63.068	13.013	0.025	0.087	0.153
0.263	0.407	0.681	1.002	2.087	5.325	9.802	16.925	10.066	15.441	60.184	143.582	57.715	13.217	0.027	0.095
0.163	0.276	0.541	0.849	1.372	2.389	5.996	10.899	6.814	10.394	32.125	61.080	131.396	58.621	10.592	0.029
0.050	0.171	0.366	0.675	1.163	1.570	2.691	6.668	4.388	7.036	21.626	32.603	55.896	133.458	46.981	12.205
22.295	0.052	0.227	0.457	0.924	1.331	1.768	2.992	2.684	4.531	14.639	21.948	29.836	56.773	106.958	54.135
98.887	23.904	0.070	0.283	0.626	1.058	1.499	1.966	1.204	2.772	9.427	14.857	20.085	30.304	45.500	123.245
225.128	106.021	26.923	0.087	0.388	0.717	1.192	1.667	0.792	1.244	5.767	9.567	13.596	20.401	24.287	52.428
95.769	241.369	119.413	28.527	0.119	0.444	0.807	1.325	0.671	0.817	2.588	5.853	8.755	13.810	16.350	27.985
51.120	102.678	271.857	126.526	35.781	0.137	0.500	0.898	0.533	0.693	1.701	2.626	5.356	8.893	11.067	18.839
34.413	54.808	115.648	288.052	158.701	35.967	0.154	0.556	0.361	0.551	1.442	1.726	2.403	5.440	7.127	12.753
23.295	36.896	61.731	122.537	361.302	159.526	20.605	0.171	0.224	0.373	1.146	1.463	1.579	2.441	4.360	8.212
15.001	24.976	41.556	65.408	153.697	363.180	91.392	20.786	0.069	0.231	0.776	1.163	1.339	1.604	1.956	5.024
9.177	16.083	28.131	44.032	82.041	154.496	208.064	92.195	26.618	0.071	0.481	0.788	1.064	1.360	1.286	2.254
4.118	9.839	18.114	29.806	55.229	82.467	88.510	209.893	118.059	25.381	0.148	0.488	0.721	1.081	1.090	1.481
2.706	4.415	11.082	19.193	37.386	55.516	47.245	89.288	268.776	112.573	25.554	0.150	0.446	0.732	0.866	1.256
2.294	2.901	4.973	11.742	24.074	37.580	31.805	47.661	114.337	256.285	113.343	24.312	0.137	0.453	0.587	0.998
1.824	2.460	3.268	5.269	14.728	24.199	21.529	32.084	61.031	109.023	258.039	107.834	23.068	0.139	0.363	0.676
1.235	1.955	2.770	3.462	6.609	14.804	13.864	21.719	41.085	58.195	109.769	245.498	102.314	21.821	0.112	0.419
0.765	1.324	2.202	2.935	4.343	6.643	8.481	13.986	27.812	39.176	58.593	104.434	232.930	96.782	16.331	0.129
0.235	0.820	1.492	2.333	3.682	4.365	3.806	8.556	17.909	26.519	39.444	55.745	99.088	220.337	72.435	16.492
0.848	0.252	0.923	1.581	2.927	3.701	2.501	3.839	10.956	17.077	26.701	37.527	52.892	93.731	164.907	73.148
3.761	0.848	0.284	0.978	1.983	2.942	2.120	2.523	4.916	10.447	17.194	25.403	35.606	50.032	70.151	166.530
8.562	3.761	0.636	0.301	1.227	1.993	1.685	2.139	3.231	4.688	10.518	16.358	24.103	33.681	37.446	70.841
3.642	8.562	2.821	0.636	0.378	1.234	1.142	1.700	2.739	3.081	4.720	10.007	15.521	22.799	25.208	37.814
1.944	3.642	6.421	2.821	1.060	0.380	0.707	1.152	2.177	2.612	3.102	4.490	9.495	14.681	17.064	25.456
1.309	1.944	2.732	6.421	4.701	1.060	0.217	0.713	1.475	2.076	2.630	2.951	4.261	8.982	10.988	17.232
0.886	1.309	1.458	2.732	10.702	4.701	1.060	0.219	0.913	1.406	2.090	2.502	2.800	4.030	6.722	11.096
0.570	0.886	0.982	1.458	4.553	10.702	4.701	0.848	0.281	0.871	1.416	1.989	2.374	2.648	3.016	6.788
0.349	0.570	0.664	0.982	2.430	4.553	10.702	3.761	0.848	0.268	0.877	1.347	1.887	2.245	1.982	3.046
0.157	0.349	0.428	0.664	1.636	2.430	4.553	8.562	3.761	0.848	0.270	0.834	1.278	1.785	1.681	2.002
0.103	0.157	0.262	0.428	1.107	1.636	2.430	3.642	8.562	3.761	0.636	0.257	0.791	1.209	1.336	1.697
0.087	0.103	0.117	0.262	0.713	1.107	1.636	1.944	3.642	8.562	2.821	0.424	0.243	0.748	0.905	1.349
0.069	0.087	0.077	0.117	0.436	0.713	1.107	1.309	1.944	3.642	6.421	1.880	0.636	0.230	0.560	0.914
0.047	0.069	0.065	0.077	0.196	0.436	0.713	0.886	1.309	1.944	2.732	4.281	2.821	0.848	0.172	0.566
0.029	0.047	0.052	0.065	0.129	0.196	0.436	0.570	0.886	1.309	1.458	1.821	6.421	3.761	0.636	0.174
0.009	0.029	0.035	0.052	0.109	0.129	0.196	0.349	0.570	0.886	0.982	0.972	2.732	8.562	2.821	0.424
0.636	0.009	0.022	0.035	0.087	0.109	0.129	0.157	0.349	0.570	0.664	0.654	1.458	3.642	6.421	1.880

1230	15.157
1245	16.213
1260	16.323
1275	15.685
1290	14.308
1305	14.825
1320	13.871
1335	14.575
1350	13.704
1365	14.234
1380	12.682
1395	12.058
1410	11.748
1425	11.557
1440	11.411
1455	10.902
1470	8.957
1485	4.651
1500	2.816
1515	1.832
1530	1.167
1545	0.718
1560	0.427
1575	0.251
1590	0.172
1605	0.121
1620	0.077
1635	0.043
1650	0.019
1665	0.004

[illegible]

Quail-Run - 100yr-6hr Convolution

Area (acres)		Effective Rain	
2568			

Time (min)	Total Hydrograph	S-Curve
0	0.000	2.13
10	5.879	7.44
20	27.276	15.28
30	73.320	30.15
40	166.581	13.92
50	226.361	8.11
60	273.581	5.66
70	314.148	4.38
80	346.601	3.42
90	381.725	2.62
100	412.196	2.00
110	430.824	1.42
120	444.414	1.06
130	456.841	0.61
140	470.518	0.33
150	490.301	0.31
160	505.626	0.29
170	525.489	0.24
180	541.449	0.20
190	561.265	0.17
200	594.301	0.12
210	620.969	0.08
220	660.320	0.06
230	714.110	
240	790.852	
250	874.545	
260	957.278	
270	1047.907	
280	1154.589	
290	1273.834	
300	1390.308	
310	1518.311	
320	1684.724	
330	1933.252	
340	2268.993	
350	2461.602	
360	2368.440	

0.107	0.122	0.138	0.153	0.153	0.169	0.185	0.185	0.185	0.185	0.185	0.200	0.200	0.216	0.216	0.216	0.247	0.247	0.263	0.278	0.325	0.372	0.403
0.434	0.481	0.543	0.590	0.637	0.684	0.731	0.980	1.199	1.542	0.372	0.107	0.013										

5.879																						
20.537	6.740																					
42.177	23.542	7.600																				
83.223	48.350	26.547	8.461																			
38.423	95.402	54.522	29.553	8.461																		
22.386	44.046	107.581	60.694	29.553	9.321																	
15.623	25.662	49.669	119.760	60.694	32.558	10.181																
12.090	17.910	28.938	55.292	119.760	66.867	35.563	10.181															
9.440	13.859	20.196	32.214	55.292	131.939	73.039	35.563	10.181														
7.232	10.822	15.629	22.482	32.214	60.915	144.118	73.039	35.563	10.181													
5.521	8.290	12.203	17.398	22.482	35.490	66.538	144.118	73.039	35.563	10.181												
3.920	6.328	9.349	13.585	17.398	24.769	38.766	66.538	144.118	73.039	35.563	11.042											
2.926	4.493	7.136	10.407	13.585	19.167	27.055	38.766	66.538	144.118	73.039	38.569	11.042										
1.684	3.354	5.067	7.944	10.407	14.966	20.937	27.055	38.766	66.538	144.118	79.211	38.569	11.902									
0.911	1.930	3.782	5.640	7.944	11.465	16.348	20.937	27.055	38.766	66.538	156.297	79.211	41.574	11.902								
0.856	1.044	2.177	4.210	5.640	8.752	12.524	16.348	20.937	27.055	38.766	72.161	156.297	85.383	41.574	11.902							
0.800	0.981	1.178	2.423	4.210	6.214	9.560	12.524	16.348	20.937	27.055	42.042	72.161	168.476	85.383	41.574	13.623						
0.662	0.918	1.106	1.311	2.423	4.639	6.788	9.560	12.524	16.348	20.937	29.341	42.042	77.784	168.476	85.383	47.585	13.623					
0.552	0.759	1.035	1.231	1.311	2.669	5.067	6.788	9.560	12.524	16.348	22.706	29.341	45.318	77.784	168.476	97.728	47.585	14.483				
0.469	0.633	0.856	1.152	1.231	1.444	2.916	5.067	6.788	9.560	12.524	17.729	22.706	31.628	45.318	77.784	192.834	97.728	50.590	15.344			
0.331	0.538	0.714	0.953	1.152	1.357	1.577	2.916	5.067	6.788	9.560	13.582	17.729	24.475	31.628	45.318	89.030	192.834	103.900	53.596	17.925		
0.221	0.380	0.607	0.794	0.953	1.269	1.482	1.577	2.916	5.067	6.788	10.368	13.582	19.111	24.475	31.628	51.870	89.030	205.013	110.073	62.612	20.506	
0.166	0.253	0.428	0.675	0.794	1.050	1.386	1.482	1.577	2.916	5.067	7.361	10.368	14.640	19.111	24.475	36.200	51.870	94.653	217.192	128.590	71.628	22.227
23.948	0.190	0.285	0.477	0.675	0.875	1.147	1.386	1.482	1.577	2.916	5.495	7.361	11.176	14.640	19.111	28.014	36.200	55.146	100.276	253.729	147.107	77.638
83.649	26.529	0.214	0.318	0.477	0.744	0.956	1.147	1.386	1.482	1.577	3.162	5.495	7.935	11.176	14.640	21.874	28.014	38.487	58.422	117.144	290.266	159.451
171.796	92.665	29.971	0.238	0.318	0.525	0.813	0.956	1.147	1.386	1.482	1.711	3.162	5.923	7.935	11.176	16.757	21.874	29.783	40.773	68.250	134.013	314.624
338.982	190.313	104.687	32.552	0.238	0.350	0.574	0.813	0.956	1.147	1.386	1.607	1.711	3.409	5.923	7.935	12.792	16.757	23.255	31.552	47.632	78.078	145.259
156.505	375.519	215.002	113.703	35.133	0.263	0.382	0.574	0.813	0.956	1.147	1.503	1.607	1.844	3.409	5.923	9.082	12.792	17.815	24.637	36.860	54.491	84.630
91.182	173.374	424.235	233.519	122.719	37.714	0.287	0.382	0.574	0.813	0.956	1.244	1.503	1.732	1.844	3.409	6.780	9.082	13.600	18.874	28.781	42.168	59.064
63.636	101.010	195.866	460.772	252.036	131.735	40.296	0.287	0.382	0.574	0.813	1.037	1.244	1.620	1.732	1.844	3.901	6.780	9.656	14.407	22.049	32.926	45.707
49.245	70.495	114.114	212.734	497.309	270.553	140.751	54.062	0.287	0.382	0.574	0.881	1.037	1.341	1.620	1.732	2.111	3.901	7.208	10.229	16.831	25.224	35.689
38.452	54.553	79.641	123.942	229.603	533.845	289.069	188.837	66.108	0.287	0.382	0.622	0.881	1.118	1.341	1.620	1.983	2.111	4.148	7.636	11.950	19.255	27.340
29.457	42.596	61.630	86.500	133.770	246.472	570.382	387.826	230.912	85.037	0.287	0.415	0.622	0.950	1.118	1.341	1.855	1.983	2.244	4.394	8.920	13.671	20.871
22.486	32.632	48.122	66.938	93.359	143.598	263.341	765.246	474.238	297.030	20.506	0.311	0.415	0.671	0.950	1.118	1.535	1.855	2.108	2.377	5.133	10.205	14.818
15.965	24.910	36.865	52.267	72.246	100.218	153.426	353.308	935.752	610.029	71.628	5.879	0.311	0.447	0.671	0.950	1.279	1.535	1.972	2.233	2.777	5.873	11.061
11.918	17.686	28.142	40.041	56.411	77.554	107.077	205.842	432.029	1203.690	147.107	20.537	0.717	0.335	0.447	0.671	1.087	1.279	1.632	2.089	2.609	3.177	6.366

Quail-Run - 100yr-24hr Convolution

Area
(acres)
2568

Effective Rain	

0.006	0.009	0.009	0.012	0.009	0.009	0.009	0.012	0.012	0.012	0.015	0.015	0.015	0.015	0.015	0.024
0.026	0.047	0.048	0.069	0.030	0.052	0.073	0.074	0.095	0.096	0.117	0.118	0.119	0.141	0.162	0.183
0.224	0.225	0.246	0.267	0.308	0.329	0.350	0.371	0.232	0.233	0.334	0.335	0.316	0.317	0.278	0.299
0.440	0.461	0.501	0.522	0.623	0.624	0.405	0.406	0.487	0.467	0.468	0.449	0.430	0.411	0.331	0.332
0.033	0.033	0.014	0.015	0.056	0.056	0.057	0.038	0.038	0.039	0.019	0.006	0.020	0.041	0.022	0.006
0.023	0.023	0.024	0.006	0.024	0.006	0.025	0.006	0.026	0.006	0.007	0.007	0.007	0.007	0.007	0.007

Time	Total
(min)	Hydrograph
0	0
15	0.589
30	3.495
45	10.747
60	16.543
75	20.169
90	23.420
105	22.782
120	23.190
135	24.716
150	27.772
165	29.347
180	31.348
195	34.787
210	36.397
225	37.301
240	38.806
255	43.358
270	55.473
285	70.111
300	96.415
315	113.693
330	126.325
345	112.327
360	133.860
375	162.555
390	184.058
405	213.991
420	237.623
435	267.236
450	285.398
465	306.519
480	344.646
495	391.477
510	446.352

S-Curve

3.79
16.81
38.27
16.28
8.69
5.85
3.96
2.55
1.56
0.70
0.46
0.39
0.31
0.21
0.13
0.04

0.589															
2.612	0.883														
5.946	3.918	0.883													
2.529	8.919	3.918	1.178												
1.350	3.794	8.919	5.223	0.883											
0.909	2.025	3.794	11.892	3.918	0.883										
0.615	1.363	2.025	5.059	8.919	3.918	0.883									
0.396	0.923	1.363	2.700	3.794	8.919	3.918	1.178								
0.242	0.594	0.923	1.818	2.025	3.794	8.919	5.223	1.178							
0.109	0.364	0.594	1.230	1.363	2.025	3.794	11.892	5.223	1.178						
0.071	0.163	0.364	0.792	0.923	1.363	2.025	5.059	11.892	5.223	1.472					
0.061	0.107	0.163	0.485	0.594	0.923	1.363	2.700	5.059	11.892	6.529	1.472				
0.048	0.091	0.107	0.218	0.364	0.594	0.923	1.818	2.700	5.059	14.864	6.529	1.472			
0.033	0.072	0.091	0.143	0.163	0.364	0.594	1.230	1.818	2.700	6.323	14.864	6.529	1.472		
0.020	0.049	0.072	0.121	0.107	0.163	0.364	0.792	1.230	1.818	3.375	6.323	14.864	6.529	1.472	
0.006	0.030	0.049	0.096	0.091	0.107	0.163	0.485	0.792	1.230	2.272	3.375	6.323	14.864	6.529	2.391
2.510	0.009	0.030	0.065	0.072	0.091	0.107	0.218	0.485	0.792	1.538	2.272	3.375	6.323	14.864	10.605
11.132	4.591	0.009	0.040	0.049	0.072	0.091	0.143	0.218	0.485	0.990	1.538	2.272	3.375	6.323	24.143
25.344	20.362	4.708	0.012	0.030	0.049	0.072	0.121	0.143	0.218	0.606	0.990	1.538	2.272	3.375	10.271
10.781	46.355	20.882	6.787	0.009	0.030	0.049	0.096	0.121	0.143	0.272	0.606	0.990	1.538	2.272	5.482
5.755	19.720	47.539	30.104	2.977	0.009	0.030	0.065	0.096	0.121	0.179	0.272	0.606	0.990	1.538	3.691
3.874	10.526	20.223	68.534	13.205	5.055	0.009	0.040	0.065	0.096	0.151	0.179	0.272	0.606	0.990	2.498
2.622	7.086	10.795	29.154	30.063	22.420	7.131	0.012	0.040	0.065	0.120	0.151	0.179	0.272	0.606	1.609
1.689	4.797	7.267	15.562	12.789	51.041	31.630	7.244	0.012	0.040	0.082	0.120	0.151	0.179	0.272	0.984
1.033	3.089	4.919	10.476	6.826	21.713	72.010	32.132	9.319	0.012	0.050	0.082	0.120	0.151	0.179	0.442
0.464	1.890	3.168	7.092	4.595	11.590	30.633	73.152	41.335	9.431	0.016	0.050	0.082	0.120	0.151	0.290
0.305	0.848	1.938	4.567	3.111	7.802	16.351	31.119	94.104	41.829	11.504	0.016	0.050	0.082	0.120	0.246
0.258	0.557	0.870	2.794	2.003	5.281	11.008	16.611	40.032	95.228	51.024	11.614	0.016	0.050	0.082	0.196
0.205	0.472	0.571	1.254	1.225	3.401	7.451	11.182	21.368	40.510	116.163	51.511	11.722	0.016	0.050	0.132
0.139	0.375	0.484	0.824	0.550	2.081	4.798	7.569	14.385	21.624	49.416	117.270	51.993	13.793	0.016	0.082
0.086	0.254	0.385	0.698	0.361	0.934	2.935	4.874	9.737	14.557	26.377	49.886	118.368	61.177	15.863	0.025
0.026	0.157	0.261	0.555	0.306	0.614	1.317	2.982	6.270	9.854	17.757	26.629	50.354	139.276	70.357	17.932
21.962	0.048	0.161	0.376	0.244	0.520	0.866	1.338	3.836	6.345	12.020	17.926	26.878	59.248	160.175	79.533
97.410	22.066	0.050	0.233	0.165	0.413	0.734	0.879	1.721	3.882	7.740	12.135	18.094	31.626	68.138	181.066

