FLYING HORSE NORTH

COUNTY OF EL PASO, STATE OF COLORADO

IRRIGATION RESERVOIR EMBANKMENT

SECTION 31, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF 6TH PRINCIPAL MERIDIAN

WATER DIVISION 1, WATER DISTRICT 8

GENERAL CONSTRUCTION NOTES:

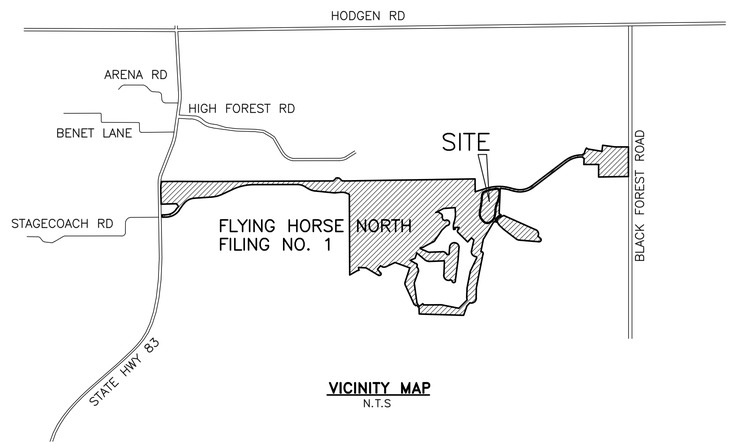
1. THE LOCATION OF EXISTING UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND MAY NOT INCLUDE ALL UTILITIES. THE EXCAVATION CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATED AND PRESERVE ANY AND ALL UTILITIES.
2. BEFORE COMMENCING ANY EXCAVATION, CALL **1-800-922-1987** FOR EXISTING UTILITY LOCATIONS.
3. THE CONTRACTOR WILL TAKE THE NECESSARY PRECAUTIONS TO PROTECT EXISTING UTILITIES FROM DAMAGE DUE TO THIS OPERATION. ANY DAMAGE TO THE UTILITIES WILL BE REPAIRED AT THE CONTRACTOR'S EXPENSE, AND ANY SERVICE DISRUPTION WILL BE SETTLED BY THE CONTRACTOR.
4. ALL BACKFILL, SUB-BASE AND/OR BASE COURSE (CLASS 6) MATERIAL SHALL BE COMPACTED TO THE SOILS ENGINEER'S RECOMMENDATIONS, AND APPROVED BY EL PASO COUNTY DEVELOPMENT SERVICES ENGINEERING DIVISION.
5. ALL STATIONING IS CENTERLINE UNLESS OTHERWISE INDICATED. ALL ELEVATIONS ARE CENTERLINE UNLESS OTHERWISE INDICATED.
6. THE CONTRACTOR SHALL REVEGETATE ALL DISTURBED AREAS AS SOON AS POSSIBLE AND EROSION CONTROL SHALL BE INSTALLED AND MAINTAINED IN A FUNCTIONAL MANNER AT ALL TIMES. DEVELOPER RESPONSIBLE FOR MAINTAINING DISTURBED AREAS UNTIL REVEGETATION IS COMPLETE.
7. ALL DISTURBED PAVEMENT EDGES SHALL BE CUT TO NEAT LINES. REPAIR SHALL CONFORM TO THE EPC ECM APPENDIX K – 1.2C.
8. ADDITIONAL EROSION CONTROL STRUCTURES MAY BE REQUIRED AT THE TIME OF CONSTRUCTION.
9. BUILDING CONTRACTORS WILL BE RESPONSIBLE FOR CONSTRUCTING POSITIVE DRAINAGE AWAY FROM ALL STRUCTURES.
10. ASPHALT THICKNESS AND BASE COURSE THICKNESS (COMPACTED) FOR ROADS SHALL BE PER DESIGN REPORT BY OWNER'S GEOTECHNICAL ENGINEER. OWNER'S GEOTECHNICAL ENGINEER TO BE ON SITE AT TIME OF ROAD CONSTRUCTION TO EVALUATE SOIL CONDITIONS AND DETERMINE IF ADDITIONAL MEASURES ARE NECESSARY TO ASSURE STABILITY OF THE NEW ROADS. PAVEMENT DESIGN SHALL BE APPROVED BY DEVELOPMENT SERVICES DEPARTMENT PRIOR TO CONSTRUCTION.
11. THE CONTRACTOR SHALL REVEGETATE ALL DISTURBED AREAS WITHIN 21 DAYS OF SUBSTANTIAL GRADING COMPLETION. EROSION CONTROL SHALL BE INSTALLED AND MAINTAINED IN A FUNCTIONAL MANNER AT ALL TIMES. DEVELOPER IS RESPONSIBLE FOR MAINTAINING DISTURBED AREAS UNTIL REVEGETATION IS COMPLETE.
12. TYPE M RIP-RAP WITH 4" OF TYPE II GRANULAR BEDDING AND MIRAFI 180N OR EQUAL MAY BE SUBSTITUTED WHERE TYPE L RIP-RAP WITH MIRAFI FW 700 OR EQUAL IS SPECIFIED
13. ALL MATERIALS AND INSTALLATION PROCEDURES SHALL BE IN COMPLIANCE WITH ANY AND ALL APPLICABLE EL PASO COUNTY STANDARDS.

STANDARD NOTES FOR EL PASO COUNTY CONSTRUCTION PLANS:

1. ALL DRAINAGE AND ROADWAY CONSTRUCTION SHALL MEET THE STANDARDS AND SPECIFICATIONS OF THE CITY OF COLORADO SPRINGS/EL PASO COUNTY DRAINAGE CRITERIA MANUAL, VOLUMES 1 AND 2, AND THE EL PASO COUNTY ENGINEERING CRITERIA MANUAL.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR THE NOTIFICATION AND FIELD NOTIFICATION OF ALL EXISTING UTILITIES, WHETHER SHOWN ON THE PLANS OR NOT, BEFORE BEGINNING CONSTRUCTION. LOCATION OF EXISTING UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. CALL 811 TO CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO (UNCC).
3. CONTRACTOR SHALL KEEP A COPY OF THESE APPROVED PLANS, THE GRADING AND EROSION CONTROL PLAN, THE STORMWATER MANAGEMENT PLAN (SWMP), THE SOILS AND GEOTECHNICAL REPORT, AND THE APPROPRIATE DESIGN AND CONSTRUCTION STANDARDS AND SPECIFICATIONS AT THE JOB SITE AT ALL TIMES, INCLUDING THE FOLLOWING:
   a. EL PASO COUNTY ENGINEERING CRITERIA MANUAL (ECM)
   b. CITY OF COLORADO SPRINGS/EL PASO COUNTY DRAINAGE CRITERIA MANUAL, VOLUMES 1 AND 2
   c. COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION
   d. CDOT M & S STANDARDS
4. NOTWITHSTANDING ANYTHING DEPICTED IN THESE PLANS IN WORDS OR GRAPHIC REPRESENTATION, ALL DESIGN AND CONSTRUCTION RELATED TO ROADS, STORM DRAINAGE AND EROSION CONTROL SHALL CONFORM TO THE STANDARDS AND REQUIREMENTS OF THE MOST RECENT VERSION OF THE RELEVANT ADOPTED EL PASO COUNTY STANDARDS, INCLUDING THE LAND DEVELOPMENT CODE, THE ENGINEERING CRITERIA MANUAL, THE DRAINAGE CRITERIA MANUAL, AND THE DRAINAGE CRITERIA MANUAL VOLUME 2. ANY DEVIATIONS FROM REGULATIONS AND STANDARDS MUST BE REQUESTED, AND APPROVED, IN WRITING. ANY MODIFICATIONS NECESSARY TO MEET CRITERIA AFTER-THE-FACT WILL BE ENTIRELY THE DEVELOPER'S RESPONSIBILITY TO RECTIFY.
5. IT IS THE DESIGN ENGINEER'S RESPONSIBILITY TO ACCURATELY SHOW EXISTING CONDITIONS, BOTH ONSITE AND OFFSITE, ON THE CONSTRUCTION PLANS. ANY MODIFICATIONS NECESSARY DUE TO CONFLICTS, OMISSIONS, OR CHANGED CONDITIONS WILL BE ENTIRELY THE DEVELOPER'S RESPONSIBILITY TO RECTIFY.
6. CONTRACTOR SHALL SCHEDULE A PRE-CONSTRUCTION MEETING WITH EL PASO COUNTY PLANNING AND COMMUNITY DEVELOPMENT – INSPECTIONS, PRIOR TO STARTING CONSTRUCTION.
7. IT IS THE CONTRACTOR'S RESPONSIBILITY TO UNDERSTAND THE REQUIREMENTS OF ALL JURISDICTIONAL AGENCIES AND TO OBTAIN ALL REQUIRED PERMITS, INCLUDING BUT NOT LIMITED TO EL PASO COUNTY EROSION AND STORMWATER QUALITY CONTROL PERMIT (ESQCP), REGIONAL BUILDING FLOODPLAIN DEVELOPMENT PERMIT, U.S. ARMY CORPS OF ENGINEERS-ISSUED 401 AND/OR 404 PERMITS, AND COUNTY AND STATE FUGITIVE DUST PERMITS.
8. CONTRACTOR SHALL NOT DEVIATE FROM THE PLANS WITHOUT FIRST OBTAINING WRITTEN APPROVAL FROM THE DESIGN ENGINEER AND DSD. CONTRACTOR SHALL NOTIFY THE DESIGN ENGINEER IMMEDIATELY UPON DISCOVERY OF ANY ERRORS OR INCONSISTENCIES.
9. ALL STORM DRAIN PIPE SHALL BE CLASS III RCP UNLESS OTHERWISE NOTED AND APPROVED BY DSD.
10. CONTRACTOR SHALL COORDINATE GEOTECHNICAL TESTING PER ECM STANDARDS. PAVEMENT DESIGN SHALL BE APPROVED BY EL PASO COUNTY DSD PRIOR TO PLACEMENT OF CURB AND GUTTER AND PAVEMENT.
11. ALL CONSTRUCTION TRAFFIC MUST ENTER/EXIT THE SITE AT APPROVED CONSTRUCTION ACCESS POINTS.
12. SIGHT VISIBILITY TRIANGLES AS IDENTIFIED IN THE PLANS SHALL BE PROVIDED AT ALL INTERSECTIONS. OBSTRUCTIONS GREATER THAN 18 INCHES ABOVE FLOWLINE ARE NOT ALLOWED WITHIN SIGHT TRIANGLES.
13. SIGNING AND STRIPING SHALL COMPLY WITH EL PASO COUNTY DOT AND MUTCD CRITERIA.
14. CONTRACTOR SHALL OBTAIN ANY PERMITS REQUIRED BY EL PASO COUNTY DOT, INCLUDING WORK WITHIN THE RIGHT-OF-WAY AND SPECIAL TRANSPORT PERMITS.
15. THE LIMITS OF CONSTRUCTION SHALL REMAIN WITHIN THE PROPERTY LINE UNLESS OTHERWISE NOTED. THE OWNER/DEVELOPER SHALL OBTAIN WRITTEN PERMISSION AND EASEMENTS, WHERE REQUIRED, FROM ADJOINING PROPERTY OWNER(S) PRIOR TO ANY OFF-SITE DISTURBANCE, GRADING, OR CONSTRUCTION.

SIGNING AND STRIPING NOTES:

1. ALL SIGNS AND PAVEMENT MARKINGS SHALL BE IN COMPLIANCE WITH THE CURRENT MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD).
2. REMOVAL OF EXISTING PAVEMENT MARKINGS SHALL BE ACCOMPLISHED BY A METHOD THAT DOES NOT MATERIALLY DAMAGE THE PAVEMENT. THE PAVEMENT MARKINGS SHALL BE REMOVED TO THE EXTENT THAT THEY WILL NOT BE VISIBLE UNDER DAY OR NIGHT CONDITIONS. AT NO TIME WILL IT BE ACCEPTABLE TO PAINT OVER EXISTING PAVEMENT MARKINGS.
3. ANY DEVIATION FROM THE STRIPING AND SIGNING PLAN SHALL BE APPROVED BY EL PASO COUNTY PLANNING AND COMMUNITY DEVELOPMENT.
4. ALL SIGNS SHOWN ON THE SIGNING AND STRIPING PLAN SHALL BE NEW SIGNS. EXISTING SIGNS MAY REMAIN OR BE REUSED IF THEY MEET CURRENT EL PASO COUNTY AND MUTCD STANDARDS.
5. STREET NAME AND REGULATORY STOP SIGNS SHALL BE ON THE SAME POST AT INTERSECTIONS.
6. ALL REMOVED SIGNS SHALL BE DISPOSED OF IN A PROPER MANNER BY THE CONTRACTOR.
7. ALL STREET NAME SIGNS SHALL HAVE "D" SERIES LETTERS, WITH LOCAL ROADWAY SIGNS BEING 4" UPPER-LOWER CASE LETTERING ON 8" BLANK AND NON-LOCAL ROADWAY SIGNS BEING 6" LETTERING, UPPER-LOWER CASE ON 12" BLANK, WITH A WHITE BORDER THAT IS NOT RECESSED. MULTI-LANE ROADWAYS WITH SPEED LIMITS OF 40 MPH OR HIGHER SHALL HAVE 8" UPPER-LOWER CASE LETTERING ON 18" BLANK WITH A WHITE BORDER THAT IS NOT RECESSED. THE WIDTH OF THE NON-RECESSED WHITE BORDERS SHALL MATCH PAGE 255 OF THE 2012 MUTCD "STANDARD HIGHWAY SIGNS."
8. ALL TRAFFIC SIGNS SHALL HAVE A MINIMUM HIGH INTENSITY PRISMATIC GRADE SHEETING.
9. ALL LOCAL RESIDENTIAL STREET SIGNS SHALL BE MOUNTED ON A 1.75" X 1.75" SQUARE TUBE SIGN POST AND STUB POST BASE. FOR OTHER APPLICATIONS, REFER TO THE CDOT STANDARD S-614-8 REGARDING USE OF THE P2 TUBULAR STEEL POST SLIPBASE DESIGN.
10. ALL SIGNS SHALL BE SINGLE SHEET ALUMINUM WITH 0.100" MINIMUM THICKNESS.
11. ALL LIMIT LINES/STOP LINES, CROSSWALK LINES, PAVEMENT LEGENDS, AND ARROWS SHALL BE A MINIMUM 125 MIL THICKNESS PREFORMED THERMOPLASTIC PAVEMENT MARKINGS WITH TAPERED LEADING EDGES PER CDOT STANDARD S-627-1. WORD AND SYMBOL MARKINGS SHALL BE THE NARROW TYPE. STOP BARS SHALL BE 24" IN WIDTH. CROSSWALKS LINES SHALL BE 12" WIDE AND 8' LONG PER CDOT S-627-1.
12. ALL LONGITUDINAL LINES SHALL BE A MINIMUM 15MIL THICKNESS EPOXY PAINT. ALL NON-LOCAL RESIDENTIAL ROADWAYS SHALL INCLUDE BOTH RIGHT AND LEFT EDGE LINE STRIPING AND ANY ADDITIONAL STRIPING AS REQUIRED BY CDOT S-627-1.
13. THE CONTRACTOR SHALL NOTIFY EL PASO COUNTY DEVELOPMENT SERVICES **(719) 520-6819** PRIOR TO AND UPON COMPLETION OF SIGNING AND STRIPING.
14. THE CONTRACTOR SHALL OBTAIN A WORK IN THE RIGHT OF WAY PERMIT FROM THE EL PASO COUNTY PUBLIC SERVICES DEPARTMENT (PSD) PRIOR TO ANY SIGNAGE OR STRIPING WORK WITHIN AN EXISTING EL PASO COUNTY ROADWAY.



VICINITY MAP
N.T.S

SHEET INDEX

Include the design engineer's statement.

CONTACT INFORMATION:

PROPERTY OWNER/DEVELOPER:	PRI #2 LLC 6385 CORPORATE DRIVE, SUITE 200 COLORADO SPRINGS, CO 80919 MR. DREW BALSICK, (719) 592-9333
CIVIL ENGINEER:	CLASSIC CONSULTING ENGINEERS & SURVEYORS 619 N. CASCADE, SUITE 200 COLORADO SPRINGS, CO 80903 MR. MARC A. WHORTON, P.E. (719) 785-2802
GEOTECHNICAL ENGINEER:	ENTECH ENGINEERING LLC 505 ELKTON DRIVE COLORADO SPRINGS, CO 80907 MR. JOE GOODE, P.E. (719) 531-5599
DAM SAFETY ENGINEER:	COLORADO DIVISION OF WATER RESOURCES 4255 SINTON ROAD COLORADO SPRINGS, CO 80907 MR. JOHN HUNYADI, P.E. (719) 227-5294
COUNTY ENGINEERING	EL PASO COUNTY PLANNING AND COMMUNITY DEVELOPMENT 2880 INTERNATIONAL CIRCLE, SUITE 110 COLORADO SPRINGS, COLORADO 80903 MR. GILBERT LAFORCE, (719) 520-7945

OWNER/DEVELOPER'S STATEMENT:

I, THE OWNER/DEVELOPER HAVE READ AND WILL COMPLY WITH THE REQUIREMENTS SPECIFIED IN THESE DETAILED PLANS AND SPECIFICATIONS.

_____ DATE
MR. DREW BALSICK
PRI #2

EL PASO COUNTY:

COUNTY PLAN REVIEW IS PROVIDED ONLY FOR GENERAL CONFORMANCE WITH COUNTY DESIGN CRITERIA. THE COUNTY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, DIMENSIONS, AND/OR ELEVATIONS WHICH SHALL BE CONFIRMED AT THE JOB SITE. THE COUNTY THROUGH THE APPROVAL OF THIS DOCUMENT ASSUMES NO RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

FILED IN ACCORDANCE WITH THE REQUIREMENTS OF THE EL PASO COUNTY LAND DEVELOPMENT CODE, DRAINAGE CRITERIA MANUAL, VOLUMES 1 AND 2 AND ENGINEERING CRITERIA MANUAL AS AMENDED.

IN ACCORDANCE WITH WITH ECM SECTION 1.12, THESE CONSTRUCTION DOCUMENTS WILL BE VALID FOR CONSTRUCTION FOR A PERIOD OF 2 YEARS FROM THE DATE SIGNED BY THE EL PASO COUNTY ENGINEER. IF CONSTRUCTION HAS NOT STARTED WITHIN THOSE 2 YEARS, THE PLANS WILL NEED TO BE RESUBMITTED FOR APPROVAL, INCLUDING PAYMENT OF REVIEW FEES AT THE PLANNING AND COMMUNITY DEVELOPMENT DIRECTOR'S DISCRETION.

_____ DATE
JENNIFER IRVINE, P.E.
COUNTY ENGINEER / ECM ADMINISTRATOR

STATE ENGNEER APPROVAL:

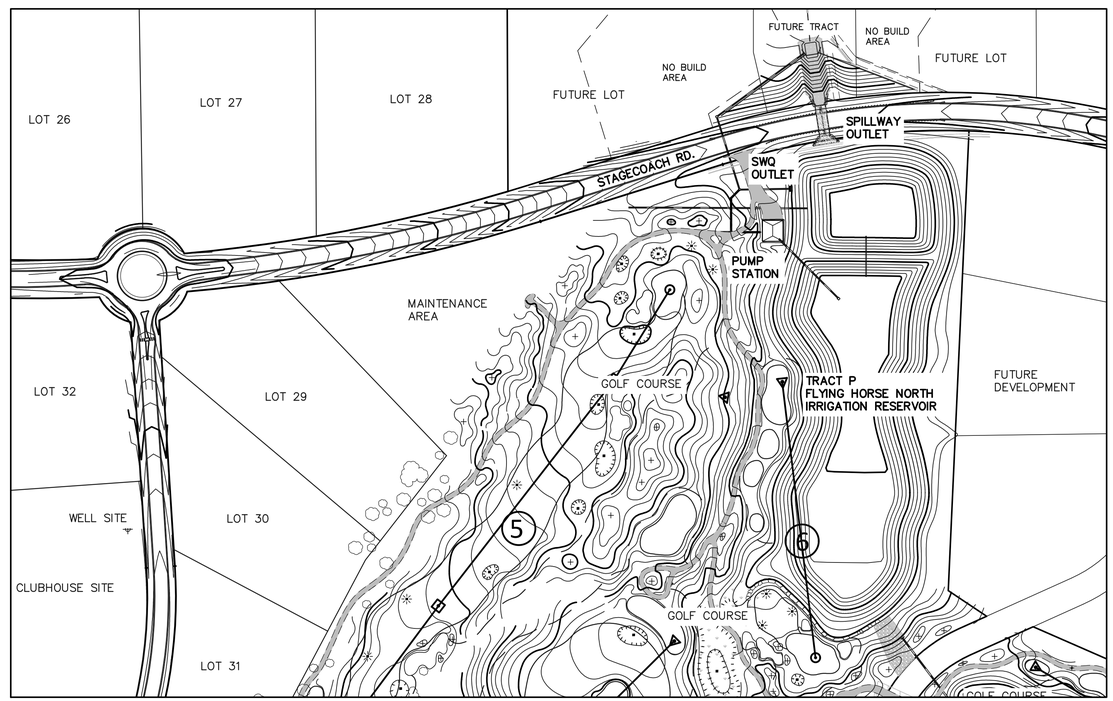
APPROVED ON THE _____ DAY OF _____ 2018

_____
STATE ENGINEER

BY: _____
DEPUTY STATE ENGINEER

THESE PLANS REPRESENT THE **AS-CONSTRUCTED** CONDITIONS OF THE FLYING HORSE NORTH IRRIGATION RESERVOIR EMBANKMENT TO THE BEST OF OUR KNOWLEDGE AND JUDGEMENT, BASED IN PART ON INFORMATION FURNISHED BY OTHERS, AS OF THE _____ DAY OF _____ 2018.

_____
FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC
MARC A. WHORTON, P.E. #37155



KEY MAP
N.T.S.

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C-2085

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE
1	REVISED PER STATE COMMENTS	4-3-18

DESIGN ENGNEER SIGNATURE:

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

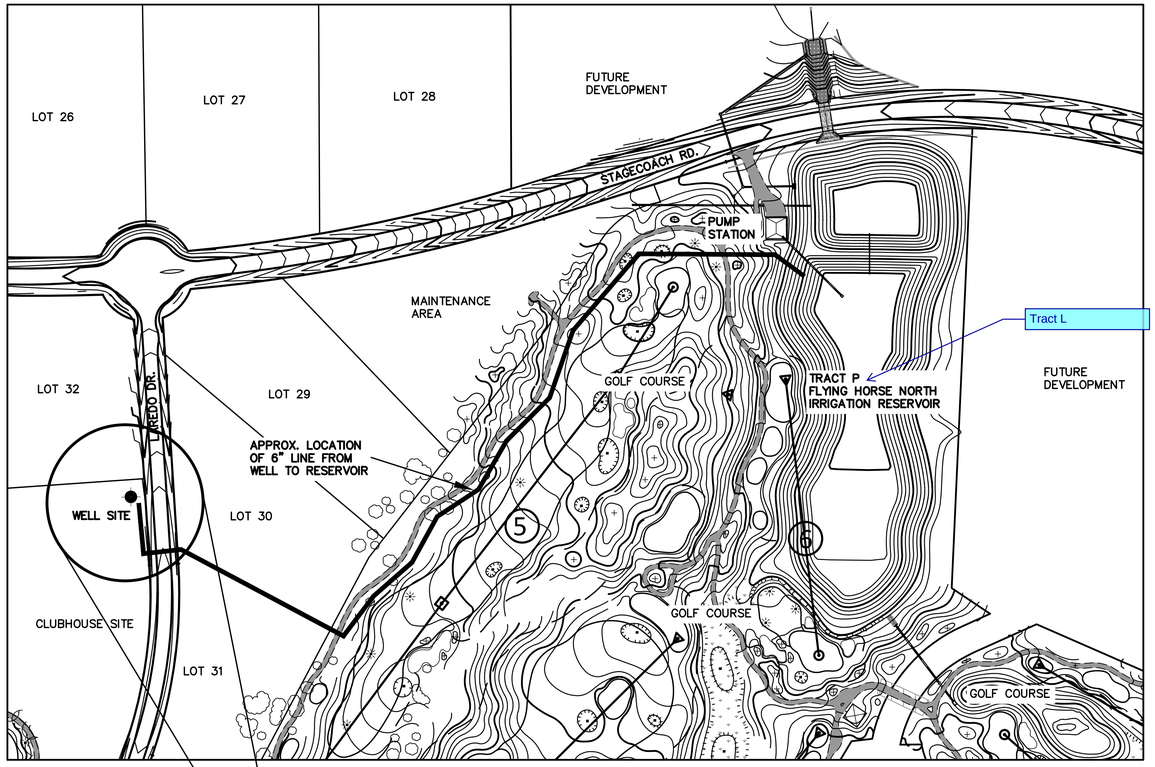
_____ DATE
MARC A. WHORTON, P.E. #37155

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
TITLE SHEET
DAM ID – 080459

DESIGNED BY	MAW	SCALE	DATE	1-4-18
DRAWN BY	MAW	(H) 1"= N/A	SHEET	1 OF 12
CHECKED BY		(V) 1"= N/A	JOB NO.	1096.11

N:\10961\DRAWINGS\CONSTRUCTION\Jurisdictional Plans\1-D POND TITLE.dwg, 6/15/2018 8:37:41 AM, 1:1



KEY MAP
N.T.S.

WELL INFORMATION:

WELL NAME: FLYING HORSE NORTH A–1

LOCATION: SEC. 36, T 11 SOUTH, R 66 WEST, 6TH P.M.
NORTHING: 1445275.0
EASTING: 3220345.0
(STATE PLANE)

PERMIT # 81145–F

ISSUE DATE: 7/24/17

WATER DIVISION 1

WATER DISTRICT 8

ARAPAHOE AQUIFER
TOTAL DEPTH 2400 FT.

Layne-Western, a Division of Layne Christensen Company
17800 East 22nd Avenue
Aurora, CO 80011
Phone: 303-755-1281, FAX: 303-755-1236, E-Mail: 1031@laynechristensen.com

WELL TEST
TEST ENGINE

Well #: A/1 Customer: FLYING HORSE CIty: BLACK FOREST State: COLORADO
Job #: 47170 Date: 12/1/2017 Test Type (Step, Continuous, Duration): CONT Tested By: SNYDER
Pump Setting Depth (ft): 1830 Transducer setting depth: 1812.26
Static Water Level (ft): [Pitot-of (psi)] (ft): 1534 Airline Length (ft): 1812.26
Airline Reading @ Start (psi): 4237 Transducer reading @ Start: 2775FT
Airline Reading @ End (psi): 125
Flow Meter Totalizer-Start: 0 Flow Meter Totalizer-End: 591333 Flow Meter Size (dia): 6
MOTOR: 350HP @ 2054V Test Pump Make & Model: GE12000 # Pump Stages: 31 Probe Model: 900PSI DYNOTEC
Ground Level Correction: Pumping water levels (column F) are from ground level. M-Scope readings (Column C) are actual from top of sounder tube.

Time of Day (am/pm)	Elapsed Time (min)	GPM	AIR	Transducer #1	Pumping Level (ft)	Drawdown (ft)	Amps	Volts	Hertz	Discharge Pressure	Sand Test (ml/min)	Flow Meter Totalizer	Remarks (adjustments, conditions, etc.)
908A	0	0	125	277	0	0	0	0	0	0	0	0	ROUGH PUMP
925A	17	196	109	234.13	1578.15	44.15	X	X	47	14	0.7	1266	ORANGE WATER
927A	19	194	107	231	1581.28	47.28	X	X	X	14	0.8	1652	
929A	21	188	105	229	1583.28	49.28	X	X	46.7	12	0.7	2034	
931A	23	188	105	225	1587.28	53.28	X	X	X	12	-	2492	
933A	25	183	105	223.91	1588.37	54.37	X	X	X	12	0.7	2892	ORANGE WATER
935A	27	186	104	221	1591.28	57.28	355	317	47	-	0.7	3137	
937A	29	193	101	223.5	1588.78	54.78	X	X	X	14	0.7	3602	
939A	31	197	101	221.2	1591.08	57.08	X	X	X	14	0.7	3931	
943A	35	202	100	219.93	1592.65	58.65	X	X	X	12	0.7	4654	
945A	37	196	101	215.8	1596.48	62.48	X	X	X	10	0.7	4992	
950A	42	203	100	215.03	1597.25	63.25	X	X	X	10	0.7	6008	
955A	47	196	99	212.02	1600.26	66.26	X	X	X	10	0.7	6990	
1000A	52	200	99	209	1603.28	69.28	X	X	X	10	0.7	7983	
1006A	60	194	98	203.94	1608.34	68.34	X	X	X	10	0.7	8521	
1018A	72	203	96	211.69	1600.59	66.59	X	X	X	10	0.7	11468	SCALE FROM 4-5
1026A	80	195	95	207.46	1604.82	70.82	X	X	X	10	0.7	13384	CLEAN OUT TUBE
1038A	90	203	95	207.29	1604.99	70.99	X	X	X	10	0	15413	
1048A	100	191	94	206.28	1606	72	X	X	X	10	0	17321	
1058A	110	192	94	204.36	1607.92	73.92	356	318	47	10	0	19135	
1108A	120	195	94	202.2	1610.08	76.08	X	X	X	10	0	20961	
1110A	122	299	90	185.28	1626	92	415	412	51.9	15	0	21629	
1112A	124	300	86	180.9	1631.38	97.38	X	X	51.9	15	0	22145	
1114A	126	302	84	177.36	1634.88	100.88	X	X	51.9	15	0	22737	
1116	128	302	84	175.04	1637.24	103.24	X	X	51.9	15	0	23444	
1118	130	299	82	173.74	1638.54	104.54	X	X	51.9	15	0	23947	
1120A	132	300	82	172.39	1639.89	105.89	X	X	51.9	15	0	24562	
1122A	134	299	81	171.25	1641.03	107.03	X	X	51.9	15	0	25163	
1124A	136	300	81	170.27	1642.01	108.01	X	X	51.9	15	0	25874	
1126A	138	298	81	170.03	1642.25	108.25	X	X	51.9	15	0	26372	
1128A	140	299	80	169.54	1642.74	108.74	X	X	51.9	15	0	27024	
1130A	142	300	80	168.2	1644.08	110.08	X	X	51.9	15	TRACE	27689	ADJUST VALVE
1135A	147	297	80	166.77	1645.51	111.51	X	X	51.9	15	TRACE	29033	ADJUST VALVE
Time of Day (am/pm)	Elapsed Time (min)	GPM	AIR	Transducer #1	Pumping Level (ft)	Drawdown (ft)	Amps	Volts	Hertz	Discharge Pressure	Sand Test (ml/min)	Flow Meter Totalizer	Remarks (adjustments, conditions, etc.)

47170 FLYING HORSE GOLF PUMP TEST.xlsx Page # 1 of 3

1140A	152	299	80	165.22	1647.06	113.06	X	X	51.9	15	TRACE	30553	
1145A	157	-	X	X	X	X	X	X	X	X	X	X	
1155A	167	297	79	163.68	1648.6	114.6	X	X	X	15	TRACE	33487	
1155A	167	296	79	163.02	1649.26	115.26	415	414	52	15	TRACE	34988	
1200P	172	299	77	161.8	1650.48	116.48	X	X	52	15	TRACE	36472	
1205P	177	300	77	160.58	1651.7	117.7	415	414	52	15	TRACE	37972	
1210P	182	300	76	160.01	1652.27	118.27	X	X	52	15	TRACE	39457	
1220P	192	297	76	159.2	1653.08	119.08	415	414	52	15	TRACE	42457	
1230P	202	300	76	157.77	1654.31	120.31	415	414	52	15	TRACE	45459	
1240P	212	299	75	157.38	1654.92	120.92	X	X	52	15	TRACE	48414	
1250P	222	299	75	156.06	1656.22	122.22	415	414	52	15	TRACE	51383	
1300	232	299	75	155.29	1656.99	122.99	415	414	52	14	TRACE	54372	
1308	240	298	75	153.96	1658.42	124.42	415	414	52	14	TRACE	56570	
1310	242	438	X	X	X	X	X	X	58.9	X	X	57083	
1312	244	450	62	123.93	1688.35	154.35	X	X	58.9	10	TRACE	58543	
1314	246	448	59	118.27	1694.01	160.01	X	X	58.9	10	TRACE	59500	
1316	248	448	59	116.03	1696.25	162.25	X	X	58.9	10	TRACE	60231	
1318	250	449	57	114.48	1697.8	163.8	X	X	58.9	10	0.1	60989	
1320	252	446	56	112.97	1699.31	165.31	509	461	59	10	0.1	61886	
1322	254	447	55	110.73	1701.55	167.55	X	X	59	10	0.1	63136	
1324	256	448	55	110	1702.28	168.28	X	X	59	10	0.1	63696	
1326	258	446	55	109.19	1703.09	169.09	X	X	59	10	0.1	64572	
1328	260	447	54	107.76	1704.52	170.52	X	X	59	9	0.2	65659	
1330	262	445	54	107.31	1704.97	170.97	X	X	59	9	0.2	66345	
1335	267	450	52	104.58	1707.7	173.7	X	X	59.2	9	0.2	68606	
1340	272	453	52	102.79	1709.49	175.49	X	X	59.2	9	0.2	70873	
1345	277	449	51	101.9	1710.38	176.38	X	X	59.2	9	0.2	73126	
1350	282	449	51	100.51	1711.77	177.77	X	X	59.2	9	0.25	75371	
1355	287	450	50	99.45	1712.83	178.83	509	461	59.2	9	0.3	77566	
1400	292	449	50	98.67	1713.61	179.61	X	X	59.2	9	0.3	79816	
1410	302	450	50	97.57	1714.71	180.71	X	X	59.2	9	0.3	84235	
1420	312	449	50	95.5	1716.78	182.78	X	X	59.2	9	0.3	88769	
1430	322	448	49	94.64	1717.64	183.64	X	X	59.2	9	0.3	93268	
1440	332	447	48	92.52	1719.76	185.76	X	X	59.2	9	0.3	98695	
1450	342	450	47	91.71	1720.57	186.57	X	X	59.2	9	0.3	102268	
1500	352	450	46	90.41	1721.87	187.87	X	X	59.2	9	0.35	106744	
1515	367	449	45	89.49	1722.81	188.31	X	X	59.2	9	0.4	113868	
1530	382	447	45	88.17	1724.11	190.11	X	X	59.2	10	0.4	120007	
1545	397	449	45	96.66	1725.62	191.62	512	472	59.4	9.5	0.4	126730	SURGE IN PUMP
1600	412	449	45	86.01	1726.27	192.27	X	X	59.4	9.5	0.4	133398	
1615	427	448	42	84.54	1727.74	193.74	X	X	59.4	9.5	0.4	140493	
1630	442	448	42	84.79	1727.49	193.49	X	X	59.4	9.5	0.4	146691	
Time of Day (am/pm)	Elapsed Time (min)	GPM	AIR	Transducer #1	Pumping Level (ft)	Drawdown (ft)	Amps	Volts	Hertz	Discharge Pressure	Sand Test (ml/min)	Flow Meter Totalizer	Remarks (adjustments, conditions, etc.)
1645	457	446	42	82.79	1729.49	195.49	X	X	59.4	9.5	0.4	153478	
1700	472	449	42	81.53	1730.45	196.45	X	X	59.4	9.5	0.4	160164	
1730	502	449	41	80.39	1731.89	197.89	512	475	59.4	9.5	0.45	173506	

47170 FLYING HORSE GOLF PUMP TEST.xlsx Page # 2 of 3

1800	532	445	40	78.03	1734.25	200.25	X	X	X	9.5	0.5	185374	
1830	562	446	40	76.22	1735.96	201.96	X	X	X	9.5	0.5	199707	
1900	592	445	40	75.22	1737.06	203.06	X	X	X	9.5	0.5	213059	
2000	652	446	39	72.98	1739.3	205.3	X	X	59.4	9	0.5	229494	
2100	712	445	37	71.27	1741.01	207.01	X	X	X	9	0.5	265900	
2200	772	445	37	69.03	1743.25	209.25	X	X	X	9.5	0.5	292248	
2300	832	442	35	67.93	1744.35	210.35	511	471	59.5	9	0.5	318539	
2400	892	448	35	66.79	1745.49	211.49	X	X	X	10	0.6	344891	
100A	952	448	34	65.69	1746.59	212.59	X	X	X	10	0.6	370800	
200A	1012	445	34	63.41	1748.87	214.87	X	X	59.6	9	0.6	396906	
300A	1072	447	33	62.84	1749.44	215.44	X	X	X	10	0.6	422522	
400A	1132	443	33	61.17	1751.11	217.11	513	470	59.6	10	0.6	449018	
500A	1192	448	30	58.69	1753.67	221.67	X	X	X	10	0.6	475551	
600A	1252	448	29	54.98	1757.3	223.3	X	X	X	10	0.6	502254	
700A	1312	448	29	53.88	1758.4	224.4	X	X	X	10	0.6	529291	
800A	1372	447	27	52.65	1759.63	225.63	513	471	59.8	8.5	0.6	556394	
900A	1432	449	26	51.23	1761.05	227.05	513	471	59.8	8.5	0.6	583199	
918A	1450	449	26	50.82	1761.46	227.46	514	472	59.8	8	0.6	591333	
919A	X	X	X	63.56	1708.72	174.72	X	X	X	X	X	X	
929A	X	X	X	156.42	1655.86	121.86	X	X	X	X	X	X	
1027A	X	X	X	201.23	1611.05	77.05	X	X	X	X	X	X	
1101A	X	X	X	208.84	1603.44	69.44	X	X	X	X	X	X	

47170 FLYING HORSE GOLF PUMP TEST.xlsx Page # 3 of 3

Form No. GWS-31 02/2017

WELL CONSTRUCTION AND YIELD ESTIMATE REPORT
State of Colorado, Office of the State Engineer
1313 Sherman St., Room 821, Denver, CO 80203 303.866.3581
www.water.state.co.us and dwrpermitsonline@state.co.us

For Office Use Only

1. Well Permit Number: 811145-F **Receipt Number:** 3680462
2. Owner's Well Designation: A1
3. Well Owner Name: PRIIF2
4. Well Location Street Address: N/A
5. As Built GPS Well Location (required): ☐ Zone 12 ☒ Zone 13 Easting: 523876.9 Northing: 4322742.4
6. Legal Well Location: NE 1/4, NE 1/4, Sec., 36 Twp. 11 ☐ N or S ☒, Range 66 ☐ E or W ☒, 6 P.M.
County: El Paso
Subdivision: _____, Lot ____, Block _____, Filing (Unit) _____
7. Ground Surface Elevation: ____ feet **Date Completed:** 11/15/2017 **Drilling Method:** Reverse Air
8. Completed Aquifer Name : Arapahoe **Total Depth:** 2555 feet **Depth Completed:** 2540 feet
9. Advance Notification: Was Notification Required Prior to Construction? ☒ Yes ☐ No, Date Notification Given: _____
10. Aquifer Type: (Check one) ☐ Type I (One Confining Layer) ☒ Type I (Multiple Confining Layers) ☐ Laramie-Fox Hills ☐ Type II (Not overlain by Type III) ☐ Type II (Overlain by Type III) ☐ Type III (alluvial/colluvial)

11. Geologic Log:

Depth	Type	Grain Size	Color	Water Loc.
60-140	Clay/Gravel	Small	Gray	
140-170	Clay		Brown	
170-810	Clay/Sand	Small	Tan	
810-1250	Clay		Gray	
1250-2220	Sandy Clay	Small	Tan	
2220-2300	Shale/Clay		Black/Gray	
2300-2520	Sand/Clay	Small	Gray	
2520-2555	Clay		Gray	

12. Hole Diameter (in.)

	From (ft)	To (ft)
30	0	60
17.5	60	2555

13. Plain Casing

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
10.75	Steel	.375	2210	0
10.75	Steel	.375	2270	2280
10.75	Steel	.375	2520	2540

Perforated Casing Screen Slot Size (in): 40

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
10.75	SS	.375	2270	2210
10.75	SS	.375	2520	2280

14. Filter Pack: Material Silica Sand, Size 8/16, Interval 2555-2035
15. Packer Placement: Type _____, Depth _____
16. Grouting Record

Material	Amount	Density	Interval	Method
Neet Cement	83 YDS	7	2035-0	Tremie

Remarks:

17. Disinfection: Type HTH Chlorine Amt. Used 10 GAL
18. Well Yield Estimate Data: ☐ Check box if Test Data is submitted on Form Number GWS-39, Well Yield Test Report
Well Yield Estimate Method: Submersible Pump
Static Level: 1534 Estimated Yield (gpm) 450
Date/Time measured: 12/1/2017 Estimated Length (hrs) 24
Remarks:
19. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402 2. The filing of a document that contains false statements is a violation of section 37 91 108(1)(e), C.R.S., and is punishable by fines up to $1,000 and/or revocation of the contracting license. If filing online the State Engineer considers the entry of the licensed contractor's name to be compliance with Rule 17.4.

Company Name:	Email:	Phone w/area code:	License Number:
Layne Christensen CO	mike.schanaman@layne.com	(303) 755-1281	1290

Mailing Address: 17800 E22nd Ave. Aurora Colorado 80011

Sign (or enter name if filing online)	Print Name and Title	Date:
Mike Schanaman	Mike Schanaman, Project Manager	12/04/2017

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, P.E. #37155 DATE

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH IRRIGATION RESERVOIR EMBANKMENT

WELL SITE / TEST REPORTS

DESIGNED BY	MAW	SCALE	DATE 1–4–18
DRAWN BY	MAW	(H) 1"= N/A	SHEET 2 OF 12
CHECKED BY		(V) 1"= N/A	JOB NO. 1096.11

N:\1096\11\DRAWINGS\CONSTRUCTION\Jurisdictional Plans\2-JD POND - Well Site - 3.dwg, 1/12/2018 3:30:03 PM, DWG To PDF.pc3

PUMP STATION SPECIFICATIONS:
NAME: FLYING HORSE RANCH
STATION MODEL:
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

STATION TOTAL PERFORMANCE:
2250GPM @ 110PSI
3000GPM @ 110PSI (FUTURE)

PUMP HORSEPOWER:
SUSTAIN PUMP: 5HP
PUMP NO.1-3: 75HP
PUMP NO.4: 75HP (FUTURE PUMP/MOTOR)

CHECK VALVE SIZE
SUSTAIN: BUILT IN
PUMP NO.1-2: 6"

ISOLATION VALVE SIZES:
SUSTAIN PUMP: 2",
PUMP NO.1-2: 5" (EBV)

DISCHARGE ISOLATION VALVE: 10"
RELIEF VALVE SIZE: 6"

PUMP STATION DISCONNECT: 600 AMP
POWER REQUIREMENTS:
480V, 60 HZ, 3 PZ, 386 FLA
EXHAUST FAN REQ'D FOR BUILDING:
5400 CFM

WET WELL DIMS: ..... Ø96"

WET WELL DEPTH: ...25'-0"

MAIN LINE CONNECTION: .... *16" FLANGED*
NOMINAL PIPE SIZE: ..... *NA*

DROP PIPE COVER: ..... 48"
INTAKE FLUME PIPE SIZE: .....*30"*
INTAKE FLUME MATERIAL:.....SDR35 PVC
OD .....32"

PLEASE VERIFY ALL INFO WITH YOUR INITIALS AND DATE

PLEASE INDICATE POWER SUPPLY CONDITION BELOW FOR FCC COMPLIANCE. REFER TO WATERTRONICS DRAWING # FCC-1 FOR ADDITIONAL INFORMATION

- ☐ A: CONNECTED THROUGH A COMMERCIAL BUILDING
- ☐ B: CONNECTED THROUGH A DEDICATED TRANSFORMER
- ☐ C: CONNECTED THROUGH A PAD TRANSFORMER SHARED WITH OTHER NON-RESIDENTIAL EQUIPMENT.
- ☐ D: CONNECTED TO A POLE TRANSFORMER ON A RESIDENTIAL POWER GRID.
- ☐ E: CONNECTED TO A PAD TRANSFORMER SHARED WITH RESIDENTIAL DWELLINGS.

PLEASE USE THE SPACE BELOW FOR ANY ADDITIONAL COMMENTS:
1. *MIN. WATER LEVEL IN THE WET WELL 56" FROM THE BOTTOM*
2. *NORMAL WATER LEVEL AT THE WET WELL ??*
3. *MAX/HIGH WATER LEVEL IN THE WET WELL ??*
4. *TO DRAIN THE BOND COMPLETELY THE BOTTOM OF THE BOND NEED TO BE LOWER THAN THE BOTTOM OF WET WELL !*

☐ APPROVED AS SUBMITTED
☐ APPROVED AS NOTED
☐ REVISE AND RESUBMIT

REVIEWED BY: _____

NAME: _____

DATE: _____

DIMENSIONS AND SIZES OF EXISTING STRUCTURES, AND/OR COMPONENTS MUST BE VERIFIED TO WATERTRONICS BEFORE STATION CONSTRUCTION BEGINS.

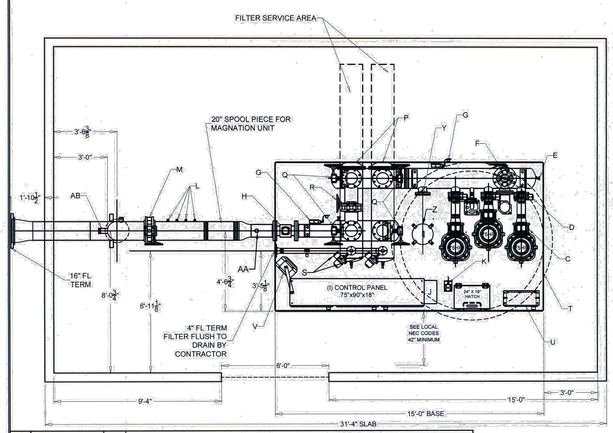
UNLESS SPECIFIED BY THE CUSTOMER, PUMP HOUSE/CONCRETE SLAB DIMENSIONS ARE RECOMMENDED MINIMUMS FOR NEC AND SERVICE CLEARANCE, AND ARE FOR ILLUSTRATION PURPOSES ONLY. PROJECT MANAGER SHALL BE CONSULTED ON FINAL DESIGN.

THE PUMP STATION PROPOSED HEREIN IS DESIGNED TO BE PLACED IN A PUMP HOUSE FOR PROTECTION FROM THE ENVIRONMENT. IF A PUMP HOUSE IS NOT USED, WATERTRONICS MUST BE NOTIFIED AT TIME OF QUOTATION SO SPECIAL PROVISIONS CAN BE MADE.

WATERTRONICS
A LINDSAY COMPANY
PHONE: 1-262-367-5000
FAX: 1-262-367-5551

SHEET 1 OF 4 SHEETS

DRAWING NO. PRVT12023 09/15/2016



STATION COMPONENTS:
A 75HP PUMP AND MOTOR
B 5HP SUBMERSIBLE PUMP AND MOTOR
C 6" CHECK VALVE
D 5" PUMP ISO VALVE W/ EBV CONTROL
E BOILER DRAIN 3/4"
F 6" PRESSURE RELIEF VALVE
G PRESSURE TRANSDUCER W/ GAUGE
H 8" MAGNETIC FLOW METER
I CONTROL CABINET
J HEAT EXCHANGER
K LEVEL SENSOR W/ ALARM FLOAT
L T-LETS 3/4" W/ PLUG (X4)-SPACED @ 6"
M STATION ISOLATION VALVE 12"
N BLOW OUT FITTING 2" W/ PLUG
O 12" X 12" DROP PIPE AND 12"X16" ECCENTRIC WITH 16" FL
P 8" VAF1500 FILTER W/ 300 MICRON SCREEN (X2)
Q 8" FILTER ISOLATION VALVE
R 8" FILTER BY-PASS VALVE
S FILTER FLUSH W/ EBV CONTROL
T PAINTED STEEL BASE (SANDSTONE)
U 3KVA REGULATED POWER SUPPLY (4X15CB)
V 5KW ELECTRIC HEATER
W SBS-48 INLET STAINLESS STEEL SCREEN
X NA
Y 5" BLIND FLANGE FOR FUTURE PUMP
Z 14" Ø HATCH FOR FUTURE 75HP PUMP
AA 2" TOL INJECTION PORT- TOP OF PIPE
AB 3" TOL INJECTION PORT

NO.	DATE	BY	DESCRIPTION
12	11/13/2017	MJH	REVISED ELEVATION
11	10/24/2017	MJH	REVISED SIZE OF THE MAGNATION UNIT PIPE SPOOL FROM 10" TO 12"
10	10/18/2017	MJH	REVISED LOCATION OF AB AND AA FITTING INJECTION PORTS WILL SHULL 10/18/2017
9	10/17/2017	MJH	REVISED LOCATION OF MAGNATION SPOOL PIPE, ISO VALVE, DISCHARGE ELBOW, BLDG. DIM.
8	08/07/2017	MJH	REVISED WET WELL DEPTH FROM 19'-0" TO 25'-0"
7	07/14/2017	MJH	REVISED WET WELL DEPTH FROM 12'-0" TO 19'-0"
6	03/29/2017	MJH	ADDED 20" SPOOL PIECE FOR MAGNATION UNIT
5	03/24/2017	MJH	REVISED DROP PIPE TERMINATION TO 16" FL
4	03/23/2017	MJH	ADD 3KVA REGULATED POWER SUPPLY
3	03/02/2017	MJH	DELETED FERTIGATION, 5KVA REGULATED AND RELOCATED 2" O LET TO TOP
2	02/08/2017	MJH	LOCATED 3/4" TOL, ADDING 2" & 3" TOL TO OTHER SIDE OF THE PIPE
1	10/10/2016	MJH	REVISED WET WELL DEPTH TO 12'-0" & ADDING 2" TOL

PLAN VIEW

DRAWN BY: MJH DATE: 09/15/2016
CHECKED BY: RJS DATE: 08/07/17

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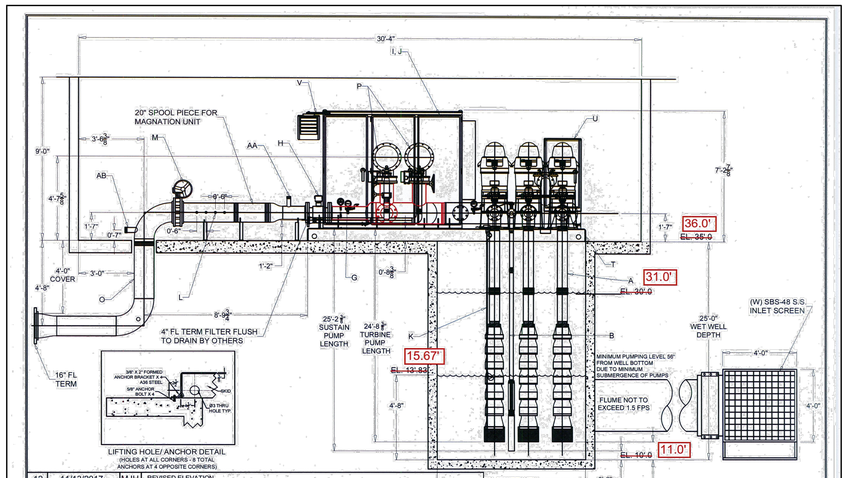
THIS DRAWING LOANED AND SUBJECT TO RETURN ON DEMAND

TITLE: FLYING HORSE RANCH
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

WATERTRONICS A LINDSAY COMPANY

SCALE: NTS SHEET 2 OF 4 SHEETS
JOB NO.: --- DRAWING NO. PRVT12023



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1	10/10/2016	MJH	REVISED WET WELL DEPTH TO 12'-0" & ADDING 2" TOL

ELEVATION VIEW

DRAWN BY: MJH DATE: 09/15/2016
CHECKED BY: RJS DATE: 08/07/17

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TITLE: FLYING HORSE RANCH
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

WATERTRONICS A LINDSAY COMPANY

SCALE: NTS SHEET 3 OF 4 SHEETS
JOB NO.: --- DRAWING NO. PRVT12023

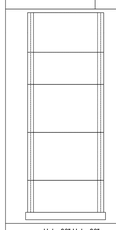
Job Name: Flying Horse Ranch Wet Well
Frontier Environmental

Oldcastle Precast

1) 96" - FLAT TOP RISER - 96BXG60
1) 96" - RISER - 96TXG48
2) 96" - RISER - 96TXG72
1) 96" - PBU - 96PBU48
2) KOR-N-SEAL - BOOT36

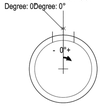
Structure ID: **Wet Well**
Size: 96"
Rim to Invert: 24'
Precast Height: 25'
Step Position:

*NOTE: The invert elevation of the 30" PVC is not indicated on the detail drawing. To be confirmed by contractor.

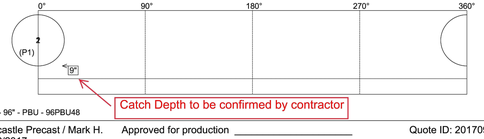


Position	Elev	Angle	Pipe	UP (_)	Hole	Connector
Rim	25'					
Reducer						
Invert 1	1'	0°	30" PVC	9"	36"	KOR-N-SEAL BOOT36
Invert 2	1'	0°	30" PVC	9"	36"	KOR-N-SEAL BOOT36
Invert 3						
Invert 4						
Invert 5						
Invert 6						
Invert 7						
Invert 8						

Hole: 36" Hole: 36"
Flow Direction: OUT
Degree: 0Degree: 0°



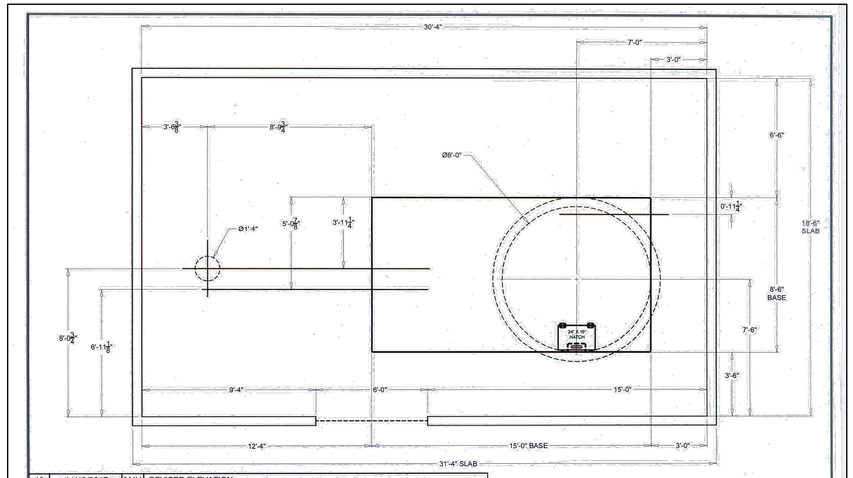
Bottom of Hole - Left - Top of Floor



(P1) - 96" - PBU - 96PBU48

Oldcastle Precast / Mark H. 9/22/2017 Approved for production _____ Quote ID: 2017090089

Page: 1 of 1



NO.	DATE	BY	DESCRIPTION
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2	02/08/2017	MJH	LOCATED 3/4" TOL, ADDING 2" & 3" TOL TO OTHER SIDE OF THE PIPE
1	10/10/2016	MJH	REVISED WET WELL DEPTH TO 12'-0" & ADDING 2" TOL

SLAB VIEW

DRAWN BY: MJH DATE: 09/15/2016
CHECKED BY: RJS DATE: 08/07/17

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THIS DRAWING LOANED AND SUBJECT TO RETURN ON DEMAND

TITLE: FLYING HORSE RANCH
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

WATERTRONICS A LINDSAY COMPANY

SCALE: NTS SHEET 4 OF 4 SHEETS
JOB NO.: --- DRAWING NO. PRVT12023

Pump Data Sheet - Hydroflo Pumps USA, Inc.

Company:
Name:
Date: 9/15/2016

Hydroflo Pumps Fluid Solutions

Pump:
Size: 11MH (5 stage)
Type: Vertical
Synch speed: 1800 rpm
Curve: 11MH
Specific Speeds:
Dimensions:
Vertical Turbine:
Speed: 1770 rpm
Dia: 7.445 in
Impeller: 11MH SS ENCL
Ns: 2130
Nss: ---
Suction: 8 in
Discharge: 8 in
Bowl size: 11 in
Max lateral: 0.75 in
Thrust K factor: 7.8 lb/ft

Search Criteria:
Flow: 750 US gpm
Head: 291 ft

Fluid:
Water
SG: 1
Viscosity: 1.105 cP
NPSHa: ---
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Pump Limits:
Temperature: 120 °F
Pressure: 400 psi g
Sphere size: 0.68 in
Power: ---
Eye area: ---

Motor:
Standard: NEMA
Enclosure: WP1
Size: 100 hp
Speed: 1800
Frame: 404T
Sizing criteria: Max Power on Design Curve

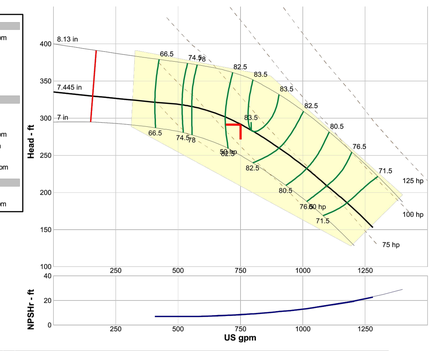
---- Data Point ----

Flow:	750 US gpm
Head:	291 ft
Eff:	83.1%
Power:	66.2 hp
NPSHr:	8.63 ft

---- Design Curve ----

Shutoff head:	335 ft
Shutoff dP:	145 psi
Min flow:	158 US gpm
BEP:	83.5% @ 792 US gpm
NOL power:	79.7 hp @ 1280 US gpm

-- Max Curve --
Max power:
102 hp @ 1300 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
900	1770	261	82.5	71.7	10.9
750	1770	291	83.1	66.2	8.63
600	1770	311	79.5	59	7.33
450	1770	320	69.7	52	7
300	1770	325	58.7	43.8	7

Selected from catalog: hydroflo vs pumps.60 Vers: 18.3

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NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, P.E. #37155 DATE

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT

PUMP STATION PLAN / DETAILS

DESIGNED BY	MAW	SCALE		DATE	1-4-18
DRAWN BY	MAW	(H) 1"= N/A		SHEET 3 OF 12	
CHECKED BY		(V) 1"= N/A		JOB NO.	1096.11

N:\1096\11\DRAWINGS\CONSTRUCTION\Jurisdictional Plans\3-JD POND - Pump Station.dwg, 1/12/2018 2:59:08 PM, DWG To PDF.pc3

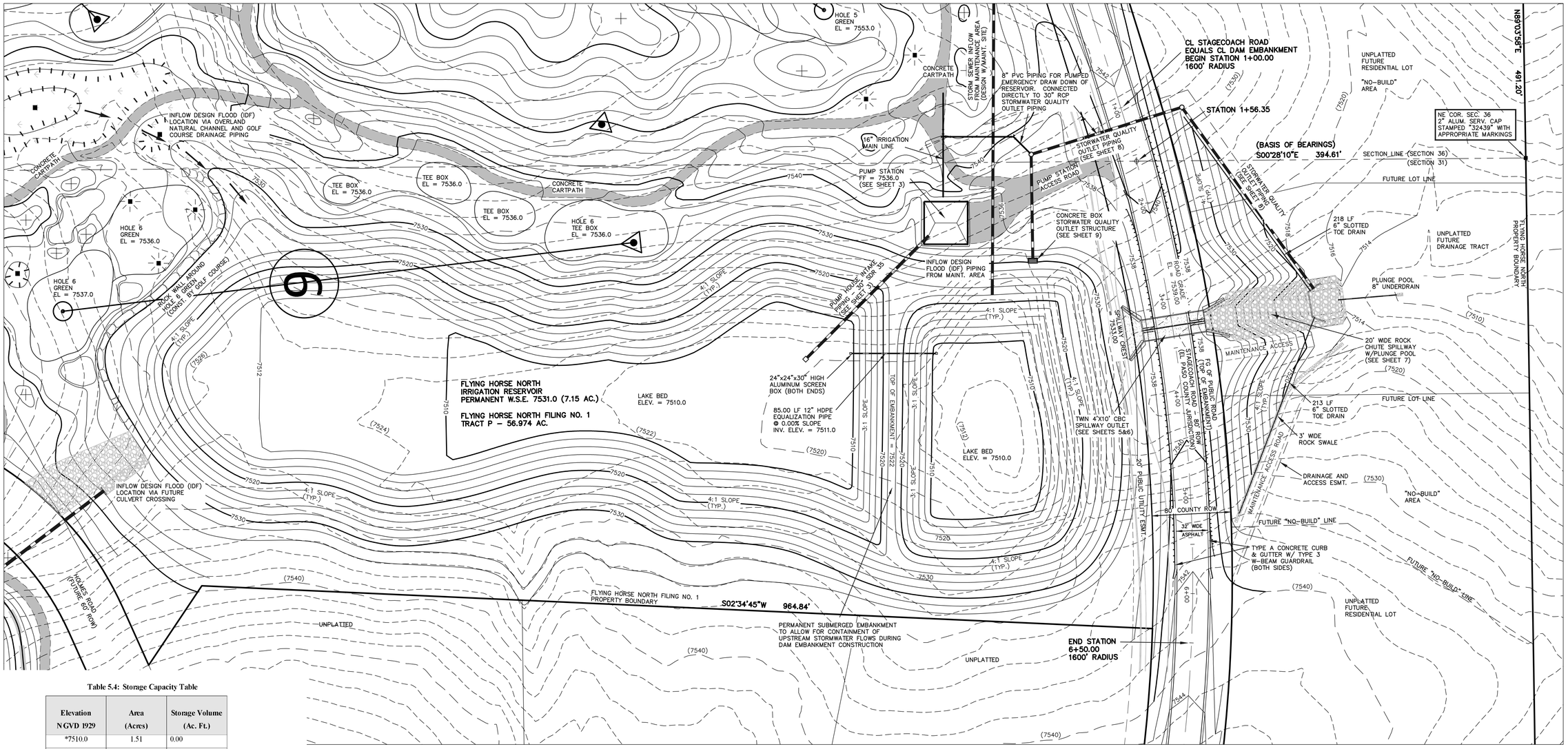

Table 5.4: Storage Capacity Table

Elevation NGVD 1929	Area (Acres)	Storage Volume (Ac. Ft.)
*7510.0	1.51	0.00
*7511.0	1.99	1.74
*7512.0	2.52	3.99
*7513.0	2.85	6.68
*7514.0	3.05	9.63
*7515.0	3.26	12.78
7516.0	3.48	16.15
7517.0	3.70	19.74
7518.0	3.93	23.56
7519.0	4.16	27.60
7520.0	4.40	31.88
7521.0	4.64	36.40
7522.0	4.88	41.16
7523.0	5.14	46.17
7524.0	5.36	51.42
7525.0	5.59	56.89
7526.0	5.84	62.61
7527.0	6.08	68.57
7528.0	6.33	74.77
7529.0	6.57	81.22
7530.0	6.81	87.91
7531.0	7.15	94.89
7532.0	7.52	102.22
7533.0	7.83	109.90
7534.0	8.37	118.00
7535.0	8.77	126.57
7536.0	9.17	135.53

*Indicates dead storage below pumping ability

Table 5.5: Reservoir Discharge Table

Elevation	Discharge (cfs) (SWQ Outlet Box)	Discharge (cfs) (Twin CBC Spillway)	Discharge (cfs) (Total)
7531.0	0.0	0.0	0.0
7532.0	13.89	0.0	13.89
7533.0	27.77	0.0	27.77
7534.0	51.31	49.05	100.36
7535.0	69.52	138.56	208.08
7536.0	74.61	254.72	329.33

Permanent WSE = 7531.0

Top of SWQ Outlet box = 7533.0

Spillway elevation = 7533.0

NOTES:

1. TOPOGRAPHIC BASE MAPPING PRODUCED FROM AERIAL PHOTOGRAPHY PROVIDED BY NORTH AMERICAN MAPPING IN 2009. HORIZONTAL CONTROL IS BASED ON LOCAL CALIBRATION TIED TO SECTION CORNER AND VERTICAL CONTROL IS BASED ON NGVD 1929 DATUM.
2. PERMANENT WSE = 7531.0
3. RESERVOIR LINER INSTALLED UP TO ELEVATION 7534.0

50 25 0 50 100

SCALE: 1" = 50'

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C–2085

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NO.	REVISION	DATE
1	REVISED PER STATE COMMENTS	5–14–18

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, COLORADO P.E. #37155 DATE

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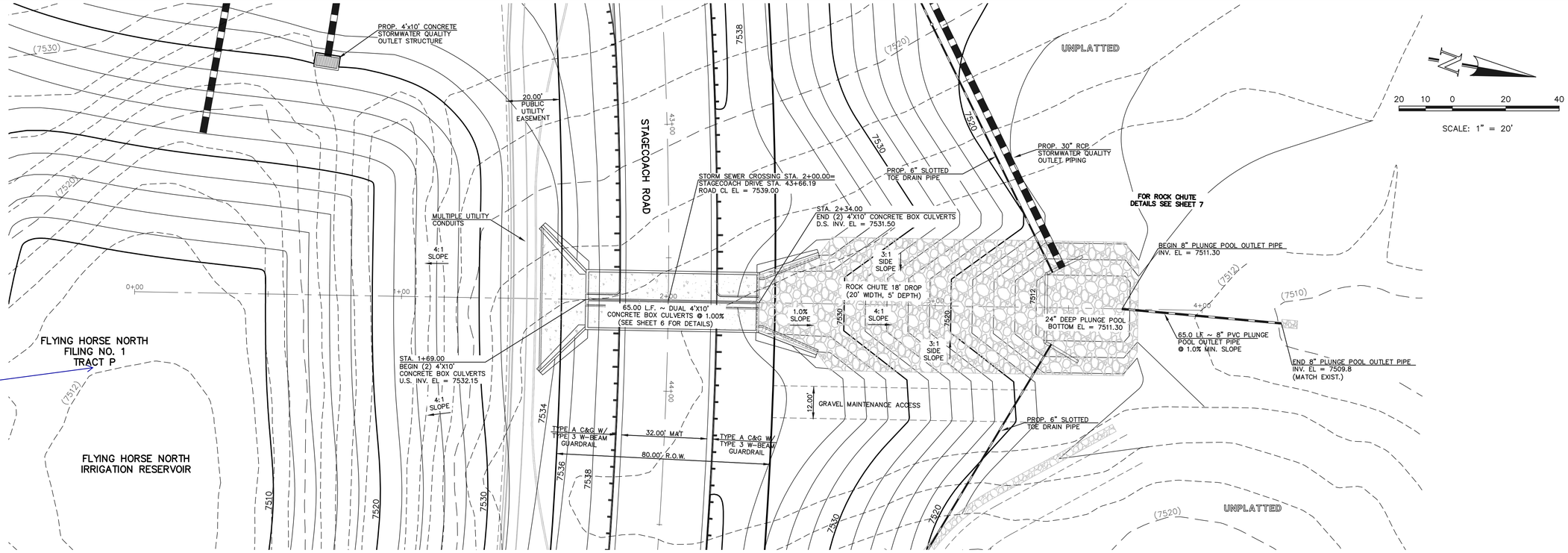
619 N. Cascade Avenue, Suite 200 (719)785–0790
Colorado Springs, Colorado 80903 (719)785–0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
SITE LAYOUT WITH GRADING
DAM ID – 080459

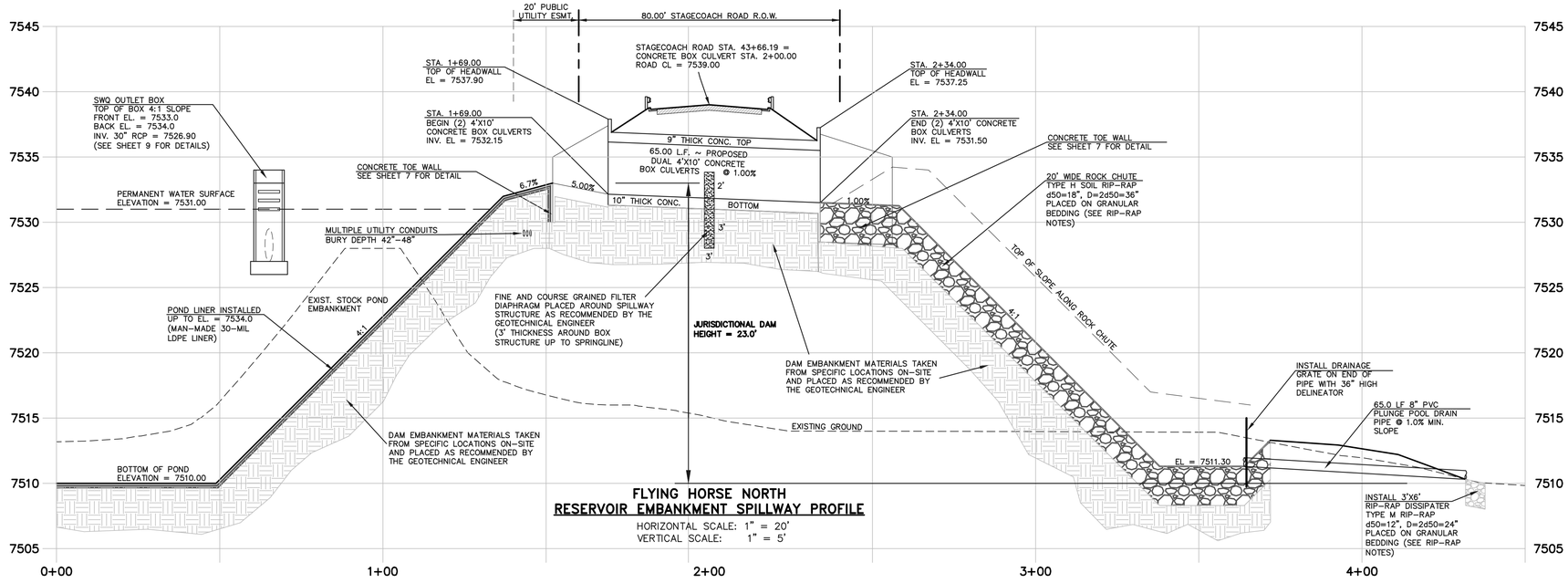
DESIGNED BY	MAW	SCALE	DATE 1–4–18
DRAWN BY	MAW	(H) 1"= 50'	SHEET 4 OF 12
CHECKED BY		(V) 1"= N/A	JOB NO. 1096.11

N:\10961\DRAWINGS\CONSTRUCTION\Jurisdictional Plans\4-D POND - Site Grading.dwg, 6/15/2018 8:49:39 AM, 1:1



Revise to Tract L per the final plat.

