UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation	**Project Nos. 14803-001;**
PacifiCorp	**2082-063**

AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT R
100% Design Report
(Part 11 of 12)

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EXHIBIT R-6
City of Yreka Waterline

City of Yreka Waterline Modification 100% Design Drawings

KLAMATH RIVER RENEWAL CORPORATION

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

VOLUME 2 - CONSTRUCTION DRAWINGS
FEBRUARY, 2021

100% DESIGN SUBMITTAL

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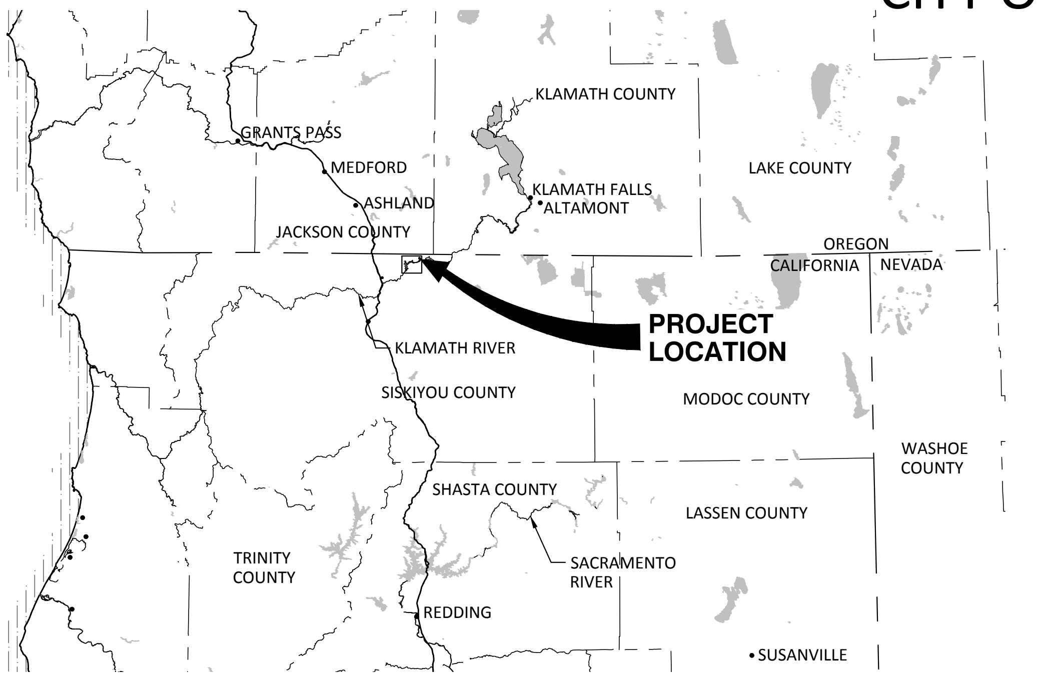
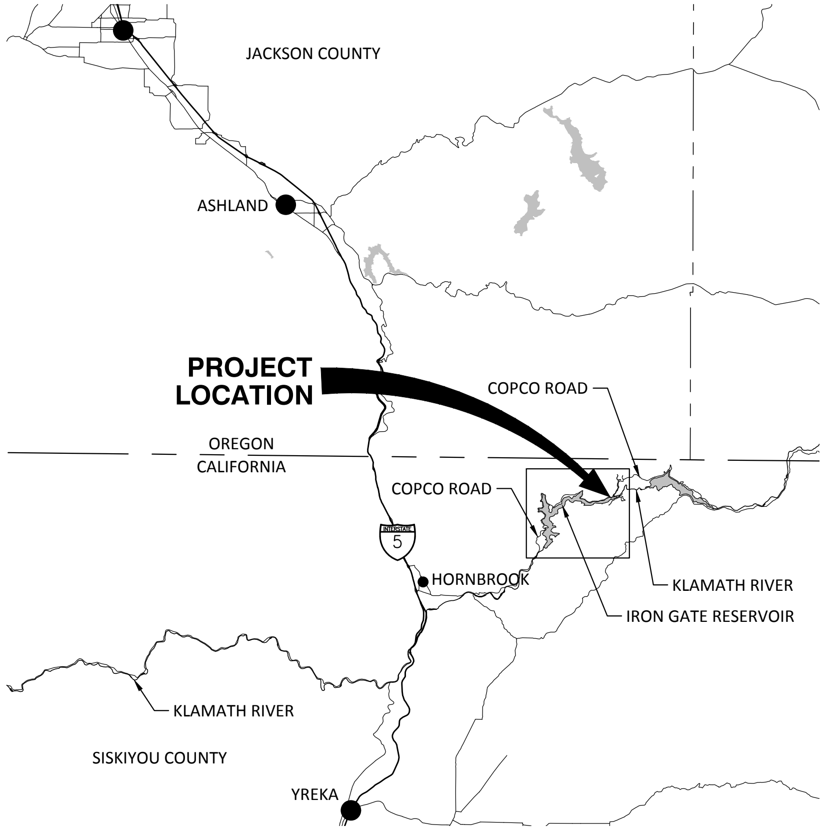
KLAMATH RIVER RENEWAL CORPORATION

CITY OF YREKA WATERLINE MODIFICATION PROJECT

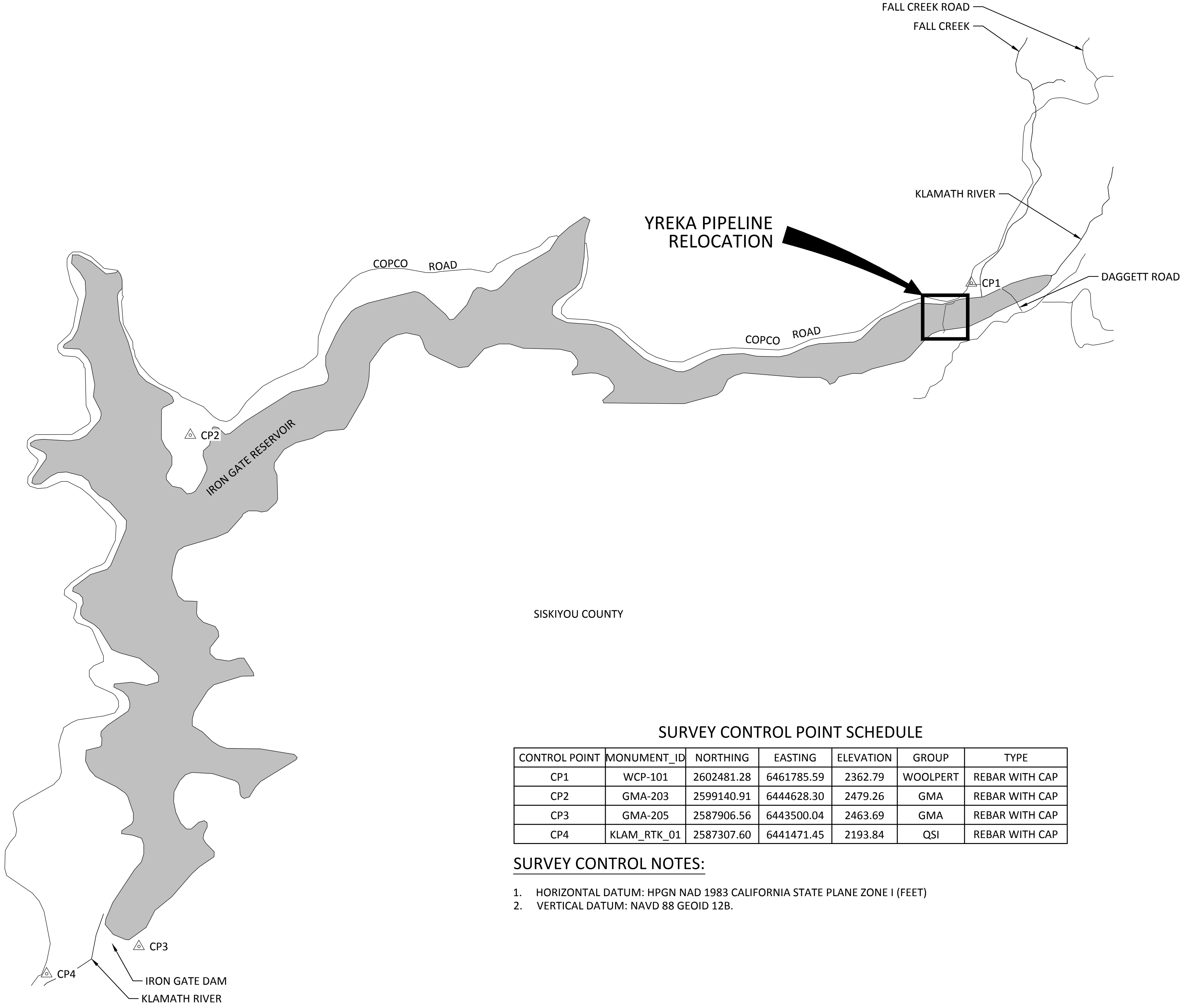
100% DESIGN SUBMITTAL



LOCATION MAP
NTS



VICINITY MAP



SURVEY CONTROL POINT SCHEDULE

CONTROL POINT	MONUMENT_ID	NORTHING	EASTING	ELEVATION	GROUP	TYPE
CP1	WCP-101	2602481.28	6461785.59	2362.79	WOOLPERT	REBAR WITH CAP
CP2	GMA-203	2599140.91	6444628.30	2479.26	GMA	REBAR WITH CAP
CP3	GMA-205	2587906.56	6443500.04	2463.69	GMA	REBAR WITH CAP
CP4	KLAM_RTK_01	2587307.60	6441471.45	2193.84	QSI	REBAR WITH CAP

SURVEY CONTROL NOTES:

1. HORIZONTAL DATUM: HPGN NAD 1983 CALIFORNIA STATE PLANE ZONE I (FEET)
2. VERTICAL DATUM: NAVD 88 GEOID 12B.

SURVEY CONTROL POINTS PLAN
NTS

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
LOCATION MAP, VICINITY MAP AND SURVEY CONTROL POINTS

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
G001

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\G001.dwg Plot date: Feb 05, 2021 04:54pm, CAD User: rooney

JOB NO: 000000

DRAWING INDEX

DWG NO	SHEET NO.	DESCRIPTION
GENERAL		
		COVER SHEET
1	G001	LOCATION MAP, VICINITY MAP AND SURVEY CONTROL POINTS
2	G002	DRAWING INDEX
3	G003	STANDARD ABBREVIATIONS
4	G004	STANDARD SYMBOLS
5	G005	OVERALL PLAN AND PROJECT CONTROL
6	G006	CONTRACTOR STAGING AREA
7	G007	PIPING AND VALVE SCHEDULE
EROSION AND SEDIMENT CONTROL		
8	EC001	EROSION AND SEDIMENT CONTROL STANDARD DETAILS 1
9	EC002	EROSION AND SEDIMENT CONTROL STANDARD DETAILS 2
10	EC100	EROSION AND SEDIMENT CONTROL PLAN
11	EC101	EROSION AND SEDIMENT CONTROL SITE COORDINATES
DEMOLITION		
12	D101	DEMOLITION WATERLINE PLAN AND PROFILE
CIVIL		
13	GC001	CIVIL GENERAL NOTES
14	GC002	CIVIL STANDARD DETAILS 1
15	GC003	CIVIL STANDARD DETAILS 2
16	GC004	CIVIL STANDARD DETAILS 3
17	C001	OVERALL SITE PLAN
18	C100	TEMPORARY WATERLINE PLAN AND PROFILE 1
19	C101	TEMPORARY WATERLINE PLAN AND PROFILE 2
20	C102	TEMPORARY WATERLINE PLAN AND PROFILE 3
21	C103	TEMPORARY WATERLINE PLAN AND PROFILE 4
22	C104	TEMPORARY WATERLINE PLAN AND PROFILE 5
23	C105	TEMPORARY WATERLINE PLAN AND PROFILE 6
24	C106	TEMPORARY WATERLINE PLAN AND PROFILE 7
25	C107	TEMPORARY WATERLINE PLAN AND PROFILE 8
26	C200	PERMANENT WATERLINE PLAN AND PROFILE
27	C201	CIVIL SECTIONS AND DETAILS 1
28	C202	CIVIL SECTIONS AND DETAILS 2

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
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KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
DRAWING INDEX

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
G002

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\G002.dwg Plot date: Feb 05, 2021 04:54pm, CAD User: rooney