525	507.910
540	548.492
555	599.577
570	660.494
585	733.251
600	794.984
615	837.416
630	822.630
645	719.446
660	720.664
675	797.978
690	818.394
705	808.777
720	795.396
735	782.045
750	852.264
765	1006.399
780	1104.9
795	1203.7
810	1311.3
825	1425.7
840	1396.5
855	1225.2
870	1190.6
885	1228.8
900	1219.3
915	1203.9
930	1172.0
945	1127.847
960	1063.135
975	940.798
990	767.936
1005	445.385
1020	295.282
1035	202.744
1050	161.458
1065	163.750
1080	155.530
1095	141.930
1110	121.951
1125	112.086
1140	97.851
1155	70.560
1170	54.648
1185	64.299
1200	74.172
1215	57.639

221.766	97.873	24.133	0.072	0.102	0.280	0.583	0.745	1.131	1.742	4.735	7.814	12.248	21.290	36.371	77.025
94.339	222.819	107.037	26.198	0.031	0.173	0.395	0.593	0.959	1.145	2.125	4.780	7.887	14.412	24.485	41.115
50.357	94.787	243.682	116.196	30.225	0.053	0.245	0.401	0.762	0.970	1.396	2.145	4.825	9.280	16.574	27.678
33.899	50.596	103.662	264.535	134.058	32.288	0.075	0.248	0.516	0.771	1.184	1.410	2.165	5.677	10.673	18.736
22.947	34.060	55.333	112.533	305.199	143.209	34.351	0.076	0.320	0.523	0.941	1.195	1.423	2.548	6.529	12.065
14.777	23.056	37.249	60.068	129.831	326.033	152.357	36.412	0.098	0.323	0.637	0.950	1.206	1.674	2.930	7.381
9.040	14.847	25.215	40.437	69.302	138.694	346.859	161.500	22.770	0.100	0.395	0.643	0.959	1.419	1.925	3.312
4.056	9.083	16.237	27.373	46.653	74.033	147.553	367.674	100.994	22.867	0.121	0.398	0.650	1.128	1.632	2.176
2.666	4.076	9.933	17.626	31.581	49.838	78.761	156.408	229.926	101.424	32.777	0.123	0.402	0.764	1.297	1.845
2.260	2.678	4.457	10.783	20.336	33.736	53.021	83.488	97.810	230.903	145.376	32.871	0.124	0.473	0.879	1.467
1.796	2.271	2.929	4.839	12.441	21.724	35.891	56.203	52.209	98.226	330.966	145.797	31.003	0.146	0.544	0.994
1.217	1.805	2.483	3.180	5.582	13.290	23.112	38.045	35.147	52.431	140.793	331.924	137.507	31.095	0.167	0.615
0.753	1.223	1.974	2.696	3.668	5.964	14.139	24.499	23.792	35.296	75.153	141.200	313.052	137.919	27.262	0.189
0.232	0.757	1.337	2.143	3.110	3.919	6.344	14.988	15.320	23.893	50.592	75.370	133.172	313.989	120.915	29.315
43.144	0.233	0.828	1.452	2.472	3.323	4.169	6.725	9.372	15.385	34.247	50.738	71.085	133.570	275.278	130.023
191.360	45.196	0.255	0.899	1.675	2.641	3.535	4.419	4.206	9.412	22.053	34.346	47.853	71.298	117.103	296.014
435.655	200.460	49.209	0.276	1.037	1.789	2.810	3.747	2.764	4.223	13.491	22.117	32.393	47.997	62.507	125.924
185.327	456.370	218.260	51.258	0.319	1.108	1.903	2.978	2.343	2.775	6.054	13.530	20.859	32.490	42.079	67.216
98.925	194.139	496.894	227.349	61.158	0.341	1.178	2.018	1.862	2.353	3.978	6.071	12.761	20.922	28.484	45.249
66.595	103.628	211.378	517.589	271.257	61.242	0.363	1.249	1.262	1.870	3.373	3.990	5.726	12.799	18.342	30.630
45.080	69.761	112.830	220.181	617.549	271.632	39.735	0.384	0.781	1.267	2.681	3.383	3.763	5.743	11.221	19.724
29.028	47.223	75.956	117.529	262.704	618.402	176.240	39.818	0.240	0.784	1.816	2.689	3.190	3.774	5.035	12.066
17.759	30.409	51.416	79.119	140.227	263.067	401.233	176.606	47.750	0.241	1.124	1.821	2.536	3.200	3.309	5.414
7.969	18.603	33.109	53.558	94.399	140.421	170.684	402.064	211.788	45.867	0.346	1.128	1.718	2.543	2.805	3.558
5.237	8.348	20.255	34.488	63.901	94.530	91.108	171.037	482.161	203.438	45.946	0.347	1.063	1.723	2.230	3.017
4.440	5.486	9.089	21.098	41.148	63.989	61.333	91.297	205.111	463.150	203.788	44.061	0.327	1.067	1.511	2.398
3.529	4.651	5.973	9.467	25.173	41.205	41.518	61.460	109.485	197.023	463.948	195.427	42.175	0.328	0.935	1.624
2.391	3.697	5.064	6.221	11.296	25.208	26.735	41.604	73.704	105.168	197.363	444.914	187.062	40.288	0.288	1.006
1.480	2.504	4.025	5.275	7.423	11.311	16.355	26.790	49.892	70.798	105.349	189.266	425.868	178.691	32.511	0.309
0.455	1.550	2.727	4.193	6.293	7.433	7.339	16.389	32.127	47.925	70.920	101.027	181.164	406.811	144.198	32.584
3.214	0.477	1.688	2.840	5.002	6.302	4.823	7.354	19.654	30.861	48.007	68.010	96.702	173.057	328.284	144.522
14.257	3.285	0.519	1.758	3.389	5.009	4.089	4.833	8.819	18.879	30.914	46.038	65.099	92.375	139.651	329.022
32.458	14.570	1.392	0.541	2.098	3.393	3.250	4.097	5.796	8.472	18.912	29.645	44.067	62.186	74.544	139.965
13.808	33.171	6.172	1.460	0.645	2.101	2.202	3.257	4.914	5.567	8.486	18.136	28.376	42.095	50.182	74.711
7.370	14.111	14.051	6.474	5.452	0.646	1.363	2.206	3.906	4.720	5.577	8.138	17.360	27.107	33.969	50.295
4.962	7.532	5.977	14.738	24.181	5.517	0.419	1.366	2.646	3.752	4.728	5.348	7.790	16.583	21.874	34.046
3.359	5.071	3.191	6.270	55.051	24.471	5.581	0.420	1.638	2.541	3.758	4.534	5.119	7.441	13.382	21.923
2.163	3.432	2.148	3.347	23.419	55.711	24.755	3.681	0.504	1.573	2.546	3.604	4.340	4.890	6.005	13.412
1.323	2.210	1.454	2.253	12.500	23.700	56.358	16.328	3.743	0.484	1.576	2.441	3.450	4.146	3.946	6.018
0.594	1.352	0.936	1.525	8.415	12.650	23.975	37.172	16.600	3.803	0.485	1.511	2.337	3.295	3.345	3.955
0.390	0.607	0.573	0.982	5.696	8.516	12.797	15.813	37.792	16.866	1.898	0.465	1.447	2.232	2.659	3.353
0.331	0.399	0.257	0.601	3.668	5.765	8.615	8.441	16.076	38.396	8.419	0.589	0.445	1.382	1.801	2.665
0.263	0.338	0.169	0.270	2.244	3.712	5.832	5.682	8.581	16.334	19.167	2.612	2.011	0.425	1.115	1.805
0.178	0.269	0.143	0.177	1.007	2.271	3.755	3.846	5.777	8.719	8.154	5.946	8.918	4.027	0.343	1.118
0.110	0.182	0.114	0.150	0.662	1.019	2.297	2.477	3.910	5.869	4.352	2.529	20.303	17.863	2.117	0.344
0.034	0.113	0.077	0.119	0.561	0.670	1.031	1.515	2.518	3.973	2.930	1.350	8.637	40.666	9.389	0.589
2.217	0.035	0.048	0.081	0.446	0.568	0.677	0.680	1.540	2.558	1.983	0.909	4.610	17.299	21.376	2.612

APPENDIX 3

Stage-Storage-Discharge Analysis

Tory R. Walker Engineering, Inc.



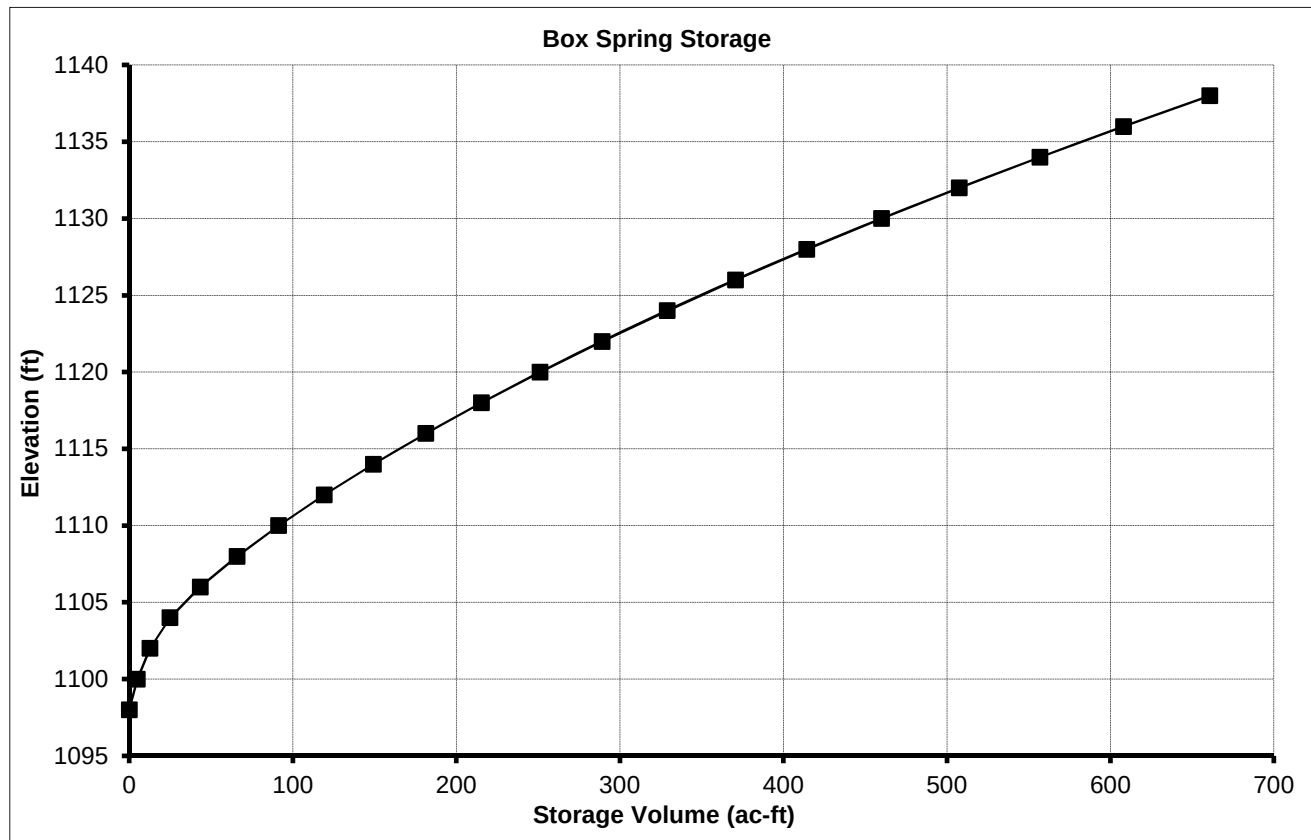
TORY R. WALKER ENGINEERING
RELIABLE SOLUTIONS IN WATER RESOURCES

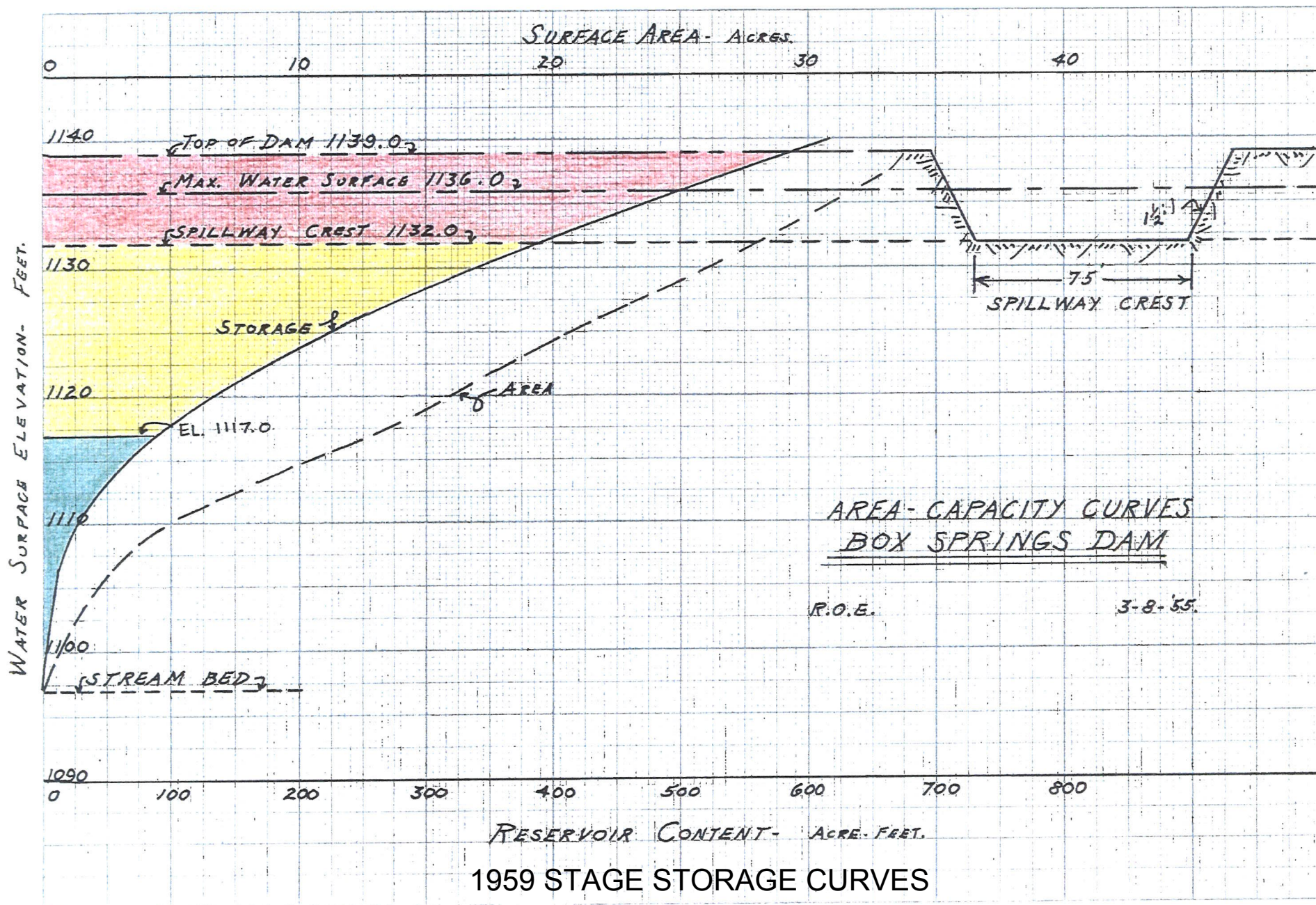
Project Name.....
Project No.....
Date.....

Quail-Run
156-14
9/16/2014

Stage-Storage Table for Box Springs with Proposed Quail Run Project 2008 topo

Elev.	Area (ft2)	Incre. Vol (ft3)	Total Vol (ft3)	Vol. (ac-ft)	Area (ac)
1098	73,715	-	-	0.00	1.69
1100	143,881	213,722	213,722	4.91	3.30
1102	196,358	338,882	552,603	12.69	4.51
1104	342,194	531,845	1,084,448	24.90	7.86
1106	464,233	803,331	1,887,779	43.34	10.66
1108	522,787	986,441	2,874,220	65.98	12.00
1110	582,406	1,104,657	3,978,877	91.34	13.37
1112	633,508	1,215,556	5,194,432	119.25	14.54
1114	676,646	1,309,917	6,504,350	149.32	15.53
1116	718,125	1,394,565	7,898,915	181.33	16.49
1118	760,158	1,478,084	9,376,999	215.27	17.45
1120	804,515	1,564,463	10,941,462	251.18	18.47
1122	848,039	1,652,363	12,593,825	289.11	19.47
1124	887,633	1,735,521	14,329,346	328.96	20.38
1126	929,137	1,816,612	16,145,958	370.66	21.33
1128	972,257	1,901,231	18,047,189	414.31	22.32
1130	1,014,772	1,986,877	20,034,067	459.92	23.30
1132	1,057,280	2,071,907	22,105,973	507.48	24.27
1134	1,094,394	2,151,567	24,257,541	556.88	25.12
1136	1,130,409	2,224,706	26,482,247	607.95	25.95
1138	1,169,455	2,299,754	28,782,000	660.74	26.85





RIVERSIDE COUNTY FLOOD CONTROL

DAMS & BASINS INFORMATION

(Changes to gate opening to be authorized by Assitant Chief Engineer or his designee.)