FLYING HORSE NORTH
RESERVOIR EMBANKMENT SPILLWAY PLAN



FLYING HORSE NORTH
RESERVOIR EMBANKMENT SPILLWAY PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 5'

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C-2085

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NO.	REVISION	DATE
1	REVISED PER STATE COMMENTS	4-2-18

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FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
EMBANKMENT SPILLWAY PLAN
DAM ID - 080459

DESIGNED BY	MAW	SCALE		DATE	1-4-18
DRAWN BY	MAW	(H) 1"= 20'		SHEET	5 OF 12
CHECKED BY		(V) 1"= 5'		JOB NO.	1096.11

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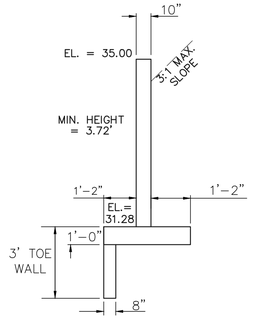
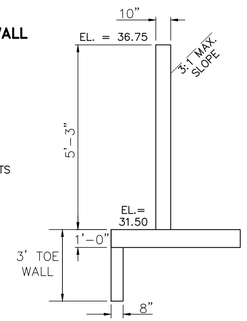
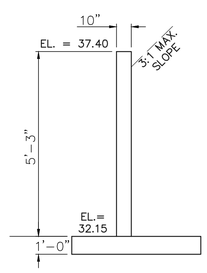


NORTHWEST WINGWALL BOTTOM
N.T.S.
(WALL NW2)

NORTHWEST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
CBC INV. EL = 7531.50
EL AT TOP OF CBC = 7537.25
EL AT TOP OF WINGWALL NW1 = 7536.75
EL AT TOP OF WINGWALL NW2 = 7535.00

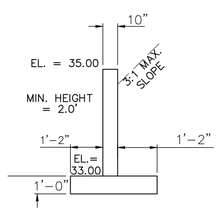


NORTHWEST WINGWALL TOP
N.T.S.
(WALL NW1)

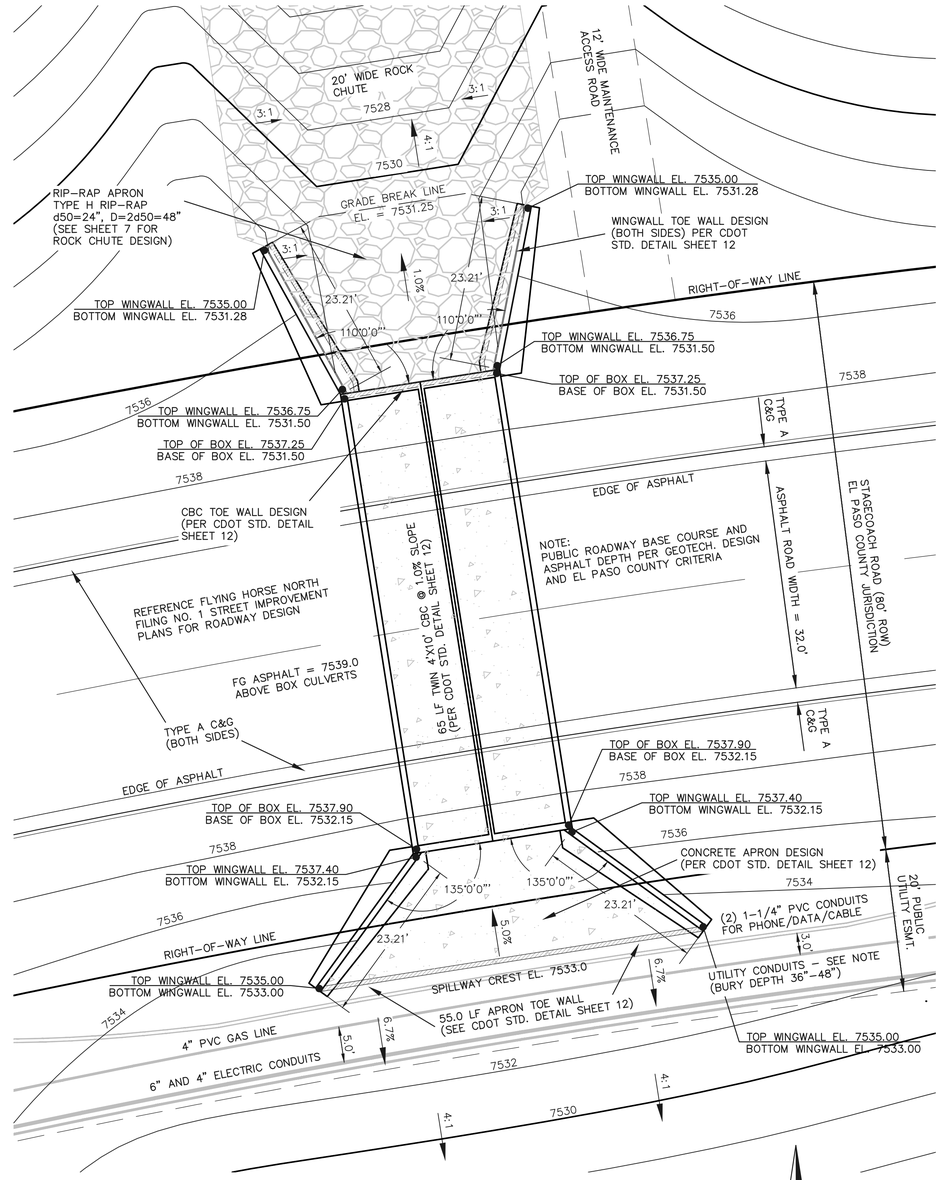


SOUTHWEST WINGWALL TOP
N.T.S.
(WALL SW1)

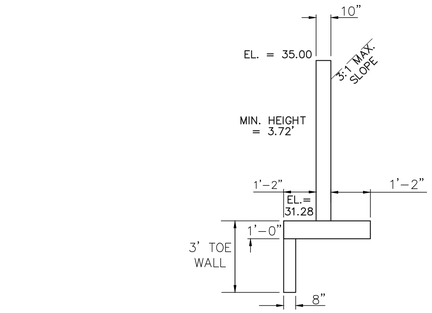
SOUTHWEST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
CBC INV. EL = 7532.15
EL AT TOP OF CBC = 7537.90
EL AT TOP OF WINGWALL SW1 = 7537.40
EL AT TOP OF WINGWALL SW2 = 7535.00



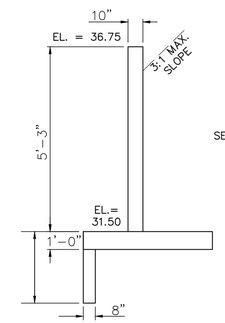
SOUTHWEST WINGWALL BOTTOM
N.T.S.
(WALL SW2)



EMBANKMENT SPILLWAY DESIGN



NORTHEAST WINGWALL BOTTOM
N.T.S.
(WALL NE2)



NORTHEAST WINGWALL TOP
N.T.S.
(WALL NE1)

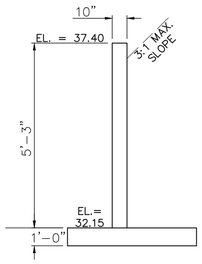
NORTHEAST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
CBC INV. IN EL = 7531.50
EL AT TOP OF CBC = 7537.25
EL AT TOP OF WINGWALL NE1 = 7536.75
EL AT TOP OF WINGWALL NE2 = 7535.00

UTILITY CONDUIT NOTE:
BURIED CONDUITS WITHIN THE 20' PUBLIC UTILITY ESMT. INCLUDE THE FOLLOWING:

(1) 6" SCHEDULE 40 PVC FOR 3 PHASE ELECTRIC
(1) 4" PVC FOR SINGLE PHASE ELECTRIC

(1) 4" PVC NATURAL GAS LINE

(2) 1-1/4" PVC CONDUIT FOR PHONE/DATA/CABLE



SOUTHEAST WINGWALL TOP
N.T.S.
(WALL SE1)

SOUTHEAST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
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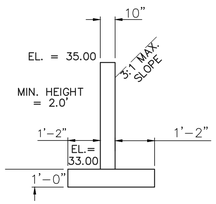
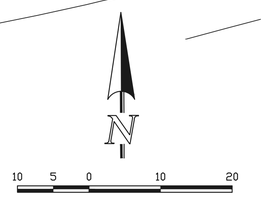
EL AT TOP OF CBC = 7537.90
EL AT TOP OF WINGWALL SE1 = 7537.40
EL AT TOP OF WINGWALL SE2 = 7535.00



SOUTHEAST WINGWALL BOTTOM
N.T.S.
(WALL SE2)



SCALE: 1" = 10'

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C-2085

48 HOURS BEFORE YOU DIG,
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NO.	REVISION	DATE
1	REVISED PER STATE COMMENTS	5-2-18

REVIEW:
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MARC A. WHORTON, COLORADO P.E. #37155 DATE

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Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799(Fax)

FLYING HORSE NORTH IRRIGATION RESERVOIR EMBANKMENT
EMBANKMENT SPILLWAY DETAILS
DAM ID - 080459

DESIGNED BY	MAW	SCALE	DATE 1-4-18
DRAWN BY	MAW	(H) 1"= 20'	SHEET 6 OF 12
CHECKED BY		(V) 1"= N/A	JOB NO. 1096.11

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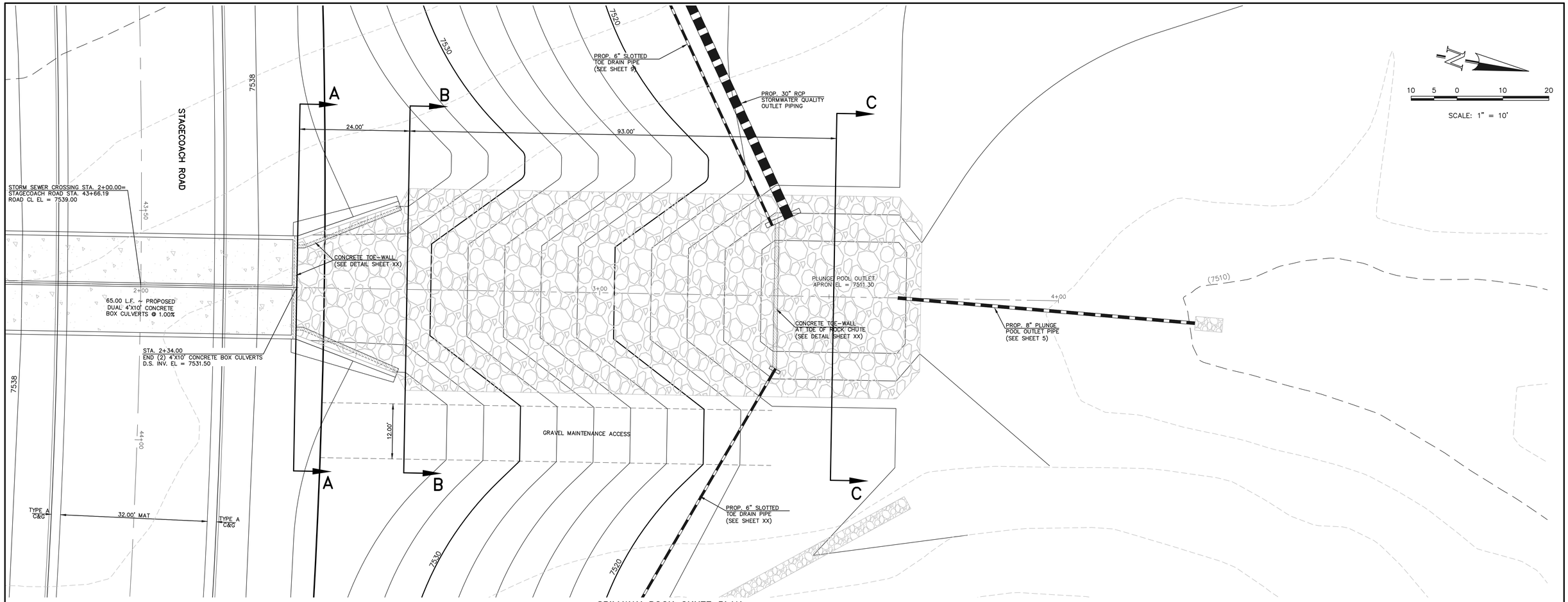
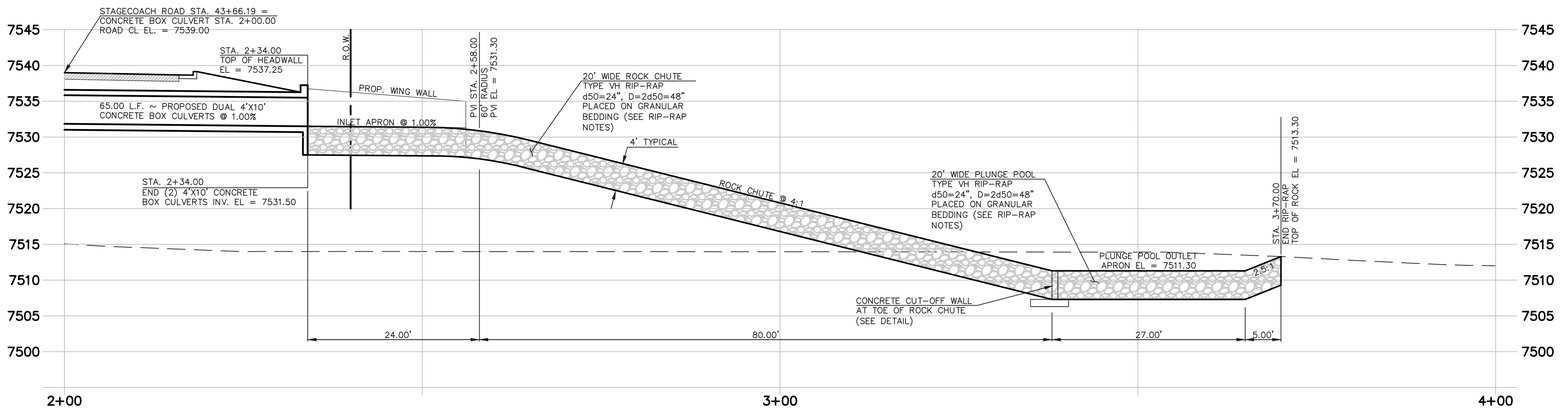
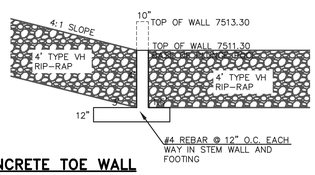


SPILLWAY ROCK CHUTE PLAN



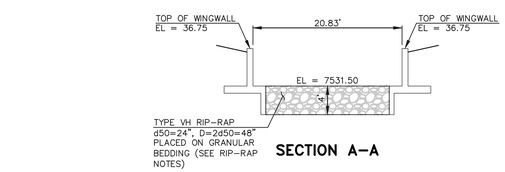
SPILLWAY ROCK CHUTE PROFILE

HORIZONTAL SCALE: 1" = 10'
VERTICAL SCALE: 1" = 1'

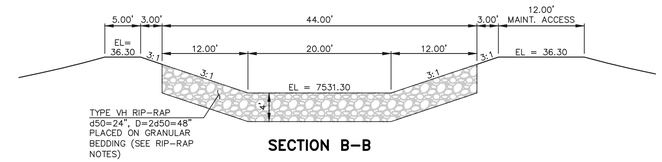


CONCRETE TOE WALL

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 1'



SECTION A–A



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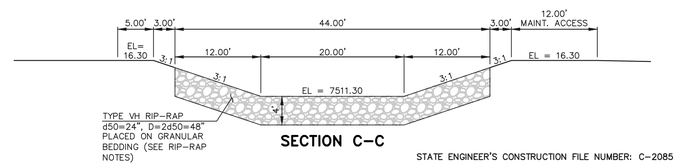

SECTION C–C

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C–2085

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NO.	REVISION	DATE
1	REVISED PER STATE COMMENTS	5–4–18

REVIEW:

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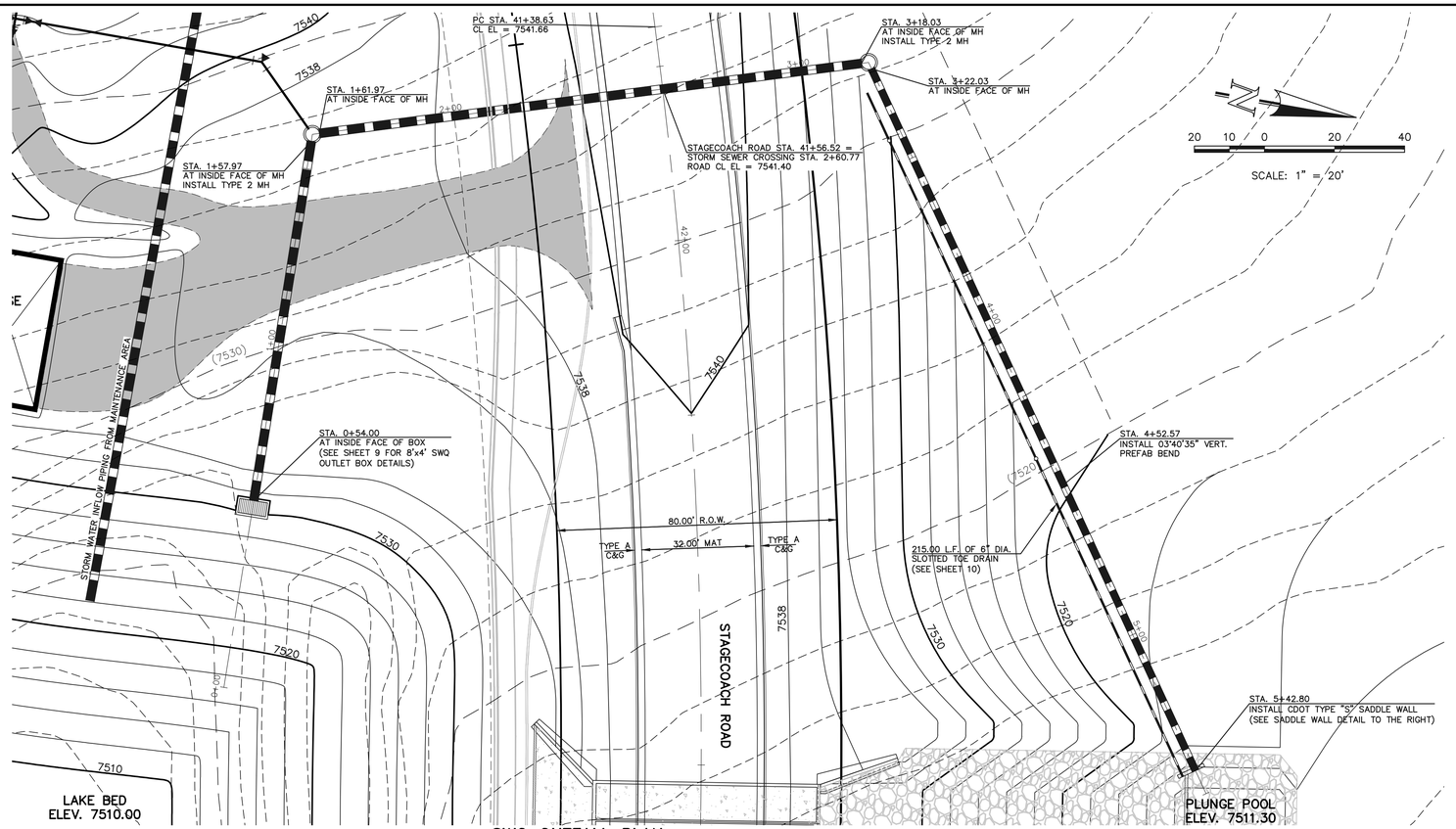
(719)785–0790
(719)785–0799(Fax)

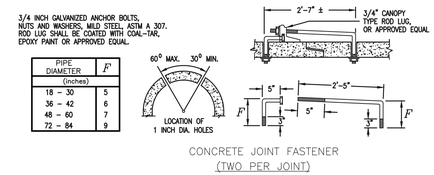
FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
SPILLWAY ROCK CHUTE DESIGN
DAM ID – 080459

DESIGNED BY	MAW	SCALE		DATE	1–4–18
DRAWN BY	MAW	(H) 1"= 10'		SHEET 7	OF 12
CHECKED BY		(V) 1"= 1'		JOB NO.	1096.11

N:\1096111\DRAWINGS\CONSTRUCTION\Jurisdictional Plans\7-D POND - Spillway ROCK CHUTE.dwg, 5/16/2018 4:10:43 PM, 1:1



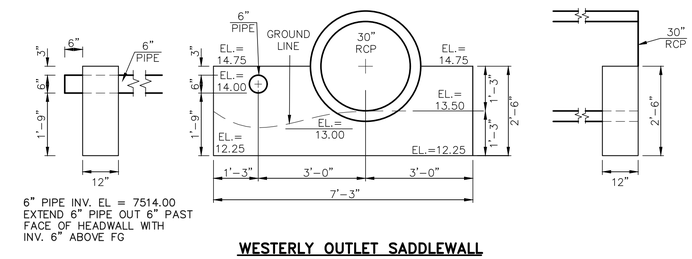
SWQ OUTFALL PLAN



PIPE DIAMETER (inches)	F
18 – 30	5
36 – 42	6
48 – 60	7
72 – 84	9

CONCRETE JOINT FASTENER
(TWO PER JOINT)

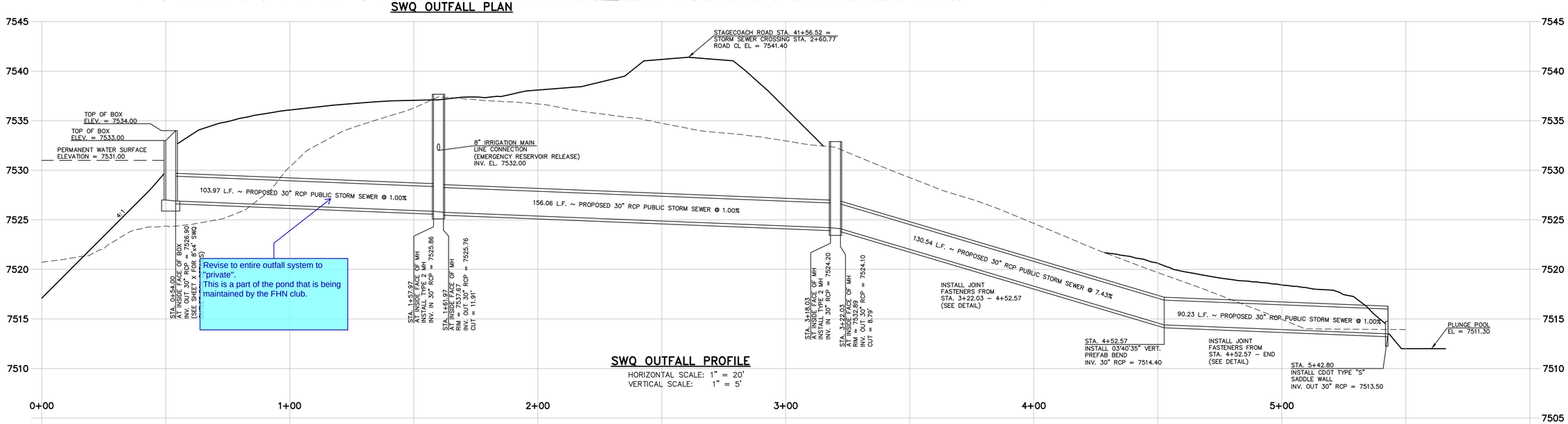
CONCRETE JOINT FASTENER



6" PIPE INV. EL = 7514.00
EXTEND 6" PIPE OUT 6" PAST
FACE OF HEADWALL WITH
INV. 6" ABOVE FG

WESTERLY OUTLET SADDLEWALL

PER CDOT M-601-11
SEE CDOT M-601-11 FOR DESIGN REQUIREMENTS
6" PIPE INV. OUT EL = 7514.00
30" RCP INV. OUT EL = 7513.50
EL AT TOP OF SADDLEWALL = 7514.75
EL AT BOTTOM SADDLEWALL = 7512.25



Revise to entire outfall system to "private".
This is a part of the pond that is being maintained by the FHN club.

SWQ OUTFALL PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 5'

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C-2085

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NO.	REVISION	DATE
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FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
SWQ OUTFALL PLAN & PROFILE
DAM ID – 080459

DESIGNED BY	MAW	SCALE		DATE	1-4-18
DRAWN BY	MAW	(H) 1"= 20'		SHEET	8 OF 12
CHECKED BY		(V) 1"= 5'		JOB NO.	1096.11

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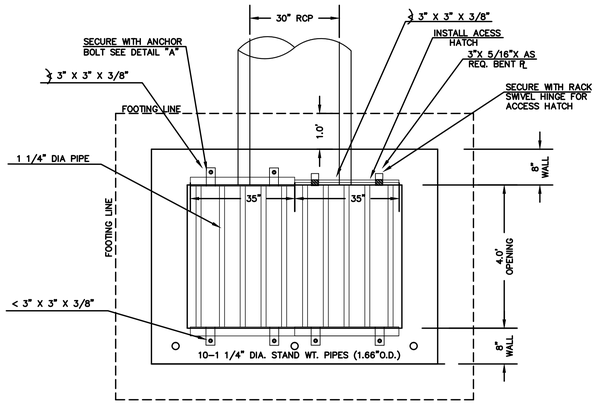
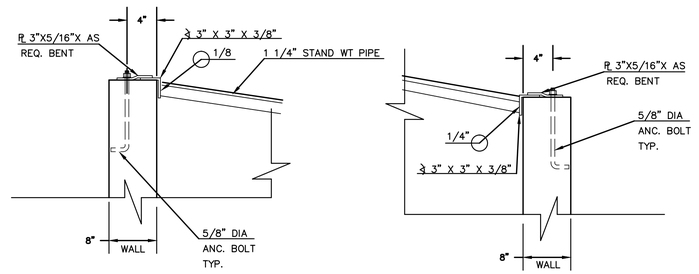
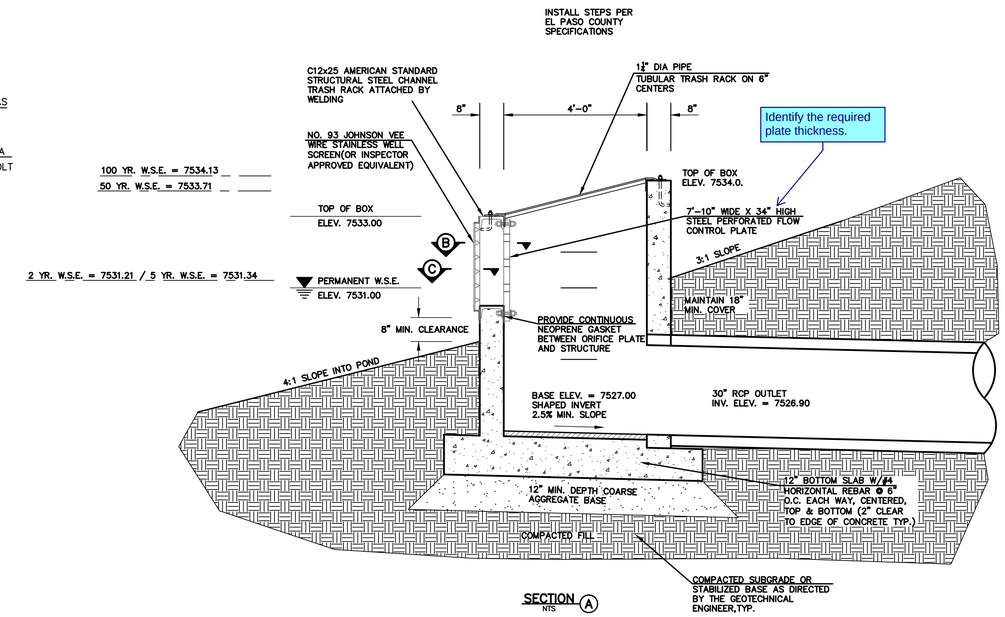


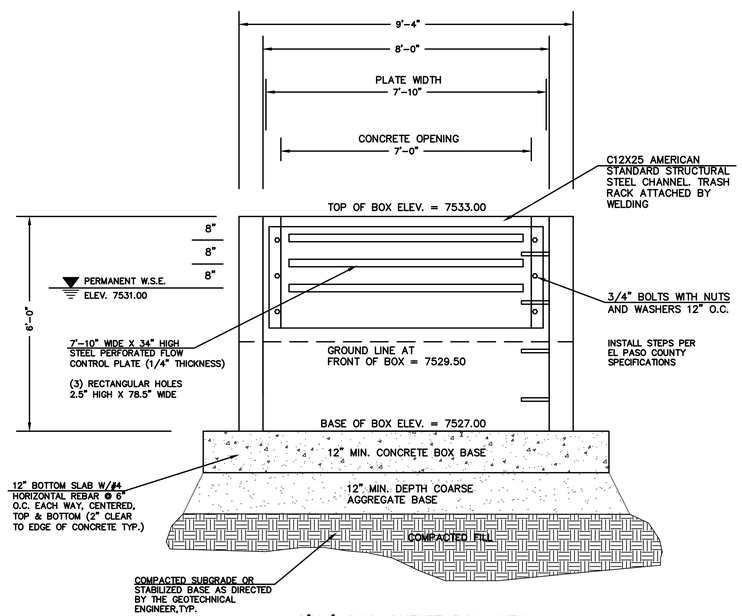
TRASH RACK
ALL WELDED CONSTRUCTION
N.T.S.





SECTION A
NTS

8'X4' SWQ OUTLET BOX WITH FLOW CONTROL PLATE
SCALE: 1"=2'



8'X4' SWQ OUTLET BOX WITH FLOW CONTROL PLATE
SCALE: 1"=2'

(ALL MATERIALS PER EL PASO COUNTY SPECIFICATIONS)

ORIFICE PLATE NOTES:

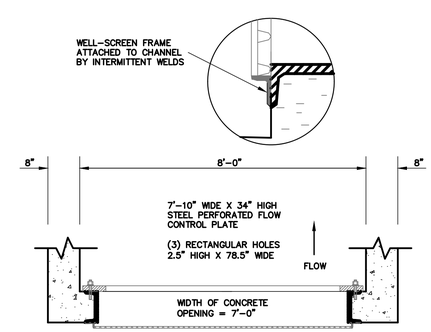
1. INSTALL HOLES AS SHOWN ON DETAIL TO RIGHT.
2. PROVIDE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE

EURV AND WQCV TRASH RACKS:

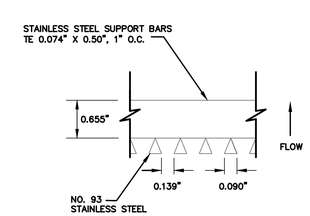
3. WELL-SCREEN TRASH RACKS SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
4. BAR GRATE TRASH RACKS SHALL BE ALUMINUM AND SHALL BE BOLTED USING STAINLESS STEEL HARDWARE.
5. STRUCTURAL DESIGN OF TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF RACK

OVERFLOW TRASH RACKS:

1. ALL TRASH RACKS SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE AND PROVIDED WITH HINGED AND LOCKABLE OR BOLTABLE ACCESS PANELS
2. TRASH RACKS SHALL BE STAINLESS STEEL, ALUMINUM, OR STEEL. STEEL TRASH RACKS SHALL BE HOT DIP GALVANIZED AND MAY BE HOT POWDER COATED AFTER GALVANIZING.
3. TRASH RACKS SHALL BE DESIGNED SUCH THAT THE DIAGONAL DIMENSION OF EACH OPENING IS SMALLER THAN THE DIAMETER OF THE OUTLET PIPE.
4. STRUCTURAL DESIGN OF THE TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.



SECTION B
NTS



R VALUE = (NET OPEN AREA)/(GROSS RACK AREA) = 0.60

SECTION C
NTS

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UTILITY NOTIFICATION OF COLORADO
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NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A WHORTON, COLORADO P.E. #37155 DATE

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
DETENTION/SWQ OUTLET BOX DESIGN

DESIGNED BY	MAW	SCALE	DATE	1-4-18
DRAWN BY	MAW	(H) 1"= 2'	SHEET 9	OF 12
CHECKED BY		(V) 1"= 2'	JOB NO.	1096.11

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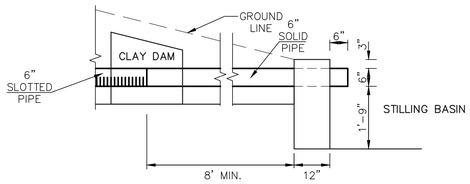
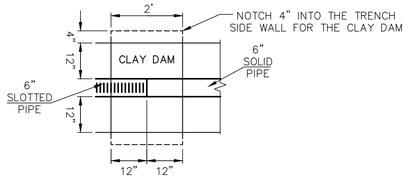
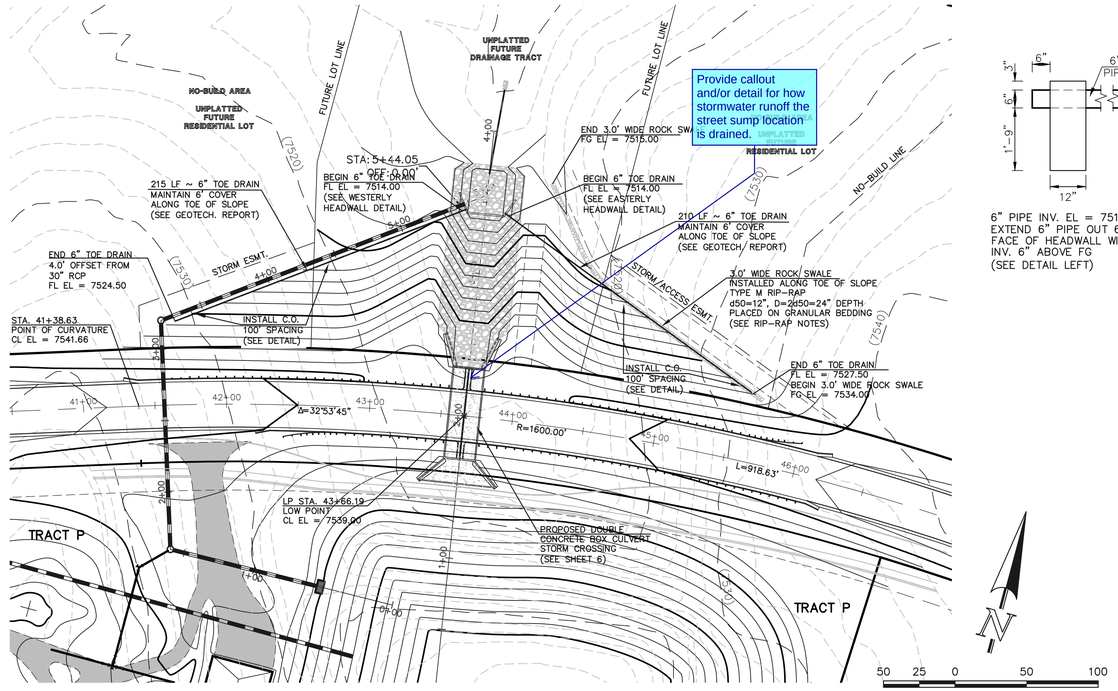


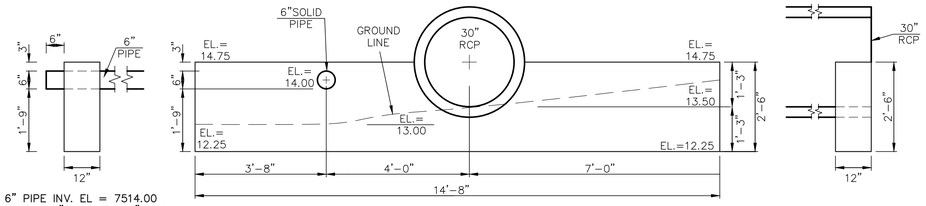


NOTE:
CONSTRUCT CLAY DAM A MINIUM OF 10 FEET UPGRADIENT OF TIE-IN TO STILLING BASIN WALL. THE CLAY DAM SHALL EXTEND ONE FOOT BEYOND THE DRAIN PIPE CONNECTION TO SOLID PIPE, IN BOTH DIRECTIONS. THE CLAY DAM SHALL EXTEND TO WITHIN ONE FOOT OF THE BLANKET DRAIN OR DOWNSTREAM DAM SURFACE. THE CLAY DAM SHALL BE NOTCHED INTO THE SIDEWALLS OF THE PIPE TRENCH A MINIMUM OF 4 INCHES. THE CLAY SOILS SHALL HAVE A MINIMUM PI OF 25 AND COMPACTED TO THE REQUIREMENTS OF STRUCTURAL FILL.



Provide callout and/or detail for how stormwater runoff the street sump location is drained.

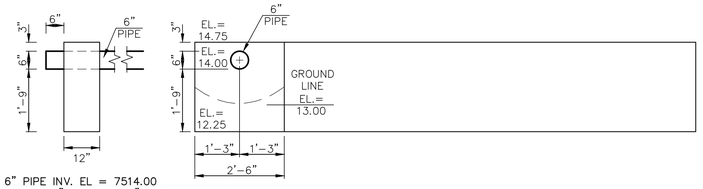
SCALE: 1" = 50'



6" PIPE INV. EL = 7514.00
EXTEND 6" PIPE OUT 6" PAST FACE OF HEADWALL WITH INV. 6" ABOVE FG
(SEE DETAIL LEFT)

WESTERLY OUTLET SADDLEWALL

6" PIPE INV. OUT EL = 7514.00
30" RCP INV. OUT EL = 7513.50
EL AT TOP OF SADDLEWALL = 7514.75
EL AT BOTTOM SADDLEWALL = 7512.25

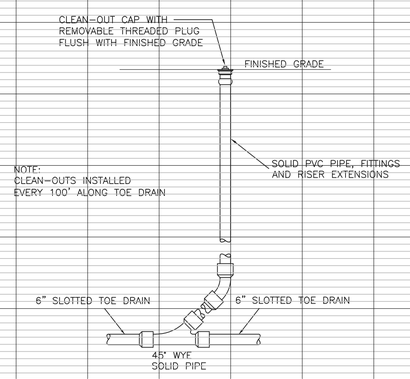


6" PIPE INV. EL = 7514.00
EXTEND 6" PIPE OUT 6" PAST FACE OF HEADWALL WITH INV. 6" ABOVE FG
(SEE DETAIL LEFT)

EASTERLY OUTLET HEADWALL

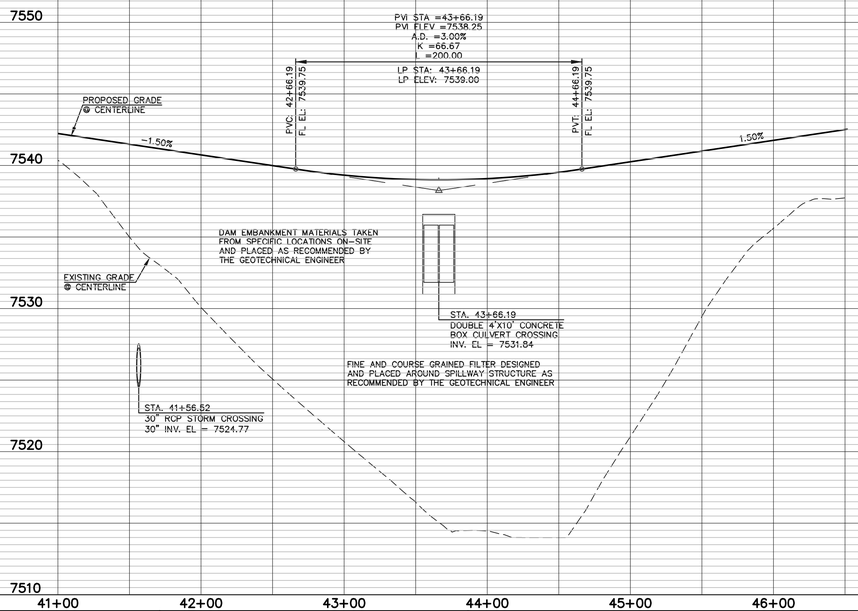
6" PIPE INV. OUT EL = 7514.00
EL AT TOP OF SADDLEWALL = 7514.75
EL AT BOTTOM SADDLEWALL = 7512.25

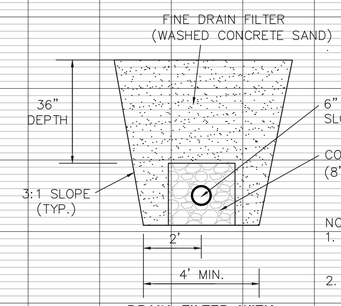
STAGECOACH ROAD



TOE DRAIN CLEANOUT DETAIL

NO SCALE





DRAIN FILTER WITH SLOTTED DRAIN DETAIL

N.T.S.

NOTES:
1. SPECIFIED DRAIN FILTER SECTION TO BE CONSTRUCTED ENTIRE LENGTH OF SLOTTED TOE DRAIN PIPING.
2. MINIMUM 12" OF SPECIFIED EMBANKMENT MATERIAL PLACED ABOVE DRAIN FILTER.
3. SEE GEOTECH. REPORT APPENDIX D FOR ADDITIONAL FILTER CALCULATIONS/DETAILS.

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C-2085

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NO.	REVISION	DATE
1	REVISED PER STATE COMMENTS	5-14-18

REVIEW:
PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, COLORADO P.E. #37155 DATE

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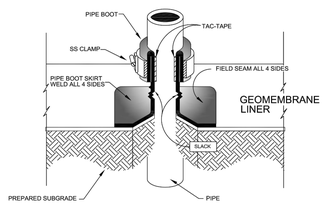
(719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
ROAD EMBANKMENT / TOE DRAIN DESIGN
DAM ID - 080459

DESIGNED BY	MAW	SCALE	DATE 1-4-18
DRAWN BY	MAW	(H) 1"= 50'	SHEET 10 OF 12
CHECKED BY		(V) 1"= 5'	JOB NO. 1096.11

N:\1096.11\DRAWINGS\CONSTRUCTION\Jurisdictional Plans\10-JD POND - Embankment Profile - Toe Drain REV.dwg, 6/15/2018 9:07:35 AM, 1:1



90 DEGREE PIPE BOOT

NO SCALE

MATERIALS AND DIMENSIONS SHOWN ARE FOR GENERAL INFORMATION ONLY.
AND SHOULD BE DETERMINED BY SITE SPECIFIC DESIGN.

Drawing Title: STANDARD DETAIL 90 DEGREE PIPE BOOT

Designer: Ken C. | Sheet: 4 of 9
Date: 11/06/13
Scale: AS SHOWN

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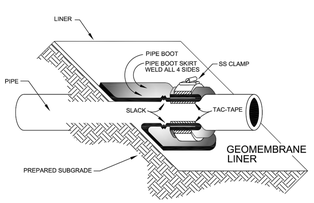
Fax: 303-470-3197

Watersaver Company
5870 E. 56th. Ave.
Commerce City, C0 80022
Phone 303-289-1818
Fax: 303-287-3136



45 DEGREE PIPE BOOT

NO SCALE

MATERIALS AND DIMENSIONS SHOWN ARE FOR GENERAL INFORMATION ONLY.
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Drawing Title: STANDARD DETAIL 45 DEGREE PIPE BOOT

Designer: Ken C. | Sheet: 7 of 9
Date: 11/06/13
Scale: AS SHOWN

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Watersaver Company
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Commerce City, C0 80022
Phone 303-289-1818
Fax: 303-287-3136

TABLE 10-7

CLASSIFICATION AND GRADATION OF ORDINARY RIPRAP

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (Inches)	d_{50}* (Inches)
Type VL	70-100	12	
	50-70	9	
	35-50	6	6
	2-10	2	
Type L	70-100	15	
	50-70	12	
	35-50	9	9
	2-10	3	
Type M	70-100	21	
	50-70	18	
	35-50	12	12
	2-10	4	
Type H	100	30	
	50-70	24	
	35-50	18	18
	2-10	6	
Type VH	100	42	
	50-70	33	
	35-50	24	24
	2-10	9	

*d_{50} = Mean particle size

TABLE 10-8

RIPRAP GRADATION LIMITS FOR STEEP SLOPES

$$\frac{D_{max}}{D_{50}} = 1.25$$

$$\frac{D_{50}}{D_{10-20}} = 2\text{-}3$$

TABLE 10-9

THICKNESS REQUIREMENTS FOR GRANULAR BEDDING

Riprap Designation	Minimum Bedding Thickness (Inches): Fine Grained Soils* (Two Layer System) Type I	Fine Grained Soils* (Two Layer System) Type II	Course Grained Soils** Type II
L, G, SM	4	4	6
M	4	4	6
H	4	6	8
VH	4	6	8

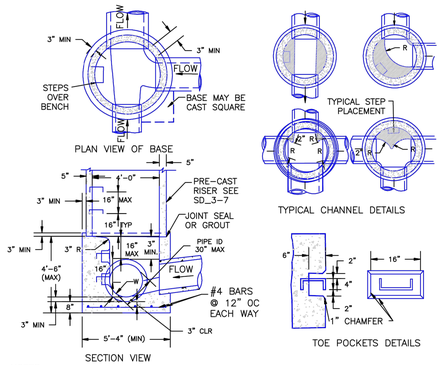
*May substitute one 12 inch layer of Type II bedding. Substitution of one layer of Type II bedding shall not be permitted at drop structures. Use of a combination of filter fabric and Type II bedding at drop structures is acceptable.

** Fifty percent or more by weight retained on the #40 sieve.

TABLE 10-10

GRADATION FOR GRANULAR BEDDING

U.S. Standard Sieve Size	Percent Weight By Passing Type I	Square Mesh Sieves Type II
3"	-	90 - 100
1-1/2"	-	-
3/4"	-	20 - 90
3/8	100	-
#4	95 - 100	0 - 20
#16	45 - 80	-
#50	10 - 30	-
#100	2 - 10	-
#200	0 - 2	0 - 3



NOTES

1. TYPE II MANHOLES SHALL BE USED WHEN APPROPRIATE AND TYPICALLY WHEN THE PIPE SIZES ARE 30" OR LESS INSIDE DIAMETER.

2. VIEW AND DETAILS ARE TYPICAL. DESIGN ENGINEER SHALL DETERMINE MANHOLE BASE CONFIGURATION AND DIMENSIONS FOR PARTICULAR PIPE SIZES AND ALIGNMENT.

3. EITHER LADDER OF STEPS SHALL BE INSTALLED WHEN MANHOLE DEPTH EXCEEDS 30". STEPS IN BASE SHALL BE INSTALLED IN "TOE POCKETS" (SEE DETAIL THIS SHEET). LOWEST STEP SHALL BE A MAXIMUM OF 16" ABOVE THE FLOOR.

4. PIPES SHALL BE TRIMMED TO FINAL SHAPE AND SET BEFORE MANHOLE IS POURED.

5. BENCH SHALL BE SLOPED TOWARD CENTER OF MANHOLE BASE (4:1 MAX., ½" PER FOOT. MIN.).

6. FLOOR OF MANHOLE SHALL BE TROWELLED TO A SMOOTH, HARD SURFACE AND SHALL SLOPE TOWARDS THE OUTLET (8:1., ½" PER FT. MIN.) . FLOOR SHALL BE SHAPED AND CHANNELED; SEE DETAILS THIS SHEET.

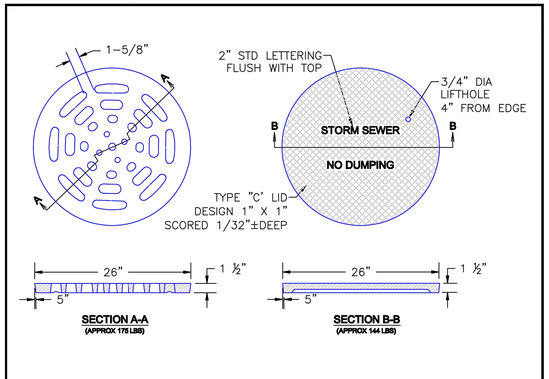
SCALE: NOT TO SCALE

DATE APPROVED:
André P. Brackin
DEPARTMENT OF TRANSPORTATION

Storm Sewer Manhole Detail
Type II
Standard Drawing

REVISION DATE: 11/10/04 | FILE NAME: SD_3-2

EL PASO COUNTY DEPARTMENT OF TRANSPORTATION



SCALE: NOT TO SCALE

9/16/10
DATE APPROVED:
André P. Brackin
DEPARTMENT OF TRANSPORTATION

Storm Sewer Manhole Details
Standard Drawing

REVISION DATE: 9/16/10 | FILE NAME: SD_3-5

EL PASO COUNTY DEPARTMENT OF TRANSPORTATION

STATE ENGINEER'S CONSTRUCTION FILE NUMBER: C-2085

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NO.	REVISION	DATE
1	REVISED PER STATE COMMENTS	5-4-18

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619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
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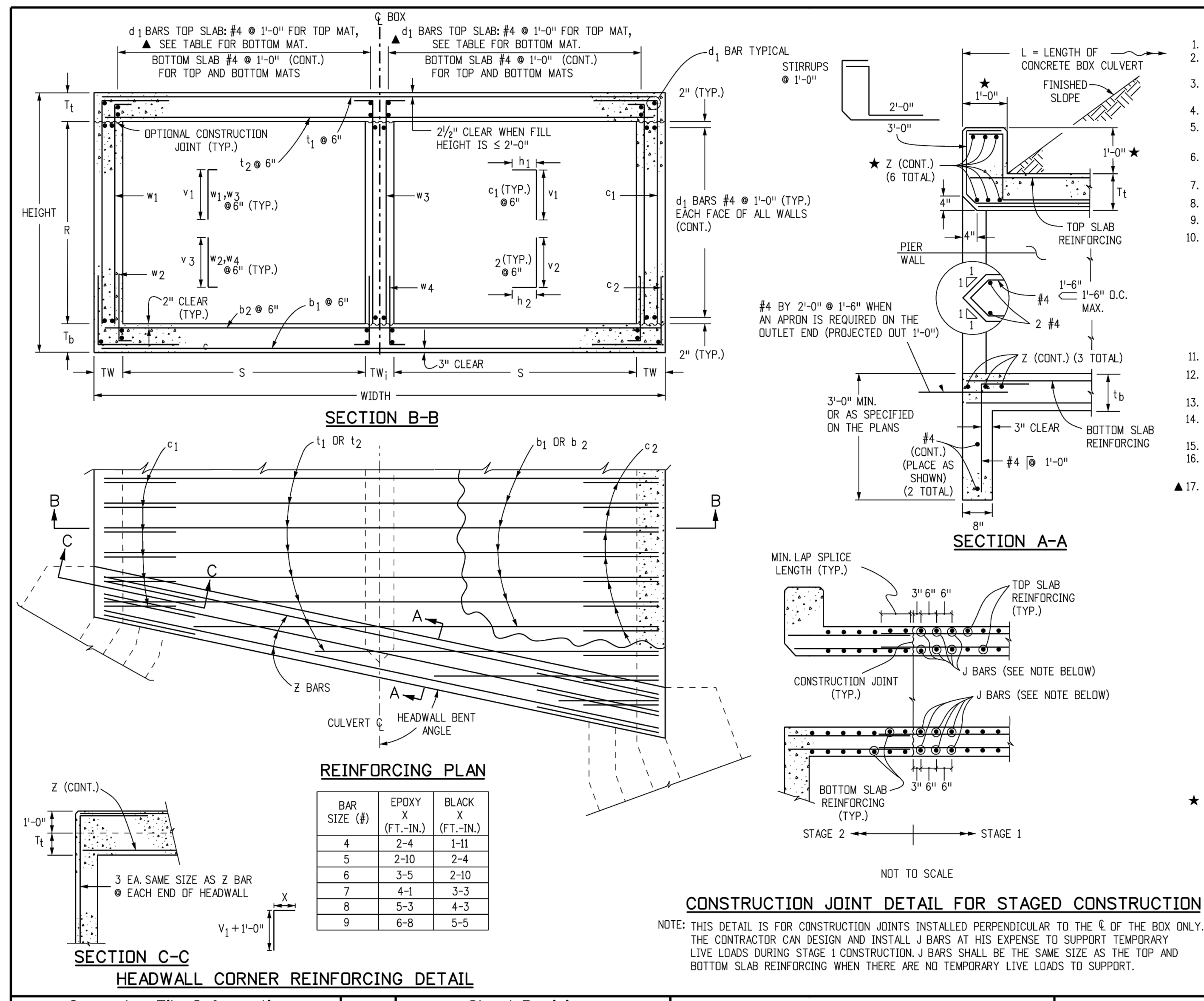
FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
DETAIL SHEET
DAM ID - 080459

DESIGNED BY	MAW	SCALE		DATE	1-4-18
DRAWN BY	MAW	(H) 1"=	20'	SHEET 11	OF 12
CHECKED BY		(V) 1"=	5'	JOB NO.	1096.11

N:\1096\DRAWINGS\CONSTRUCTION\Jurisdictional Plans\11-JD POND - Details.dwg, 6/15/2018 9:09:52 AM, 1:1



BAR SIZE (#)	EPOXY X (FT.-IN.)	BLACK X (FT.-IN.)
4	2-4	1-11
5	2-10	2-4
6	3-5	2-10
7	4-1	3-3
8	5-3	4-3
9	6-8	5-5

CONSTRUCTION JOINT DETAIL FOR STAGED CONSTRUCTION

NOTE: THIS DETAIL IS FOR CONSTRUCTION JOINTS INSTALLED PERPENDICULAR TO THE ℄ OF THE BOX ONLY. THE CONTRACTOR CAN DESIGN AND INSTALL J BARS AT HIS EXPENSE TO SUPPORT TEMPORARY LIVE LOADS DURING STAGE 1 CONSTRUCTION. J BARS SHALL BE THE SAME SIZE AS THE TOP AND BOTTOM SLAB REINFORCING WHEN THERE ARE NO TEMPORARY LIVE LOADS TO SUPPORT.

GENERAL NOTES

1. ALL CONCRETE SHALL BE CLASS D (BOX CULVERT).
2. ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED BEFORE FRESH CONCRETE IS PLACED.
3. ALL CONSTRUCTION JOINTS NOT SHOWN ON THE PLANS SHALL BE CONSTRUCTED ONLY IF APPROVED BY THE ENGINEER.
4. THE CONTRACTOR SHALL MAINTAIN THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION.
5. STRUCTURE EXCAVATION AND BACKFILL SHALL BE IN ACCORDANCE WITH STANDARD PLAN M-206-1.
6. FOR ANY CULVERT SPAN 20 FT. OR GREATER, A FOUNDATION INVESTIGATION AND REPORT ARE REQUIRED.
7. BACKFILL SHALL NOT BEGIN UNTIL TOP SLAB HAS REACHED DESIGN STRENGTH, f'_c.
8. SPLICE QUANTITIES FOR LONGITUDINAL AND TRANSVERSE BARS ARE NOT INCLUDED.
9. REINFORCING STEEL SHALL BE GRADE 60.
10. THE MINIMUM LAP SPLICE LENGTH FOR EPOXY COATED REINFORCING BARS SHALL BE:

BAR SIZE:	#4	#5	#6	#7	#8	#9	#10	#11
SPLICE LENGTH:	1'-3"	1'-7"	2'-5"	2'-10"	3'-8"	4'-8"	5'-11"	7'-3"

THE MINIMUM LAP SPLICE LENGTH FOR BLACK REINFORCING BARS SHALL BE:

BAR SIZE:	#4	#5	#6	#7	#8	#9	#10	#11
SPLICE LENGTH:	1'-1"	1'-4"	1'-7"	1'-11"	2'-6"	3'-1"	3'-11"	4'-10"

THE ABOVE SPLICE LENGTHS ARE FOR CLASS B SPLICES.

11. ALL DIMENSIONS ARE PERPENDICULAR TO THE CENTERLINE OF THE BOX.
12. WINGWALLS SHALL BE TIED TO CONCRETE BOX CULVERT IN ACCORDANCE WITH STANDARD PLAN M-601-20.
13. ALL TRANSVERSE REINFORCING SHALL BE NORMAL TO THE CENTERLINE OF THE BOX.
14. THE FILL HEIGHT IS THE DISTANCE MEASURED FROM THE TOP OF THE TOP SLAB TO THE TOP OF PAVEMENT.
15. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾".
16. FOR FILL HEIGHTS LESS THAN 2 FT, A WATERPROOFING MEMBRANE SHALL BE PROVIDED FOR THE TOP OF THE TOP SLAB AND 18" DOWN ALONG THE TOPS OF THE EXTERIOR WALLS.

▲ 17. FOR FILL HIEGHTS LESS THAN 2 FT, THE d_1 BARS FOR THE BOTTOM MAT OF THE TOP SLAB SHALL BE AS FOLLOWS:

S	6, 8	10, 12, 16	14, 18	20
BAR SIZE:	#4	#5	#6	#7
SPACING	0'-6"	1'-0"	1'-2"	1'-2"

DESIGN DATA: 7TH EDITION, 2014, OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

RATING DATA: 2ND EDITION, 2011, OF THE AASHTO MANUAL FOR BRIDGE EVALUATION

LOADING DATA: $f_y = 60{,}000$ psi., $f'_c = 4{,}500$ psi.,

LIVE LOAD = AASHTO LRFD, HL-93 TRUCK, HL-93 TANDEM, COLORADO PERMIT TRUCK AND NRL

DEAD LOAD CASE 1: VERTICAL EARTH LOAD = 120 LBS./CU. FT.
HORIZONTAL EARTH LOAD = 30 LBS./CU.FT.

DEAD LOAD CASE 2: VERTICAL EARTH LOAD = 120 LBS./CU. FT.
HORIZONTAL EARTH LOAD = 60 LBS./CU. FT.

WEARING SURFACE - 12 IN. THICK CONCRETE PAVEMENT.
DEAD LOAD - TYPE 7 BARRIER.
THRUST IS NOT CONSIDERED IN THIS STANDARD, I.E. THRUST = 0.
EXTREME HEADWATER TO DEPTH RATIO IS IN ACCORDANCE WITH THE CDOT DRAINAGE MANUAL.
EXTREME HEADWATER TO DEPTH RATIO WAS INCLUDED IN THE CULVERT DESIGNS BUT EXCLUDED FROM THE RATINGS AS PER THE AASHTO MANUAL FOR BRIDGE EVALUATION.
LIVE LOAD SURCHARGE ON EXTERIOR WALLS = 2 FT. OF EARTH

★ IF HEADWALL MOUNT GUARDRAIL IS USED (SEE STANDARD PLAN M-606-1, SHEET 19) AND THE NOTES BELOW:
- ALL REINFORCING STEEL SHALL BE ACCORDING TO THIS BOX CULVERT PLAN.
- ANY SPECIAL DESIGN FOR STIRRUPS WILL NOT BE MEASURED AND PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE WORK.
- HEADWALL DIMENSION AND CONCRETE QUANTITY SHALL BE ACCORDING TO STANDARD PLAN M-606-1, SHEET 19.
- POST ANCHORS SHALL BE PROVIDED ACCORDING TO STANDARD PLAN M-606-1, SHEET 19.
- POST ANCHORS AND CONCRETE FOR HEADWALL MOUNT OF GUARDRAIL WILL NOT BE MEASURED AND PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE WORK.
- POST ANCHORS WHEN REQUIRED AND ENCASED IN HEADWALL CONCRETE, SHALL CONFORM TO ASTM A 36 OR AASHTO M 169 STEEL.

Computer File Information	
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Last Modification Date: 11/25/15	Initials: JBE
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	Sheet Revisions Date:	Comments
(R-1)	08/27/13	LRFD Design
(R-2)	08/01/15	Analysis Program Updates

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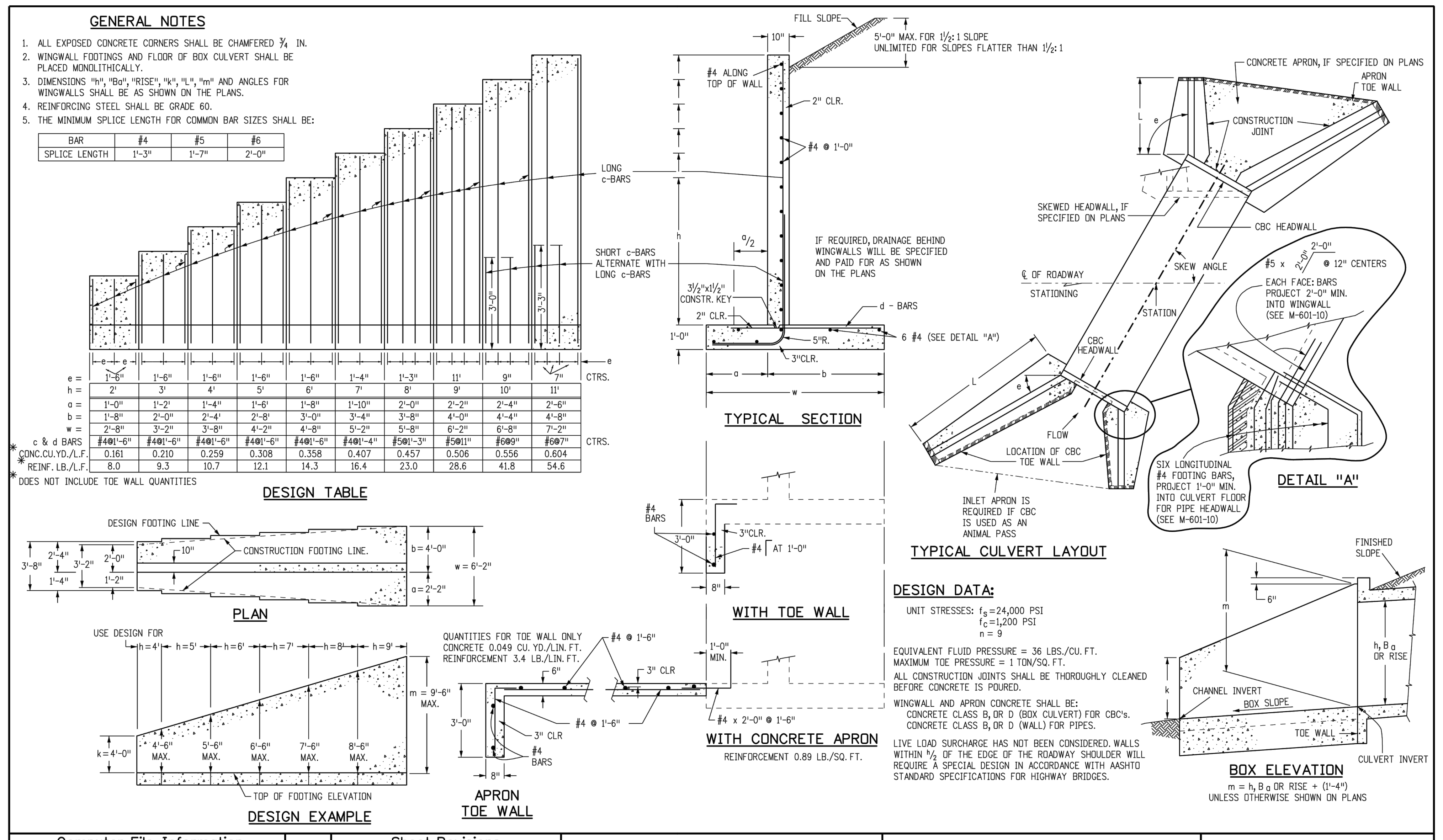
Division of Project Support DDG/Bridge

DOUBLE CONCRETE BOX CULVERT

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-2
Sheet No. 1 of 2



GENERAL NOTES

1. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾ IN.
2. WINGWALL FOOTINGS AND FLOOR OF BOX CULVERT SHALL BE PLACED MONOLITHICALLY.
3. DIMENSIONS "h", "Ba", "RISE", "k", "L", "m" AND ANGLES FOR WINGWALLS SHALL BE AS SHOWN ON THE PLANS.
4. REINFORCING STEEL SHALL BE GRADE 60.
5. THE MINIMUM SPLICE LENGTH FOR COMMON BAR SIZES SHALL BE:

BAR	#4	#5	#6
SPLICE LENGTH	1'-3"	1'-7"	2'-0"

DESIGN TABLE

e =	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-4"	1'-3"	11'	9"	7"	CTRS.
h =	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	
a =	1'-0"	1'-2'	1'-4"	1'-6'	1'-8"	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"	
b =	1'-8"	2'-0"	2'-4'	2'-8'	3'-0"	3'-4"	3'-8"	4'-0"	4'-4"	4'-8"	
w =	2'-8"	3'-2"	3'-8"	4'-2"	4'-8"	5'-2"	5'-8"	6'-2"	6'-8"	7'-2"	
c & d BARS	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-4"	#5@1'-3"	#5@11"	#6@9"	#6@7"	CTRS.
* CONC.CU.YD./L.F.	0.161	0.210	0.259	0.308	0.358	0.407	0.457	0.506	0.556	0.604	
* REINF. LB./L.F.	8.0	9.3	10.7	12.1	14.3	16.4	23.0	28.6	41.8	54.6	

* DOES NOT INCLUDE TOE WALL QUANTITIES

DESIGN DATA:

UNIT STRESSES: $f_s = 24{,}000$ PSI
$f_c = 1{,}200$ PSI
$n = 9$

EQUIVALENT FLUID PRESSURE = 36 LBS./CU. FT.
MAXIMUM TOE PRESSURE = 1 TON/SQ. FT.

ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED BEFORE CONCRETE IS POURED.

WINGWALL AND APRON CONCRETE SHALL BE:
CONCRETE CLASS B, OR D (BOX CULVERT) FOR CBC's.
CONCRETE CLASS B, OR D (WALL) FOR PIPES.

LIVE LOAD SURCHARGE HAS NOT BEEN CONSIDERED. WALLS WITHIN h/2 OF THE EDGE OF THE ROADWAY SHOULDER WILL REQUIRE A SPECIAL DESIGN IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES.

Computer File Information	
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WINGWALLS FOR PIPE OR BOX CULVERTS

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-20
Sheet No. 1 of 1

DOUBLE CONCRETE BOX CULVERT DIMENSIONS, QUANTITIES & RATING FACTORS (EXCLUDING HEADWALL & TOEWALL QUANTITIES)

BOX SIZE S				FILL HEIGHT ALLOWED	SLAB & WALL THICKNESS (INHES)			BAR SIZES									DIMENSIONS					QUANTITIES			RATING FACTORS			
S	R	HT.	WIDTH					t_1*	t_2	b_1	b_2	w_1* & w_2	w_3* & w_4	c_1*	c_2	d_1▲	h_1	h_2	v_1	v_2	v_3	CONCRETE	REBAR STL	MEMBRANE	HL-93 INVENTORY	HL-93 OPERATING	COLORADO PERMIT	NRL VEHICLE
FT	FT	FT-IN	FT-IN	FT-FT	T_t	T_b	TW & TW_i	#	#	#	#	#	#	#	#	NO.	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	CY/LF	LBS/LF	CY/LF				
6	6	7-9	14-6	< 2	11	10	10	5	6	5	6	4	4	5	5	114	3-5	2-4	6-8	3-1	1-11	1.495	338	1.944	1.27	1.65	2.09	2.05
		7-7.5	14-6	2 TO 10	10	9.5	10	5	5	5	5	4	4	5	5	102	2-6	2-4	6-8	3-1	1-11	1.428	300		1.81	2.35	2.90	2.82
		7-7.5	14-6	10 TO 12.8	10	9.5	10	4	4	4	4	4	4	5	5	102	2-6	2-4	6-8	3-1	1-11	1.428	258		4.53	5.88	6.42	7.36
		7-8	14-6	12.8 TO 20	10	10	10	4	4	4	4	4	4	5	5	102	2-6	2-4	6-8	3-1	1-11	1.451	258		◆	◆	◆	◆
	8	9-9	14-6	< 2	11	10	10	5	6	5	6	4	4	5	5	126	3-5	2-4	8-8	3-1	1-11	1.681	365	1.944	1.28	1.66	2.10	2.05
		9-7.5	14-6	2 TO 10	10	9.5	10	5	5	5	5	4	4	5	5	114	2-6	2-4	8-8	3-1	1-11	1.613	327		1.82	2.36	2.85	2.77
		9-7.5	14-6	10 TO 12.8	10	9.5	10	4	4	4	4	4	4	5	5	114	2-6	2-4	8-8	3-1	1-11	1.613	285		4.66	6.04	6.82	5.08
		9-8	14-6	12.8 TO 20	10	10	10	4	5	5	5	4	4	5	5	114	2-6	2-4	8-8	3-1	1-11	1.636	317		◆	◆	◆	◆
	10	11-9	14-6	< 2	11	10	10	5	6	5	6	4	4	5	5	138	3-5	2-4	10-8	3-1	1-11	1.866	392	1.944	1.28	1.67	1.00	2.06
		11-7.5	14-6	2 TO 10	10	9.5	10	5	5	5	5	4	4	5	5	126	2-6	2-4	10-8	3-1	1-11	1.799	354		1.83	2.38	1.00	2.78
		11-7.5	14-6	10 TO 12.8	10	9.5	10	4	4	4	4	4	4	5	5	126	2-6	2-4	10-8	3-1	1-11	1.799	312		2.22	2.88	2.79	1.96
		11-8.5	14-10.5	12.8 TO 20	10	10.5	11.5	4	5	4	5	4	4	5	5	126	2-6	2-4	10-8	3-2	2-0	2.006	336		◆	◆	◆	◆
8	6	7-10.5	18-6	< 2	12.5	10	10	5	6	5	6	4	4	5	5	134	3-5	2-4	6-10	3-1	1-11	1.840	394	2.389	1.20	1.56	1.76	1.65
		7-8	18-6	2 TO 10	10	10	10	5	5	5	5	4	4	5	5	118	2-6	2-4	6-8	3-1	1-11	1.698	344		1.47	1.90	2.19	2.15
		7-10	18-6	10 TO 15	10	12	10	5	4	5	5	4	4	5	5	118	2-6	2-4	6-8	3-3	2-1	1.812	332		2.89	3.74	4.00	4.38
		7-11	18-9	15 TO 16.8	10.5	12.5	11	5	4	5	5	4	4	5	5	118	2-6	2-5	6-8	3-4	2-2	1.942	335		3.37	4.37	4.60	4.86
		7-11	18-9	16.8 TO 20	10.5	12.5	11	5	4	5	5	4	4	5	5	118	2-6	2-4	6-8	3-4	2-2	1.942	335		◆	◆	◆	◆
	8	9-10.5	18-6	< 2	12.5	10	10	5	6	5	6	4	4	5	5	146	3-5	2-4	8-10	3-1	1-11	2.025	421	2.389	1.21	1.57	1.71	1.61
		9-8	18-6	2 TO 10	10	10	10	5	5	5	5	4	4	5	5	130	2-6	2-4	8-8	3-1	1-11	1.883	371		1.46	1.89	2.18	2.13
		9-10	18-6	10 TO 15	10	12	10	5	4	5	5	4	4	5	5	130	2-6	2-4	8-8	3-3	2-1	1.997	359		2.96	3.83	4.10	4.37
		9-11	18-9	15 TO 16.8	10.5	12.5	11	5	4	5	5	4	4	5	5	130	2-6	2-5	8-8	3-4	2-2	2.146	362		3.44	4.46	4.70	4.96
		9-11	18-9	16.8 TO 20	10.5	12.5	11	5	4	5	5	4	4	5	5	130	2-6	2-5	8-8	3-4	2-2	2.146	362		◆	◆	◆	◆
10	6	8-0.5	22-6	< 2	13.5	11	10	5	6	5	6	4	4	5	5	134	3-5	2-4	6-11	3-2	2-0	2.257	444	2.833	1.15	1.49	1.65	1.49
		8-1.5	22-6	2 TO 5	13	12.5	10	5	6	5	6	4	4	5	5	134	2-6	2-4	6-11	3-4	2-2	2.326	434		1.52	1.98	1.82	1.84
		8-2	22-6	5 TO 10	13	13	10	5	4	6	6	4	4	5	5	134	2-6	2-4	6-11	3-5	2-2	2.361	417		1.77	2.29	2.65	3.77
		8-2.5	22-9	10 TO 15	13	13.5	11	6	5	6	6	5	5	5	5	134	2-6	2-5	6-11	3-5	2-7	2.472	495		3.57	4.63	4.62	5.05
		8-5.5	23-0	15 TO 20	14	15.5	12	6	5	6	6	5	5	5	5	134	2-6	2-6	7-0	3-7	2-9	2.761	501		3.36	4.36	4.38	4.52
	8	10-1	22-6	< 2	14	11	10	5	6	5	6	4	4	5	5	146	3-5	2-5	8-11	3-2	2-0	2.477	472	2.833	1.22	1.58	1.60	1.44
		10-1.5	22-6	2 TO 5	13	12.5	10	5	6	5	6	4	4	5	5	146	2-6	2-4	8-11	3-4	2-2	2.512	461		1.52	1.97	1.79	1.79
		10-3	22-6	5 TO 10	13	14	10	5	4	5	6	4	4	5	5	146	2-6	2-4	8-11	3-5	2-3	2.616	425		1.74	2.25	2.61	3.53
		10-3	22-9	10 TO 15	13	14	11	6	5	6	5	5	5	5	5	146	2-6	2-5	8-11	3-5	2-7	2.711	508		3.95	5.12	5.26	5.69
		10-5.5	23-0	15 TO 20	14	15.5	12	6	5	6	6	6	6	5	5	146	2-6	2-6	9-0	3-7	2-9	2.983	588		3.46	4.48	4.51	4.64
	10	12-2	22-6	< 2	14	12	10	5	6	5	6	4	4	5	5	158	3-5	2-5	10-11	3-3	2-1	2.731	499	2.833	1.24	1.60	1.79	1.61
		12-2	22-6	2 TO 5	13	13	10	5	6	5	6	4	4	5	5	158	2-6	2-4	10-11	3-4	2-2	2.731	488		1.64	2.12	1.89	1.88
		12-3	22-6	5 TO 10	13	14	10	5	4	5	6	4	4	5	5	158	2-6	2-4	10-11	3-5	2-3	2.801	452		1.72	2.23	2.58	2.74
		12-5.5	22-9	10 TO 15	14	15.5	11	5	6	6	4	5	5	5	5	158	2-6	2-5	11-0	3-7	2-9	3.090	527		2.42	3.14	3.18	2.25
		12-5.5	23-0	15 TO 20	14	15.5	12	6	5	6	6	5	5	5	5	158	2-6	2-5	11-0	3-7	2-9	3.205	567		2.11	2.73	2.64	1.86
12	6	8-3.5	26-6	< 2	14.5	13	10	5	6	5	6	4	4	5	5	150	3-5	2-5	7-0	3-4	2-2	2.805	500	3.278	1.16	1.51	1.51	1.59
		8-5	26-6	2 TO 5	14	15	10	5	6	6	6	4	4	5	5	150	2-6	2-4	7-0	3-6	2-4	2.927	512		1.22	1.59	1.43	1.54
		8-5.5	26-6	5 TO 10	14	15.5	10	6	5	6	6	4	4	5	5	150	2-6	2-4	7-0	3-6	2-5	2.968	488		2.10	2.72	3.13	3.89
		8-6.5	26-9	10 TO 15	15	15.5	11	6	6	7	6	5	5	5	5	150	3-3	2-5	7-1	3-7	2-9	3.129	610		1.86	2.42	2.36	2.53
	8	10-4	26-6	< 2	14.5	13.5	10	5	6	5	6	4	4	5	5	162	3-5	2-5	9-0	3-5	2-3	3.031	528	3.278	1.16	1.51	1.56	1.59
		10-5.5	26-6	2 TO 5	14	15.5	10	5	6	5	6	4	4	5	5	162	2-6	2-4	9-0	3-7	2-5	3.154	515		1.22	1.58	1.43	1.51
		10-7.5	26-6	5 TO 10	16	15.5	10	5	6	6	6	4	4	5	5	162	3-3	2-4	9-2	3-7	2-5	3.317	544		1.70	2.21	2.16	2.39
		10-7.5	26-9	10 TO 15	16	15.5	11	6	6	7	6	5	5	5	5	162	3-3	2-5	9-2	3-7	2-9	3.416	644		2.83	3.67	3.54	3.80
	10	12-5	26-6	< 2	15	14	10	5	6	5	6	4	4	5	5	174	3-9	2-5	11-0	3-5	2-3	3.298	556	3.278	1.23	1.60	1.66	1.69
		12-5.5	26-6	2 TO 5	14	15.5	10	5	6	5	6	4	4	5	5	174	2-6	2-5	11-0	3-7	2-5	3.339	543		1.22	1.58	1.43	1.52
		12-7.5	26-6	5 TO 10	16	15.5	10	5	6	6	6	4	4	5	5	174	3-3	2-4	11-2	3-7	2-5	3.502	571		1.82	2.36	2.31	2.56
		12-7.5	26-9	10 TO 15	16	15.5	11	6	6	7	6	5	5	5	5	174	3-3	2-5	11-2	3-7	2-9	3.619	678		2.33	3.02	2.92	2.08
14	6	8-5.5	30-6	< 2	15.5	14	10	6	7	6	7	5	5	6	6	166	4-4	2-9	7-1	3-9	2-7	3.333	766	3.722	1.15	1.49	1.54	1.53
		8-4.5	30-6	2 TO 5	14	14.5	10	6	7	6	7	5	5	6	6	166	2-10	2-8	7-0	3-10	2-8	3.238	731		1.28	1.66	1.41	1.50
		8-6.5	30-6	5 TO 10	15.5	15	10	6	7	7	7	5	5	6	6	166	3-8	2-8	7-1	3-10	2-8	3.427	770		1.37	1.78	1.65	1.83
		8-8	30-6	10 TO 12	16	16	10	7	6	7	7	5	5	6	6	166	3-8	2-9	7-2	3-11	2-9	3.568	773		2.27	2.95	2.50	2.66
	8	10-5.5	30-6	< 2	15.5	14	10	6	7	6	7	5	5	6	6	178	4-4	2-9	9-1	3-9	2-7	3.518	803	3.722	1.15	1.49	1.49	1.50
		10-4.5	30-6	2 TO 5	14	14.5	10	6	7	6	7	5	5	6	6	178	2-10	2-8	9-0	3-10	2-8	3.424	768		1.26	1.64	1.38	1.46
		10-6.5	30-6	5 TO 10	15.5	15	10	6	7	7	7	5	5	6	6	178	3-8	2-8	9-1	3-10	2-8	3.612	807		1.37	1.77	1.65	1.83
		10-8.5	30-6	10 TO 12	16	16.5	10	7	5	7	7	5	5	6	6	178	3-8	2-8	9-2	4-0	2-10	3.800	783		1.46	1.90	2.09	2.27
	10	12-5.5	30-6	< 2	15.5	14	10	6	7	6	7	5	5	6	6	190	4-4	2-9	11-1	3-9	2-7	3.703	839	3.722	1.15	1.50	1.46	1.48
		12-5	30-9	2 TO 5	14	15	11	6	7	6	7	5	5	6	6	190	2-10	2-9	11-0	3-10	2-8	3.771	809		1.30	1.69	1.42	1.57
		12-6.5	30-6	5 TO 7	15.5	15	10	6	5	7	7	5	5	6	6	190	3-8	2-8	11-1	3-10	2-8	3.797	783		1.49	1.93	2.18	2.78
		12-8.5	30-6	7 TO 12	16	16.5	10	7	5	7	7	5	5	6	6	190	3-8	2-8	11-2	4-0	2-10	3.985	820		1.47	1.91	2.11	2.02
16	6	8-6.5	34-9	< 2	16	14.5	11	6	7	6	7	5	5	6	6	182	4-4	2-9	7-1	3-9	2-8	3.882	825	4.194	1.12	1.46	1.44	1.44
		8-5	34-6	2 TO 5	14	15	10	7	6	6	7	5	5	6	6	182	2-10	2-8	7-0	3-10	2-8	3.644	799		1.00	1.29	1.09	1.02
		8-6	34-6	5 TO 7	14	16	10	7	6	7	6	5	5	6	6	182	2-10	2-8	7-0	3-11	2-9	3.750	800		1.66	2.16	1.94	2.21
		8-7.5	34-9	7 TO 10	15.5	16	11	7	6	8	6	5	5	6	6	182	3-8	2-9	7-1	3-11	2-9	3.990	853		1.64	2.13	1.89	2.06
	8	10-7.5	34-9	< 2	16.5	15	11	6	7	6	7	5	5	6	6	194	4-4	2-9	9-2	3-10	2-8	4.193	864	4.194	1.18	1.54	1.45	1.46
		10-6	34-6	2 TO 5	15	15	10	8	6	7	6	5	5	6	6	194	2-10	2-8	9-1	3-10	2-8	3.935	880		1.02	1.32	1.42	1.36
		10-7	34-6	5 TO 7	15	16	10	8	6	7	6	5	5	6	6	194	2-10	2-8	9-1	3-11	2-9	4.042	881		1.72	2.23	2.23	2.13
		10-8	34-9	7 TO 10	15.5	16.5	11	7	6	8	6	5	5	6	6	194	3-8	2-9	9-1	4-0	2-10	4.247	891		1.60	2.07	1.84	2.00
	10	12-7.5	34-9	< 2	16.5	15	11	6	7	6	7	5	5	6	6	206	4-4	2-9	11-2	3-10	2-8	4.397	901	4.194	1.19	1.54	1.41	1.42
		12-6.5	34-6	2 TO 5	15.5	15	10	8	6	7	6	5	5	6	6	206	2-10	2-8	11-1	3-10	2-8	4.174	916		1.02	1.33	1.43	1.37
		12-7.5	34-6	5 TO 7	15.5	16	10	8	6	7	6	5	5	6	6	206	2-10	2-8	11-1	3-11	2-9	4.280	918		1.74	2.26	2.23	2.12
18	6	8-8	38-9	< 2	17	15	11	7	8	7	8	5	5	6	6	198	4-4	2-10	7-2	3-10	2-9	4.438	1094	4.639	1.14	1.47	1.27	1.32
		8-6.5	38-9	2 TO 5	15	15.5	11	8	8	8	8	5	5	6	6	198	3-8	2-9	7-1	3-11	2-9	4.259	1153		1.32	1.71	1.73	1.65
		8-7.5	38-9	5 TO 7	15.5	16	11	8	8	8	8	5	5	6	6	198	3-8	2-9	7-1	3-11	2-9	4.378	1153		2.23	2.89	2.57	2.58
	8	10-9	38-9	< 2	17.5	15.5	11	7	8	7	8	5	5	6	6	210	4-4	2-9	9-3	3-10	2-9	4.762	1132	4.639	1.19	1.55	1.28	1.33
		10-7	38-9	2 TO 5	15	16	11	8	9	8	9	5	5	6	6	210	3-8	2-9	9-1	3-11	2-9	4.522	1302		1.47	1.90	1.80	1.83
		10-7	38-9	5 TO 7	15	16	11	8	9	8	9	5	5	6	6	210	3-8	2-9	9-1	3-11	2-9	4.522	1302		2.20	2.85	2.45	2.46
	10	12-9	38-9	< 2	17.5	15.5	11	7	8	7	8	5	5	6	6	222	4-4	2-9	11-3	3-10	2-9	4.965	1168	4.639	1.16	1.51	1.24	1.29
		12-7	38-9	2 TO 5	15	16	11	8	9	8	9	6	6	6	6	222	3-8	2-9	11-1	3-11	3-1	4.726	1404		1.53	1.98	1.78	1.88
		12-7	38-9	5 TO 7	15	16	11	8	9	8	9	6	6	6	6	222	3-8	2-9	11-1	3-11	3-1	4.726	1404		2.20	2.85	2.39	2.39
20	6	8-10	43-0	< 2	18	16	12	8	9	8	9	6	6	7	7	214	5-0	3-3	7-3	4-3	3-1	5.179	1546	5.111	1.16	1.51	1.22	1.31
		8-7.5	43-0	2 TO 5	15.5	16	12	8	9	8	9	6	6	7	7	214	4-3	3-3	7-1	4-4	3-1	4.847	1480		1.48	1.91	1.51	1.70
	8	10-10	43-0	< 2	18	16	12	8	9	8	9	6	6	7	7	226	5-0	3-3	9-3	4-4	3-1	5.401	1595	5.111	1.14	1.48	1.16	1.24
		10-7.5	43-0	2 TO 5	15.5	16	12	8	9	8	9	6	6	7	7	226	4-3	3-3	9-1	4-4	3-1	5.069	1528		1.52	1.97	1.46	1.68
	10	12-10.5	43-0	< 2	18	16.5	12	8	9	8	9	6	6	7	7	238	5-0	3-3	11-3	4-4	3-2	5.690	1645	5.111	1.16	1.50	1.20	1.28
		12-7.5	43-0	2 TO 5	15.5	16	12	8	9	8	9	6	6	7	7	238	5-4	3-3	11-1	4-4	3-1	5.292	1585		1.52	1.97	1.43	1.64

HEADWALL AND TOEWALL QUANTITIES

HEADWALL BENT ANGLE	90° TO 75°			74° TO 60°			59° TO 45°		
CLEAR SPAN (S)	Z	STIRRUPS	REBAR QUANT.	Z	STIRRUPS	REBAR QUANT.	Z	STIRRUPS	REBAR QUANT.
	#	#	LBS/LF	#	#	LBS/LF	#	#	LBS/LF
6	4	4	20.8	4	4	20.4	6	4	31.2
8	4	4	19.9	5	4	24.3	7	4	36.2
10	5	4	25.0	6	4	30.6	9	4 ■	57.8
12	6	4	30.0	6	4	29.6	9	5 ■	61.3
14	6	4	29.7	7	4	35.7	★	★	★
16	6	4	29.0	8	5	46.7	★	★	★
18	7	4	35.0	9	5	54.9	★	★	★
20	7	4	34.4	★	★	★	★	★	★
CONCRETE QUANTITY = 0.086 CY/LF									

NOTES

■ 1. SIX INCH SPACING AT EACH END OF THE SPAN FOR A DISTANCE OF 1/4 OF THE SPAN LENGTH; 12 INCH SPACING ELSEWHERE.

2. QUANTITIES ARE GIVEN FOR ONE HEADWALL AND ONE TOEWALL AND ARE BASED ON PER LINEAR FOOT OF HEADWALL. STEEL QUANTITIES INCLUDE ALL REINFORCING. QUANTITIES SHALL BE PAID FOR AS SHOWN ON THE PLANS.

★ 3. SKEWED HEADWALLS ARE NOT RECOMMENDED FOR THESE SPANS. A SPECIAL DESIGN IS REQUIRED.

4. FOR HEADWALL AND TOEWALL DETAILS SEE M-601-2, SHEET 1 OF 2.

5. WHEN THE FILL HEIGHTS ARE LESS THAN OR EQUAL TO 2 FT, ALL REINFORCING BARS IN THE HEADWALL, ALL REINFORCING BARS DESIGNATED BY AN ASTERISK (*), AND THE d_1 BARS IN THE TOP MAT OF THE TOP SLAB SHALL BE EPOXY COATED.

6. REINFORCING QUANTITIES INCLUDE BOTH EPOXY-COATED AND UNCOATED BARS.

7. WHEN A (RISE) R OF LESS THAN 6 FT IS REQUIRED, USE THE BAR SIZES AND THE SLAB AND WALL THICKNESSES FOR THE 6 FT RISE (IF AVAILABLE ON THE TABLE).

▲ 8. FOR SIZE AND SPACING OF THE BOTTOM MAT BARS IN THE TOP SLAB SEE TABLE ON M-601-2, SHEET 1 OF 2. ALL OTHER d_1 BARS ARE #4's AT 1'-0" SPACING. THE NUMBER OF BARS REQUIRED IS LISTED ON THIS SHEET AND INCLUDES BOTH #4 BARS AND THOSE FROM THE TABLE.

◆ 9. LIVE LOAD IS NEGLECTED AS PER AASHTO LRFD SECTION 3.6.1.2.6. FOR THESE STRUCTURES REFER TO THE CDOT RATING MANUAL.

10. FOR ALL NEW CULVERT DESIGNS, A RATING IS REQUIRED. THE RATING SUMMARY SHEET SHOULD BE PRINTED FROM THE CDOT EXTERNAL WEBSITE AND SUBMITTED TO THE BRIDGE RATING UNIT OR INCLUDED AS PART OF A LARGER DESIGN PACKAGE. FOR ADDITIONAL INFORMATION, SEE THE CDOT RATING MANUAL.

Computer File Information	
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Last Modification Date: 11/25/15	Initials: JBE
Full Path: www.codot.gov/business/designsupport	
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	Sheet Revisions Date:	Comments
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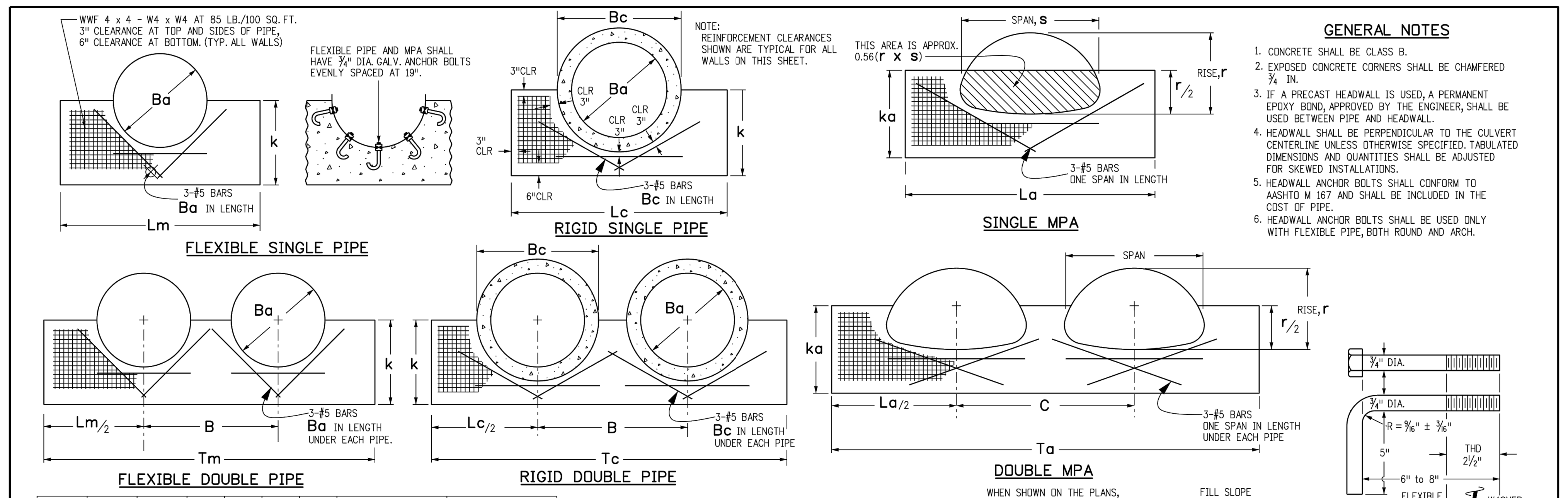
(R-2)	08/01/15	Analysis Program Updates

Colorado Department of Transportation
4201 East Arkansas Avenue
CDOT HQ, 4th Floor
Denver, CO 80222
Phone: 303-757-9021 FAX: 303-757-9868
Division of Project Support DDG/Bridge

DOUBLE CONCRETE BOX CULVERT

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-2
Sheet No. 2 of 2



GENERAL NOTES

1. CONCRETE SHALL BE CLASS B.
2. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾ IN.
3. IF A PRECAST HEADWALL IS USED, A PERMANENT EPOXY BOND, APPROVED BY THE ENGINEER, SHALL BE USED BETWEEN PIPE AND HEADWALL.
4. HEADWALL SHALL BE PERPENDICULAR TO THE CULVERT CENTERLINE UNLESS OTHERWISE SPECIFIED. TABULATED DIMENSIONS AND QUANTITIES SHALL BE ADJUSTED FOR SKEWED INSTALLATIONS.
5. HEADWALL ANCHOR BOLTS SHALL CONFORM TO AASHTO M 167 AND SHALL BE INCLUDED IN THE COST OF PIPE.
6. HEADWALL ANCHOR BOLTS SHALL BE USED ONLY WITH FLEXIBLE PIPE, BOTH ROUND AND ARCH.

RANGE OF EQUIV. DIAMS.	RANGE OF SPANS s	RANGE OF RISES r	ka	La	C	Ta	SINGLE CONCRETE	SINGLE STEEL	DOUBLE CONCRETE	DOUBLE STEEL
IN.							CU. YDS.	LBS.	CU. YDS.	LBS.
36-42 42-48	39-47 48-59	30-36 31-41	36 41	94 118	71 89	165 207	0.72 1.04	26.2 36.5	1.22 1.77	49.8 68.7
54-60 60-75	60-71 72-83	40-51 44-69	51 69	142 166	107 119	249 285	1.53 2.49	52.2 78.3	2.61 4.14	97.2 142.0
72-81 84-90	84-95 96-107	63-72 69-76	72 76	190 214	131 143	321 357	2.93 3.42	93.1 110.1	4.76 5.45	166.5 194.6

Ø HEADWALL FOR METAL PIPE ARCH (MPA)

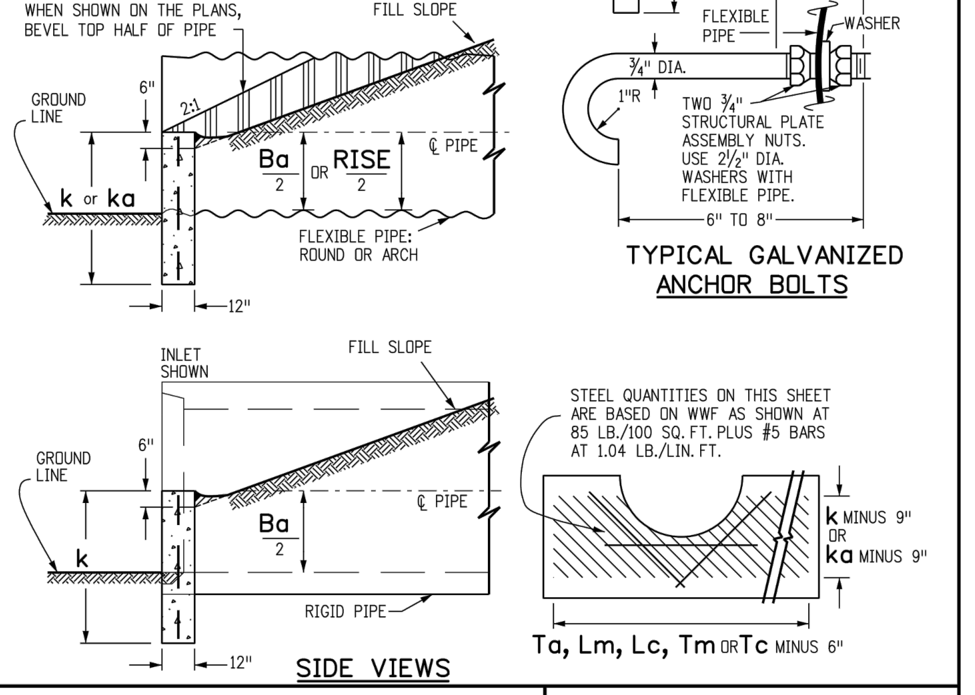
Ø NOTE: EACH LINE OF THE PIPE ARCH TABLE DESCRIBES A SINGLE HEADWALL THAT WILL ACCOMMODATE SEVERAL SIZES OF PIPE-ARCH. THE CONCRETE QUANTITIES IN THIS TABLE ARE BASED ON DEDUCTION OF CONCRETE FROM THE HEADWALL OF THE MEDIAN SIZE PIPE IN THE RANGE OF EQUIVALENT DIAMETERS SHOWN.

◪ ADJUST L, B, T, C, #5 BAR LENGTH AND QUANTITIES WHEN SKEW IS < 90°

NOM. DIA. Ba	RCP O.D. Bc	k	Lm	Lc	B	Tm	Tc	FLEXIBLE PIPE SINGLE CONCRETE	FLEXIBLE SINGLE STEEL	FLEXIBLE DOUBLE CONCRETE	FLEXIBLE DOUBLE STEEL	RIGID PIPE SINGLE CONCRETE	RIGID SINGLE STEEL	RIGID DOUBLE CONCRETE	RIGID DOUBLE STEEL
IN.								CU. YDS.	LBS.	CU. YDS.	LBS.	CU. YDS.	LBS.	CU. YDS.	LBS.
36 42	44 51	36 42	81 94	99 114	56 63	137 157	155 177	0.62 0.84	21.3 28.1	1.01 1.34	39.6 51.3	0.72 0.97	26.3 34.3	1.04 1.39	46.2 59.8
48 54	58 65	48 54	108 121	130 146	72 81	180 202	202 227	1.10 1.39	36.0 44.6	1.76 2.22	64.4 80.1	1.27 1.60	43.6 54.1	1.81 2.30	75.3 92.5
60 66	72 79	60 66	134 148	161 177	90 99	224 247	251 276	1.70 2.07	54.1 64.9	2.73 3.31	96.8 115.4	1.96 2.37	65.7 78.1	2.83 3.42	111.2 131.9
72 78	86 93	72 78	161 175	193 208	108 114	269 289	301 322	2.46 2.90	76.4 89.1	3.93 4.57	135.2 155.8	2.83 3.30	91.9 106.5	4.08 4.71	154.4 177.1
84 90	100 107	84 90	188 202	224 240	120 126	308 328	344 366	3.35 3.86	102.4 117.1	5.23 5.96	177.4 200.8	3.83 4.40	122.5 139.7	5.41 6.16	201.6 227.8
96	114	96	215	255	132	347	387	4.38	132.3	6.71	225.1	4.98	157.5	6.93	254.9

HEADWALL FOR ROUND PIPE

◪ SKEW°	FACTOR
90	1.000
85	1.004
80	1.015
75	1.035
70	1.064
65	1.103
60	1.155
55	1.221
50	1.305
45	1.414
40	1.556
35	1.743
30	2.000



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(R-X)		
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(R-X)		

Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083
Fax: (303) 757-9820
Project Development Branch DD/LTA

TYPE "S" SADDLE HEADWALLS FOR PIPE

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-11
Sheet No. 1 of 1

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48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, COLORADO P.E. #37155 DATE

CLASSIC℠
CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH IRRIGATION RESERVOIR EMBANKMENT

DETAIL SHEET

DESIGNED BY MAW	SCALE	DATE 1-4-18	
DRAWN BY MAW	(H) 1"= 20'	SHEET 12 OF 12	
CHECKED BY	(V) 1"= 5'	JOB NO. 1096.11	

INNOVATIVE DESIGN. **CLASSIC RESULTS.**

FLYING HORSE NORTH

IRRIGATION RESERVOIR EMBANKMENT

DESIGN REPORT

DAMID: 080459
Construction File No.: C-2085

MAY 2018

Prepared for:
PRI #2 LLC
6385 CORPORATE DRIVE SUITE 200
COLORADO SPRINGS CO 80919
(719) 592-9333

Prepared by:
CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. CASCADE AVE SUITE 200
COLORADO SPRINGS CO 80903
(719) 785-0790

Job no. 1096.11
PCD File No. SF-18-001

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
DESIGN REPORT

TABLE OF CONTENTS:

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CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
DESIGN REPORT

DRAINAGE REPORT STATEMENT

ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

_____ _____

Marc A. Whorton, P.E. Colorado P.E. #37155 Date

OWNER/DEVELOPER'S STATEMENT:

I, the owner/developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name: PRI #2 LLC

By: _____

Title: _____

Address: 6385 Corporate Drive, Suite 200

Colorado Springs, CO 80919

EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____

Jennifer Irvine, P.E. Date
County Engineer / ECM Administrator

Conditions:

CLASSIC CONSULTING ENGINEERS & SURVEYORS

ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CCES	Classic Consulting Engineers and Surveyors
EDB	Extended Detention Basin
EURV	Excess Urban Runoff Volume
GIS	Global Information System
HEC-HMS	Hydrologic Engineering Center – Hydrologic Modeling System
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PUD	Planned Unit Development
SCS	Soil Conservation Service
SWQ	Storm Water Quality
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WQCV	Water Quality Capture Volume

SECTION 1: INTRODUCTION

1.1 PROJECT BACKGROUND

PRI #2 LLC is the property owner and developer of the Flying Horse North (FHN) development in northern El Paso County, Colorado. The overall site contains 1,418 acres located in all of section 36, township 11 south, range 66 west of the sixth principal meridian, and a portion of sections 30 and 31 township 11 south, range 65 west of the sixth principal meridian. The site is bounded on the north by Hodgen Road and the High Forest Ranch Community, to the south by the Cathedral Pines Subdivision and unplatted county land, to the east by Black Forest Road, and to the west by the State Highway 83 and unplatted county land. **(See Figure 1.1)** A Planned Unit Development (PUD) Plan for this property was approved and recorded by El Paso County in February 2017. The development includes large lot single family residential, open space/park land and a private golf course with club house amenities. **(See Figure 1.2)** A phase 1 Final Plat to include the golf course, clubhouse and 80 residential lots was submitted to El Paso County December 2017. As a part of the private golf course, a lake is planned to serve as a golf course feature, irrigation reservoir for the golf course as well as provide for detention and SWQ. The specific location of this reservoir is within a portion of Section 36, township 11 south, range 66 west of the sixth principal meridian, and a portion of Section 31 township 11 south, range 65 west of the sixth principal meridian. **(See Figure 1.3)** A well, also located in Section 36, is designed to pump directly into the irrigation reservoir with a surface area at normal pool depth of 6.8 acres. A minor jurisdictional dam with low hazard classification will then provide the operational storage for the associated irrigation pump station located adjacent to the reservoir. The pump station is designed to meet the daily peak irrigation demand for the private golf course. The system is planned to be operational in late Summer 2018. Also, per the El Paso County Drainage Criteria Manual and the requirement to provide both stormwater detention and SWQ, this reservoir will also be designed with a separate outlet structure to facilitate the specific release for the various stormwater events.

1.2 TOPOGRAPHIC MAPPING

The topographic base mapping was produced from aerial photography provided by North American Mapping in 2009. The horizontal control is based on a local calibration and the vertical control is based on NGVD 1929 datum.

SECTION 2: IRRIGATION WELL

2.1 LOCATION / WELL DRILLING

The Flying Horse North Well A-1 is located in the NE ¼ of the NE ¼ of Section 36, Township 11 South, Range 66 West of the Principal Meridian. This location is approximately 1,650 LF SW of the Flying Horse North irrigation reservoir embankment and within the Golf Course Clubhouse site. Construction and testing of the well, permit number 81145-F, was completed in November 2017 by Layne-Western and TZA Water Engineers. The well is completed into the Arapahoe Aquifer at a depth of 2,540 feet. The well was drilled using the reverse air method at a diameter of 17.5 inches to total depth.

2.2 HYDRAULIC TESTING

On December 1, 2017, a step test was performed to evaluate the specific capacity of the well over a 24-hr. test period. The well produced an average flow rate of 450 GPM. The static water level was shown at 1,534 feet. (See Appendix A for test report documents)

2.3 PUMP DESIGN AND EQUPMENT

The well downhole equipment will consist of a submersible pump, pressure transducer and airline piping. A 350 HP 3-phase submersible pump setting at a depth of 1,830 feet will the provide the necessary pumping ability to achieve the 450 GPM flow rate. A six inch diameter flow meter will also be provided. The well location is approximately 75 feet higher than the irrigation reservoir permanent WSE. A 6" PVC water line will be installed to convey the pumped well water towards the irrigation reservoir.

2.4 WELL HOUSING

There are currently no plans for a Well House. Any pertinent well facilities will be contained within a vault located adjacent to the well head, along with all above ground electrical facilities installed near the well head.

SECTION 3: PUMP STATION

3.1 LOCATION / IRRIGATION DEMAND

The proposed irrigation pump station will be located directly adjacent to the Flying Horse North reservoir as shown on the conceptual plan in **Figure 1.3**. The pump station pumps stored groundwater from the reservoir to the irrigation system that serves the entire golf course that anticipates using an average of 200 AF per year.

3.3 MECHANICAL EQUPMENT

The pump station will include the following components: intake, wet well, pumping equipment, filters and metering equipment and controls.

Lake Intake

The intake for the pump station is located in the Flying Horse North reservoir towards the north end. **(See Figure 1.3)** The 4'x4' intake with 48" stainless steel inlet screens will sit on a 12" thick concrete slab near the base of the lake. A 30" SDR 35 pipe will convey the water from the intake structure to the wet well located beneath the pump station.

Wet Well

The pump station wet well consists of a 96" diameter precast concrete structure with a height of 25'. The base elevation equals 7511. The invert of the 30" SDR 35 intake pipe is 1.0' above the wet well base. This connection is made with a KOR-N-SEAL Boot36. In the wet well there are high and low level water probes that turn on and off the lake fill pump and will shut down the station if the water level gets down to elevation 7515.67. The wet well has access through a 24"x26" hatch located in the floor of the pump station.

Pumping Equipment / Filtering

The pump station is designed as a Variable Frequency Drive (VCD) station with pumping equipment consisting of three 75 hp. pumps and one 5 hp. sustain pump. The VCD system turns on and off the pumps on a pressure / GPM demand allowing each of the 75 hp. pumps to facilitate 150 – 750 GPM rated for a total performance of 2250 GPM @ 110 psi. The construction will also include a blind flange for a

fourth 75 hp. pump which may be installed in the future for a total rating of 3000 GPM @ 110 psi. The pumps are designed to deliver the required flow for the golf course irrigation system via a flanged 16" mainline from the pump station. Internal to the pump station, two 8" VAF 1500 filters with 300 micron screens will provide filtration of the system to eliminate system blockage.

3.4 PUMP HOUSE STRUCTURE

The pump station will be located adjacent to the reservoir along the western edge and have a FF elevation of 7536. (Three feet above spillway) The footprint of the structure is approximately 30'x20'. The access to this facility will be via a paved driveway directly off of Old Stagecoach Road. The pump station power requirements are 480 V, 60 Hz, 3 PZ, 386 FLA with a 600 AMP disconnect. The power supply will be provided by Mountain View Electric Association (MVEA) via a 3-phase circuit. The underground electric infrastructure serving the entire Flying Horse North development will be designed by MVEA and installed by the property owner/developer. Based on the location of the pump station (directly adjacent to Old Stagecoach Road and the 3-phase loop) and design provided by the MVEA, this facility will have redundant service built into the system as it will be fed from two directions (both east and west buried within Old Stagecoach Road). Thus, the reliability of power is nearly 100% given the buried looped system design. However, in this extreme unlikely event of complete power failure, a generator will be rented to keep the pump station on-line. In the unlikely event of a pump failure simultaneous with the need to drain the reservoir, the 3 pump system will still have the ability to drain the reservoir using the other two pumps.

SECTION 4: RESERVOIR AND DAM

4.1 DESIGN CRITERIA

The proposed dam for the Flying Horse North Irrigation Reservoir was designed in accordance with Rule 5 of the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, dated January 2007.

4.2 RESERVOIR

This watershed will contain development of a private golf course (currently under construction) including an outdoor golf maintenance facility, along with 2.5 ac. rural residential lot development accessed by rural County paved roadways. As such, the irrigation reservoir will also be designed with a separate stormwater detention and SWQ component per El Paso County criteria. This separate structure will be in the form of a concrete outlet box with an orifice plate and 30" RCP outlet allowing the release of the smaller storm events to meet the standards as specified per this criteria and the County's MS4 permit with the State. This SWQ release through the 30" RCP will be constructed outside of the reservoir embankment. The specific location of this reservoir is within a portion of Section 36, township 11 south, range 66 west of the sixth principal meridian, and a portion of Section 31 township 11 south, range 65 west of the sixth principal meridian, El Paso County Colorado. **(See Figure 1.3)**

The reservoir has a surface area at its permanent WSE (Elev. 7531.0) of 7.0 acres with a storage volume of 94.9 acre feet. The maximum depth at this elevation is 21 feet with the lake bed at 7510. The reservoir will have a liner constructed of a flexible membrane. This liner will be laid up to a maximum elevation of 7534. The reservoir is supplied by water from a well located on the Clubhouse site within the development approximately 1/4 mile west of the reservoir. The level in the reservoir is controlled by the two outlet structures. The Detention/SWQ structure will facilitate the State required 72 hr. drain time for the smaller stormwater events and help maintain the permanent water level while the twin box culvert spillway will allow for the County required 100 yr. detention release of the major stormwater events. The total storage capacity table is found in Section 5, Table 5.4.

4.3 DAM EMBANKMENT

The dam embankment for this reservoir will be constructed within the County owned and maintained Old Stagecoach Road (80' ROW - Collector). A separate agreement between El Paso County and the State of

Colorado will be prepared addressing ownership and maintenance responsibilities. The crest of the embankment, which will be the finished grade of asphalt for the roadway is at elevation 7539.0 at the lowest point. The regulatory height from the twin box culvert emergency spillway invert to the native channel grade equals 23.0'. The length of the embankment measured from the tow of slopes on each side is approximately 450'. Both the upstream and downstream slopes of the embankment will be constructed at no greater than a 4:1 slope. The roadway will have a typical 2% crown with an asphalt width of 32.0' with El Paso County Type A concrete curb and gutter on both sides and then 6:1 maximum to edge of ROW with a County required clear zone of 14.0'. The twin box culvert emergency spillway structure is outside this clear zone. El Paso County will also require CDOT Type 3 W-Beam guardrail along both sides of the embankment. The embankment itself will be constructed of local material found on-site and tested by the Geotech. According to the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, Rules 4.2.5.1 and 4.2.5.4, this facility is considered a "**Small Jurisdictional Dam"** given the jurisdictional height greater than 20 feet but less than 50 feet and a capacity greater than 100 acre-feet.

4.4 SPILLWAY AND OUTLET WORKS

This facility will be designed with two separate outlet structures. One will facilitate the State/County required detention/SWQ component of the facility while the other will allow for the 100 yr. stormwater event and emergency flow situations. A low level outlet will be built into the pump station design allowing for an emergency drawdown of the reservoir to be with connection to the SWQ outlet piping.

Detention / SWQ Outlet

Per the County's MS4 permit with the State, this development is required to provide detention and stormwater quality within this reservoir facility. The design for this is being handled by a separate concrete outlet box constructed outside the formal dam embankment. This structure is a 4'x8' concrete box with a steel flow control plate and protective well screen located on the front. The control plate is designed with three rectangular holes to facilitate the State required drain times. The first holes is located at elevation 7531.0 with the top of box at elevation 7533.0. The top of box will be constructed with a grate to allow flows to enter the box as well. A 30" RCP outlet pipe will allow for the release of all the flows entering the box structure. The design of this structure meets all State and County requirements for both EURV and WQCV. The 30" RCP outlet piping will be routed around the dam embankment and into the rock chute and plunge pool at the base of the emergency spillway.

Spillway Outlet

Given that the embankment for this reservoir will be a County roadway, the conventional emergency spillway channel design at the crest of the embankment was not appropriate. But rather a concrete box culvert spillway design under the roadway to allow for both the major stormwater events and emergency release has been employed. Twin 4'x10' concrete box culverts (CBC) will facilitate the required releases. The crest of the spillway will be constructed at elevation 7533.0 where the release will then travel under the roadway and into a 20' wide rock chute. The rock chute will have a 4:1 slope with 3:1 side slopes and a total drop of 18.0' into a 2.0' deep plunge pool. The rip-rap sizing will be d50=18" with a depth of 3.0' over bedding material as specified in the Geotechnical report. The spillway has been designed to accommodate both the 100 yr. release of 227 cfs with a headwater depth ratio (Hw/D) of 0.62 and the total basin inflow of 505 cfs with a (Hw/D) of 1.15. This design is well within the maximum County criteria of (Hw/D) of 1.40.

Low Level Outlet

This reservoir will not be designed with a formal low level outlet given the nature of the facility and the ability for the pump station to facilitate the draining of the reservoir for embankment inspection or emergency purposes. Thus, directly off of the 16" irrigation main just outside the pump station, a 16"x8" tee with gate valves and a 8" drain line will be installed to allow for the pumped release and draining of the reservoir. This 8" drain line will then connect directly to the 30" RCP storm system via a Type II concrete storm manhole constructed as a part of the release of the Detention/SWQ component as required by El Paso County. This 30" storm system then daylights into the base of the rock chute and plunge pool on the backside of the embankment. The 8" drain line @ 110 psi is expected to release 800-1200 GPM. However, using the maximum pump station capacity of 2,250 GPM while opening system drain valves and irrigation heads, the drain time is as follows: As mentioned earlier, the pumps will allow for release down to an elevation of 7515.67. Based on the permanent WSE of 7531, this equates to a total of approximately 26 million gallons (MG) to be drained. The total drain time is estimated at approximately 8 days.

4.6 COST ESTIMATE

The construction costs have been estimated for the dam and reservoir construction for budgetary planning purposes. See Table 4.1 below for the major construction activities:

Table 4.1: Estimated Construction Costs

Description	Estimated Cost
Irrigation Pump Station and Intake (Under separate contract)	$ N/A
Reservoir Lining and installation (Face of Embankment)	$ 50,000
Embankment earthwork / Revegetation	$ 85,000
SWQ Outlet box and piping	$ 50,000
Twin 4'x10' CBC Spillway Outlet and wingwalls	$ 180,000
20' wide rock chute and plunge pool	$ 80,000
Two 6" slotted pipe toe drains / 3' rip-rap swale	$ 8,000
8" Irrigation drain piping / 12" HDPE pipe	$ 4,000
Subtotal	**$ 457,000**
Contingency (10%)	$ 45,700
Engineering / Construction staking / Materials testing	$ 40,000
Total Project Cost	**$ 542,700**

4.7 PERMITTING / SCHEDULE

The dam application package will be submitted to The Dam Safety Branch (DSB) for review and comment in January 2018. No dam related construction will take place on-site until a notice to proceed from DSB is received. A separate submittal package will also be provided to El Paso County for review. Owner/developer to provide DSB approval and notice to proceed to El Paso County prior to their final approval of the facility. Construction is anticipated to begin in the of Summer 2018.

SECTION 5: HYDROLOGY AND HYDRAULICS

5.1 DESIGN CRITERIA

The Flying Horse North irrigation reservoir will function as both a water source for the golf course irrigation and a detention/stormwater quality (SWQ) pond for stormwater flows within the basin. As such, CCES has applied hydrology criteria from the following sources:

"State of Colorado Rules and Regulations for Dam Safety and Dam Construction", dated January 2007 (Inflow Design Flood – IDF requirements)

"City of Colorado Springs/El Paso County Drainage Criteria Manual, Vol. 1 & 2", dated May 2014 (Stormwater detention and SWQ requirements)

"Urban Drainage and Flood Control District Vol. 1, 2 & 3", dated 2017 (Detention and SWQ design requirements)

"NOAA Atlas 14 Point Precipitation Frequency Estimate", dated October 2017 (Precipitation Frequency – 24hr duration)

A Bentley Systems PondPack V8i NRCS unit hydrograph model was utilized to estimate the peak discharge for the 2-, 5-, 50- and 100-year, 24-hour duration storms. NOAA Atlas 14 point precipitation frequency estimates were obtained from the NOAA's National Weather Service Hydro-Meteorological Design Studies Center Precipitation Frequency Data Server (PFDS). This data was taken near the centroid of the basin. (See Appendix B) The NRCS 24-Hour Type II design storm distribution was used within the model.

According to the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, Rules 4.2.5.1 and 4.2.5.4, this facility is considered a "**Small Jurisdictional Dam"** given the jurisdictional height greater than 20 feet but less than 50 feet and a capacity greater than 100 acre-feet. Dead storage of approximately 5.67' (Elev. 7510 – 7515.67) is assumed based on the low-level outlet design facilitated by the pump station in-take pipe located at elev. 7511 and suction head of 4.0' min. required above pipe. Based on

the "**Low Hazard Classification**" as described in section 5.6 of this report the Inflow Design Flood Requirements (IDF) as found in Rule 5.9.1, Table 5.1 utilize the (NOAA 14 – 24 Hr. duration) 100 Yr. storm event. However, along with the SWQ design component as required by the County, the (NOAA 2 – 24 Hr. duration) 100 Yr. storm event is required. The UD-Detention v3.07 spreadsheet (Per Urban Drainage Vol. 3) will also be utilized in the final design of the Detention and SWQ aspects of this facility. This spreadsheet uses 1 Hr. precipitation depths. See Table 5.1 for precipitation depth comparison.

Table 5.1: Precipitation Depth Comparison

Return Period	1-Hr. Depth (City/County)	1-Hr. Depth (NOAA 14)	24-Hr. Depth (City/County)	24-Hr. Depth (NOAA 14)
2	1.19	0.92	2.10	1.93
5	1.50	1.20	2.70	2.44
50	2.25	2.15	4.20	**4.33**
100	2.52	2.49	**4.60**	**5.04**

5.2 WATER RIGHTS

Based on the water decree filed October 6, 2017 (See Appendix), PRI #2, LLC has the water rights to pump and store in the on-site Flying Horse North reservoir. PRI #2, LLC has a lease from the State Land Board for the following water rights: 515 AF in the Dawson, 577 AF in the Denver, 239 AF in the Arapahoe and 182 AF in the Laramie Fox Hills. The Arapahoe and Laramie Fox Hills are both deemed non-tributary reservoirs. The Flying Horse North Golf Course will take an average of 200 AF per year from their Arapahoe well that will be pumped into the reservoir. Evaporative loss is not an issue when pumping from a non-tributary source. Upon termination of the State Land Board Lease in 2048, all water rights revert automatically back to PRI #2, LLC who will own them in perpetuity.

5.3 WATERSHED CHARACTERISTICS

The watershed of the irrigation reservoir includes a total area of 366.8 acres within the East Cherry Creek drainage basin and just north of the Palmer Divide. A portion of this area is outside the Flying Horse North development as shown in basins OS-12, OS-13 and OS-14. These basins are both currently undeveloped and developed as County zoned RR-5 (5 ac. rural residential). All the on-site basins are zoned PUD for either 2.5 ac. rural residential or golf course/open space. (See Tables 5.2 and 5.3 for sub-basin CN values and associated Tc times) Nearly the entire watershed is outside of the black forest tree line and mainly consists of prairie grasses with grades ranging from 2%-20% with three major natural ravines that drain in a northwesterly direction directly towards the planned irrigation reservoir. The golf course layout aides in the natural conveyance of the majority of the stormwater flows to the reservoir. The storage capacity table for the reservoir is listed in Table 5.4.

Table 5.2: Sub-basin CN Values

ALL LAND ASSUMED 2 ACRE RESIDENTIAL LOTS OR
GOOD CONDITION OPEN SPACE (LAWNS, PARKS GOLF COURSES, CEMETARIES ETC.)

C_N VALUES - DEVELOPED CONDITIONS

BASIN (label)	BASIN AREA (Ac)	GOLF COURSE (B)		2 AC. RESIDENTIAL (B)		COMPOSITE C_N
		CN	AREA (Ac.)	CN	AREA (Ac.)	
CC-1	22.3	61	0.0	65	22.3	**65.0**
CC-2	36.4	61	0.0	65	36.4	**65.0**
CC-3	51.9	61	19.1	65	32.8	**63.5**
CC-4A	108.2	61	63.2	65	45.0	**62.7**
CC-4B	17.0	61	5.5	65	11.5	**63.7**
OS-12	67.7	61	0.0	65	67.7	**65.0**
OS-13	36.9	61	0.0	65	36.9	**65.0**
OS-14	26.4	61	0.0	65	26.4	**65.0**

Table 5.3: Sub-basin Time of Concentration

TIME OF CONCENTRATION DEVELOPED										
	COMPOSITE	OVERLAND			STREET / CHANNEL FLOW(DCM Vol. 1 Fig. 6-25)				Tc	Tc
BASIN	Cn	Length	Height	Tc	Length	Slope	Velocity	Tc	TOTAL	LAG (0.6tc)
		(ft)	*(ft)*	*(hr)*	*(ft)*	*(%)*	*(fps)*	*(hr)*	*(hr)*	*(hr)*
CC-1	65.0	300	10	0.40	900	2.0%	1.8	0.14	0.53	0.32
CC-2	65.0	300	10	0.40	1700	2.0%	1.8	0.26	0.66	0.39
CC-3	63.5	300	14	0.35	900	2.5%	2.4	0.10	0.45	0.27
CC-4A	62.7	300	14	0.35	2900	2.0%	2.1	0.38	0.73	0.44
CC-4B	63.7	300	12	0.37	900	3.0%	2.5	0.10	0.47	0.28
OS-12	65.0	300	14	0.35	1500	3.0%	2.5	0.17	0.51	0.31
OS-13	65.0	300	16	0.33	900	3.0%	2.5	0.10	0.43	0.26
OS-14	65.0	300	14	0.35	600	3.5%	2.7	0.06	0.41	0.24

Table 5.4: Storage Capacity Table

Elevation NGVD 1929	Area (Acres)	Storage Volume (Ac. Ft.)
*7510.0	1.51	0.00
*7511.0	1.99	1.74
*7512.0	2.52	3.99
*7513.0	2.85	6.68
*7514.0	3.05	9.63
*7515.0	3.26	12.78
7516.0	3.48	16.15
7517.0	3.70	19.74
7518.0	3.93	23.56
7519.0	4.16	27.60
7520.0	4.40	31.88
7521.0	4.64	36.40
7522.0	4.88	41.16

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7523.0	5.14	46.17
7524.0	5.36	51.42
7525.0	5.59	56.89
7526.0	5.84	62.61
7527.0	6.08	68.57
7528.0	6.33	74.77
7529.0	6.57	81.22
7530.0	6.81	87.91
7531.0	7.15	94.89
7532.0	7.52	102.22
7533.0	7.83	109.90
7534.0	8.37	118.00
7535.0	8.77	126.57
7536.0	9.17	135.53

*Indicates dead storage below pumping ability

5.4 HYDROLOGIC MODEL

The PondPack model produced peak discharges for the 2-yr, 5-yr, 50-yr and 100-yr storm events assuming a permanent pool elevation of 7531.0. Reference Appendix B for specific hydrologic model results. Table 5.5 below shows the results of these storm events upon the irrigation reservoir.

Table 5.5: Inflow Design Flood (IDF) Summary Table

Storm Event	Peak Inflow (cfs)	Max. WSE (ft.)	Total Discharge (cfs)
2-yr (City/County)	49	7531.45	6
5-yr (City/County)	122	7531.95	13
50-yr (NOAA 14)	446	7533.63	68
100-yr (NOAA 14)	609	7534.23	124

5.5 HYDRAULIC MODEL

Both the SWQ Outlet and the CBC Spillway were modeled using both PondPack (24-hr. precipitation) and the Urban Drainage UD Detention Spreadsheet (1-hr precipitation) as required by County design criteria. Table 5.6 below shows the results of the PondPack model. Reference Appendix B for the UD Detention – Retention Pond Spreadsheet results. As this facility is required to meet both detention and SWQ criteria, the following is applicable to these design components:

Required WQCV =	1.40 ac-ft.	Provided WQCV =	15.01 ac-ft.
Required EURV =	2.82 ac-ft.	Provided EURV =	15.01 ac-ft.
Required 100-yr. =	12.42 ac-ft.	Provided 100-yr =	27.35 ac-ft.

Table 5.6: Reservoir Discharge Table

Elevation	Discharge (cfs) (SWQ Outlet Box)	Discharge (cfs) (Twin CBC Spillway)	Discharge (cfs) (Total)
7531.0	0.0	0.0	0.0
7532.0	13.89	0.0	13.89
7533.0	27.77	0.0	27.77
7534.0	51.31	49.05	100.36
7535.0	69.52	138.56	208.08
7536.0	74.61	254.72	329.33

Permanent WSE = 7531.0

Top of SWQ Outlet box = 7533.0

Spillway elevation = 7533.0

The twin 4'x10' CBC Spillway design has the following results:

100-yr storm release = 227 cfs	Hw/D = 0.62
Emergency release – Max. basin IDF = 505 cfs	Hw/D = 1.15
County Criteria (max.)	Hw/D = 1.40

5.6 HAZARD CLASSIFICATION

As discussed earlier based on the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, dated January 2007, defined by Rule 4.2.5.3, this proposed irrigation reservoir is considered a "Minor Dam". This facility will be lined and has also been designed based on County criteria for detention and SWQ that meets the 100-yr event, which is in excess of the required NOAA 14 50-yr. requirement. The location of the facility is in a rural environment with downstream characteristics being a single property ownership (362 acres) within El Paso County, zoned RR-5 with a single family home and multiple out-buildings. Based on topography, the home seems to be well outside of the possible floodway with no loss of human life expected. Thus, based on the rural nature, location and size of this proposed irrigation reservoir, it is considered a "Low Hazard Dam" as described in the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, dated January 2007, defined by Rule 4.2.14.3.

SECTION 6: GEOLOGICAL INVESTIGATION

6.1 FIELD INVESTIGATIONS

Subsurface conditions within the dam footprint and soil borrow areas were explored by drilling thirteen test borings. The locations of the soil borings were determined based on access points on the property. Six test borings were drilled in the proposed dam footprint, two test borings were drilled in the proposed west borrow area, and five test borings were drilled in the proposed east borrow area to obtain soils information for use within the new dam embankment. The borings were typically advanced to depths of approximately 10 to 40 feet below ground surface (bgs) with one tested area, Test Boring No. 13, that was excavated with a small backhoe by an onsite contractor, prepared to 3 feet (bgs) in the proposed east borrow area. The soils in all but Test Boring No. 13 were obtained using a truck mounted, drilling rig with continuous flight auger supplied and operated by Entech.

Representative soil samples were recovered from each of the borings at approximate 5-foot intervals using 2-inch O.D. split barrel and California samplers and following Standard Penetration Test (ASTM D-1586) procedures. The locations and soil descriptions of the soils field investigation are presented in the appendicies of the Subsurface Soil Investigation which is included in this report, Appendix C.

6.2 TEST BORINGS / LABORATORY TESTING

Boring logs describing the subsurface conditions encountered in each of the borings and excavated area are included in the above-referenced Subsurface Soil Investigation. Laboratory classification testing was completed on selected soil samples recovered from the borings and soil borrow area for purposes of determining water content, evaluating engineering properties, classification and for grouping the materials by soil type. The water content testing results and soil types (by number) are included on the boring logs with respect to the sample depth measured from the existing ground surface. In addition to the classification testing sulfate, pH, resistivity, permeability, and direct shear testing was completed. A summary of the laboratory testing and the Unified Soil Classification System (USCS) designations for each of the soils encountered in the borings and the soil borrow areas are included in the appendicies of the geotechnical report included in Appendix C.

6.3 RECOMMENDATIONS FOR CONSTRUCTION

The test borings were located to provide general geotechnical information and subsurface profiles at the new embankment location and soil borrow areas. Variations in subsurface conditions may be encountered across the site. Pockets of low soil densities determined from the standard penetration testing conducted during drilling indicated isolated zones within the surficial native soil exist in the existing drainageway. The loose zones were encountered in Test Boring Nos. 2 and 3. Surficial clays and silts with low bearing capacities were encountered in Test Boring Nos. 2, 4, and 6 were also encountered in the existing drainageway within the location of the proposed dam embankment. During excavations for the dam foundation, the loose and potentially low bearing soils will be excavated to the underlying medium dense to dense soil strata below. It is likely the granular soils removed from the foundation areas will be reused in the embankment foundation or reused in the new dam embankment. Spoils removed will likely be used elsewhere on the golf course property in softscape areas.

Additional soils drilling and testing is recommended after the dam foundation is exposed to verify the condition of the underlying geology for support and construction of the dam foundation and outlet structures. Based on our Sulfate, pH, and Resistivity Testing conducted on the soils proposed to construct the new dam, the soils exhibit a negligible potential for attack on concrete structures and Type II concrete is recommended. The soils are slightly to moderately acidic and corrosive to highly corrosive; therefore, all steel materials in contact with the new dam embankment soils should be cathodically protected.

The property in the vicinity of the new dam would provide a close staging area for construction equipment and storage of usable soils removed from the dam. The east borrow are was determined to provide an ample and close soil source for the dam embankment. Laboratory testing performed on the soils located at the east borrow area determined the soil suitable for the construction of a new earthen embankment. Initial slope stability analysis' indicates the embankment stability with elevated groundwater seepage through the embankment would meet acceptable factors of safety based on the soils tested for this investigation. Notably, it is likely that the groundwater within the embankment will never reach this elevated state with the proposed manmade pond liner and active toe drains proposed with this project. Additional dam testing is recommended prior to and during construction of the new earthen embankment. It is likely that a toe drain

will be required consisting of manmade and earthen materials during construction of the new dam embankment.

After the dam embankment foundation soils are exposed, potentially mitigated, and approved by the Dam Safety Branch and Geotechnical Engineers, the new embankment shall be constructed and periodically observed and tested. The foundation granular materials (site sands) as approved by the geotechnical engineer shall be compacted to a minimum of 100% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The embankment shell materials (site sands and very sandy clays) as approved by the geotechnical engineer shall be compacted to a minimum of 98% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The filter materials shall be tamped and observed by a construction materials testing agency prior to covering the filters with embankment materials to verify thicknesses and compaction efforts. The soils testing requirements and frequencies of testing will be noted on the construction drawings and technical specifications.

PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC

Marc A. Whorton, P.E.
Project Manager

maw/1096.11/PHN JD Design Report.doc

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REFERENCES

1. State of Colorado Rules and Regulations for Dam Safety and Dam Construction, January 2007

2. State of Colorado Hydrologic Basin Response Parameter Estimation Guidelines, May 2008

3. City of Colorado Springs/County of El Paso Drainage Criteria Manual Volumes I and II, dated May 2014.

4. "Black Squirrel Creek Drainage Basin Planning Study," URS Corporation, dated August 1987.

5. "Flying Horse North Master Development Drainage Plan MDDP" Classic Consulting Engineers and Surveyors, dated October 2016.

6. "Urban Storm Drainage Criteria Manual Volume 1, 2 & 3" Urban Drainage and Flood Control District, dated January 2016.

APPENDIX A

WELL CONSTRUCTION AND TEST REPORT

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COLORADO DIVISION OF WATER RESOURCES
DEPARTMENT OF NATURAL RESOURCES
1313 SHERMAN ST, RM 821, DENVER, CO 80203
Main: (303) 866-3581 dwrpermitsonline@state.co.us

Office Use Only

Form GWS-45 (07/2013)

GENERAL PURPOSE
Water Well Permit Application

Review instructions on reverse side prior to completing form.
The form must be computer generated, typed or in black or blue ink.

1. Applicant Information

Name of applicant: PRI#2

Mailing address: 6385 Corporate Drive

City: Colorado Springs | State: C | Zip code: 80919

Telephone # (area code & number): | E-mail (online filing required):

2. Type Of Application (check applicable boxes)

- [x] Construct new well
- [ ] Replace existing well
- [ ] Change source (aquifer)
- [ ] COGCC Well
- [ ] Use existing well
- [ ] Change or increase use
- [ ] Reapplication (expired permit)
- [ ] Other: _____

3. Refer To (if applicable)

Well permit #: | Water Court case #: 04-CW-098

Designated Basin Determination #: | Well name or #: Flying Horse North A-1

4. Location Of Proposed Well

County: El Paso | NE 1/4 of the NE 1/4

Section: 36 | Township: 11 N or S [ ] [x] | Range: 66 E or W [ ] [x] | Principal Meridian: 6th

Distance of well from section lines (section lines are typically not property lines): 1130 Ft. from [x] N [ ] S 1296 Ft. from [x] E [ ] W

For replacement wells only – distance and direction from old well to new well: feet direction

Well location address (include City, State, Zip) [ ] Check if well address is same as in item 1.

Optional: GPS well location information in UTM format. You must check GPS unit for required settings as follows:

Format must be UTM
[ ] Zone 12 or [ ] Zone 13
Units must be Meters
Datum must be NAD83
Unit must be set to true north
Was GPS unit checked for above? [ ] YES

Easting _____
Northing _____
Remember to set Datum to NAD83

5. Parcel On Which Well Will Be Located
(PLEASE ATTACH A CURRENT DEED FOR THE SUBJECT PARCEL)

A. Legal Description (may be provided as an attachment):
See legal description attached to 04-CW-098

B. # of acres in parcel: 640 | C. Owner: Applicant

D. Will this be the only well on this parcel? [ ] YES [x] NO (if no list other wells)
Other wells may be applied for at a later date

E. State Parcel ID# (optional):

6. Use Of Well (check applicable boxes)

Attach a detailed description of uses applied for.