JOB NO: 000000

A/C	AIR CONDITIONING
A/E	ARCHITECT/ENGINEER
A	ARCHITECTURAL (DWG DISCIPLINE), AMP
AB	ANCHOR BOLT
ABC	AGGREGATE BASE COURSE
ABAN	ABANDON
AC	ALTERNATING CURRENT
ACST	ACOUSTIC
AD	ADDENDUM, AREA DRAIN
ADDL	ADDITIONAL
ADH	ADHESIVE
ADJ	ADJUSTABLE, ADJACENT
AF	AMP FRAME, AMP FUSE
AFF	ABOVE FINISH FLOOR
AFG	ABOVE FINISH GRADE
AGGR	AGGREGATE
AIC	AMPS INTERRUPTING CAPACITY
ALIG	ALIGNMENT
ALUM	ALUMINUM
ALT	ALTERNATE, ALTITUDE
AMB	AMBIENT
ANC	ANCHOR
AP	ACCESS PANEL
APRX	APPROXIMATE
APVD	APPROVED ARCH ARCHITECTURAL
ASSY	ASSEMBLY
AT	AMP TRIP
ATM	ATMOSPHERE
AUTO	AUTOMATIC
AUX	AUXILIARY
AVE	AVENUE
AVG	AVERAGE
AWG	AMERICAN WIRE GAGE
B/B	BACK TO BACK
BAL	BALANCE
BBD	BULLETIN BOARD
BC	BASE CABINET, BOTTOM CHORD, BOLT CENTER, BOLT CIRCLE
BD	BOARD
BE	BOTH ENDS, BELL END
BF	BOTH FACES, BOTTOM FACE, BLIND FLANGE, BOARD FEET
BFV	BUTTERFLY VALVE
BITUM	BITUMINOUS
BKG	BACKING
BL	BASE LINE
BLDG	BUILDING
BLK	BLOCK
BLKG	BLOCKING
BM	BENCHMARK, BEAM
BOC	BACK OF CURB
BOD	BOTTOM OF DUCT
BOG	BOTTOM OF GRILLE
BOL	BOTTOM OF LOUVER
BOP	BOTTOM OF PIPE
BOR	BOTTOM OF REGISTER
BOT	BOTTOM
BOU	BOTTOM OF UNIT
BP	BASE PLATE
BRG	BEARING
BRGP	BEARING PLATE
BRKT	BRACKET
BS	BOTH SIDES
BTU	BRITISH THERMAL UNIT
BTW	BETWEEN
BTWLD	BUTT WELD
BV	BALL VALVE
BW	BOTH WAYS
BYP	BYPASS
C TO C	CENTER TO CENTER
C&G	CURB & GUTTER
C	CHANNEL SHAPE, CENTIGRADE, CONDUIT, CIVIL (DRAWING DISCIPLINE)
CAP	CAPACITY
CAT	CATALOG
CAV	CAVITY
CB	CATCH BASIN
CCB	CONCRETE BLOCK
CCW	COUNTER CLOCKWISE
CF	CUBIC FEET (FOOT)
CHFR	CHAMFER
CHD	CHORD
CHH	COMMUNICATION HANDHOLE
CI	CURB INLET
CIP	CAST-IN-PLACE
CIPB	CONCRETE INTERLOCKING PAVER BALLAST
CIRC	CIRCULATION, CIRCULAR
CJ	CONSTRUCTION JOINT, CONTROL JOINT
CKT	CIRCUIT
CL	CENTERLINE, CLASS, CLOSE
CLR	CLEAR
CMH	COMMUNICATION MANHOLE
CMU	CONCRETE MASONRY UNIT
CO	CLEAN OUT, CONCRETE OPENING
COL	COLUMN
COM	COMMON
COMB	COMBINATION
COMM	COMMUNICATION
COMP	COMPOSITION, COMPRESSIBLE, COMPOSITE
CONC	CONCENTRIC, CONCRETE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS, CONTINUED
COORD	COORDINATE
CORR	CORROSIVE, CORRUGATED
CP	CHECKER PLATE, CONTROL POINT
CPLG	COUPLING
CSK	COUNTERSINK
CTR	CENTER
CTRL	CONTROL
CU	COPPER, CUBIC
CW	CLOCKWISE
CY	CUBIC YARD
d	PENNY (NAIL MEASURE)
D	DEEP, DIFFUSER
DB	DUCT BANK, DECIBEL, DRY BULB
DBA	DEFORMED BAR ANCHOR
DBL	DOUBLE
DC	DIRECT CURRENT
DEG	DEGREE
DEG C	DEGREE CENTIGRADE
DEG F	DEGREE FAHRENHEIT
DEMO	DEMOLITION
DEP	DEPRESSED
DEPT	DEPARTMENT
DET	DETAIL
DI	DROP INLET, DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL, DIAGRAM
DIFF	DIFFERENTIAL, DIFFERENCE
DIM	DIMENSION
DISCH	DISCHARGE
DIST	DISTANCE, DISTRIBUTION
DIV	DIVISION
DL	DEAD LOAD
DN	DOWN
DP	DEPTH
DS	DOWN SPOUT
DT	DOUBLE TEE, DRIP TRAP ASSEMBLY
DUP	DUPLICATE
DWG	DRAWING
DWL	DOWEL
E	EAST, ELECTRICAL (DWG DISCIPLINE)
EA	EACH, EXHAUST AIR
EC	ELECTRICAL CONTRACTOR
ECC	ECCENTRIC
EDB	ELECTRICAL DUCT BANK
EE	EACH END
EF	EACH FACE
EG	EXISTING GRADE
EGL	ENERGY GRADE LINE
EFF	EFFLUENT, EFFICIENCY
EHH	ELECTRICAL HANDHOLE
EIFS	EXTERIOR INSULATION & FINISH SYSTEM
EJ	EXPANSION JOINT
EL	ELBOW, ELEVATION
ELEC	ELECTRICAL
EMBD	EMBEDDED
EMER	EMERGENCY
EMH	ELECTRICAL MANHOLE
ENCL	ENCLOSURE
ENGR	ENGINEER
ENTR	ENTRANCE
EOP	EDGE OF PAVEMENT
EOW	EDGE OF WATER
EQ	EQUAL
EQUIP	EQUIPMENT
EQUIV	EQUIVALENT
ES	EACH SIDE, EQUAL SPACE, EMERGENCY SHOWER
ESEW	EMERGENCY SHOWER AND EYE WASH
EST	ESTIMATE
EW	EACH WAY, EMERGENCY EYE/FACE WASH
EWC	ELECTRIC WATER COOLER
EWEF	EACH WAY, EACH FACE
EWTB	EACH WAY, TOP AND BOTTOM
EXC	EXCAVATION
EXH	EXHAUST
EXIST	EXISTING
EXP	EXPANSION, EXPOSED
EXT	EXTERIOR, EXTERNAL, EXTENSION
F TO F	FACE TO FACE
FAB	FABRICATE
FBO	FURNISHED BY OWNER
FC	FLUSHING CONNECTION
FCA	FLANGED COUPLING ADAPTER
FCV	FIXED CONE VALVE
FD	FLOOR DRAIN
FDC	FLEXIBLE DUCT CONNECTION
FDR	FEEDER
FE	FLANGED END
FEC	FIRE EXTINGUISHER CABINET
FEXT	FIRE EXTINGUISHER
FF	FAR FACE, FACTORY FINISH, FLAT FACE
FG	FINISHED GRADE
FIG	FIGURE
FH	FIRE HYDRANT
FIN	FINISH
FL	FLOW, FLOW LINE
FLEX	FLEXIBLE
FLG	FLANGE
FLOR	FLUORESCENT
FLR	FLOOR
FLS	FLASHING, FLUSH
FND	FOUNDATION
FNC	FENCE
FO	FINISHED OPENING
FOB	FLAT ON BOTTOM
FOC	FACE OF CONCRETE, FACE OF CURB, FIBER OPTIC CABLE
FOF	FACE OF FINISH
FOM	FACE OF MASONRY
FOS	FACE OF STUDS
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FR	FRAME
FRP	FIBERGLASS REINFORCED PLASTIC
FS	FLOOR SINK, FAR SIDE
FT	FEET, FOOT
FTG	FOOTING, FITTING FUR FURRED, FURRING
FURN	FURNITURE, FURNISH
FUT	FUTURE
FV	FACE VELOCITY
FW	FIELD WELD, FIRE WALL
FWD	FORWARD
FWE	FURNISHED WITH EQUIPMENT
FXTR	FIXTURE
G	GRILLE, GROUND, GENERAL (DWG DISCIPLINE)
GA	GAGE (METAL THICKNESS)
GAL	GALLON
GALV	GALVANIZED
GB	GRADE BREAK
GD	GUARD
GEN	GENERAL
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GL	GLASS
GP	GUY POLE
GR	GRADE
GRND	GROUND
GRTG	GRATING
GT	GREASE TRAP
GWB	GYPSUM WALLBOARD
GYP	GYPSUM HARDBOARD
H	HIGH
HB	HOSE BIB
HBD	HARDBOARD
HC	HANDICAPPED, HOLLOW CORE, HORIZONTAL CURVE
HC	HORIZONTAL CENTERLINE
HDR	HEADER
HDW	HARDWARE
HEX	HEXAGONAL
HH	HANDHOLE
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HIGH POINT, HORSEPOWER
HPC	HORIZONTAL POINT OF CURVATURE
HPS	HIGH PRESSURE SODIUM
HPT	HORIZONTAL POINT OF TANGENCY
HR	HOUR
HS	HEADED STUD, HIGH STRENGTH
HSS	HOLLOW STRUCTURAL SHAPE
HT	HEIGHT
HV	HIGH VOLTAGE
HVAC	HEATING, VENTILATION & AIR CONDITIONING
HWD	HARDWOOD
HWL	HIGH WATER LEVEL
HYD	HYDRAULIC HZ HERTZ, CYCLES PER SECOND
I	INSTRUMENTATION (DWG DISCIPLINE)
ID	INSIDE DIAMETER, INTERIOR DIMENSION
IE	INVERT ELEVATION
IF	INSIDE FACE
IFC	ISSUED FOR CONSTRUCTION
IH	INTAKE HOOD
IMP	IMPACT
IN	INCH
INC	INCLUDE, INCANDESCENT
INF	INFLUENT
INSTR	INSTRUMENTATION
INSUL	INSULATION
INT	INTERIOR, INTERSECTION
INTR	INTERMEDIATE, INTERIOR
INV	INVERT
IPS	IRON PIPE SIZE
IPT	INTERNAL PIPE THREAD
IRR	IRRIGATION
ISO	ISOMETRIC
JB	JUNCTION BOX
JCT	JUNCTION
JF	JOINT FILLER
JT	JOINT
K	KIP
KB	KNEE BRACE
KCMIL	THOUSAND CIRCULAR MILS
KD	KNOCK DOWN
KO	KNOCK OUT
KSI	KIPS PER SQUARE INCH
L	ANGLE, LENGTH, LAVATORY
LAM	LAMINATE
LATL	LATERAL
LB	LAG BOLT, POUND
LDR	LEADER
LF	LINEAR FOOT
LG	LONG
LH	LEFT HAND
LIN	LINEAR
LIQ	LIQUID
LL	LIVE LOAD
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LMLU	LIQUID MARKER LECTURE UNIT
LNG	LONGITUDINAL
LOC	LOCATION
LP	LOW POINT
LPS	LOW PRESSURE SODIUM
LR	LONG RADIUS
LT	LEFT
LTD	LIMITED
LTG	LIGHTING
LTL	LINTEL
LTNG	LIGHTNING
LV	LOW VOLTAGE
LVR	LOUVER
LW	LIGHTWEIGHT
LWC	LIGHTWEIGHT CONCRETE
LWL	LOW WATER LEVEL
M	MECHANICAL (DWG DISCIPLINE)
MA	MIXED AIR
MAINT	MAINTENANCE
MAN	MANUAL
MAOP	MAXIMUM ALLOWABLE OPERATING PRESSURE
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MBR	MEMBER
MCJ	MASONRY CONTROL JOINT
MECH	MECHANICAL
MED	MEDIUM
MFR	MANUFACTURER
MH	MANHOLE, METAL HALIDE
MIN	MINIMUM
MIR	MIRROR
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MMB	MEMBRANE
MO	MASONRY OPENING
MOD	MODULAR, MODIFY
MON	MONUMENT
MPT	MALE PIPE THREAD
MSL	MEAN SEA LEVEL
MT	MOUNT
MU	MASONRY UNIT
MULL	MULLION
MV	MEDIUM VOLTAGE
MW	MONITORING WELL
N	NORTH, NEUTRAL
NA	NOT APPLICABLE
NAT	NATURAL
NC	NORMALLY CLOSED
NEG	NEGATIVE
NF	NEAR FACE, NON-FUSED
NG	NATURAL GAS
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN, NUMBER
NOM	NOMINAL
NPS	NOMINAL PIPE SIZE
NPT	NATIONAL PIPE THREAD
NS	NEAR SIDE
NTS	NOT TO SCALE
NWL	NORMAL WATER LEVEL
O TO O	OUT-TO-OUT
OA	OUTSIDE AIR, OVERALL
OC	ON CENTER
OCPD	OVER CURRENT PROTECTION DEVICE
OD	OUTSIDE DIAMETER
OH	OVERHEAD
OPNG	OPENING
OPP	OPPOSITE
OPT	OPTIONAL
ORD	OVERFLOW ROOF DRAIN
ORIG	ORIGINAL
OVFL	OVERFLOW
OVHG	OVERHANG
OZ	OUNCE
P	PAINT, PROCESS (DWG DISCIPLINE)
PAR	PARALLEL, PARAPET
PB	PANIC BAR, PULL BOX
PBD	PARTICLE BOARD
PC	POINT OF CURVE, PIECE, PRECAST
PCC	POINT OF COMPOUND CURVATURE
PCF	POUNDS PER CUBIC FOOT
PCT	PERCENT
PE	PLAIN END
PED	PEDESTAL
PEN	PENETRATION
PERF	PERFORATED
PERM	PERMANENT
PERP	PERPENDICULAR
PF	POWER FACTOR
PH	PHASE
PI	POINT OF INTERSECTION
PKG	PACKAGE
PL	PLATE, PROPERTY LINE
PLBG	PLUMBING
PLF	POUNDS PER LINEAR FOOT
PNEU	PNEUMATIC
POS	POSITIVE, POSITION
PP	POLYPROPYLENE, POWER POLE
PRC	POINT OF REVERSE CURVATURE
PREF	PREFINISHED
PREFAB	PREFABRICATED
PRELIM	PRELIMINARY
PREP	PREPARE
PRES	PRESSURE
PROP	PROPERTY
PROT	PROTECTION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAGE
PT	POINT, POINT OF TANGENCY
PTN	PARTITION
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
PWD	PLYWOOD
PZ	PIEZOMETER
Q	RATE OF FLOW
QTR	QUARTER
QTY	QUANTITY
QUAL	QUALITY
R&R	REMOVE AND REPLACE
R&S	REMOVE AND SALVAGE
R	RADIUS, REGISTER, RISER
RA	RETURN AIR
RB	RESILIENT BASE, ROCK BERM
RCPT	RECEPTACLE
RD	ROOF DRAIN
REC	RECESS
RECD	RECEIVED
RECT	RECTANGULAR
RED	REDUCER
REF	REFERENCE
REINF	REINFORCING
REQD	REQUIRED
RESIL	RESILIENT
RET	RETAINING, RETURN
REV	REVISION, REVERSE
RFL	REFLECTED, REFLECTOR
RGS	RIGID GALVANIZED STEEL
RH	RELIEF HOOD, RIGHT HAND, RELATIVE HUMIDITY
RL	REQUIRED LAP
RND	ROUND
RNG	RENEWABLE NATURAL GAS
RO	ROUGH OPENING
ROW	RIGHT-OF-WAY
RPM	REVOLUTIONS PER MINUTE
RR	RAILROAD
RT	RIGHT
S	SOUTH, SINK, STRUCTURAL (DWG DISCIPLINE)
SA	SUPPLY AIR
SAN	SANITARY
SC	SOLID CORE
SCH	SCHEDULE
SCHEM	SCHEMATIC
SCRN	SCREEN
SE	STEEL/ALUMINUM EDGE
SEC	SECONDARY, SECONDS
SECT	SECTION
SEP	SEPARATE
SF	SQUARE FOOT
SH	SHOWER
SHT	SHEET
SHTG	SHEATHING
SIM	SIMILAR
SL	SLOPE
SLTD	SLOTTED
SLV	SLEEVE
SMLS	SEAMLESS
SOG	SLAB ON GRADE
SP	SOUNDPROOF, STANDPIPE
SPC	SPACING
SPEC	SPECIFICATION
SPLY	SUPPLY
SPT	SET POINT
SQ	SQUARE
SS	SERVICE SINK
SST	STAINLESS STEEL
ST	STREET
STA	STATION
STD	STANDARD
STIF	STIFFENER
STIR	STIRRUP
STL	STEEL
STOR	STORAGE
STR	STRUCTURAL, STRAIGHT
SUB	SUBSTITUTE
SUC	SUCTION
SUSP	SUSPENDED
SY	SQUARE YARD
SYM	SYMBOL
SYMM	SYMMETRICAL
SYN	SYNTHETIC
SYS	SYSTEM
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
T	TILE, TREAD
TA	TEMPERED AIR
TAN	TANGENT
TBM	TEMPORARY BENCHMARK
TEMP	TEMPORARY, TEMPERATURE
THK	THICK
THRD	THREAD
THRU	THROUGH
TOB	TOP OF BOLT, TOP OF BANK, TOP OF BEAM
TOC	TOP OF CURB, TOP OF CONCRETE
TOD	TOP OF DUCT
TOF	TOP OF FOOTING
TOG	TOP OF GRATING
TOL	TOLERANCE, TOP OF LEDGER
TOM	TOP OF MASONRY
TOP	TOP OF PLATE
TOPO	TOPOGRAPHY
TOS	TOP OF SLAB, TOP OF STEEL
TOW	TOP OF WALL
TP	TELEPHONE POLE, TOE PLATE, TRAP PRIMER
TPG	TOPPING
TRANS	TRANSITION
TRD	TRENCH DRAIN
TYP	TYPICAL
U	URINAL
UG	UNDERGROUND
ULT	ULTIMATE
UNFN	UNFINISHED
UNO	UNLESS NOTED OTHERWISE
UTIL	UTILITY
V	VENT, VELOCITY, VOLT
VA	VOLT AMPERE
VAC	VACUUM
VAR	VARNISH, VARIABLE, VOLT AMPERES REACTIVE
VB	VAPOR BARRIER, VINYL BASE, VALVE BOX
VC	VERTICAL CURVE
VCT	VINYL COMPOSITION TILE, VERTICAL CENTERLINE
VEL	VELOCITY
VENT	VENTILATION
VERT	VERTICAL
VS	VERSES, VAPOR SEAL
VOL	VOLUME
VPC	VERTICAL POINT OF CURVATURE
VPI	VERTICAL POINT OF INTERSECTION
VPT	VERTICAL POINT OF TANGENCY
VTR	VENT THROUGH ROOF
VWC	VINYL WALL COVERING
W/	WITH
W/O	WITHOUT
W	WATT, WEST, WIDE, WINDOW, WIRE, WIDE FLANGE BEAM
WC	WATER CLOSET, WATER COLUMN
WD	WIDTH
WF	WIDE FLANGE, WASH FOUNTAIN
WG	WIRE GLASS, WATER GAGE
WH	WALL HYDRANT, WEEP HOLE
WL	WATER LEVEL
WLD	WELDED
WM	WIRE MESH
WP	WATERPROOF, WORKING POINT
WTHP	WEATHERPROOF
WS	WATERSTOP, WATER SURFACE
WSEL	WATER SURFACE ELEVATION
WT	WEIGHT, WATER TIGHT
WWF	WELDED WIRE FABRIC
XS	EXTRA STRONG
XXS	DOUBLE EXTRA STRONG
XSECT	CROSS SECTION
YH	YARD HYDRANT
YS	YIELD STRENGTH

AGENCY AND PROJECT ABBREVIATIONS:

KRRC	KLAMATH RIVER RENEWAL CORPORATION
KRRP	KLAMATH RIVER RENEWAL PROJECT
OHWM	ORDINARY HIGH WATER MARK

GENERAL NOTES:

1. THESE ABBREVIATIONS APPLY TO THE ENTIRE SET OF CONTRACT DRAWINGS.
2. LISTING OF ABBREVIATIONS DOES NOT IMPLY ALL ABBREVIATIONS ARE USED IN THE CONTRACT DRAWINGS.
3. ABBREVIATIONS SHOWN ON THIS SHEET INCLUDE VARIATIONS OF THE WORD. FOR EXAMPLE, "MOD" MAY MEAN MODIFY OR MODIFICATION; "INC" MAY MEAN INCLUDED OR INCLUDING; "REINF" MAY MEAN EITHER REINFORCE OR REINFORCING.
4. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.
5. SEE SHEET PF001 FOR PROJECT SPECIFIC EQUIPMENT SYMBOLS, EQUIPMENT ABBREVIATIONS AND PIPING SYSTEM ABBREVIATIONS.

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\G003.dwg Plot date: Feb 05, 2021 04:54pm, CAD User: rooney

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

CITY OF YREKA WATER LINE

STANDARD ABBREVIATIONS

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING

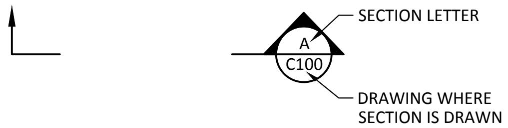
G003

JOB NO: 000000

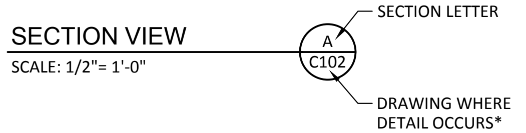
SHEET SYMBOLS

SECTION IDENTIFICATION

(1) SECTION CUT ON DRAWING C102:

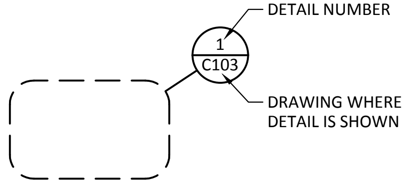


(2) ON DRAWING C103 THIS SECTION IS IDENTIFIED AS:

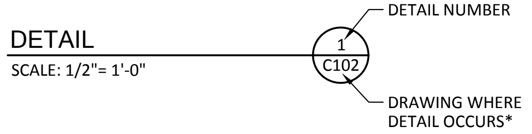


DETAIL IDENTIFICATION

(1) DETAIL CALL-OUT ON DRAWING C102:



(2) ON DRAWING C103 THIS SECTION IS IDENTIFIED AS:

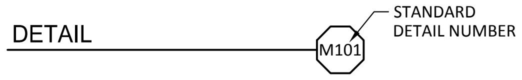


*NOTE: IF PLAN AND SECTION (OR DETAIL CALL-OUT AND DETAIL) ARE SHOWN ON SAME DRAWING. DRAWING NUMBER IS REPLACED BY A LINE.

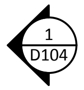
STANDARD DETAIL IDENTIFICATION

(1) DETAIL CALL-OUT ON PLAN OR SECTION:

(2) ON DETAIL DRAWINGS, IDENTIFIED AS:



ELEVATION/IMAGE IDENTIFICATION



SITE PLAN LINE TYPES

—— X —— X ——	FENCE LINE
—— P —— P ——	OVERHEAD POWER
—— 455 ——	MAJOR CONTOUR
—— 456 ——	MINOR CONTOUR
—— ··· ——	EDGE OF WATERLINE
—— TOE ——	TOE OF SLOPE
—— TOB ——	TOP OF BANK
—— SS —— SS ——	SANITARY SEWER
—— SD —— SD ——	STORM DRAIN
—— EP —— EP ——	EDGE OF PAVEMENT
—— EG —— EG ——	EDGE OF GRAVEL
—— W ——	WATTLE
—— CF —— CF ——	CONSTRUCTION FENCE
—— GAS ——	GAS LINE
—— IRR —— IRR ——	IRRIGATION LINE
—— WTR ——	WATER LINE
—— TEL ——	TELEPHONE LINE
—— COM ——	COMMUNICATION LINE
—— OHP ——	OVERHEAD ELECTRICAL/POWER
—— EUG ——	UNDERGROUND ELECTRICAL
—— P/L ——	PROPERTY LINE
—— OHP ——	EXISTING OVERHEAD POWER LINE
—— OHP&T ——	EXISTING OVERHEAD POWER & TELEPHONE LINE
—— T ——	EXISTING OVERHEAD TELEPHONE LINE
—— BT ——	EXISTING BURIED TELEPHONE LINE EVIDENCED BY PEDESTALS & WARNING PADDLES
—×—×—×—×—×—	EXISTING FENCE LINE
———— — — ————	PROJECT BOUNDARY
—○——○——○——○—	TREE PROTECTION FENCE
—— TC ——	TURBIDITY CURTAIN
├┼┼┼┼┼┼┼┼┼┼┤	COFFERDAM

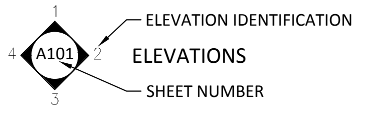
SITE PLAN SYMBOLS

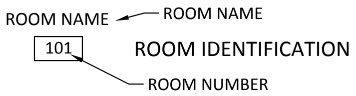
N	ARROW INDICATES DIRECTION OF PLAN NORTH
	CONIFER TREE: FIR, SPRUCE, LARCH OR PINE, 8" DIAMETER OR LARGER.
	DECIDUOUS TREE: COTTONWOOD, HAWTHORN, ASPEN, 8" DIAMETER OR LARGER.
○ MH	MANHOLE
□ EB	ELECTRIC BOX
◎	STORM DRAIN MANHOLE
● FH	FIRE HYDRANT
● YH-X	YARD HYDRANT
⊠	SURVEY CONTROL POINT, AS NOTED.
	POLE ANCHOR
	POWER POLE
	LIGHT POLE
	SIGN
□	SURVEY HUB
	SECTION CORNER
○	BENCH MARK
	EXISTING HEADWALL
	EXISTING MONITORING STATION
—— X —— X ——	EXISTING FENCE
+	STATE PLANE COORDINATE MARKER
	EXISTING TREE LINE
□	EXISTING BUILDING, STRUCTURES
	EXISTING SECTION CORNER MONUMENT FOUND AS DESCRIBED
	EXISTING 5/8" REBAR CONTROL POINT MONUMENT, BORING LOCATION
□W	EXISTING HOSE BIB
P	EXISTING PORTABLE IRRIGATION WATER PUMP
⊙ WELL	EXISTING 6" WATER WELL
	EXISTING ELECTRICAL OUTLET
P	EXISTING POWER POLE
□T	EXISTING TELEPHONE PEDESTAL
	CONTROL POINT
	PUMP
	PUMP
TP	TEST PIT LOCATION

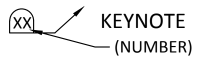
MISCELLANEOUS SYMBOLS

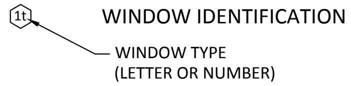
	CHANGE OF PIPE MTL
OR	END OF PIPE
℄	CENTERLINE
Ø	DIAMETER
∠	ANGLE
℘	PLATE
±	PLUS/MINUS

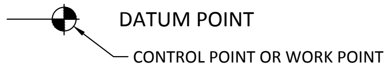
ARCHITECTURAL SYMBOLS

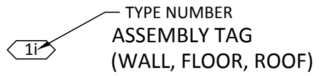




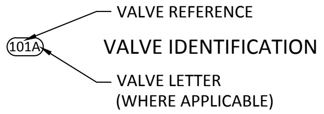




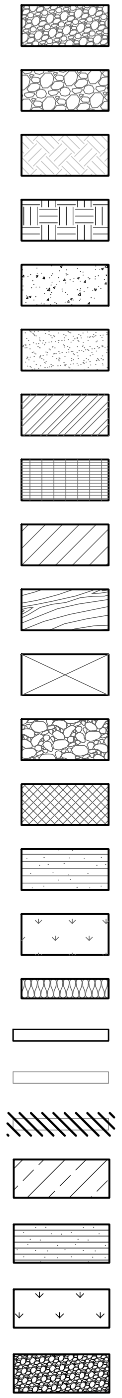




MECHANICAL SYMBOLS



HATCH SYMBOLS



- ROCK, TYPE AS NOTED (PLAN/SECTION)
- BED ROCK
- EXISTING GRADE (SECTION)
- NEW SOIL (SECTION)
- CONCRETE (SECTION/PLAN)
- SAND, GROUT (PLAN/SECTION)
- STEEL (SECTION)
- GRATING (PLAN)
- MASONRY (PLAN)
- WOOD, SIZE/TYPE AS NOTED (PLAN)
- WOOD, SIZE/TYPE AS NOTED (SECTION)
- RIP RAP (PLAN/SECTION)
- RIGID INSULATION (SECTION)
- ASPHALT CONCRETE PAVEMENT SURFACE (PLAN/SECTION)
- GRASS/VEGETATION (PLAN)
- BATT INSULATION (SECTION)
- NEW CONSTRUCTION
- EXISTING
- EXISTING TO BE REMOVED OR DEMOLISHED
- CLEARING AND GRUBBING
- ASPHALT
- GRASS/VEGETATION
- GRAVEL

GENERAL NOTES:

1. ALL SYMBOLS ARE NOT NECESSARILY USED. THIS IS A STANDARD DRAWING SHOWING COMMON SYMBOLS ON THIS PROJECT.
2. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH DRAWING FOR USAGE.