Name of Facility	Ranges	Stage			
		Top of Inlet <u>Green</u> elev. (ft)	<u>Yellow</u> elev/depth	<u>Orange</u> elev/depth	Crest of Spillway - Dam <u>Red</u> elev/depth
Alessandro Dam	elev. (ft)	1099 - 1118.0	1118.0 - 1125.0	1125.0 - 1138.0	1138.0 - 1146.0
	depth (ft)	0.0 - 19.0	19.0 - 26.0	26.0 - 39.0	39.0 - 47.0
Proj# 1-0043	storage (ac-ft)	~ 115.0	115.0 ~ 180.0	180.0 ~ 370.0	370.0 ~ 510.0
Dwg#1-100	gate open (in)	0.0 - 3.0	3.0 - 10.0	10.0 - 30.0	max = 30.0
Box Springs Dam	elev. (ft)	1100.5 - 1117.0	1117.0 - 1123.5	1123.5 - 1132.0	1132.0 - 1139.0
	depth (ft)	0.0 - 16.5	16.5 - 23.0	23.0 - 31.5	31.5 - 38.5
Proj# 1-0041	storage (ac-ft)	0.0 ~ 85.0	85.0 ~ 193.0	193.0 ~ 387.0	387.0 ~ 580.0
Dwg#1-101	gate open (in)	0.0 - 3.0	3.0 - 10.0	10.0 - 30.0	max = 30.0
Harrison Dam	elev. (ft)	1086.9 - 1103.0	1103.0 - 1108.9	1108.9 - 1118.0	1118.0 - 1123.5
	depth (ft)	0.0 - 16.1	16.1 - 22.0	22.0 - 31.1	31.1 - 36.6
Proj# 1-0046	storage (ac-ft)	0.0 ~ 60.0	60.0 ~ 105.0	105.0 ~ 200.0	200.0 +
Dwg#1-096	gate open (in)	6.0 inches*	6.0 inches*	6.0 - 30.0	max = 30.0
Mary Dam	elev. (ft)	978.2 - 987.0	987.0 - 992.8	992.8 - 1002.0	1002.0 - 1009.0
	depth (ft)	0.0 - 8.8	8.8 - 14.6	14.6 - 23.8	23.8 - 30.8
Proj# 1-0180	storage (ac-ft)	0.0 ~ 75.0	75.0 ~ 160.0	160.0 ~ 320.0	320.0 +
Dwg#1-196	gate open (in)	0.0 - 3.0	3.0 - 10.0	10.0 - 42.0	max = 42.0
Prenda Dam	elev. (ft)	1210.9 - 1226.0	1226.0 - 1229.0	1229.0 - 1236.0	1236.0 - 1242.0
	depth (ft)	0.0 - 15.1	15.1 - 18.1	18.1 - 25.1	25.1 - 31.1
Proj# 1-0044	storage (ac-ft)	0.0 ~ 51.0	51.0 ~ 72.0	72.0 ~ 144.0	144.0 - 237.0
Dwg#1-097	gate open (in)	0.0 - 3.0	3.0 - 10.0	10.0 - 24.0	max = 24.0
Sycamore Dam	elev. (ft)	963.9 - 983.0	983.0 - 991.3	991.3 - 1003.0	1003.0 - 1013.0
	depth (ft)	0.0 - 19.1	19.1 - 27.4	27.4 - 39.1	39.1 - 49.1
Proj# 1-0042	storage (ac-ft)	0.0 ~ 310.0	310.0 ~ 575.0	575.0 ~ 1150.0	1150.0 +
Dwg#1-099	gate open (in)	6.0 inches*	6.0 inches*	6.0 - 30.0	max = 30.0
Woodcrest Dam	elev. (ft)	1088.3 - 1101.3	1101.3 - 1105.5	1105.5 - 1116.3	1116.3 - 1122.5
	depth (ft)	0.0 - 13.0	13.0 - 17.2	17.2 - 28.0	28.0 - 34.2
Proj# 1-0045	storage (ac-ft)	0.0 ~ 143.0	143.0 ~ 213.0	213.0 ~ 427.0	427.0 +
Dwg#1-095	gate open (in)	6.0 inches*	6.0 inches*	6.0 - 30.0	max = 30.0

* Harrison, Sycamore, and Woodcrest are normally set at 6-in opening because of the year round discharge.

Stage definitions:

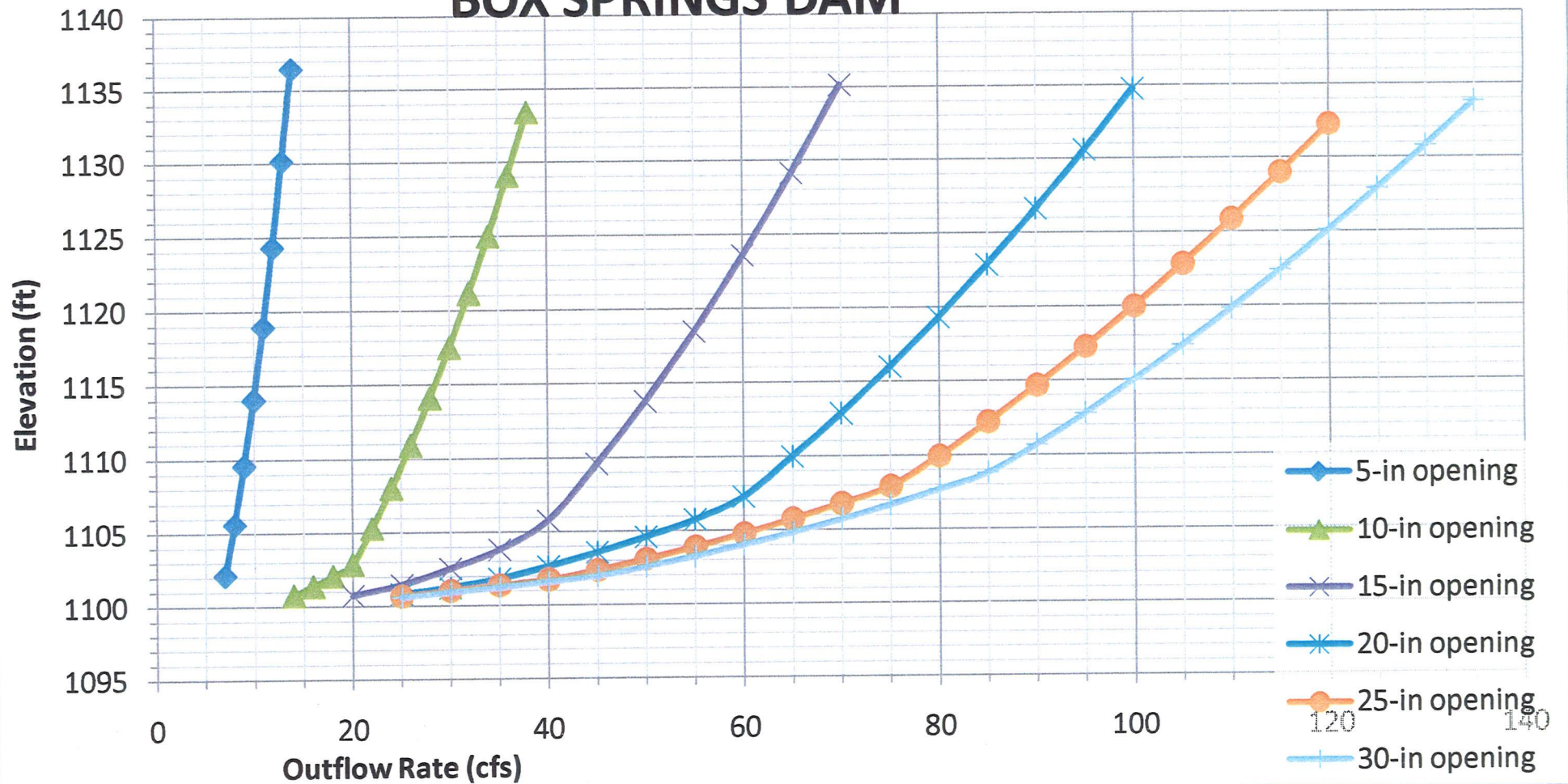
Green = one-third of reservoir storage volume to the spillway crest

Yellow = one-third to one-half of the storage volume to the spillway crest

Orange = one-half of the reservoir storage volume to the spillway crest

Red = storage volume from spillway crest to the top of dam

BOX SPRINGS DAM





TORY R. WALKER ENGINEERING
RELIABLE SOLUTIONS IN WATER RESOURCES

Project Name: Quail-Run
Project No: 156-14
Date: 12/2/2014

Elevation (ft)	Culvert Q (cfs)	Spillway Q (cfs)	Total Q (cfs)
1098.00	0	0	0.0
1100.00	0	0	0.0
1102.50	0	0	0.0
1105.00	0	0	0.0
1107.50	0	0	0.0
1110.00	0	0	0.0
1112.50	0	0	0.0
1115.00	0	0	0.0
1117.00	10.56	0	10.56
1117.50	10.68	0	10.68
1120.00	31.38	0	31.38
1122.50	32.71	0	32.71
1123.50	33.27	0	33.27
1125.00	63.62	0	63.62
1127.50	91.22	0	91.22
1130.00	116.74	0	116.74
1132.00	144.00	0	144.00
1132.50	144.50	0	144.50
1133.00	145.00	240	385.00
1134.00	147.00	675	822.00
1135.00	148.43	1271	1419.86
1135.40	149.00	1510	1659.00
1136.00	150.00	1950	2100.00
1137.00	151.00	2770	2921.00
1137.50	152.00	3230	3382.00

APPENDIX 4

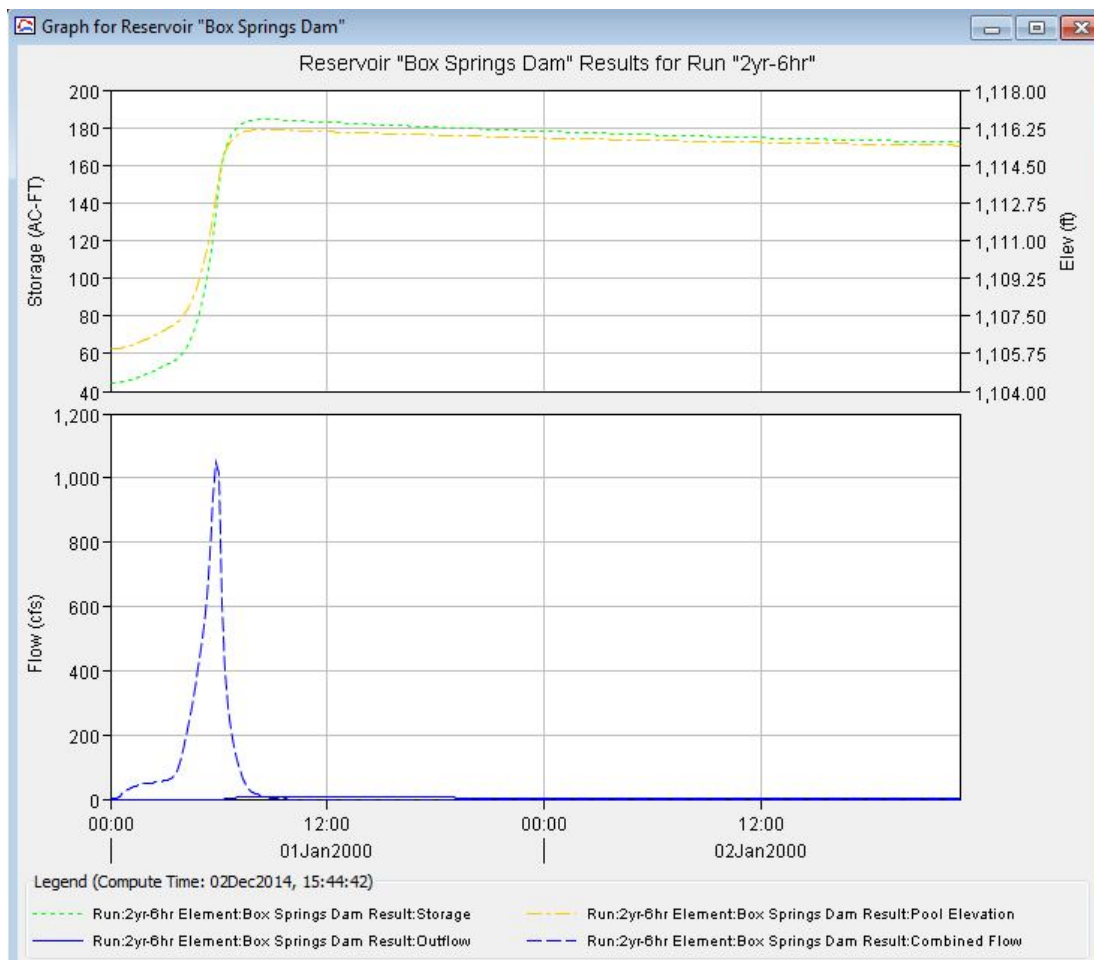
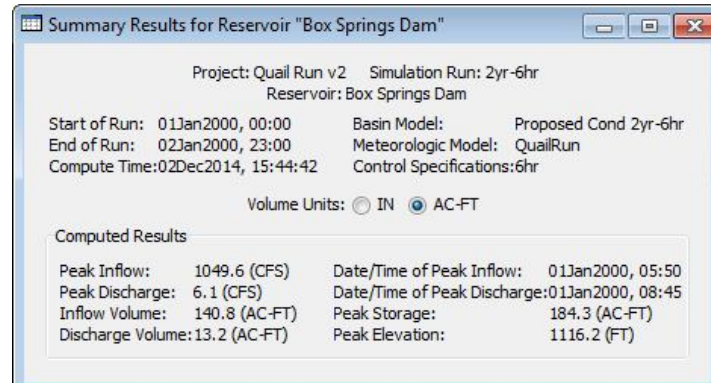
HEC-HMS Reservoir Routing Results

Quail Run HEC-HMS Output

Proposed Stage Storage

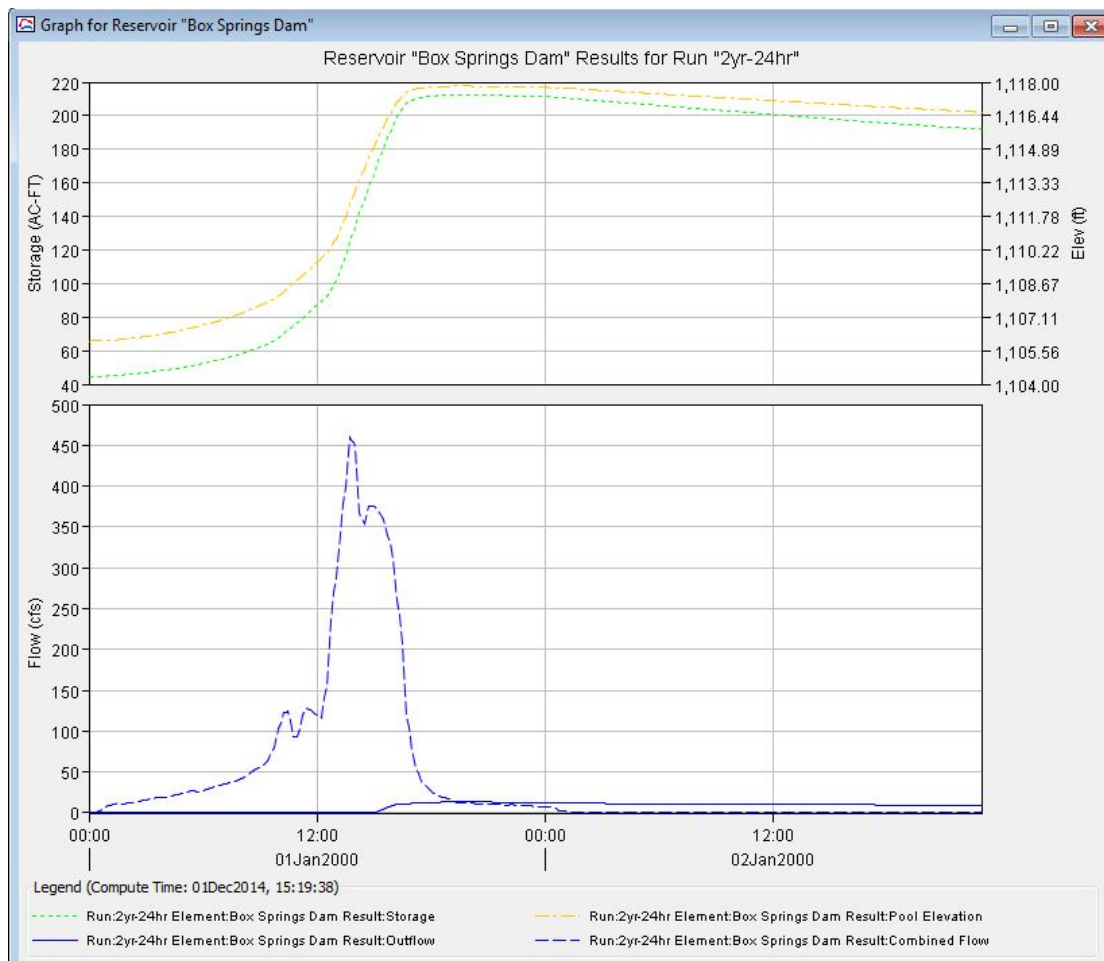
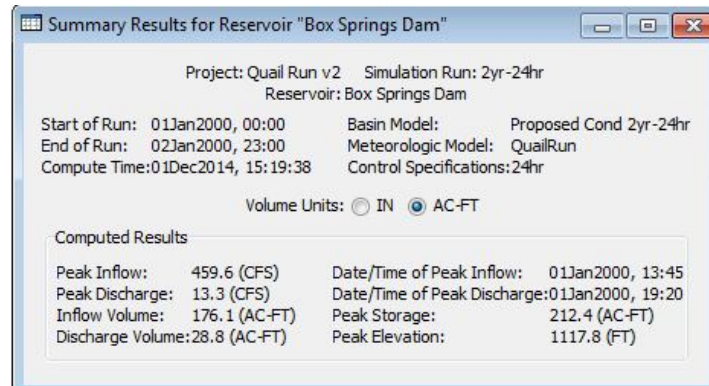
2-yr, 6-hr