- [x] Industrial
- [x] Municipal
- [x] Irrigation
- [x] Commercial
- [ ] Dewatering System
- [ ] Geothermal (production or reinjection
- [ ] Other (describe): See 04-CW-098

7. Well Data (proposed)

Maximum pumping rate: 500 gpm | Annual amount to be withdrawn: 239 acre-feet

Total depth: 2400 feet | Aquifer: Arapahoe

8. Land On Which Ground Water Will Be Used

Legal Description of Land (may be provided as an attachment):
Section 36, T 11 South, R 66 West

(If used for crop irrigation, attach a scaled map that shows irrigated area.)

A. # Acres: 640 | B. Owner: Applicannt

C. List any other wells or water rights used on this land:

9. Proposed Well Driller License #(optional):

10. Sign or Entered Name Of Applicant(s) Or Authorized Agent

The making of false statements herein constitutes perjury in the second degree, which is punishable as a class 1 misdemeanor pursuant to C.R.S. 24-4-104 (13)(a). I have read the statements herein, know the contents thereof and state that they are true to my knowledge.

Sign or enter name(s) of person(s) submitting application: TBD | Date (mm/dd/yyyy):

If signing print name and title:

Office Use Only

USGS map name | DWR map no. | Surface elev.

Receipt area only

AQUAMAP
WE
WR
CWCB
TOPO
MYLAR
SB5

DIV ____ WD ____ BA ____ MD ____

COLORADO
Division of Water Resources
Department of Natural Resources

WELL PERMIT NUMBER **81145-F**
RECEIPT NUMBER **3680462**

ORIGINAL PERMIT APPLICANT(S)

PRI#2

APPROVED WELL LOCATION

Water Division: 1 Water District: 8
Designated Basin: N/A
Management District: N/A
County: EL PASO
Parcel Name: N/A

NE 1/4 NE 1/4 Section 36 Township 11.0 S Range 66.0 W Sixth P.M.

UTM COORDINATES (Meters, Zone:13, NAD83)

Easting: 523876.9 Northing: 4322742.4

PERMIT TO CONSTRUCT A NEW WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.

2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.

3) Approved pursuant to CRS 37-90-137(4) and the decree granted in case no. 2004CW098 Division 2 Water Court. The operation of this well is subject to the terms and conditions of said decree.

4) The use of ground water from this well is limited to municipal, industrial, domestic, commercial, irrigation, stock watering, recreational, fish and wildlife, fire protection, and augmentation purposes.

5) The pumping rate of this well shall not exceed 500 GPM (as requested).

6) The allowed average annual amount of ground water to be withdrawn is 239 acre-feet.

7) Production is limited to the Arapahoe aquifer which is located 1,995 feet below land surface and extends to a depth of 2,495 feet. Plain casing must be installed and grouted to prevent the withdrawal of ground water from other aquifers and the movement of ground water between aquifers.

8) The entire length of the hole shall be geophysically logged as required by Rule 9 of the Statewide Nontributary Ground Water Rules prior to installing casing.

9) The owner shall mark the well in a conspicuous place with well permit number(s), name of the aquifer, and court case number (s) as appropriate. The owner shall take necessary means and precautions to preserve these markings.

10) A totalizing flow meter must be installed on this well and maintained in good working order. Permanent records of all diversions must be maintained by the well owner (recorded at least annually) and submitted to the Division Engineer upon request.

11) This well shall be constructed more than 600 feet from any existing well, completed in the same aquifer, that is not owned by the applicant.

12) This well shall be constructed not more than 200 feet from the location specified on this permit.

13) Pursuant to CRS 37-90-137(9)(b) and the Denver Basin Rules, no more than 98% of the nontributary ground water withdrawn annually shall be consumed and the well owner shall demonstrate to the reasonable satisfaction of the State Engineer that no more than 98% of the water withdrawn will be consumed.

14) This well is subject to administration by the Division Engineer in accordance with applicable decrees, statutes, rules, and regulations.

NOTE: The ability of this well to withdraw its authorized amount of water from this non-renewable aquifer may be less than the 100 years upon which the amount of water in the aquifer is allocated, due to anticipated water level declines.

NOTE: To ensure a maximum productive life of this well, perforated casing should be set through the entire producing interval of the approved zone or aquifer indicated above.

WELL PERMIT NUMBER 81145-F **RECEIPT NUMBER 3680462**

NOTE: This permit will expire on the expiration date unless the well is constructed and a pump is installed by that date. A Well Construction and Yield Estimate Report (GWS-31) and Pump Installation and Production Equipment Test Report (GWS-32) must be submitted to the Division of Water Resources to verify the well has been constructed and the pump has been installed. A one-time extension of the expiration date may be available. Contact the DWR for additional information or refer to the extension request form (GWS-64) available at: http://www.water.state.co.us

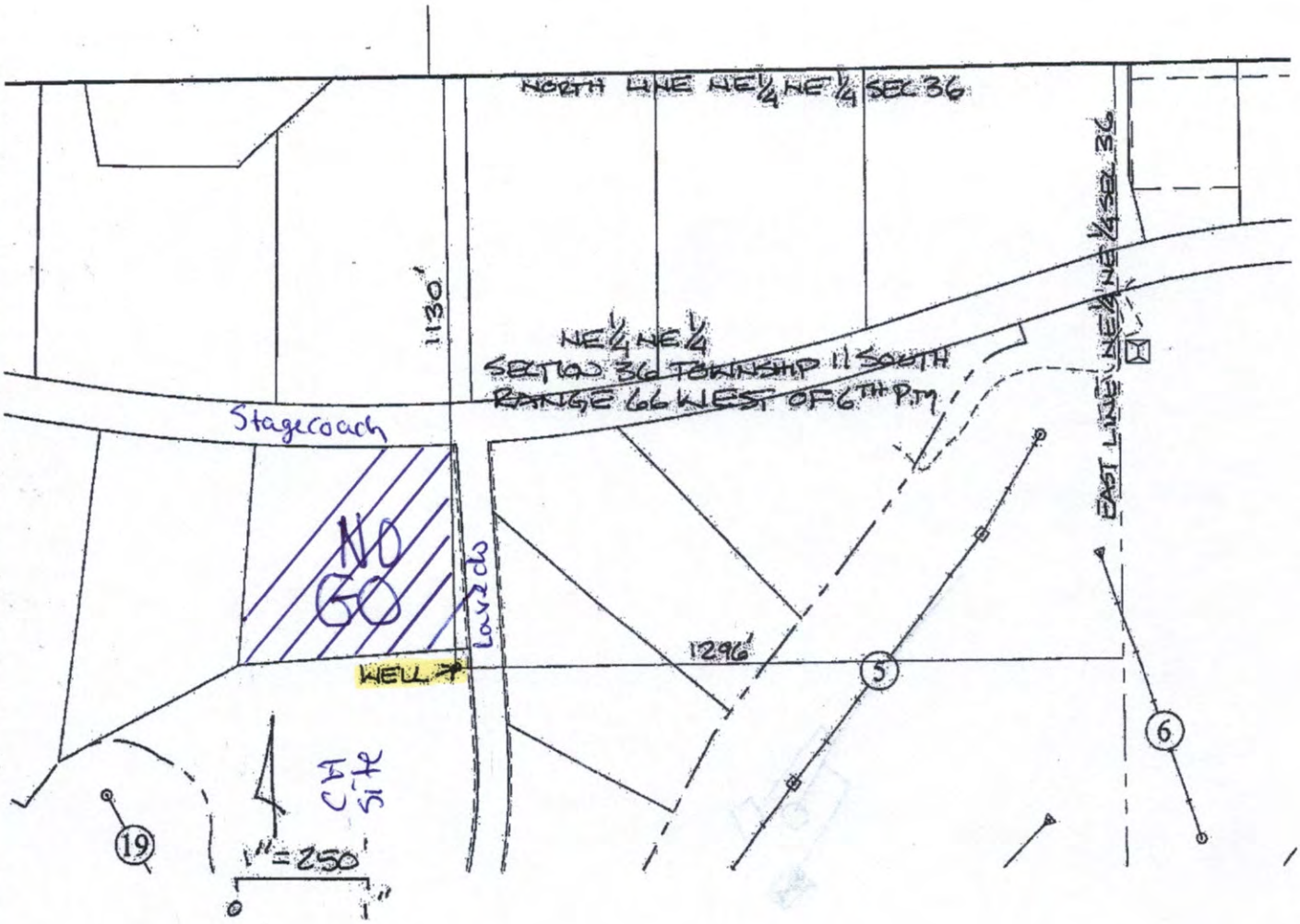
NOTICE: This permit has been approved subject to the following changes: The UTM coordinate values were calculated from the distances from section lines provided with the permit application. You are hereby notified that you have the right to appeal the issuance of this permit, by filing a written request with this office within sixty (60) days of the date of issuance, pursuant to the State Administrative Procedures Act. (See Section 24-4-104 through 106, C.R.S.)

Issued By IOANA COMANICIU

Date Issued: 7/24/2017

Expiration Date: 7/24/2018

From Doug Reinhelt
@ CCES



N:\109610\DRAWINGS\SURVEY\EXHIBITS\109610 PROPOSED WELL LOCATIONS 6-14-17.dwg, 6/14/2017 3:02:34 PM, 1:250

Form No. GWS-31 02/2017	**WELL CONSTRUCTION AND YIELD ESTIMATE REPORT** State of Colorado, Office of the State Engineer 1313 Sherman St., Room 821, Denver, CO 80203 303.866.3581 www.water.state.co.us and dwrpermitsonline@state.co.us	For Office Use Only

1. Well Permit Number: 81145-F **Receipt Number:** 6

2. Owner's Well Designation: A-1

3. Well Owner Name: PRI#2

4. Well Location Street Address:

5. As Built GPS Well Location (required): ☐ Zone 12 ☐ Zone 13 Easting: 523876.9 Northing: 4322742.4

6. Legal Well Location: NE 1/4, NE 1/4, Sec., 36 Twp. 11 ☐ N or S ☐, Range 66 ☐ E or W ☐, 6 P.M.

County: El Paso

Subdivision: Flying Horse, Lot ____, Block ____, Filing (Unit) ____

7. Ground Surface Elevation: ____ feet **Date Completed:** 11/15/2017 **Drilling Method:** Reverse Air

8. Completed Aquifer Name : Arapahoe **Total Depth:** 2555 feet **Depth Completed:** 2540 feet

9. Advance Notification: Was Notification Required Prior to Construction? ☐ Yes ☐ No, Date Notification Given: ____

10. Aquifer Type: (Check one)
☐ Type I (One Confining Layer) ☐ Type I (Multiple Confining Layers) ☐ Laramie-Fox Hills
☐ Type II (Not overlain by Type III) ☐ Type II (Overlain by Type III) ☐ Type III (alluvial/colluvial)

11. Geologic Log:

Depth	Type	Grain Size	Color	Water Loc.
60-140	Clay/Gravel	Small	Gray	
140-170	Clay		Brown	
170-810	Clay/Sand	Small	Tan	
810-1250	Clay		Gray	
1250-2220	Sandy Clay	Small	Tan	
2220-2300	Shale/Clay		Black/Gray	
2300-2520	Sand/Clay	Small	Gray	
2520-2555	Clay		Gray	

12. Hole Diameter (in.)

	From (ft)	To (ft)
30	0	60
17.5	60	2555

13. Plain Casing

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
10.75	Steel	.375	2210	0
10.75	Steel	.375	2270	2280
10.75	Steel	.375	2520	2540

Perforated Casing Screen Slot Size (in): .40

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
10.75	SS	.375	2270	2210
10.75	SS	.375	2520	2280

14. Filter Pack:
Material: Silica Sand
Size: 8/16
Interval: 2555-2035

15. Packer Placement:
Type: Mag5100W
Depth: ____

16. Grouting Record

Material	Amount	Density	Interval	Method
Neet Cement	83 YDS	7	2035-0	Tremie

Remarks:

17. Disinfection: Type HTH Chlorine Amt. Used 10 GAL

18. Well Yield Estimate Data: ☐ Check box if Test Data is submitted on Form Number GWS-39, Well Yield Test Report

Well Yield Estimate Method: Submersible Pump

Static Level: 1534

Date/Time measured: 12/1/2017

Estimated Yield (gpm) 450

Estimate Length (hrs) 24

Remarks:

19. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402 2. The filing of a document that contains false statements is a violation of section 37 91 108(1)(e), C.R.S., and is punishable by fines up to $1,000 and/or revocation of the contracting license. If filing online the State Engineer considers the entry of the licensed contractor's name to be compliance with Rule 17.4.

Company Name:	Email:	Phone w/area code:	License Number:
Layne Christensen CO	Mike.schanaman@layne.com	(303) 755-1281	1290

Mailing Address: 17800 E 22nd Ave Aurora, CO 80011

Sign (or enter name if filing online)	Print Name and Title	Date:
Mike Schanaman	Mike Schanaman/ Project Manager	12/04/2017

FORM No. GWS-39 9/2016	**WELL YIELD TEST REPORT** State Of Colorado, Office Of The State Engineer 1313 Sherman St., Room 821, Denver, CO 80203 303.866.3581 www.water.state.co.us and dwrpermitsonline@state.co.us	For Office Use Only

1. Well Permit Number: 81145-F **Receipt Number:** 3680462

2. Owner's Well Designation: A-1

3. Well Owner Name: PRI#2

4. Well Location Street Address:

5. GPS Well Location: ☐ Zone 12 ☒ Zone 13 Easting: 523876.90 Northing: 4322742.40 **County:** EL PASO

6. Legal Well Location: NE 1/4, NE 1/4, Sec. 36 Twp. 11 ☐ N or S ☒, Range 66 ☐ E or W ☒ 6 PM
Distances from Section Lines: _____ ft. from ☐ N or S ☐ section line, and _____ ft. from ☐ E or W ☐ section line
Subdivision: Flying Horse, Lot _____, Block _____, Filing (Unit) _____

7. Static Water Level: 1534 feet Date/Time measured 12/1/2017
Measurement Method Transducer Length of airline (if used) 1812.28

8. Pump: Type Submersible Horsepower 350 Depth Setting 1830 feet
Voltage 2034 Discharge pipe 6 inches Discharge Pressure 15 psi

9. Flow Meter: Manufacturer Siemens Type Mag5100W
Diameter 6 inches Average pumping rate 450 gpm Volume pumped during test 591,333 Gal.

10. Test Data: ***Test Data may be submitted by spreadsheet in lieu of filling out Section 10***

Date of Test 12/01/2017

Time	Pumping Level (feet)	Drawdown (feet)	Pumping Rate (gpm)	Pumping Pressure (psi)	-------Recovery Data------- Time	Water Level (feet)

11. Disinfection: Type HTH Chlorine Amount Used 5 GAL

12. Water Quality Analysis Available: ☐ Yes or ☒ No

13. Water Level / Pumping Spreadsheet Attached: ☒ Yes or ☐ No Spreadsheet File Name Flying Horse Constant Test

14. Remarks:

15. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402 2. The filing of a document that contains false statements is a violation of section 37 91 108(1)(e), C.R.S., and is punishable by fines up to $1,000 and/or revocation of the contracting license. If filing online, the State Engineer considers the entry of the licensed contractor's name to be compliance with Rule 17.4.

Company Name:	Email:	Phone w/area code:	License Number:
Layne Christensen CO	Mike.schanaman@layne.com	(303) 755-1281	1290

Mailing Address: 17800 E 22nd Ave Aurora, CO 80011

Sign (or enter name if filing online)	Print Name and Title	Date:
Mike Schanaman	Mike Schanaman/ Project Manager	12/04/2017

Layne-Western, a Division of Layne Christensen Company
17800 East 22nd Avenue
Aurora, CO 80011
Phone: 303-755-1281, FAX: 303-755-1236, E-Mail: 1031@laynechristensen.com

WELL TEST
TEST ENGINE

Well # A-1 | Customer FLYING HORSE | City BLACK FOREST | State COLORADO

Job # 47170 | Date 12/1/2017 | Test Type (Step, Continuous, Duration) CONT | Tested By SNYDER

Pump Setting Depth (ft) 1830 | Shroud Info. (ft) X (dia) 42X7 | Airline Length (ft) 1812.28 | Transducer setting depth 1812.28

Static Water Level (ft) (manual correct gl) 1534 | Airline Reading @ Start (psi) 125 | Transducer reading @ Start 277FT

Flow Meter Totalizer-Start 0 | Flow Meter Totalizer-End 591333 | Flow Meter Size (dia) 6

MOTOR 350HP @ 2034V | Test Pump Make & Model GE TJ2000 | # Pump Stages 31 | Probe Model 900PSI DYNOTEC

Ground Level Correction

Pumping water levels (column F) are from ground level. M-Scope readings (Column D) are actual from top of sounder tube.

Time of Day (am/pm)	Elapsed Time (min)	GPM	AIR	Transducer FT	Pumping Level (ft)	Drawdown (ft)	Amps	Volts	Hertz	Discharge Pressure	Sand Test (ml/min)	Flow Meter Totalizer	Remarks (adjustments, conditions, etc.)
908A	0	0	125	277	0	0	0	0	0	0	0	0	ROUGH PUMP
925A	17	196	109	234.13	1578.15	44.15	X	X	47	14	0.7	1266	ORANGE WATER
927A	19	194	107	231	1581.28	47.28	X	X	X	14	0.8	1652	
929A	21	188	105	229	1583.28	49.28	X	X	46.7	12	0.7	2034	
931A	23	188	105	225	1587.28	53.28	X	X	X	12	-	2492	
933A	25	183	105	223.91	1588.37	54.37	X	X	X	12	0.7	2882	ORANGE WATER
935A	27	186	104	221	1591.28	57.28	355	317	47	-	0.7	3137	
937A	29	193	101	223.5	1588.78	54.78	X	X	X	14	0.7	3602	
939A	31	197	101	221.2	1591.08	57.08	X	X	X	14	0.7	3931	
943A	35	202	100	219.63	1592.65	58.65	X	X	X	12	0.7	4654	
945A	37	196	101	215.8	1596.48	62.48	X	X	X	10	0.7	4992	
950A	42	203	100	215.03	1597.25	63.25	X	X	X	10	0.7	6008	
955A	47	196	99	212.02	1600.26	66.26	X	X	X	10	0.7	6990	
1000A	52	200	99	209	1603.28	69.28	X	X	X	10	0.7	7983	
1008A	60	194	98	209.94	1602.34	68.34	X	X	X	10	0.7	9521	
1018A	70	202	96	211.69	1600.59	66.59	X	X	X	10	0.7	11468	SCALE FROM 4.5
1028A	80	195	95	207.46	1604.82	70.82	X	X	X	10	0.7	13384	CLEAN OUT TUBE
1038A	90	203	95	207.29	1604.99	70.99	X	X	X	10	0	15413	
1048A	100	191	94	206.28	1606	72	X	X	X	10	0	17321	
1058A	110	192	94	204.36	1607.92	73.92	356	318	47	10	0	19135	
1108A	120	195	94	202.2	1610.08	76.08	X	X	X	10	0	20961	
1110A	122	299	90	186.28	1626	92	415	412	51.9	15	0	21629	
1112A	124	300	86	180.9	1631.38	97.38	X	X	51.9	15	0	22145	
1114A	126	302	84	177.36	1634.88	100.88	X	X	51.9	15	0	22737	
1116	128	302	84	175.04	1637.24	103.24	X	X	51.9	15	0	23444	
1118	130	299	82	173.74	1638.54	104.54	X	X	51.9	15	0	23947	
1120A	132	300	82	172.39	1639.89	105.89	X	X	51.9	15	0	24562	
1122A	134	299	81	171.25	1641.03	107.03	X	X	51.9	15	0	25163	
1124A	136	300	81	170.27	1642.01	108.01	X	X	51.9	15	0	25874	
1126A	138	298	81	170.03	1642.25	108.25	X	X	51.9	15	0	26372	
1128A	140	299	80	169.54	1642.74	108.74	X	X	51.9	15	0	27024	
1130A	142	300	80	168.2	1644.08	110.08	X	X	51.9	15	TRACE	27689	ADJUST VALVE
1135A	147	297	80	166.77	1645.51	111.51	X	X	51.9	15	TRACE	29033	ADJUST VALVE
Time of Day (am/pm)	Elapsed Time (min)	GPM	AIR	Transducer FT	Pumping Level (ft)	Drawdown (ft)	Amps	Volts	Hertz	Discharge Pressure	Sand Test (ml/min)	Flow Meter Totalizer	Remarks (adjustments, conditions, etc.)

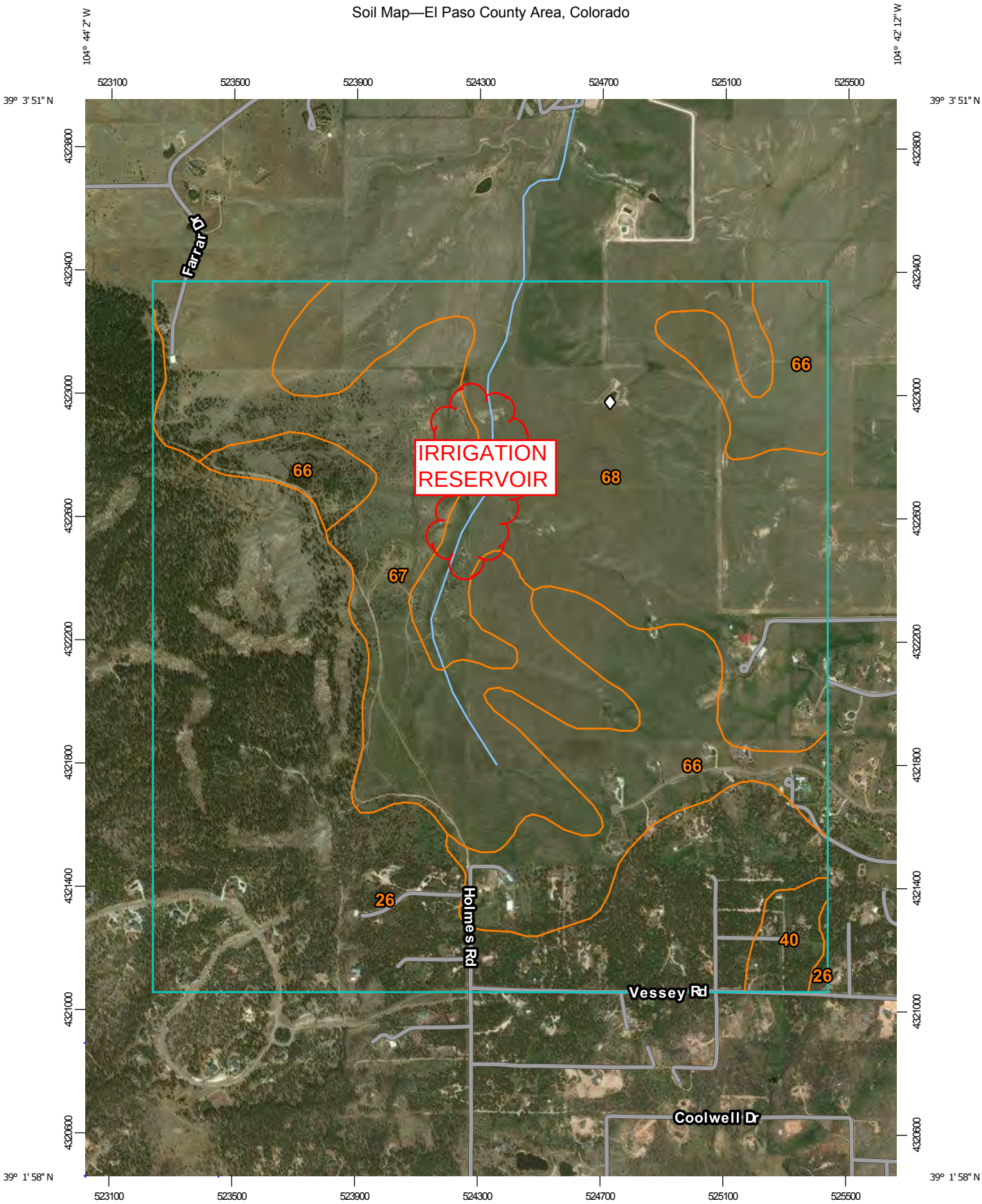
1140A	152	299	80	165.22	1647.06	113.06	X	X	51.9	15	TRACE	30553	
1145A	157	-	X	X	X	X	X	X	X	X	X	X	
1150A	162	297	79	163.68	1648.6	114.6	X	X	X	15	TRACE	33487	
1155A	167	296	79	163.02	1649.26	115.26	415	414	52	15	TRACE	34988	
1200P	172	299	77	161.8	1650.48	116.48	X	X	52	15	TRACE	36472	
1205P	177	300	77	160.58	1651.7	117.7	415	414	52	15	TRACE	37972	
1210P	182	300	76	160.01	1652.27	118.27	X	X	52	15	TRACE	39457	
1220P	192	297	76	159.2	1653.08	119.08	415	414	52	15	TRACE	42457	
1230P	202	300	76	157.77	1654.31	120.31	415	414	52	15	TRACE	45459	
1240P	212	299	75	157.36	1654.92	120.92	X	X	52	15	TRACE	48414	
1250P	222	299	75	156.06	1656.22	122.22	415	414	52	15	TRACE	51383	
1300	232	299	75	155.29	1656.99	122.99	415	414	52	14	TRACE	54372	
1308	240	298	75	153.86	1658.42	124.42	415	414	52	14	TRACE	56570	
1310	242	438	X	X	X	X	X	X	58.9	X	X	57983	
1312	244	450	62	123.93	1688.35	154.35	X	X	58.9	10	TRACE	58543	
1314	246	448	59	118.27	1694.01	160.01	X	X	58.9	10	TRACE	59500	
1316	248	448	59	116.03	1696.25	162.25	X	X	58.9	10	TRACE	60231	
1318	250	449	57	114.48	1697.8	163.8	X	X	58.9	10	0.1	60989	
1320	252	446	56	112.97	1699.31	165.31	509	461	59	10	0.1	61886	
1322	254	447	55	110.73	1701.55	167.55	X	X	59	10	0.1	63136	
1324	256	448	55	110	1702.28	168.28	X	X	59	10	0.1	63696	
1326	258	446	55	109.19	1703.09	169.09	X	X	59	10	0.1	64572	
1328	260	447	54	107.76	1704.52	170.52	X	X	59	9	0.2	65659	
1330	262	445	54	107.31	1704.97	170.97	X	X	59	9	0.2	66345	
1335	267	450	52	104.58	1707.7	173.7	X	X	59.2	9	0.2	68606	
1340	272	453	52	102.79	1709.49	175.49	X	X	59.2	9	.2.2	70873	
1345	277	449	51	101.9	1710.38	176.38	X	X	59.2	9	0.2	73126	
1350	282	449	51	100.51	1711.77	177.77	X	X	59.2	9	0.25	75371	
1355	287	450	50	99.45	1712.83	178.83	509	461	59.2	9	0.3	77566	
1400	292	449	50	98.67	1713.61	179.61	X	X	59.2	9	0.3	79816	
1410	302	450	50	97.57	1714.71	180.71	X	X	59.2	9	0.3	84235	
1420	312	449	50	95.5	1716.78	182.78	X	X	59.2	9	0.3	88769	
1430	322	448	49	94.64	1717.64	183.64	X	X	59.2	9	0.3	93288	
1440	332	447	48	92.52	1719.76	185.76	X	X	59.2	9	0.3	98695	
1450	342	450	47	91.71	1720.57	186.57	X	X	59.2	9	0.3	102268	
1500	352	450	46	90.41	1721.87	187.87	X	X	59.2	9	0.35	106744	
1515	367	449	45	89.49	1722.81	188.31	X	X	59.2	9	0.4	113988	
1530	382	447	45	88.17	1724.11	190.11	X	X	59.2	10	0.4	120007	
1545	397	449	45	96.66	1725.62	191.62	512	472	59.4	9.5	0.4	126730	SURGE IN PUMP
1600	412	449	45	86.01	1726.27	192.27	X	X	59.4	9.5	0.4	133398	
1615	427	448	42	84.54	1727.74	193.74	X	X	59.4	9.5	0.4	140493	
1630	442	448	42	84.79	1727.49	193.49	X	X	59.4	9.5	0.4	146691	
Time of Day (am/pm)	Elapsed Time (min)	GPM	AIR	Transducer FT	Pumping Level (ft)	Drawdown (ft)	Amps	Volts	Hertz	Discharge Pressure	Sand Test (ml/min)	Flow Meter Totalizer	Remarks (adjustments, conditions, etc.)
1645	457	446	42	82.79	1729.49	195.49	X	X	59.4	9.5	0.4	153478	
1700	472	449	42	81.53	1730.45	196.45	X	X	59.4	9.5	0.4	160184	
1730	502	449	41	80.39	1731.89	197.89	512	475	59.4	9.5	0.45	173506	

1800	532	445	40	78.03	1734.25	200.25	X	X	X	9.5	0.5	186374	
1830	562	446	40	76.32	1735.96	201.96	X	X	X	9.5	0.5	199707	
1900	592	445	40	75.22	1737.06	203.06	X	X	X	9.5	0.5	213059	
2000	652	446	39	72.98	1739.3	205.3	X	X	59.4	9	0.5	239494	
2100	712	445	37	71.27	1741.01	207.01	X	X	X	9	0.5	265900	
2200	772	445	37	69.03	1743.25	209.25	X	X	X	9.5	0.5	292248	
2300	832	442	35	67.93	1744.35	210.35	511	471	59.5	9	0.5	318539	
2400	892	448	35	66.79	1745.49	211.49	X	X	X	10	0.6	344691	
100A	952	448	34	65.69	1746.59	212.59	X	X	X	10	0.6	370800	
200A	1012	445	34	63.41	1748.87	214.87	X	X	59.6	9	0.6	396906	
300A	1072	447	33	62.84	1749.44	215.44	X	X	X	10	0.6	422522	
400A	1132	443	33	61.17	1751.11	217.11	513	470	59.8	10	0.6	449018	
500A	1192	448	30	56.69	1755.67	221.67	X	X	X	10	0.6	475551	
600A	1252	448	29	54.98	1757.3	223.3	X	X	X	10	0.6	502254	
700A	1312	448	29	53.88	1758.4	224.4	X	X	X	10	0.6	529291	
800A	1372	447	27	52.65	1759.63	225.63	513	471	59.8	8.5	0.6	556394	
900A	1432	449	26	51.23	1761.05	227.05	513	471	59.8	8.5	0.6	583199	
918A	1450	449	26	50.82	1761.46	227.46	514	472	59.8	8	0.6	591333	
919A	X	X	X	63.56	1708.72	174.72	X	X	X	X	X	X	
929A	X	X	X	156.42	1655.86	121.86	X	X	X	X	X	X	
1027A	X	X	X	201.23	1611.05	77.05	X	X	X	X	X	X	
1101A	X	X	X	208.84	1603.44	69.44	X	X	X	X	X	X	

APPENDIX B

HYDROLOGIC / HYDRAULIC MODELS

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS



Map Scale: 1:17,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 250 500 1000 1500

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
26	Elbeth sandy loam, 8 to 15 percent slopes	433.1	34.4%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	17.8	1.4%
66	Peyton sandy loam, 1 to 5 percent slopes	200.4	15.9%
67	Peyton sandy loam, 5 to 9 percent slopes	253.2	20.1%
68	Peyton-Pring complex, 3 to 8 percent slopes	353.2	28.1%
Totals for Area of Interest		**1,257.7**	**100.0%**

El Paso County Area, Colorado

66—Peyton sandy loam, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 369c
Elevation: 6,800 to 7,600 feet
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Peyton and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Flats, hills
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

El Paso County Area, Colorado

67—Peyton sandy loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369d
Elevation: 6,800 to 7,600 feet
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 115 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

El Paso County Area, Colorado

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369f
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

ALL LAND ASSUMED 2 ACRE RESIDENTIAL LOTS OR
GOOD CONDITION OPEN SPACE (LAWNS, PARKS GOLF COURSES, CEMETARIES ETC.)

C_N VALUES - DEVELOPED CONDITIONS

BASIN (label)	BASIN AREA (Ac)	**GOLF COURSE (B)**		**2 AC. RESIDENTIAL (B)**		**COMPOSITE C_N**
		CN	AREA (Ac.)	CN	AREA (Ac.)	
CC-1	22.3	61	0.0	65	22.3	**65.0**
CC-2	36.4	61	0.0	65	36.4	**65.0**
CC-3	51.9	61	19.1	65	32.8	**63.5**
CC-4A	108.2	61	63.2	65	45.0	**62.7**
CC-4B	17.0	61	5.5	65	11.5	**63.7**
OS-12	67.7	61	0.0	65	67.7	**65.0**
OS-13	36.9	61	0.0	65	36.9	**65.0**
OS-14	26.4	61	0.0	65	26.4	**65.0**

TIME OF CONCENTRATION DEVELOPED

BASIN	COMPOSITE Cn	OVERLAND Length (ft)	OVERLAND Height (ft)	OVERLAND Tc (hr)	STREET / CHANNEL FLOW (DCM Vol. 1 Fig. 6-25) Length (ft)	Slope (%)	Velocity (fps)	Tc (hr)	Tc TOTAL (hr)	Tc LAG (0.6tc) (hr)
CC-1	65.0	300	10	0.40	900	2.0%	1.8	0.14	0.53	0.32
CC-2	65.0	300	10	0.40	1700	2.0%	1.8	0.26	0.66	0.39
CC-3	63.5	300	14	0.35	900	2.5%	2.4	0.10	0.45	0.27
CC-4A	62.7	300	14	0.35	2900	2.0%	2.1	0.38	0.73	0.44
CC-4B	63.7	300	12	0.37	900	3.0%	2.5	0.10	0.47	0.28
OS-12	65.0	300	14	0.35	1500	3.0%	2.5	0.17	0.51	0.31
OS-13	65.0	300	16	0.33	900	3.0%	2.5	0.10	0.43	0.26
OS-14	65.0	300	14	0.35	600	3.5%	2.7	0.06	0.41	0.24

NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, USA*
Latitude: 39.051°, Longitude: -104.7161°
Elevation: 7569.65 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.237 (0.194-0.290)	0.288 (0.236-0.353)	0.376 (0.308-0.463)	0.455 (0.370-0.562)	0.570 (0.450-0.736)	0.665 (0.510-0.867)	0.765 (0.566-1.02)	0.871 (0.616-1.19)	1.02 (0.692-1.43)	1.14 (0.749-1.61)
10-min	0.346 (0.284-0.425)	0.421 (0.345-0.517)	0.551 (0.450-0.678)	0.666 (0.541-0.823)	0.835 (0.658-1.08)	0.974 (0.747-1.27)	1.12 (0.828-1.50)	1.27 (0.902-1.75)	1.49 (1.01-2.10)	1.67 (1.10-2.36)
15-min	0.422 (0.347-0.518)	0.514 (0.421-0.631)	0.672 (0.549-0.827)	0.812 (0.660-1.00)	1.02 (0.803-1.31)	1.19 (0.911-1.55)	1.37 (1.01-1.82)	1.56 (1.10-2.13)	1.82 (1.24-2.56)	2.03 (1.34-2.88)
30-min	0.603 (0.495-0.739)	0.732 (0.601-0.899)	0.957 (0.782-1.18)	1.16 (0.939-1.43)	1.45 (1.14-1.87)	1.69 (1.30-2.20)	1.94 (1.44-2.59)	2.21 (1.56-3.03)	2.59 (1.76-3.64)	2.89 (1.90-4.10)
60-min	0.768 (0.631-0.942)	0.921 (0.755-1.13)	1.20 (0.977-1.47)	1.45 (1.17-1.79)	1.83 (1.45-2.37)	2.15 (1.65-2.81)	2.49 (1.84-3.33)	2.86 (2.03-3.93)	3.39 (2.30-4.78)	3.82 (2.51-5.42)
2-hr	0.934 (0.771-1.14)	1.11 (0.915-1.35)	1.43 (1.18-1.75)	1.74 (1.42-2.13)	2.20 (1.76-2.85)	2.60 (2.02-3.39)	3.03 (2.27-4.05)	3.51 (2.51-4.80)	4.19 (2.87-5.88)	4.75 (3.15-6.69)
3-hr	1.02 (0.849-1.24)	1.20 (0.996-1.46)	1.54 (1.27-1.88)	1.87 (1.53-2.29)	2.39 (1.92-3.09)	2.84 (2.21-3.70)	3.33 (2.50-4.44)	3.88 (2.79-5.30)	4.68 (3.22-6.55)	5.34 (3.55-7.49)
6-hr	1.20 (0.999-1.44)	1.39 (1.16-1.67)	1.76 (1.46-2.13)	2.13 (1.76-2.59)	2.73 (2.22-3.52)	3.26 (2.56-4.23)	3.85 (2.92-5.11)	4.51 (3.27-6.14)	5.49 (3.81-7.65)	6.29 (4.22-8.78)
12-hr	1.41 (1.18-1.69)	1.63 (1.36-1.95)	2.05 (1.71-2.46)	2.47 (2.05-2.98)	3.15 (2.57-4.03)	3.74 (2.96-4.82)	4.41 (3.36-5.81)	5.15 (3.76-6.96)	6.24 (4.36-8.63)	7.14 (4.82-9.90)
* 24-hr	1.65 (1.39-1.96)	1.93 (1.62-2.29)	2.44 (2.05-2.91)	2.93 (2.44-3.50)	3.68 (3.01-4.65)	4.33 (3.44-5.51)	5.04 (3.86-6.57)	5.82 (4.26-7.78)	6.95 (4.88-9.52)	7.87 (5.35-10.8)
2-day	1.93 (1.63-2.27)	2.28 (1.93-2.69)	2.91 (2.46-3.45)	3.48 (2.92-4.13)	4.32 (3.53-5.36)	5.01 (3.99-6.30)	5.75 (4.41-7.40)	6.54 (4.81-8.64)	7.66 (5.41-10.4)	8.56 (5.86-11.7)
3-day	2.12 (1.80-2.49)	2.51 (2.13-2.94)	3.18 (2.69-3.74)	3.78 (3.18-4.47)	4.66 (3.82-5.76)	5.39 (4.30-6.73)	6.16 (4.74-7.88)	6.98 (5.15-9.17)	8.13 (5.76-11.0)	9.05 (6.23-12.3)
4-day	2.28 (1.95-2.67)	2.68 (2.28-3.14)	3.37 (2.86-3.96)	3.99 (3.37-4.70)	4.90 (4.02-6.03)	5.65 (4.52-7.04)	6.45 (4.98-8.23)	7.30 (5.40-9.56)	8.49 (6.03-11.4)	9.44 (6.51-12.8)
7-day	2.68 (2.30-3.12)	3.10 (2.65-3.61)	3.84 (3.27-4.48)	4.49 (3.81-5.26)	5.46 (4.50-6.68)	6.26 (5.03-7.74)	7.10 (5.51-9.01)	8.01 (5.96-10.4)	9.28 (6.63-12.4)	10.3 (7.14-13.9)
10-day	3.03 (2.61-3.51)	3.48 (2.99-4.04)	4.27 (3.65-4.96)	4.96 (4.22-5.80)	5.99 (4.95-7.29)	6.83 (5.51-8.41)	7.71 (6.01-9.74)	8.66 (6.46-11.2)	9.98 (7.16-13.3)	11.0 (7.69-14.9)
20-day	4.03 (3.48-4.63)	4.61 (3.98-5.31)	5.60 (4.82-6.47)	6.45 (5.52-7.48)	7.66 (6.36-9.21)	8.63 (6.99-10.5)	9.63 (7.53-12.0)	10.7 (8.01-13.7)	12.1 (8.73-16.0)	13.2 (9.27-17.7)
30-day	4.85 (4.21-5.55)	5.56 (4.82-6.37)	6.73 (5.81-7.74)	7.72 (6.62-8.91)	9.08 (7.54-10.8)	10.1 (8.23-12.3)	11.2 (8.80-13.9)	12.3 (9.27-15.7)	13.8 (9.98-18.1)	14.9 (10.5-19.9)
45-day	5.88 (5.12-6.71)	6.75 (5.87-7.71)	8.15 (7.07-9.33)	9.30 (8.01-10.7)	10.8 (9.01-12.8)	12.0 (9.77-14.4)	13.2 (10.3-16.2)	14.3 (10.8-18.1)	15.8 (11.5-20.6)	16.9 (12.0-22.4)
60-day	6.76 (5.90-7.68)	7.76 (6.76-8.83)	9.35 (8.12-10.7)	10.6 (9.18-12.2)	12.3 (10.2-14.5)	13.6 (11.0-16.2)	14.8 (11.6-18.1)	15.9 (12.0-20.0)	17.4 (12.6-22.5)	18.4 (13.1-24.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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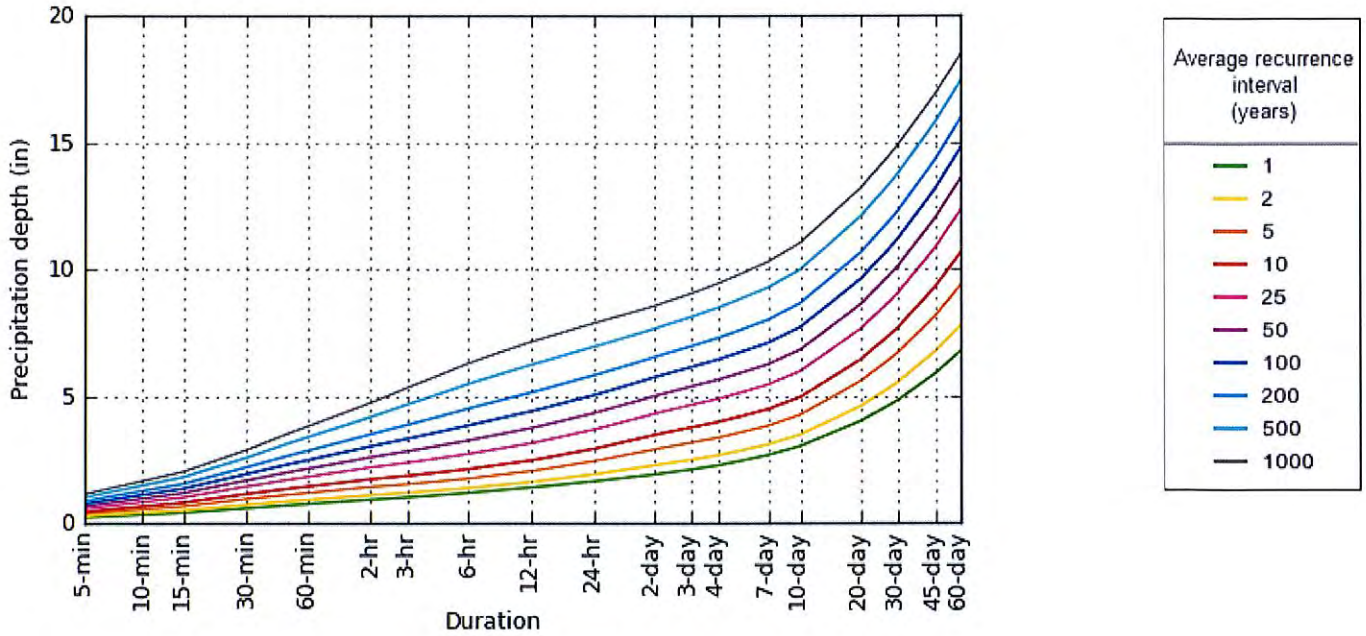
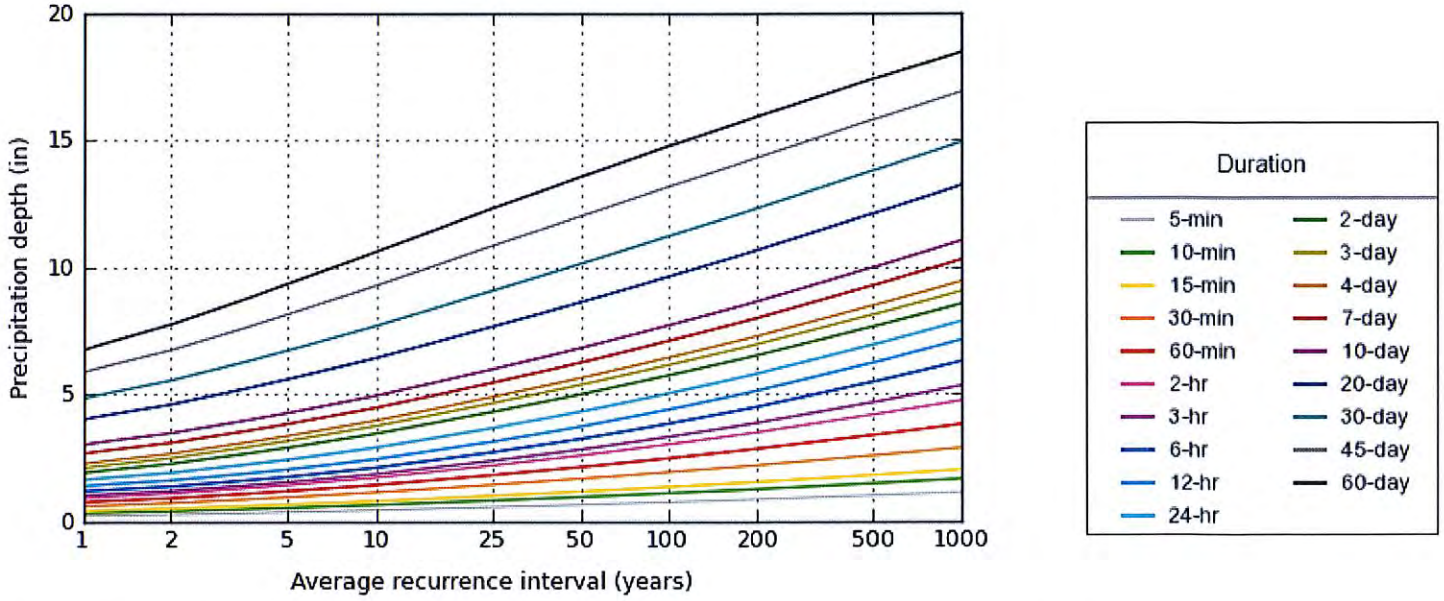
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 39.0510°, Longitude: -104.7161°





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Created (GMT): Fri Sep 22 14:35:57 2017

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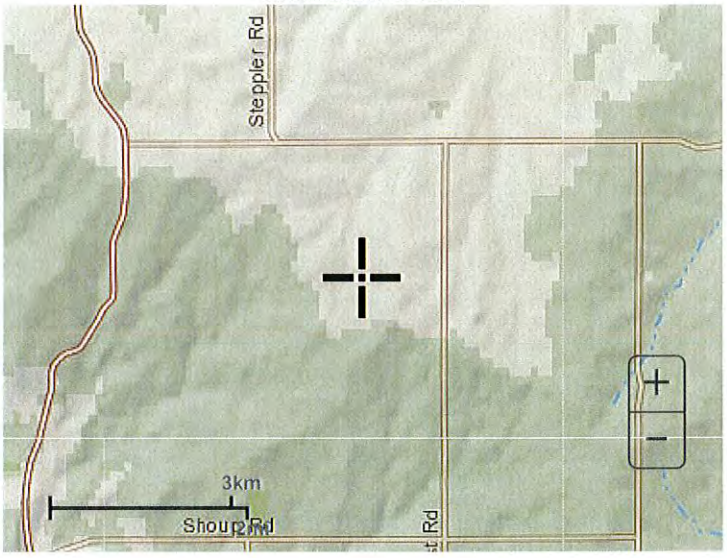
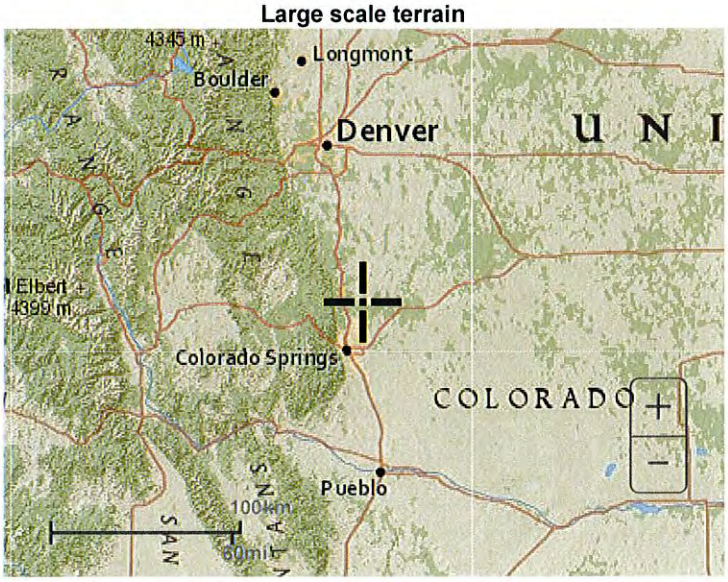
Maps & aerials

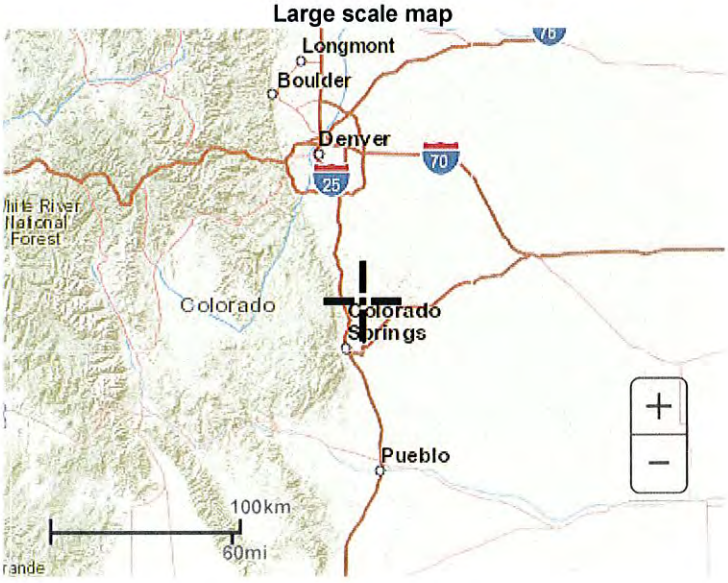
Small scale terrain



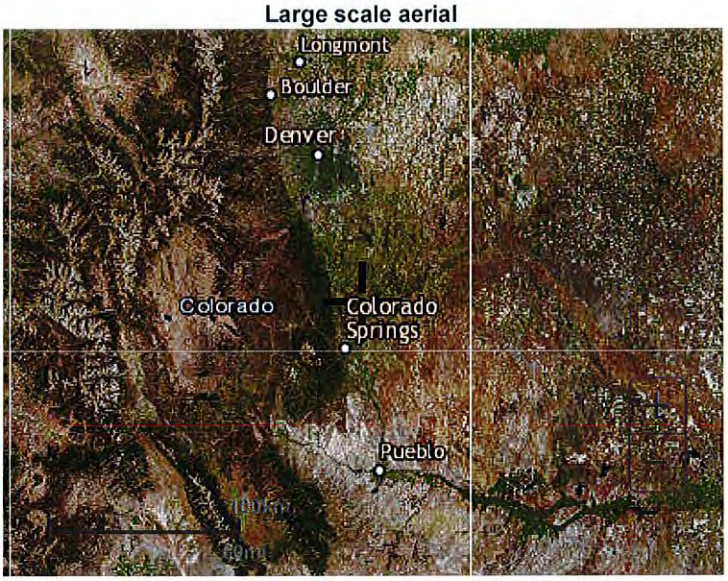
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions? HDSC.Questions@noaa.gov

Disclaimer

Table 6-4. NRCS 24-Hour Type II Design Storm Distribution, <10 mi^2
(Fraction of 24-Hour Rainfall Depth)

Hour	Minutes			
	0	15	30	45
0	0.000	0.0020	0.0050	0.0080
1	0.0110	0.0140	0.0170	0.0200
2	0.0230	0.0260	0.0290	0.0320
3	0.0350	0.0380	0.0410	0.0440
4	0.0480	0.0520	0.0560	0.0600
5	0.0604	0.0680	0.0720	0.0760
6	0.0800	0.0850	0.0900	0.0950
7	0.1000	0.1050	0.1100	0.1150
8	0.1200	0.1260	0.1330	0.1400
9	0.1470	0.1550	0.1630	0.1720
10	0.1810	0.1910	0.2030	0.2180
11	0.2360	0.2570	0.2830	0.3870
12	0.6630	0.7070	0.7350	0.7580
13	0.7760	0.7910	0.8040	0.8150
14	0.8250	0.8340	0.8420	0.8490
15	0.8560	0.8630	0.8690	0.8750
16	0.8810	0.8870	0.8930	0.8980
17	0.9030	0.9080	0.9130	0.9180
18	0.9220	0.9260	0.9300	0.9340
19	0.9380	0.9420	0.9460	0.9500
20	0.9530	0.9560	0.9590	0.9620
21	0.9650	0.9680	0.9710	0.9740
22	0.9770	0.9800	0.9830	0.9860
23	0.9890	0.9920	0.9950	0.9980

2.2.1 Depth-Area Reduction Factors (DARFs)

Depth Area Reduction Factors (DARFs) are used to adjust point rainfall depths to average depths as the size of drainage basins increase. As a part of the 2011 rainfall study, Carlton analyzed radar data to develop DARF curves applicable to the Fountain Creek watershed, El Paso County and eastern Colorado. However, these relationships were determined for short-duration thunderstorms and are not applicable to longer-duration frontal storms. Therefore, the DARFs provided in the NOAA Atlas will continue to be applied for the frontal-type storms.

- **Thunderstorm DARFs**: The Carlton study provided DARF curves for various storm return periods for short-duration thunderstorm events; however, the difference between the sets of curves was determined to be insignificant. As described in the technical memorandum *Stormwater Management Assessment and Standards Development Project, Proposed Rainfall and Standard Design Storms* (City of Colorado Springs 2012), the 5-year set of DARF curves was selected for the development of thunderstorm type design storms. These DARF curves for short-duration events are shown in Figure 6-21 at the end of this chapter.

  As described in the memorandum documenting the development of design storms, the HEC-HMS program provides guidance on the application of DARFs to define adjusted design storms as the

Project Summary	
Title	Flying Horse North Irrigation Reservoir (Pond 13)
Engineer	MAW
Company	CCES
Date	11/1/2016

Notes	50 Year (NOAA 14 - 24 hr.)

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Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Basin CC-3	Post-Development 50YR	50	5.726	12.050	75.00
Basin CC-4A	Post-Development 50YR	50	13.623	12.150	139.82
Basin CC-4B	Post-Development 50YR	50	3.062	12.050	41.47
Basins OS-12, CC-1	Post-Development 50YR	50	11.135	12.100	137.81
Basins OS-13, CC-2	Post-Development 50YR	50	9.284	12.150	103.18
Basins OS-14	Post-Development 50YR	50	2.805	12.050	39.36

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
DP-18 (MDDP DP 16)	Post-Development 50YR	50	34.622	13.250	68.24

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Golf Course Pond 12 (IN)	Post-Development 50YR	50	8.532	12.050	114.36	(N/A)	(N/A)
Golf Course Pond 12 (OUT)	Post-Development 50YR	50	8.154	12.300	47.35	7,544.99	5.758
JD Reservoir (Pond 13) (IN)	Post-Development 50YR	50	45.258	12.150	446.46	(N/A)	(N/A)
JD Reservoir (Pond 13) (OUT)	Post-Development 50YR	50	34.622	13.250	68.24	7,533.63	114.941

Subsection: Time-Depth Curve
Label: NOAA 14

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

Time-Depth Curve: Type II 24-Hour (NOAA 14)	
Label	Type II 24-Hour (NOAA 14)
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	50 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.00	0.00	0.01	0.01	0.02
0.500	0.02	0.03	0.03	0.04	0.04
1.000	0.05	0.05	0.06	0.06	0.06
1.500	0.07	0.07	0.08	0.08	0.09
2.000	0.10	0.10	0.11	0.11	0.12
2.500	0.12	0.13	0.13	0.14	0.14
3.000	0.15	0.16	0.16	0.17	0.17
3.500	0.18	0.18	0.19	0.20	0.20
4.000	0.21	0.21	0.22	0.23	0.23
4.500	0.24	0.25	0.25	0.26	0.27
5.000	0.27	0.28	0.29	0.29	0.30
5.500	0.31	0.32	0.32	0.33	0.34
6.000	0.35	0.35	0.36	0.37	0.38
6.500	0.39	0.39	0.40	0.41	0.42
7.000	0.43	0.44	0.45	0.46	0.46
7.500	0.47	0.48	0.49	0.50	0.51
8.000	0.52	0.53	0.54	0.55	0.56
8.500	0.57	0.58	0.60	0.61	0.62
9.000	0.64	0.65	0.66	0.68	0.69
9.500	0.71	0.72	0.73	0.75	0.77
10.000	0.78	0.80	0.82	0.84	0.86
10.500	0.88	0.91	0.93	0.96	0.99
11.000	1.02	1.05	1.09	1.13	1.18
11.500	1.23	1.33	1.53	1.87	2.46
12.000	2.87	2.95	3.03	3.09	3.14
12.500	3.18	3.22	3.25	3.29	3.32
13.000	3.34	3.37	3.39	3.42	3.44
13.500	3.46	3.48	3.50	3.52	3.53
14.000	3.55	3.57	3.58	3.60	3.61
14.500	3.63	3.64	3.66	3.67	3.68
15.000	3.70	3.71	3.72	3.73	3.75
15.500	3.76	3.77	3.78	3.79	3.80
16.000	3.81	3.82	3.83	3.84	3.85
16.500	3.86	3.87	3.88	3.89	3.90
17.000	3.90	3.91	3.92	3.93	3.94

Subsection: Time-Depth Curve
Label: NOAA 14

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	3.95	3.96	3.96	3.97	3.98
18.000	3.99	4.00	4.00	4.01	4.02
18.500	4.03	4.03	4.04	4.05	4.05
19.000	4.06	4.07	4.07	4.08	4.09
19.500	4.09	4.10	4.10	4.11	4.12
20.000	4.12	4.13	4.13	4.14	4.14
20.500	4.15	4.16	4.16	4.17	4.17
21.000	4.18	4.18	4.19	4.19	4.20
21.500	4.20	4.21	4.21	4.22	4.23
22.000	4.23	4.24	4.24	4.25	4.25
22.500	4.26	4.26	4.27	4.27	4.28
23.000	4.28	4.29	4.29	4.30	4.30
23.500	4.31	4.31	4.32	4.32	4.33
24.000	4.33	(N/A)	(N/A)	(N/A)	(N/A)

Requested Pond Water Surface Elevations	
Minimum (Headwater)	7,510.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	7,536.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Inlet Box	SWQ Outlet Box	Forward	SWQ Outlet Pipe	7,533.00	7,536.00
Orifice-Area	SWQ Orifice Plate	Forward	SWQ Outlet Pipe	7,531.00	7,536.00
Culvert-Circular	SWQ Outlet Pipe	Forward	TW	7,526.90	7,536.00
Culvert-Box	Twin CBC Spillway	Forward	TW	7,533.00	7,536.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: SWQ Outlet Box Structure Type: Inlet Box	
Number of Openings	1
Elevation	7,533.00 ft
Orifice Area	20.8 ft²
Orifice Coefficient	0.600
Weir Length	8.00 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: SWQ Orifice Plate Structure Type: Orifice-Area	
Number of Openings	3
Elevation	7,531.00 ft
Orifice Area	1.4 ft²
Top Elevation	7,533.00 ft
Datum Elevation	7,531.00 ft
Orifice Coefficient	0.600

Structure ID: SWQ Outlet Pipe Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	30.0 in
Length	100.00 ft
Length (Computed Barrel)	100.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.009
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.090
T2 ratio (HW/D)	1.192
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,529.63 ft	T1 Flow	27.16 ft^3/s
T2 Elevation	7,529.88 ft	T2 Flow	31.05 ft^3/s

Structure ID: Twin CBC Spillway Structure Type: Culvert-Box	
Number of Barrels	2
Width	10.00 ft
Height	4.00 ft
Length	65.00 ft
Length (Computed Barrel)	65.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.003
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0260
M	1.0000
C	0.0347
Y	0.8100
T1 ratio (HW/D)	1.173
T2 ratio (HW/D)	1.360
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,537.69 ft	T1 Flow	280.00 ft^3/s
T2 Elevation	7,538.44 ft	T2 Flow	320.00 ft^3/s

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	0.00	0.00	0.00	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	0.00	0.00	0.00	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	0.00	0.00	0.00	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	0.00	0.00	0.00	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	8.49	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	24.00	7,534.00	Free Outfall	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	44.09	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	67.88	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	94.87	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	124.71	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
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WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.5ft
Weir: H =1ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =1.5ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2.5ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

Subsection: Individual Outlet Curves | Return Event: 50 years
Label: FH North Pond 13 | Storm Event: Type II 24-Hour (NOAA 14)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,531.50	Free Outfall	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,532.00	Free Outfall	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,532.50	Free Outfall	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,533.00	Free Outfall	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	31.05	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	27.25	7,534.00	7,532.08	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	17.92	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	1.59	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	0.00	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	0.00	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Hi=.50; Ht=2.00; Qt=9.26
Hi=1.00; Ht=2.00; Qt=9.26
Hi=1.50; Ht=2.00; Qt=9.26
H =2.00
H =2.50
H =1.92
H =.83
H =.01
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,527.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,528.16	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,528.75	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,529.24	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,529.71	Free Outfall	Free Outfall	0.00	0.01	(N/A)	0.00	WS below an invert; no flow.
7,533.50	39.53	7,530.67	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	51.31	7,532.08	Free Outfall	Free Outfall	0.00	0.06	(N/A)	0.00	WS below an invert; no flow.
7,534.50	61.99	7,533.67	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00	WS below an invert; no flow.
7,535.00	69.52	7,534.99	Free Outfall	Free Outfall	0.00	0.05	(N/A)	0.00	WS below an invert; no flow.
7,535.50	72.13	7,535.50	Free Outfall	Free Outfall	0.00	22.74	(N/A)	0.00	WS below an invert; no flow.
7,536.00	74.61	7,536.00	Free Outfall	Free Outfall	0.00	50.10	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .321ft Dcr= .874ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .493ft Dcr= 1.255ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .659ft Dcr= 1.551ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .840ft Dcr= 1.797ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =3.77
INLET CONTROL... Submerged: HW =5.18
INLET CONTROL... Submerged: HW =6.77

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft^3/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
FULL FLOW...Lfull=98.92ft Vh=3.117ft HL=6.583ft Hev= .00ft
FULL FLOW...Lfull=99.10ft Vh=3.356ft HL=7.092ft Hev= .00ft
FULL FLOW...Lfull=99.31ft Vh=3.590ft HL=7.594ft Hev= .00ft

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft^3/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00
7,531.50	0.00	(N/A)	0.00
7,532.00	0.00	(N/A)	0.00
7,532.50	0.00	(N/A)	0.00
7,533.00	0.00	(N/A)	0.00
7,533.50	17.36	(N/A)	0.00
7,534.00	49.05	(N/A)	0.00
7,534.50	90.08	(N/A)	0.00
7,535.00	138.56	(N/A)	0.00
7,535.50	193.63	(N/A)	0.00
7,536.00	254.72	(N/A)	0.00

Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .143ft Dcr= .286ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .286ft Dcr= .572ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .429ft Dcr= .858ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .571ft Dcr= 1.143ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .714ft Dcr= 1.428ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .857ft Dcr= 1.715ft CRIT.DEPTH Hev= .00ft

Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00

Subsection: Composite Rating Curve	Return Event: 50 years
Label: FH North Pond 13	Storm Event: Type II 24-Hour (NOAA 14)

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,531.50	6.94	(N/A)	0.00
7,532.00	13.89	(N/A)	0.00
7,532.50	20.83	(N/A)	0.00
7,533.00	27.77	(N/A)	0.00
7,533.50	56.89	(N/A)	0.00
7,534.00	100.36	(N/A)	0.00
7,534.50	152.07	(N/A)	0.00
7,535.00	208.08	(N/A)	0.00
7,535.50	265.76	(N/A)	0.00
7,536.00	329.33	(N/A)	0.00

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
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Composite Outflow Summary

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
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Composite Outflow Summary

Contributing Structures
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Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

Composite Outflow Summary

Contributing Structures
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
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SWQ Outlet Box,SWQ Outlet Pipe,Twin CBC Spillway (no Q: SWQ Orifice Plate)

Subsection: Elevation-Volume-Flow Table (Pond)
Label: JD Reservoir (Pond 13)

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	7,531.00 ft
Volume (Initial)	94.889 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.050 hours

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
7,510.00	0.00	0.000	1.510	0.00	0.00	0.00
7,510.50	0.00	0.812	1.742	0.00	0.00	393.13
7,511.00	0.00	1.744	1.990	0.00	0.00	844.33
7,511.50	0.00	2.803	2.247	0.00	0.00	1,356.72
7,512.00	0.00	3.994	2.520	0.00	0.00	1,933.23
7,512.50	0.00	5.295	2.682	0.00	0.00	2,562.63
7,513.00	0.00	6.678	2.850	0.00	0.00	3,231.95
7,513.50	0.00	8.127	2.949	0.00	0.00	3,933.62
7,514.00	0.00	9.627	3.050	0.00	0.00	4,659.48
7,514.50	0.00	11.178	3.154	0.00	0.00	5,410.14
7,515.00	0.00	12.781	3.260	0.00	0.00	6,186.22
7,515.50	0.00	14.439	3.369	0.00	0.00	6,988.30
7,516.00	0.00	16.151	3.480	0.00	0.00	7,817.01
7,516.50	0.00	17.918	3.589	0.00	0.00	8,672.34
7,517.00	0.00	19.740	3.700	0.00	0.00	9,554.30
7,517.50	0.00	21.619	3.814	0.00	0.00	10,463.47
7,518.00	0.00	23.555	3.930	0.00	0.00	11,400.48
7,518.50	0.00	25.548	4.044	0.00	0.00	12,365.32
7,519.00	0.00	27.599	4.160	0.00	0.00	13,357.99
7,519.50	0.00	29.709	4.279	0.00	0.00	14,379.10
7,520.00	0.00	31.879	4.400	0.00	0.00	15,429.24
7,520.50	0.00	34.108	4.519	0.00	0.00	16,508.43
7,521.00	0.00	36.398	4.640	0.00	0.00	17,616.66
7,521.50	0.00	38.748	4.759	0.00	0.00	18,753.94
7,522.00	0.00	41.158	4.880	0.00	0.00	19,920.26
7,522.50	0.00	43.630	5.009	0.00	0.00	21,116.81
7,523.00	0.00	46.167	5.140	0.00	0.00	22,344.83
7,523.50	0.00	48.764	5.249	0.00	0.00	23,601.92
7,524.00	0.00	51.417	5.360	0.00	0.00	24,885.64
7,524.50	0.00	54.125	5.474	0.00	0.00	26,196.58
7,525.00	0.00	56.891	5.590	0.00	0.00	27,535.35

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 50 years
Label: JD Reservoir (Pond 13) Storm Event: Type II 24-Hour (NOAA 14)

Elevation (ft)	Outflow (ft^3/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft^3/s)	Flow (Total) (ft^3/s)	2S/t + O (ft^3/s)
7,525.50	0.00	59.717	5.714	0.00	0.00	28,903.14
7,526.00	0.00	62.606	5.840	0.00	0.00	30,301.19
7,526.50	0.00	65.556	5.959	0.00	0.00	31,728.89
7,526.90	0.00	67.959	6.056	0.00	0.00	32,891.95
7,527.00	0.00	68.565	6.080	0.00	0.00	33,185.63
7,527.50	0.00	71.636	6.204	0.00	0.00	34,672.01
7,528.00	0.00	74.770	6.330	0.00	0.00	36,188.65
7,528.50	0.00	77.965	6.449	0.00	0.00	37,734.94
7,529.00	0.00	81.220	6.570	0.00	0.00	39,310.27
7,529.50	0.00	84.534	6.689	0.00	0.00	40,914.64
7,530.00	0.00	87.909	6.810	0.00	0.00	42,548.05
7,530.50	0.00	91.356	6.979	0.00	0.00	44,216.48
7,531.00	0.00	94.889	7.150	0.00	0.00	45,926.04
7,531.50	6.94	98.509	7.334	0.00	6.94	47,685.48
7,532.00	13.89	102.223	7.520	0.00	13.89	49,489.69
7,532.50	20.83	106.021	7.674	0.00	20.83	51,335.10
7,533.00	27.77	109.897	7.830	0.00	27.77	53,218.02
7,533.50	56.89	113.879	8.098	0.00	56.89	55,174.31
7,534.00	100.36	117.996	8.370	0.00	100.36	57,210.28
7,534.50	152.07	122.230	8.569	0.00	152.07	59,311.55
7,535.00	208.08	126.565	8.770	0.00	208.08	61,465.51
7,535.50	265.76	131.000	8.969	0.00	265.76	63,669.55
7,536.00	329.33	135.534	9.170	0.00	329.33	65,927.87

Subsection: Pond Routed Hydrograph (total out) Return Event: 50 years
Label: JD Reservoir (Pond 13) (OUT) Storm Event: Type II 24-Hour (NOAA 14)

Peak Discharge	68.24 ft³/s
Time to Peak	13.250 hours
Hydrograph Volume	34.622 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
8.350	0.00	0.00	0.00	0.00	0.01
8.600	0.01	0.01	0.01	0.02	0.02
8.850	0.02	0.03	0.03	0.04	0.05
9.100	0.05	0.06	0.07	0.08	0.09
9.350	0.09	0.10	0.11	0.12	0.13
9.600	0.14	0.15	0.16	0.17	0.18
9.850	0.19	0.20	0.21	0.22	0.23
10.100	0.24	0.25	0.26	0.27	0.28
10.350	0.30	0.31	0.32	0.34	0.35
10.600	0.37	0.39	0.40	0.42	0.44
10.850	0.46	0.48	0.50	0.52	0.55
11.100	0.57	0.60	0.63	0.67	0.71
11.350	0.76	0.81	0.87	0.95	1.03
11.600	1.14	1.27	1.46	1.76	2.20
11.850	2.88	3.92	5.48	7.65	10.36
12.100	13.51	16.75	19.88	22.68	25.10
12.350	27.16	32.39	38.30	43.23	47.34
12.600	50.79	53.65	56.03	58.48	60.78
12.850	62.65	64.15	65.35	66.30	67.03
13.100	67.57	67.94	68.15	68.24	68.22
13.350	68.10	67.89	67.61	67.27	66.87
13.600	66.41	65.91	65.36	64.78	64.17
13.850	63.54	62.88	62.21	61.52	60.81
14.100	60.09	59.37	58.63	57.89	57.15
14.350	56.56	56.04	55.53	55.01	54.49
14.600	53.98	53.47	52.96	52.45	51.95
14.850	51.45	50.95	50.45	49.96	49.48
15.100	48.99	48.51	48.03	47.56	47.09
15.350	46.62	46.16	45.70	45.24	44.79
15.600	44.34	43.89	43.44	43.00	42.56
15.850	42.13	41.69	41.26	40.83	40.40
16.100	39.98	39.56	39.14	38.73	38.32
16.350	37.91	37.52	37.12	36.74	36.36
16.600	35.98	35.62	35.26	34.90	34.56
16.850	34.22	33.88	33.55	33.23	32.91
17.100	32.60	32.29	31.99	31.69	31.40
17.350	31.12	30.83	30.56	30.28	30.02
17.600	29.75	29.49	29.24	28.99	28.74
17.850	28.49	28.25	28.02	27.78	27.71

Subsection: Pond Routed Hydrograph (total out) Return Event: 50 years
Label: JD Reservoir (Pond 13) (OUT) Storm Event: Type II 24-Hour (NOAA 14)

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
18.100	27.65	27.60	27.54	27.48	27.42
18.350	27.36	27.30	27.24	27.18	27.12
18.600	27.05	26.99	26.93	26.87	26.80
18.850	26.74	26.67	26.61	26.54	26.48
19.100	26.41	26.34	26.28	26.21	26.14
19.350	26.07	26.00	25.93	25.86	25.79
19.600	25.72	25.65	25.58	25.51	25.44
19.850	25.36	25.29	25.22	25.14	25.07
20.100	25.00	24.92	24.85	24.77	24.70
20.350	24.63	24.55	24.48	24.40	24.33
20.600	24.26	24.18	24.11	24.04	23.97
20.850	23.89	23.82	23.75	23.68	23.61
21.100	23.54	23.47	23.40	23.33	23.26
21.350	23.19	23.12	23.05	22.99	22.92
21.600	22.85	22.78	22.72	22.65	22.58
21.850	22.52	22.45	22.39	22.32	22.26
22.100	22.19	22.13	22.07	22.00	21.94
22.350	21.88	21.81	21.75	21.69	21.63
22.600	21.56	21.50	21.44	21.38	21.32
22.850	21.26	21.20	21.14	21.08	21.02
23.100	20.96	20.90	20.84	20.79	20.73
23.350	20.67	20.61	20.55	20.49	20.43
23.600	20.38	20.32	20.26	20.20	20.15
23.850	20.09	20.03	19.98	19.92	(N/A)

Index

Project Summary	
Title	Flying Horse North Irrigation Reservoir (Pond 13)
Engineer	MAW
Company	CCES
Date	11/1/2016

Notes	100 Year (Colo. Spgs.)