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\G004.dwg Plot date: Feb 05, 2021 04:54pm, CAD User: rooney

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
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PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

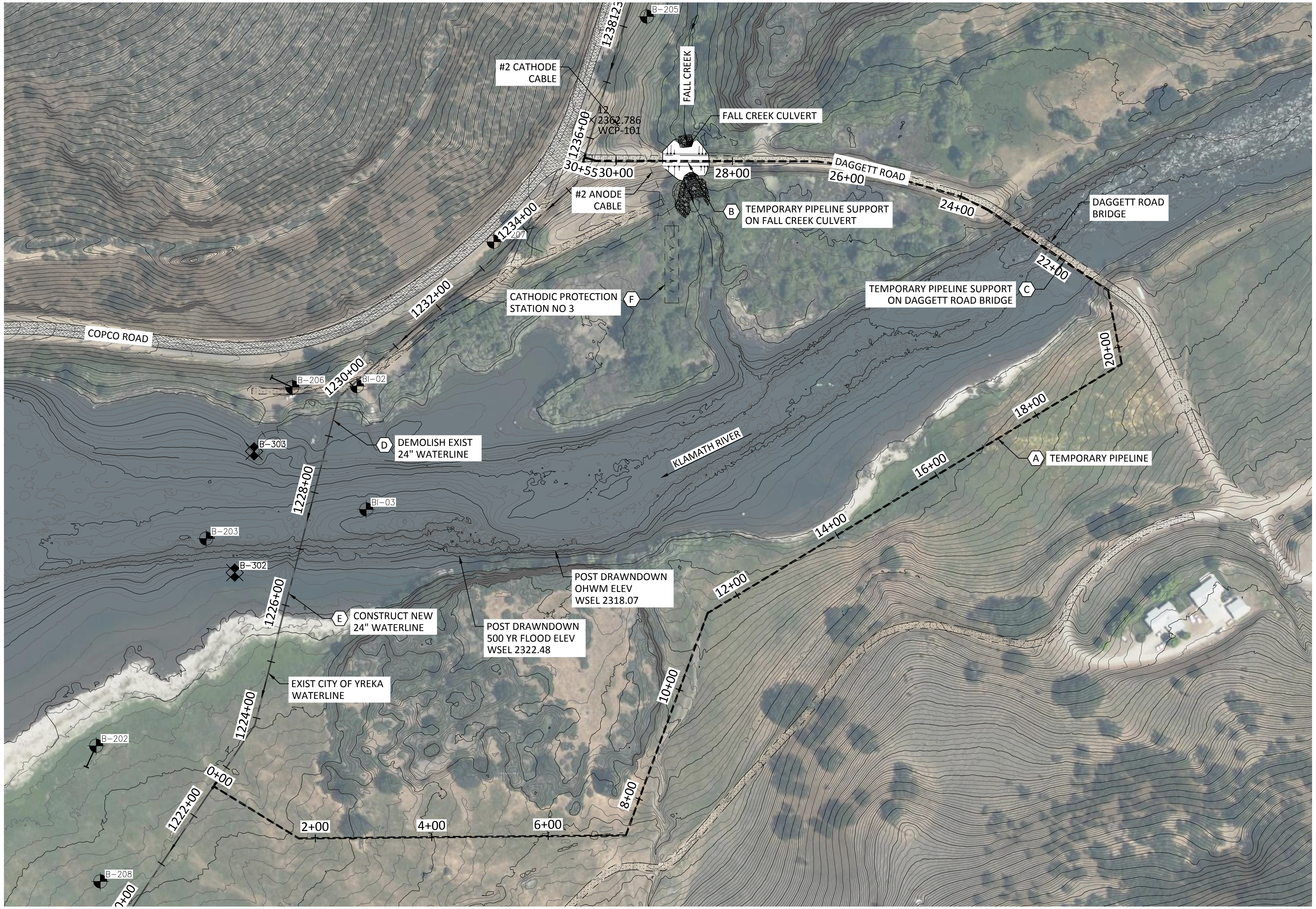
KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

STANDARD SYMBOLS

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
G004

JOB NO: 000000



OVERALL SITE PLAN

SCALE: 1"= 100'

0' 100' 200'

N

SHEET NOTES:

1. LIDAR SURVEY PROVIDED BY KRRC ON NOVEMBER 2020, CONTRACTOR SHALL CONFIRM AND VERIFY ELEVATIONS PRIOR TO CONSTRUCTION.
2. THE HORIZONTAL DATUM FOR THE PROJECT IS BASED UPON THE CALIFORNIA COORDINATE SYSTEM OF 1983, ZONE 1 NORTH AMERICAN DATUM OF 1983 (NAD83) IN FEET.
3. THE VERTICAL DATUM FOR THE PROJECT IS BASED UPON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88, GEOID 12B).

⬡ MAJOR CONSTRUCTION ITEMS:

A	CONSTRUCT NEW TEMPORARY PIPELINE.
B	SUPPORT THE TEMPORARY PIPELINE AT THE FALL CREEK CULVERT DURING CONSTRUCTION AND REMOVAL.
C	SUPPORT THE TEMPORARY PIPELINE ALONG THE DAGGETT ROAD BRIDGE DURING CONSTRUCTION AND REMOVAL.
D	DEMOLISH & DISPOSE OF EXISTING 24" DIAMETER WATERLINE. DISPOSE OF MATERIALS OFFSITE AT APPROVED LOCATION.
E	CONSTRUCT NEW 24" DIAMETER WATERLINE.
F	RETAIN AND PROTECT EXIST CATHODIC PROTECTION SYSTEM.

REV	DATE	BY	DESCRIPTION
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PRELIMINARY
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WARNING

0 1/2 1

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

CITY OF YREKA WATER LINE

OVERALL PLAN AND PROJECT CONTROL

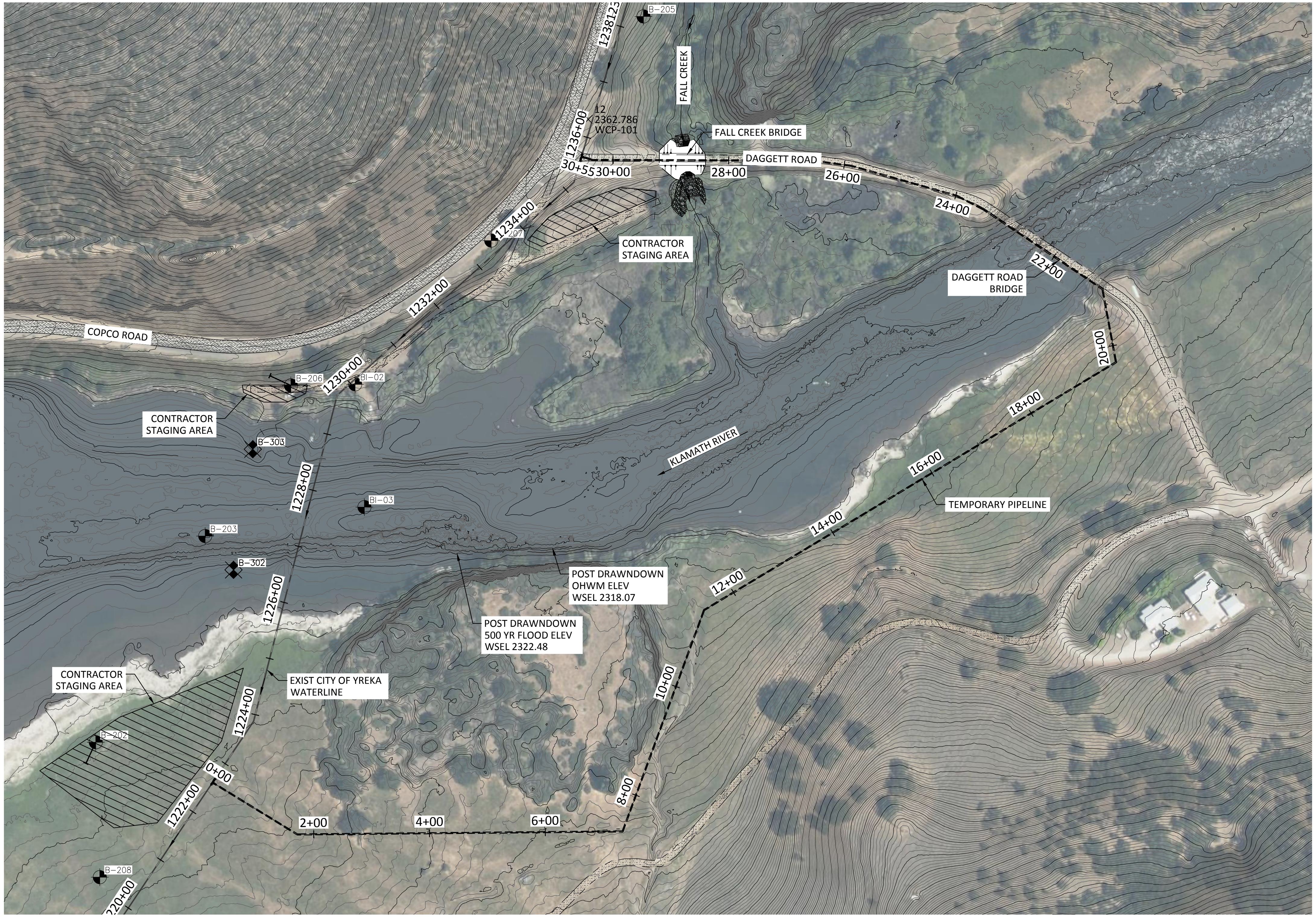
DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING

G005

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\G005.dwg Plot date: Feb 05, 2021 04:55pm, CAD User: rooney

JOB NO: 000000



CONTRACTOR STAGING AREA PLAN

SCALE: 1"= 100'

0' 100' 200'

N

SHEET NOTES:

1. CONTRACTOR SHALL COORDINATE LAYDOWN AND STAGING AREAS WITH OWNER.
2. CONTRACTOR SHALL DEVELOP A DETAILED ACCESS PLAN IN ACCORDANCE WITH SPECIFICATIONS AND SUBMIT FOR REVIEW AND APPROVAL BY OWNER PRIOR TO INITIATING CONSTRUCTION ACTIVITIES.
3. CONTRACTOR STAGING AREA IS SUGGESTED ONLY, AND WILL BE AT THE DISCRETION OF THE CONTRACTOR, SUBJECT TO APPROVAL BY THE OWNER AND ENGINEER.
4. THE CONTRACTOR SHALL MAKE ITS OWN ARRANGEMENTS FOR ANY NECESSARY OFF-SITE STORAGE OR SHOP AREAS AS NECESSARY FOR THE PROPER EXECUTION OF THE WORK.
5. THE CONTRACTOR SHALL DEVELOP AND SUBMIT TO THE ENGINEER A PLAN FOR STORING AND DISPOSING OF HAZARDOUS MATERIALS.
6. THE CONTRACTOR SHALL RESTORE THE STAGING AREAS AT PROJECT COMPLETION TO PRE CONSTRUCTION CONDITIONS.

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\G006.dwg Plot date: Feb 05, 2021 04:55pm, CAD User: rooney

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
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0 1/2 1
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

CITY OF YREKA WATER LINE

CONTRACTOR STAGING AREA

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
G006

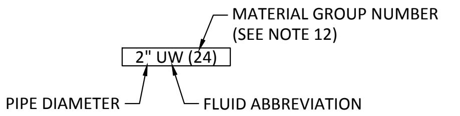
JOB NO: 000000

FLUID ABBREVIATION	FUNCTION	ALLOWABLE PIPING MATERIAL GROUP NO. (SEE NOTE 1 AND 4)				FIELD TEST REQUIREMENTS (SEE NOTE 3 AND NOTE 4)		
	THIS LIST MAY INCLUDE FLUIDS NOT USED IN THIS PROJECT	EXPOSED PIPING (SEE NOTE 14)		BURIED PIPING (SEE NOTE 13)		MINIMUM TEST PRESSURE PSI	TEST MEDIUM	LEAKAGE ALLOWANCE (SEE NOTE 2)
	(* SEE NOTE 5)	3" DIA AND SMALLER	4" DIA AND LARGER	3" DIA AND SMALLER	4" DIA AND LARGER			
COMMONLY USED FUNCTIONS								
RW	RAW WATER	--	6,8	--	6,8	175	WATER	(A)
VT	VENT AIR	2	2	2	2	15 IN Hg	VACUUM	(A) (D)

PIPING MATERIAL SCHEDULE (SEE NOTE 1)

GROUP NO.	PIPE MATERIAL	FITTINGS / JOINTS	LININGS AND COATINGS (SEE NOTE 13)
2	STEEL, ASTM A53, SCHEDULE 40, BLACK WELDED GALVANIZED	2 ½" AND SMALLER, MALLEABLE IRON, ASME B16.3, THREADED, BANDED, GALVANIZED 150 PSI. 3" AND LARGER, CAST IRON, ASME B16.1, 125 PSI FLANGED OR MECHANICAL COUPLING.	SEE SECTION 40 23 15
6	STEEL, ASTM A53, GRADE A, SCHEDULE 10, SEAMLESS, BLACK	STEEL, ASME B16.9, BUTT-WELDED.	SEE SECTION 40 23 15
8	WELDED STEEL PIPE, CEMENT MORTAR LINING, ¼" WALL THICKNESS (AWWA C200 & MODIFIED PER SECTION 331111) (ALL PIPE CALLOUT DIAMETERS ARE 'ID' OF CML)	WELDED STEEL, AWWA C208 MODIFIED PER SECTION 33 11 11, FABRICATED.	SEE SECTION 33 11 11

TYPICAL PIPE DESIGNATION:



NOTES:

NOTE 1
ALTHOUGH SEVERAL PIPE MATERIAL GROUPS MAY BE LISTED ON THIS SHEET FOR A GIVEN FLUID SERVICE, CONTRACTOR SHALL PROVIDE ONLY THE PIPE MATERIAL GROUP SHOWN ON THE DRAWINGS AND SPECIFIED FOR THAT FLUID SERVICE.

NOTE 2
LEAKAGE ALLOWANCE IS AS FOLLOWS
A. PIPES SO DESIGNATED SHALL SHOW ZERO LEAKAGE.
B. PIPES SO DESIGNATED SHALL SHOW ZERO LEAKAGE FOR UNBURIED PIPE AND NOT MORE THAN 0.02 GALLON PER HOUR PER INCH DIAMETER PER 100 FEET OF BURIED PIPE.
C. PIPES SO DESIGNATED SHALL NOT SHOW A LEAKAGE OF MORE THAN 0.15 GALLON PER HOUR PER INCH OF DIAMETER PER 100 FEET OF PIPE.
D. PIPES SO DESIGNATED SHALL NOT SHOW A LOSS OF PRESSURE OF MORE THAN 5 PERCENT.
E. PIPE SO DESIGNATED SHALL NOT SHOW A LOSS OF VACUUM OF MORE THAN 4 INCHES MERCURY COLUMN.

NOTE 3
FOR FIELD TEST PROCEDURES AND ADDITIONAL TEST REQUIREMENTS, SEE PIPING SECTION OF SPECIFICATIONS.

NOTE 4
NO SUBSTITUTIONS U.N.O. IN THE SPECIFICATIONS.

NOTE 5
PIPING GROUP FUNCTION SHOWN THUS * SHALL BE INSULATED PER SPECIFICATIONS.

NOTE 6
STATIC WATER TEST WITH SURFACE 5 FEET ABOVE HIGH POINT OF PIPE.

NOTE 7
INSPECTION AND TESTING SHALL BE IN ACCORDANCE WITH APPLICABLE PLUMBING CODE.

NOTE 8
NO APPARENT LEAKS UNDER NORMAL OPERATING CONDITIONS.

NOTE 9
INSPECTION AND TESTING SHALL BE IN ACCORDANCE WITH APPLICABLE NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS.

NOTE 10
PIPING MATERIALS SHALL BE IN ACCORDANCE WITH NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS.

NOTE 11
FOR VALVES 4" AND LARGER SEE VALVE SCHEDULE FOR SPECIAL VALVES SEE SPECIFICATIONS.

NOTE 12
CHANGE IN PIPING MATERIAL GROUP NUMBER IS INDICATED THUS: ——◆

NOTE 13
FOR FULL PIPE LINING AND COATING REQUIREMENTS, SEE SPECIFICATIONS.

NOTE 14
EXPOSED OUTDOOR PIPING SHALL BE PAINTED IN ACCORDANCE WITH SPECIFICATIONS. COLORS TO BE SELECTED BY OWNER.

NOTE 15
NOT USED

NOTE 16
NOT USED

NOTE 17
FOR HDPE PIPING THE SIZE OF PIPE SHOWN ON DRAWING CALL-OUTS SHALL BE THE MINIMUM INSIDE DIAMETER. PIPE WALL THICKNESS SHALL BE PER DR RATING REQUIREMENT.