Box Springs Dam



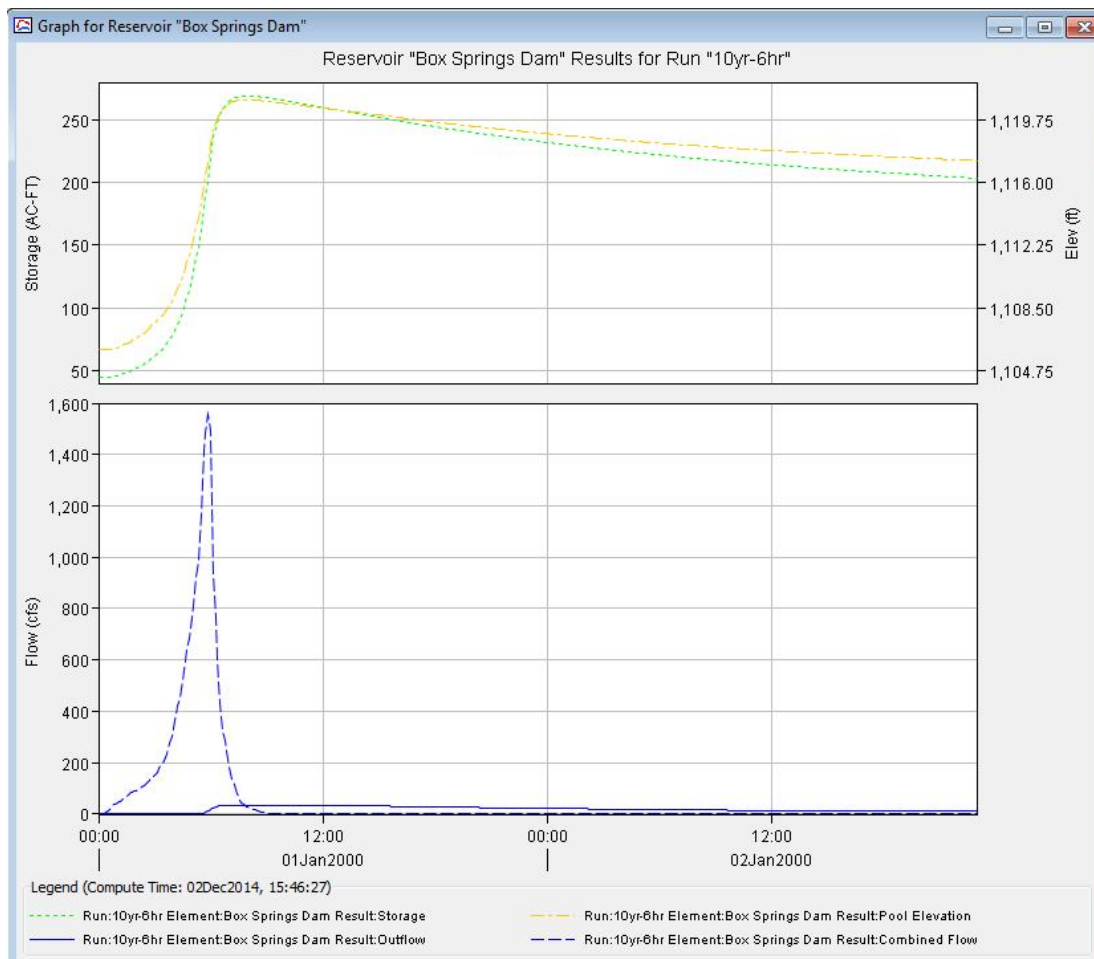
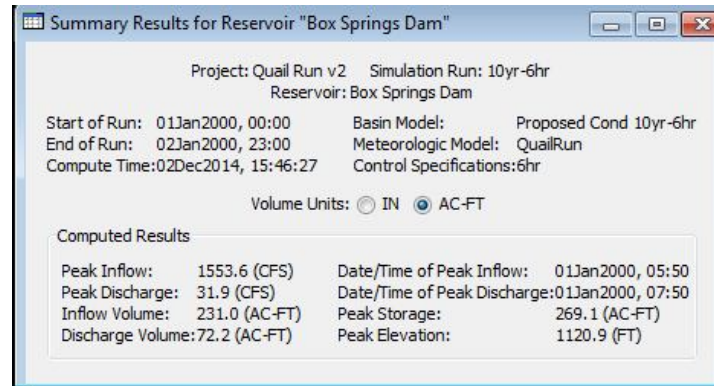
2-yr, 24-hr

Box Springs Dam



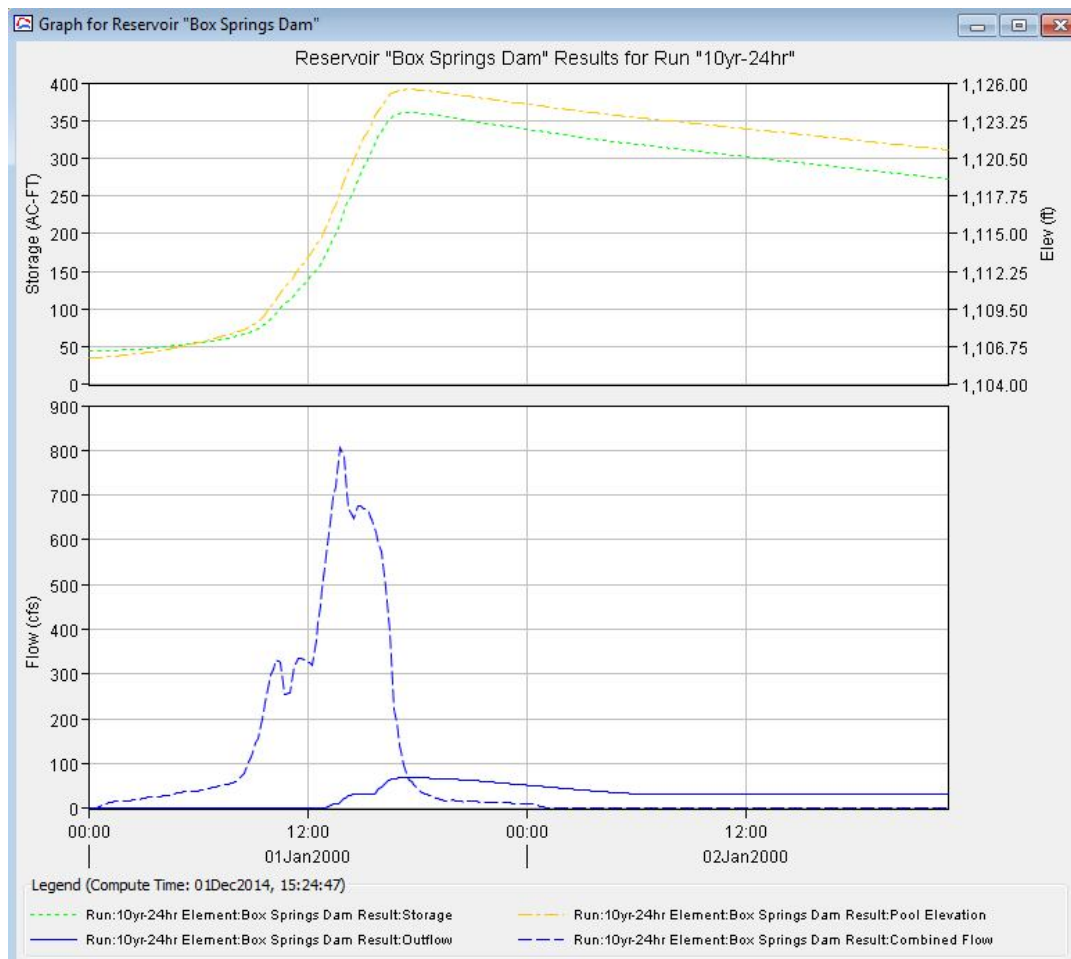
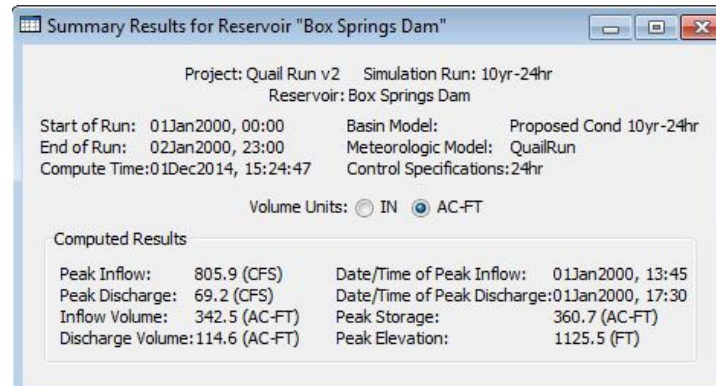
10-yr, 6-hr

Box Springs Dam



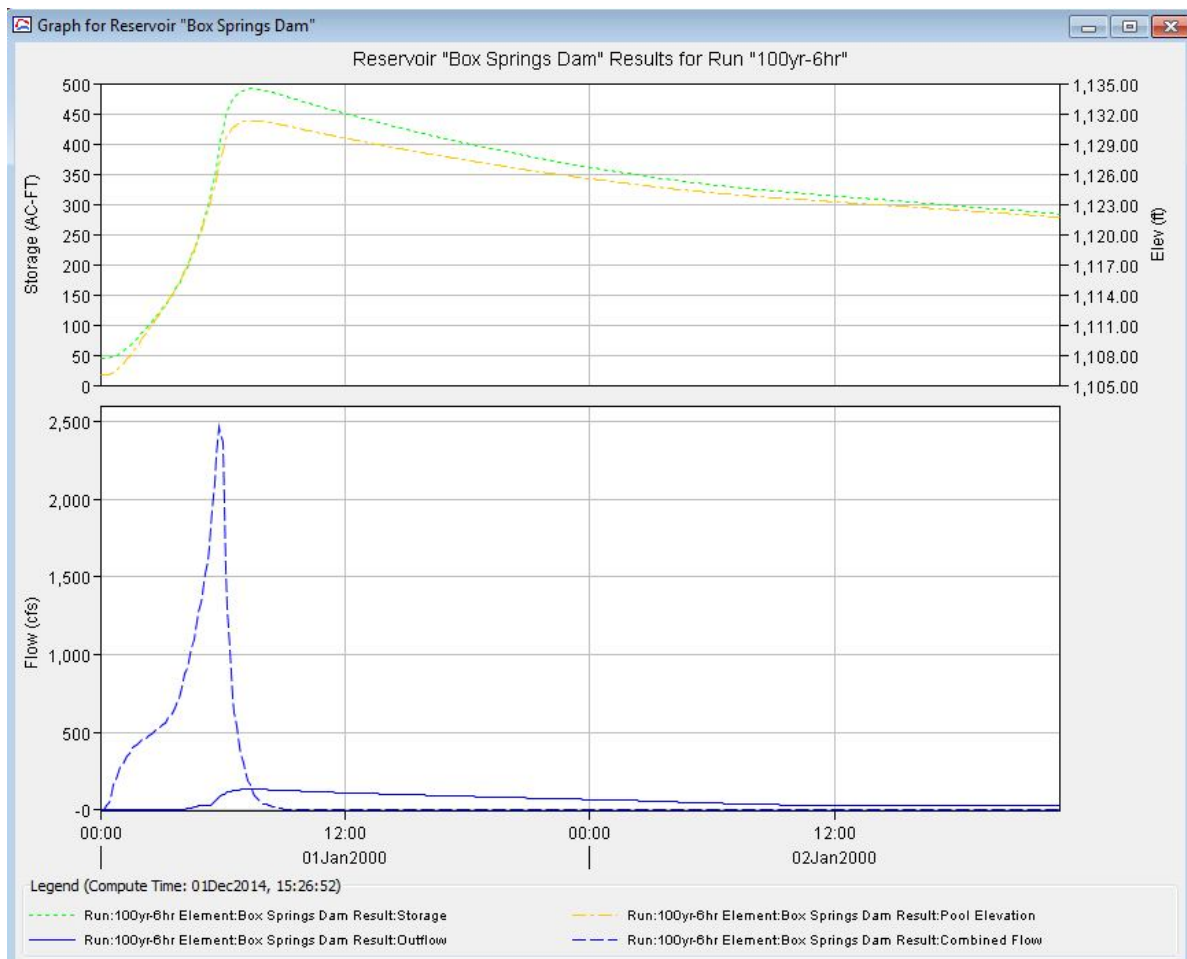
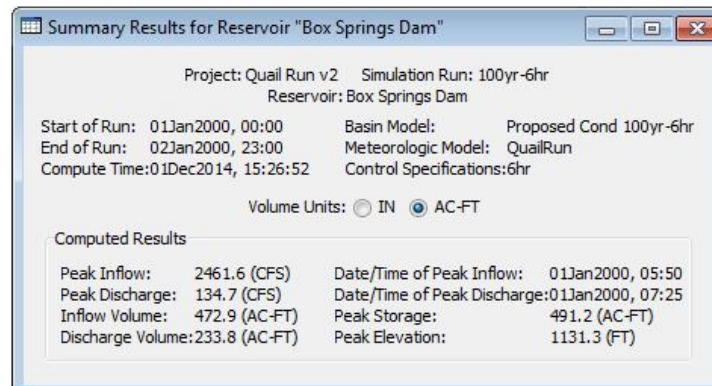
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Box Springs Dam



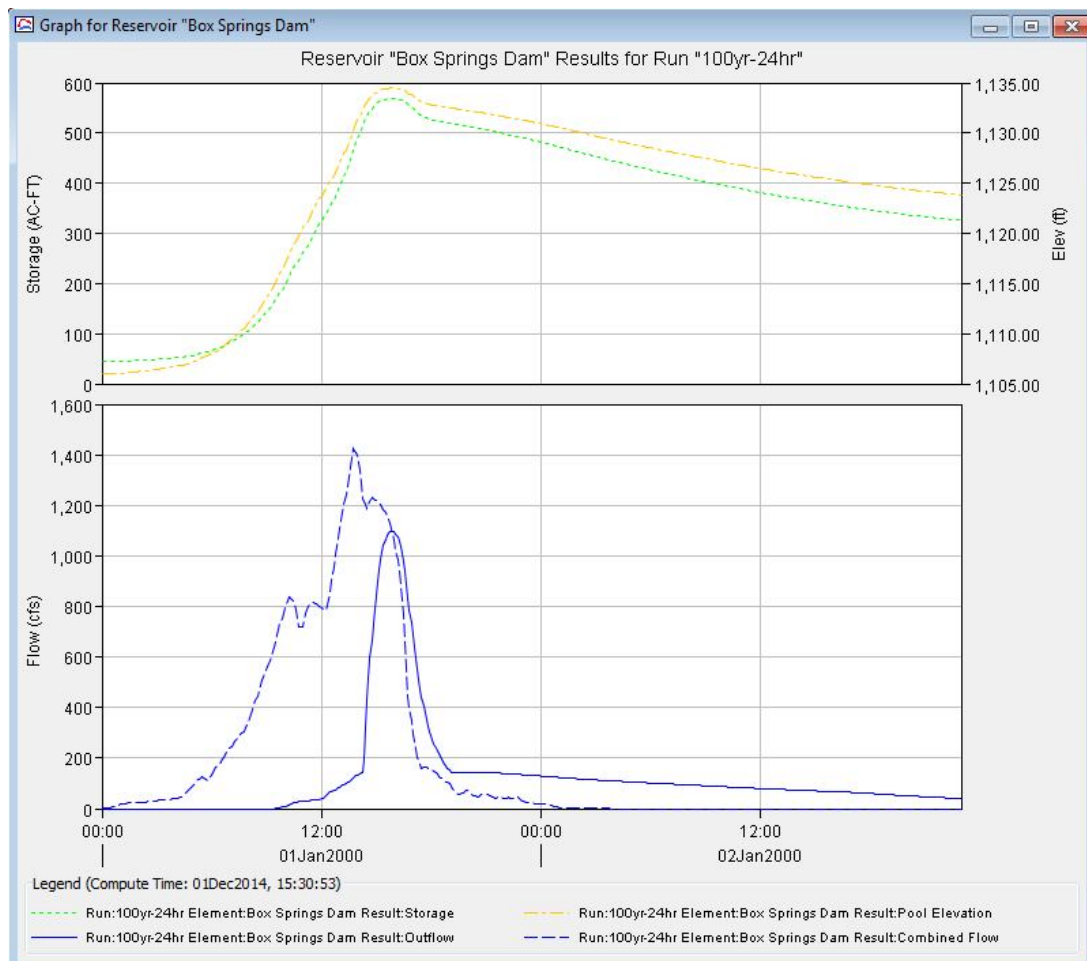
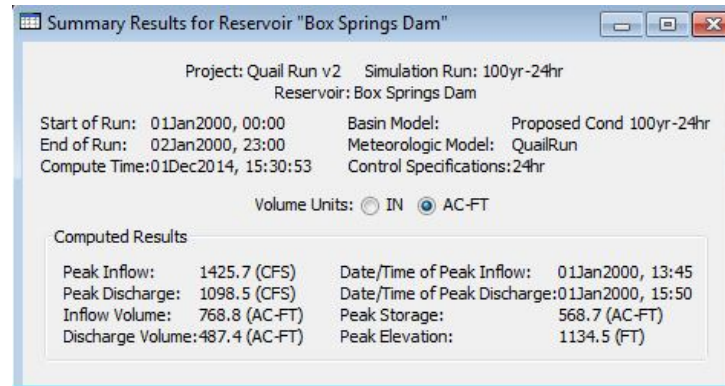
100-yr, 6-hr