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Basin CC-3	Post-Development 100YR	100	6.494	12.100	84.65
Basin CC-4A	Post-Development 100YR	100	15.363	12.150	156.02
Basin CC-4B	Post-Development 100YR	100	3.405	12.100	44.64
Basins OS-12, CC-1	Post-Development 100YR	100	12.557	12.100	153.55
Basins OS-13, CC-2	Post-Development 100YR	100	10.460	12.150	115.36
Basins OS-14	Post-Development 100YR	100	3.186	12.050	44.02

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
DP-18 (MDDP DP 16)	Post-Development 100YR	100	39.865	13.100	91.03

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Golf Course Pond 12 (IN)	Post-Development 100YR	100	9.680	12.100	127.47	(N/A)	(N/A)
Golf Course Pond 12 (OUT)	Post-Development 100YR	100	9.266	12.300	57.42	7,545.21	6.051
JD Reservoir (Pond 13) (IN)	Post-Development 100YR	100	51.051	12.150	504.67	(N/A)	(N/A)
JD Reservoir (Pond 13) (OUT)	Post-Development 100YR	100	39.865	13.100	91.03	7,533.89	117.101

Subsection: Time-Depth Curve
Label: Colo Springs 2015

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Time-Depth Curve: TYPE II 24 HOUR (Colo. Spgs.)	
Label	TYPE II 24 HOUR (Colo. Spgs.)
Start Time	0.000 hours
Increment	0.250 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.250 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.00	0.01	0.02	0.04	0.05
1.250	0.06	0.08	0.09	0.11	0.12
2.500	0.13	0.15	0.16	0.17	0.19
3.750	0.20	0.22	0.24	0.26	0.28
5.000	0.28	0.31	0.33	0.35	0.37
6.250	0.39	0.41	0.44	0.46	0.48
7.500	0.51	0.53	0.55	0.58	0.61
8.750	0.64	0.68	0.71	0.75	0.79
10.000	0.83	0.88	0.93	1.00	1.09
11.250	1.18	1.30	1.78	3.05	3.25
12.500	3.38	3.49	3.57	3.64	3.70
13.750	3.75	3.80	3.84	3.87	3.91
15.000	3.94	3.97	4.00	4.03	4.05
16.250	4.08	4.11	4.13	4.15	4.18
17.500	4.20	4.22	4.24	4.26	4.28
18.750	4.30	4.31	4.33	4.35	4.37
20.000	4.38	4.40	4.41	4.43	4.44
21.250	4.45	4.47	4.48	4.49	4.51
22.500	4.52	4.54	4.55	4.56	4.58
23.750	4.59	4.60	(N/A)	(N/A)	(N/A)

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method (Computational Notes)
Definition of Terms

At	Total area (acres): At = Ai+Ap
Ai	Impervious area (acres)
Ap	Pervious area (acres)
CNi	Runoff curve number for impervious area
CNp	Runoff curve number for pervious area
fLoss	f loss constant infiltration (depth/time)
gKs	Saturated Hydraulic Conductivity (depth/time)
Md	Volumetric Moisture Deficit
Psi	Capillary Suction (length)
hK	Horton Infiltration Decay Rate (time^-1)
fo	Initial Infiltration Rate (depth/time)
fc	Ultimate(capacity)Infiltration Rate (depth/time)
Ia	Initial Abstraction (length)
dt	Computational increment (duration of unit excess rainfall) Default dt is smallest value of 0.1333Tc, rtm, and th (Smallest dt is then adjusted to match up with Tp)
UDdt	User specified override computational main time increment (only used if UDdt is => .1333Tc)
D(t)	Point on distribution curve (fraction of P) for time step t
K	2 / (1 + (Tr/Tp)): default K = 0.75: (for Tr/Tp = 1.67)
Ks	Hydrograph shape factor = Unit Conversions * K: = ((1hr/3600sec) * (1ft/12in) * ((5280ft)**2/sq.mi)) * K Default Ks = 645.333 * 0.75 = 484
Lag	Lag time from center of excess runoff (dt) to Tp: Lag = 0.6Tc
P	Total precipitation depth, inches
Pa(t)	Accumulated rainfall at time step t
Pi(t)	Incremental rainfall at time step t
qp	Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi. = (Ks * A * Q) / Tp (where Q = 1in. runoff, A=sq.mi.)
Qu(t)	Unit hydrograph ordinate (cfs) at time step t
Q(t)	Final hydrograph ordinate (cfs) at time step t
Rai(t)	Accumulated runoff (inches) at time step t for impervious area
Rap(t)	Accumulated runoff (inches) at time step t for pervious area
Rii(t)	Incremental runoff (inches) at time step t for impervious area
Rip(t)	Incremental runoff (inches) at time step t for pervious area
R(t)	Incremental weighted total runoff (inches)
Rtm	Time increment for rainfall table
Si	S for impervious area: Si = (1000/CNi) - 10
Sp	S for pervious area: Sp = (1000/CNp) - 10
t	Time step (row) number
Tc	Time of concentration
Tb	Time (hrs) of entire unit hydrograph: Tb = Tp + Tr
Tp	Time (hrs) to peak of a unit hydrograph: Tp = (dt/2) + Lag
Tr	Time (hrs) of receding limb of unit hydrograph: Tr = ratio of Tp

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method
Computational Notes
Precipitation

Column (1)	Time for time step t
Column (2)	D(t) = Point on distribution curve for time step t
Column (3)	Pi(t) = Pa(t) - Pa(t-1): Col.(4) - Preceding Col.(4)
Column (4)	Pa(t) = D(t) x P: Col.(2) x P

Pervious Area Runoff (using SCS Runoff CN Method)

Column (5)	Rap(t) = Accumulated pervious runoff for time step t
	If (Pa(t) is <= 0.2Sp) then use: Rap(t) = 0.0
	If (Pa(t) is > 0.2Sp) then use:
	
	Rap(t) = (Col.(4)-0.2Sp)**2 / (Col.(4)+0.8Sp)

Column (6)	Rip(t) = Incremental pervious runoff for time step t Rip(t) = Rap(t) - Rap(t-1) Rip(t) = Col.(5) for current row - Col.(5) for preceding row.

Impervious Area Runoff (using depression storage method)

Column (7)	Rai(t) = Accumulated impervious runoff for time step t
	If (Pa(t) is <= Ds) then use: Rai(t) = 0.0
	If (Pa(t) is > Ds) then compute runoff using
	the infiltration in next paragraph.

Impervious Area Runoff (using SCS Runoff CN Method)

Column (7)	Rai(t) = Accumulated impervious runoff for time step t
	If (Pa(t) is <= 0.2Si) then use: Rai(t) = 0.0
	If (Pa(t) is > 0.2Si) then use:
	
	Rai(t) = (Col.(4)-0.2Si)**2 / (Col.(4)+0.8Si)

Column (8)	Rii(t) = Incremental impervious runoff for time step t Rii(t) = Rai(t) - Rai(t-1) Rii(t) = Col.(7) for current row - Col.(7) for preceding row.

Incremental Weighted Runoff

Column (9)	R(t) = (Ap/At) x Rip(t) + (Ai/At) x Rii(t) R(t) = (Ap/At) x Col.(6) + (Ai/At) x Col.(8)

SCS Unit Hydrograph Method

Column (10)	Q(t) is computed with the SCS unit hydrograph method using R(t) and Qu(t).

Subsection: Elevation-Area Volume Curve | Return Event: 100 years
Label: JD Reservoir (Pond 13) | Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Elevation (ft)	Planimeter (ft²)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
7,510.00	0.0	1.510	0.000	0.000	0.000
7,511.00	0.0	1.990	5.233	1.744	1.744
7,512.00	0.0	2.520	6.749	2.250	3.994
7,513.00	0.0	2.850	8.050	2.683	6.678
7,514.00	0.0	3.050	8.848	2.949	9.627
7,515.00	0.0	3.260	9.463	3.154	12.781
7,516.00	0.0	3.480	10.108	3.369	16.151
7,517.00	0.0	3.700	10.768	3.589	19.740
7,518.00	0.0	3.930	11.443	3.814	23.555
7,519.00	0.0	4.160	12.133	4.044	27.599
7,520.00	0.0	4.400	12.838	4.279	31.879
7,521.00	0.0	4.640	13.558	4.519	36.398
7,522.00	0.0	4.880	14.278	4.760	41.158
7,523.00	0.0	5.140	15.028	5.009	46.167
7,524.00	0.0	5.360	15.749	5.250	51.417
7,525.00	0.0	5.590	16.424	5.475	56.891
7,526.00	0.0	5.840	17.144	5.715	62.606
7,527.00	0.0	6.080	17.879	5.960	68.565
7,528.00	0.0	6.330	18.614	6.205	74.770
7,529.00	0.0	6.570	19.349	6.450	81.220
7,530.00	0.0	6.810	20.069	6.690	87.909
7,531.00	0.0	7.150	20.938	6.979	94.889
7,532.00	0.0	7.520	22.003	7.334	102.223
7,533.00	0.0	7.830	23.023	7.674	109.897
7,534.00	0.0	8.370	24.295	8.099	117.996
7,535.00	0.0	8.770	25.708	8.569	126.565
7,536.00	0.0	9.170	26.908	8.969	135.534

Requested Pond Water Surface Elevations	
Minimum (Headwater)	7,510.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	7,536.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Inlet Box	SWQ Outlet Box	Forward	SWQ Outlet Pipe	7,533.00	7,536.00
Orifice-Area	SWQ Orifice Plate	Forward	SWQ Outlet Pipe	7,531.00	7,536.00
Culvert-Circular	SWQ Outlet Pipe	Forward	TW	7,526.90	7,536.00
Culvert-Box	Twin CBC Spillway	Forward	TW	7,533.00	7,536.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: SWQ Outlet Box Structure Type: Inlet Box	
Number of Openings	1
Elevation	7,533.00 ft
Orifice Area	20.8 ft²
Orifice Coefficient	0.600
Weir Length	8.00 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: SWQ Orifice Plate Structure Type: Orifice-Area	
Number of Openings	3
Elevation	7,531.00 ft
Orifice Area	1.4 ft²
Top Elevation	7,533.00 ft
Datum Elevation	7,531.00 ft
Orifice Coefficient	0.600

Structure ID: SWQ Outlet Pipe Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	30.0 in
Length	100.00 ft
Length (Computed Barrel)	100.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.009
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.090
T2 ratio (HW/D)	1.192
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,529.63 ft	T1 Flow	27.16 ft^3/s
T2 Elevation	7,529.88 ft	T2 Flow	31.05 ft^3/s

Structure ID: Twin CBC Spillway Structure Type: Culvert-Box	
Number of Barrels	2
Width	10.00 ft
Height	4.00 ft
Length	65.00 ft
Length (Computed Barrel)	65.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.003
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0260
M	1.0000
C	0.0347
Y	0.8100
T1 ratio (HW/D)	1.173
T2 ratio (HW/D)	1.360
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,537.69 ft	T1 Flow	280.00 ft^3/s
T2 Elevation	7,538.44 ft	T2 Flow	320.00 ft^3/s

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

Subsection: Individual Outlet Curves | Return Event: 100 years
Label: FH North Pond 13 | Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

Subsection: Individual Outlet Curves | Return Event: 100 years
Label: FH North Pond 13 | Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	0.00	0.00	0.00	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	0.00	0.00	0.00	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	0.00	0.00	0.00	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	0.00	0.00	0.00	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	8.49	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	24.00	7,534.00	Free Outfall	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	44.09	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	67.88	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	94.87	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	124.71	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.5ft
Weir: H =1ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =1.5ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2.5ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Subsection: Individual Outlet Curves | Return Event: 100 years
Label: FH North Pond 13 | Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

Subsection: Individual Outlet Curves | Return Event: 100 years
Label: FH North Pond 13 | Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,531.50	Free Outfall	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,532.00	Free Outfall	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,532.50	Free Outfall	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,533.00	Free Outfall	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	31.05	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	27.25	7,534.00	7,532.08	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	17.92	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	1.59	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	0.00	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	0.00	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Hi=.50; Ht=2.00; Qt=9.26
Hi=1.00; Ht=2.00; Qt=9.26
Hi=1.50; Ht=2.00; Qt=9.26
H =2.00
H =2.50
H =1.92
H =.83
H =.01
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00

Subsection: Individual Outlet Curves | Return Event: 100 years
Label: FH North Pond 13 | Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,527.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,528.16	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,528.75	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,529.24	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,529.71	Free Outfall	Free Outfall	0.00	0.01	(N/A)	0.00	WS below an invert; no flow.
7,533.50	39.53	7,530.67	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	51.31	7,532.08	Free Outfall	Free Outfall	0.00	0.06	(N/A)	0.00	WS below an invert; no flow.
7,534.50	61.99	7,533.67	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00	WS below an invert; no flow.
7,535.00	69.52	7,534.99	Free Outfall	Free Outfall	0.00	0.05	(N/A)	0.00	WS below an invert; no flow.
7,535.50	72.13	7,535.50	Free Outfall	Free Outfall	0.00	22.74	(N/A)	0.00	WS below an invert; no flow.
7,536.00	74.61	7,536.00	Free Outfall	Free Outfall	0.00	50.10	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .321ft Dcr= .874ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .493ft Dcr= 1.255ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .659ft Dcr= 1.551ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .840ft Dcr= 1.797ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =3.77
INLET CONTROL... Submerged: HW =5.18
INLET CONTROL... Submerged: HW =6.77

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft^3/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
FULL FLOW...Lfull=98.92ft Vh=3.117ft HL=6.583ft Hev= .00ft
FULL FLOW...Lfull=99.10ft Vh=3.356ft HL=7.092ft Hev= .00ft
FULL FLOW...Lfull=99.31ft Vh=3.590ft HL=7.594ft Hev= .00ft

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00
7,531.50	0.00	(N/A)	0.00
7,532.00	0.00	(N/A)	0.00
7,532.50	0.00	(N/A)	0.00
7,533.00	0.00	(N/A)	0.00
7,533.50	17.36	(N/A)	0.00
7,534.00	49.05	(N/A)	0.00
7,534.50	90.08	(N/A)	0.00
7,535.00	138.56	(N/A)	0.00
7,535.50	193.63	(N/A)	0.00
7,536.00	254.72	(N/A)	0.00

Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.

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RATING TABLE FOR ONE OUTLET TYPE
Structure  ID  = Twin CBC Spillway  (Culvert-Box)
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Mannings open channel maximum capacity:  778.58 ft³/s
Upstream   ID  =    (Pond Water Surface)
Downstream ID  = Tailwater (Pond Outfall)
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Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .143ft Dcr= .286ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .286ft Dcr= .572ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .429ft Dcr= .858ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .571ft Dcr= 1.143ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .714ft Dcr= 1.428ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .857ft Dcr= 1.715ft CRIT.DEPTH Hev= .00ft

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00

Subsection: Composite Rating Curve Return Event: 100 years
Label: FH North Pond 13 Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,531.50	6.94	(N/A)	0.00
7,532.00	13.89	(N/A)	0.00
7,532.50	20.83	(N/A)	0.00
7,533.00	27.77	(N/A)	0.00
7,533.50	56.89	(N/A)	0.00
7,534.00	100.36	(N/A)	0.00
7,534.50	152.07	(N/A)	0.00
7,535.00	208.08	(N/A)	0.00
7,535.50	265.76	(N/A)	0.00
7,536.00	329.33	(N/A)	0.00

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
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Composite Outflow Summary

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
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(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Composite Outflow Summary

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
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(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Composite Outflow Summary

Contributing Structures
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
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SWQ Outlet Box,SWQ Outlet Pipe,Twin CBC Spillway (no Q: SWQ Orifice Plate)
SWQ Outlet Box,SWQ Outlet Pipe,Twin CBC Spillway (no Q: SWQ Orifice Plate)

Subsection: Elevation-Volume-Flow Table (Pond)
Label: JD Reservoir (Pond 13)

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	7,531.00 ft
Volume (Initial)	94.889 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.050 hours

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
7,510.00	0.00	0.000	1.510	0.00	0.00	0.00
7,510.50	0.00	0.812	1.742	0.00	0.00	393.13
7,511.00	0.00	1.744	1.990	0.00	0.00	844.33
7,511.50	0.00	2.803	2.247	0.00	0.00	1,356.72
7,512.00	0.00	3.994	2.520	0.00	0.00	1,933.23
7,512.50	0.00	5.295	2.682	0.00	0.00	2,562.63
7,513.00	0.00	6.678	2.850	0.00	0.00	3,231.95
7,513.50	0.00	8.127	2.949	0.00	0.00	3,933.62
7,514.00	0.00	9.627	3.050	0.00	0.00	4,659.48
7,514.50	0.00	11.178	3.154	0.00	0.00	5,410.14
7,515.00	0.00	12.781	3.260	0.00	0.00	6,186.22
7,515.50	0.00	14.439	3.369	0.00	0.00	6,988.30
7,516.00	0.00	16.151	3.480	0.00	0.00	7,817.01
7,516.50	0.00	17.918	3.589	0.00	0.00	8,672.34
7,517.00	0.00	19.740	3.700	0.00	0.00	9,554.30
7,517.50	0.00	21.619	3.814	0.00	0.00	10,463.47
7,518.00	0.00	23.555	3.930	0.00	0.00	11,400.48
7,518.50	0.00	25.548	4.044	0.00	0.00	12,365.32
7,519.00	0.00	27.599	4.160	0.00	0.00	13,357.99
7,519.50	0.00	29.709	4.279	0.00	0.00	14,379.10
7,520.00	0.00	31.879	4.400	0.00	0.00	15,429.24
7,520.50	0.00	34.108	4.519	0.00	0.00	16,508.43
7,521.00	0.00	36.398	4.640	0.00	0.00	17,616.66
7,521.50	0.00	38.748	4.759	0.00	0.00	18,753.94
7,522.00	0.00	41.158	4.880	0.00	0.00	19,920.26
7,522.50	0.00	43.630	5.009	0.00	0.00	21,116.81
7,523.00	0.00	46.167	5.140	0.00	0.00	22,344.83
7,523.50	0.00	48.764	5.249	0.00	0.00	23,601.92
7,524.00	0.00	51.417	5.360	0.00	0.00	24,885.64
7,524.50	0.00	54.125	5.474	0.00	0.00	26,196.58
7,525.00	0.00	56.891	5.590	0.00	0.00	27,535.35

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years
Label: JD Reservoir (Pond 13) Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Elevation (ft)	Outflow (ft^3/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft^3/s)	Flow (Total) (ft^3/s)	2S/t + O (ft^3/s)
7,525.50	0.00	59.717	5.714	0.00	0.00	28,903.14
7,526.00	0.00	62.606	5.840	0.00	0.00	30,301.19
7,526.50	0.00	65.556	5.959	0.00	0.00	31,728.89
7,526.90	0.00	67.959	6.056	0.00	0.00	32,891.95
7,527.00	0.00	68.565	6.080	0.00	0.00	33,185.63
7,527.50	0.00	71.636	6.204	0.00	0.00	34,672.01
7,528.00	0.00	74.770	6.330	0.00	0.00	36,188.65
7,528.50	0.00	77.965	6.449	0.00	0.00	37,734.94
7,529.00	0.00	81.220	6.570	0.00	0.00	39,310.27
7,529.50	0.00	84.534	6.689	0.00	0.00	40,914.64
7,530.00	0.00	87.909	6.810	0.00	0.00	42,548.05
7,530.50	0.00	91.356	6.979	0.00	0.00	44,216.48
7,531.00	0.00	94.889	7.150	0.00	0.00	45,926.04
7,531.50	6.94	98.509	7.334	0.00	6.94	47,685.48
7,532.00	13.89	102.223	7.520	0.00	13.89	49,489.69
7,532.50	20.83	106.021	7.674	0.00	20.83	51,335.10
7,533.00	27.77	109.897	7.830	0.00	27.77	53,218.02
7,533.50	56.89	113.879	8.098	0.00	56.89	55,174.31
7,534.00	100.36	117.996	8.370	0.00	100.36	57,210.28
7,534.50	152.07	122.230	8.569	0.00	152.07	59,311.55
7,535.00	208.08	126.565	8.770	0.00	208.08	61,465.51
7,535.50	265.76	131.000	8.969	0.00	265.76	63,669.55
7,536.00	329.33	135.534	9.170	0.00	329.33	65,927.87

Subsection: Pond Routed Hydrograph (total out) Return Event: 100 years
Label: JD Reservoir (Pond 13) (OUT) Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Peak Discharge	91.03 ft³/s
Time to Peak	13.100 hours
Hydrograph Volume	39.865 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
8.050	0.00	0.00	0.00	0.00	0.01
8.300	0.01	0.01	0.01	0.02	0.02
8.550	0.03	0.03	0.04	0.04	0.05
8.800	0.06	0.06	0.07	0.08	0.09
9.050	0.09	0.10	0.11	0.12	0.13
9.300	0.14	0.15	0.16	0.17	0.18
9.550	0.18	0.19	0.20	0.22	0.23
9.800	0.24	0.25	0.26	0.27	0.28
10.050	0.29	0.31	0.32	0.33	0.34
10.300	0.36	0.37	0.38	0.40	0.41
10.550	0.43	0.45	0.46	0.48	0.50
10.800	0.53	0.55	0.57	0.60	0.63
11.050	0.67	0.71	0.75	0.80	0.86
11.300	0.92	0.99	1.07	1.16	1.26
11.550	1.38	1.53	1.75	2.07	2.52
11.800	3.13	3.99	5.22	6.98	9.32
12.050	12.30	15.74	19.37	22.88	26.06
12.300	32.14	41.67	49.52	55.94	63.05
12.550	69.14	74.09	78.10	81.34	83.94
12.800	86.02	87.67	88.93	89.86	90.48
13.050	90.86	91.03	91.01	90.83	90.49
13.300	90.03	89.47	88.81	88.08	87.27
13.550	86.41	85.49	84.53	83.53	82.48
13.800	81.40	80.29	79.17	78.03	76.89
14.050	75.75	74.61	73.48	72.35	71.23
14.300	70.12	69.02	67.93	66.84	65.76
14.550	64.68	63.62	62.57	61.51	60.47
14.800	59.43	58.41	57.41	56.57	55.90
15.050	55.24	54.59	53.96	53.34	52.73
15.300	52.14	51.55	50.98	50.40	49.83
15.550	49.25	48.68	48.11	47.54	46.99
15.800	46.44	45.91	45.39	44.88	44.38
16.050	43.89	43.42	42.96	42.51	42.08
16.300	41.66	41.24	40.84	40.45	40.08
16.550	39.71	39.35	38.99	38.62	38.26
16.800	37.88	37.50	37.13	36.75	36.38
17.050	36.01	35.65	35.30	34.96	34.62
17.300	34.30	33.98	33.67	33.36	33.07
17.550	32.78	32.51	32.24	31.97	31.72

Subsection: Pond Routed Hydrograph (total out) Return Event: 100 years
Label: JD Reservoir (Pond 13) (OUT) Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
17.800	31.47	31.22	30.98	30.72	30.46
18.050	30.19	29.91	29.63	29.35	29.07
18.300	28.79	28.51	28.24	27.98	27.75
18.550	27.69	27.63	27.57	27.50	27.44
18.800	27.38	27.32	27.26	27.20	27.14
19.050	27.08	27.02	26.96	26.90	26.84
19.300	26.78	26.73	26.67	26.61	26.56
19.550	26.50	26.44	26.39	26.33	26.28
19.800	26.23	26.17	26.11	26.05	25.99
20.050	25.92	25.85	25.78	25.71	25.63
20.300	25.56	25.48	25.40	25.32	25.25
20.550	25.17	25.10	25.02	24.95	24.87
20.800	24.80	24.72	24.65	24.58	24.50
21.050	24.43	24.36	24.29	24.22	24.15
21.300	24.08	24.01	23.94	23.87	23.80
21.550	23.73	23.67	23.60	23.54	23.47
21.800	23.40	23.34	23.28	23.21	23.15
22.050	23.09	23.02	22.96	22.90	22.84
22.300	22.78	22.72	22.66	22.60	22.54
22.550	22.48	22.42	22.36	22.31	22.25
22.800	22.19	22.14	22.08	22.03	21.97
23.050	21.92	21.86	21.81	21.76	21.71
23.300	21.65	21.60	21.55	21.50	21.45
23.550	21.40	21.35	21.30	21.25	21.20
23.800	21.14	21.09	21.04	20.98	20.92

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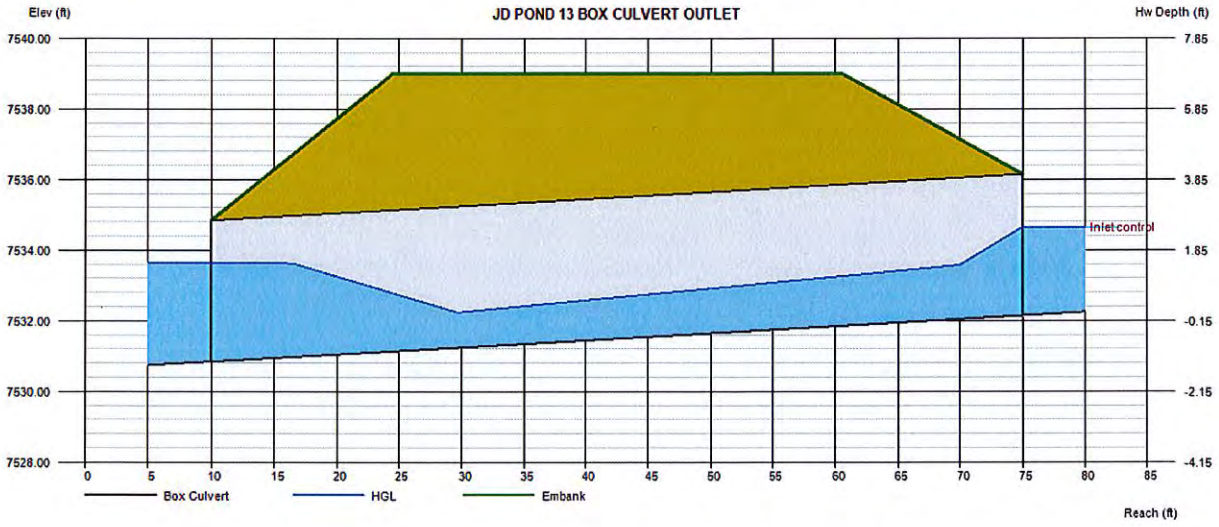
Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Saturday, Nov 4 2017

JD POND 13 BOX CULVERT OUTLET (100 yr. Storm Release)

Invert Elev Dn (ft)	= 7530.85	**Calculations**	
Pipe Length (ft)	= 65.00	Qmin (cfs)	= 0.00
Slope (%)	= 2.00	Qmax (cfs)	= 505.00
Invert Elev Up (ft)	= 7532.15	Tailwater Elev (ft)	= (dc+D)/2
Rise (in)	= 48.0		
Shape	= Box	**Highlighted**	
Span (in)	= 120.0	Qtotal (cfs)	= 227.25
No. Barrels	= 2	Qpipe (cfs)	= 227.25
n-Value	= 0.013	Qovertop (cfs)	= 0.00
Culvert Type	= Flared Wingwalls	Veloc Dn (ft/s)	= 4.07
Culvert Entrance	= 30D to 75D wingwall flares	Veloc Up (ft/s)	= 7.15
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4	HGL Dn (ft)	= 7533.65
		HGL Up (ft)	= 7533.74
Embankment		Hw Elev (ft)	= 7534.64
Top Elevation (ft)	= 7539.00	Hw/D (ft)	= 0.62
Top Width (ft)	= 36.00	Flow Regime	= Inlet Control
Crest Width (ft)	= 230.00		



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Jan 9 2018

JD POND 13 BOX CULVERT OUTLET (Max. Capacity with 1.0' Freeboard)

Invert Elev Dn (ft)	= 7530.85
Pipe Length (ft)	= 65.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 7531.50
Rise (in)	= 48.0
Shape	= Box
Span (in)	= 120.0
No. Barrels	= 2
n-Value	= 0.013
Culvert Type	= Flared Wingwalls
Culvert Entrance	= 30D to 75D wingwall flares
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4

Embankment

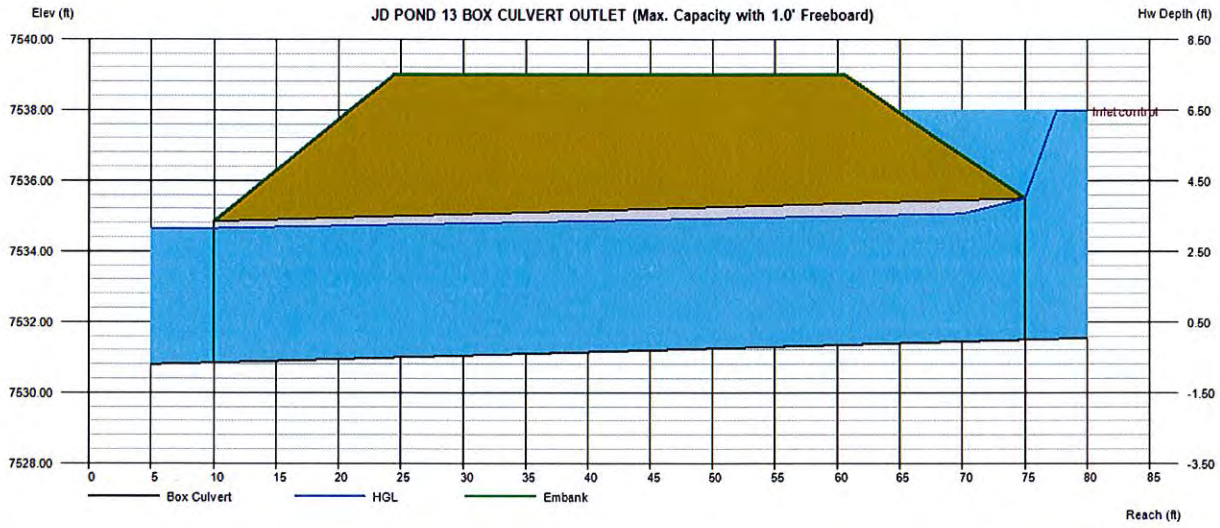
Top Elevation (ft)	= 7539.00
Top Width (ft)	= 36.00
Crest Width (ft)	= 230.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 775.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 775.00
Qpipe (cfs)	= 775.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 10.20
Veloc Up (ft/s)	= 10.78
HGL Dn (ft)	= 7534.65
HGL Up (ft)	= 7535.10
Hw Elev (ft)	= 7537.98
Hw/D (ft)	= 1.62
Flow Regime	= Inlet Control

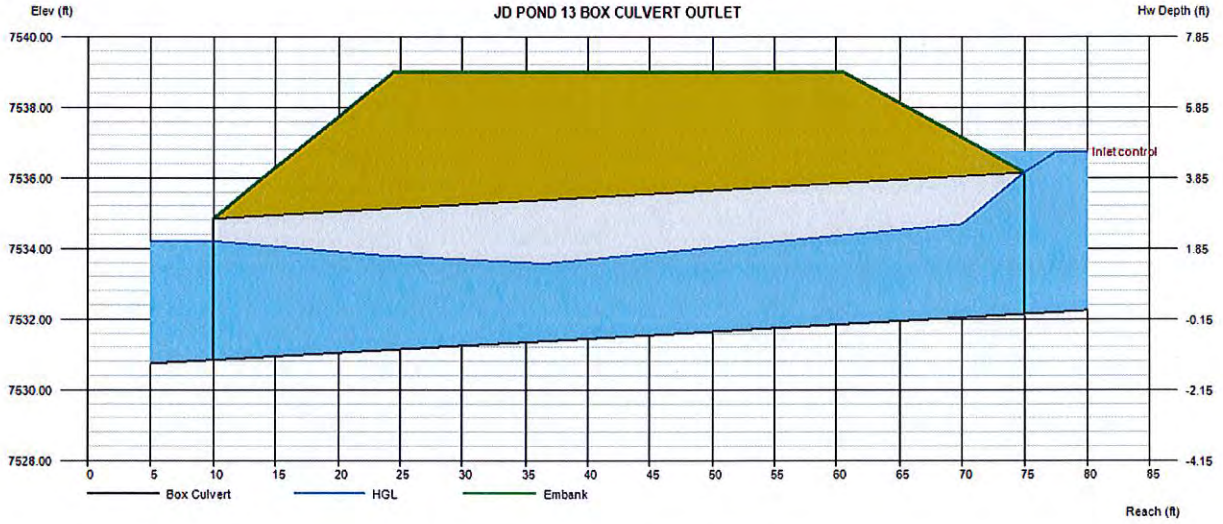


Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Saturday, Nov 4 2017

JD POND 13 BOX CULVERT OUTLET (Emergency Release)

Invert Elev Dn (ft)	= 7530.85	**Calculations**	
Pipe Length (ft)	= 65.00	Qmin (cfs)	= 0.00
Slope (%)	= 2.00	Qmax (cfs)	= 505.00
Invert Elev Up (ft)	= 7532.15	Tailwater Elev (ft)	= (dc+D)/2
Rise (in)	= 48.0		
Shape	= Box	**Highlighted**	
Span (in)	= 120.0	Qtotal (cfs)	= 505.00
No. Barrels	= 2	Qpipe (cfs)	= 505.00
n-Value	= 0.013	Qovertop (cfs)	= 0.00
Culvert Type	= Flared Wingwalls	Veloc Dn (ft/s)	= 7.53
Culvert Entrance	= 30D to 75D wingwall flares	Veloc Up (ft/s)	= 9.34
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4	HGL Dn (ft)	= 7534.20
		HGL Up (ft)	= 7534.85
Embankment		Hw Elev (ft)	= 7536.73
Top Elevation (ft)	= 7539.00	Hw/D (ft)	= 1.15
Top Width (ft)	= 36.00	Flow Regime	= Inlet Control
Crest Width (ft)	= 230.00		

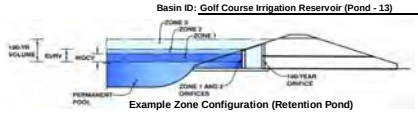


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Flying Horse North

Basin ID: Golf Course Irrigation Reservoir (Pond - 13)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**RP**	
Watershed Area =	366.80	acres
Watershed Length =	6,975	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	8.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	1.395	acre-feet
Excess Urban Runoff Volume (EURV) =	2.819	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.903	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	3.006	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	7.525	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	21.442	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	30.109	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	41.427	acre-feet
500-yr Runoff Volume (P1 = 3.39 in.) =	68.375	acre-feet
Approximate 2-yr Detention Volume =	1.765	acre-feet
Approximate 5-yr Detention Volume =	2.813	acre-feet
Approximate 10-yr Detention Volume =	6.361	acre-feet
Approximate 25-yr Detention Volume =	9.142	acre-feet
Approximate 50-yr Detention Volume =	9.507	acre-feet
Approximate 100-yr Detention Volume =	12.417	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.39	inches

Stage-Storage Calculation

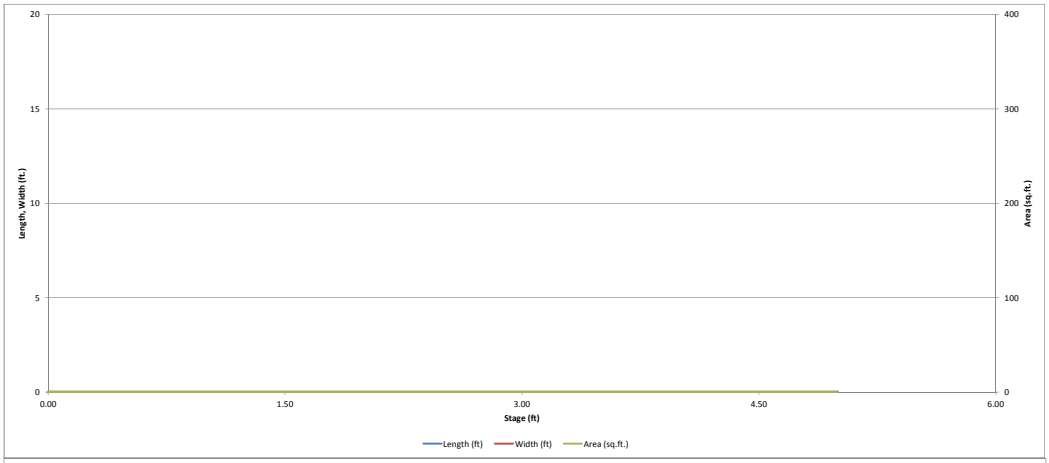
Zone 1 Volume (WQCV) =	1.395	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.424	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	9.598	acre-feet
Total Detention Basin Volume =	12.417	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

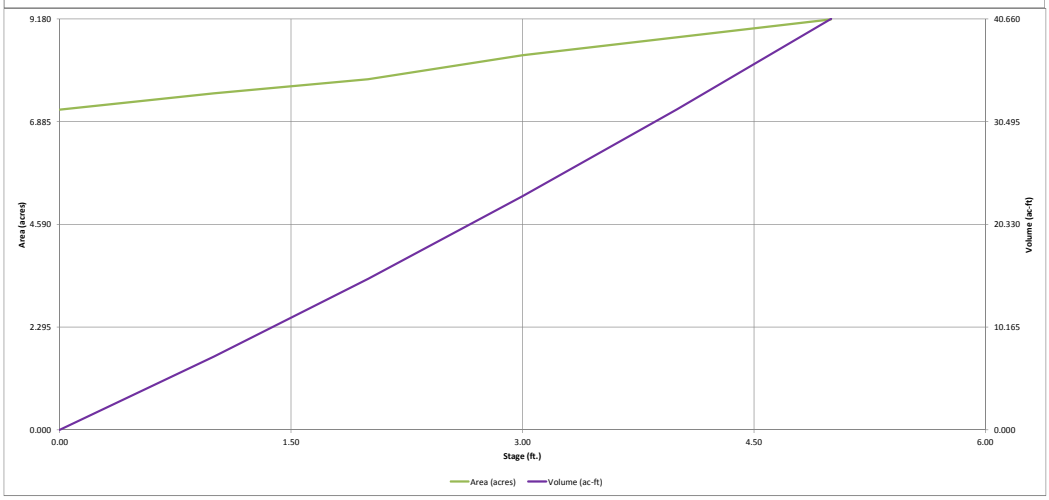
Depth Increment = 0.5 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Permanent Pool	--	0.00	--	--	--	311,545	7.152		
7532	--	1.00	--	--	--	327,571	7.520	316,283	7.261
7533	--	2.00	--	--	--	341,084	7.830	650,475	14.933
7534	--	3.00	--	--	--	364,597	8.370	1,006,726	23.111
7535	--	4.00	--	--	--	382,021	8.770	1,380,035	31.681
7536	--	5.00	--	--	--	399,445	9.170	1,770,768	40.651

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



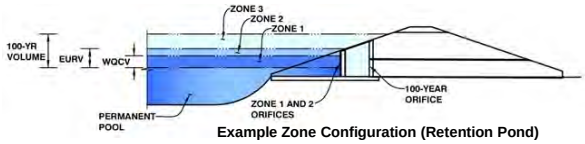


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Flying Horse North

Basin ID: Golf Course Irrigation Reservoir (Pond - 13)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.20	1.395	Orifice Plate
Zone 2 (EURV)	0.40	1.424	Orifice Plate
Zone 3 (100-year)	1.67	9.598	Weir&Pipe (Restrict)
		12.417	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.00	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.70	1.40					
Orifice Area (sq. inches)	196.25	196.25	196.25					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	75%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.00	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.04	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	24.74	N/A	ft^2
Overflow Grate Open Area w/ Debris =	12.37	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	30.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	4.91	N/A	ft^2
Outlet Orifice Centroid =	1.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

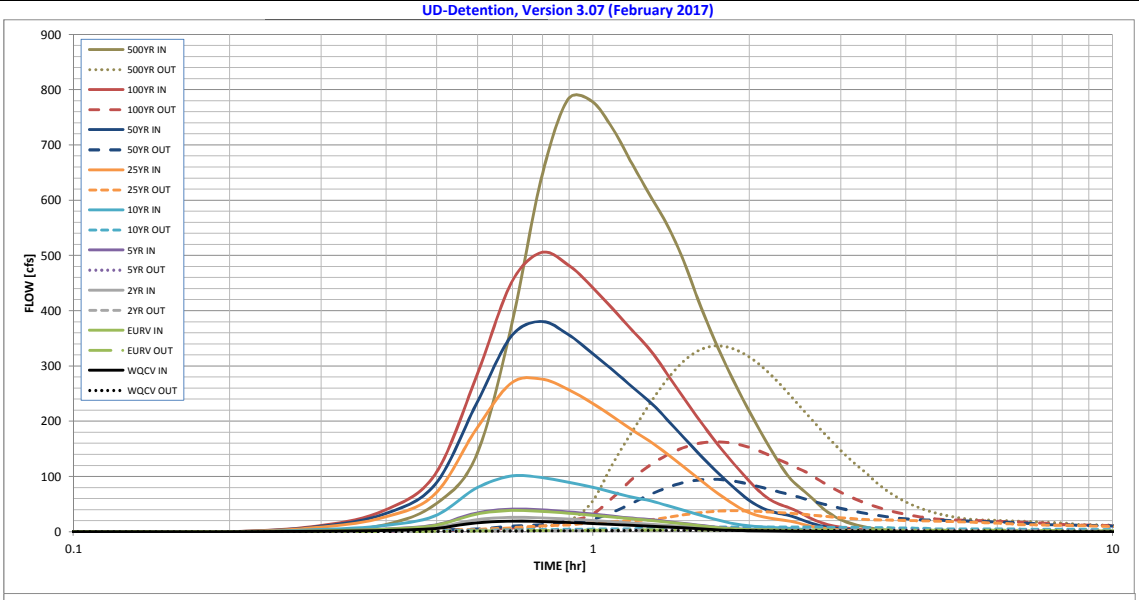
Spillway Design Flow Depth=	4.13	feet
Stage at Top of Freeboard =	7.13	feet
Basin Area at Top of Freeboard =	9.17	acres

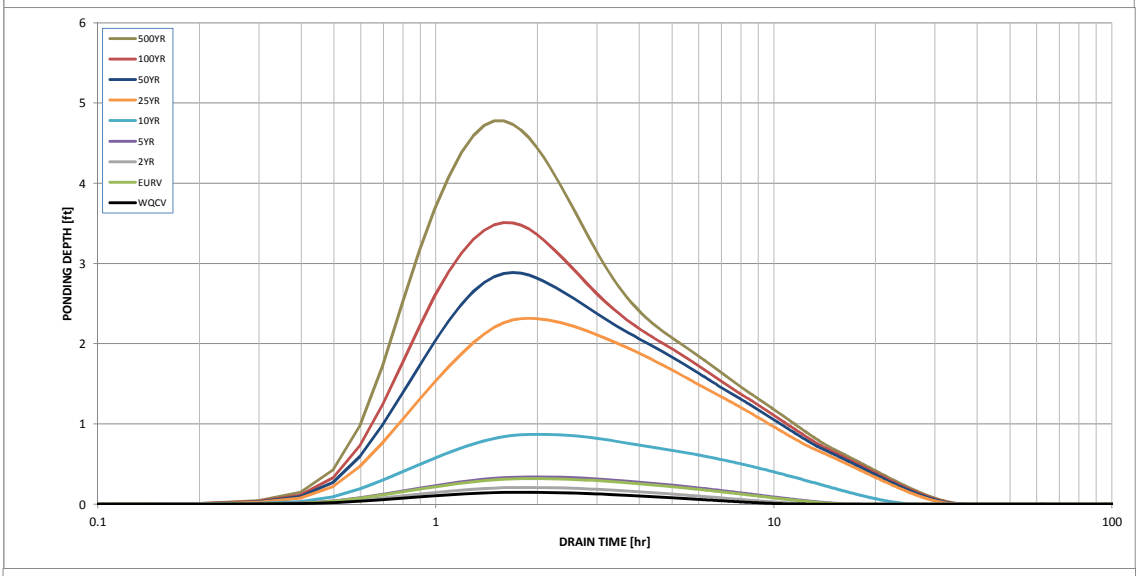
Routed Hydrograph Results

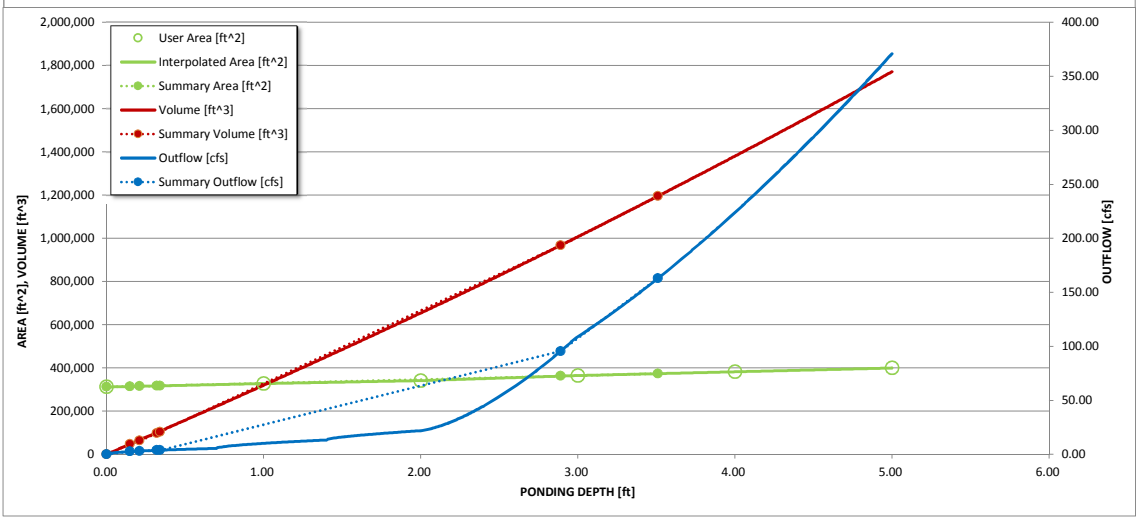
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.39
Calculated Runoff Volume (acre-ft) =	1.395	2.819	1.903	3.006	7.525	21.442	30.109	41.427	68.375
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	1.394	2.816	1.900	3.003	7.514	21.423	30.083	41.387	68.317
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.16	0.54	0.75	1.02	1.63
Predevelopment Peak Q (cfs) =	0.0	0.0	3.6	6.1	57.6	198.0	274.5	372.4	596.7
Peak Inflow Q (cfs) =	19.2	38.5	26.1	41.0	100.7	276.4	380.4	505.1	781.5
Peak Outflow Q (cfs) =	2.5	3.7	3.0	3.8	8.8	38.3	95.3	162.9	335.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.2	0.2	0.3	0.4	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.7	0.8	0.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	11	15	12	15	22	27	27	26	23
Time to Drain 99% of Inflow Volume (hours) =	**12**	16	14	17	24	31	31	30	29
Maximum Ponding Depth (ft) =	0.15	0.32	0.21	0.34	0.87	2.32	2.89	3.51	4.78
Area at Maximum Ponding Depth (acres) =	7.20	7.27	7.23	7.27	7.47	8.00	8.31	8.57	9.08
Maximum Volume Stored (acre-ft) =	1.005	2.235	1.438	2.380	6.287	17.464	22.111	27.346	38.553

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename: _____

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.96 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:11:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:17:53	0.84	1.64	1.13	1.74	3.89	8.10	9.45	10.70	12.53
0.838	0:23:50	2.27	4.50	3.07	4.78	11.19	26.31	32.42	38.79	49.32
	0:29:48	5.84	11.54	7.89	12.28	28.74	68.14	85.23	103.50	136.82
	0:35:46	16.03	31.67	21.66	33.69	78.66	185.19	230.64	279.30	368.39
	0:41:43	19.24	38.52	26.14	41.04	100.72	268.39	352.72	449.09	637.27
	0:47:41	18.41	36.94	25.03	39.36	98.13	276.41	380.45	505.10	781.53
	0:53:38	16.76	33.61	22.78	35.82	89.84	257.86	357.63	483.60	779.55
	0:59:36	15.02	30.23	20.45	32.23	81.03	233.50	324.40	444.47	728.77
	1:05:34	13.03	26.36	17.77	28.12	71.20	208.11	292.31	402.92	664.26
	1:11:31	11.33	22.96	15.44	24.50	62.30	183.66	261.37	363.61	606.64
	1:17:29	10.27	20.78	14.00	22.16	55.97	162.73	233.74	327.83	554.78
	1:23:26	8.54	17.36	11.67	18.53	47.28	140.69	202.49	284.75	493.39
	1:29:24	7.02	14.35	9.62	15.32	39.29	118.61	172.33	244.04	422.82
	1:35:22	5.47	11.31	7.54	12.08	31.42	97.62	144.02	206.83	361.25
	1:41:19	4.14	8.68	5.74	9.28	24.46	78.21	118.31	173.40	308.86
	1:47:17	3.02	6.43	4.22	6.89	18.45	61.46	95.91	143.99	262.60
	1:53:14	2.31	4.85	3.20	5.19	13.70	46.77	75.98	117.98	223.05
	1:59:12	1.89	3.93	2.61	4.20	10.92	35.49	58.65	94.43	186.88
	2:05:10	1.60	3.31	2.20	3.54	9.16	28.97	45.70	73.87	153.72
	2:11:07	1.40	2.89	1.92	3.08	7.94	24.69	38.00	58.86	123.69
	2:17:05	1.26	2.59	1.73	2.76	7.08	21.74	32.93	49.66	98.63
	2:23:02	1.15	2.37	1.59	2.53	6.47	19.61	29.37	43.65	82.75
	2:29:00	0.85	1.76	1.17	1.88	4.91	15.74	24.05	36.21	69.14
	2:34:58	0.62	1.28	0.85	1.36	3.54	11.47	17.96	27.64	54.51
	2:40:55	0.46	0.94	0.63	1.01	2.63	8.39	13.05	20.36	41.02
	2:46:53	0.34	0.70	0.46	0.75	1.95	6.26	9.65	15.04	30.77
	2:52:50	0.24	0.51	0.34	0.54	1.44	4.67	7.32	11.26	22.90
	2:58:48	0.17	0.36	0.24	0.39	1.04	3.45	5.48	8.54	17.17
	3:04:46	0.12	0.26	0.17	0.28	0.75	2.51	4.09	6.43	13.09
	3:10:43	0.08	0.18	0.12	0.20	0.53	1.87	3.05	4.85	9.94
	3:16:41	0.05	0.12	0.07	0.12	0.35	1.31	2.25	3.71	7.63
	3:22:38	0.03	0.06	0.04	0.07	0.21	0.86	1.58	2.74	5.96
	3:28:36	0.01	0.03	0.02	0.03	0.10	0.50	1.02	1.91	4.49
	3:34:34	0.00	0.01	0.00	0.01	0.03	0.24	0.59	1.23	3.23
	3:40:31	0.00	0.00	0.00	0.00	0.00	0.07	0.27	0.70	2.17
	3:46:29	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.32	1.33
	3:52:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.68
	3:58:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
	4:04:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	4:10:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:16:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:28:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:34:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:46:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:52:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:03:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:09:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:21:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:27:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:33:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:39:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:51:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:57:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:03:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:09:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:15:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:21:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:27:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:33:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:39:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:45:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:51:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:57:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:03:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:09:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
PERMANENT WSE	0.00	311,545	7.152	0	0.000	0.00
WQCV	0.15	313,949	7.207	46,912	1.077	2.54
2 YR. WSE	0.21	314,750	7.226	62,630	1.438	2.93
EURV	0.32	316,513	7.266	97,349	2.235	3.65
5 YR. WSE	0.34	316,834	7.273	103,682	2.380	3.77
50 YR. WSE	2.89	362,011	8.311	966,763	22.194	95.44
100 YR. WSE	3.51	373,483	8.574	1,194,936	27.432	162.90

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Rock Chute Design Data

(Version 4.01 - 04/23/03, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: *Flying Horse North - JD Pond Outlet* **County:** *EL Paso*
Designer: *Marc Whorton* **Checked by:**
Date: 11/12/2017 **Date:**

Input Channel Geometry

→ ***Inlet Channel***	→ ***Chute***	→ ***Outlet Channel***
Bw = *20.8* ft.	Bw = *20.0* ft.	Bw = *20.0* ft.
Side slopes = *0.0* (m:1)	Factor of safety = *1.20* (F_s)	Side slopes = *4.0* (m:1)
n-value = *0.013*	Side slopes = *3.0* (m:1) → ***2.0:1 max.***	n-value = *0.035*
Bed slope = *0.0200* ft./ft.	Bed slope (4:1) = *0.250* ft./ft. → ***2.5:1 max.***	Bed slope = *0.0100* ft./ft.
Freeboard = *1.0* ft.	Outlet apron depth, d = *2.0* ft.	Base flow = *40.0* cfs

Design Storm Data (Table 2, NHCP, NRCS Grade Stabilization Structure No. 410)

Drainage area = acres Rainfall = ○ 0 - 3 in. ● 3 - 5 in. ○ 5+ in.

Apron elev. --- Inlet = *7531.3* ft. --- Outlet = *7511.3* ft. --- (H_{drop} = 18 ft.)

Chute capacity = Q25-year
Total capacity = Q100-year
Minimum capacity (based on a 5-year, 24-hour storm with a 3 - 5 inch rainfall)

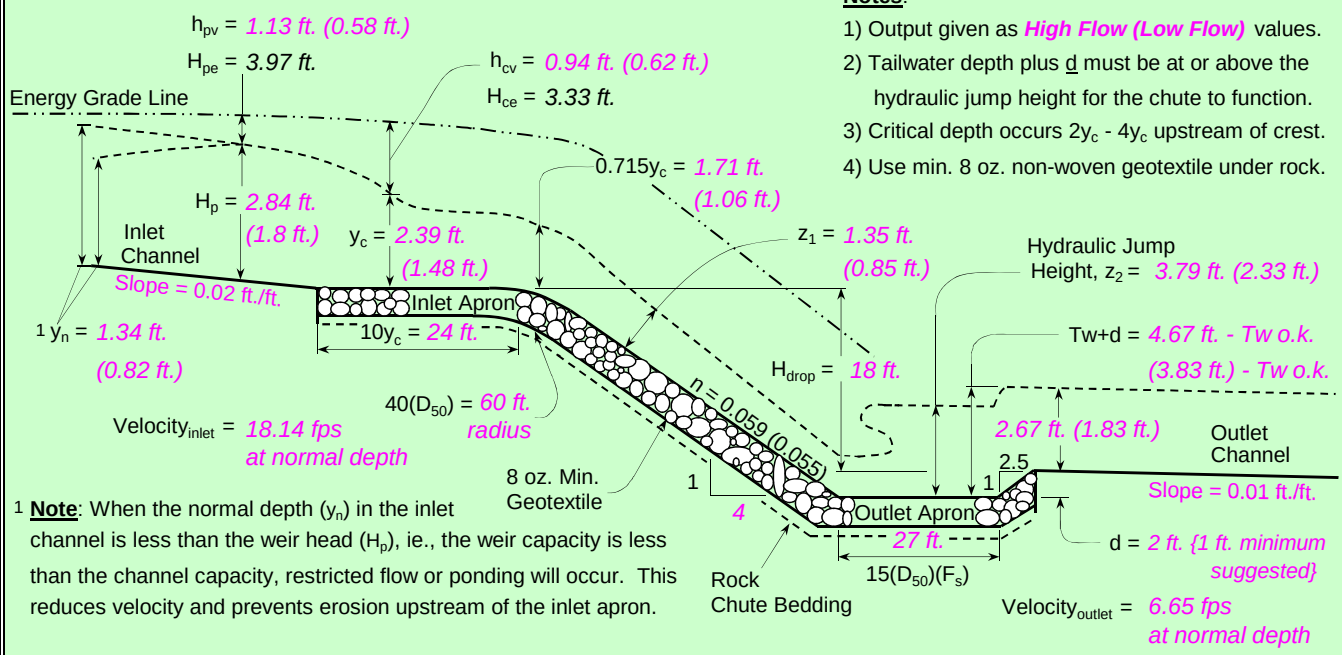
Q_{high} = *505.0* cfs High flow storm through chute → Tw (ft.) = *Program*

Q_{low} = *229.0* cfs Low flow storm through chute → Tw (ft.) = *Program*

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*
***Input tailwater (Tw)**:*

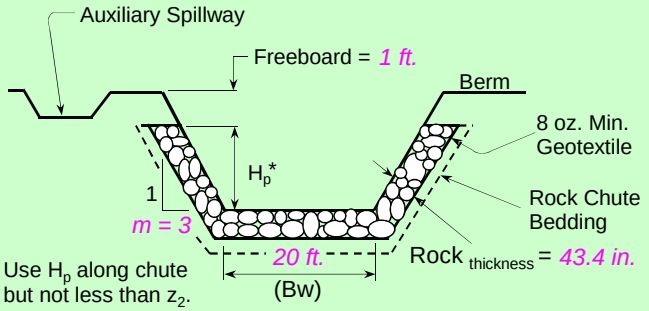
Profile and Cross Section (Output)

Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use min. 8 oz. non-woven geotextile under rock.



1 **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute



* Use H_p along chute but not less than z_2.

Typical Cross Section

q_t =	*20.9 cfs/ft.*	Equivalent unit discharge
F_S =	*1.20*	Factor of safety (multiplier)
z_1 =	*1.35 ft.*	Normal depth in chute
n-value =	*0.059*	Manning's roughness coefficient
D_{50}(F_s) =	*21.7 in. (747 lbs. - 50% round / 50% angular)*	
2(D_{50})(F_s) =	*43.4 in.*	Rock chute thickness
Tw + d =	*4.67 ft.*	Tailwater above outlet apron
z_2 =	*3.79 ft.*	Hydraulic jump height
****** The outlet***	***will***	***function adequately***

High Flow Storm Information

Rock Chute Design - Plan Sheet

(Version 4.0 - 07/10/00, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Flying Horse North - JD Pond Outlet
Designer: Marc Whorton
Date: 11/12/2017

County: EL Paso
Checked by:
Date:

Design Values

Angular D_{50} dia. = *21.7* in.
$Rock_{chute}$ thickness = *43.4* in.
Inlet apron length = *24* ft.
Outlet apron length = *27* ft.
Radius = *60* ft.
Will bedding be used? *Yes* ---------- Depth (in.) = *6.0*

Rock Gradation Envelope

% Passing	Diameter, in. (weight, lbs.)
D_{100} ---------	33 - 43 (2513 - 5957)
D_{85} ---------	28 - 39 (1636 - 4343)
D_{50} ---------	22 - 33 (745 - 2513)
D_{10} ---------	17 - 28 (381 - 1636)

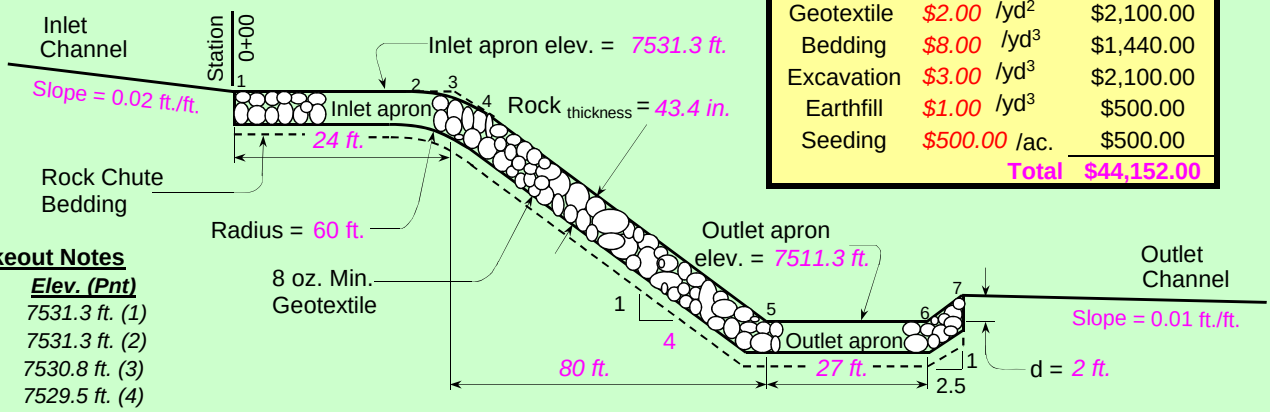
Quantities [a]

Angular Rock = 1042 yd^3
Geotextile (8 oz.)[b] = 1050 yd^2
Bedding (6 in.) = 180 yd^3
Excavation = *700* yd^3
Earthfill = *500* yd^3
Seeding = *1.0* acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile shall be overlapped (18-in. min.) and anchored (18-in. min. along sides and 24-in. min. on the ends).*

Rock Chute Cost Estimate

Unit	Unit Cost	Cost
Rock	*$36.00* /$yd^3$	$37,512.00
Geotextile	*$2.00* /$yd^2$	$2,100.00
Bedding	*$8.00* /$yd^3$	$1,440.00
Excavation	*$3.00* /$yd^3$	$2,100.00
Earthfill	*$1.00* /$yd^3$	$500.00
Seeding	*$500.00* /ac.	$500.00
	Total	**$44,152.00**

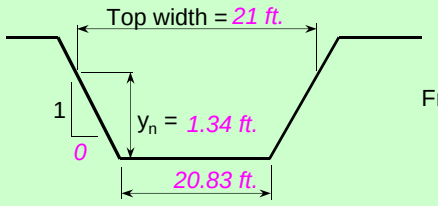


Stakeout Notes

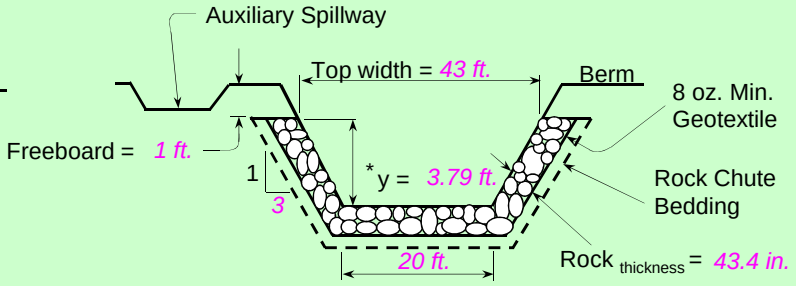
Sta.	Elev. (Pnt)
0+00	7531.3 ft. (1)
0+16.6	7531.3 ft. (2)
0+24	7530.8 ft. (3)
0+31.2	7529.5 ft. (4)
1+4	7511.3 ft. (5)
1+31	7511.3 ft. (6)
1+36	7513.3 ft. (7)

Profile Along Centerline of Rock Chute

Note**: **The outlet will function adequately

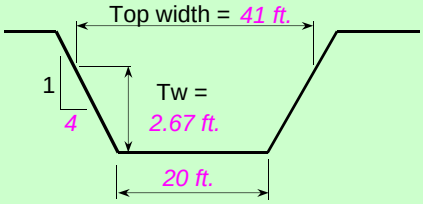


Inlet Channel Cross Section



Rock Chute Cross Section

* Use H_p throughout chute but not less than z_2.