VALVE SCHEDULE

VALVE NUMBER	LOCATION AND SERVICE	BODY, BONNET & DISC MATERIALS	VALVE TYPE, ENDS	DIAMETER	PRES. RATING (PSIG) OR CLASS	VALVE MFTR & SERIES # OR EQUAL	VALVE SHAFT/STEM AND HARDWARE	ACTUATOR TYPE, (NORMAL VALVE POSITION)
VAL-001	PERMANENT PIPE/RW ISOLATION, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	24	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (OPEN)
VAL-002	TEMPORARY PIPE/RW ISOLATION, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	24	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (CLOSED)
VAL-003	PERMANENT PIPE/RW ISOLATION, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	24	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (OPEN)
VAL-004	TEMPORARY PIPE/RW ISOLATION, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	24	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (CLOSED)
VAL-005	DRAIN PIPE/RW DRAIN, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	4	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (CLOSED)
VAL-006	DRAIN PIPE/RW DRAIN, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	4	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (CLOSED)
VAL-007	DRAIN PIPE/RW DRAIN, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	4	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (CLOSED)
VAL-008	DRAIN PIPE/RW DRAIN, 45-60F	AWWA C504 BUTTERFLY W/ DI ASTM A536D DI BODY & DISK	AWWA CLASS 275C VALMATIC BUTTERFLY VALVE, ASME B16.42 CLASS 300 FLANGE	4	CLASS 275C	VALMATIC 2700HP	ASTM A564, 17-4 PH SS/BUNA-N RESILIENT	2" OPERATING NUT (CLOSED)
AVAR - 001	TEMPORARY PIPE/ AIR & VAC RELEASE	ASTM A126 CLASS B, CLASS 250	AWWA VACUUM BREAKER VALVE, ASME B16.5 FLANGED	3	250LB CLASS	VALMATIC 1853AVB.1	SS ASTM A351 GRADE CF8M	DUAL BODY W/ FUSION BONDED EPOXY COATED INTERIOR & EXTERIOR
AVAR - 002	TEMPORARY PIPE/ AIR & VAC RELEASE	ASTM A126 CLASS B, CLASS 250	AWWA VACUUM BREAKER VALVE, ASME B16.5 FLANGED	3	250LB CLASS	VALMATIC 1853AVB.1	SS ASTM A351 GRADE CF8M	DUAL BODY W/ FUSION BONDED EPOXY COATED INTERIOR & EXTERIOR
AVAR - 003	TEMPORARY PIPE/ AIR & VAC RELEASE	ASTM A126 CLASS B, CLASS 250	AWWA VACUUM BREAKER VALVE, ASME B16.5 FLANGED	3	250LB CLASS	VALMATIC 1853AVB.1	SS ASTM A351 GRADE CF8M	DUAL BODY W/ FUSION BONDED EPOXY COATED INTERIOR & EXTERIOR
AVAR - 004	PERMANENT PIPE/ AIR & VAC RELEASE	ASTM A126 CLASS B, CLASS 250	AWWA VACUUM BREAKER VALVE, ASME B16.5 FLANGED	3	250LB CLASS	VALMATIC 1853AVB.1	SS ASTM A351 GRADE CF8M	DUAL BODY W/ FUSION BONDED EPOXY COATED INTERIOR & EXTERIOR

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WARNING
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

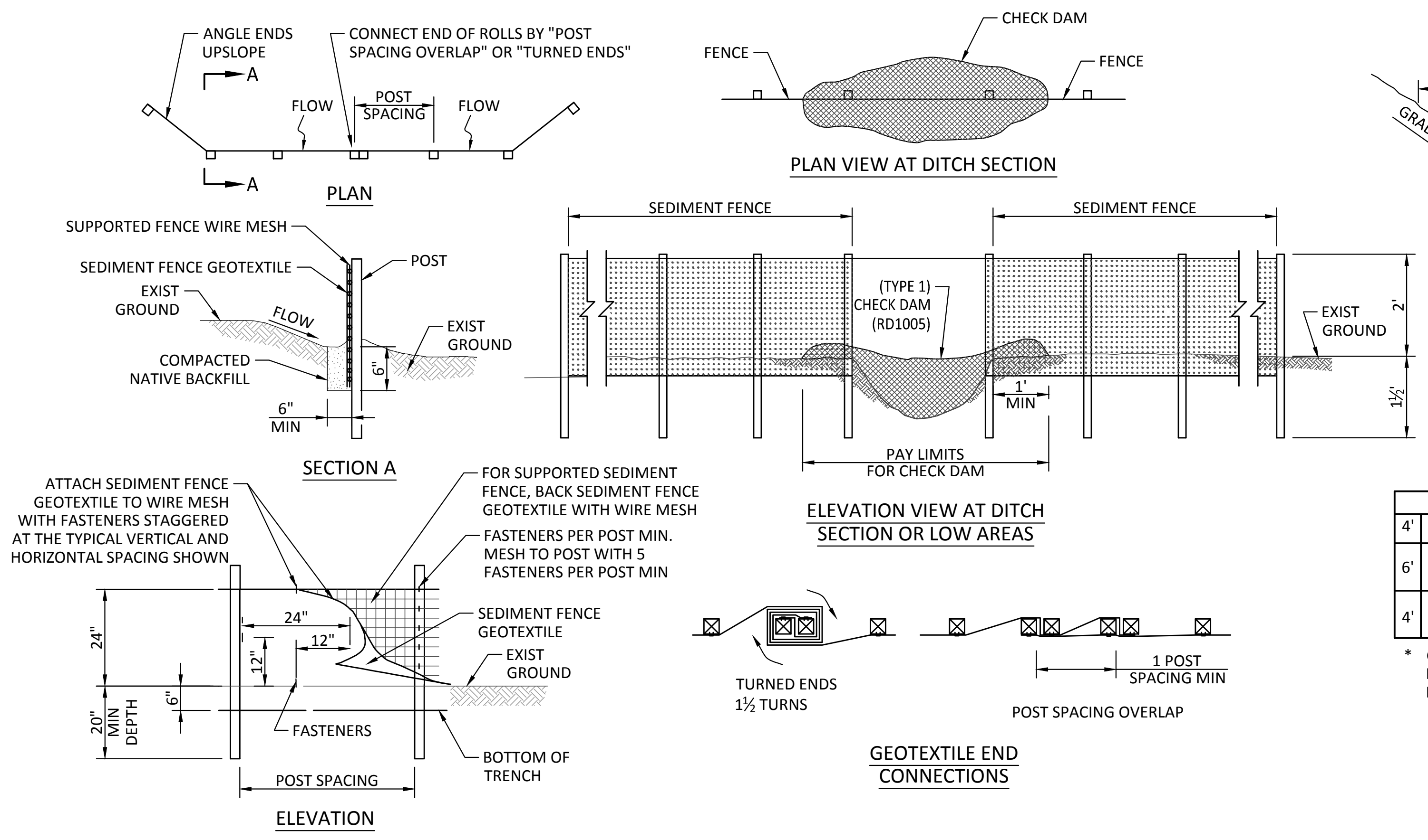
KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
PIPING AND VALVE SCHEDULE

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
G007

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\G007.dwg Plot date: Feb 05, 2021 04:55pm, CAD User: rooney

JOB NO: 000000



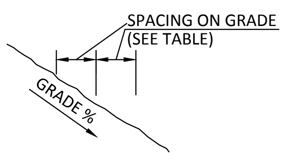


TABLE 1
FENCE SPACING FOR GENERAL APPLICATION

INSTALL PARALLEL ALONG CONTOURS AS FOLLOWS	
GRADE	MAXIMUM SPACING ON GRADE
GRADE ≤ 0%	300'
10% ≤ GRADE < 15%	150'
15% ≤ GRADE < 20%	100'
20% ≤ GRADE < 30%	50'
30% ≤ GRADE	25'

TABLE 2

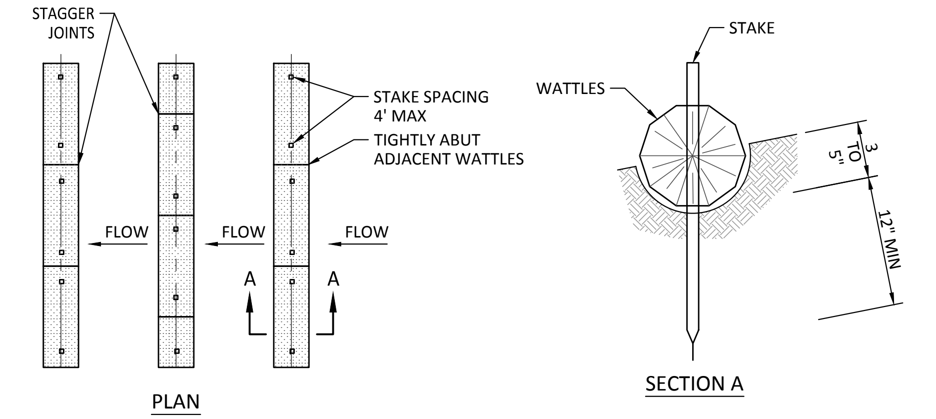
POST SPACING	
4'	SUPPORTED SEDIMENT FENCE
6'	UNSUPPORTED SEDIMENT FENCE WITH GEOTEXTILE ELONGATION * LESS THAN 50%
4'	UNSUPPORTED SEDIMENT FENCE WITH GEOTEXTILE ELONGATION * MORE THAN 50%

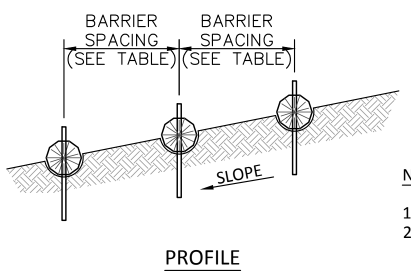
* GEOTEXTILE GRAB ELONGATION VALUE AS DOCUMENTED BY "LEVEL B" MANUFACTURER'S DOCUMENTATION (SEE STANDARD SPECIFICATIONS).

SILT FENCE DETAIL

SCALE: NTS

EC101





BARRIER SPACING FOR GENERAL APPLICATION

INSTALL PARALLEL ALONG CONTOURS AS FOLLOWS		
% SLOPE	% SLOPE	MAXIMUM SPACING ON SLOPE
10% FLATTER	1:10 OR FLATTER	300'
10 > % ≥ 15	10 > X ≥ 7.5	150'
15 > % ≥ 20	7.5 > X ≥ 5	100'
20 > % ≥ 30	5 > X ≥ 3	50'
STEEPER THAN 30%	STEEPER THAN 1:3	25'

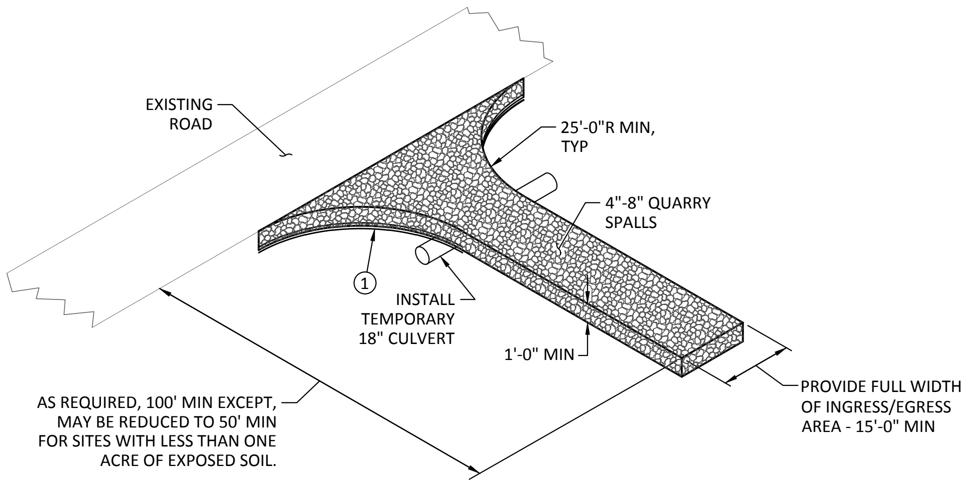
NOTES

1. INSTALL WATTLES ALONG CONTOURS.
2. WATTLES SHALL BE INSPECTED REGULARLY, AND IMMEDIATELY AFTER A RUNOFF PRODUCING RAINFALL, TO ENSURE THEY REMAIN THOROUGHLY ENTRENCHED AND IN CONTACT WITH THE SOIL.
3. INSTALL WATTLES SNUGLY INTO THE TRENCH. ABUT ADJACENT WATTLES TIGHTLY, END TO END, WITHOUT OVERLAPPING THE ENDS.
4. PILOT HOLES MAY BE DRIVEN THROUGH THE WATTLE AND INTO THE SOIL, WHEN SOIL CONDITIONS REQUIRE.

STRAW WATTLE/FIBER ROLL SEDIMENT BARRIER

SCALE: NTS

EC102

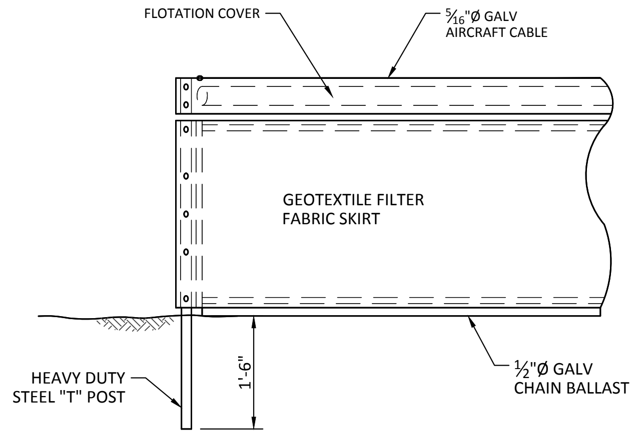


① PLACE CONSTRUCTION GEOTEXTILE FOR SOIL STABILIZATION AND A MINIMUM OF 0.15' CRUSHED ROCK UNDER THE SPALLS, FROM THE EDGE OF THE EXISTING ROADWAY TO THE RADIUS RETURNS, OR AS DIRECTED BY THE ENGINEER.

TEMPORARY ENTRANCE

SCALE: NTS

EC103



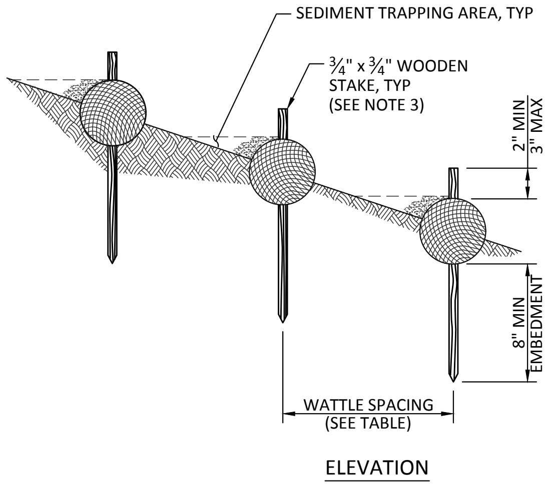
NOTE:

1. TURBIDITY BLANKET TO BE CSI GEOSYNTHETICS OR EQUAL.

TURBIDITY CURTAIN

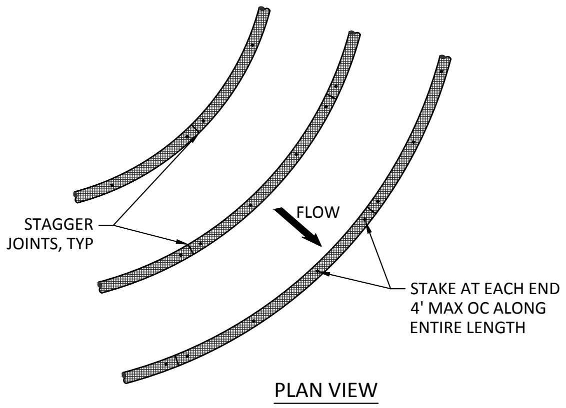
SCALE: NTS

EC105



WATTLE SPACING TABLE

SLOPE	MAXIMUM SPACING
1:1	10 FEET
2:1	20 FEET
3:1	30 FEET
4:1	40 FEET
>4:1	80 FEET



NOTES

1. INSTALL WATTLES ALONG CONTOURS. SEE TABLE FOR SPACING.
2. WATTLES SHALL BE INSPECTED REGULARLY, AND IMMEDIATELY AFTER A RUNOFF PRODUCING RAINFALL, TO ENSURE THEY REMAIN THOROUGHLY ENTRENCHED AND IN CONTACT WITH THE SOIL.
3. LIVE STAKES MAY BE USED FOR PERMANENT INSTALLATIONS.
4. INSTALL WATTLES SNUGLY INTO THE TRENCH. ABUT ADJACENT WATTLES TIGHTLY, END TO END, WITHOUT OVERLAPPING THE ENDS.
5. PILOT HOLES MAY BE DRIVEN THROUGH THE WATTLE AND INTO THE SOIL, WHEN SOIL CONDITIONS REQUIRE.
6. INSTALL AT TOE OF SLOPES. SLOPES GREATER THAN 15' IN LENGTH SHALL HAVE A WATTLE INSTALLED MID SLOPE.

WATTLE

SCALE: NTS

EC107

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

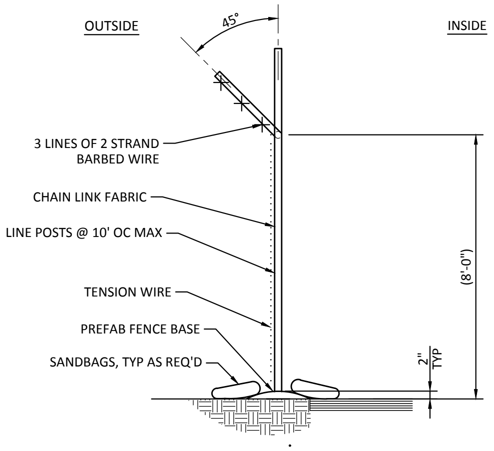
EROSION AND SEDIMENT CONTROL STANDARD DETAILS 1

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
EC001

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\EC001.dwg Plot date: Feb 05, 2021 04:55pm, CAD User: rooney



NOTES:

1. SEE SPECIFICATIONS FOR FENCE MATERIAL, COATINGS, AND INSTALLATION REQUIREMENTS.
2. EXTENSION ARM MAY BE TURNED IN AT OPTION OF OWNER.

CONSTRUCTION FENCING DETAIL

EC111

SCALE: NTS

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
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WARNING
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

CITY OF YREKA WATER LINE

EROSION AND SEDIMENT CONTROL STANDARD
DETAILS 2

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

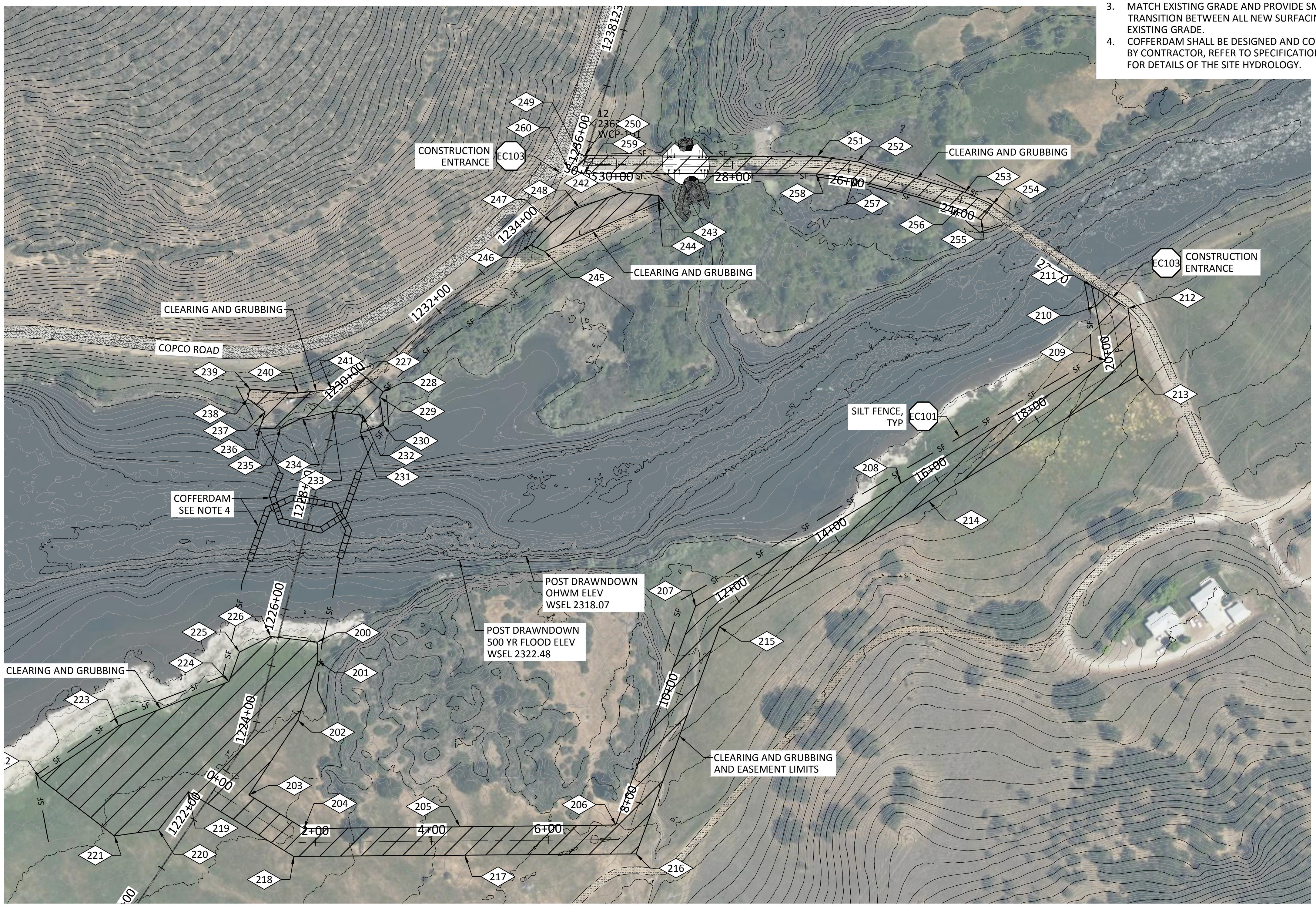
DRAWING
EC002

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\EC002.dwg Plot date: Feb 05, 2021 04:55pm, CAD User: rooney

JOB NO: 000000

SHEET NOTES:

1. THE EXPOSED AND DISTURBED AREAS SHALL BE REGRADED TO MATCH EXISTING AND RESEED WITH NATIVE GRASS PER OWNER REQUIREMENTS
2. ALL FILL MATERIALS AND COMPACTION REQUIREMENTS ARE DEFINED IN SPECIFICATION SECTION 31 00 00.
3. MATCH EXISTING GRADE AND PROVIDE SMOOTH TRANSITION BETWEEN ALL NEW SURFACING AND EXISTING GRADE.
4. COFFERDAM SHALL BE DESIGNED AND CONSTRUCTED BY CONTRACTOR, REFER TO SPECIFICATION 01 12 00 FOR DETAILS OF THE SITE HYDROLOGY.