Box Springs Dam



100-yr, 24-hr

Box Springs Dam

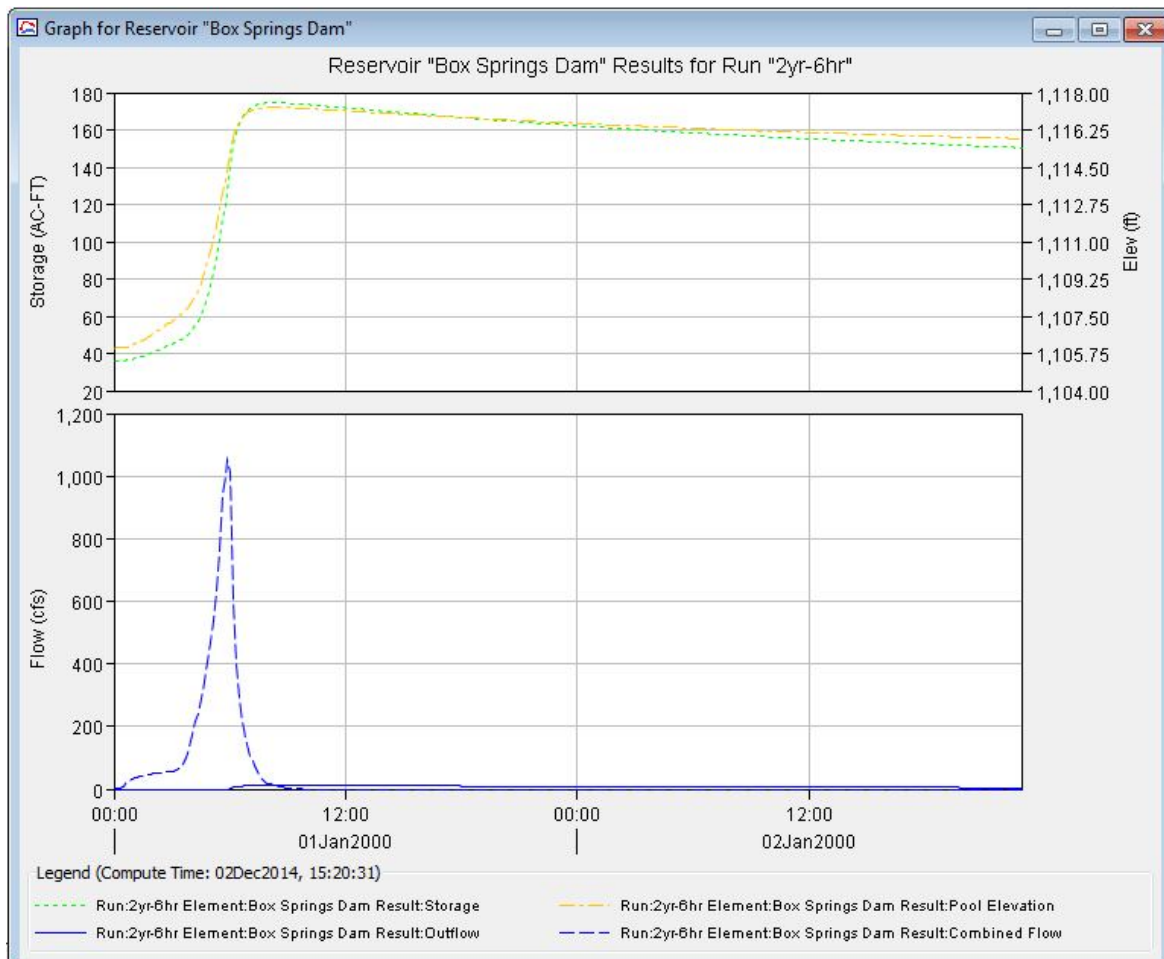
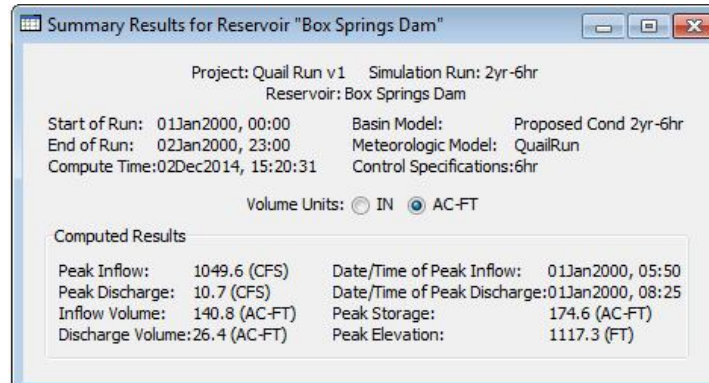


Quail Run HEC-HMS Output

Existing Stage Storage

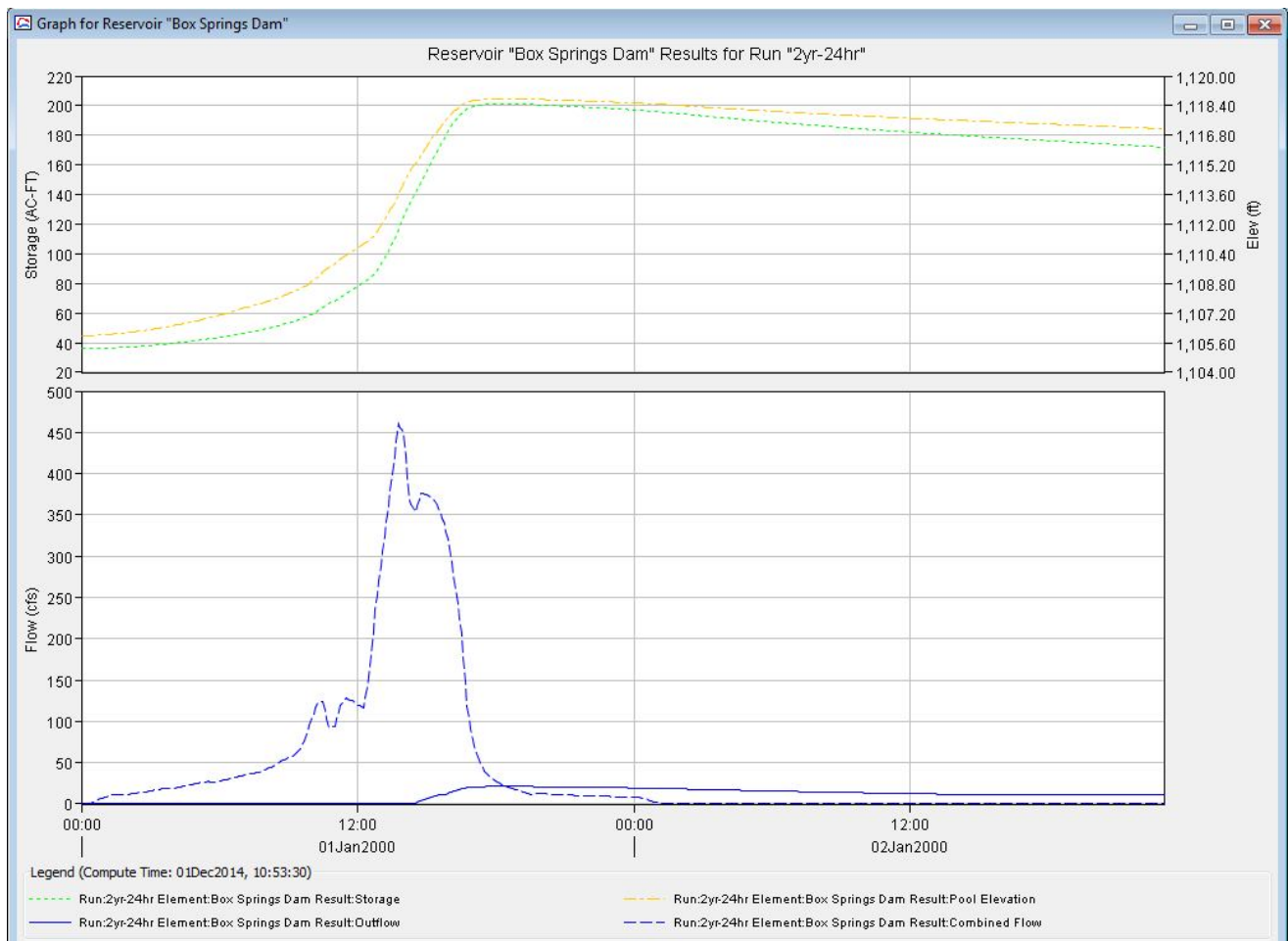
2-yr, 6-hr:

Box Springs Dam



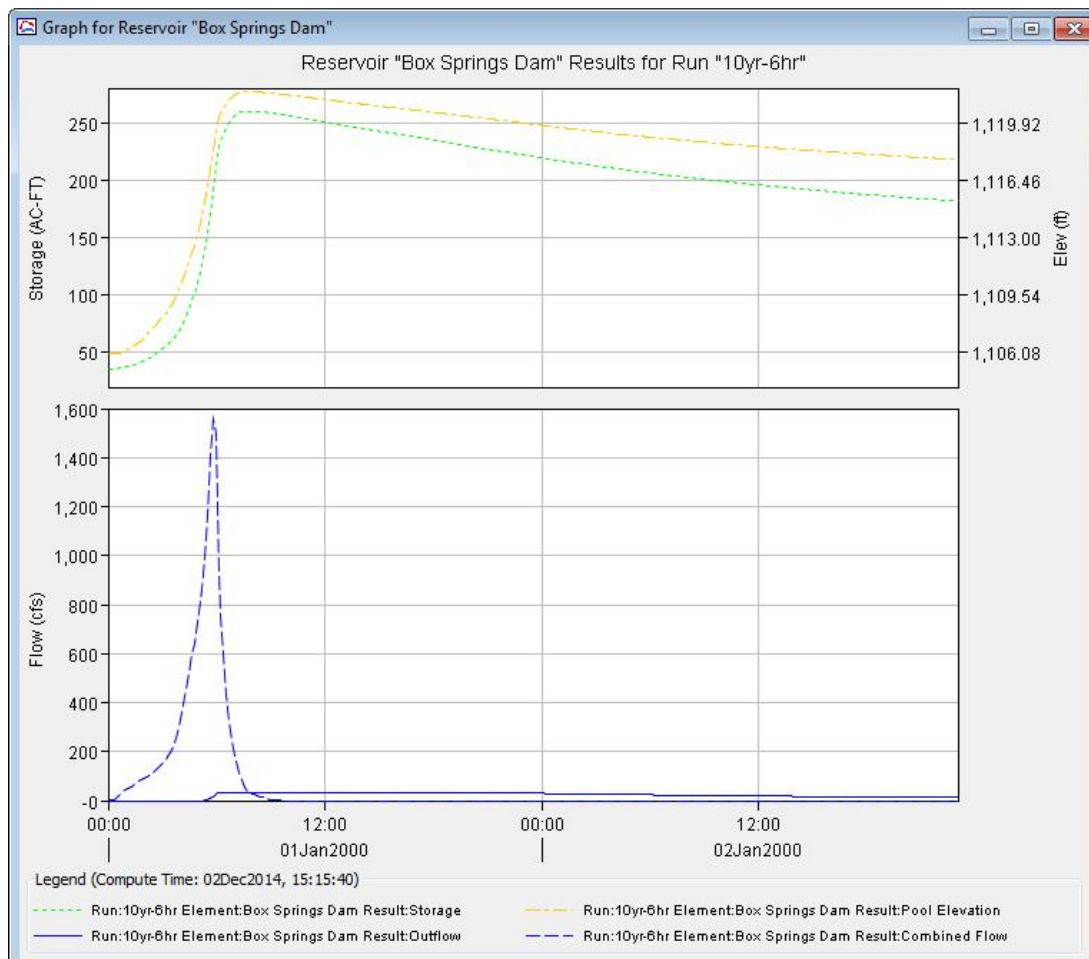
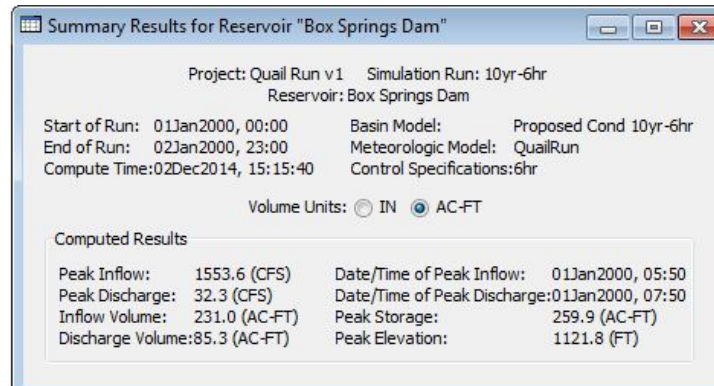
2-yr, 24-hr

Box Springs Dam



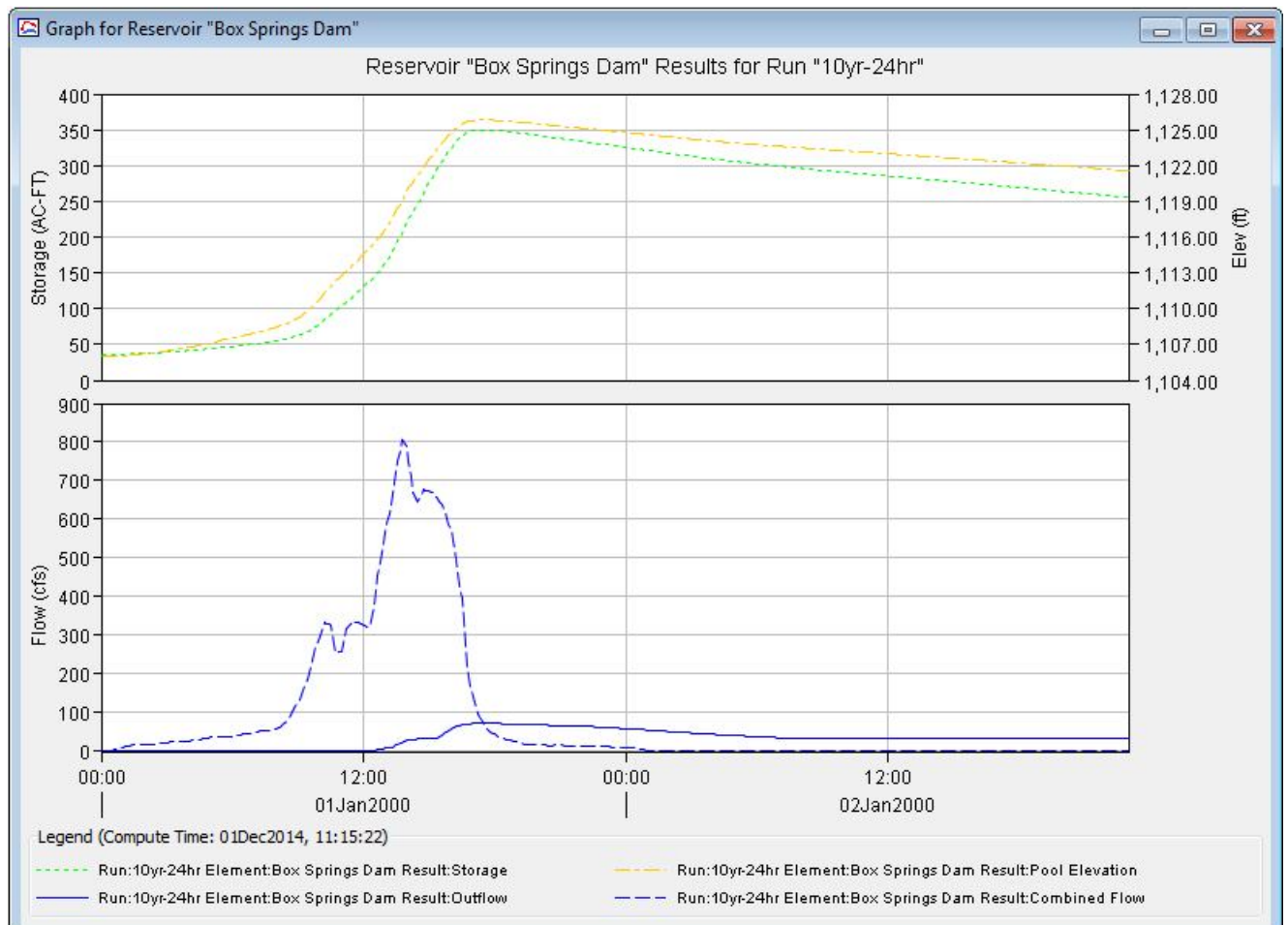
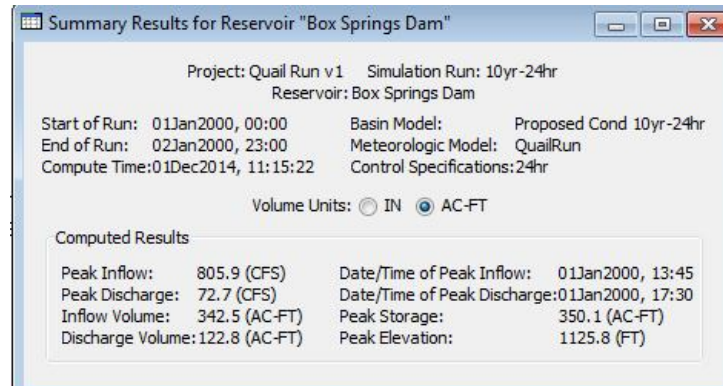
10-yr, 6-hr