Outlet Channel Cross Section

Profile, Cross Sections, and Quantities

Project: Flying Horse North - JD Pond Outlet
Location: EL Paso County

U.S. Department of Agriculture
Natural Resources Conservation Service

Designed: Marc Whorton	Approved by:	
Drawn: NRCS Standard Dwg.	Title:	
	Title:	
Traced:	Sheet No.	Drawing No.
Checked:	of	

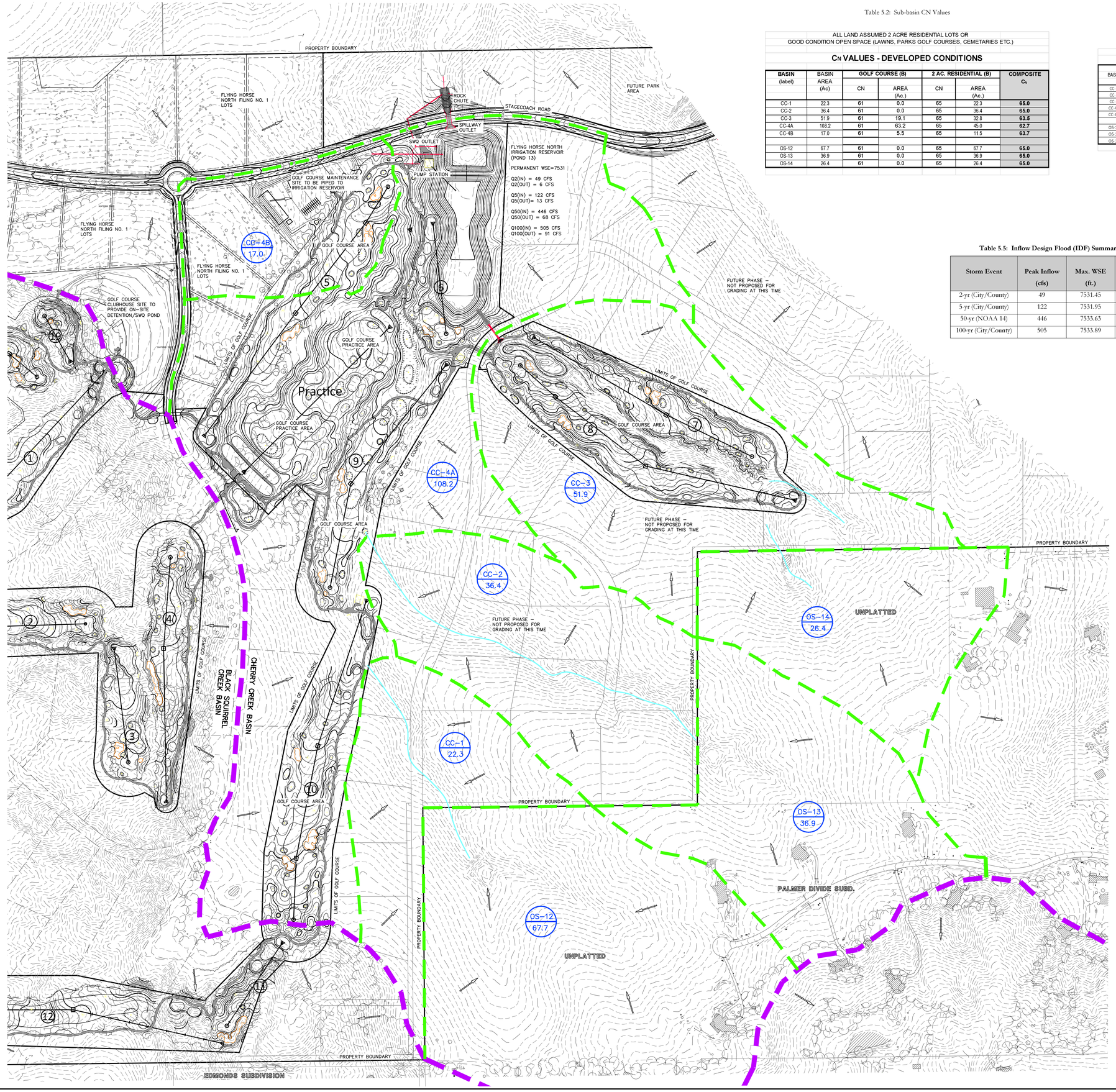


Table 5.2: Sub-basin CN Values

ALL LAND ASSUMED 2 ACRE RESIDENTIAL LOTS OR
GOOD CONDITION OPEN SPACE (LAWNS, PARKS GOLF COURSES, CEMETARIES ETC.)

CN VALUES - DEVELOPED CONDITIONS

BASIN (label)	BASIN AREA (Ac)	GOLF COURSE (B)		2 AC. RESIDENTIAL (B)		COMPOSITE C_N
		CN	AREA (Ac.)	CN	AREA (Ac.)	
CC-1	22.3	61	0.0	65	22.3	**65.0**
CC-2	36.4	61	0.0	65	36.4	**65.0**
CC-3	51.9	61	19.1	65	32.8	**63.5**
CC-4A	108.2	61	63.2	65	45.0	**62.7**
CC-4B	17.0	61	5.5	65	11.5	**63.7**
OS-12	67.7	61	0.0	65	67.7	**65.0**
OS-13	36.9	61	0.0	65	36.9	**65.0**
OS-14	26.4	61	0.0	65	26.4	**65.0**

Table 5.3 Sub-basin Time of Concentration

TIME OF CONCENTRATION DEVELOPED

BASIN	COMPOSITE Cn	OVERLAND			STREET / CHANNEL FLOW(DCM Vol. 1 Fig. 6-25)				Tc TOTAL (hr)	Tc LAG (0.6tc) (hr)
		Length (ft)	Height (ft)	Tc (hr)	Length (ft)	Slope (%)	Velocity (fps)	Tc (hr)		
CC-1	65.0	300	10	0.40	900	2.0%	1.8	0.14	0.53	0.32
CC-2	65.0	300	10	0.40	1,700	2.0%	1.8	0.26	0.66	0.39
CC-3	63.5	300	14	0.35	900	2.5%	2.4	0.10	0.45	0.27
CC-4A	62.7	300	14	0.35	2900	2.0%	2.1	0.38	0.73	0.44
CC-4B	63.7	300	12	0.37	900	3.0%	2.5	0.10	0.47	0.28
OS-12	65.0	300	14	0.35	1500	3.0%	2.5	0.17	0.51	0.31
OS-13	65.0	300	16	0.33	900	3.0%	2.5	0.10	0.43	0.26
OS-14	65.0	300	14	0.35	600	3.5%	2.7	0.06	0.41	0.24

Table 5.5: Inflow Design Flood (IDF) Summary Table

Storm Event	Peak Inflow (cfs)	Max. WSE (ft.)	Total Discharge (cfs)
2-yr (City/County)	49	7531.45	6
5-yr (City/County)	122	7531.95	13
50-yr (NOAA 14)	446	7533.63	68
100-yr (City/County)	505	7533.89	91

Table 5.6: Reservoir Discharge Table

Elevation	Discharge (cfs) (SWQ Outlet Box)	Discharge (cfs) (Twin CBC Spillway)	Discharge (cfs) (Total)
7531.0	0.0	0.0	0.0
7532.0	13.89	0.0	13.89
7533.0	27.77	0.0	27.77
7534.0	51.31	49.05	100.36
7535.0	69.52	138.56	208.08
7536.0	74.61	254.72	329.33

Permanent WSE = 7531.0

Top of SWQ Outlet box = 7533.0

Spillway elevation = 7533.0

Table 5.4: Storage Capacity Table

Elevation NGVD 1929	Area (Acres)	Storage Volume (Ac. Ft.)
*7510.0	1.51	0.00
*7511.0	1.99	1.74
*7512.0	2.52	3.99
*7513.0	2.85	6.68
*7514.0	3.05	9.63
*7515.0	3.26	12.78
7516.0	3.48	16.15
7517.0	3.70	19.74
7518.0	3.93	23.56
7519.0	4.16	27.60
7520.0	4.40	31.88
7521.0	4.64	36.40
7522.0	4.88	41.16
7523.0	5.14	46.17
7524.0	5.36	51.42
7525.0	5.59	56.89
7526.0	5.84	62.61
7527.0	6.08	68.57
7528.0	6.33	74.77
7529.0	6.57	81.22
7530.0	6.81	87.91
7531.0	7.15	94.89
7532.0	7.52	102.22
7533.0	7.83	109.90
7534.0	8.37	118.00
7535.0	8.77	126.57
7536.0	9.17	135.53

*Indicates dead storage below pumping ability

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	6910
BASIN BOUNDARY EAST CHERRY CREEK	
MAJOR BASIN BOUNDARY	
BASIN IDENTIFIER / AREA IN ACRES	BB 10.0
EXISTING DIRECTION OF FLOW	
PROPOSED DIRECTION OF FLOW	
STORM SEWER	

N

200 100 0 200 400

SCALE: 1" = 200'

CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE		DATE	9-20-17
DRAWN BY	MAW	(H) 1"= 200'		SHEET 1	OF 1
CHECKED BY		(V) 1"= N/A		JOB NO.	1096.11

APPENDIX C

GEOTECHNICAL REPORT

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

SUBSURFACE SOIL INVESTIGATION
FLYING HORSE NORTH DAM
COLORADO SPRINGS, COLORADO

Prepared for:

Pulpit Rock, LLC
6385 Corporate Drive, Suite 200
Colorado Springs, Colorado 80919

Attn: Drew Balsick

December 28, 2017

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Stan C. Culp, P.E.
Senior Engineer

COLORADO REGISTERED
STANLEY CLARE CULP
36723
12/29/17
PROFESSIONAL ENGINEER

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Encl.

Reviewed By:

Joseph C. Goode, Jr., P.E.
President

Entech Job No. 171249
AA projects/2017/171249 ssi_final

Table of Contents

SUBSURFACE SOIL INVESTIGATION
FLYING HORSE NORTH DAM
COLORADO SPRINGS, COLORADO

1.0 INTRODUCTION

As requested, personnel of Entech Engineering, Inc. have performed a Subsurface Soil Investigation at the proposed dam site and soil borrow site. The investigation was conducted to evaluate the soils to construct a new embankment; and perform laboratory testing within the dam footprint and proposed soil borrow areas. This report presents the results of our soils investigation, site evaluation, laboratory testing, and embankment recommendations. Specific design of the appurtenances within the embankment are beyond the scope of this report, however suggested geotechnical remediation is included based on our field exploration, laboratory testing, and engineering analysis' of the soils recovered from the sites investigated.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING PROGRAM

Subsurface conditions within the dam footprint and soil borrow areas were explored by drilling thirteen test borings. The locations of the soil borings were determined based on the anticipated size of the proposed embankment and access points on the property at the time of drilling. Six test borings were drilled in the proposed dam footprint, two test borings were drilled in the proposed west borrow area, and five test borings were drilled in the proposed east borrow area to obtain soils information for use to construct the new dam embankment. The borings were advanced to depths ranging from 10 to 40 feet below ground surface (bgs) with one tested area, Test Boring No. 13, that was excavated with a small backhoe by an onsite contractor, to 3 feet (bgs) in the proposed east borrow area. The soils in all but Test Boring No. 13 were obtained using a truck mounted, drilling rig with continuous flight auger supplied and operated by Entech.

Notably, the soil borrow area in the vicinity of Test Boring Nos. 7 and 8 were abandoned while developing this report. The soil was used elsewhere on the property. The test boring logs for these two borings are included in the report but have been removed from the Test Boring Location Map, included as Figure 1.

Representative soil samples were recovered from each of the borings at approximate 5-foot intervals using 2-inch O.D. split barrel and California samplers following Standard Penetration Test (ASTM D-1586) procedures. Boring logs describing the subsurface conditions encountered in each of the borings are included in Appendix A. Laboratory classification testing was completed on selected soil samples recovered from the borings and soil borrow area for purposes of determining water content, evaluating engineering properties, classification and for grouping the materials by soil type. The water content testing results and soil types (by number) are included on the boring logs with respect to the sample depth measured from the existing ground surface.

Table 1 presents a summary of the laboratory testing and the Unified Soil Classification System (USCS) designations for each of the soils encountered in the borings and the soils borrow area. The standard laboratory testing results are presented in Appendix B.

In addition to the classification testing sulfate, pH, resistivity, permeability, and direct shear testing was completed. This additional testing was conducted on samples from within the proposed embankment footprint at various depths and from soils recovered from the proposed east soil borrow site. In brief, the sulfate testing results indicate that the soils within the embankment footprint and the soils obtained from the east soil borrow site exhibit a negligible potential for sulfate attack. The sulfate, permeability, and direct shear testing are included in Appendix C.

The tables below present a summary of the permeability and direct shear testing for soils tested in the proposed embankment and soils borrow area. The permeability test results are included in Appendix D, and Filter Calculations are included in Appendix E.

The permeability testing was performed in the laboratory using a falling head permeameter arrangement. The samples were compacted in molds at 95% of their standard proctor dry density and optimum moisture content and saturated for six hours prior to initiating the test. The tests were performed for a duration of seven days.

3.0 SUMMARY OF STANDARD PROCTOR TESTING (ASTM D-698)

Sample Location	Sample Description	Depth Sampled (Feet)	Maximum Dry Density (pcf)	Optimum Moisture (%)
Test Boring 3	Silty Sand (SM)	0-5	124.1	9.0
Test Boring 6	V. Clayey Sand (SC)	5-10	115.5	13.5
Test Boring 13	V. Clayey Sand (SC)	0-3	116.6	13.3

4.0 SUMMARY OF PERMEABILITY TESTING

Sample Location	Sample Description	Depth Sampled (Feet)	Final Permeability (cm/s)
Test Boring 6	V. Clayey Sand (SC)	5-10	1.48×10^{-7}
Test Boring 13	V. Clayey Sand (SC)	0-3	3.82×10^{-7}

The direct shear testing was performed in the laboratory using a remodeled sample confined in a ring and drained. The samples were compacted in molds at 95% of their Standard Proctor Dry Density and optimum moisture content. The tests were performed for a duration of three days under a constant horizontal load and staged for each point.

5.0 SUMMARY OF DIRECT SHEAR TESTING

Sample Location	Sample Description	Depth Sampled (Feet)	Friction Angle (degrees)	Cohesion (psf)
Test Boring 3	Silty Sand (SM)	0-5	34	52
Test Boring 6	V. Clayey Sand (SC)	5-10	30	134
Test Boring 13	V. Clayey Sand (SC)	0-3	28	179

6.0 SOIL ROCK AND GROUNDWATER

Two primary soil types and two rock types were encountered in the borings:

Type No.	Description	USCS Designation
Type 1	Slightly Silty to Very Silty Sand and Very Clayey Sand	SM, SM-SW, SC
Type 2	Very Sandy Silt-Clay and Sandy to Very Sandy Clay	CL-ML, CL
Type 3	Clayey to Very Clayey Sandstone and Slightly Silty to Silty Sandstone	SC, SM-SW, SM
Type 4	Sandy Claystone	CL

7.0 SULFATE, PH, AND RESISTIVITY TESTING

Sample Description	TB # and Depth	Sulfate	pH	Resistivity
	(ft)	(%solublesulfate)		(ohm-cm)
Silty Sand	1 @ 2-3	0.02	6.0	14706
Very Clayey Sandstone	1 @ 20	<0.01	6.1	>20000
Silty Sandstone	2 @ 20	0.02	5.9	>20000
Sandy Claystone	3 @ 15	<0.01	5.8	>20000
Slightly Silty Sand	5 @ 15	<0.01	6.1	>20000
Sandy Clay	7 @ 2-3	<0.01	5.9	17867
Very Sandy Clay	8 @ 15	<0.01		
Silty Sand	3 @ 5	<0.01		
Very Clayey Sand	13 @ 0-3	<0.01	5.9	19129

Soil Type 1 is described as slightly silty to very silty sand and very clayey sand (SM-SW, SM, SC). The sand was encountered in Test Boring Nos. 1 – 6, 10, 11, and 13 from the existing ground surface and underlying Soil Type 2 to depths of 3 to 39 feet (bgs). SPT Testing conducted on the sand resulted in N-values of 7 to 42 blows-per-foot (bpf), indicating loose to medium dense states. Moisture content and grain size analysis indicated moisture contents of 1.4 to 14.8 percent and 7.7 to 42.7 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits testing resulted in Liquid Limits of no value, 29, and 32 and Plastic Indexes of being non-plastic, 13, and 13. Sulfate testing on the sand resulted in less than 0.01 to 0.02 percent soluble sulfate, indicating a negligible potential for below grade concrete degradation due to sulfate attack. pH Testing on the sands resulted in values between 5.9 and 6.1. These results indicate the soils are slightly to moderately acidic. Resistivity Testing on the sands resulted in soil resistivities between 14706 and greater than 20000 ohm-cm. The test results indicate that the sand soils are mildly corrosive to non-corrosive.

Soil Type 2 is described as sandy to very sandy clay and very sandy silt-clay (CL, CL-ML). The clay was encountered in Test Boring Nos. 2, 4, 6, 7, 8, 9 and 12 from the existing ground surfaces and underlying Soil Type 1 to approximate depths of 5 to 30 feet (bgs). SPT Testing conducted on the sandy clay resulted in N-values of 7 to 25 (bpf). This testing indicates the clays relative density ranges from firm to stiff consistencies. Moisture content indicated moisture contents ranging from 7.7 to 20.5 percent indicating moist conditions. Grain size analysis indicated a range of 51.6 to 88.4 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits testing resulted in Liquid Limits of 24 to 42 and Plastic Indexes of 5 to 19. FHA Swell Testing performed on a sample of very sandy clay-silt resulted in a swell pressure of 150 psf, indicating a low swell potential. Swell/Consolidation Testing on a sample of sandy clay resulted in a volume change of 1.2 percent, also indicating a low swell potential. Sulfate testing on the clays resulted in less than 0.01 percent soluble sulfate, indicating a negligible potential for below grade concrete degradation due to sulfate attack. pH Testing on a clay sample resulted in a value of 5.9. This result indicates the clay soils are moderately acidic. Resistivity Testing on a sample of clay resulted in soil a resistivity of 17867 ohm-cm. This result indicates that the clay soils are mildly corrosive.

Soil Type 3 is described as weathered and formational clayey to very clayey sandstone and slightly silty to silty sandstone (SC, SM, SM-SW). The sandstone was encountered in Test Boring Nos. 1-5 underlying Soil Types 1 and 4 ranging from 14 to 40 feet (bgs). SPT Testing conducted on the sandstone resulted in N-values of 31 and greater than 50 blows per foot, indicating dense to very dense states. Moisture content and grain size analysis indicated moisture contents of 2.8 to 19.5 percent and 11.0 to 38.2 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits testing resulted in the sandstone having a Liquid Limit of 42 and no value and Plastic Indexes of 11 and of being non-plastic. Sulfate testing on the sandstone resulted in less than 0.01 and 0.02 percent soluble sulfate, indicating a negligible potential for below grade concrete degradation due to sulfate attack. pH and Resistivity Testing on the sandstone resulted in values of 6.1 and greater than 20000 ohm-cm. These results indicate the sandstone materials are slightly acidic and non-corrosive.

Soil Type 4 is classified as weathered to formational sandy claystone (CL). The claystone was encountered in Test Boring Nos. 3 and 6 underlying Soil Type 1 between 14 and 40 feet below the ground surface (bgs). Standard Penetration Testing conducted on the claystone resulted in SPT N-values of 45 to greater than 50 blows per foot (bpf), which indicated very stiff to hard consistencies. Moisture content and grain size testing resulted in moisture contents of 11.0 and 17.6 percent with 69.3 to 96.0 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing was performed on samples of claystone resulted in Liquid Limits of 37 and 49 and Plastic Indexes of 19 and 23, respectively. Swell/Consolidation Testing performed on a sample of claystone resulted in a 1.6 percent volume change, indicating a low swell potential. Sulfate testing on the claystone resulted in less than 0.01 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack. pH and Resistivity Testing on the claystone resulted in values of 5.8 and greater than 20000 ohm-cm. These results indicate the claystone materials are moderately acidic and non-corrosive.

8.0 SUMMARY OF TEST BORING DRILL AND GROUNDWATER DEPTHS

Test Boring No.	Depth Drilled (feet)	Depth to Groundwater (feet)
1	25	Dry
2	30	Dry
3	25	16
4	40	Dry
5	30	Dry
6	40	Dry
7	10	Dry
8	20	Dry
9	10	Dry
10	10	Dry
11	10	Dry
12	10	Dry
13	3	Dry

It should be noted that groundwater conditions at the site will vary as a result of changes in precipitation, runoff, changes in site use/drainage as well as a result of development on the property or adjacent nearby properties.

9.0 NEW DAM EMBANKMENT

The new dam height will likely not exceed 25 feet, with a jurisdictional height of less than 20 feet, and have a 4:1 upstream slope and 3:1 downstream slope. The dam crest will be 36 feet in width supporting a paved 32-foot wide County Road. The new dam will be constructed on the same alignment of the proposed extension of Stagecoach Road. The new dam embankment will be comprised of a homogenous very sandy clay and clayey sand. During the development of this report the west soil borrow area was used on other areas of the property and additional drilling was performed at an east borrow area also located on the property. The east borrow area is approximately 0.5 miles east-southeast of the new dam embankment. Based on soils obtained from our soil borings and site evaluation of the east soils borrow area for the dam, this ~ 25-acres of land should provide a close and ample soils source to construct the new dam embankment.

The following two report sections present permeability testing, filter design, and a slope stability analysis based on the soils recovered from the field investigations, laboratory test results, and assuming an unlined homogeneous earthen embankment in direct contact with the stored waters. This proposed dam and entire pond will be lined with a man-made 30-mil LDPE liner. Approximately 12 to 18 inches of soil is proposed overlying the liner. The results of the testing and analysis assuming the earthen embankment is in direct contact with the stored waters will be conservative as seepage through the liner should be minimal.

10.0 PERMEABILITY TESTING AND FILTER DESIGN

Based on the results of the permeability testing on two remolded very clayey sand samples obtained from within the footprint of the proposed dam embankment and east soils borrow area proposed to construct the new dam embankment. The soils should provide a structure with minimal seepage. The seepage collection system for the new embankment should include a toe drain system constructed with a blanket drain. The collection systems should include a drain pipe encapsulated in a soil filter for the toe drain with a blanket drain. The toe drain pipe should consist of the minimum sized pipe acceptable by the Dam Safety Branch. The drain pipe shall be made of PVC and mill slotted. The blanket drain should extend from the upper toe drain trench parallel to the dam downstream face with a thickness of one foot. The blanket filter should be constructed with approximately 2 feet of cover and extending to within two feet of the proposed impoundments free surface. The blanket drain cover should consist of site sands proposed to construct the embankment.

The drain filter design was conducted following the National Engineering Handbook developed by the United States Department of Agriculture Natural Resources Conservation Service Division, Part 633, Chapter 26 – Gradation Design of Sand and Gravel Filters. The gradation design was conducted using sieves of the proposed dam shell materials. Coarse and fine filters are suggested to prevent migration of very clayey proposed to construct the new earthen embankment. The filter designs provide an acceptable band range for the coarse and fine filters. The fine filter should consist of a washed concrete sand and the coarse filter comprised

of a No. 8 aggregate. The coarse filter shall encapsulate the drain pipe a minimum of six inches beyond the pipe outside diameter with the fine sand filter encapsulating the coarse filter within the toe drain trench and the downstream blanket filter. Outlet pipes constructed in the new dam embankment shall also be designed with a fine and coarse grained filter constructed near the outlet below the downstream face of the dam, covered with dam shell materials. The contractor should submit sieve analysis' of the proposed filter materials prior to hauling to the site.

The spreadsheets developed for the filter design and a filter detail are included in Appendix D.

11.0 SLOPE STABILITY ANALYSIS

A slope stability analysis was performed on the new dam embankment. Soil values used were determined from our site evaluations and laboratory testing. Two primary soil types and two rock types were tested; site sands, clays, sandstone, and claystone. A slope stability analysis was performed on one section of the proposed dam embankment to quantify its structural integrity based on the geometry and soil properties obtained from this investigation. The slope section analyzed was located at approximately midspan across the length of the new dam. Refer to the Topographic Plan in Appendix E for the location of the slope section on the new dam. The slope stability analysis' were conducted utilizing the STEDwin GSTABL7 computer program. Two models were created in this analysis, both providing profiles of the new dam.

Factors of Safety were calculated by the Modified Bishop Method for Circular Failure Surface. A Factor of Safety of 1.81 was obtained on the initial slope analysis of the new dam embankment, approximately midspan at its deepest section. A Factor of Safety of 1.5 is recommended for earthen dams as specified in the Colorado Department of Natural Resources, Division of Water Resources, Rules and Regulations for Dam Safety and Dam Construction. Refer to Appendix E for the results of these slope stability analysis'.

The potential of accelerated slope failure for the new dam is relatively low due to the proposed liner which will minimize seepage through the embankment. The new dam will have a

downstream face seepage monitoring system. The dam embankment will be a homogenous structure comprised of sands and clays containing clay and silt fines.

Loose native soils were encountered below the proposed dam embankment in a couple of test borings which could be an active or future conduit for swift groundwater movement. Increased groundwater velocities tend to transport soils from below the structure and increased seepage rates are expected over time. The loose zones could be from groundwater movement. These areas will be mitigated during the dam foundation work.

12.0 EMBANKMENT CONSTRUCTION

After the dam foundation is exposed, the excavation shall be observed to determine if addition field exploration or laboratory testing is required. These evaluations will verify the condition of the underlying geology for support and construction of the dam foundation and outlet structures. Based on our Sulfate, pH, and Resistivity Testing conducted on the soils proposed to construct the new dam, the soils exhibit a negligible potential for attack on concrete structures and Type II concrete is recommended. The soils are slightly to moderately acidic and mildly corrosive and should not be corrosive in direct contact with steel; however, due to the nature of this project it is recommended that all steel materials in contact with the new dam embankment soils should be cathodically protected.

The property in the vicinity of the new dam would provide a close staging area for construction equipment and storage of usable soils removed from the dam. The east borrow area was determined to provide an ample and close soil source for the dam embankment. Laboratory testing performed on the soils located at the east borrow area determined the soil suitable for the construction of a new earthen embankment. Initial slope stability analysis' indicates the embankment stability with elevated groundwater seepage through the embankment would meet acceptable factors of safety based on the soils tested for this investigation. Notably, it is likely that the groundwater within the embankment will never reach this elevated state with the proposed manmade pond liner and active toe drains proposed with this project. Additional testing may be required prior to and during construction of the new earthen embankment depending on the contractor's construction materials submittals. It is likely that a toe drain will

be required consisting of manmade and earthen materials during construction of the new dam embankment.

After the dam embankment foundation soils are exposed, mitigated as required, and approved by the Dam Safety Branch and Geotechnical Engineers, the new embankment shall be constructed and periodically observed and tested. The foundation granular materials (site sands) as approved by the geotechnical engineer shall be compacted to a minimum of 100% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The embankment shell materials (site sands and very sandy clays) as approved by the geotechnical engineer shall be compacted to a minimum of 98% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The filter materials shall be tamped and observed by a construction materials testing agency prior to covering the filters with embankment materials to verify thicknesses and compaction efforts. The soils testing requirements and frequencies of testing will be noted on the construction drawings and technical specifications.

13.0 CLOSURE

The test borings were located to provide general geotechnical information and subsurface profiles at the new embankment location and soil borrow areas. Variations in subsurface conditions may be encountered across the site. Pockets of low soil densities determined from the standard penetration testing conducted during drilling indicated isolated zones within the surficial native soil exist in the existing drainageway. The loose zones were encountered in Test Boring Nos. 2 and 3. Surficial clays and silts with low bearing capacities were encountered in Test Boring Nos. 2, 4, and 6 were also encountered in the existing drainageway within the location of the proposed dam embankment. During excavations for the dam foundation, the loose and potentially low bearing soils will be excavated to the underlying medium dense to dense soil strata below. It is likely the granular soils removed from the foundation areas will be reused in the embankment foundation or reused in the new dam embankment. Spoils removed will likely be used elsewhere on the golf course property in softscape areas.

This report has been prepared for Pulpit Rock, LLC for application to the proposed project in accordance with generally accepted soil engineering practices. No other warranty expressed or implied is made. We trust this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLE

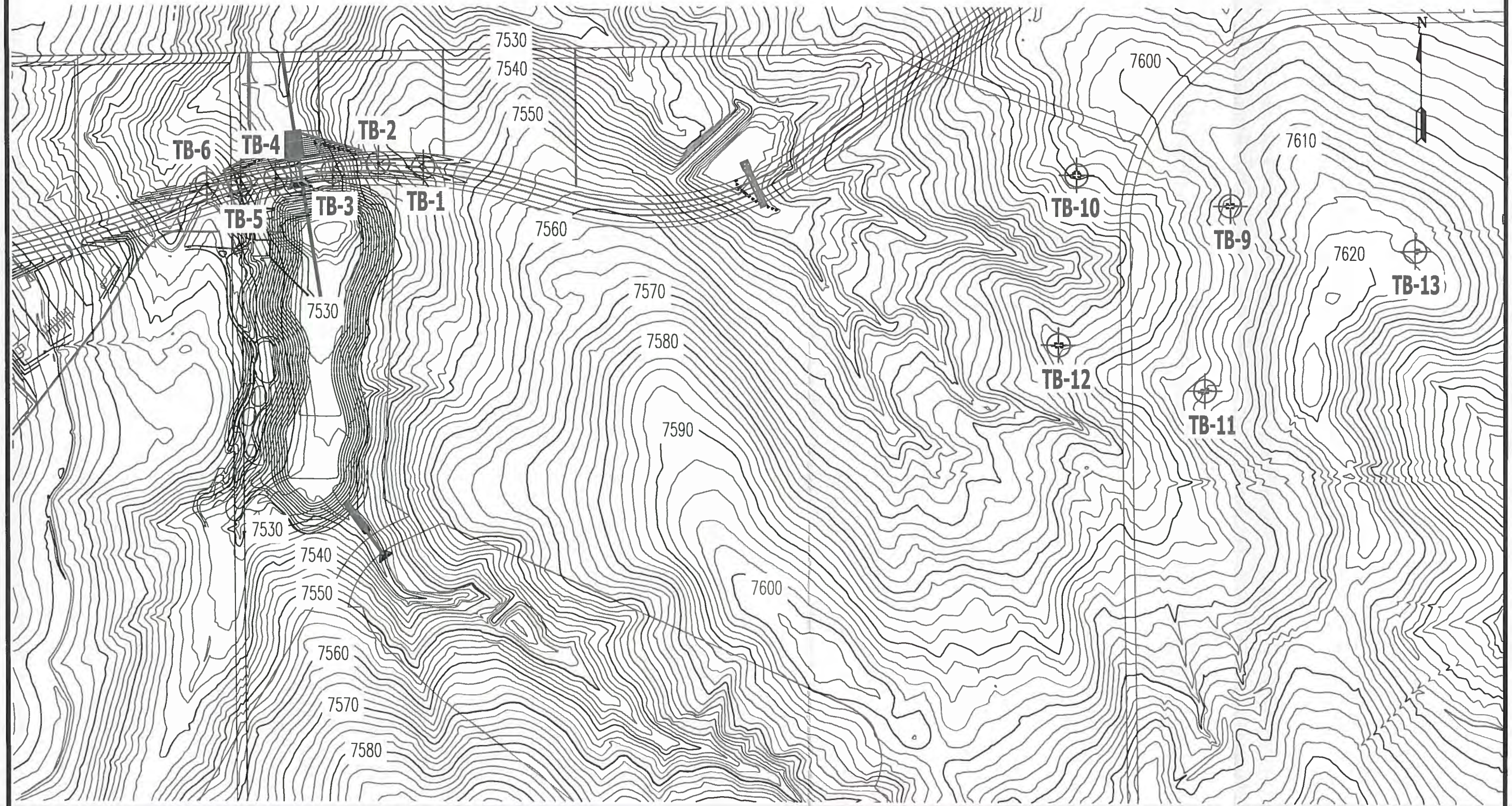
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT PULPIT ROCK, LLC
PROJECT FLYING HORSE NORTH, DAM
JOB NO. 171249

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			30.0	NV	NP	0.02			SM	SAND, SILTY
1	4	0-5			42.7						SM	SAND, VERY SILTY
1	5	15			7.7			<0.01			SM-SW	SAND, SLIGHTLY SILTY
1	3	5			22.3	NV	NP	<0.01			SM	SAND, SILTY
1	5	5			17.8						SM	SAND, SILTY
1	10	2-5			47.0						SC	SAND, VERY CLAYEY
1	11	0-10			42.5	32	13				SC	SAND, VERY CLAYEY
1	13	0-3			43.7	29	13	<0.01			SC	SAND, VERY CLAYEY
2	9	1-5			54.7						CL	CLAY, VERY SANDY
2	12	1-8			65.8	29	19				CL	CLAY, SANDY
2	8	15			73.8	28	15	<0.01			CL	CLAY, SANDY
2	2	10			55.5	24	5		150		CL-ML	CLAY, SILT, VERY SANDY
2	4	2-3			81.1	31	16				CL	CLAY, SANDY
2	4	25-30			68.9						CL	CLAY, SANDY
2	6	5-10			58.8						CL	CLAY, VERY SANDY
2	6	10	17.3	107.8	88.4	42	19			1.2	CL	CLAY, SANDY
2	7	2-3			72.7			<0.01			CL	CLAY, SANDY
2	8	0-5			72.0						CL	CLAY, SANDY
2	8	5			51.6	26	11				CL	CLAY, VERY SANDY
3	1	20			38.2			<0.01			SC	SANDSTONE, VERY CLAYEY
3	1	15-20			31.3						SC	SANDSTONE, CLAYEY
3	2	20			13.3	42	11	0.02			SM	SANDSTONE, SILTY
3	4	40			20.6	NV	NP				SM	SANDSTONE, SILTY
3	5	25			11.0						SM-SW	SANDSTONE, SLIGHTLY SILTY
4	3	15	16.8	109.3	96.0	49	23	<0.01		1.6	CL	CLAYSTONE, SANDY
4	6	40			69.3	37	19				CL	CLAYSTONE, SANDY

TEST BORING LOCATION MAP



FLYING HORSE NORTH GOLF COURSE

11" x 17" - SCALE: 1" = 300'

TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER

STATE OF COLORADO P.E.

REVISIONS	BY:

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

TEST BORING LOCATION MAP
FLYING HORSE NORTH DAM
COLORADO SPRINGS, CO
FOR: PULPIT ROCK, LLC

DRAWN BY: S. CULP.
DESIGNED BY: S. CULP
CHECKED BY:
DATE: 9/30/17
SCALE: AS SHOWN
JOB NO.: 171249
FIGURE NO.: 1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 8/23/2017
Job # 171249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 19.5', 9/7/17						
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST			■	15	7.0	1
	5		■	19	4.0	1
	10		■	16	7.9	1
SANDSTONE, VERY CLAYEY TO CLAYEY, FINE TO COARSE GRAINED, RED BROWN, VERY DENSE, MOIST	15		■	50 / 11"	19.5	3
	20		■	50 / 6"	18.6	3
	25		■	50 / 7"	11.9	3

TEST BORING NO. 2
DATE DRILLED 8/23/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 26.5', 9/7/17						
SAND, SILTY, FINE TO COARSE GRAINED, TAN, LOOSE TO DENSE, MOIST			■	7	9.2	1
	5		■	31	4.4	1
CLAY-SILT, VERY SANDY, TAN, FIRM, MOIST	10		■	7	16.6	2
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST	15		■	17	6.6	1
WEATHERED TO FORMATIONAL SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, DENSE TO VERY DENSE, MOIST	20		■	31	13.1	3
	25		■	50 / 4"	11.0	3
	30		■	50 / 4"	8.7	3

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TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 8/23/2017
Job # 171249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 16', 9/7/17						
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO LOOSE, MOIST			■	12	4.5	1
	5		■	7	11.6	1
	10		■	9	12.1	1
WEATHERED CLAYSTONE, SANDY, TAN, VERY STIFF, MOIST	15		■	45	17.6	4
SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	20		■	50/5"	15.0	3
	25		■	50/7"	13.3	3

TEST BORING NO. 4
DATE DRILLED 8/23/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 27.5', 9/7/17						
CLAY, SANDY, TAN, STIFF, MOIST			■	20	8.6	2
	5		■	25	6.4	2
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST TO VERY MOIST	10		■	27	1.7	1
	15		■	25	3.4	1
CLAYEY LENSES	20		■	12	14.8	1
	25		■	38	4.9	1
CLAY, SANDY, BROWN, STIFF, MOIST	30		■	15	9.2	2
SAND, SILTY, FINE TO COARSE GRAINED, TAN, LOOSE, MOIST	35		■	8	6.1	1
WEATHERED SANDSTONE, SILTY, FINE TO MEDIUM GRAINED, TAN, DENSE, MOIST	40		■	40	18.5	3

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TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 8/23/2017
Job # 171249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 27.5', 9/7/17						
SAND, SLIGHTLY SILTY TO SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				15	7.2	1
	5			20	7.7	1
	10			16	12.1	1
	15			22	1.4	1
	20			27	4.0	1
SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE TO DENSE, MOIST	25			50 / 11"	2.8	3
	30			47	11.6	3

TEST BORING NO. 6
DATE DRILLED 8/23/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 18.5', 9/7/17						
SAND, SILTY, FINE TO COARSE GRAINED, TAN, DENSE TO MEDIUM DENSE, MOIST				42	1.9	1
	5			13	13.2	1
CLAY, SANDY, TAN, STIFF, MOIST	10			15	20.5	2
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST	15			16	5.7	1
	20			20	4.7	1
	25			26	4.2	1
CLAYEY LENSE				*	13.6	1
	30			25	4.7	1
	35			24	5.4	1
* - BULK SAMPLE TAKEN						
CLAYSTONE, SANDY, GRAY BROWN, HARD, MOIST	40			50 / 10"	11.0	4

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TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/10/17

JOB NO.: 171249
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 9/6/2017
Job # 171249

REMARKS

DRY TO 19.5', 9/7/17

CLAY, SANDY, TAN, FIRM TO STIFF, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
		■	12	9.7	2
5		■	15	7.8	2
10		■	22	9.5	2
15					
20					

TEST BORING NO. 8
DATE DRILLED 9/6/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS

DRY TO 20', 9/6/17

CLAY, VERY SANDY TO SANDY WITH DEPTH, TAN, FIRM TO STIFF, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
		■	11	7.7	2
5		■	10	10.6	2
10		■	8	10.3	2
15		■	15	12.3	2
20		■	13	9.4	2

TEST BORING NO. 9
DATE DRILLED 10/20/2017
Job # 171249

REMARKS

DRY TO 10',
10/20/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
					2
5					
10					
15					
20					

CLAY, VERY SANDY, TAN

TEST BORING NO. 10
DATE DRILLED 10/20/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS

DRY TO 10',
10/20/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
					1
5					
10					
15					
20					

SAND, VERY CLAYEY, TAN

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TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: A- 5

TEST BORING NO. 11
DATE DRILLED 10/20/2017
Job # 171249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 10/20/17						
SAND, VERY CLAYEY, TAN						1
	5					
	10					
	15					
	20					

TEST BORING NO. 12
DATE DRILLED 10/20/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 10/20/17						
CLAY, SANDY, TAN						2
	5					
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: A- 6

TEST BORING NO. 13
DATE DRILLED 10/20/2017
Job # 171249

TEST BORING NO.
DATE DRILLED
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, VERY CLAYEY, FINE TO COARSE GRAINED, TAN						1
	5					
	10					
	15					
	20					

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	5					
	10					
	15					
	20					

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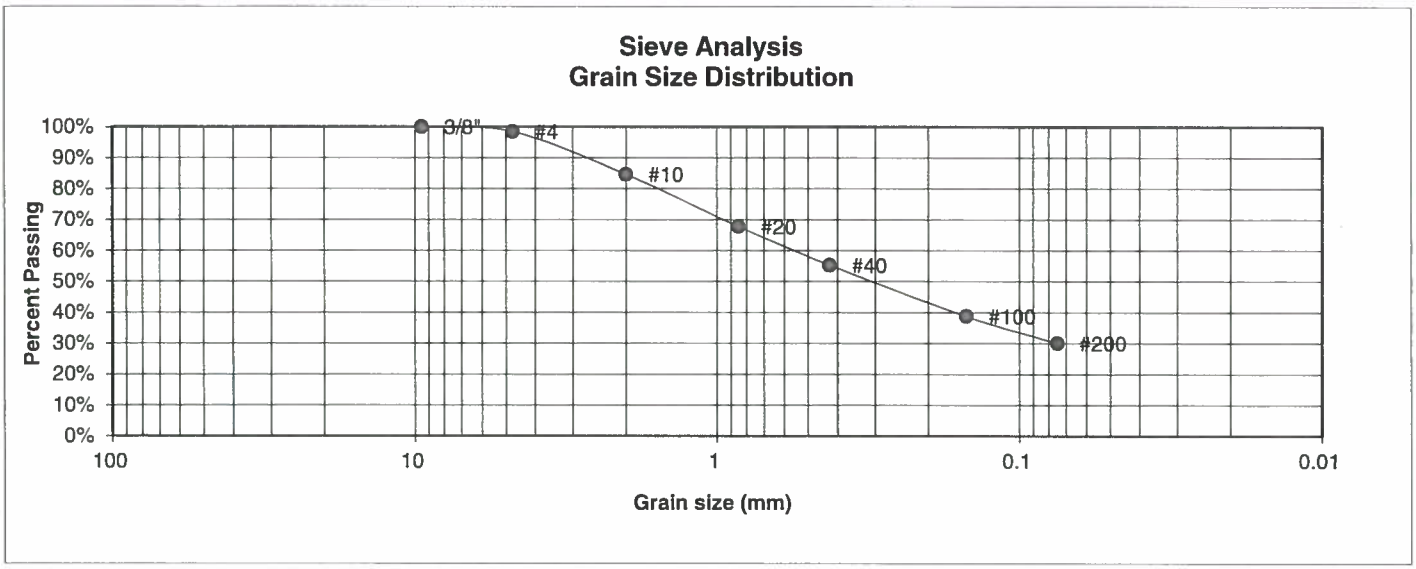
TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: A- 7

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	1	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.5%
10	84.7%
20	67.8%
40	55.3%
100	38.8%
200	30.0%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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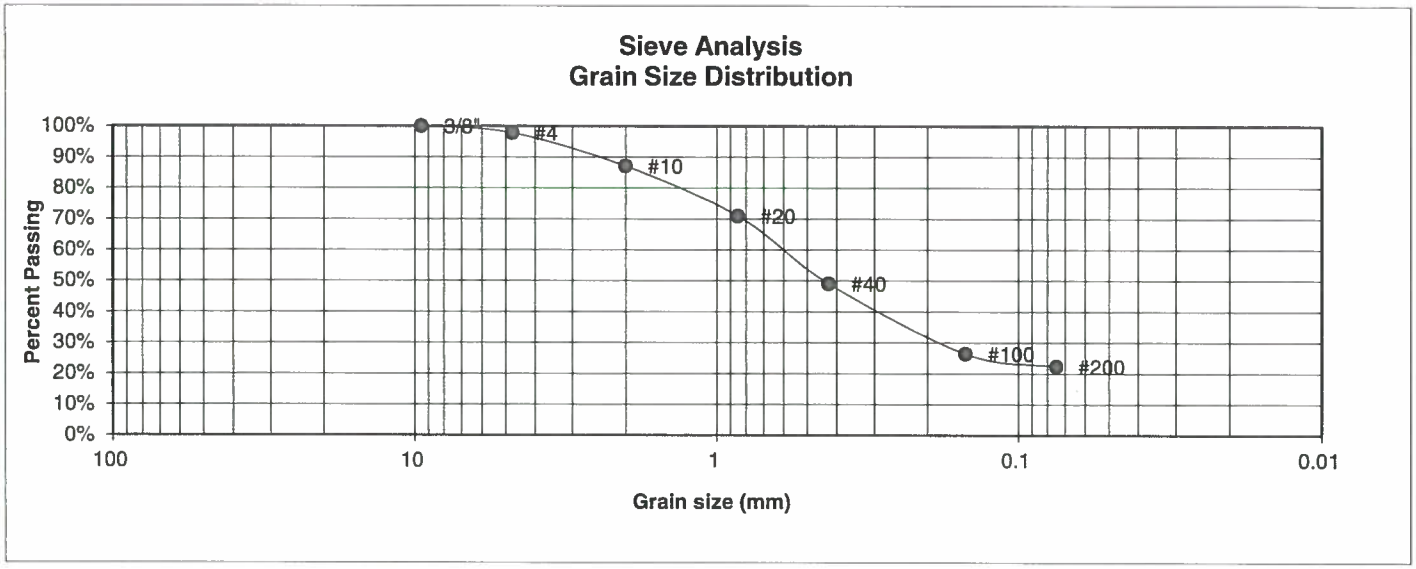
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-1

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	3	JOB NO.	171249
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.8%
10	87.1%
20	71.0%
40	49.1%
100	26.4%
200	22.3%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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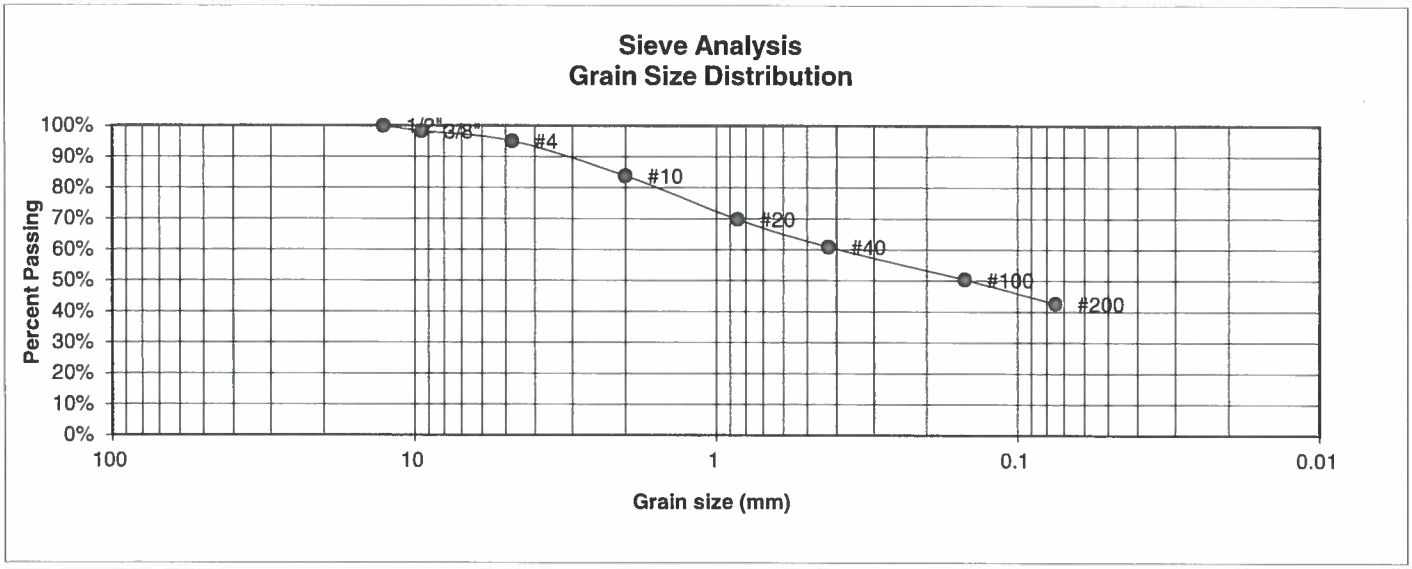
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-2

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	0-5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.3%
4	95.0%
10	83.8%
20	69.8%
40	60.9%
100	50.4%
200	42.7%

Atterberg Limits

Plastic Limit

Liquid Limit

Plastic Index

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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505 ELKTON DRIVE
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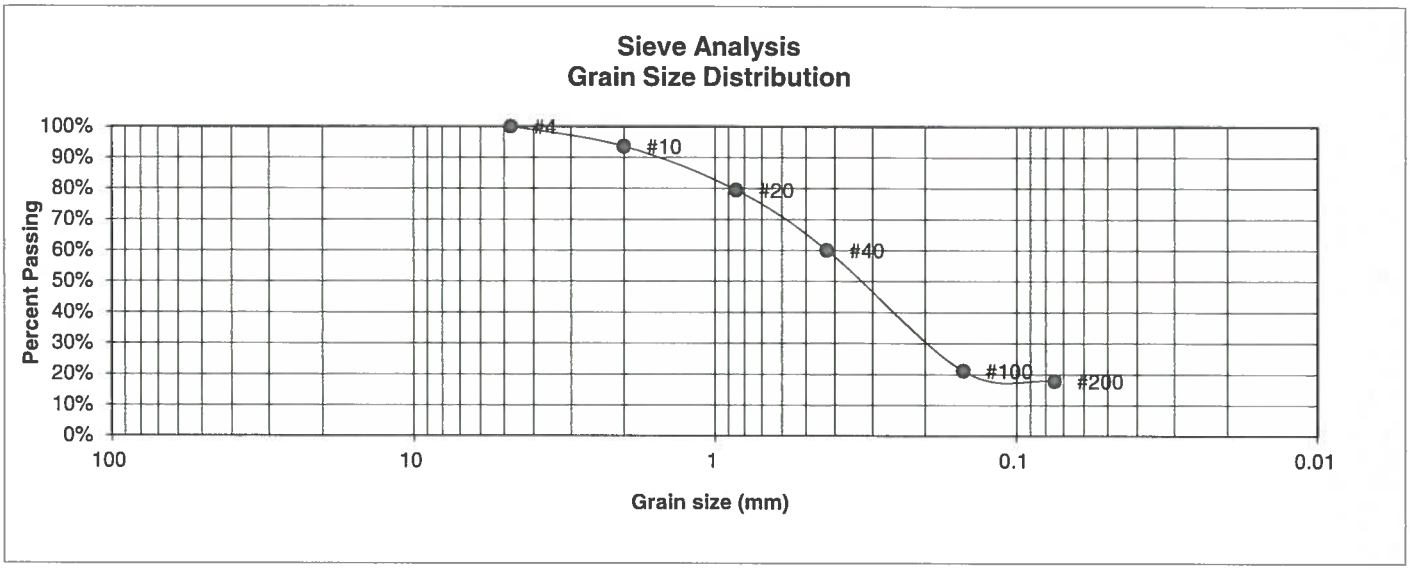
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-3

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	5	JOB NO.	171249
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	93.6%
20	79.5%
40	60.0%
100	21.1%
200	17.8%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

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LABORATORY TEST RESULTS

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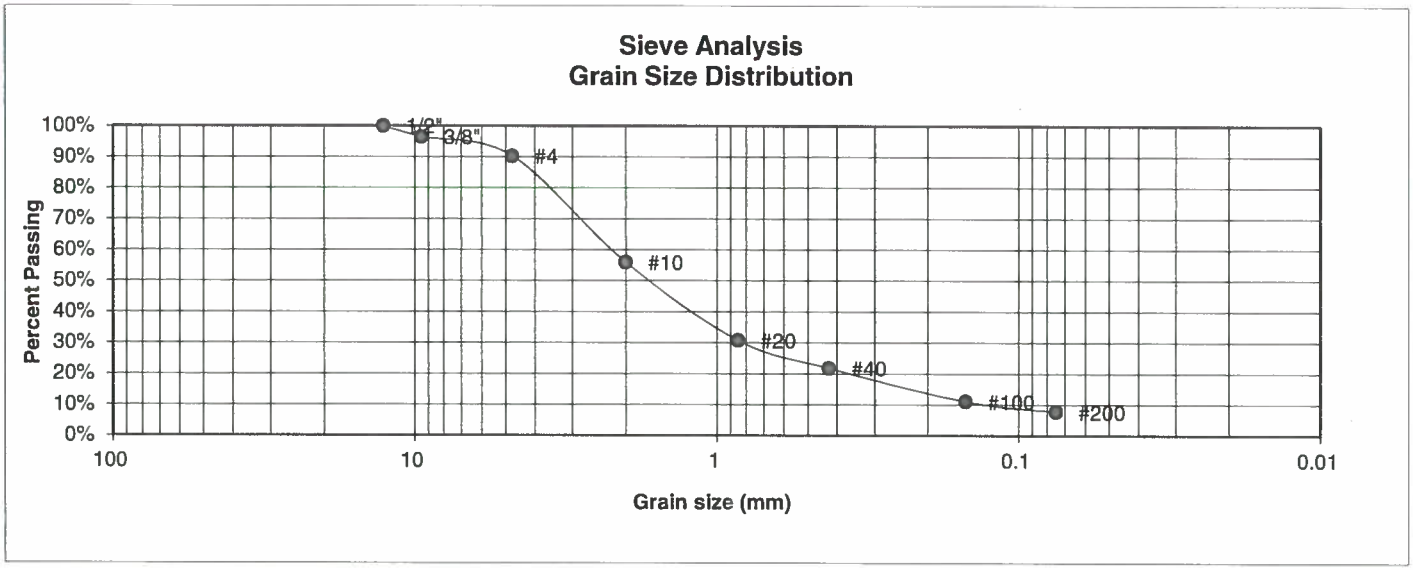
JOB NO.: 171249

FIG NO.: B-4

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	5	JOB NO.	171249
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.5%
4	90.3%
10	56.0%
20	30.8%
40	21.7%
100	11.0%
200	7.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
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LABORATORY TEST RESULTS

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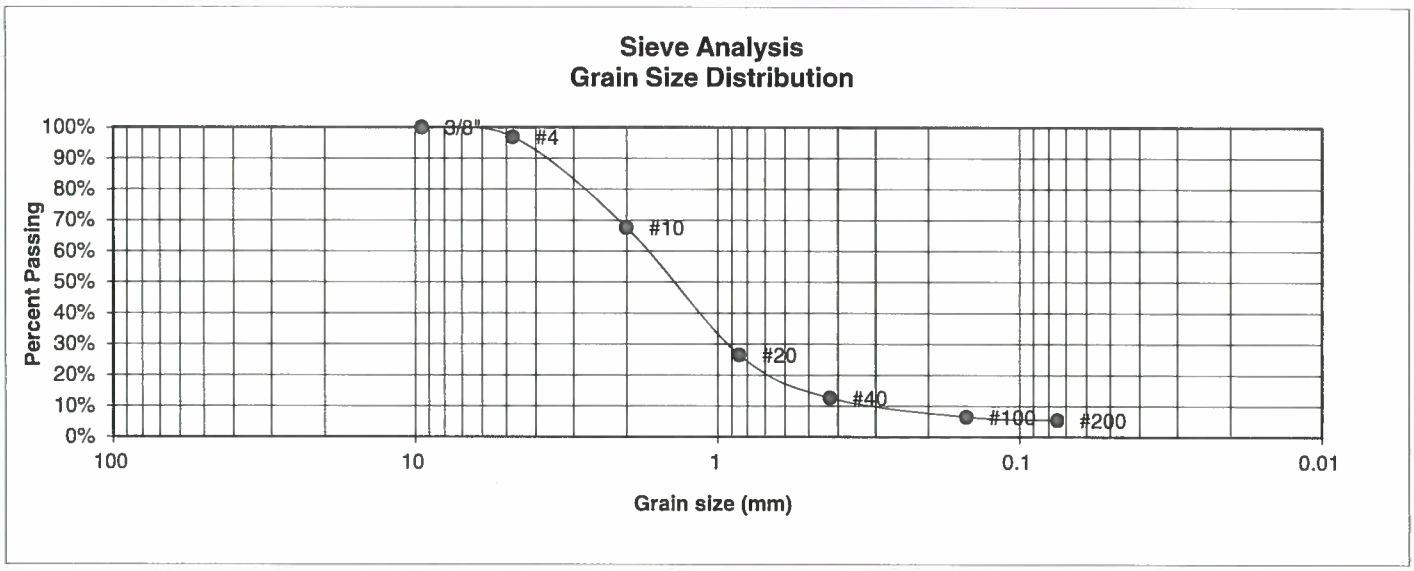
FIG NO.: B-5

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	9	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.9%
10	67.6%
20	26.5%
40	12.6%
100	6.5%
200	5.5%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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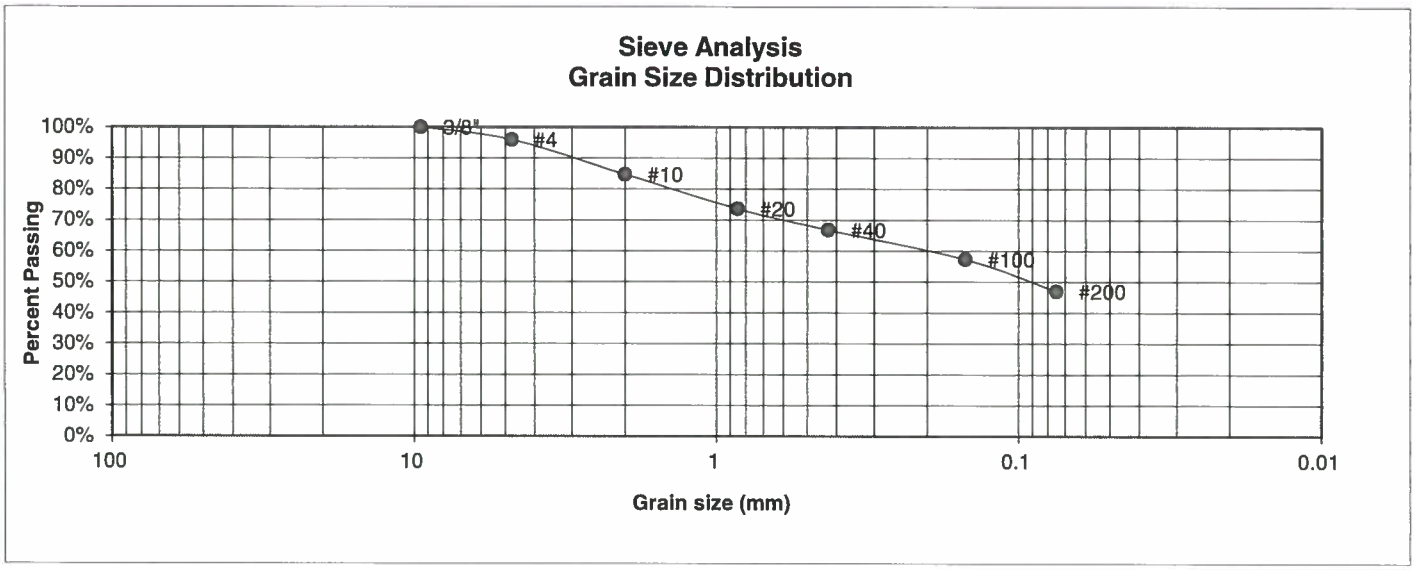
FIG NO.: B-6

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	10	JOB NO.	171249
DEPTH (FT)	2-5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.0%
10	84.7%
20	73.6%
40	66.8%
100	57.4%
200	47.0%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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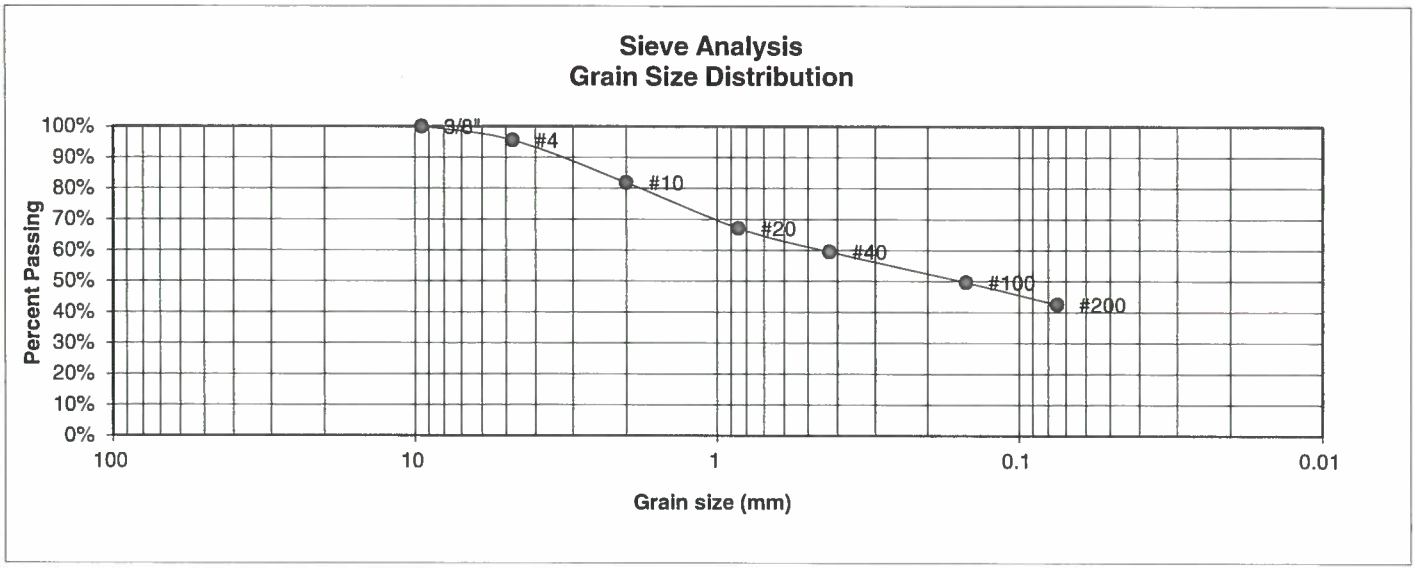
FIG NO.: B-7

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	11	JOB NO.	171249
DEPTH (FT)	0-10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.5%
10	81.8%
20	67.1%
40	59.5%
100	49.7%
200	42.5%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	32
Plastic Index	13

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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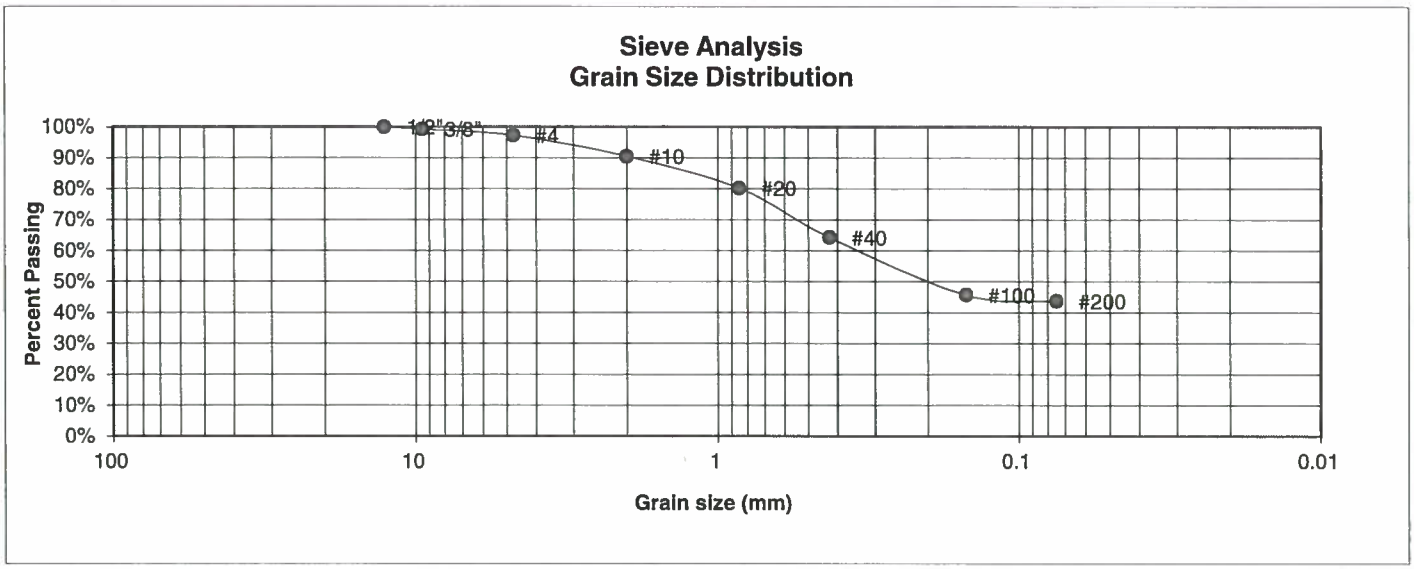
FIG NO.: B-8

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	13	JOB NO.	171249
DEPTH (FT)	0-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	99.3%
4	97.3%
10	90.5%
20	80.2%
40	64.3%
100	45.7%
200	43.7%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	29
Plastic Index	13

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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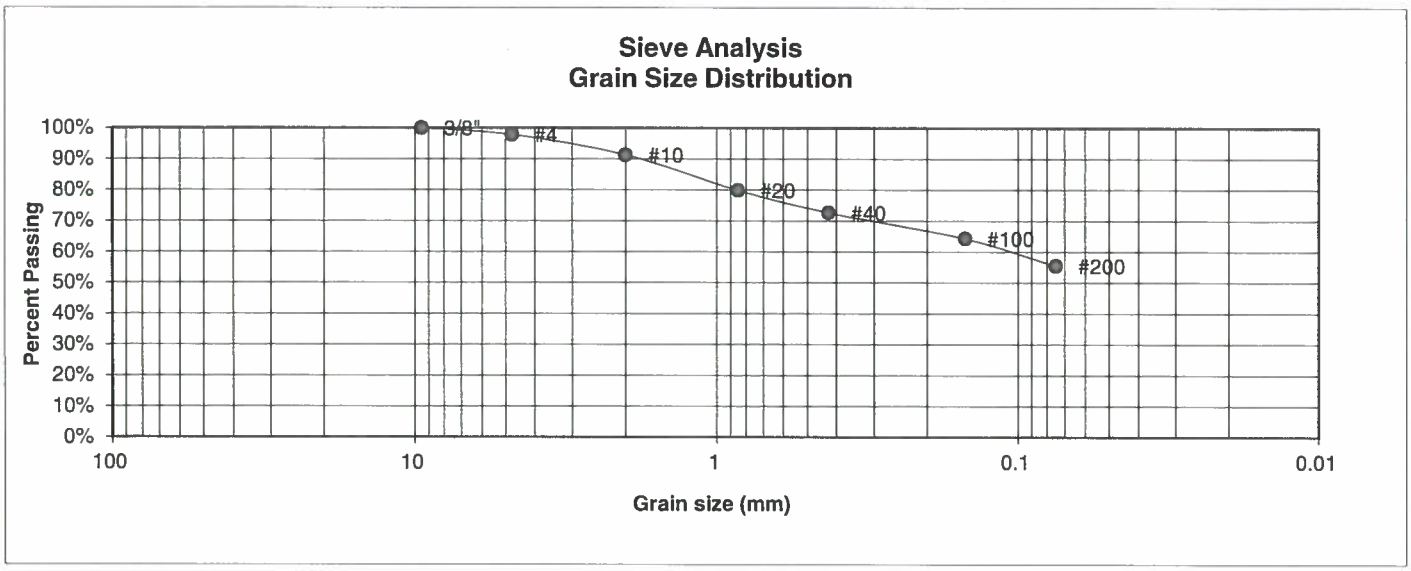
FIG NO.: B-9