EROSION AND SEDIMENT CONTROL PLAN

SCALE: 1"= 100'

0' 100' 200'

N

EROSION AND SEDIMENT CONTROL NOTES:

GENERAL NOTES:

1. THE CONTRACTOR SHALL SUBMIT AN EROSION AND SEDIMENT CONTROL PLAN FOR WORK DURING CONSTRUCTION THAT MEETS ALL FEDERAL, STATE, AND LOCAL REQUIREMENTS.
    A. THE CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTATION AND MAINTENANCE OF EROSION AND SEDIMENT CONTROL MEASURES (MULCHING OF STRAW, SAND DIVERSION DITCHES, ETC.) DICTATED BY FIELD CONDITIONS TO PREVENT EROSION OR THE INTRODUCTION OF DIRT, MUD, OR DEBRIS TO EXIST PUBLIC OR PRIVATE ROADWAY, ONTO ADJACENT PROPERTIES, INTO FALL CREEK, OR INTO KLAMATH RIVER DURING ANY PHASE OF CONSTRUCTION OPERATIONS. SPECIAL ATTENTION SHALL BE GIVEN TO ADDITIONAL EROSION AND SEDIMENT CONTROL MEASURES NOTED BELOW.
    B. THE GENERAL EROSION AND SEDIMENT CONTROL PLAN ON THE EC DRAWINGS ARE PROVIDED TO AID THE CONTRACTOR IN DEVELOPING THE EROSION AND SEDIMENT CONTROL PLAN ACCORDING TO CONTRACTOR SCHEDULE AND PHASING OF THE PROJECT.
    C. EROSION CONTROL DETAILS ARE FOR INFORMATION ONLY TO AID THE CONTRACTOR. THE FINAL LOCATIONS AND DETAIL SHALL BE SHOWN ON THE CONTRACTOR'S PREPARED STORMWATER POLLUTION PREVENTION PLAN (SWPPP) DOCUMENT.
    D. CONTRACTOR IS RESPONSIBLE TO PROVIDE ALL NECESSARY EROSION CONTROL MEASURES FOR THE DURATION OF THE PROJECT. MAINTENANCE OF BOTH TEMPORARY AND PERMANENT EROSION CONTROL MEASURES SHALL BE CONSIDERED INCIDENTAL.
    E. ALL BMP REQUIRED MATERIALS SHALL MEET OR EXCEED STATE OF CALIFORNIA STORMWATER QUALITY ASSOCIATION (CASQA) REQUIREMENTS.
    F. CONTRACTOR SHALL DEVELOP A SPILL PREVENTION, CONTAINMENT, AND RESPONSE PLAN THAT WILL BE ATTACHED TO THE SWPPP.

GRADING AND FINAL STABILIZATION:

1. CLEARING, GRUBBING, AND GROUND DISTURBING ACTIVITIES SHALL BE CONFINED TO WITHIN CLEARING LIMITS AND SHALL MEET THE REQUIREMENTS OF SPECIFICATION 31 11 00. NO GRADING OR CONSTRUCTION ACTIVITIES SHALL OCCUR OUTSIDE OF THE PROPOSED IMPROVEMENTS SHOWN ON THE CONSTRUCTION PLANS FOR THIS PROJECT. PRESERVE EXIST VEGETATION BEYOND DISTURBED AREA - UTILIZE AS NATURAL BUFFER STRIPS.
2. DURING CONSTRUCTION, PROVIDE POSITIVE DRAINAGE AWAY FROM FACILITIES.
3. CONTRACTOR SHALL REMOVE ALL TEMPORARY EROSION AND SEDIMENT CONTROL FACILITIES, FENCING, AND STAGING AREA MATERIALS WHEN CONSTRUCTION IS COMPLETE. NO CONSTRUCTION DEBRIS, DEMOLITION MATERIALS, OR EXCESS EQUIPMENT SHALL BE LEFT ON SITE.
4. CONTRACTOR SHALL REGRADE DISTURBED SLOPED TO NEAR EXIST CONDITION AS APPROVED BY THE OWNER.
5. ESTABLISH A TEMPORARY VEGETATIVE COVER ON ALL DISTURBED AREAS AS SOON AS PRACTICAL AFTER THE LAST GROUND DISTURBING ACTIVITIES IN THE AREA. CONTRACTOR SHALL RESEED ALL DISTURBED AREAS WITH NATIVE VEGETATION, PER SPECIFICATION 31 35 30, AND IN ACCORDANCE WITH SHEET EC100.

BMP MEASURES:

1. ALL RUNOFF FROM SITE CONSTRUCTION ACTIVITIES AND FROM RAINFALL EVENTS SHALL BE DETAINED ON SITE AND FILTERED PRIOR TO DISCHARGE. STORMWATER RUNOFF SHALL NOT BE ALLOWED TO LEAVE THE SITE UNTREATED (LADEN W/ SUSPENDED SEDIMENT). IF THIS OCCURS, THE CONTRACTOR WILL BE HELD SOLELY RESPONSIBLE FOR ANY PERMIT VIOLATIONS AND FINES.
2. CONTRACTOR SHALL TAKE APPROPRIATE MEASURES TO PREVENT ACCUMULATION OF CONSTRUCTION WASTE AND LITTER ON-SITE.
3. CONTRACTOR SHALL INSTALL SILT FENCE AND/OR STRAW WATTLES AS INDICATED AND IN ANY ADDITIONAL LOCATIONS WHERE MATERIAL COULD LEAVE THE CONSTRUCTION SITE, AT CONTRACTOR'S EXPENSE.
4. THE SILT FENCE AND/OR STRAW WATTLES SHALL BE INSTALLED PRIOR TO ANY CONSTRUCTION ACTIVITIES.
5. CONTRACTOR SHALL HAVE AVAILABLE AT ALL TIMES ADEQUATE SPRINKLER EQUIPMENT TO FACILITATE DUST ABATEMENT AND CONTROL. CONTRACTOR SHALL PROVIDE ALL WATER NECESSARY FOR SPRINKLER OPERATIONS.
6. STOCKPILED EXCAVATION MATERIALS SHALL BE PROTECTED FROM WATER AND WIND EROSION BY COVERING AS APPROPRIATE. WHEN EXPOSED FOR MORE THAN 14 DAYS, COVER STOCKPILES WITH IMPERMEABLE TARPS TO PROTECT DISTURBED SOILS AND SLOPES.
7. ALL TOP SOIL SHALL BE STRIPPED AND PLACED IN SEPARATE STOCKPILE. AFTER BANK RESTORATION TO EXIST GRADE, TOP SOIL SHALL BE PLACED AND RESEEDED.
8. CONTRACTOR SHALL HAVE ON-SITE AT ALL TIMES SPILL PREVENTION AND CONTROL MEASURES.
9. ENSURE ALL EQUIPMENT IS CLEAN AND FREE OF OIL/FUEL LEAKS, DIRT, PLANTS, AND ANIMALS OR FRAGMENTS OF PLANTS, AQUATIC INVASIVE SPECIES, AND OTHER VEGETATIVE MATTER.

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\EC100.dwg Plot date: Feb 05, 2021 04:56pm, CAD User: rooney

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A	12/18/20	MDM	50% DESIGN SUBMITTAL
REV	DATE	BY	DESCRIPTION

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WARNING
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
EROSION AND SEDIMENT CONTROL PLAN

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
EC100

JOB NO: 000000

CLEARING AND GRUBBING CONTROL POINTS

POINT NO	NORTHING	EASTING	DESCRIPTION
200	2601591.04	6461314.59	CLEARING AND GRUBBING LIMITS
201	2601559.03	6461315.82	CLEARING AND GRUBBING LIMITS
202	2601456.61	6461281.40	CLEARING AND GRUBBING LIMITS
203	2601328.69	6461197.31	CLEARING AND GRUBBING LIMITS
204	2601270.74	6461292.00	CLEARING AND GRUBBING LIMITS
205	2601273.82	6461559.72	CLEARING AND GRUBBING LIMITS
206	2601276.90	6461827.45	CLEARING AND GRUBBING LIMITS
207	2601652.33	6461964.53	CLEARING AND GRUBBING LIMITS
208	2601863.50	6462316.97	CLEARING AND GRUBBING LIMITS
209	2602074.68	6462669.41	CLEARING AND GRUBBING LIMITS
210	2602168.50	6462651.74	CLEARING AND GRUBBING LIMITS
211	2602203.04	6462644.91	CLEARING AND GRUBBING LIMITS
212	2602163.99	6462707.60	CLEARING AND GRUBBING LIMITS
213	2602049.59	6462724.69	CLEARING AND GRUBBING LIMITS
214	2601833.38	6462365.36	CLEARING AND GRUBBING LIMITS
215	2601617.18	6462006.03	CLEARING AND GRUBBING LIMITS
216	2601226.80	6461862.75	CLEARING AND GRUBBING LIMITS
217	2601225.07	6461568.41	CLEARING AND GRUBBING LIMITS
218	2601222.90	6461274.38	CLEARING AND GRUBBING LIMITS
219	2601333.65	6461093.42	CLEARING AND GRUBBING LIMITS
220	2601268.67	6461041.93	CLEARING AND GRUBBING LIMITS
221	2601258.02	6460966.22	CLEARING AND GRUBBING LIMITS
222	2601356.68	6460838.26	CLEARING AND GRUBBING LIMITS
223	2601447.10	6460973.34	CLEARING AND GRUBBING LIMITS
224	2601523.20	6461163.01	CLEARING AND GRUBBING LIMITS
225	2601573.73	6461181.16	CLEARING AND GRUBBING LIMITS
226	2601600.89	6461234.49	CLEARING AND GRUBBING LIMITS
227	2602056.30	6461384.92	CLEARING AND GRUBBING LIMITS
228	2602020.94	6461427.94	CLEARING AND GRUBBING LIMITS
229	2602011.59	6461422.01	CLEARING AND GRUBBING LIMITS

CLEARING AND GRUBBING CONTROL POINTS

POINT NO	NORTHING	EASTING	DESCRIPTION
230	2601963.28	6461428.54	CLEARING AND GRUBBING LIMITS
231	2601950.26	6461389.07	CLEARING AND GRUBBING LIMITS
232	2601980.79	6461392.94	CLEARING AND GRUBBING LIMITS
233	2601987.28	6461340.64	CLEARING AND GRUBBING LIMITS
234	2601976.38	6461289.67	CLEARING AND GRUBBING LIMITS
235	2601958.76	6461251.41	CLEARING AND GRUBBING LIMITS
236	2601957.34	6461215.84	CLEARING AND GRUBBING LIMITS
237	2601986.41	6461225.11	CLEARING AND GRUBBING LIMITS
238	2602008.87	6461195.30	CLEARING AND GRUBBING LIMITS
239	2602025.64	6461198.77	CLEARING AND GRUBBING LIMITS
240	2602018.73	6461281.84	CLEARING AND GRUBBING LIMITS
241	2602024.95	6461338.98	CLEARING AND GRUBBING LIMITS
242	2602364.18	6461841.28	CLEARING AND GRUBBING LIMITS
243	2602357.88	6461901.54	CLEARING AND GRUBBING LIMITS
244	2602346.71	6461901.23	CLEARING AND GRUBBING LIMITS
245	2602261.96	6461705.51	CLEARING AND GRUBBING LIMITS
246	2602273.13	6461680.79	CLEARING AND GRUBBING LIMITS
247	2602312.41	6461716.81	CLEARING AND GRUBBING LIMITS
248	2602337.27	6461764.82	CLEARING AND GRUBBING LIMITS
249	2602430.95	6461763.76	CLEARING AND GRUBBING LIMITS
250	2602426.37	6461773.84	CLEARING AND GRUBBING LIMITS
251	2602425.11	6462173.73	CLEARING AND GRUBBING LIMITS
252	2602415.89	6462242.90	CLEARING AND GRUBBING LIMITS
253	2602363.52	6462427.33	CLEARING AND GRUBBING LIMITS
254	2602342.31	6462475.11	CLEARING AND GRUBBING LIMITS
255	2602316.31	6462455.37	CLEARING AND GRUBBING LIMITS
256	2602335.38	6462416.64	CLEARING AND GRUBBING LIMITS
257	2602386.44	6462236.79	CLEARING AND GRUBBING LIMITS
258	2602395.11	6462171.69	CLEARING AND GRUBBING LIMITS
259	2602396.37	6461772.86	CLEARING AND GRUBBING LIMITS
260	2602403.01	6461746.40	CLEARING AND GRUBBING LIMITS

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
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WARNING
0 1/2 1
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

EROSION AND SEDIMENT CONTROL SITE COORDINATES

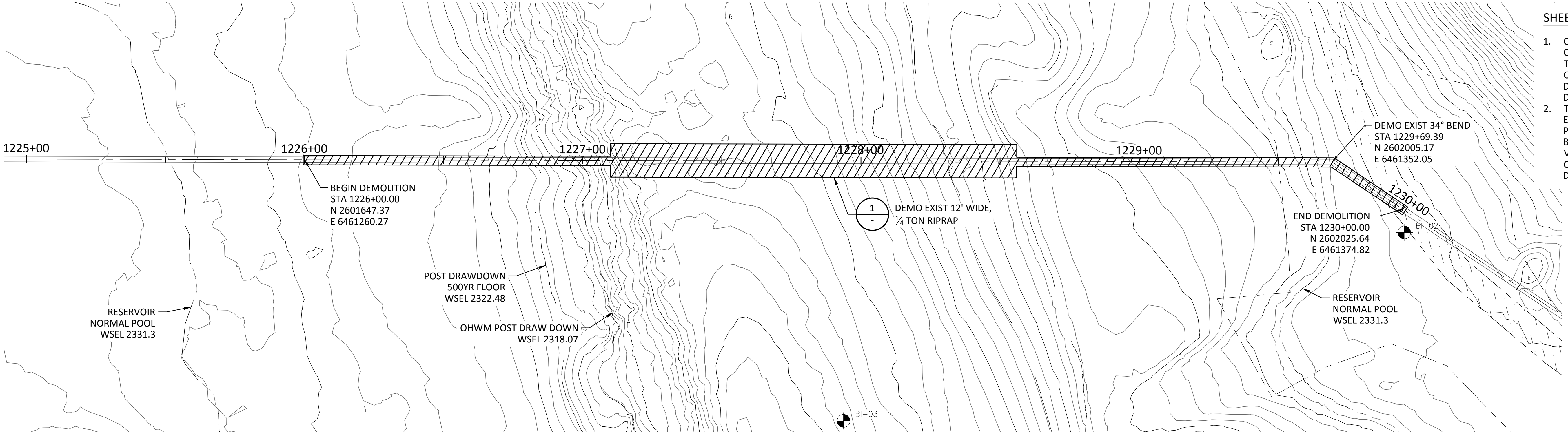
DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
EC101

JOB NO: 000000

SHEET NOTES:

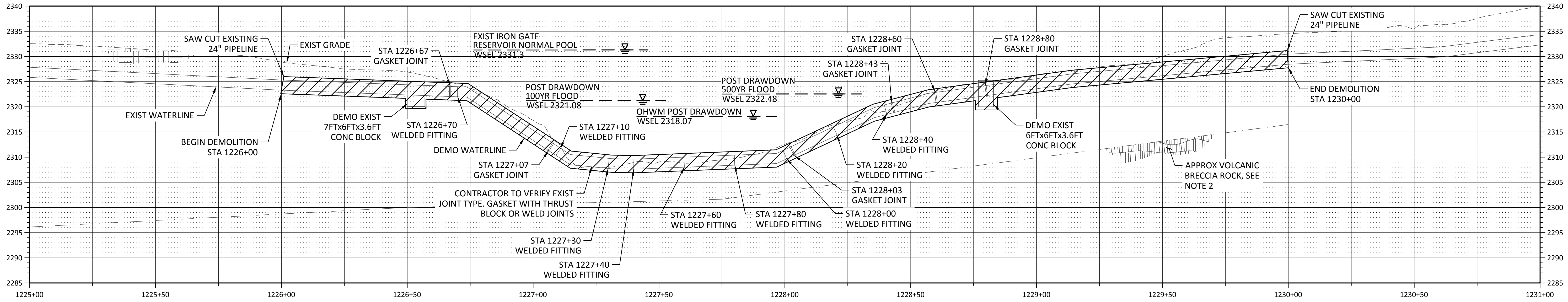
1. CONTRACTOR SHALL DEMOLISH AND DISPOSE OF EXISTING 24-INCH DIAMETER PIPELINE AFTER THE TEMPORARY PIPELINE IS IN SERVICE AND OPERATIONAL AS APPROVED BY OWNER. DISPOSE OF MATERIALS OFFSITE AT APPROVED DISPOSAL LOCATION.
2. THE EXISTING ROCK LINE IS BASED SOLELY UPON EXISTING BORINGS COMPLETED FOR THE PROJECT. SEE SPECIFICATIONS FOR DETAILED BORING INFORMATION. CONTRACTOR SHALL VERIFY THE LOCATION OF ROCK LINE PRIOR TO CONSTRUCTION OF THE NEW 24-INCH DIAMETER PERMANENT PIPELINE.