Box Springs Dam



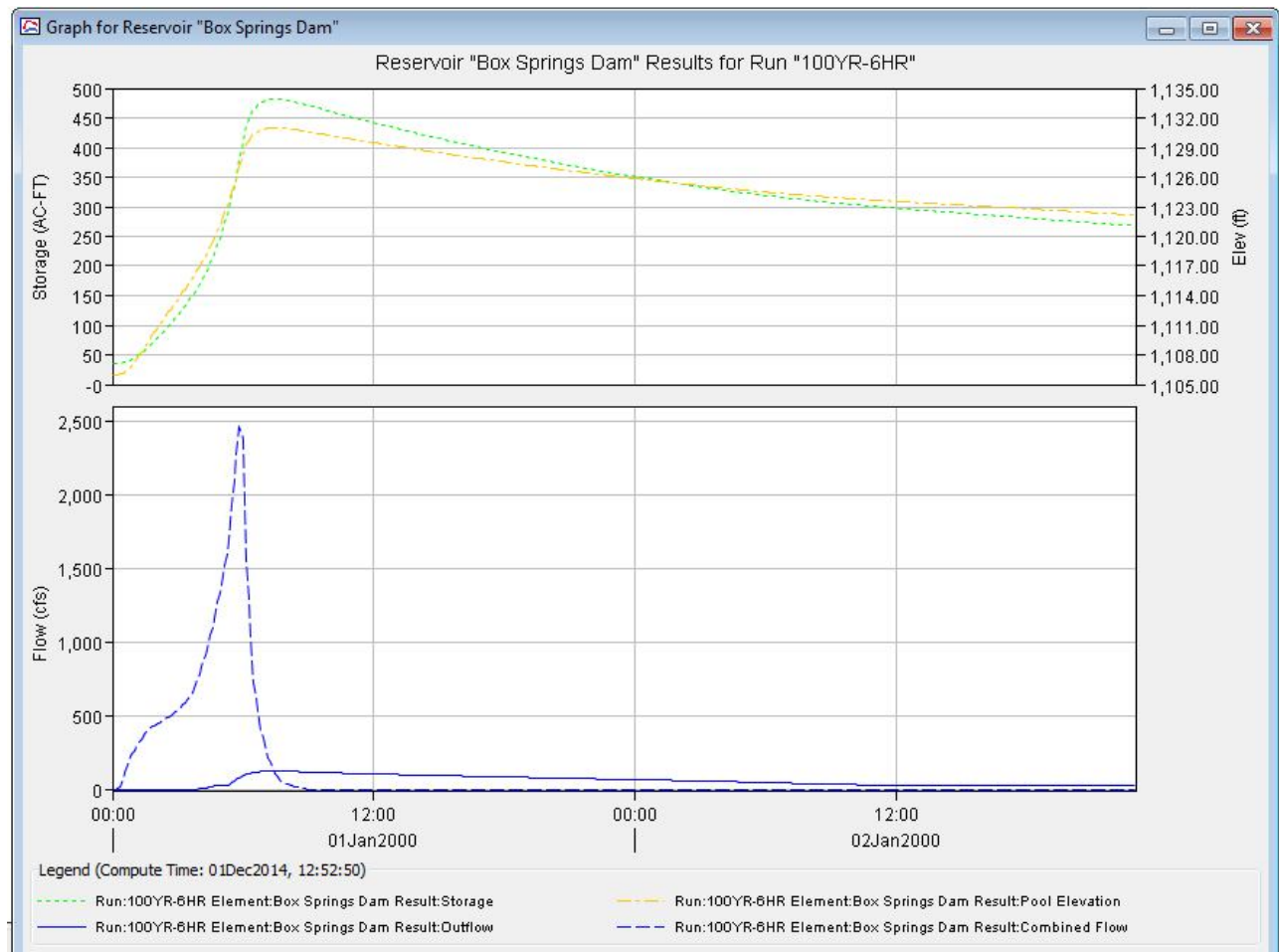
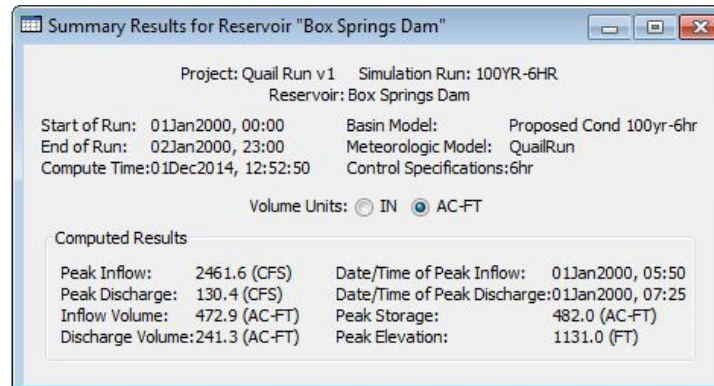
10-yr, 24-hr

Box Springs Dam



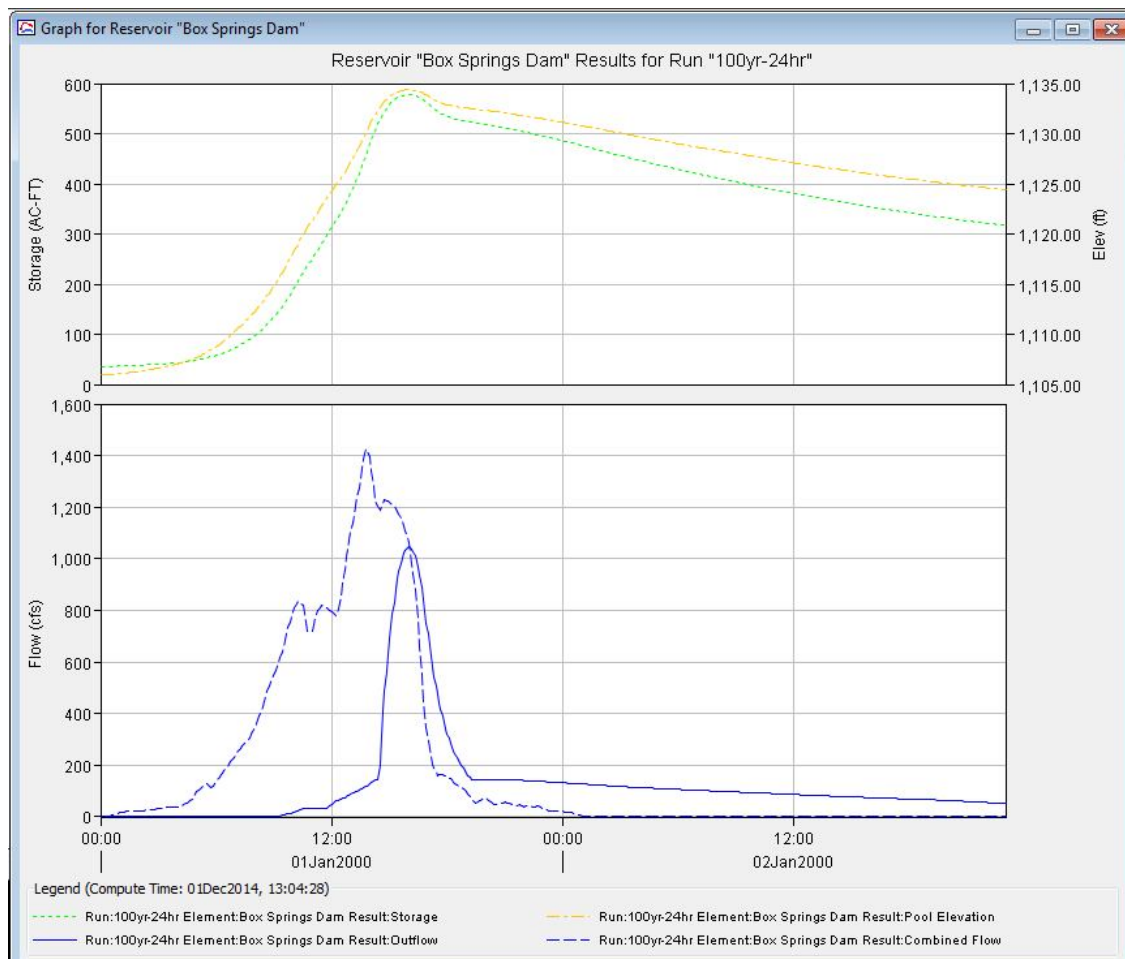
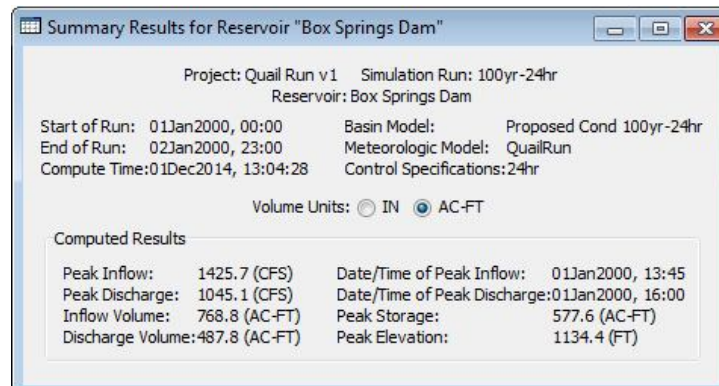
100-yr, 6-hr

Box Springs Dam



100-yr, 24-hr

Box Springs Dam



APPENDIX 5

Box Springs Dam Drawings

CONSTRUCTION DRAWINGS

BOX SPRINGS DAM

AND DIKE

PREPARED BY

RIVERSIDE COUNTY FLOOD CONTROL

AND

WATER CONSERVATION DISTRICT

CONVALLIA DEVELOPMENT CO. & CITY OF RIVERSIDE
Petitioned for Volume Exchange within the
District's Flood Easement Area as shown
Per Gov. Permit # 1-0-91-1737

Calloway Construction Co.
Encroachment Permit No.
1-0-040-132 March 22, 1966
100 Gunite Lined Channel &
Headwall Also 30'-48" RCP

T.2S. R.4W.
Sec. 32

CENTER SECTION LINE

AREA OF FILL

AREA OF EXCAVATION

NOTE: BORROW NOT TO BE TAKEN LESS THAN
100' UPSTREAM FROM TOE OF DAM

NOTE: TO INK SLOPE TO
IMPERVIOUS MATERIAL

13.80 Acres

1/100 Year Inundation
with dam constructed
28.0 Acres

1/50 Year Inundation
with dam constructed
21.7 Acres

1/25 Year Inundation
with dam constructed
7.2 Acres

1/10 Year Inundation
with dam constructed
140 Acres

Maximum water surface
with dam constructed
31.8 Acres

City of Riverside Eng. Dept.
Encroachment Permit No. 1-0-040-132
Encroachment Permit No. 1-0-040-132
4-0-040-132 - March 6, 1972

ROADWAY FILL

SADDLE DIKE
RELOCATION

20' ROAD/EASEMENT
TO
CANYON CREST ROAD

Area Inundated 1/100 year frequency
natural conditions - without dam

Note: Inundation areas from Box Springs Dam
Area Capacity Curves dated 3/1/55

PLAN

0 20 40 60 80 100 FEET

MARCH 1960

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

BOX SPRINGS DAM

APPLICATION NO. 1003-7
APPROVED AS TO SAFETY

9-10-19

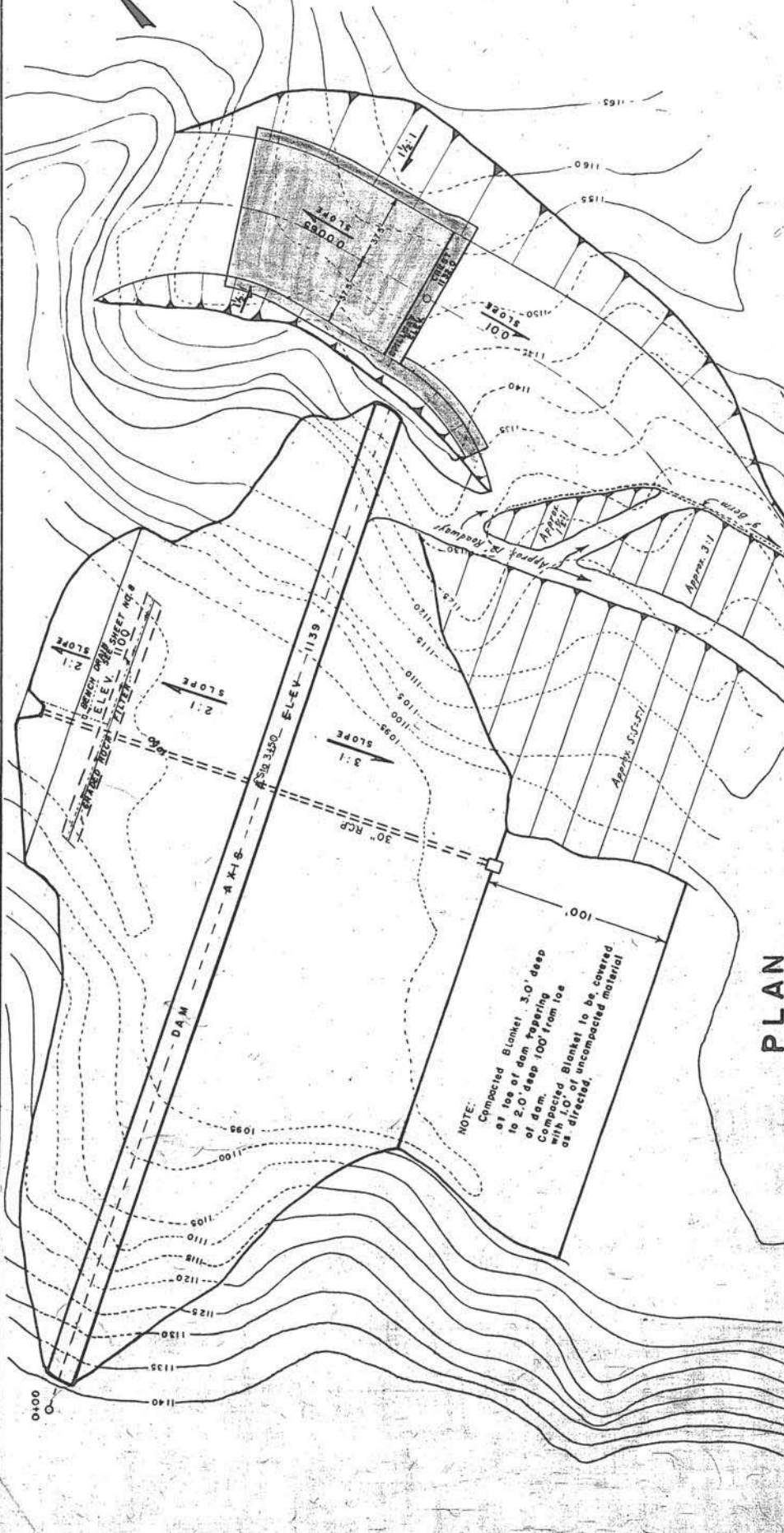
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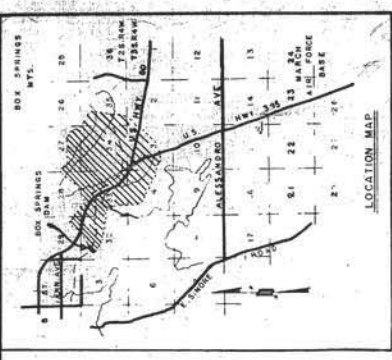
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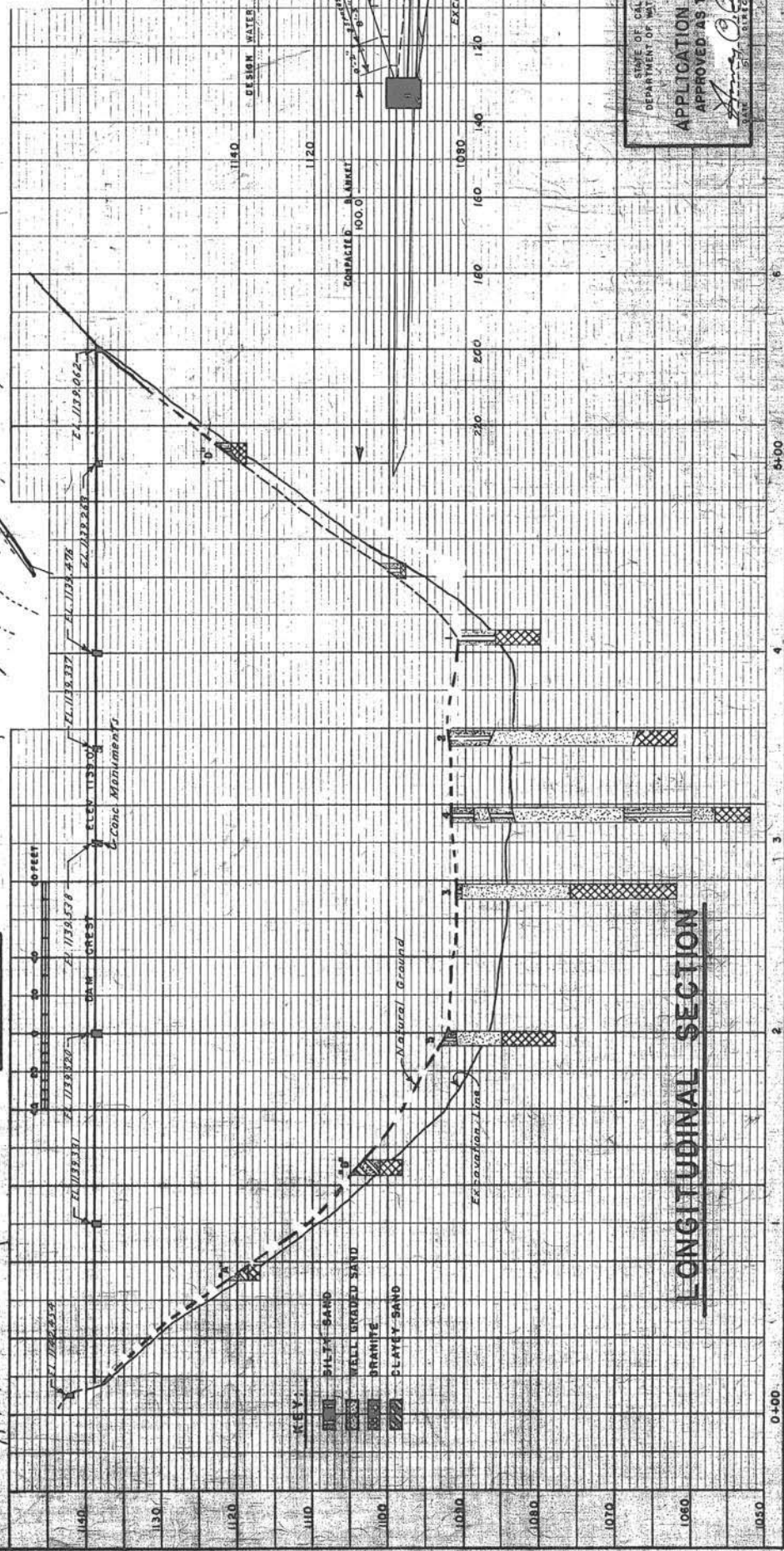
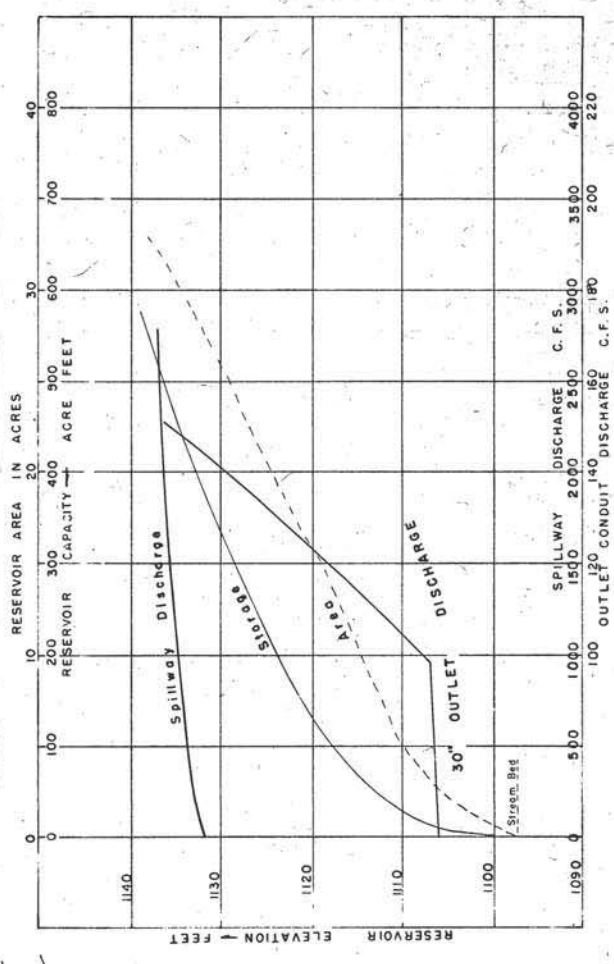
T2S R4W
Sec. 32