UNIFIED CLASSIFICATION	CL-ML	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	2	JOB NO.	171249
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.8%
10	91.3%
20	79.9%
40	72.6%
100	64.3%
200	55.5%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	24
Plastic Index	5

Swell	
Moisture at start	10.0%
Moisture at finish	16.4%
Moisture increase	6.4%
Initial dry density (pcf)	111
Swell (psf)	150

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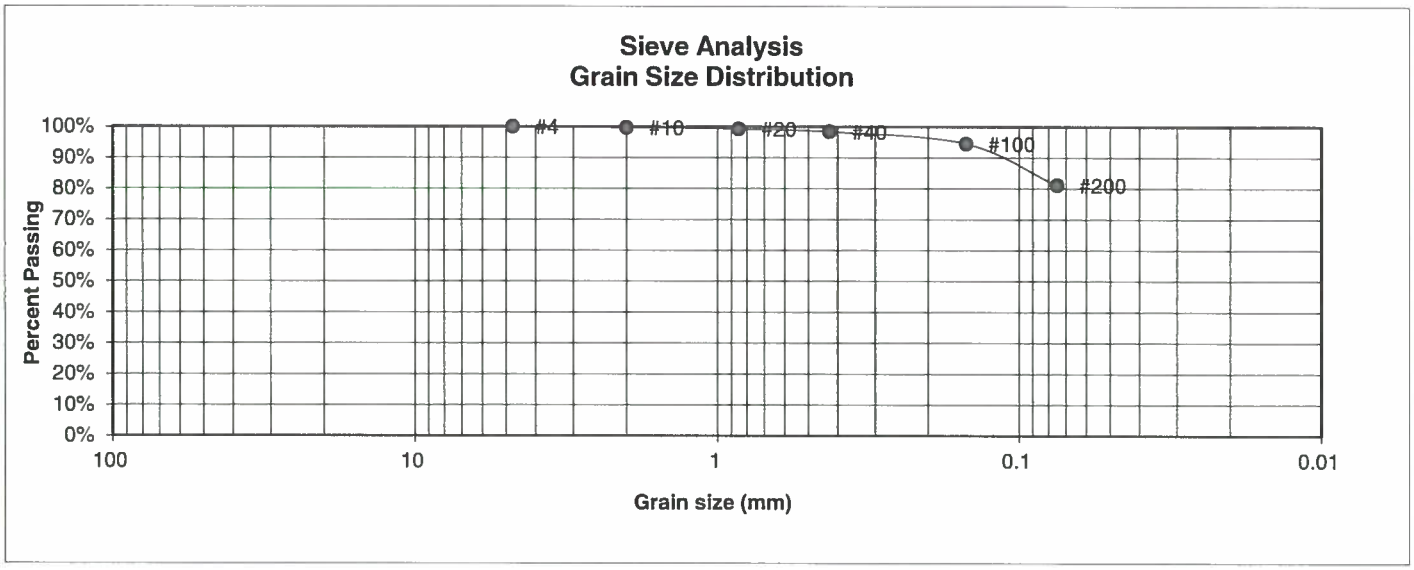
FIG NO.: B-10

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.7%
20	99.3%
40	98.4%
100	94.5%
200	81.1%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	31
Plastic Index	16

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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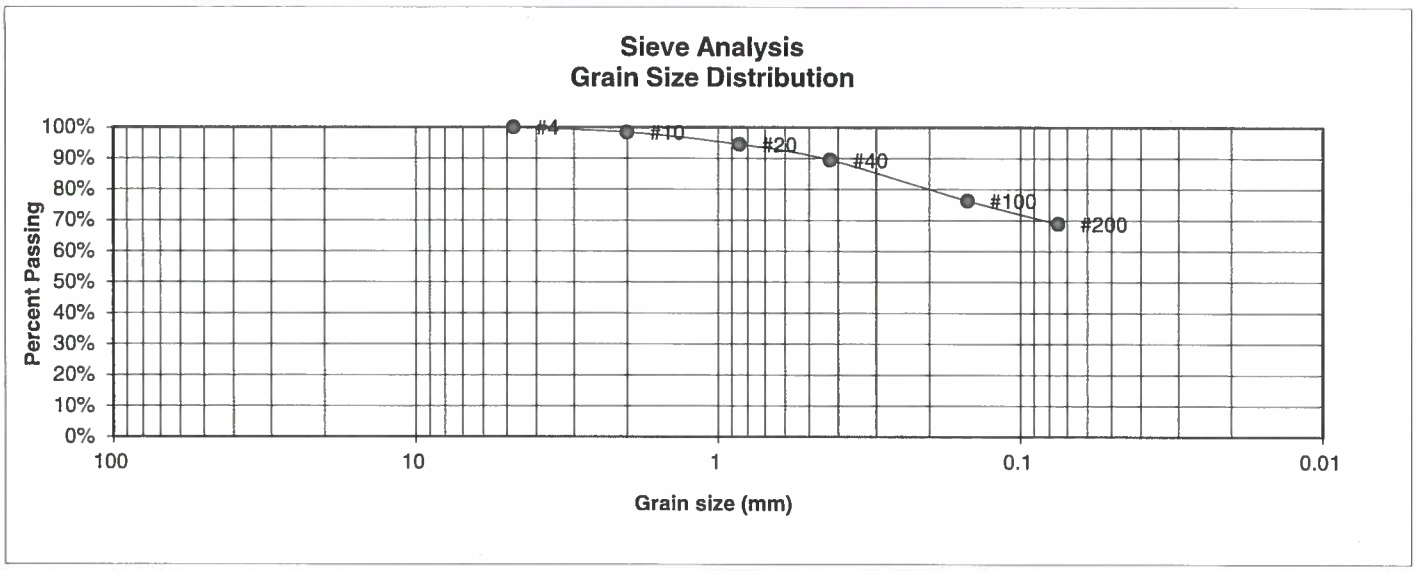
FIG NO.: B-11

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	25-30	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.4%
20	94.5%
40	89.5%
100	76.4%
200	68.9%

Atterberg Limits

Plastic Limit

Liquid Limit

Plastic Index

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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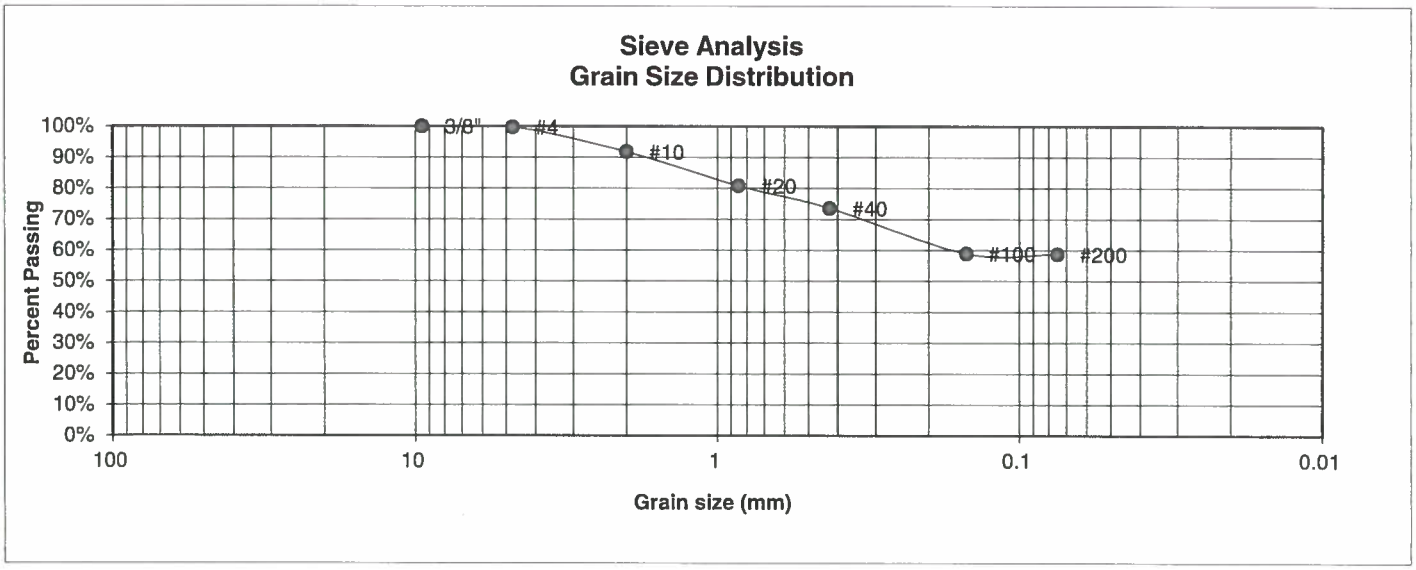
FIG NO.: B-12

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	6	JOB NO.	171249
DEPTH (FT)	5-10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.7%
10	91.8%
20	80.8%
40	73.6%
100	58.9%
200	58.8%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

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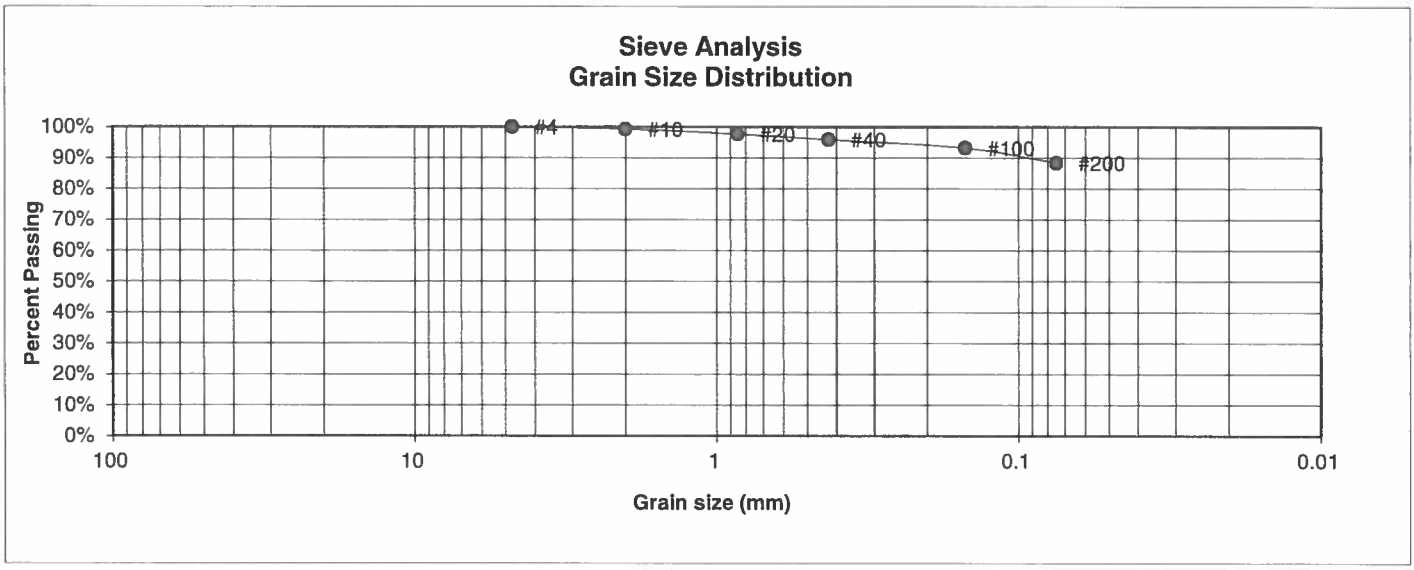
FIG NO.: B-13

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	6	JOB NO.	171249
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.3%
20	97.7%
40	95.9%
100	93.2%
200	88.4%

Atterberg Limits	
Plastic Limit	23
Liquid Limit	42
Plastic Index	19

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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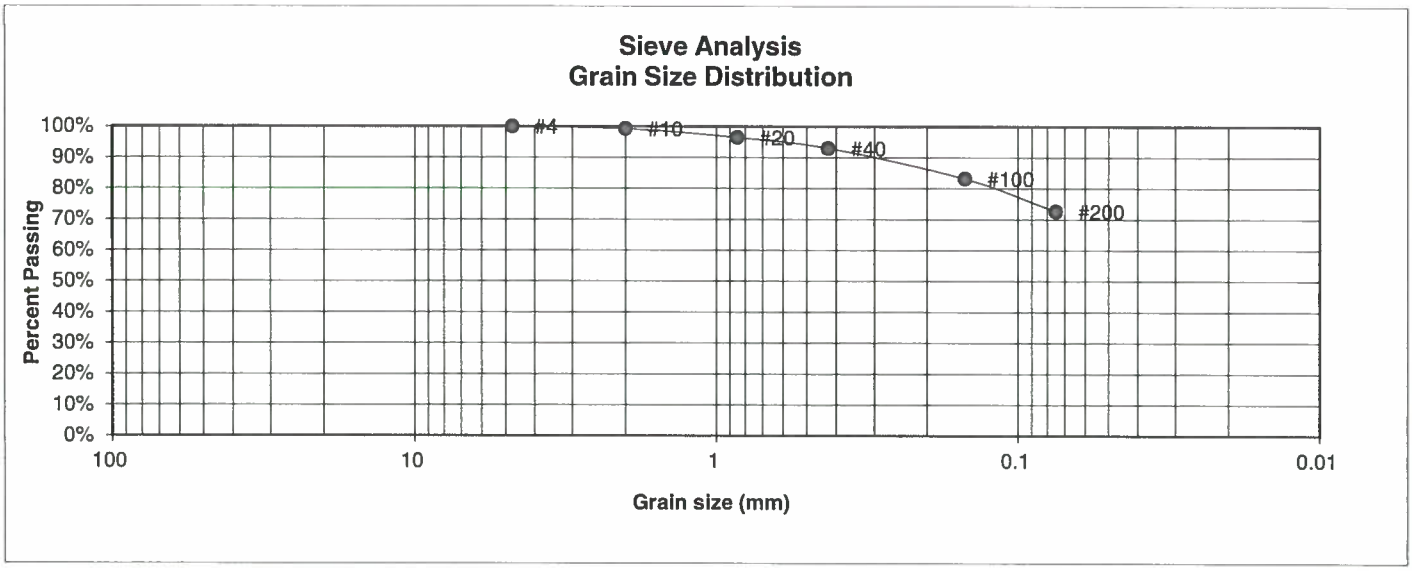
FIG NO.: B-14

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	7	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.3%
20	96.5%
40	93.0%
100	83.2%
200	72.7%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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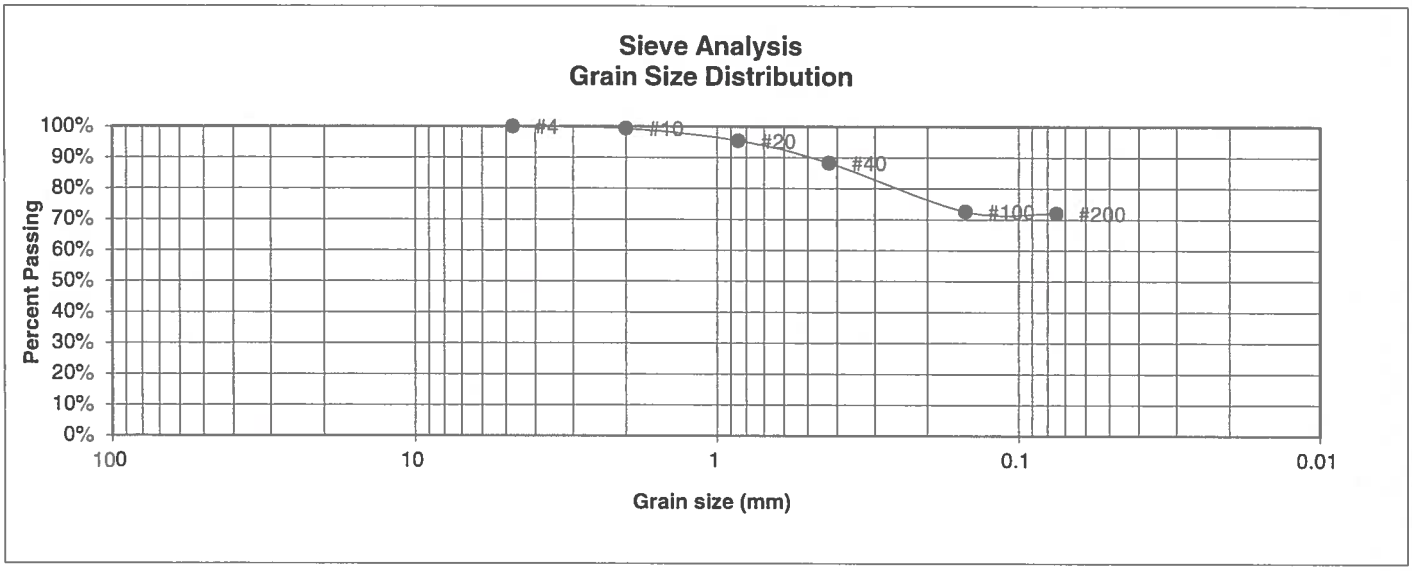
FIG NO.: B-15

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	8	JOB NO.	171249
DEPTH (FT)	0-5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.4%
20	95.4%
40	88.3%
100	72.6%
200	72.0%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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COLORADO SPRINGS, COLORADO 80907

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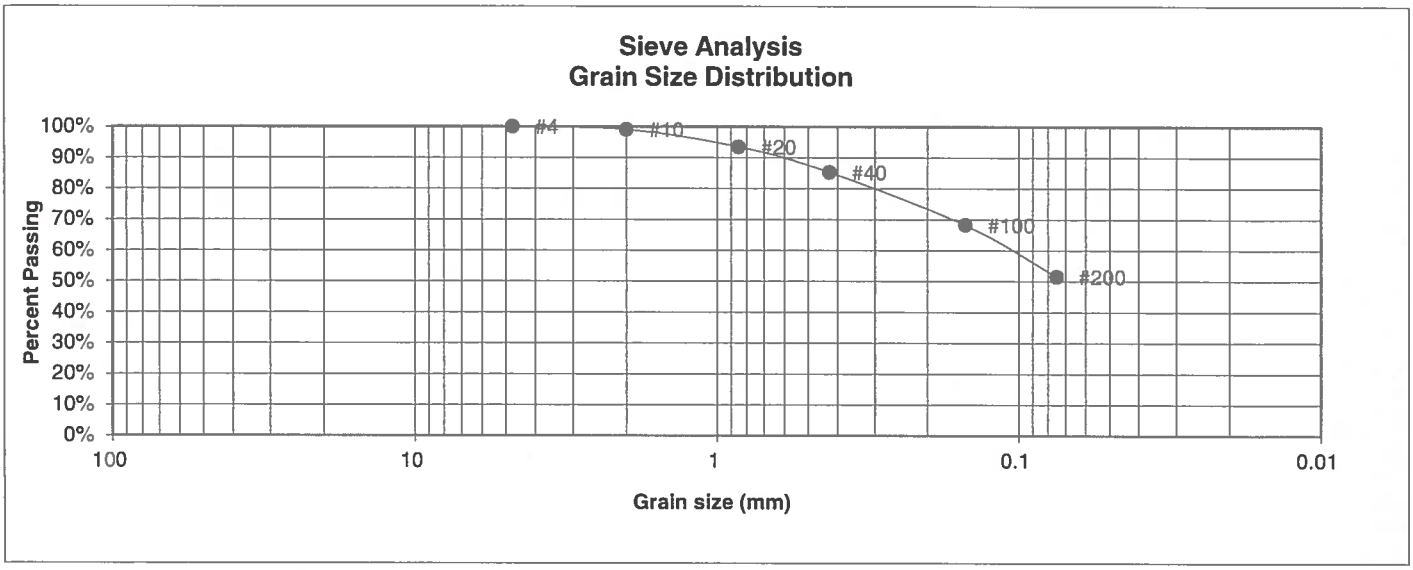
FIG NO.: B-16

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	8	JOB NO.	171249
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.1%
20	93.5%
40	85.3%
100	68.2%
200	51.6%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	26
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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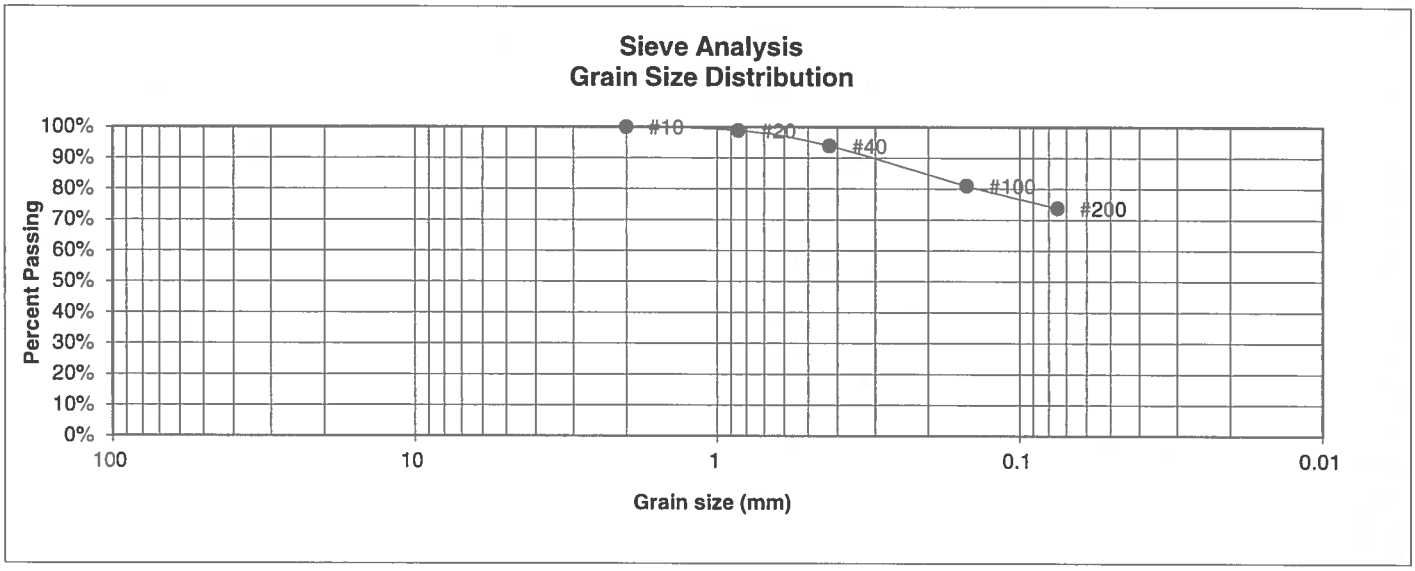
JOB NO.: 171249

FIG NO.: B-17

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	8	JOB NO.	171249
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.9%
40	93.9%
100	81.0%
200	73.8%

Atterberg Limits	
Plastic Limit	13
Liquid Limit	28
Plastic Index	15

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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COLORADO SPRINGS, COLORADO 80907

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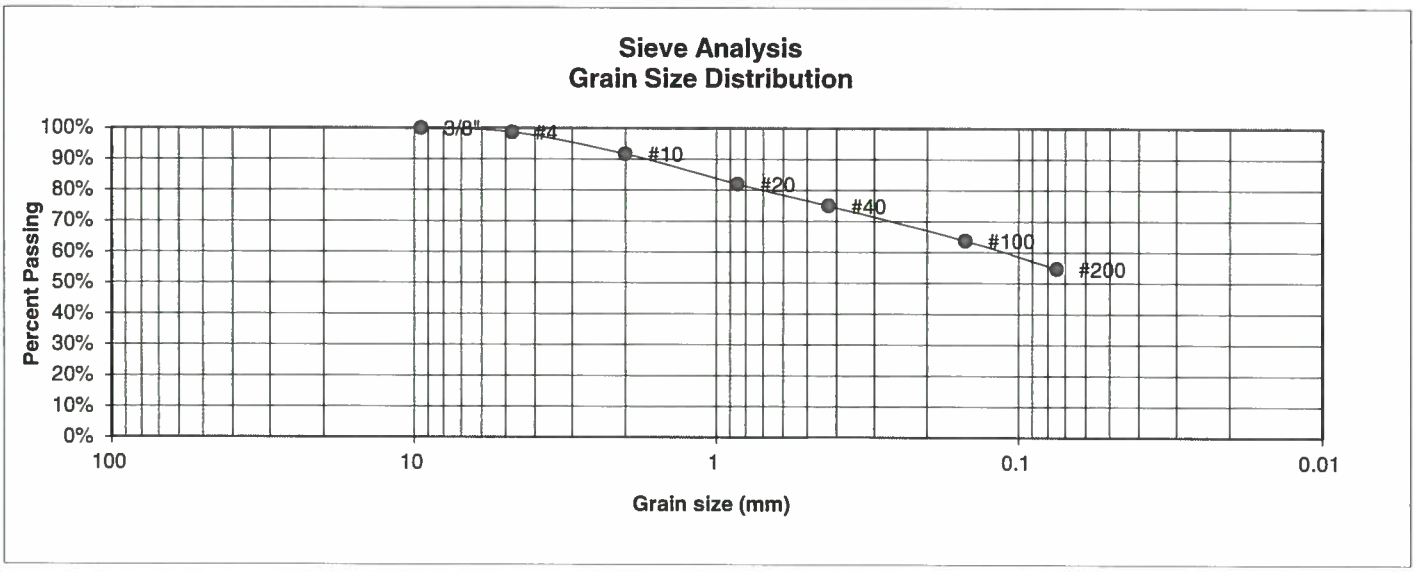
FIG NO.: B-18

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	9	JOB NO.	171249
DEPTH (FT)	1-5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.7%
10	91.7%
20	81.9%
40	75.0%
100	63.8%
200	54.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

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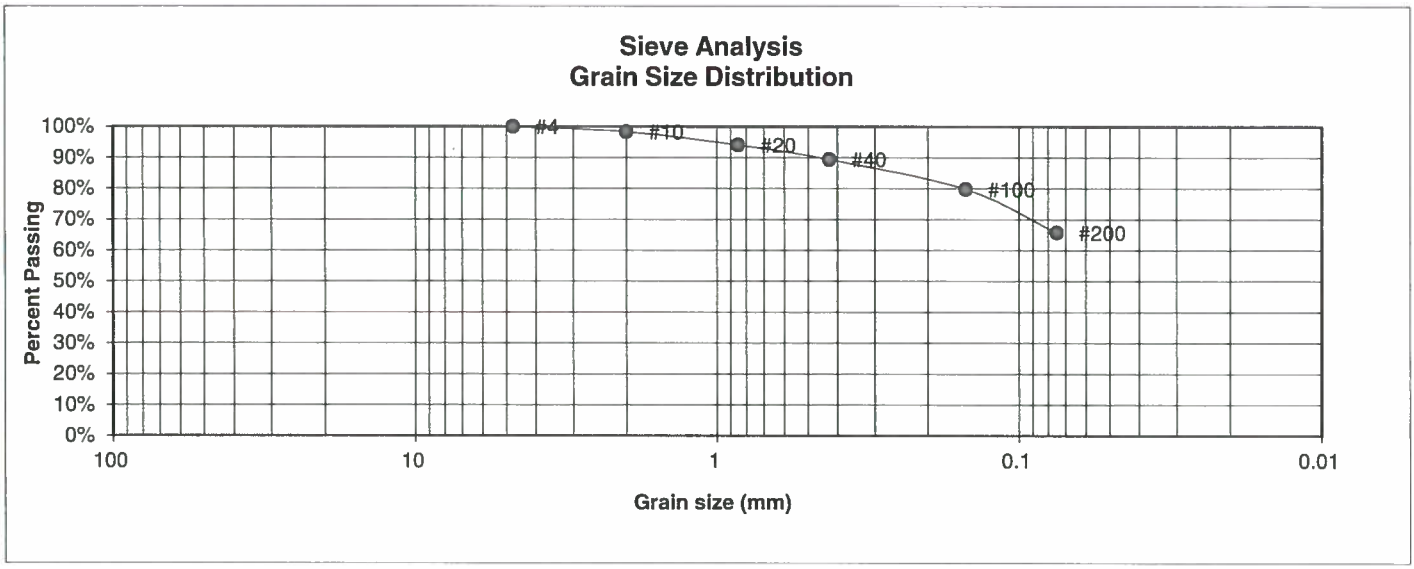
FIG NO.: B-19

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	12	JOB NO.	171249
DEPTH (FT)	1-8	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.3%
20	94.1%
40	89.4%
100	79.8%
200	65.8%

Atterberg Limits	
Plastic Limit	10
Liquid Limit	29
Plastic Index	19

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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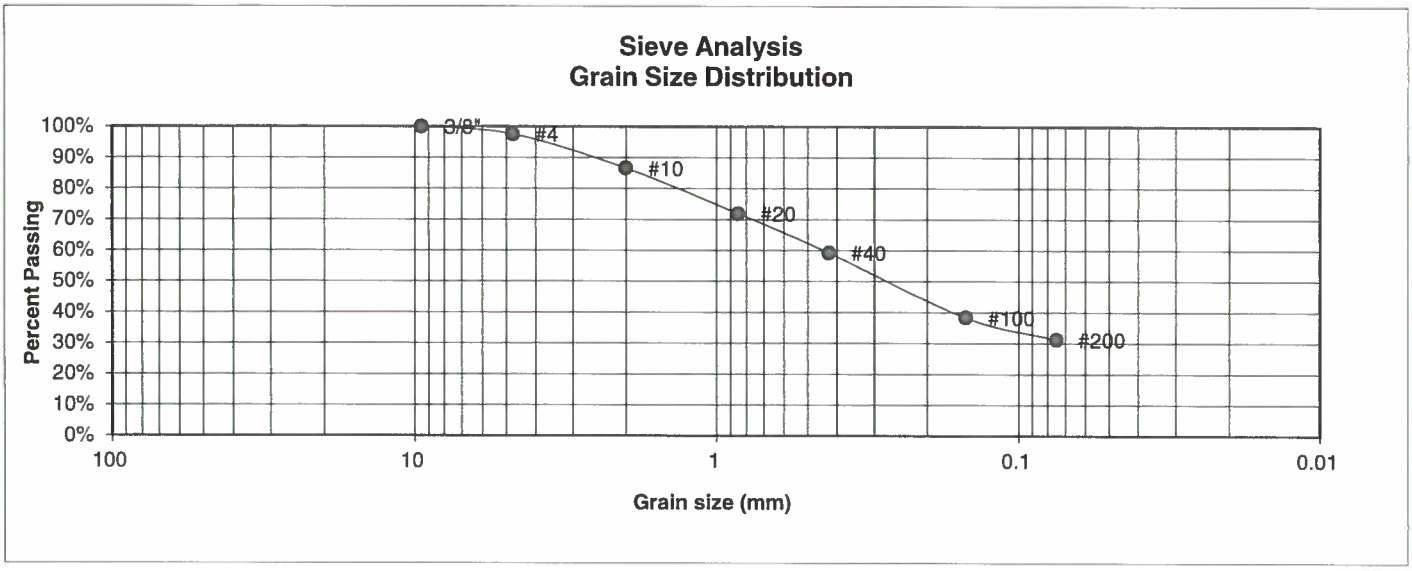
JOB NO.: 171249

FIG NO.: B-20

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	1	JOB NO.	171249
DEPTH (FT)	15-20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.6%
10	86.6%
20	71.9%
40	59.2%
100	38.3%
200	31.3%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

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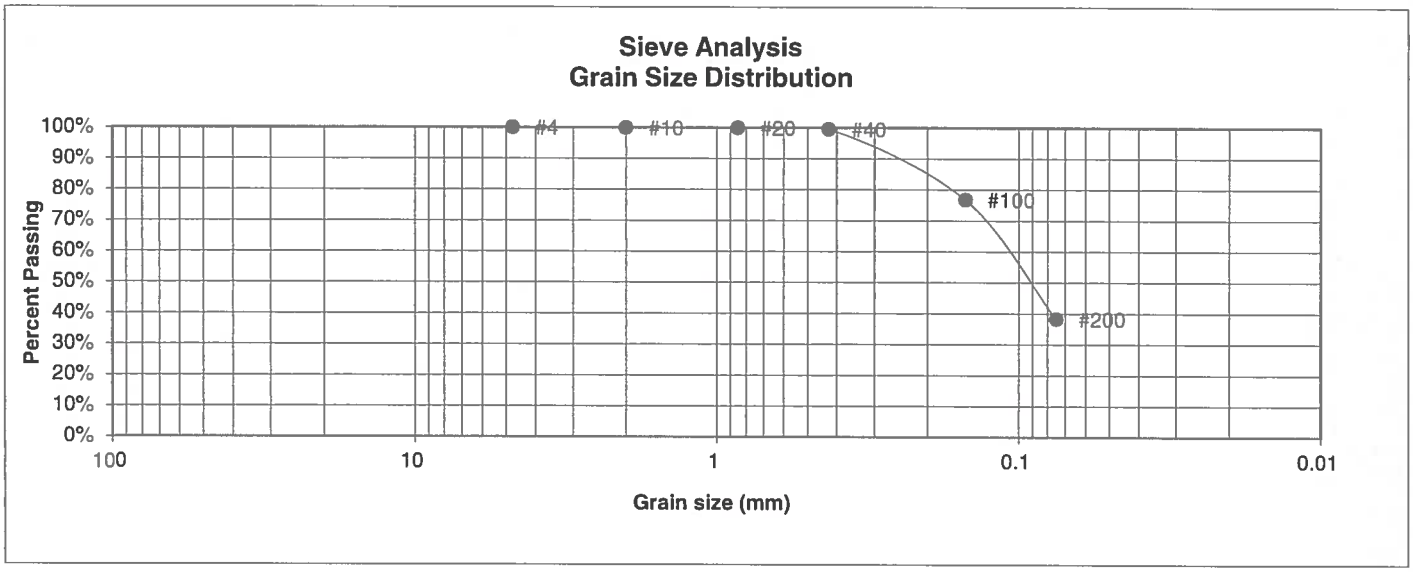
FIG NO.: B-21

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	1	JOB NO.	171249
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.9%
20	99.9%
40	99.5%
100	76.7%
200	38.2%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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LABORATORY TEST RESULTS

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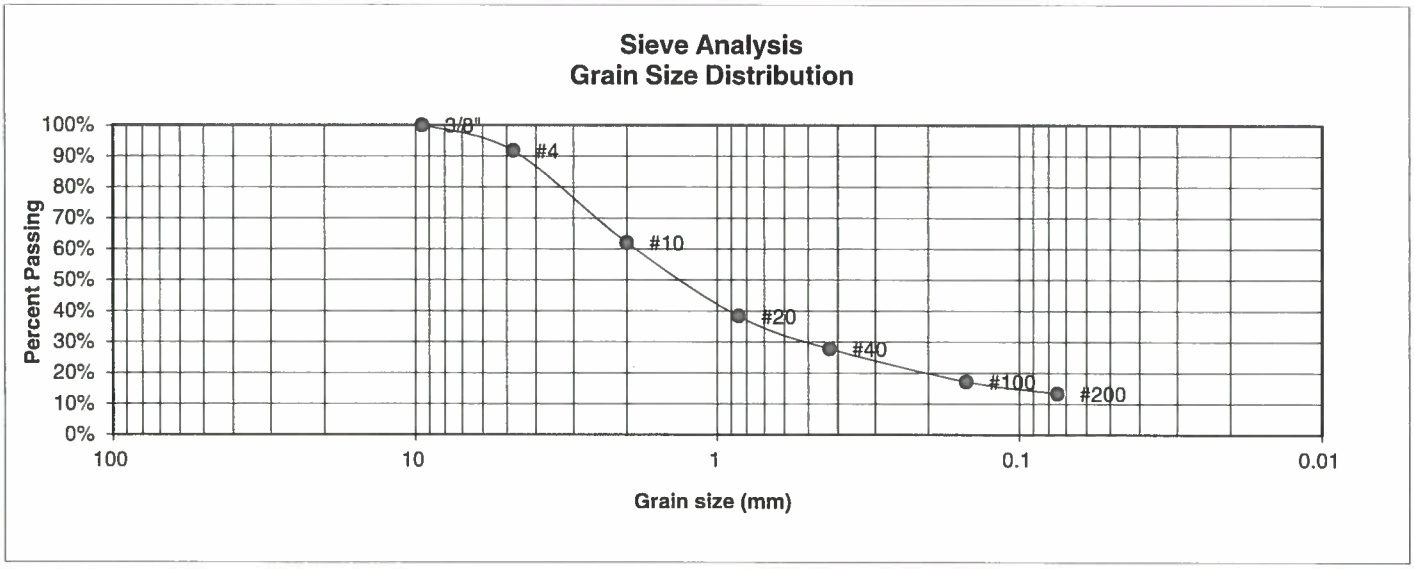
JOB NO.: 171249

FIG NO.: B-22

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	2	JOB NO.	171249
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.8%
10	62.0%
20	38.3%
40	27.8%
100	17.2%
200	13.3%

Atterberg Limits	
Plastic Limit	31
Liquid Limit	42
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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LABORATORY TEST RESULTS

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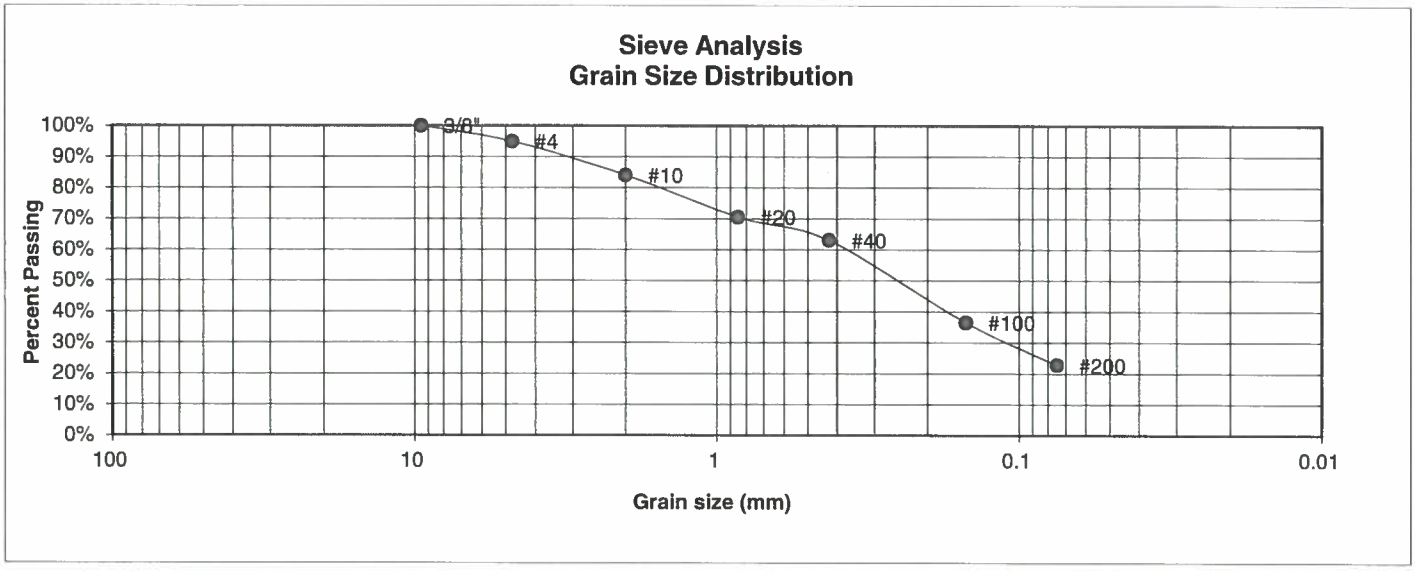
JOB NO.: 171249

FIG NO.: B-23

UNIFIED CLASSIFICATION	SC-SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.9%
10	84.1%
20	70.6%
40	63.0%
100	36.6%
200	22.8%

Atterberg Limits	
Plastic Limit	20
Liquid Limit	27
Plastic Index	7

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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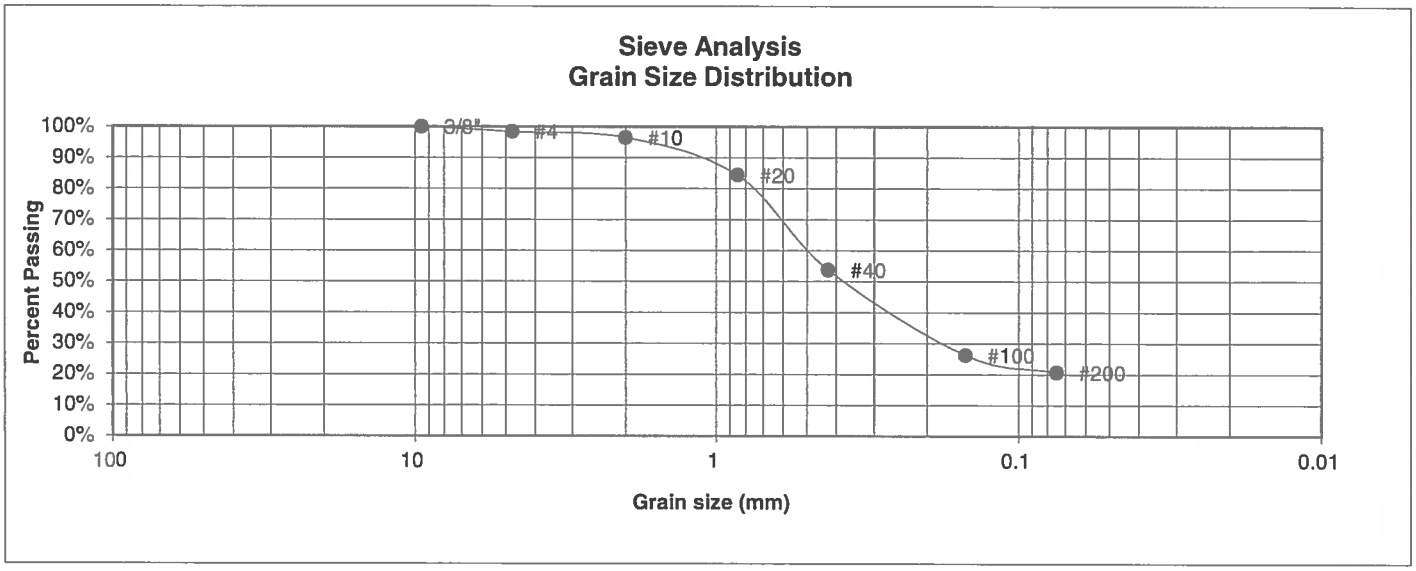
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-24

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	40	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.4%
10	96.5%
20	84.4%
40	53.7%
100	26.3%
200	20.6%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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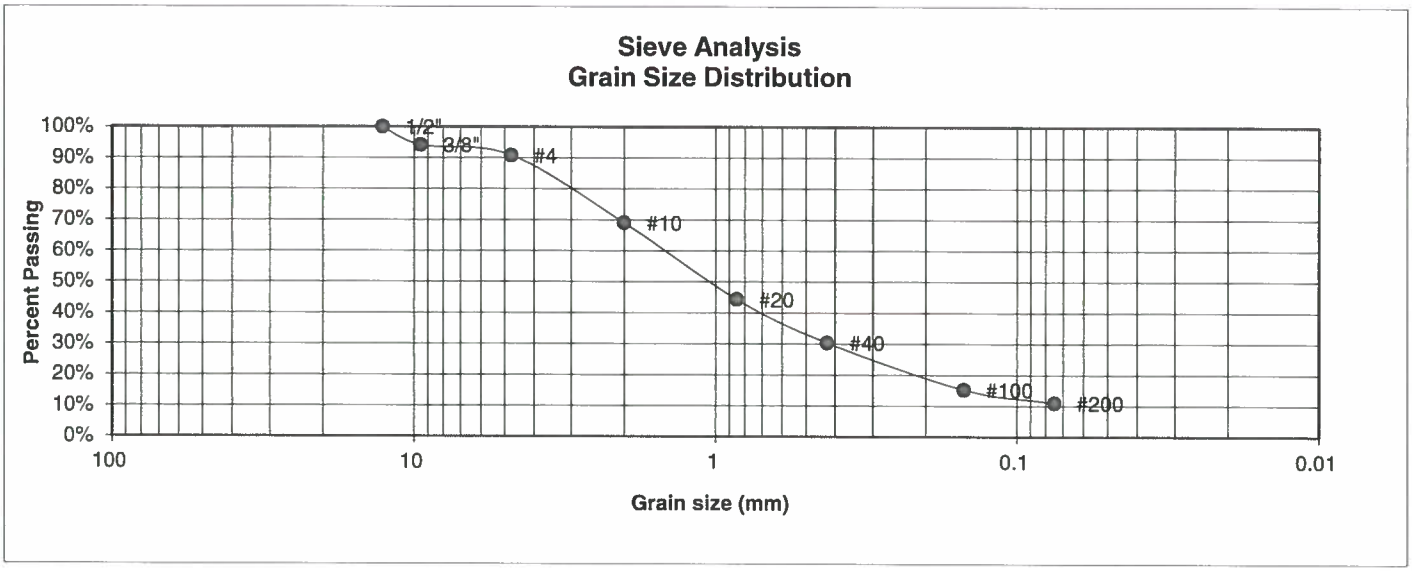
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-25

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	5	JOB NO.	171249
DEPTH (FT)	25	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	94.2%
4	90.8%
10	69.0%
20	44.3%
40	30.4%
100	15.3%
200	11.0%

Atterberg Limits

Plastic Limit

Liquid Limit

Plastic Index

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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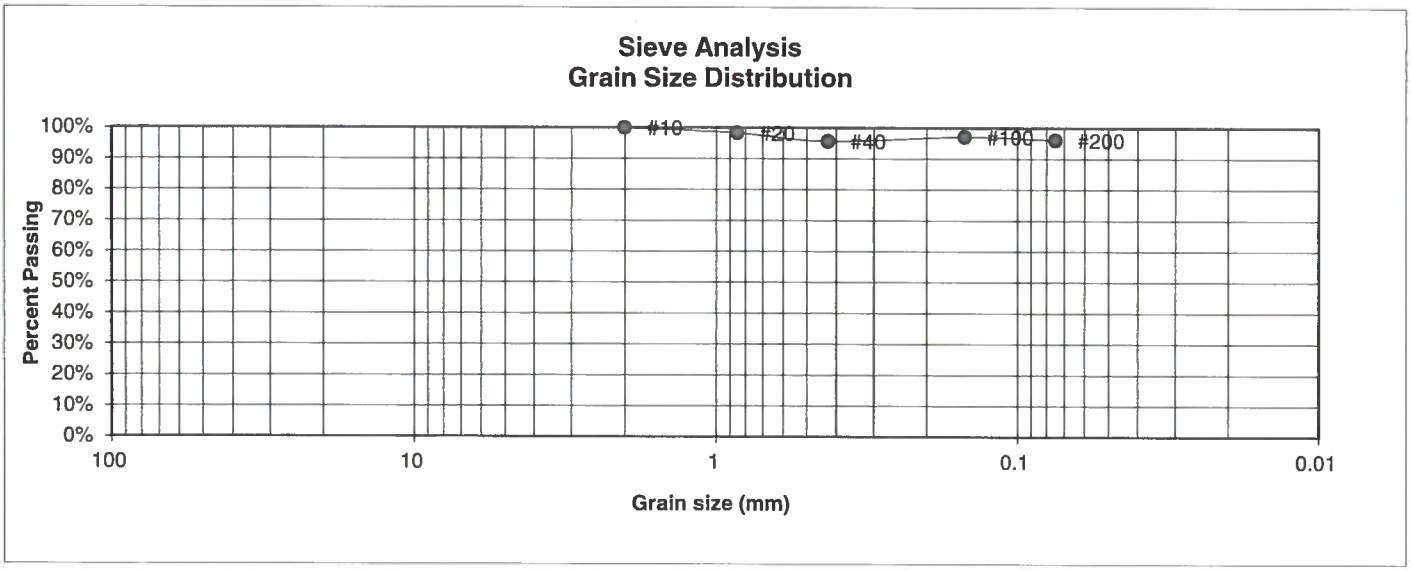
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-26

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	4	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	3	JOB NO.	171249
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.3%
40	95.7%
100	97.1%
200	96.0%

Atterberg Limits	
Plastic Limit	26
Liquid Limit	49
Plastic Index	23

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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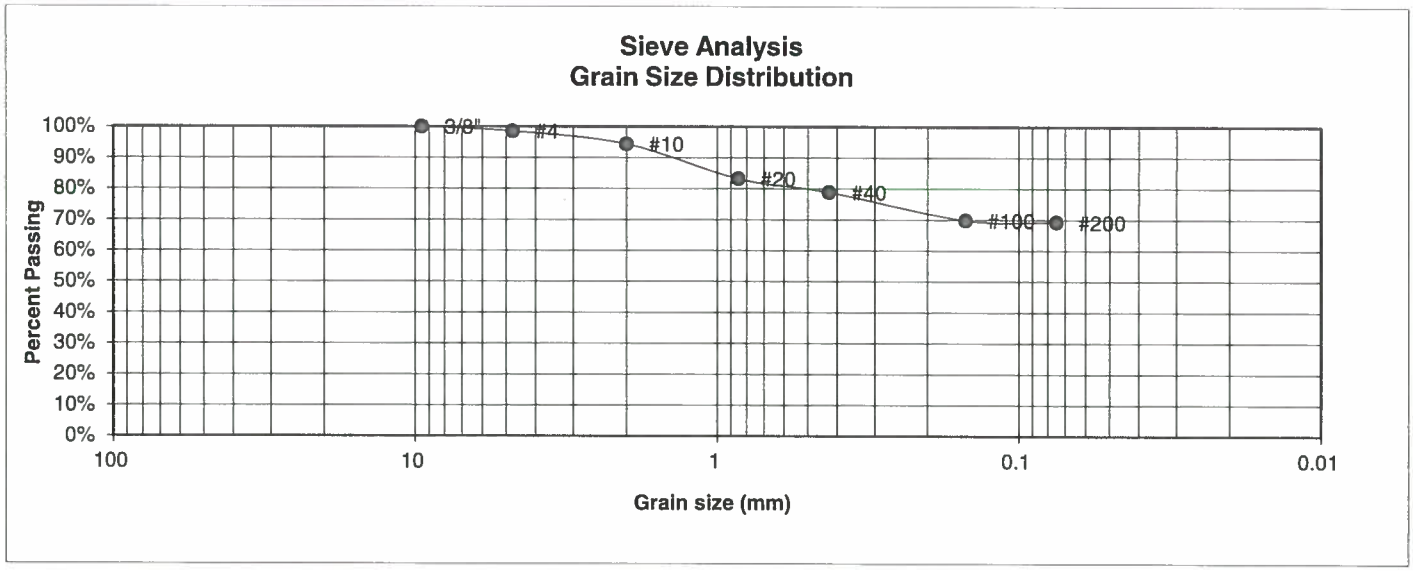
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-27

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	4	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	6	JOB NO.	171249
DEPTH (FT)	40	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.6%
10	94.4%
20	83.2%
40	78.8%
100	69.9%
200	69.3%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	37
Plastic Index	19

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

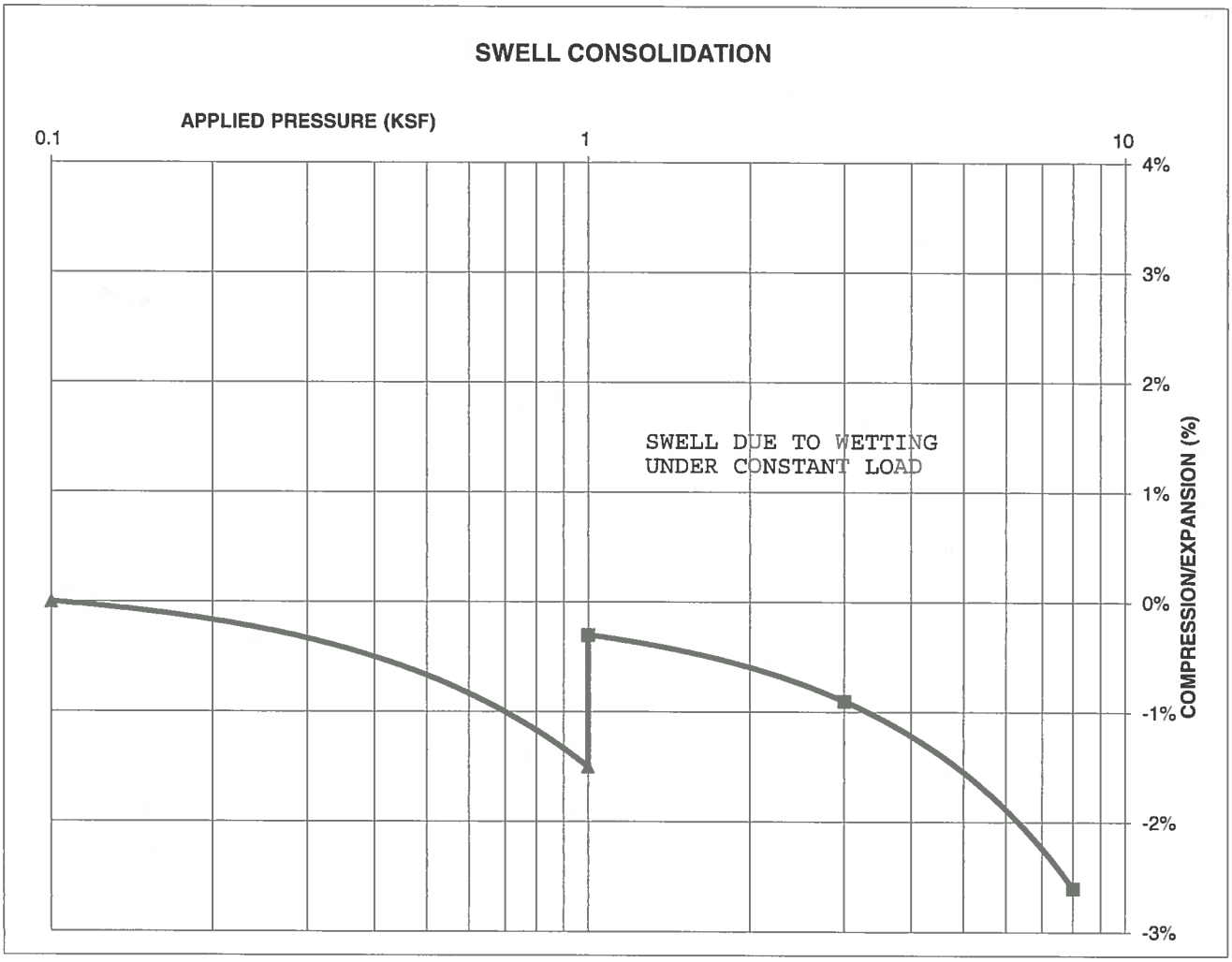
JOB NO.: 171249

FIG NO.: B-28

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	10
DESCRIPTION	CL	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			108
NATURAL MOISTURE CONTENT			17.3%
SWELL/CONSOLIDATION (%)			1.2%

JOB NO. 171249
CLIENT PULPIT ROCK, LLC
PROJECT FLYING HORSE NORTH, DAM



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SWELL CONSOLIDATION
TEST RESULTS

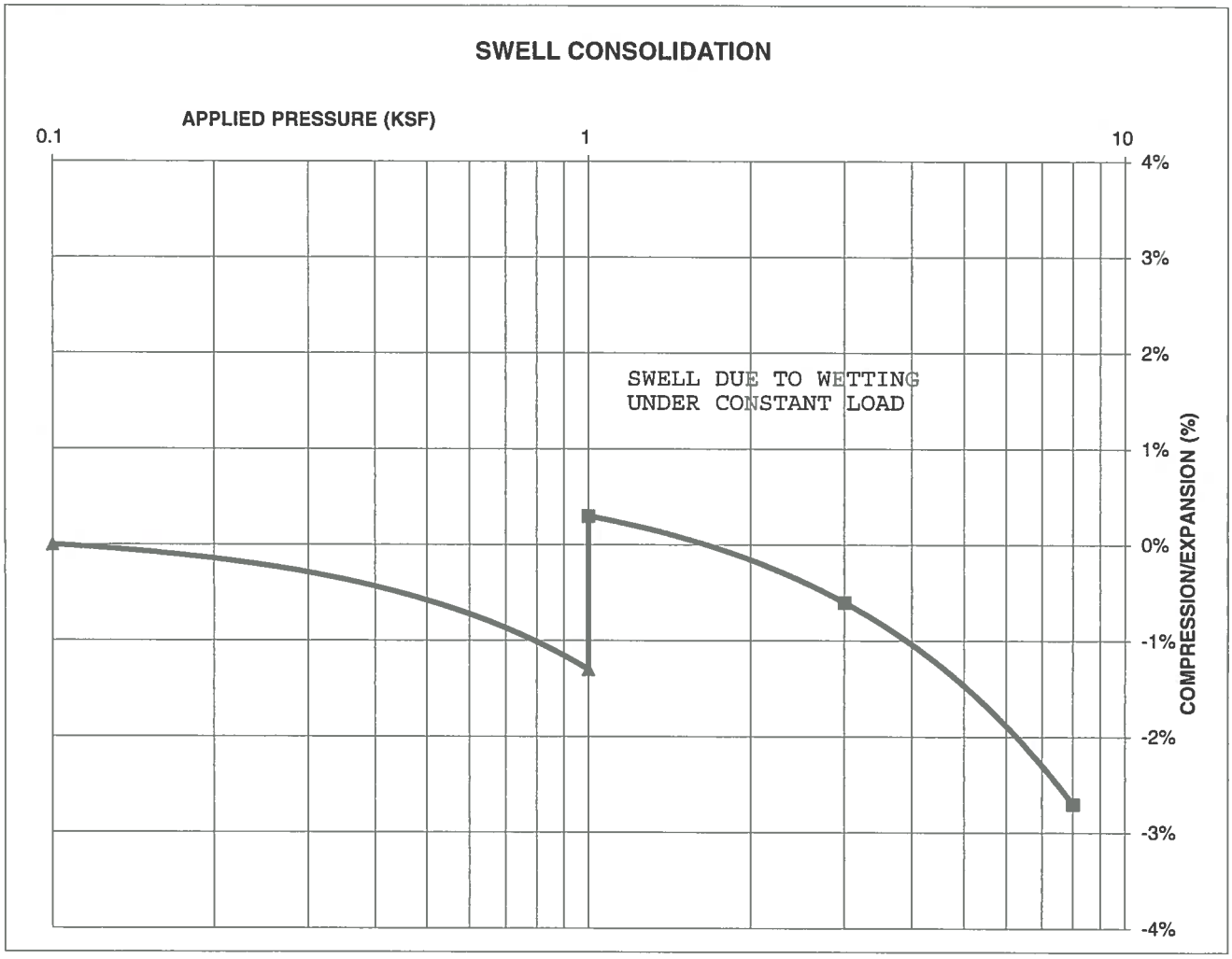
DRAWN:	DATE:	CHECKED: SCC	DATE: 8/16/17

JOB NO.: 171249
FIG NO.: B-29

CONSOLIDATION TEST RESULTS

TEST BORING #	3	DEPTH(ft)	15
DESCRIPTION	CL	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			16.8%
SWELL/CONSOLIDATION (%)			1.6%

JOB NO. 171249
CLIENT PULPIT ROCK, LLC
PROJECT FLYING HORSE NORTH, DAM



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SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DCE	11/16/17

JOB NO.: 171249
FIG NO.: B-30

APPENDIX C: Additional Laboratory Test Results

CLIENT	PULPIT ROCK, LLC	JOB NO.	171249
PROJECT	FLYING HORSE NORTH, DAM	DATE	9/8/2017
LOCATION	FLYING HORSE NORTH, DAM	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	2-3	1	SM	0.02
TB-1	20	3	SC	<0.01
TB-2	20	3	SM	0.02
TB-3	15	4	CL	<0.01
TB-5	15	1	SM-SW	<0.01
TB-7	2-3	2	CL	<0.01
TB-8	15	2	CL	<0.01
TB-3	5	1	SM	<0.01
TB-13	0-3	1	SC	<0.01

QC BLANK PASS

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LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-1

JOB # 171249

CLIENT PULPIT ROCK, LLC

PROJECT FLYING HORSE NORTH, DAM

LOCATION FLYING HORSE NORTH, DAM

DATE 9/8/2017

BY BL

SAMPLE LOCATION	UNIFIED CLASS.	RESISTIVITY, (ohm-cm)	pH
TB-1 @ 2-3'	SM	14706	6.0
TB-5 @ 15'	SM-SW	>20000	6.1
TB-2 @ 20'	CL-ML	>20000	5.9
TB-3 @ 15'	CL	>20000	5.8
TB-1 @ 20'	SC	>20000	6.1
TB-7 @ 2-3'	CL	17857	5.9
TB-13 @ 0-3'	SC	16129	5.9

NOTES: All analysis QC checks passed

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pH & RESISTIVITY REPORT

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-2

PERMEABILITY WORKSHEET

CLIENT	PULPIT ROCK, LLC	PROCTOR % MC	13.50%	JOB #	171249
PROJECT	FLYING HORSE NORTH, DAM	PROCTOR DENSITY	115.5	DATE	10/06/17
LOCATION	TB-6 @ 5-10'	TARGET COMPACTION	95%	TEST BY	BL

INITIAL SAMPLE + MOLD	7104		AREA OF SAMPLE	81.07	cm²	DISH WT.	266.24	FINAL % MC	19.8%
MOLD WT.	5400		HT. OF SAMPLE	10.45	cm	DISH + WET	384.24	WHOLE SAMPLE	
INITIAL SAMPLE WT.	1704		VOL. OF SAMPLE	847	cm³	DISH + DRY	364.71		
INITIAL SAMPLE % MC	13.50%		AREA OF TUBING	0.7	cm²	DISH WT.	261.32	FINAL % MC	23.2%
INIT. SAMPLE DENSITY	110.67	Dry (PCF)	FINAL SAMPLE+MOLD			DISH + WET	299.23	BOTTOM 1"	
INITIAL % COMPACTION	95.8		FINAL SAMPLE % MC	19.8%		DISH + DRY	292.10		

FALLING HEAD DATA

STARTING				ENDING					cc	cc	TEMP		
DATE	TIME	HEIGHT	CATCH	DATE	TIME	HEIGHT	CATCH	SECONDS	OUTFLOW	INFLOW	°C	k_T	k_{20}
10/6	1214	523	0.00	10/6	1314	518	0.00	3600	0.0	3.5	21	2.41E-07	2.42E-07
10/6	1314	518	0.00	10/6	1357	511	0.00	1548	0.0	4.9	21	7.93E-07	7.97E-07
10/6	1357	511	0.00	10/6	1600	496	2.00	8748	2.0	10.5	21	3.07E-07	3.09E-07
10/6	1600	496	2.00	10/7	1100	454	6.00	68400	4.0	29.4	21	1.17E-07	1.17E-07
10/7	1100	454	6.00	10/9	800	342	12.00	162000	6.0	78.4	21	1.58E-07	1.59E-07
10/9	800	342	12.00	10/9	1100	336	13.00	10800	1.0	4.2	21	1.48E-07	1.49E-07

Calculations based on:
Bowles, Joseph E.; "Physical and Geotechnical Properties of Soils," 2nd Edition, 1984

C-3

PERMEABILITY WORKSHEET

CLIENT	PULPIT ROCK, LLC	PROCTOR % MC	13.50%	JOB #	171249
PROJECT	FLYING HORSE NORTH, DAM	PROCTOR DENSITY	116.6	DATE	11/10/17
LOCATION	TB-13 @ 0-3'	TARGET COMPACTION	95%	TEST BY	BL

INITIAL SAMPLE + MOLD	7123		AREA OF SAMPLE	81.07	cm^2	DISH WT.	261.36	FINAL % MC	14.7%
MOLD WT.	5400		HT. OF SAMPLE	10.45	cm	DISH + WET	322.45	WHOLE SAMPLE	
INITIAL SAMPLE WT.	1723		VOL. OF SAMPLE	847	cm^3	DISH + DRY	314.63		
INITIAL SAMPLE % MC	13.50%		AREA OF TUBING	0.7	cm^2	DISH WT.	266.45	FINAL % MC	22.6%
INIT. SAMPLE DENSITY	111.90	Dry (PCF)	FINAL SAMPLE+MOLD			DISH + WET	313.96	BOTTOM 1"	
INITIAL % COMPACTION	96.0		FINAL SAMPLE % MC	14.7%		DISH + DRY	305.21		

FALLING HEAD DATA

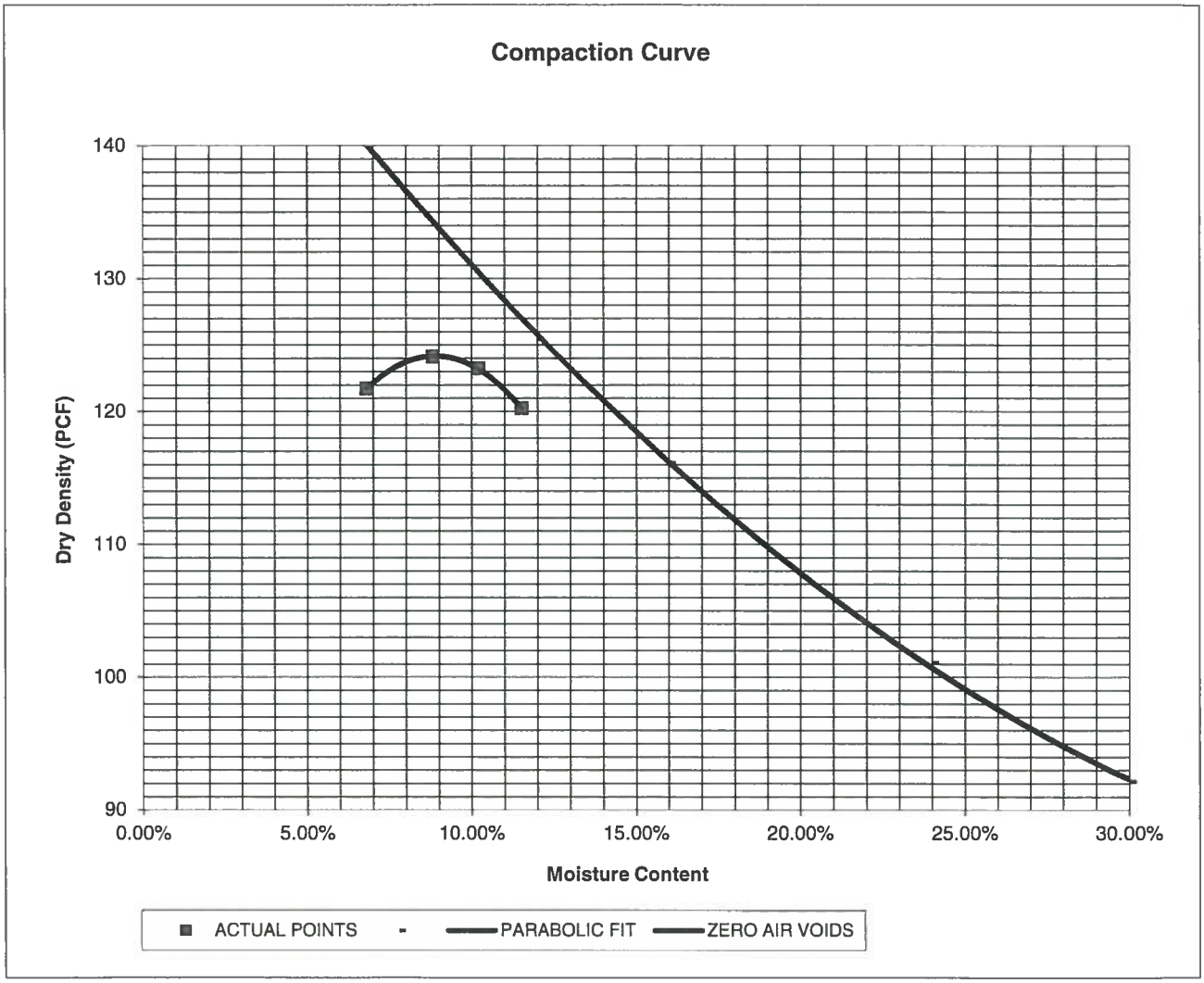
STARTING				ENDING									
DATE	TIME	HEIGHT	CATCH	DATE	TIME	HEIGHT	CATCH	SECONDS	cc OUTFLOW	cc INFLOW	TEMP °C	k_T	k_{20}
11/3	1425	527	0.00	11/3	1447	508	0.00	792	0.0	13.3	21	4.18E-06	4.22E-06
11/3	1447	508	0.00	11/3	1555	492	0.00	3888	0.0	11.2	21	7.43E-07	7.49E-07
11/3	1555	492	0.00	11/4	845	431	0.00	60840	0.0	42.7	21	1.96E-07	1.98E-07
11/4	845	431	0.00	11/6	805	223	0.00	171360	0.0	145.6	21	3.47E-07	3.5E-07
11/6	815	519	0.00	11/6	1130	506	2.00	11340	2.0	9.1	21	2.02E-07	2.03E-07
11/6	1130	506	2.00	11/6	1600	498	5.00	16920	3.0	5.6	22	8.5E-08	8.32E-08
11/6	1600	498	5.00	11/7	805	472	11.00	57780	6.0	18.2	23	8.37E-08	7.96E-08
11/7	805	472	11.00	11/7	1100	466	19.00	10620	8.0	4.2	24	1.09E-07	1E-07
11/7	1100	466	19.00	11/7	1300	452	36.00	7200	17.0	9.8	25	3.82E-07	3.41E-07