PLAN

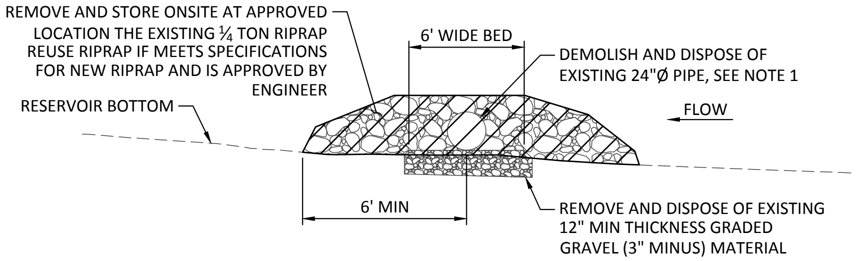
1 -

SCALE: 1"= 20'



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 10'



EXISTING UNDER WATER RIPRAP DETAIL

1 -

SCALE: NTS

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

DEMOLITION WATERLINE PLAN AND PROFILE

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
D101

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\D101.dwg Plot date: Feb 05, 2021 04:57pm, CAD User: rooney

JOB NO: 000000

GENERAL PROJECT NOTES:

1. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN UNSCREENED AND HEAVY-LINED.
2. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.
3. VERTICAL DATUM BASED UPON NAVD 88 DATUM, GEOID 12B.
4. HORIZONTAL DATUM BASED UPON THE CALIFORNIA COORDINATE SYSTEM OF 1983, ZONE 1 NORTH AMERICAN DATUM OF 1983 (NAD83) IN FEET.
5. STAGING AREA SHALL BE FOR CONTRACTOR'S EMPLOYEE PARKING, CONTRACTOR'S TRAILERS AND ON-SITE STORAGE OF MATERIALS, SEE SHEET G006. COORDINATE SPECIFIC AREA LIMITS WITH OWNER.
6. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE SHOWN.
7. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS SHOWN.
8. A GEOTECHNICAL EVALUATION WAS PREFORMED FOR THIS PROJECT. A 2019 GEOTECHNICAL ENGINEERING EVALUATION REPORT WAS PREPARED BY AECOM TECHNICAL SERVICES AND CDM SMITH. A GEOTECHNICAL MEMO WAS PREPARED BY CDM SMITH BASED ON THE REVIEW OF THE LARGER REPORT FOR THIS PROJECT AND IS ATTACHED TO THE PROJECT SPECIFICATIONS.
9. CONTRACTOR SHALL CONTACT KRRC A MINIMUM OF 48 HOURS PRIOR TO COMMENCING CONSTRUCTION ACTIVITIES TO REQUEST VERIFICATION OF UNDERGROUND UTILITY LOCATIONS.
10. PROVIDE MINIMUM 3-FT COVER OVER WATER MAIN PIPES UNLESS OTHERWISE INDICATED ON THE DRAWINGS.
11. CONTRACTOR SHALL KEEP CONSTRUCTION ACTIVITIES WITHIN THE SITE BOUNDARIES FOR THIS PROJECT AS SHOWN. THIS INCLUDES, BUT IS NOT LIMITED TO, VEHICLES AND EQUIPMENT. LIMITS OF TRENCH EXCAVATION, STOCKPILED EXCAVATED MATERIALS, BACKFILL MATERIAL, AND PIPE MATERIAL.

GENERAL CONSTRUCTION NOTES:

1. CONTRACTOR SHALL ATTEND A PRE-CONSTRUCTION CONFERENCE (OR AN ON-SITE MEETING) WITH THE PROJECT REPRESENTATIVE PRIOR TO THE START OF WORK.
2. CONTRACTOR SHALL NOTIFY THE PROJECT REPRESENTATIVE WHEN MATERIALS ARE ON SITE OR INSPECTION OF THE WORK IS REQUIRED. NO WORK MAY BEGIN ON ANY PROJECT WITHOUT TWENTY FOUR (24) HOUR PRIOR NOTICE.
3. ALL MATERIAL FURNISHED ON, OR FOR THE PROJECT MUST MEET THE MINIMUM REQUIREMENTS OF THE APPROVING AGENCIES. AT THE REQUEST OF THE APPROVING AGENCY OR THE DESIGN ENGINEER, CONTRACTOR SHALL FURNISH PROOF THAT ALL MATERIALS INSTALLED ON THIS PROJECT MEET THE SPECIFICATION REQUIREMENTS SET FORTH IN THE PROJECT SPECIFICATIONS.
4. WORK SUBJECT TO APPROVAL BY ENGINEER MUST BE APPROVED PRIOR TO (A) BACKFILL TRENCHES FOR PIPE; (B) PLACING OF AGGREGATE BASE; (C) PLACING OF CONCRETE; (D) PLACING OF ASPHALT PAVING; (E) OR AS OTHERWISE SPECIFIED.
5. ANY DEVIATION FROM THE APPROVED PLANS AND SPECIFICATIONS MUST HAVE DESIGN ENGINEER AND OWNER APPROVAL IN WRITING PRIOR TO CONSTRUCTION.
6. ALL DISTURBED SURFACES SHALL BE RETURNED TO ORIGINAL OR BETTER CONDITIONS.

GENERAL YARD PIPING AND UTILITIES NOTES:

1. EXISTING UNDERGROUND UTILITIES OBTAINED FROM AS-BUILTS AND FROM TOPOGRAPHIC FIELD SURVEY PROVIDED BY KRRP. CONTRACTOR SHALL FIELD VERIFY DEPTH AND LOCATION PRIOR TO EXCAVATION. CONTRACTOR SHALL PROTECT ALL EXISTING UTILITIES DURING CONSTRUCTION. IF EXISTING UTILITIES (GAS, ELECTRIC, POTABLE WATER, ETC.) ARE IN CONFLICT WITH THE PIPELINE REALIGNMENT OR TRENCH ALIGNMENT, CONTRACTOR SHALL CONTACT ENGINEER.
2. EXISTING PIPING AND EQUIPMENT ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW PIPING AND EQUIPMENT ARE SHOWN UNSCREENED AND HEAVY-LINED.
3. ALL PIPES SHALL HAVE CONSTANT UNIFORM SLOPE.
4. THE HORIZONTAL SEPARATION OF POTABLE WATER MAINS AND NON-POTABLE WATER MAINS (SANITARY SEWER, STORM DRAIN, AND IRRIGATION) SHALL BE A MINIMUM OF TEN (10) FEET OUTSIDE OF PIPE TO OUTSIDE OF PIPE. WHERE IT IS NECESSARY FOR A POTABLE WATER MAIN AND NON-POTABLE WATER MAIN TO CROSS WITH LESS THAN EIGHTEEN (18) INCHES OF VERTICAL SEPARATION. THE CROSSING SHALL BE CONSTRUCTED IN ACCORDANCE WITH SECTION 64572, TITLE 22, CALIFORNIA ADMINISTRATION CODE.
5. CONTRACTOR SHALL REPAIR ALL EXISTING SURFACES, UTILITIES, BUILDINGS AND FOUNDATIONS IMPACTED BY CONSTRUCTION.
6. ALL VALVES SET FLUSH WITH GRADE SHALL HAVE BOXES AND COLLARS.

DESIGN CRITERIA

CRITERIA	UNITS	VALUE	COMMENTS
MAXIMUM DESIGN FLOW	CFS	15	MAXIMUM DESIGN FLOW WITH THREE PUMPS RUNNING
AVERAGE SUMMER PEAK FLOW RATE	CFS	11	PEAK FLOW RATE DURING SUMMER MONTHS WITH TWO PUMPS RUNNING
AVERAGE WINTER PEAK FLOW RATE	CFS	6	PEAK FLOW RATE DURING WINTER MONTHS WITH ONE PUMP RUNNING
DESIGN HYDROSTATIC PRESSURE	PSIG	308	
DESIGN MAXIMUM SURGE PRESSURE	PSIG	375	
PIPE DIAMETER	IN	24	STEEL PIPE WITH WALL THICKNESS = ¼" WITH CEMENT MORTAR LINING. COAL TAR ENAMEL WITH ADDITIONAL 3-INCH CEMENT MORTAR EXTERIOR COATING

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

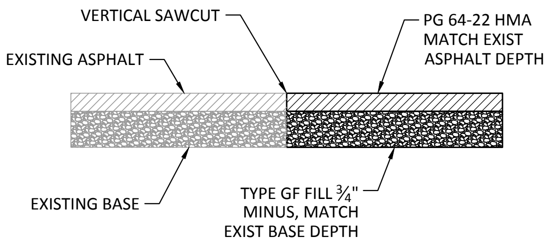
GENERAL CIVIL NOTES

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
GC001

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\GC001.dwg Plot date: Feb 05, 2021 04:57pm, CAD User: rooney

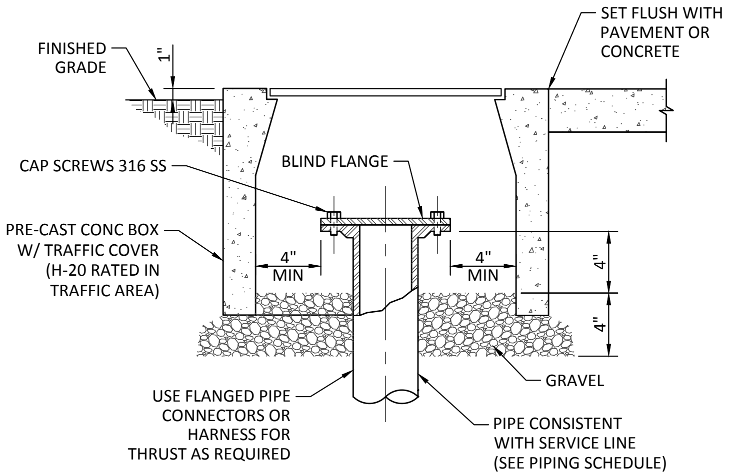


NOTES:
1. AFTER ASPHALT REPLACEMENT, RESTORE LANE STRIPING, AS REQUIRED, WITH PAVEMENT MARKING PAINT PER SPECIFICATION 32 11 13.

ASPHALT REPAIR

C134

SCALE: NTS

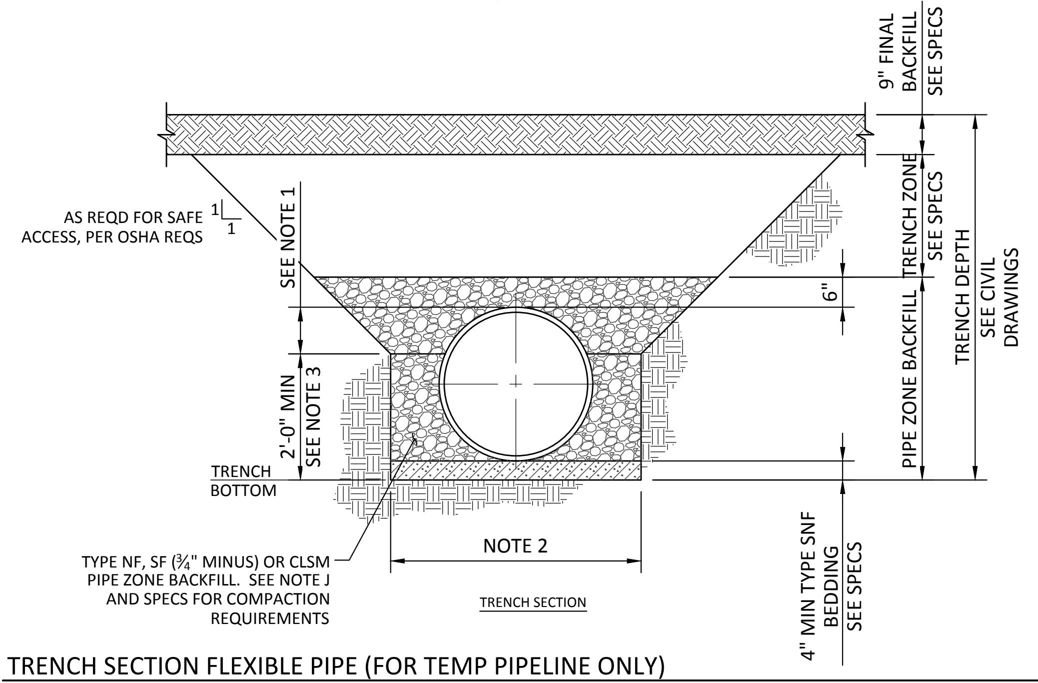


DRAIN BLIND FLANGE TO GRADE

C305

SCALE: NTS

A. FLEXIBLE PIPE REFERS TO ALL STEEL, AND HDPE PLASTIC PIPES.
B. TYPICAL TRENCH SECTION TO BE USED ONLY WHERE STABLE, COMPACT SOIL CONDITIONS EXIST. IF BOULDERS OR LARGE OBSTRUCTIONS ARE ENCOUNTERED, TRENCH SECTIONS MAY BE DEEPER OR WIDER THAN SHOWN. THE ENGINEER SHALL BE ADVISED SHOULD THIS OCCUR.
C. THE NEED FOR PROTECTIVE SYSTEMS AND EXCAVATION SLOPES SHALL BE DETERMINED CONSIDERING APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS, AND GEOTECHNICAL CONSULTANTS' RECOMMENDATIONS.
D. PROTECTIVE SYSTEMS SHALL BE DESIGNED AND BUILT IN ACCORDANCE WITH THE APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS.
E. SUPPORTING DOCUMENTATION SHALL BE SUBMITTED TO THE ENGINEER REGARDING PIPE DESIGN AND COMPLIANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS.
F. UNSUPPORTED VERTICAL AND/OR SLOPING TRENCH WALL SLOPES SHALL NOT BE STEEPER THAN ALLOWED BY APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS, UNLESS SUPPORTING DOCUMENTATION IS SUBMITTED, ACCORDING TO AFOREMENTIONED SAFETY STANDARDS.
G. TRENCH SECTIONS OTHER THAN THE TYPICAL SECTION SHOWN MAY BE UTILIZED PROVIDED THEY COMPLY WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS. DOCUMENTATION SUPPORTING THIS COMPLIANCE AND PIPE DESIGN CALCULATIONS SHALL BE SUBMITTED TO THE ENGINEER.
H. IF OVER-EXCAVATION DUE TO POOR FOUNDATION MATERIAL IS ORDERED BY THE ENGINEER, THE BACKFILL MATERIAL SHALL BE ACCORDING TO THE EARTHWORK SECTION OF THE SPECIFICATIONS ARTICLE ENTITLED, "FILL AND BACKFILL MATERIAL REQUIREMENTS."
I. IF DURING CONSTRUCTION, THE WATER TABLE IS DISCOVERED TO BE ABOVE THE TRENCH BOTTOM, THE ENGINEER SHALL BE NOTIFIED, AND APPROPRIATE DEWATERING SHALL BE IMPLEMENTED TO LOWER THE WATER LEVEL BELOW THE TRENCH BOTTOM. THE BACKFILL MATERIAL SHALL BE ACCORDING TO THE EARTHWORK SECTIONS OF THE SPECIFICATIONS, OR AS ORDERED BY THE ENGINEER.
J. IF CONTRACTOR SELECTS CLSM PIPE ZONE BACKFILL, THEN ELIMINATE THE SAND BEDDING MATERIAL AND USE CLSM FOR BEDDING ALSO.

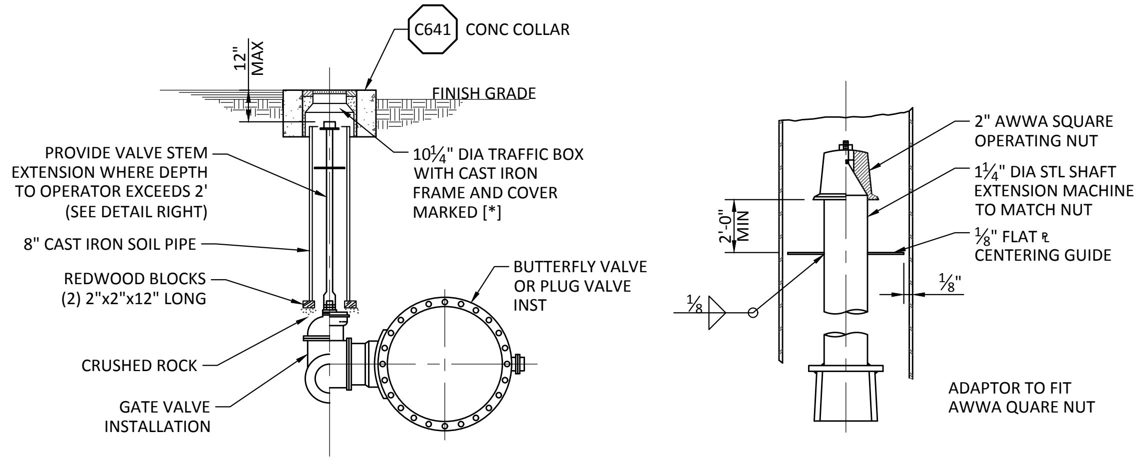


NOTES:
1. 6" MIN FOR PIPE DIAMETER < 24"
   12" MIN FOR PIPE DIAMETER > 24"
2. MIN TRENCH BOTTOM WIDTH = O.D. + 24" FOR MAX COMPACTION
3. IF 2-FT MINIMUM IS NOT MET, CONTRACTOR SHALL CONSULT WITH ENGINEER TO REVISE TRENCH DETAIL.

TRENCH SECTION FLEXIBLE PIPE (FOR TEMP PIPELINE ONLY)

C601

SCALE: NTS

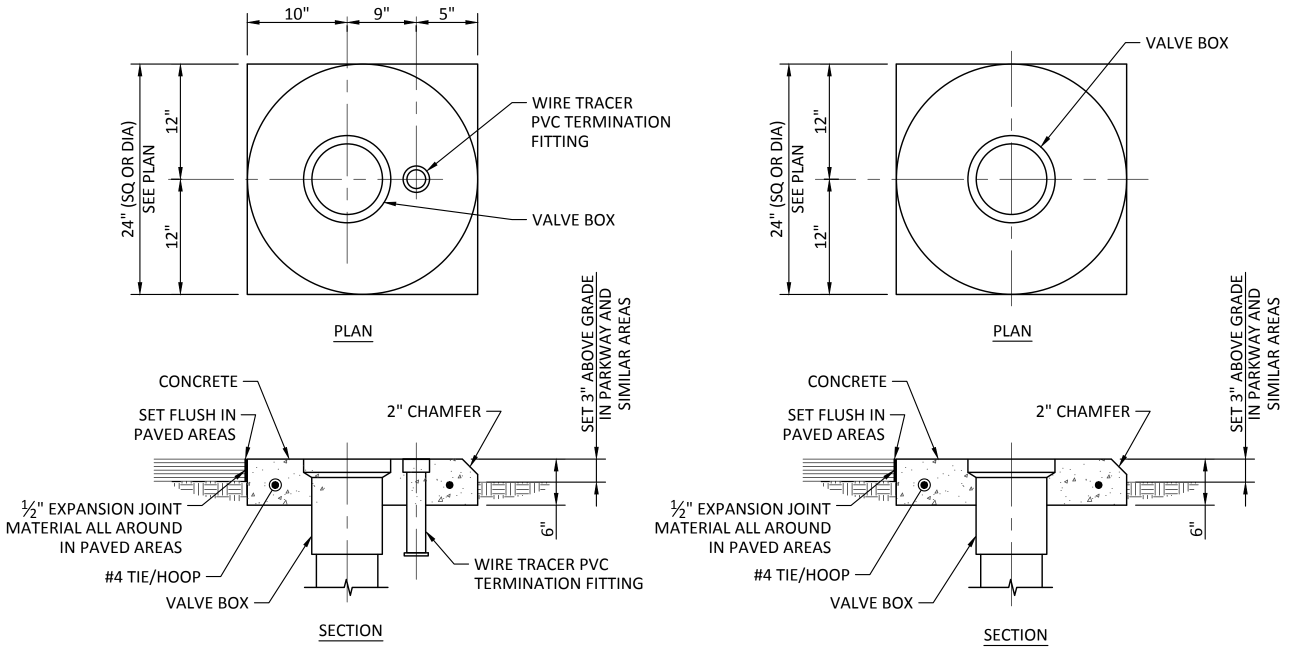


NOTES:
1. PROVIDE PROTECTIVE COATING TO EXTERIOR SURFACE OF VALVE BODY IN ACCORDANCE WITH SPECS.
2. FOR LUBRICATED PLUG VALVE, EXTEND LUBRICATION LINE TO GRADE PER MANUFACTURER'S INSTRUCTIONS.