PLAN



AREA CAPACITY — DISCHARGE CURVES



LONGITUDINAL SECTION

TRANSVERSE SECTION

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
APPLICATION NO. 1003-7
APPROVED AS TO SAFETY
[Signature]
DATE: 10/10/50

RIVERSIDE COUNTY FLOOD CONTROL
WATER CONSERVATION DISTRICT
BOX SPRINGS DAM
PLAN & PROFILE

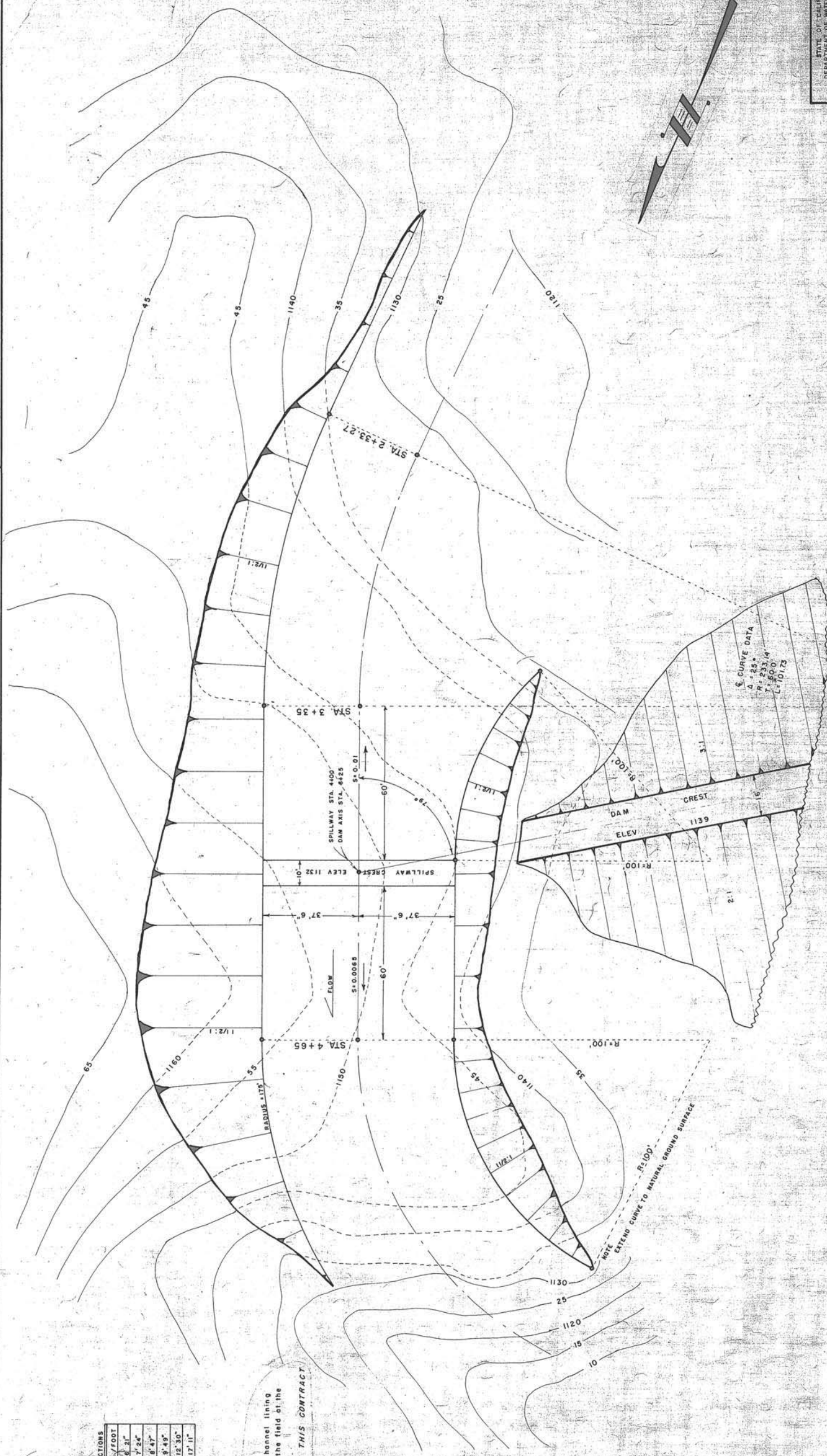
PROJECT NO. 10-0-22

PLAN	DATE	BY
NO. 1003-7	10/10/50	W. H. HARRIS
NOTE BOOK	10/10/50	W. H. HARRIS
REVIEWED	10/10/50	W. H. HARRIS
REVIEWED	10/10/50	W. H. HARRIS
REVIEWED	10/10/50	W. H. HARRIS

PROFILE	DATE	BY
NO. 1003-7	10/10/50	W. H. HARRIS
NOTE BOOK	10/10/50	W. H. HARRIS
REVIEWED	10/10/50	W. H. HARRIS
REVIEWED	10/10/50	W. H. HARRIS
REVIEWED	10/10/50	W. H. HARRIS

CURVE	RADIUS	DEFL./FOOT	DEFLECTIONS
	270.64	0° 6' 21"	
	233.14	0° 7' 24"	
	195.64	0° 8' 47"	
	175.0	0° 9' 49"	
	137.5	0° 12' 30"	
	100.0	0° 17' 11"	

NOTE:
Extent of spillway channel lining
to be determined in the field at the
time of construction.
NOT A PART OF THIS CONTRACT



PLAN



STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

APPLICATION NO. 1003-7

APPROVED AS TO SAFETY

9-10-59
SAY

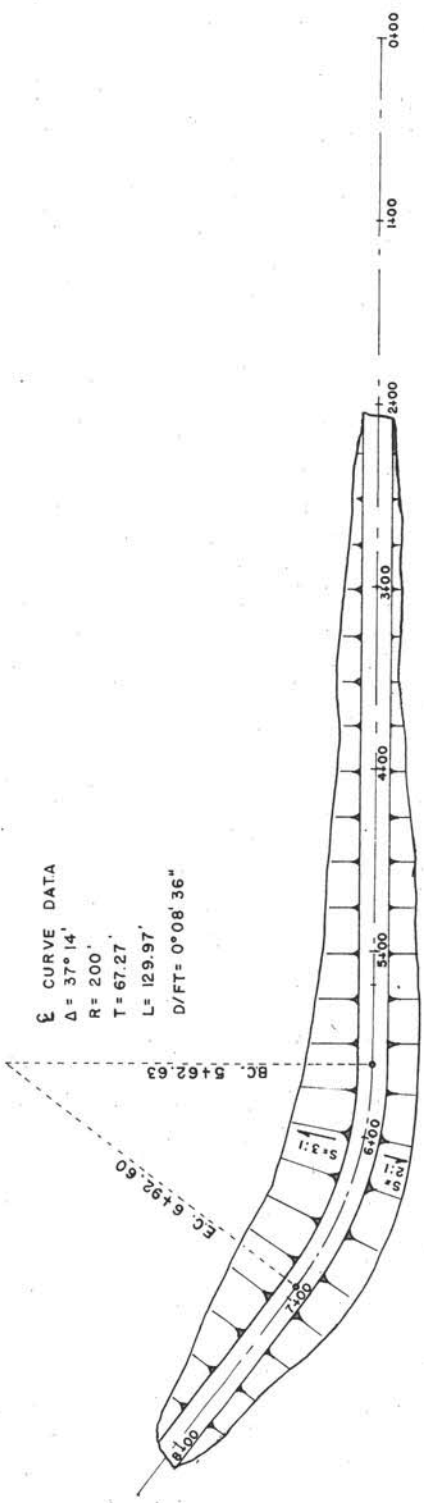
James E. D. [Signature]
01-26-1961

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT
BOX SPRINGS DAM
SPILLWAY ALIGNMENT

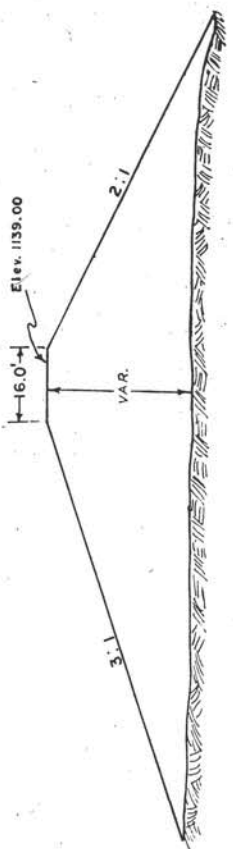
PROJECT NO. 1-0-040

PLAN	
NO.	NOTE BOOK
DATE	BY
SURVEYED	
PLOTTED	
CHECKED	
BY	
DATE	

PROFILE	
NO.	NOTE BOOK
DATE	BY
SURVEYED	
PLOTTED	
CHECKED	
BY	
DATE	

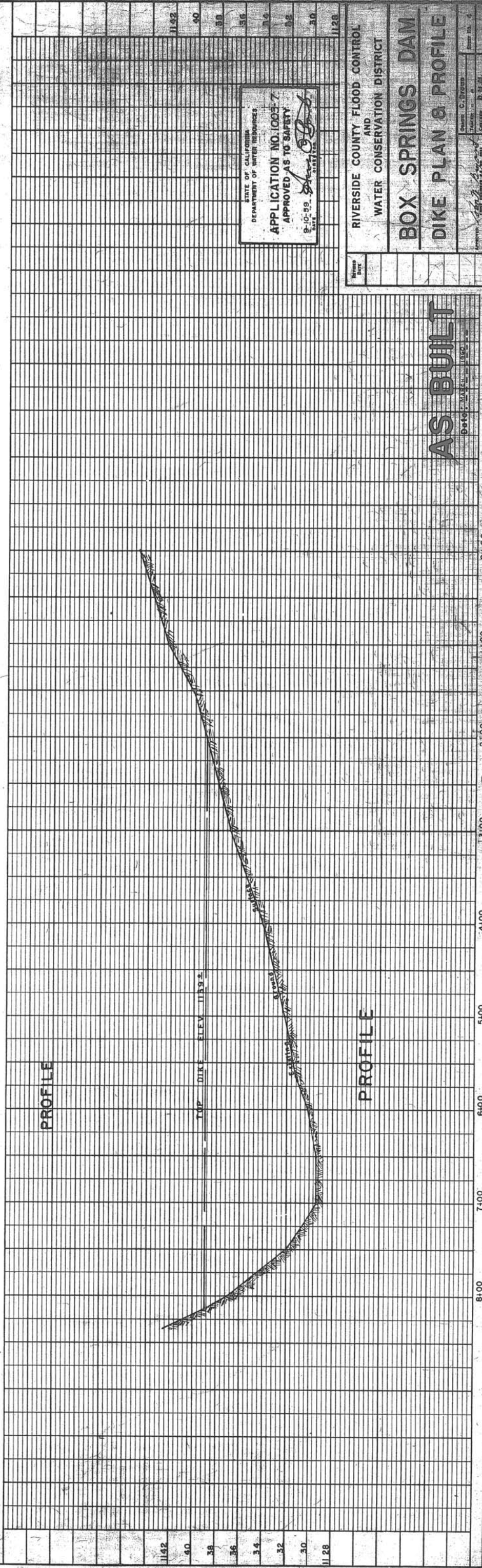


PLAN



TYPICAL SECTION

NO. SCALE



PROFILE

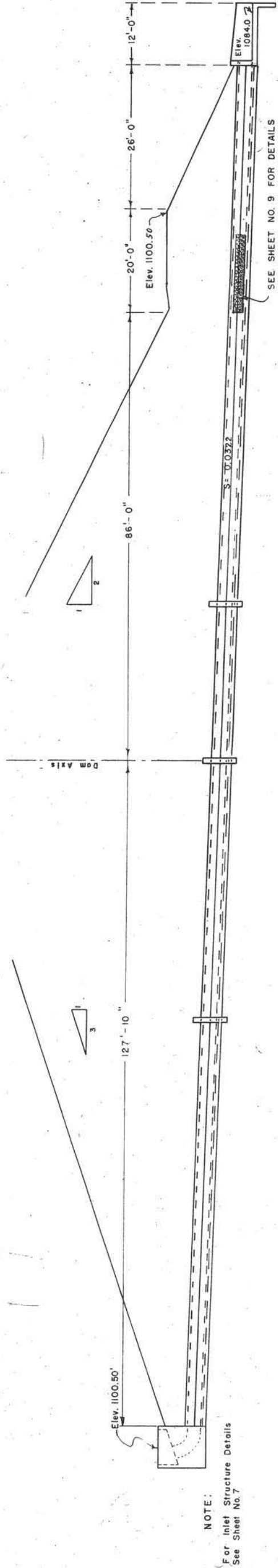
PROFILE

AS BUILT

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
APPLICATION NO. 1003-7
APPROVED AS TO SAFETY
9-10-59
DATE

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT
BOX SPRINGS DAM
DIKE PLAN & PROFILE

PROJECT NO. 1-8-040

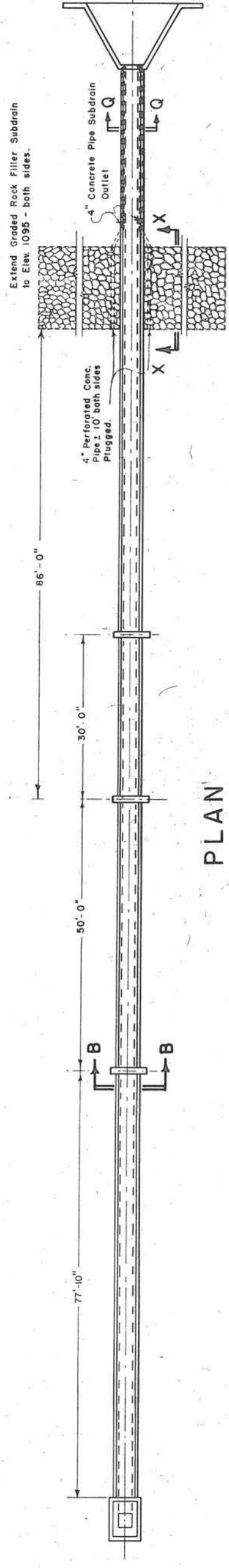


NOTE:
For Inlet Structure Details
See Sheet No. 7

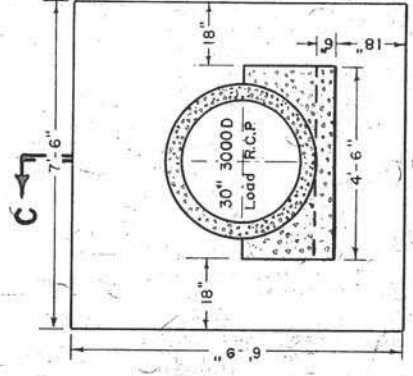
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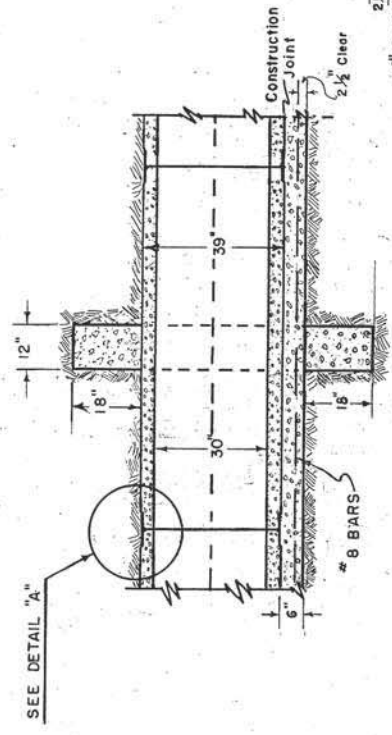
NOTE:
For Outlet Structure Details
See Sheet No. 6



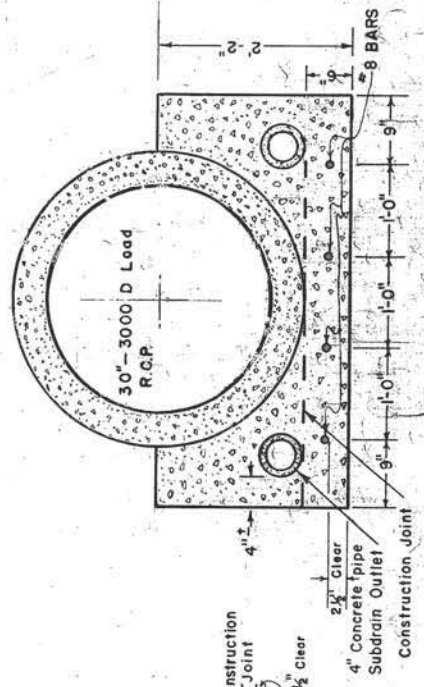
PLAN



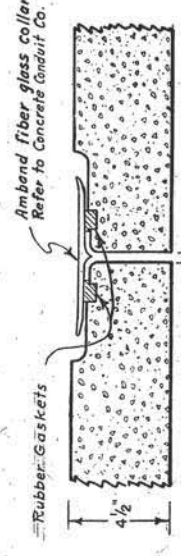
SECTION B-B



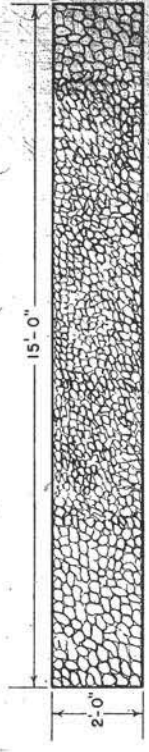
SECTION C-C



SECTION Q-Q



DETAIL - A



SECTION X-X
GRADED ROCK FILTER REQUIREMENTS

Sieve No.	% Passing
1 1/2"	80-80
1"	---
3/4"	30-55
1/2"	---
3/8"	20-40
#4	15-30
#8	0-10
#16	0