Calculations based on:
Bowles, Joseph E.; "Physical and Geotechnical Properties of Soils," 2nd Edition, 1984

C-4

PROJECT	FLYING HORSE DAM	CLIENT	PULPIT ROCK
SAMPLE LOCATION	TB-3 @ 0-5'	JOB NO.	171249
SOIL DESCRIPTION	SAND, SILTY, BROWN	DATE	09/28/17

IDENTIFICATION	SM	COMPACTION TEST #	3
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	AS
MAXIMUM DRY DENSITY (PCF)	124.1	OPTIMUM MOISTURE	9.0%



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MOISTURE DENSITY RELATION

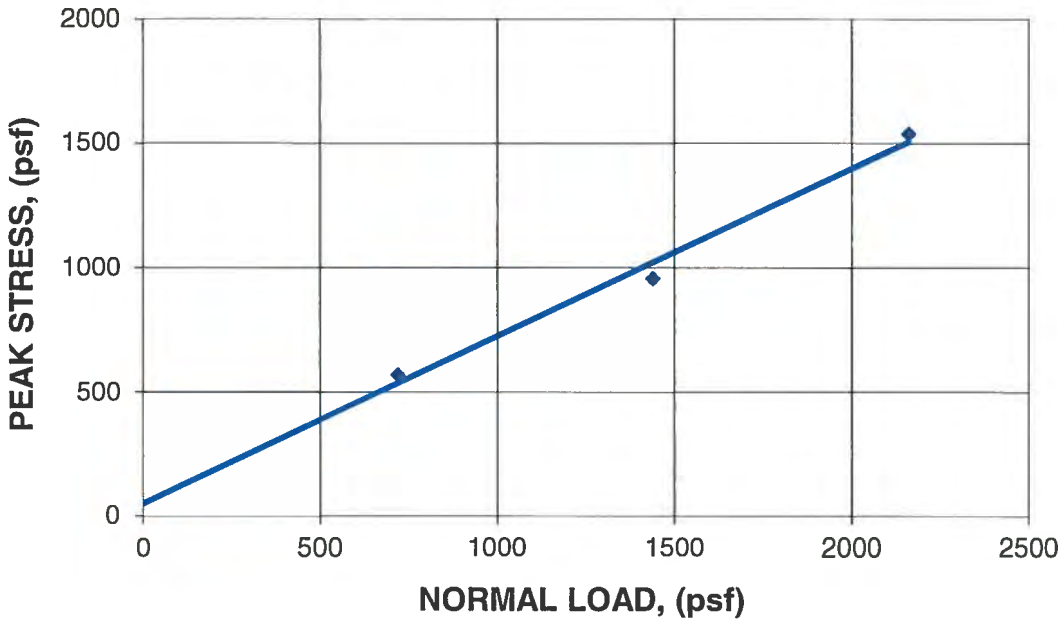
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-5

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-3 @ 0-5'		

C = 52 psf
ø = 34°



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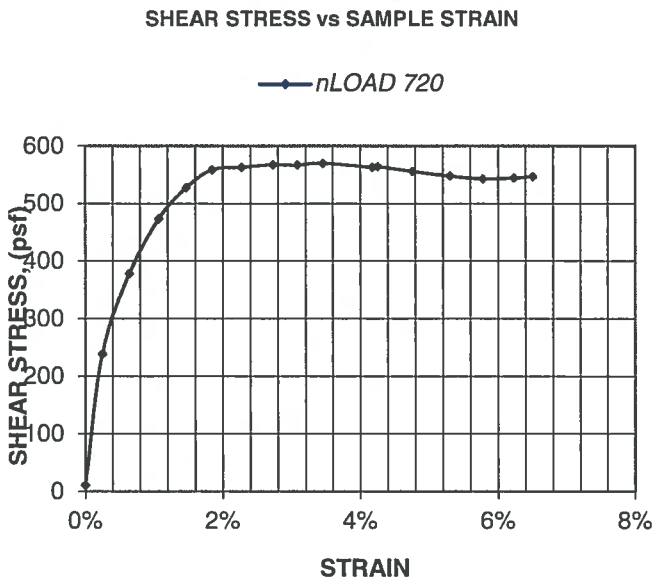
FRICTION ANGLES

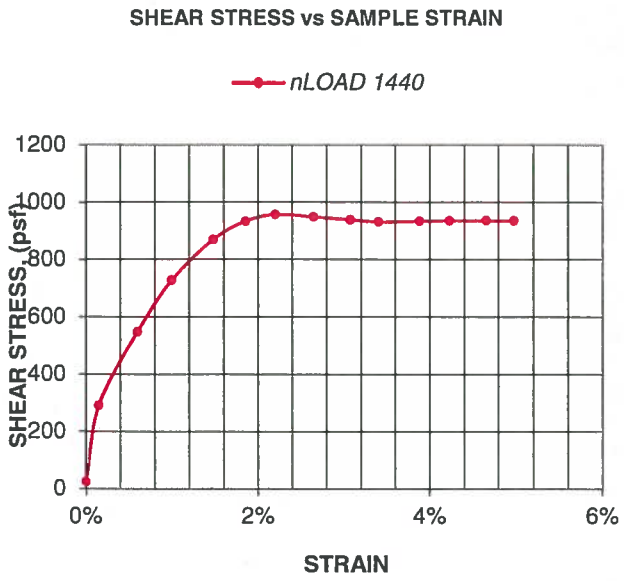
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

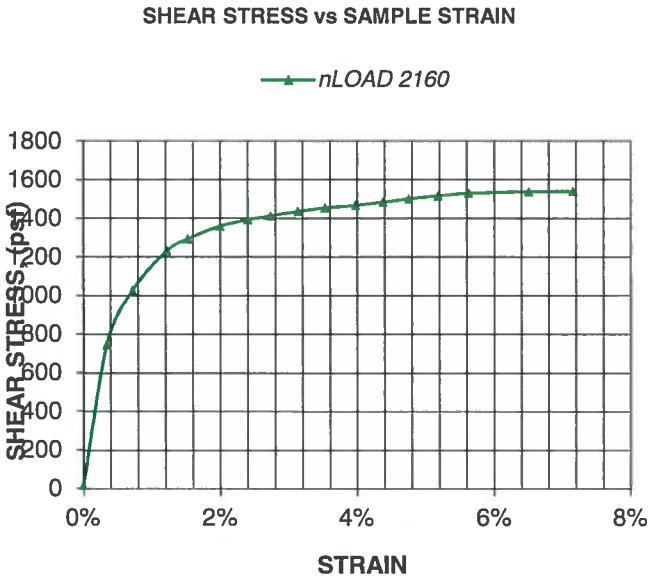
JOB NO.: 171249

FIG NO.: C-6

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-3 @ 0-5'		







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COLORADO SPRINGS, COLORADO 80907

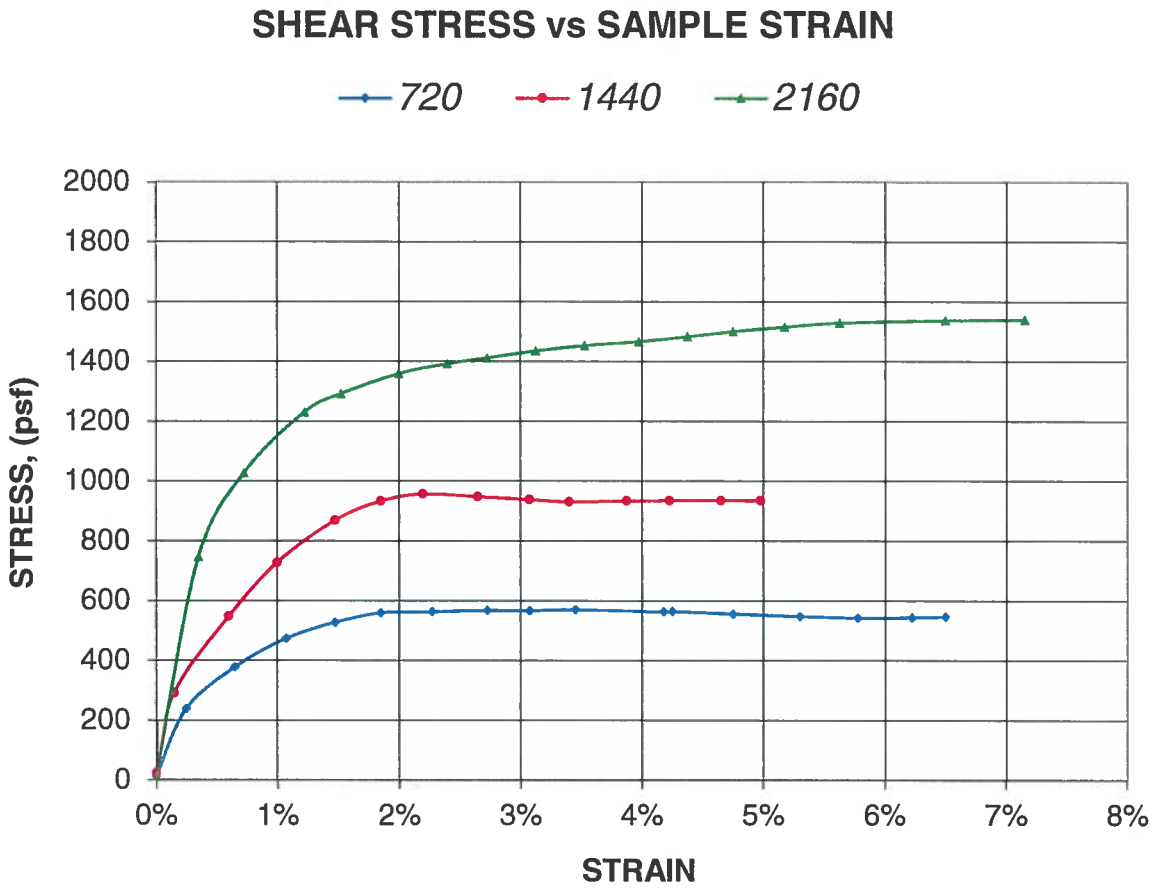
INDIVIDUAL SHEAR POINTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-7

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-3 @ 0-5'		



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DIRECT SHEAR COMPOSITE

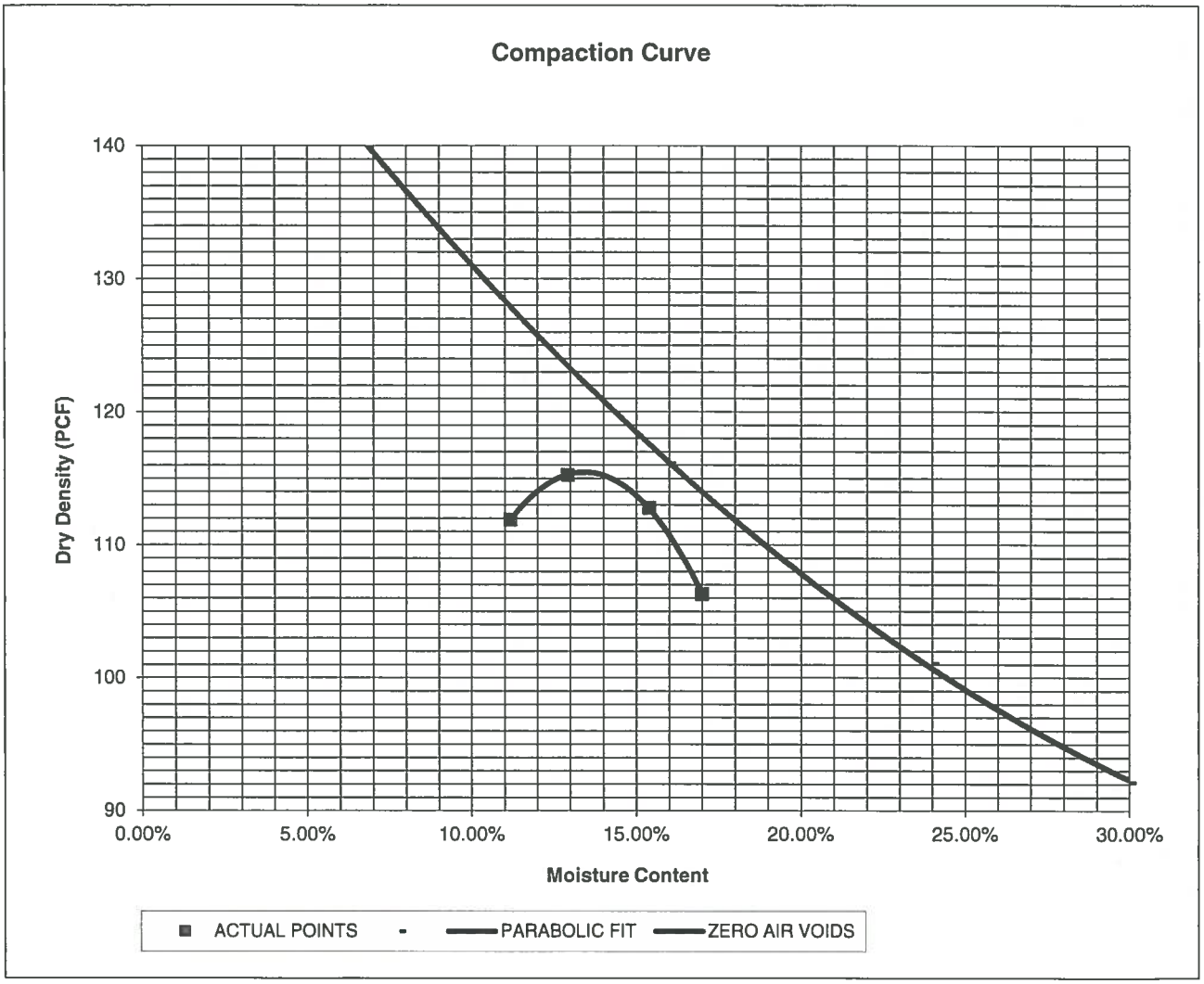
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-8

PROJECT	FLYING HORSE DAM	CLIENT	PULPIT ROCK
SAMPLE LOCATION	TB-6 @ 5-10	JOB NO.	171249
SOIL DESCRIPTION	SAND, V. CLAYEY, BROWN	DATE	09/28/17

IDENTIFICATION	SC	COMPACTION TEST #	2
TEST DESIGNATION / METHOD	ASTM D-698-A	TEST BY	AS
MAXIMUM DRY DENSITY (PCF)	115.5	OPTIMUM MOISTURE	13.5%



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COLORADO SPRINGS, COLORADO 80907

MOISTURE DENSITY RELATION

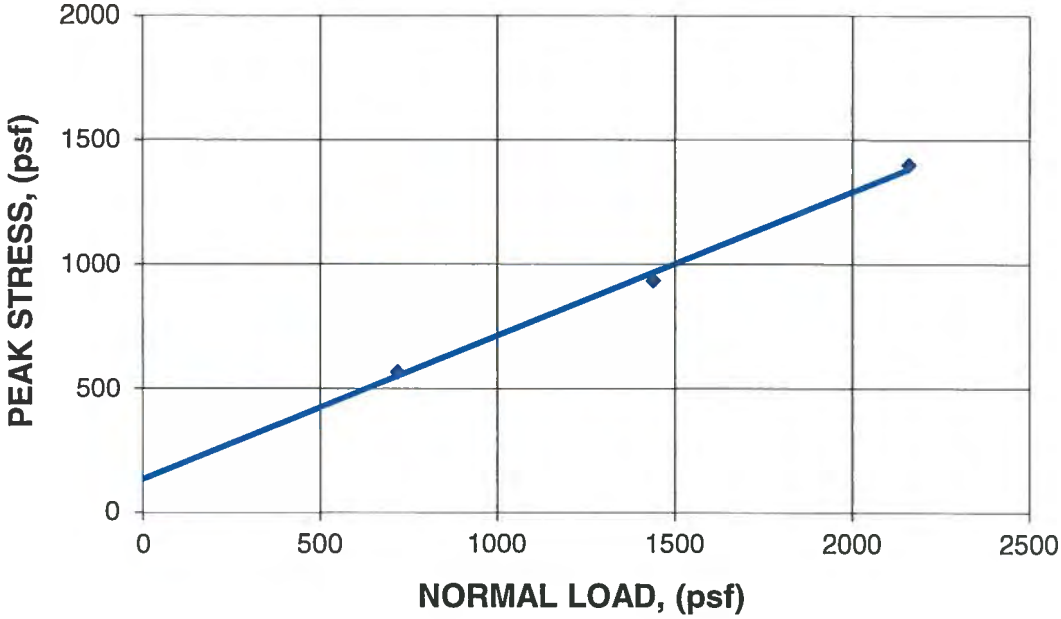
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-9

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-6 @ 5-10'		

C = 134 psf
ø = 30°



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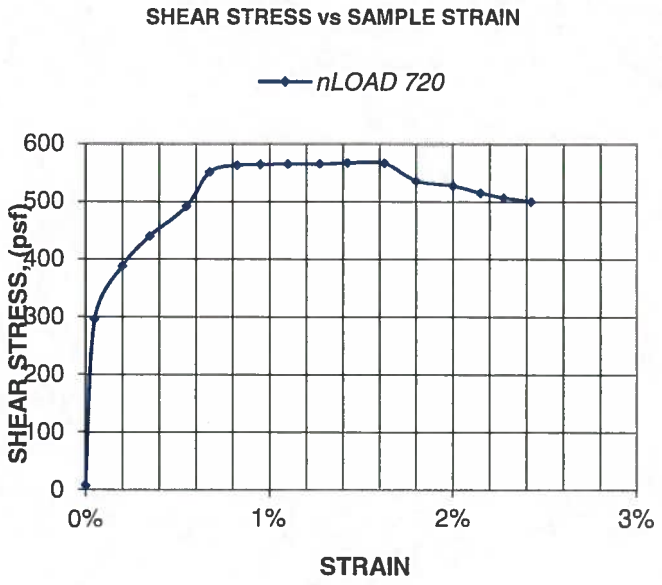
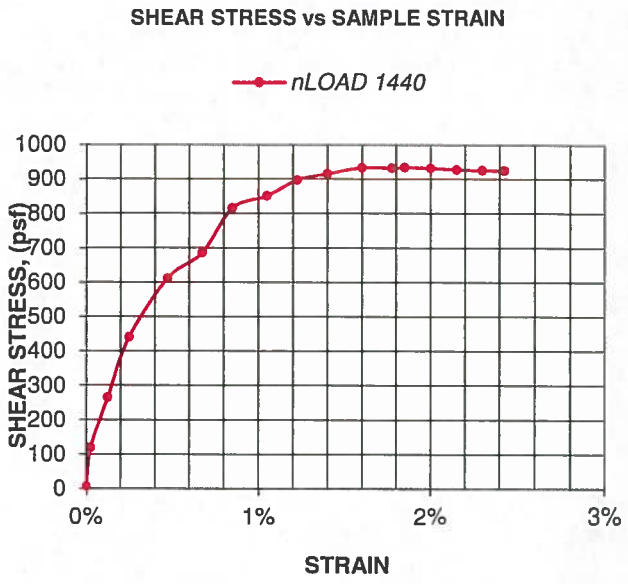
FRICTION ANGLES

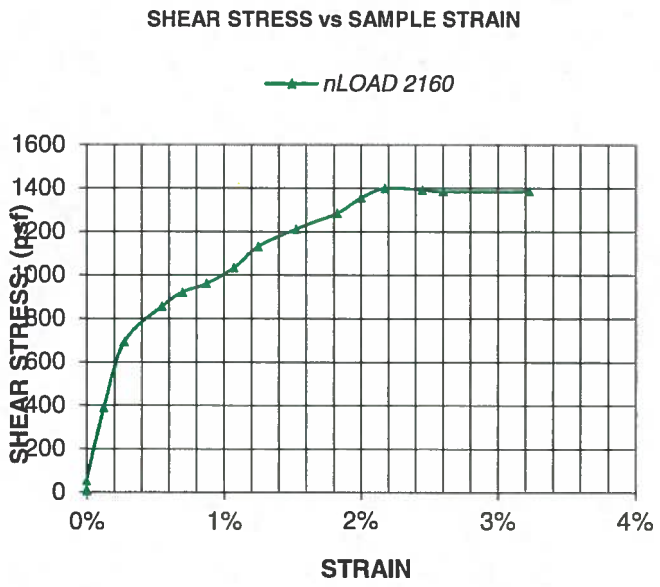
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: C-10

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-6 @ 5-10'		







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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

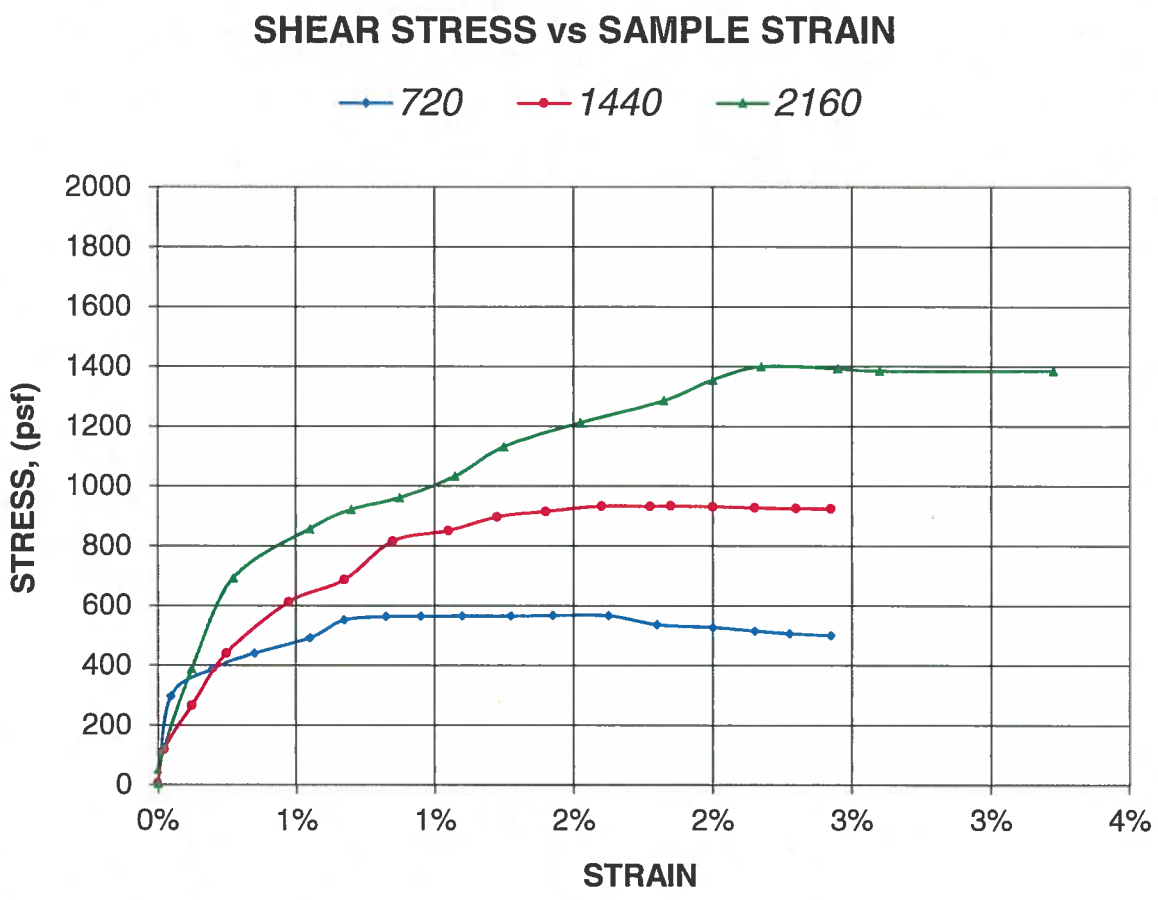
INDIVIDUAL SHEAR POINTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-11

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-6 @ 5-10'		



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DIRECT SHEAR COMPOSITE

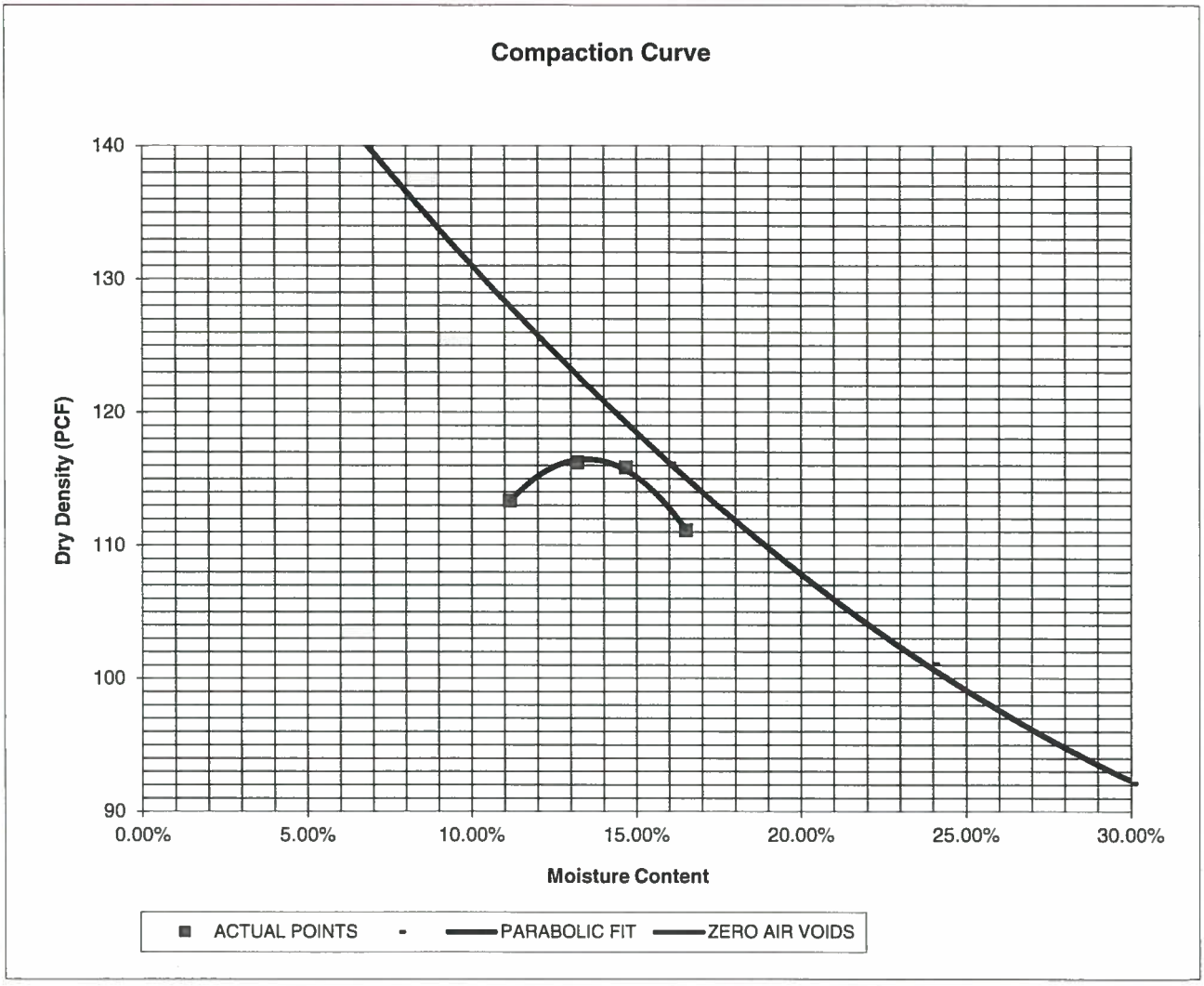
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-12

PROJECT	FLYING HORSE DAM	CLIENT	PULPIT ROCK
SAMPLE LOCATION	TB-13 @ 0-3'	JOB NO.	171249
SOIL DESCRIPTION	SAND, VERY CLAYEY, TAN	DATE	10/27/17

IDENTIFICATION	SC	COMPACTION TEST #	4
TEST DESIGNATION / METHOD	ASTM D-698-A	TEST BY	BL
MAXIMUM DRY DENSITY (PCF)	116.6	OPTIMUM MOISTURE	13.3%



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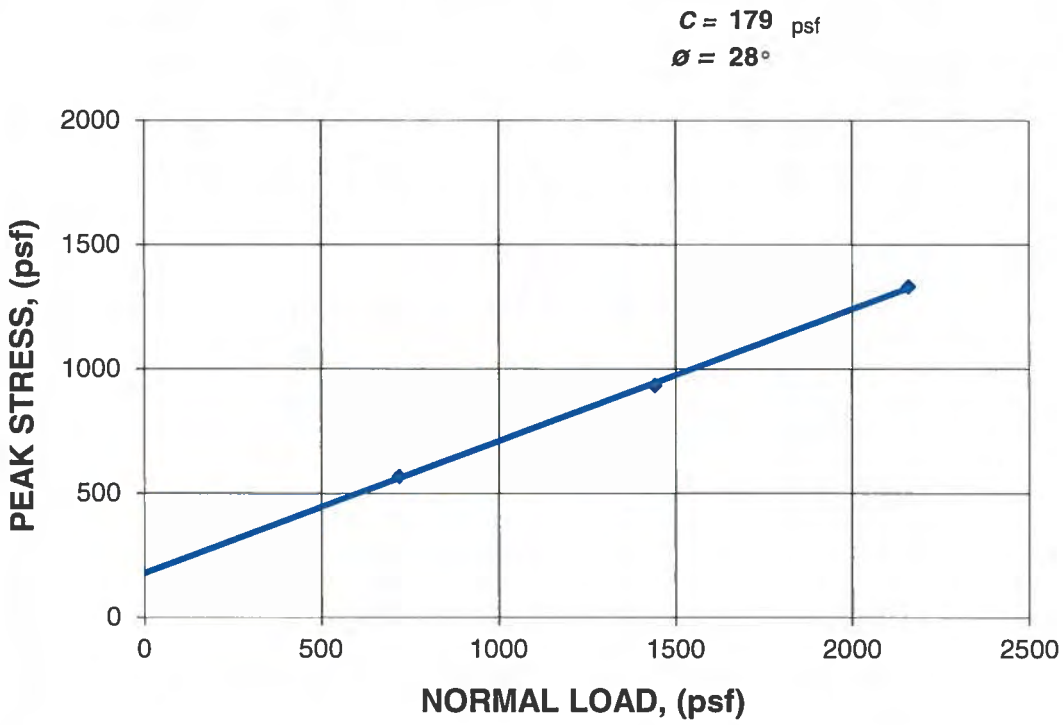
MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-13

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-13 @ 0-3'		



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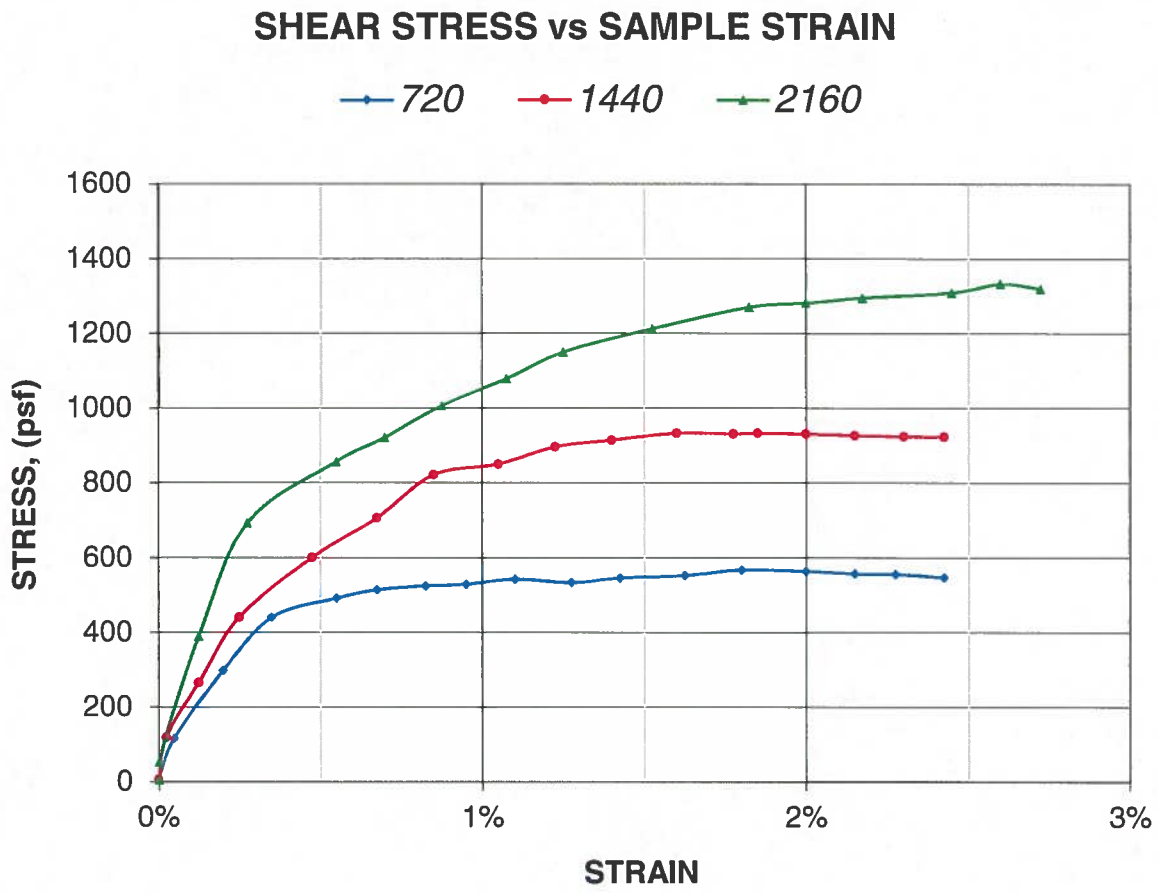
FRICTION ANGLES

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-14

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-13 @ 0-3'		



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COLORADO SPRINGS, COLORADO 80907

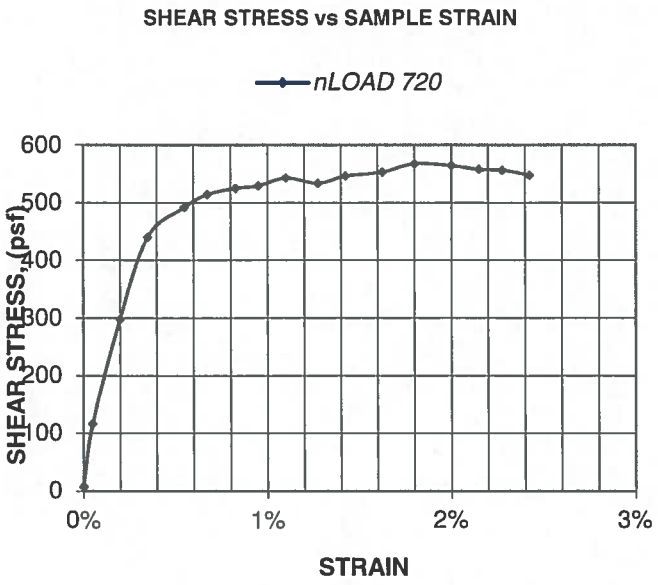
DIRECT SHEAR COMPOSITE

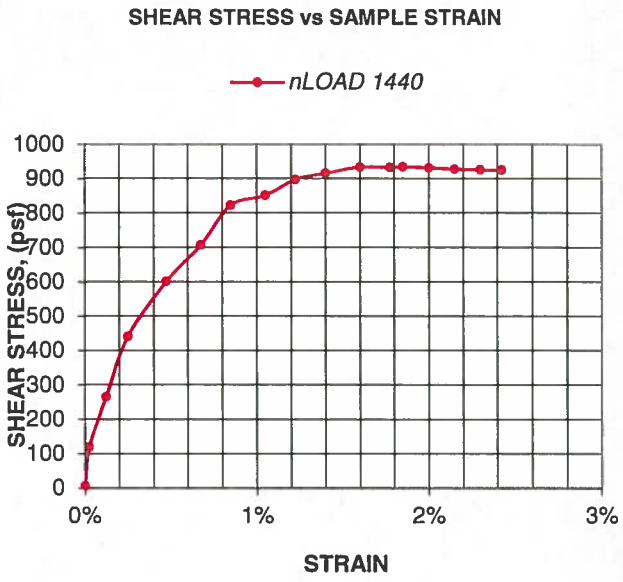
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

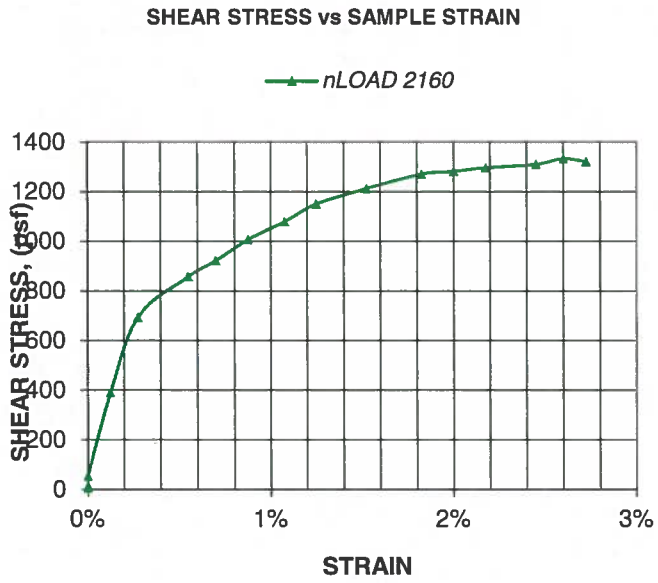
JOB NO.: 171249

FIG NO.: C-15

CLIENT	PULPIT ROCK	JOB NO	171249
PROJECT	FLYING HORSE DAM		
LOCATION	TB-13 @ 0-3'		







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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

INDIVIDUAL SHEAR POINTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCE	11/16/17

JOB NO.: 171249

FIG NO.: C-16

APPENDIX D: Filter Calculations

Flying Horse North Dam
Filter Compatibility for Dam Embankment

Sieve Analysis TB12 at 1 to 8 feet

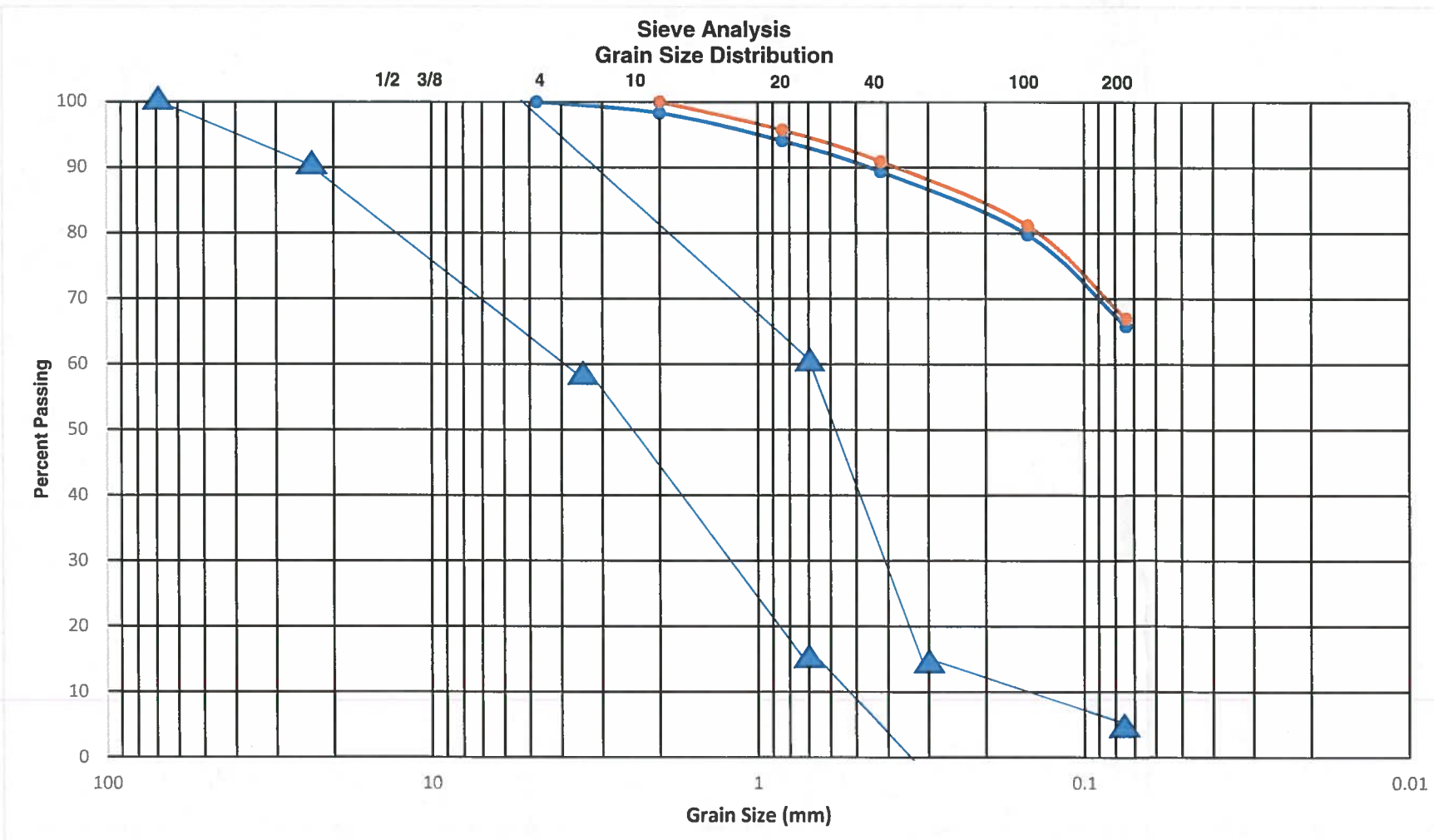
Sieve #	Opening (mm)	% Finer (%)	Regraded (%)
1.5	37.5		
3/4	19.05		
1/2	12.7		
3/8	9.53		
4	4.76	100	
10	2	98.3	100.0
20	0.841	94.1	95.7
40	0.42	89.4	90.9
100	0.149	79.8	81.2
200	0.074	65.8	66.9

NEH - Part 633 - Example 26-2

1)	Regrade Factor	0	
2)	Base Soil Category, Table 26-1	2	
3)	Max D15, Table 26-2	0.7 mm	5.7 D1
4)	Min D15, Table 26-3	0.3 mm	1.14 D2
5)	Band Width	mm	
6)	Max D10	0.58 mm	
7)	Max D60	3.5 mm	D3
8)	Min D60	0.7 mm	D4
9)	Min D5	0.075 mm	D5
10)	Max D100	75 mm	D6
11)	Max D90	25 mm	D7
	Min D10		0.95

Acceptable Band Range - washed concrete sand

Sieve #	Minimum (%)	Maximum (%)
1.5"	95	100
3/4"	87	100
1/2"	80	100
3/8"	74	100
4	63	97
10	44	80
20	18	65
40	5	31
100	0	10
200	0	5



Flying Horse North Dam
Coarse Filter Compatibility

Sieve Analysis TB11 at 0 to 10 feet

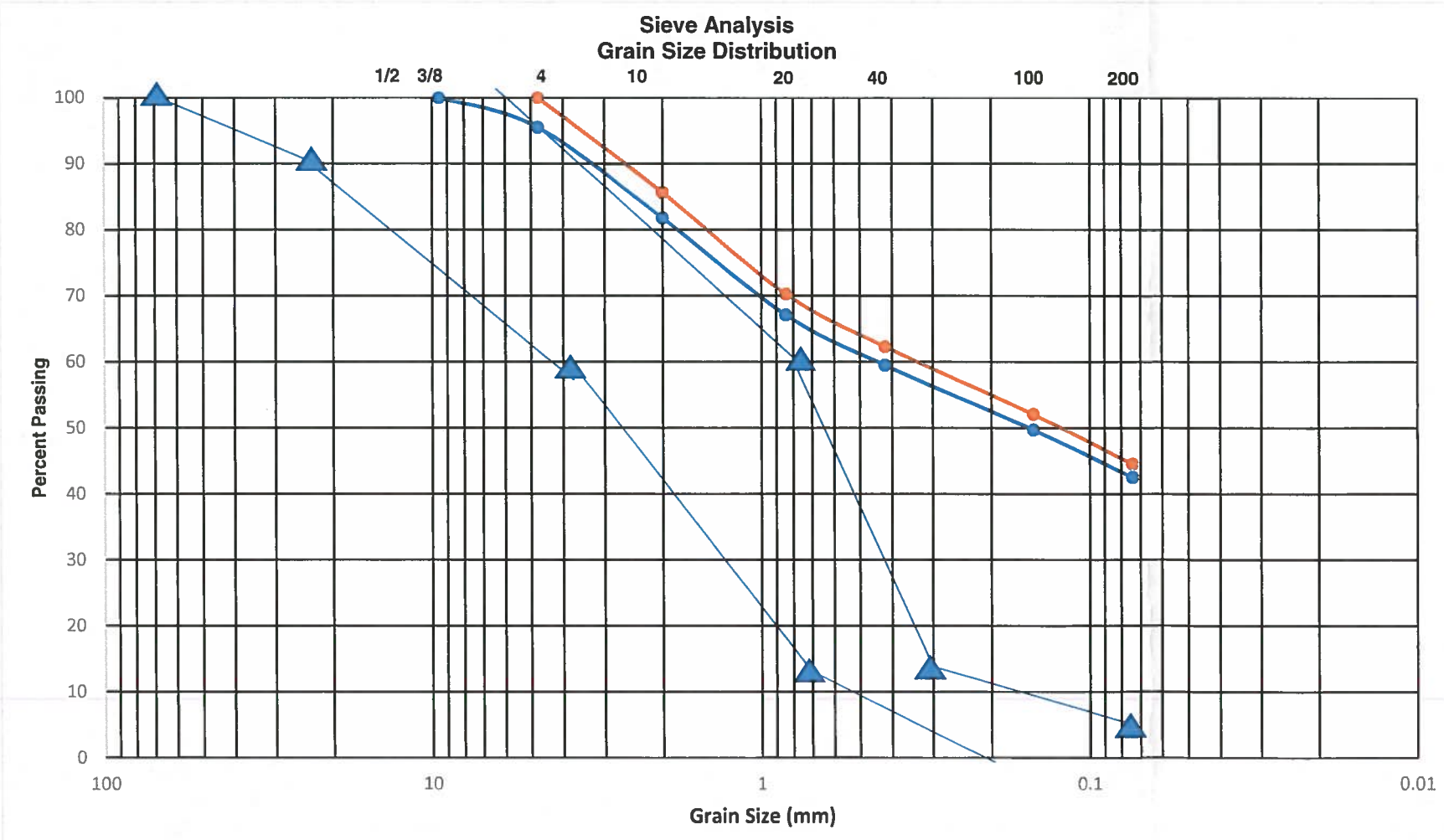
Sieve #	Opening	% Finer	Regraded
	(mm)	(%)	(%)
1.5	37.5		
3/4	19.05		
1/2	12.7		
3/8	9.53	100	
4	4.76	95.5	100.0
10	2	81.8	85.7
20	0.841	67.1	70.3
40	0.42	59.5	62.3
100	0.149	49.7	52.0
200	0.074	42.5	44.5

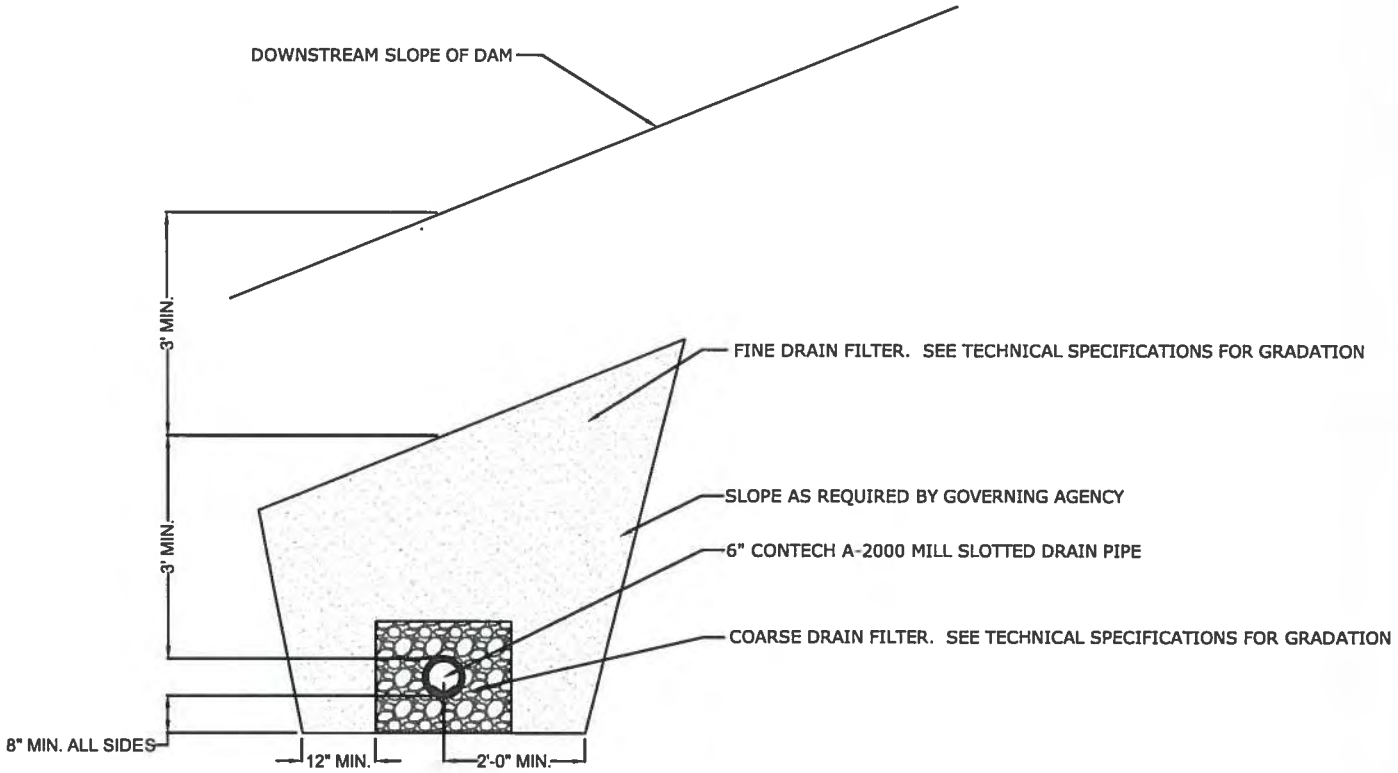
NEH - Part 633 - Example 26-5

1)	Regrade Factor	1.04712		
2)	Base Soil Category, Table 26-1	2		
3)	Max D15	0.7 mm	5.7	D1
4)	Min D15, Table 26-3	0.3 mm	1.14	D2
5)	Band Width	mm		
6)	Max D10	0.58 mm		
7)	Max D60	3.5 mm		D3
8)	Min D60	0.7 mm		D4
9)	Min D5	0.075 mm		D5
10)	Max D100	75 mm		D6
11)	Max D90	25 mm		D7
	Min D10		0.95	

Acceptable Band Range - #8

Sieve #	Minimum	Maximum
	(%)	(%)
1.5"	95	100
3/4"	87	100
1/2"	80	100
3/8"	74	100
4	63	95
10	42	78
20	15	63
40	8	31
100	0	10
200	0	5





ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907 (719) 531-5599

TOE DRAIN SECTION
FLYING HORSE NORTH DAM
FOR: PULPIT ROCK, LLC

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
SCC	11/16/17	SCC	SCC

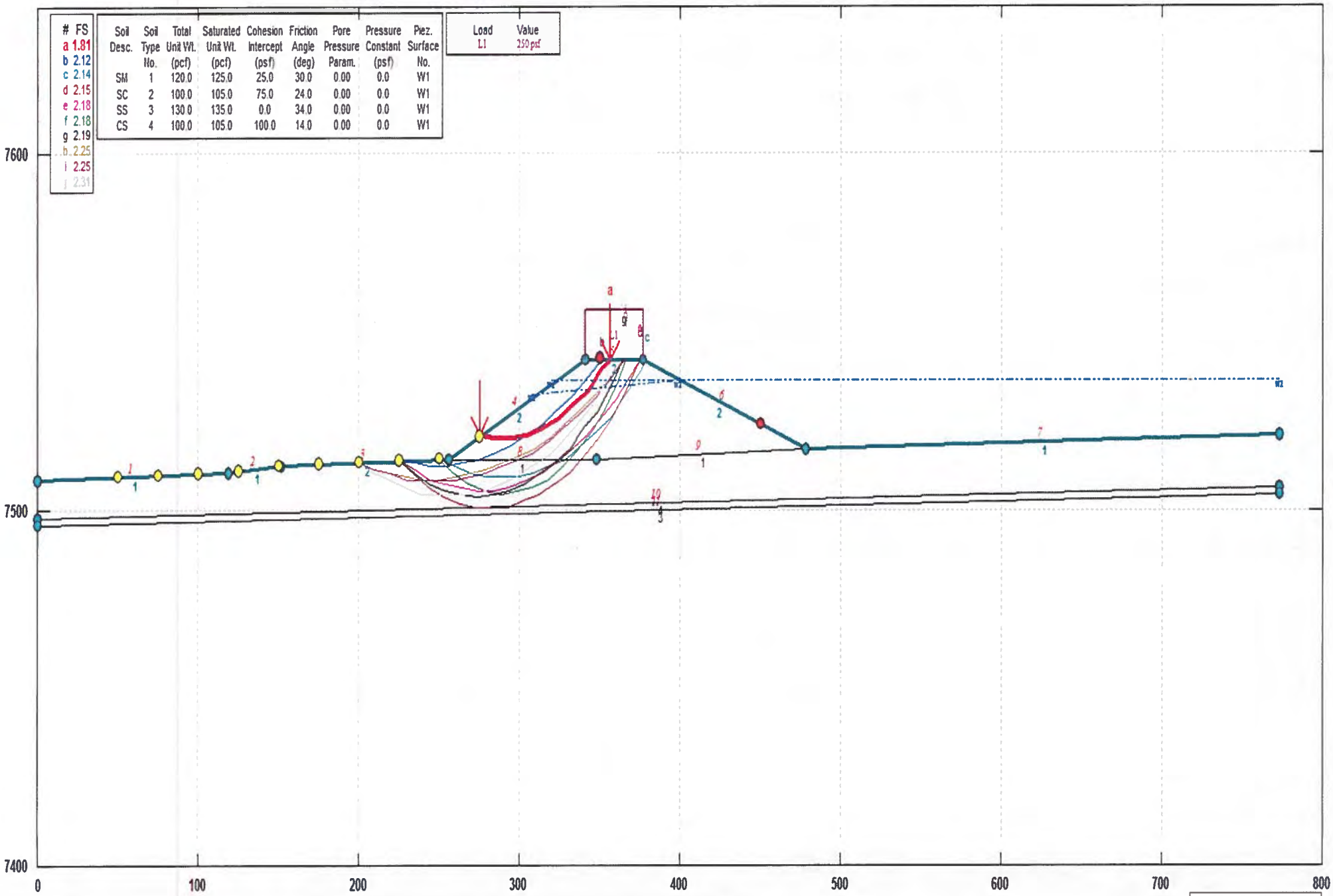
JOB NO.: 171249

FIG. NO.: 1

APPENDIX E: Slope Stability Calculations

Flying Horse North Golf Course Dam

f:\aa projects\2017\171249-pulpit rock-flying horse north, dam investigation-ssi-200\proposed contour - classic - updated.pl2 Run By: Insert Name/company Here 11/15/2017 04:53PM



#	FS
a	1.81
b	2.12
c	2.14
d	2.15
e	2.18
f	2.18
g	2.19
h	2.25
i	2.25
j	2.31

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SM	1	120.0	125.0	25.0	30.0	0.00	0.0	W1
SC	2	100.0	105.0	75.0	24.0	0.00	0.0	W1
SS	3	130.0	135.0	0.0	34.0	0.00	0.0	W1
CS	4	100.0	105.0	100.0	14.0	0.00	0.0	W1

Load	Value
L1	250 psf

GSTABL7 v.2 FSmin=1.81

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
   ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                   SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        11/15/2017
Time of Run:              04:53PM
Run By:                   Insert Name/company Here
Input Data Filename:      F:\AA projects\2017\171249-Pulpit Rock-Flying Horse North, D
am Investigation-SSI-200\proposed contour - classic - updated.in
Output Filename:          F:\AA projects\2017\171249-Pulpit Rock-Flying Horse North, D
am Investigation-SSI-200\proposed contour - classic - updated.OUT
Unit System:              English
Plotted Output Filename:  F:\AA projects\2017\171249-Pulpit Rock-Flying Horse North, D
am Investigation-SSI-200\proposed contour - classic - updated.PLT
PROBLEM DESCRIPTION:  Flying Horse North
                      Golf Course Dam
BOUNDARY COORDINATES
    7 Top   Boundaries
   11 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00    7508.50     119.00    7510.50        1
    2       119.00    7510.50     152.00    7512.50        1
    3       152.00    7512.50     256.50    7514.50        2
    4       256.50    7514.50     341.00    7542.50        2
    5       341.00    7542.50     376.50    7542.50        2
    6       376.50    7542.50     478.00    7517.00        2
    7       478.00    7517.00     773.00    7520.50        1
    8       256.50    7514.50     348.00    7514.40        1
    9       348.00    7514.40     478.00    7517.00        1
   10         0.00    7498.00     773.00    7506.00        4
   11         0.00    7496.00     773.00    7504.00        3
User Specified Y-Origin =      7400.00(ft)
Default X-Plus Value = 0.00(ft)
User Specified Y-Plus Value = 7458.00(ft)
ISOTROPIC SOIL PARAMETERS
 4 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0      25.0     30.0    0.00       0.0      1
  2   100.0    105.0      75.0     24.0    0.00       0.0      1
  3   130.0    135.0       0.0     34.0    0.00       0.0      1
  4   100.0    105.0     100.0     14.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
   No.        (ft)        (ft)
    1       320.00     7536.00
    2       773.00     7536.00
Piezometric Surface No.  2 Specified by  3 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
   No.        (ft)        (ft)
    1       308.00     7532.00
    2       399.00     7536.00
```

```
     3        773.00     7536.00
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         341.00       376.50       250.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  100 Trial Surfaces Have Been Generated.
   10 Surface(s) Initiate(s) From Each Of    10 Points Equally Spaced
 Along The Ground Surface Between  X =  50.00(ft)
                              and  X = 275.00(ft)
 Each Surface Terminates Between   X = 350.00(ft)
                             and   X = 450.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
 10.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   100
       Number of Trial Surfaces With Valid FS =  100
       Statistical Data On All Valid FS Values:
          FS Max =  29.761   FS Min =   1.812   FS Ave =   6.530
          Standard Deviation =    3.954   Coefficient of Variation =   60.55 %
       Failure Surface Specified By 10 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        275.000     7520.630
           2        284.973     7519.895
           3        294.972     7520.040
           4        304.919     7521.064
           5        314.738     7522.961
           6        324.351     7525.715
           7        333.684     7529.305
           8        342.665     7533.703
           9        351.224     7538.875
          10        356.179     7542.500
       Circle Center At X =   288.368 ; Y =  7632.608 ; and Radius =   112.773
              Factor of Safety
             ***    1.812   ***
            Individual data on the    14  slices
                      Water  Water     Tie     Tie     Earthquake
                      Force  Force    Force   Force       Force   Surcharge
Slice  Width   Weight   Top    Bot    Norm    Tan     Hor     Ver    Load
 No.    (ft)    (lbs)   (lbs)  (lbs)   (lbs)   (lbs)   (lbs)   (lbs)  (lbs)
  1     10.0    2115.3  8992.8  9820.1      0.      0.     0.0     0.0     0.0
  2     10.0    5905.1  6841.6 10004.7      0.      0.     0.0     0.0     0.0
  3      9.9    8715.3  4645.3  9639.7      0.      0.     0.0     0.0     0.0
  4      3.1    3135.4  1001.5  2866.1      0.      0.     0.0     0.0     0.0
  5      6.7    7336.6  1469.9  5861.8      0.      0.     0.0     0.0     0.0
  6      5.3    6052.7   460.3  4196.2      0.      0.     0.0     0.0     0.0
  7      4.4    5097.1     0.0  3080.5      0.      0.     0.0     0.0     0.0
  8      9.3   10680.7     0.0  5297.6      0.      0.     0.0     0.0     0.0
  9      7.3    7635.5     0.0  2492.6      0.      0.     0.0     0.0     0.0
 10      1.3    1192.6     0.0   246.0      0.      0.     0.0     0.0   315.7
 11      0.4     362.8     0.0    67.0      0.      0.     0.0     0.0   100.6
 12      3.8    2929.4     0.0   318.3      0.      0.     0.0     0.0   950.4
 13      4.8    2408.7     0.0     0.0      0.      0.     0.0     0.0  1189.4
 14      5.0     898.0     0.0     0.0      0.      0.     0.0     0.0  1238.7
       Failure Surface Specified By 15 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        225.000     7513.897
```

E-3

2	234.952	7512.922
3	244.942	7512.467
4	254.942	7512.535
5	264.924	7513.124
6	274.863	7514.233
7	284.729	7515.860
8	294.498	7518.000
9	304.141	7520.646
10	313.634	7523.792
11	322.949	7527.430
12	332.061	7531.548
13	340.946	7536.136
14	349.580	7541.182
15	351.587	7542.500

Circle Center At X = 248.649 ; Y = 7703.969 ; and Radius = 191.537
Factor of Safety
*** 2.124 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	250.000	7514.375
2	259.694	7511.919
3	269.537	7510.159
4	279.482	7509.104
5	289.476	7508.760
6	299.469	7509.129
7	309.410	7510.208
8	319.250	7511.993
9	328.937	7514.474
10	338.423	7517.639
11	347.660	7521.471
12	356.600	7525.951
13	365.199	7531.056
14	373.412	7536.760
15	379.576	7541.727

Circle Center At X = 289.301 ; Y = 7649.096 ; and Radius = 140.336
Factor of Safety
*** 2.136 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.000	7513.897
2	234.085	7509.718
3	243.475	7506.279
4	253.110	7503.601
5	262.927	7501.701
6	272.866	7500.591
7	282.861	7500.279
8	292.849	7500.767
9	302.766	7502.051
10	312.549	7504.124
11	322.135	7506.971
12	331.463	7510.575
13	340.473	7514.913
14	349.108	7519.957
15	357.312	7525.674
16	365.034	7532.028
17	372.223	7538.979
18	375.324	7542.500

Circle Center At X = 281.724 ; Y = 7625.099 ; and Radius = 124.834
Factor of Safety
*** 2.147 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.000	7513.897
2	234.553	7510.939

3	244.279	7508.614
4	254.136	7506.930
5	264.082	7505.896
6	274.075	7505.514
7	284.071	7505.788
8	294.028	7506.716
9	303.903	7508.293
10	313.653	7510.514
11	323.237	7513.369
12	332.613	7516.844
13	341.742	7520.927
14	350.584	7525.598
15	359.101	7530.838
16	367.257	7536.625
17	374.484	7542.500

Circle Center At X = 274.896 ; Y = 7658.160 ; and Radius = 152.648
Factor of Safety
*** 2.178 ***
Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	250.000	7514.375
2	259.183	7510.416
3	268.738	7507.468
4	278.556	7505.565
5	288.521	7504.729
6	298.518	7504.971
7	308.431	7506.286
8	318.145	7508.661
9	327.547	7512.067
10	336.528	7516.465
11	344.983	7521.804
12	352.816	7528.021
13	359.933	7535.045
14	366.014	7542.500

Circle Center At X = 291.277 ; Y = 7597.451 ; and Radius = 92.765
Factor of Safety
*** 2.182 ***
Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.000	7513.897
2	234.331	7510.300
3	243.919	7507.461
4	253.704	7505.399
5	263.623	7504.127
6	273.612	7503.653
7	283.606	7503.980
8	293.543	7505.106
9	303.357	7507.023
10	312.987	7509.721
11	322.369	7513.180
12	331.445	7517.379
13	340.155	7522.292
14	348.445	7527.885
15	356.259	7534.125
16	363.550	7540.969
17	364.939	7542.500

Circle Center At X = 274.531 ; Y = 7628.479 ; and Radius = 124.829
Factor of Safety
*** 2.193 ***
Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.000	7513.418
2	209.831	7511.589
3	219.733	7510.191

4	229.687	7509.228
5	239.673	7508.700
6	249.672	7508.609
7	259.666	7508.955
8	269.636	7509.738
9	279.561	7510.956
10	289.424	7512.606
11	299.205	7514.686
12	308.887	7517.191
13	318.449	7520.117
14	327.874	7523.458
15	337.145	7527.207
16	346.242	7531.358
17	355.150	7535.903
18	363.850	7540.833
19	366.514	7542.500

Circle Center At X = 246.751 ; Y = 7737.354 ; and Radius = 228.764

Factor of Safety

*** 2.252 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.000	7513.418
2	209.789	7511.377
3	219.663	7509.792
4	229.600	7508.667
5	239.578	7508.005
6	249.576	7507.806
7	259.572	7508.071
8	269.546	7508.800
9	279.474	7509.991
10	289.337	7511.641
11	299.113	7513.747
12	308.781	7516.304
13	318.319	7519.307
14	327.708	7522.749
15	336.927	7526.624
16	345.956	7530.921
17	354.776	7535.634
18	363.368	7540.750
19	366.019	7542.500

Circle Center At X = 248.862 ; Y = 7723.270 ; and Radius = 215.465

Factor of Safety

*** 2.254 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.000	7513.418
2	209.530	7510.390
3	219.223	7507.929
4	229.043	7506.043
5	238.958	7504.740
6	248.932	7504.023
7	258.932	7503.896
8	268.921	7504.359
9	278.866	7505.411
10	288.731	7507.046
11	298.483	7509.261
12	308.087	7512.046
13	317.510	7515.394
14	326.719	7519.291
15	335.683	7523.724
16	344.370	7528.678
17	352.749	7534.135
18	360.792	7540.077
19	363.697	7542.500

Circle Center At X = 256.083 ; Y = 7673.395 ; and Radius = 169.522

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 Factor of Safety
***     2.310    ***
    **** END OF GSTABL7 OUTPUT ****
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