BURIED VALVE INSTALLATION

C640

SCALE: NTS



VALVE BOX COLLAR

C641

SCALE: NTS

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

CIVIL STANDARD DETAILS 1

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
GC002

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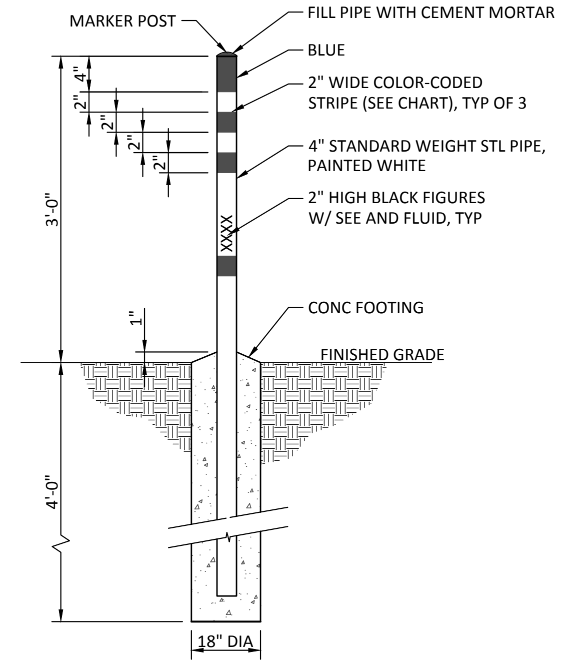
JOB NO: 000000



BURIED APPURTENANCE	STRIPE COLOR (DEFLECTIVE TAPE)
ISOLATION VALVE	BLUE & WHITE STRIPED
COMBINATION AIR RELEASE/ VACUUM VALVE	BLUE
BLOW-OFF	YELLOW
ACCESS MANWAY	GREEN
FIBER OPTICS CABEL	ORANGE
CORROSION TEST STATION	FLUORESCENT GREEN

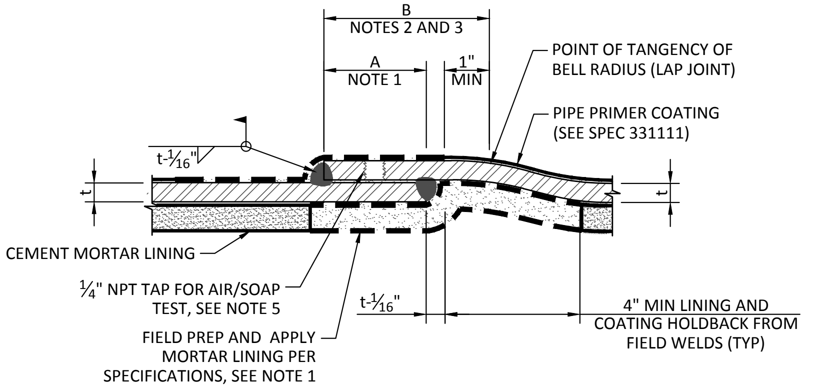
NOTES:

1. MARKER POSTS SHALL BE OFFSET 5'-0" FROM ACTUAL APPURTANCES LOCATION UNLESS INDICATED OTHERWISE.
2. EXACT LOCATIONS OF MARKER POSTS SHALL BE FIELD VERIFIED BY THE CONTRACTOR AND APPROVED BY THE ENGINEER.

PIPELINE MARKER

SCALE: NTS

C650



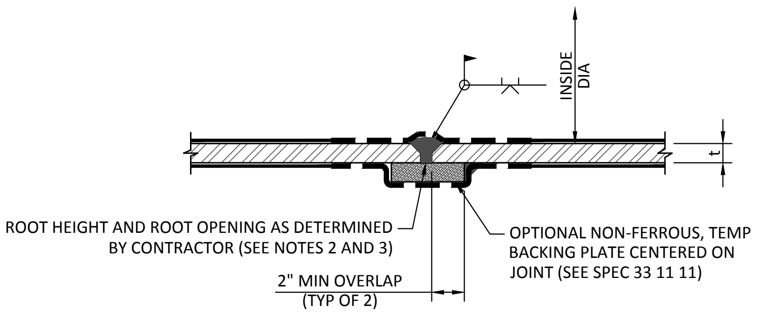
NOTES:

1. DIMENSION "A" CORRESPONDS TO THE COMPLETED JOINT OVERLAP AFTER WELDING. DIMENSION "A" AT A MINIMUM, SHALL BE THE GREATER OF 3" OR 5t.
2. FOR STANDARD JOINTS, THE MINIMUM DIMENSION "B" SHALL BE AS REQUIRED TO PROVIDE THE MINIMUM OVERLAP DIMENSION "A" AND MAINTAIN THE INDICATED HOLDBACK FOR THE WELD.
3. FOR SPECIAL TEMPERATURE CONTROL JOINTS, THE MINIMUM DIMENSION "B" SHALL BE INCREASED BY AT LEAST 3 INCHES. AT THE TIME OF INSTALLATION AND PRIOR TO WELDING, THE SPIGOT SHALL BE INSERTED INTO THE LENGTHENED BELL TO PROVIDE "A" +3 INCHES MINIMUM OVERLAP. SEE SPECIFICATIONS FOR SPECIAL TEMPERATURE CONTROL JOINT WELDING REQUIREMENTS.
4. FILLET WELDS FOR BELL AND SPIGOT LAP JOINTS SHOWN. FILLET WELDS ON OTHER JOINTS ARE SIMILAR.
5. CONTRACTOR SHALL INSTALL SPIGOT TAP, WHEN INSIDE FILLET WELD IS REQUIRED.
6. THE JOINTS SHALL BE FABRICATED AND INSTALLED TO BE WITHIN THE TOLERANCES AND GENERAL REQUIREMENTS OF AWWA C206.

STEEL PIPE BELL AND SPIGOT LAP JOINT WELD

SCALE: NTS

C701



SINGLE BEVEL - BUTT WELD JOINT (FOR t ≤ 0.625") EXT WELD (W/OPTIONAL BACKING PLATE)

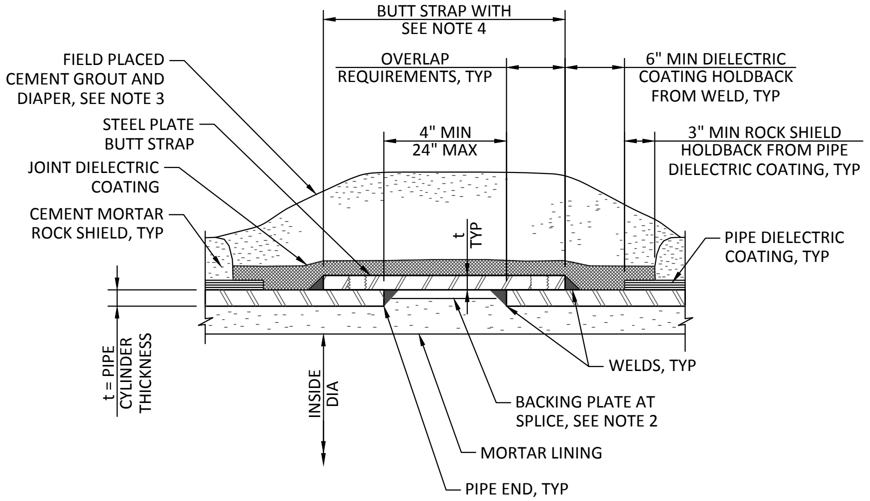
NOTES:

1. FIELD APPLIED JOINT LINING PROTECTION REQUIRED FOR SHOP-LINED PIPE.
2. CONTRACTOR SHALL DEVELOP DETAILS OF CJP WELDS IN ACCORDANCE W/ SPEC 33 11 11. PRE-QUALIFIED CJP WELDS IN ACCORDANCE W/ SECTION VIII OF THE ASME BOILER AND PRESSURE VESSEL CODE OR TABLE 8-2 OF THE AISC STEEL CONSTRUCTION MANUAL MAY BE UTILIZED.
3. INTERIOR OR EXTERIOR BACK-GOUGING OF BUTT WELD NOT REQUIRED UNLESS SPECIFICALLY CALLED FOR IN SECTION 33 11 11.

STEEL PIPE - BUTT WELD JOINT (SINGLE OUTSIDE BEVEL)

SCALE: NTS

C703



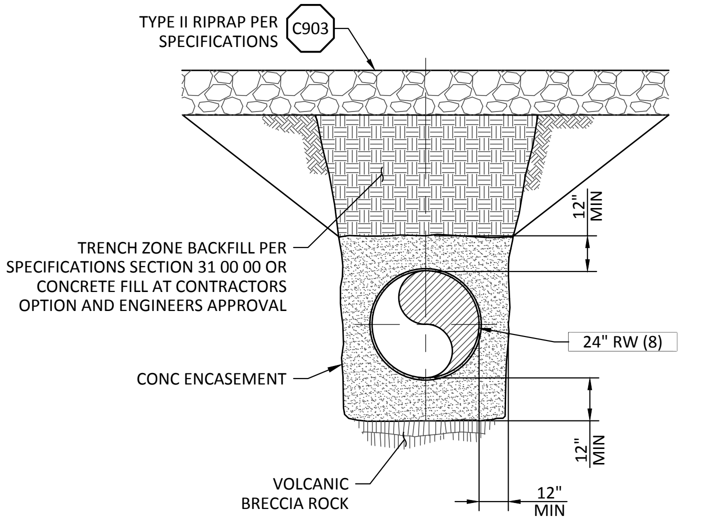
NOTES:

1. CONTRACTOR SHALL CONDUCT AN AIR/SOAP SOLUTION LEAK TEST AT 40 PSI AIR PRESSURE IN ADDITION TO DYE PENETRANT OR MAGNETIC PARTICLE TESTING PERFORMED BY THE CONSTRUCTION MANAGER. IF LEAKS ARE DETECTED, REPAIR AND RETEST THE WELDS UNTIL THERE ARE NO DEFECTS. PLUG HOLES WITH A THREADED OR WELDED PLUG AT COMPLETION OF TEST AND COAT AS SHOWN. TAP HOLES MAY BE ON INSIDE OR OUTSIDE OF JOINT.
2. FOR FIELD WELDING OF INDIVIDUAL BUTT STRAP PIECES TO EACH OTHER, SEE DETAIL C705.
3. FIELD PLACED CEMENT GROUT AND DIAPER IS NOT REQUIRED WHERE THE PIPE IS FULLY ENCASED IN CONTROLLED LOW STRENGTH MATERIAL (CLSM).
4. UNLESS OTHERWISE NOTED, BUTT STRAP WIDTH SHALL CONFORM TO THE LIMITATIONS SHOWN FOR PIPE END SEPARATION AND STEEL OVERLAP REQUIREMENTS.

BUTT STRAP JOINT (WSP - FLEXIBLE/DIELECTRIC COATING SYSTEM)

SCALE: NTS

C704



A. THE NEED FOR PROTECTIVE SYSTEMS, AND EXCAVATION SLOPES SHALL BE DETERMINED CONSIDERING APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS, AND GEOTECHNICAL CONSULTANTS' RECOMMENDATIONS.
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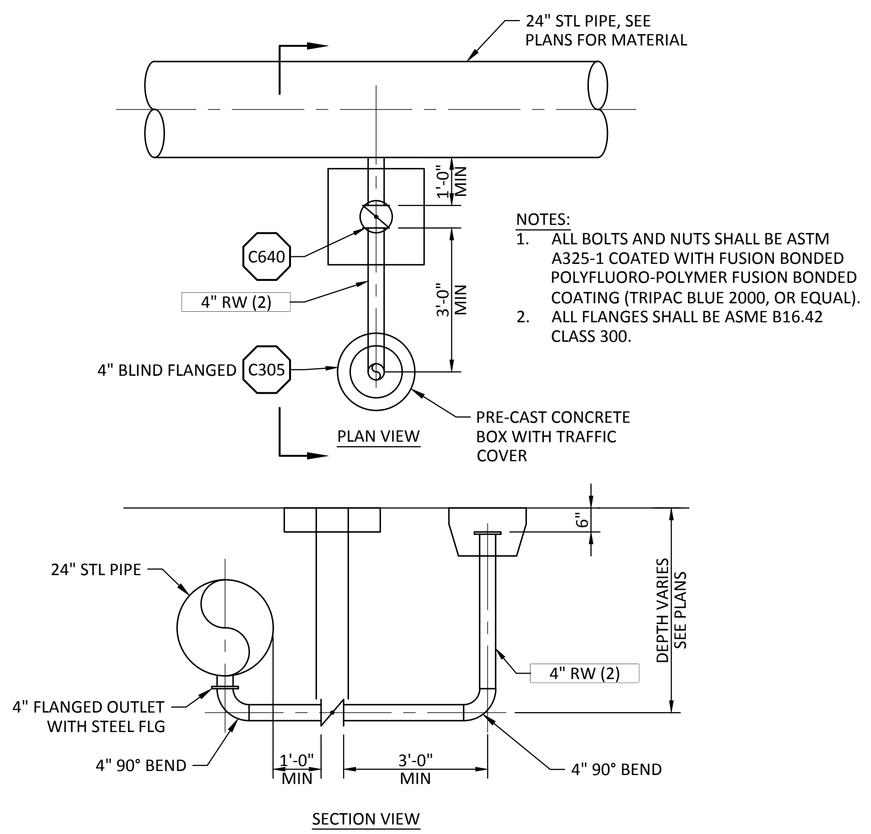
C. SUPPORTING DOCUMENTATION SHALL BE SUBMITTED TO THE ENGINEER REGARDING PIPE DESIGN AND COMPLIANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS.
D. UNSUPPORTED VERTICAL AND/OR SLOPING TRENCH WALL SLOPES SHALL NOT BE STEEPER THAN ALLOWED BY APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS, UNLESS SUPPORTING DOCUMENTATION IS SUBMITTED, ACCORDING TO AFOREMENTIONED SAFETY STANDARDS.
E. TRENCH SECTIONS OTHER THAN THE TYPICAL SECTIONS SHOWN MAY BE UTILIZED PROVIDED THEY COMPLY WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS. DOCUMENTATION SUPPORTING THIS COMPLIANCE AND PIPE DESIGN CALCULATIONS SHALL BE SUBMITTED TO THE ENGINEER.
F. IF DURING CONSTRUCTION, THE WATER TABLE IS DISCOVERED TO BE ABOVE THE TRENCH BOTTOM, THE ENGINEER SHALL BE NOTIFIED, AND APPROPRIATE DEWATERING SHALL BE IMPLEMENTED TO LOWER THE WATER LEVEL BELOW THE TRENCH BOTTOM. THE BACKFILL MATERIAL SHALL BE ACCORDING TO THE EARTHWORK SECTIONS OF THE SPECIFICATIONS, OR AS ORDERED BY THE ENGINEER.

CONCRETE ENCASED TRENCH PIPE

SCALE: NTS

C900



NOTES:

1. ALL BOLTS AND NUTS SHALL BE ASTM A325-1 COATED WITH FUSION BONDED POLYFLUORO-POLYMER FUSION BONDED COATING (TRIPAC BLUE 2000, OR EQUAL).
2. ALL FLANGES SHALL BE ASME B16.42 CLASS 300.

DRAIN LINE

SCALE: 1/2"=1'-0"

C901

B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL
REV	DATE	BY	DESCRIPTION

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WARNING
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

CIVIL STANDARD DETAILS 2

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
GC003

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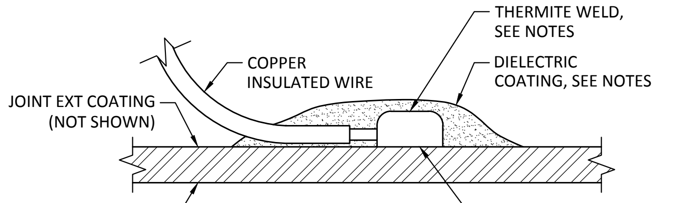
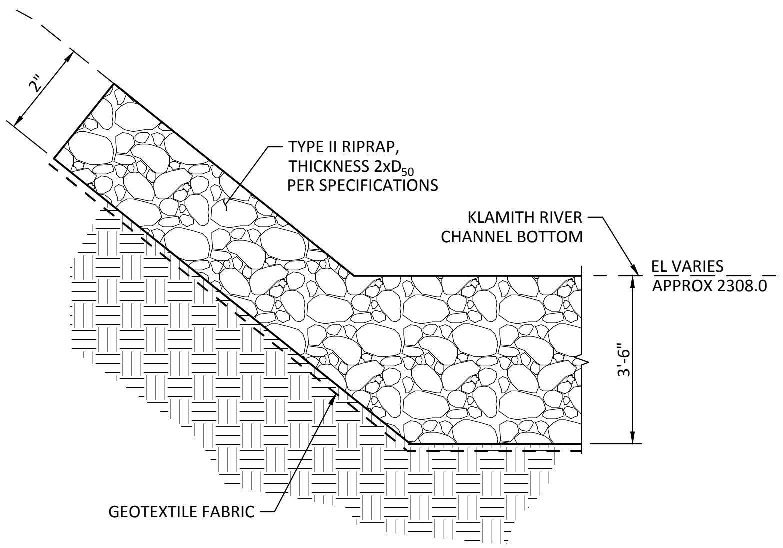


NOTES:
1. IF POSSIBLE, MAKE WIRE CONNECTION TO STEEL PIPE AT FIELD JOINT AT HOLDBACK OF PIPELINE COATING.
2. MAINTAIN SEPARATION BETWEEN MULTIPLE TEST WIRE CONNECTIONS OF ONE PIPE DIA OR 12", WHICHEVER IS LESS.
3. COPPER SLEEVE REQUIRED FOR #2 AWG JOINT BONDS OR FOR #12 AWG OR SMALLER TEST WIRES.
4. WELDER AND CARTRIDGE SIZE VARIES ACCORDING TO PIPE SIZE AND PIPE MATERIAL, CONSULT WELDER MANUFACTURER FOR RECOMMENDED WELDER AND CARTRIDGE.
5. COAT COMPLETED CONNECTIONS WITH DIELECTRIC COATING AS SPECIFIED.
6. PIPELINE JOINT COATING NOT SHOWN FOR CLARITY.