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
APPLICATION NO. 1003-7
APPROVED AS TO SAFETY
MARCH 1960

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

BOX SPRINGS DAM

DETAILS

30" OUTLET PIPE

APPROVED

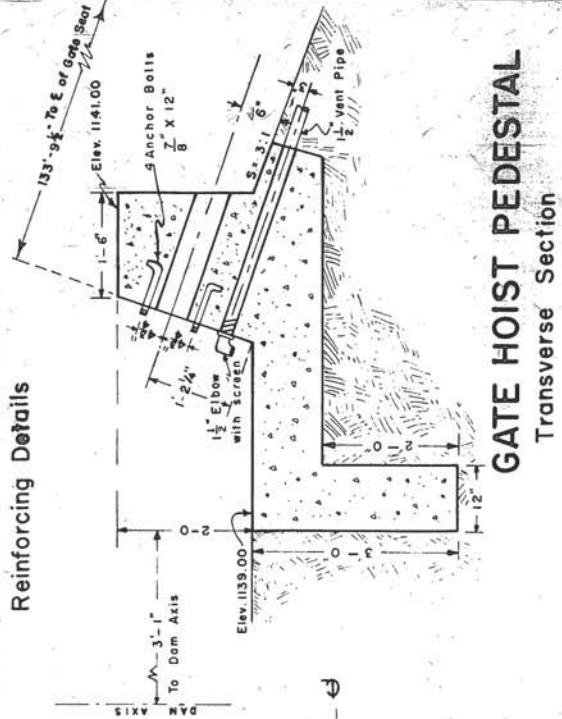
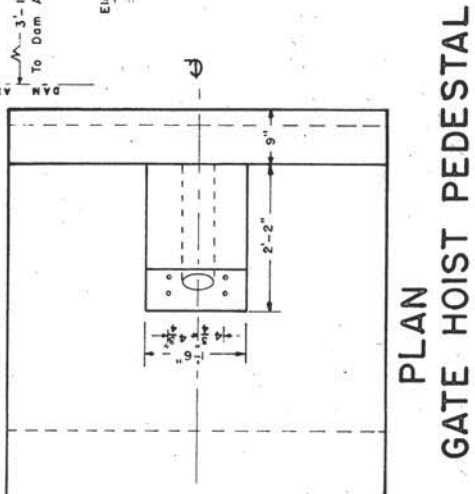
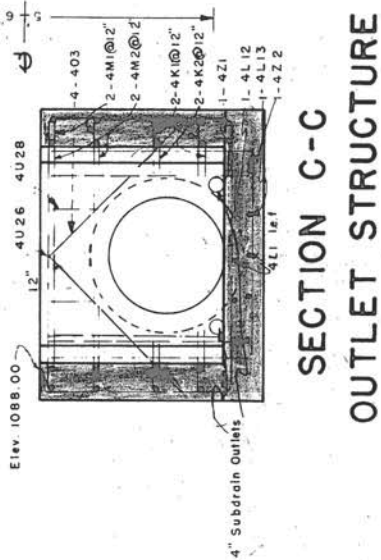
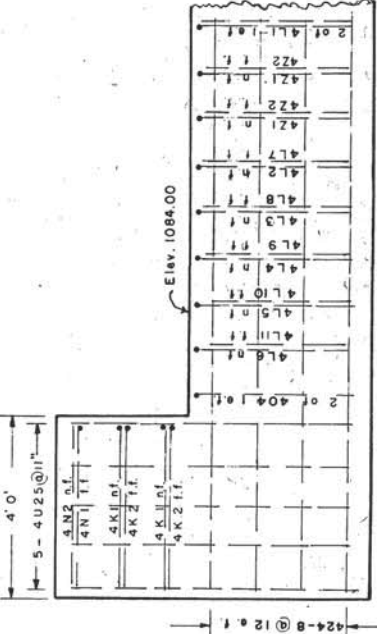
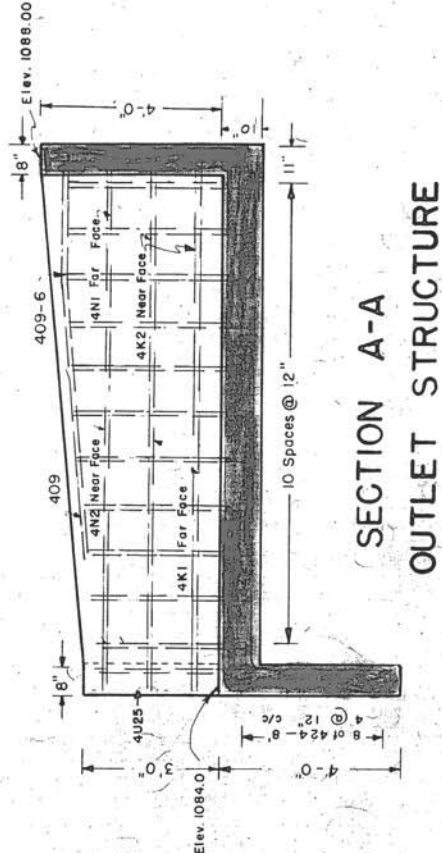
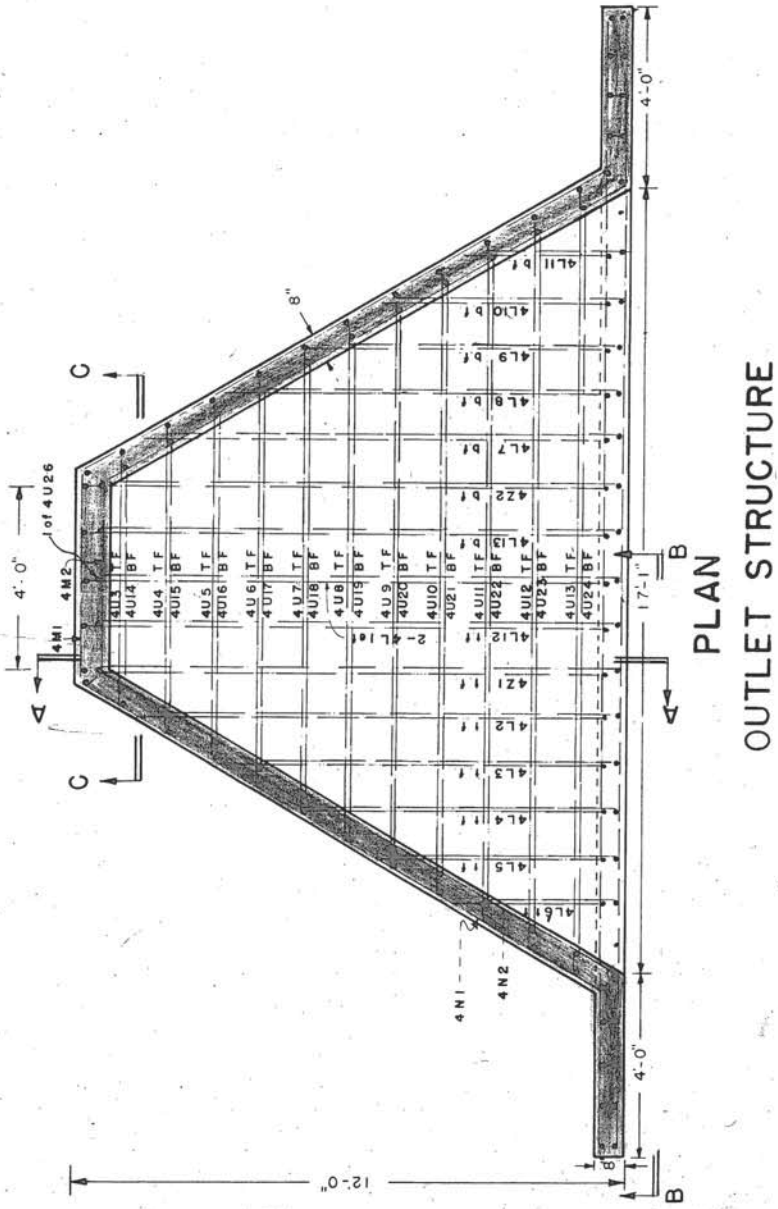
DATE: 3/23/60

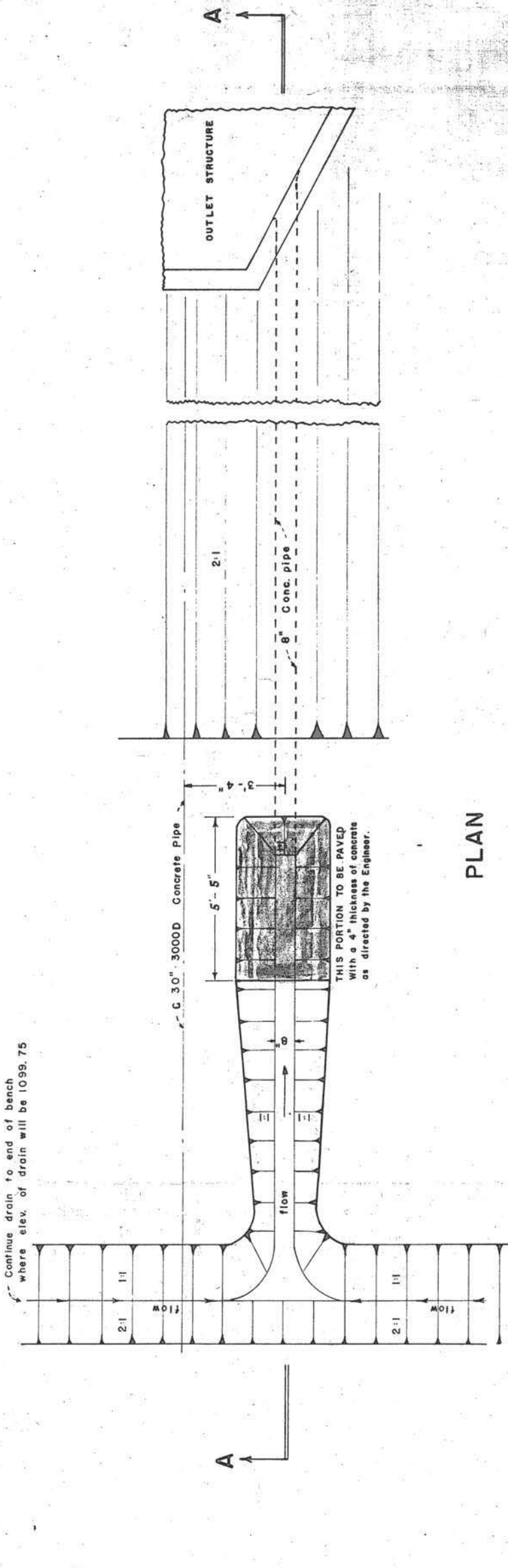
DESIGNED BY: C.B. KRO

CHECKED BY: B.B. D.M.

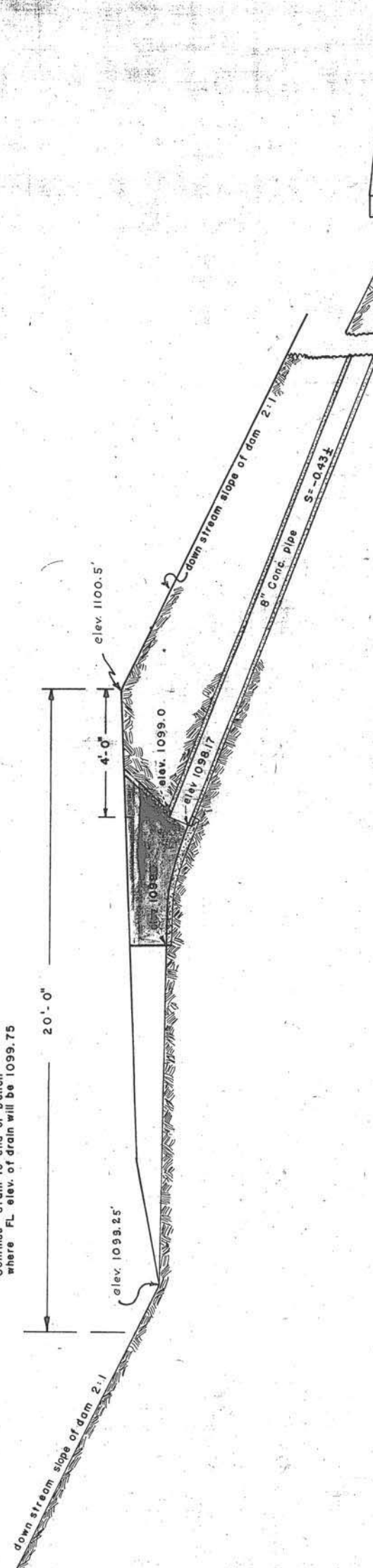
DATE: JULY 1959

PROJECT NO. 1-O-040





PLAN



SECTION A-A



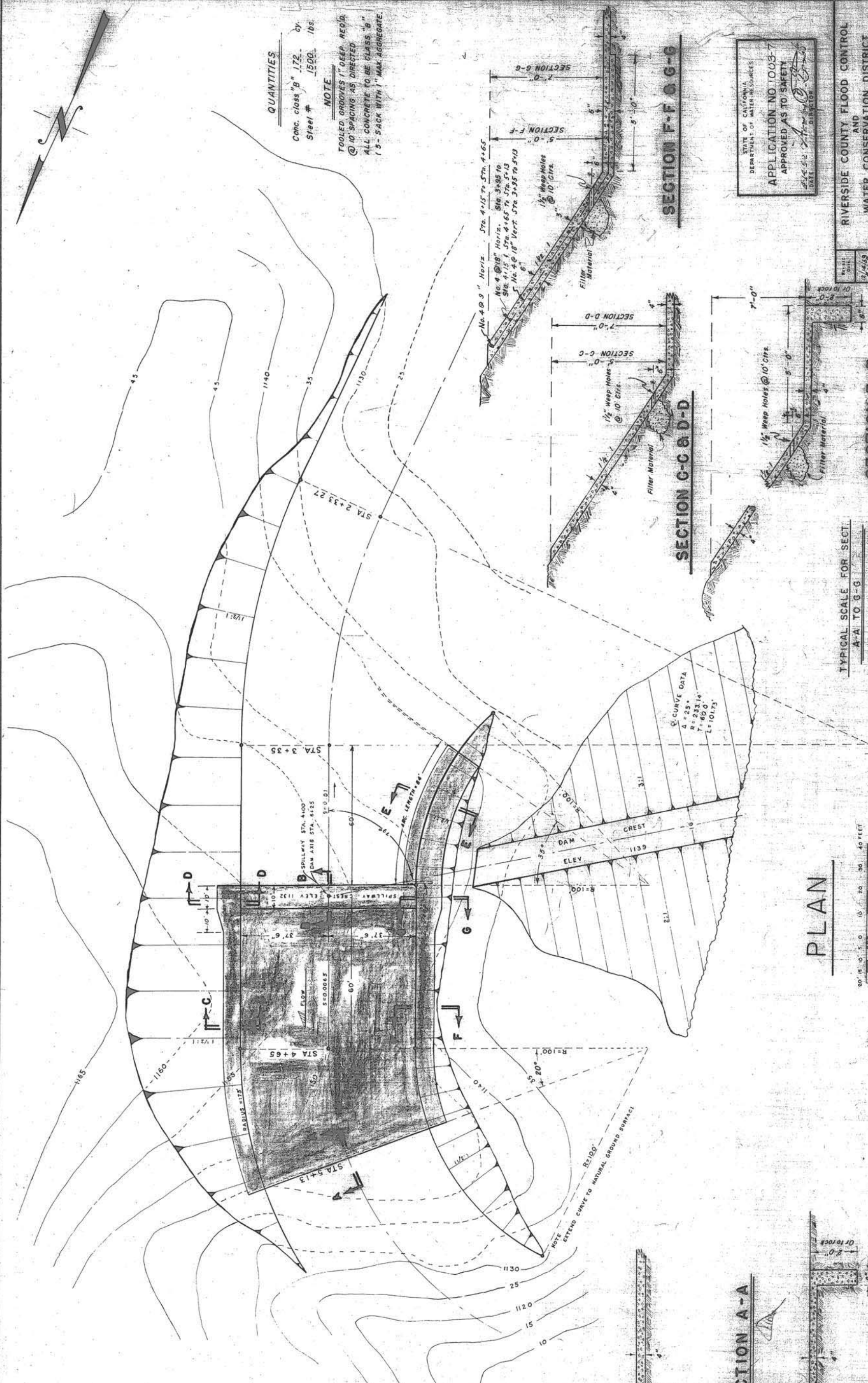
AS BUILT
Date: MARCH 1960

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
APPLICATION NO. 1003-7
APPROVED AS TO SAFETY
Henry O. B. B.
1960

DATE	3/15/60
BY	
CHECKED	
DESIGNED	
CONTRACT NO.	
PROJECT NO.	1-0-040
SHEET NO.	101
TOTAL SHEETS	101
DATE	3/15/60
BY	
CHECKED	
DESIGNED	
CONTRACT NO.	
PROJECT NO.	1-0-040
SHEET NO.	101
TOTAL SHEETS	101

RIVERSIDE COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT
BOX SPRINGS DAM
BENCH DRAIN DETAIL

CURVE	RADIUS	DEFL./FOOT
	270.64	0° 6' 21"
	233.14	0° 7' 24"
	193.64	0° 8' 47"
	175.0	0° 9' 49"
	137.5	0° 12' 30"
	100.0	0° 17' 11"



QUANTITIES

Conc. class "B"	172	cy.
Steel #	1500	lbs.

NOTE

TOOLED GROOVES 1" DEEP REQ'D.
@ 10" SPACING AS DIRECTED
ALL CONCRETE TO BE CLASS "B"
1 5/8" SACK WITH 1" MAX. AGGREGATE.

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

APPLICATION NO. 1003-7

APPROVED AS TO SAFETY

W. H. ...
DIRECTOR

DATE

RIVERSIDE COUNTY FLOOD CONTROL
 AND
 WATER CONSERVATION DISTRICT

BOX SPRINGS DAM

SPILLWAY LINING

DETAILS

Project No. **10-10-10**
 Date **10/10/10**

Drawn by **10-10-10**
 Checked by **10-10-10**
 Designated **10-10-10**

S BUILT
Date: March 1960 - J.W.D.