PIPE WIRE CONNECTION DETAIL

C902

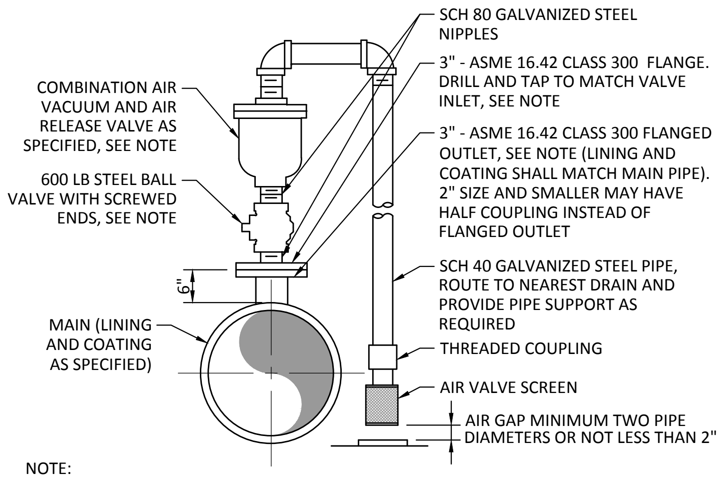
SCALE: NTS



BANK RIPRAP DETAIL

C903

SCALE: NTS

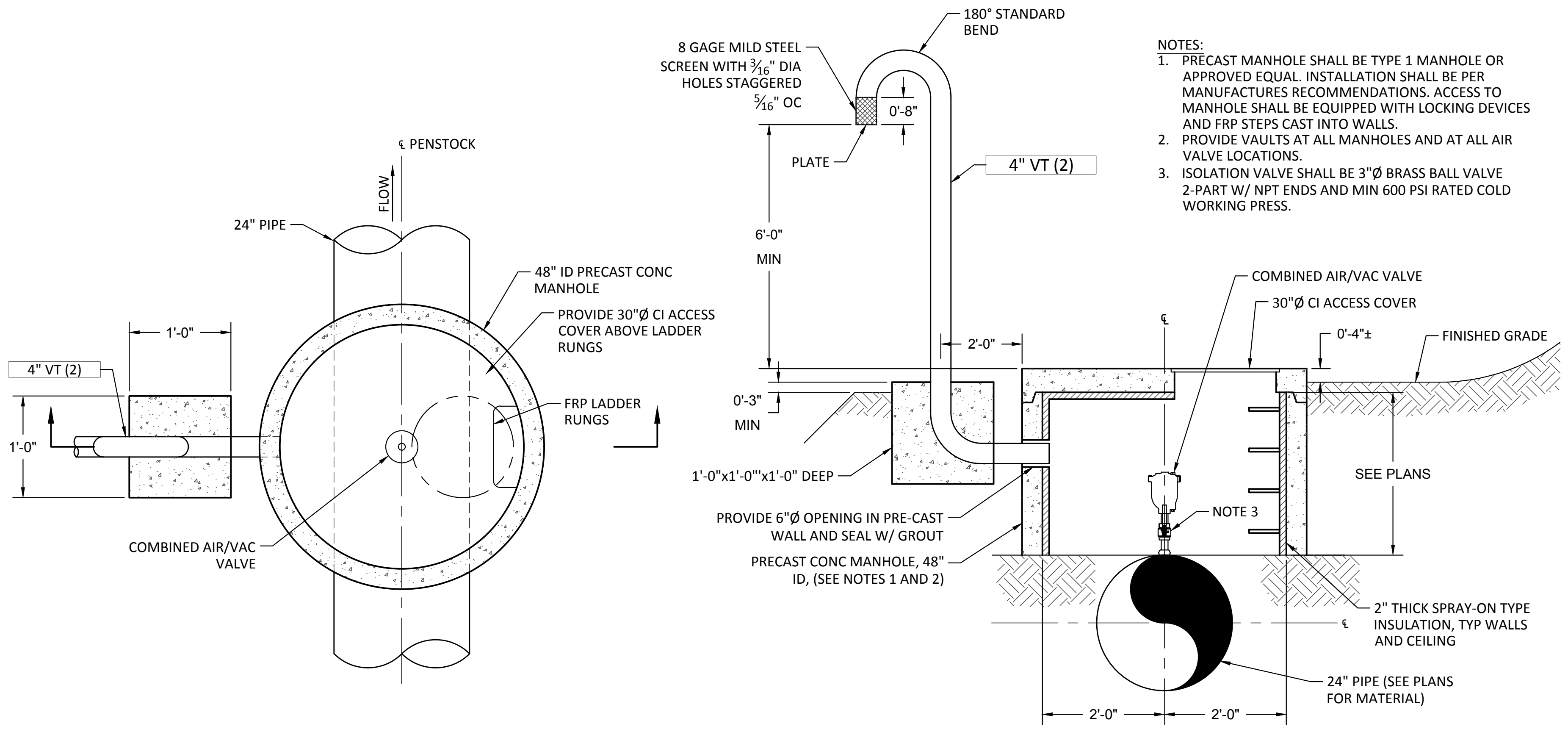


NOTE:
1. FOR PIPING SYSTEM WITH SERVICE PRESSURE CLASS GREATER THAN 150 PSI. ALL COMPONENTS FURNISHED SHALL BE SUITABLE FOR THE HIGHER PRESSURE.

AIR-VACUUM AND AIR-RELEASE VALVE ASSEMBLY - 3" AND SMALLER

C904

SCALE: NTS



NOTES:
1. PRECAST MANHOLE SHALL BE TYPE 1 MANHOLE OR APPROVED EQUAL. INSTALLATION SHALL BE PER MANUFACTURES RECOMMENDATIONS. ACCESS TO MANHOLE SHALL BE EQUIPPED WITH LOCKING DEVICES AND FRP STEPS CAST INTO WALLS.
2. PROVIDE VALVE ISOLATION AT ALL MANHOLES AND AT ALL AIR VALVE LOCATIONS.
3. ISOLATION VALVE SHALL BE 3"Ø BRASS BALL VALVE 2-PART W/ NPT ENDS AND MIN 600 PSI RATED COLD WORKING PRESS.

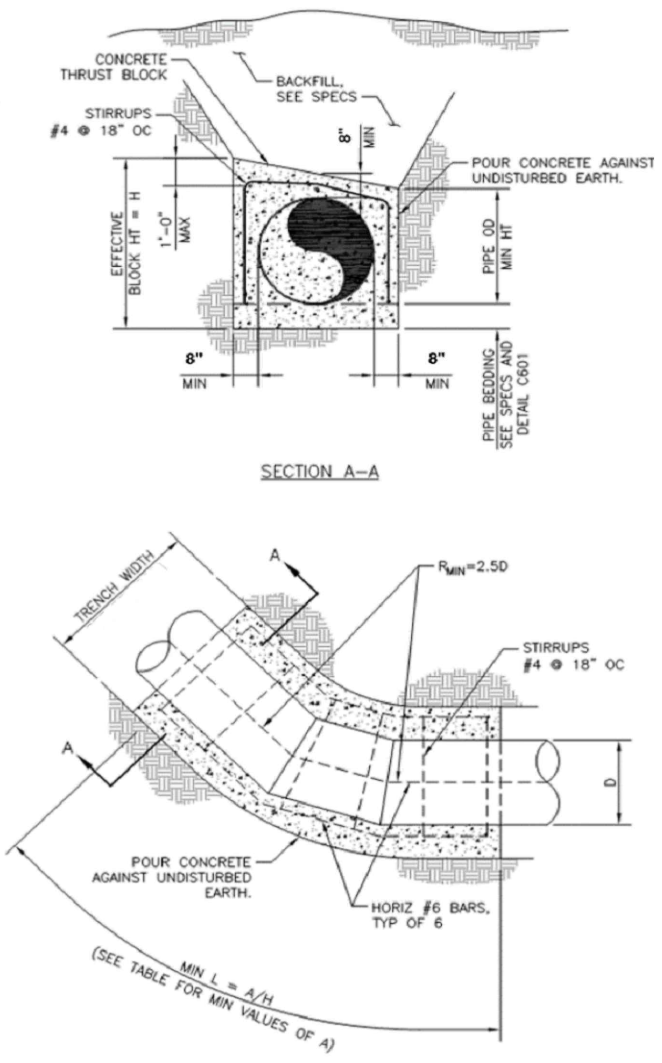
PLAN VIEW

SECTION VIEW

BURIED AIR/VAC ASSEMBLY - PLAN/SECTION

C905

SCALE: NTS



SECTION A–A

TABLE FOR BURIED THRUST BLOCKS, DETAIL C-906

PIPE BEND (DEG):	35.0				45.0				70.0				90.0			
MAX HYDROSTATIC: PRESSURE (PSI)	< 100	< 300	< 400	< 500	< 100	< 300	< 400	< 500	< 100	< 300	< 400	< 500	< 100	< 300	< 400	< 500

Bearing Capacity 3,500 PSF*

NOM PIPE DIAMETER (OD) (inches)																
24	8	23	31	39	10	30	40	49	15	44	59	74	18	55	73	91

* NOTE THAT THIS BEARING CAPACITY **DOES NOT APPLY** TO ANY OTHER PORTIONS OF PROJECT & SHALL BE USED ONLY FOR THE WATERLINE THRUST BLOCK CALCS

THRUST BLOCK DETAIL

C906

SCALE: NTS

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
CIVIL STANDARD DETAILS 3

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
GC004

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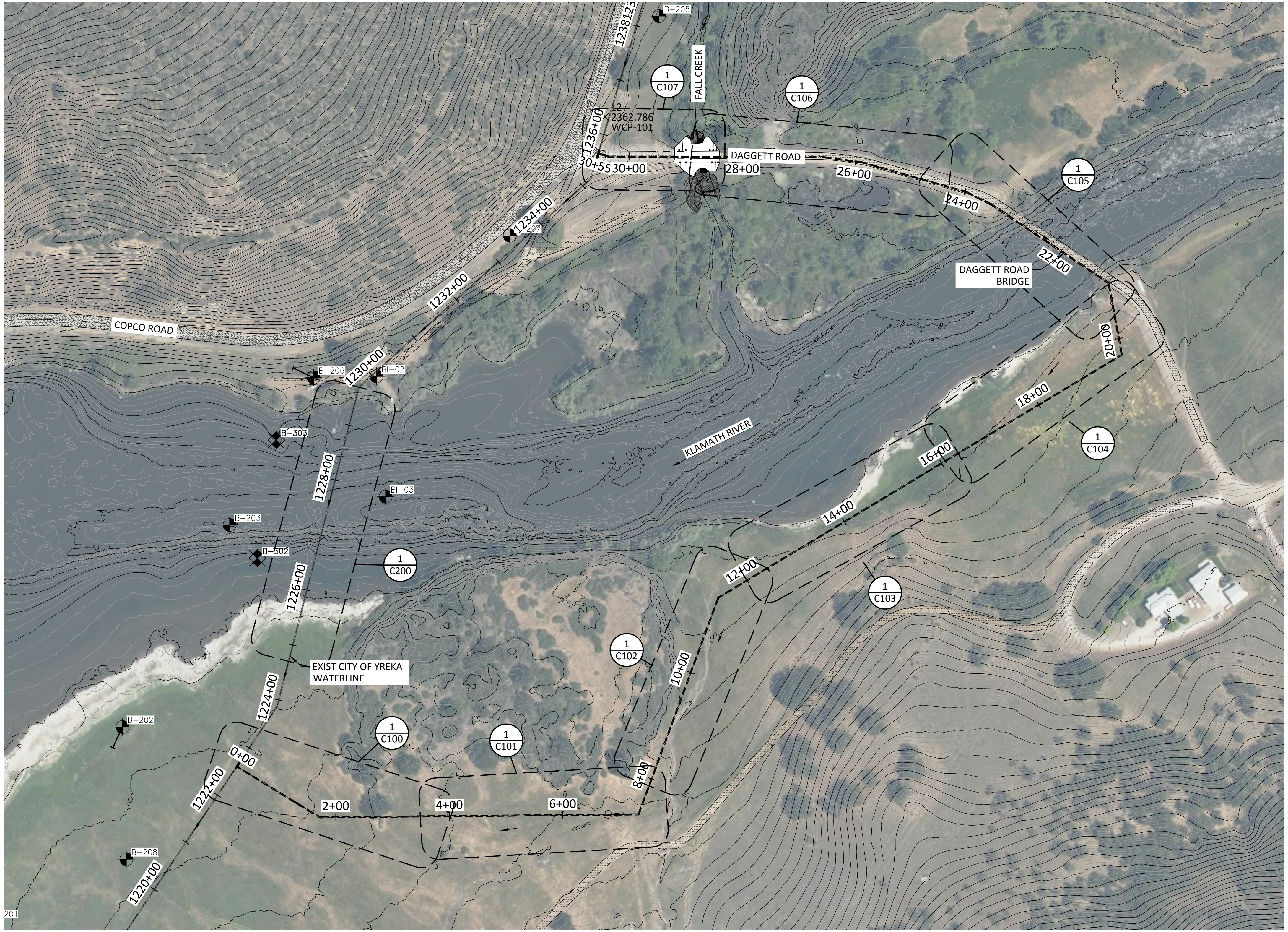

OVERALL SITE PLAN

SCALE: 1"= 100'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

CITY OF YREKA WATER LINE

OVERALL SITE PLAN

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
C001

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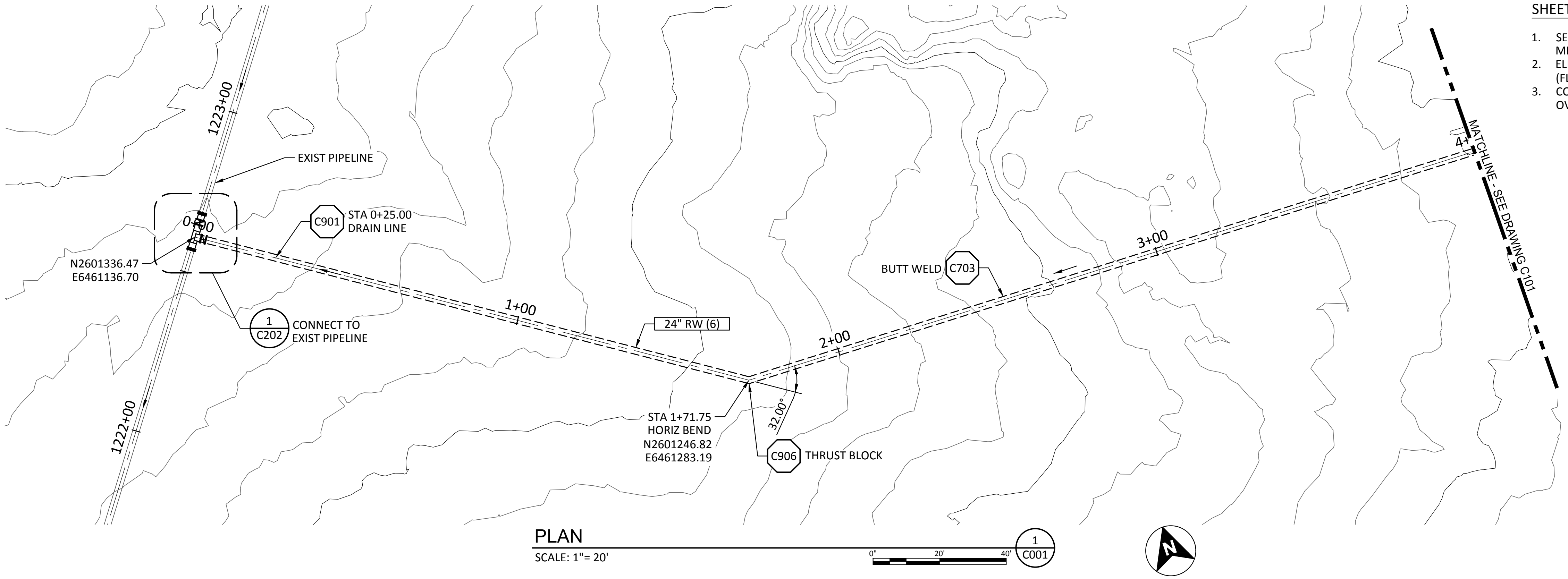
JOB NO: 000000

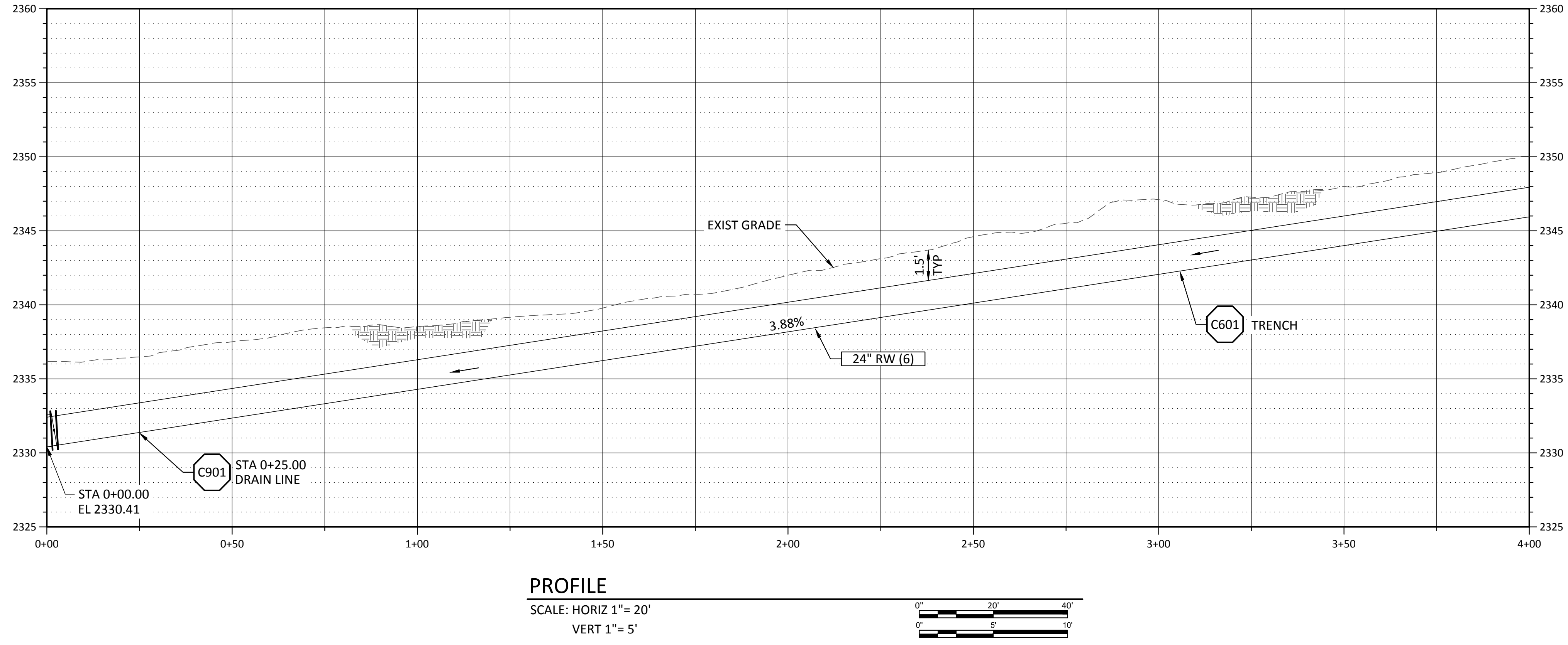
SHEET NOTES:

1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.



PLAN

SCALE: 1"= 20'



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

TEMPORARY WATERLINE PLAN AND PROFILE 1

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

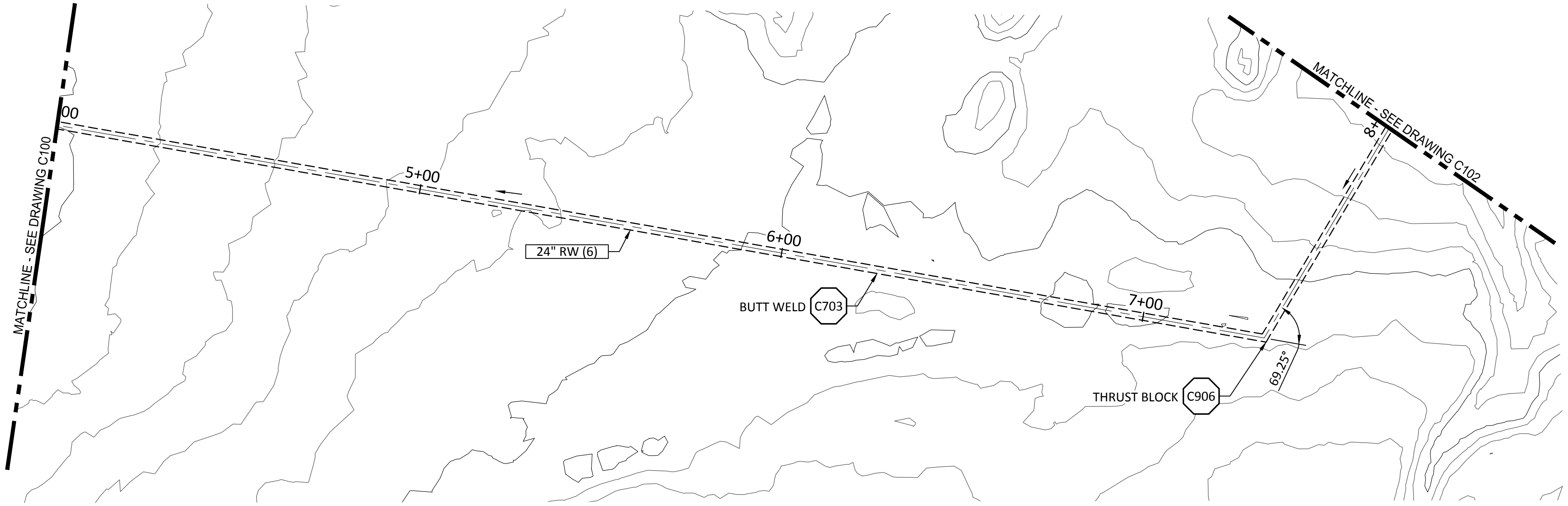
DRAWING
C100

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C100.dwg Plot date: Feb 05, 2021 04:59pm, CAD User: rooney

JOB NO: 000000

SHEET NOTES:

1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.

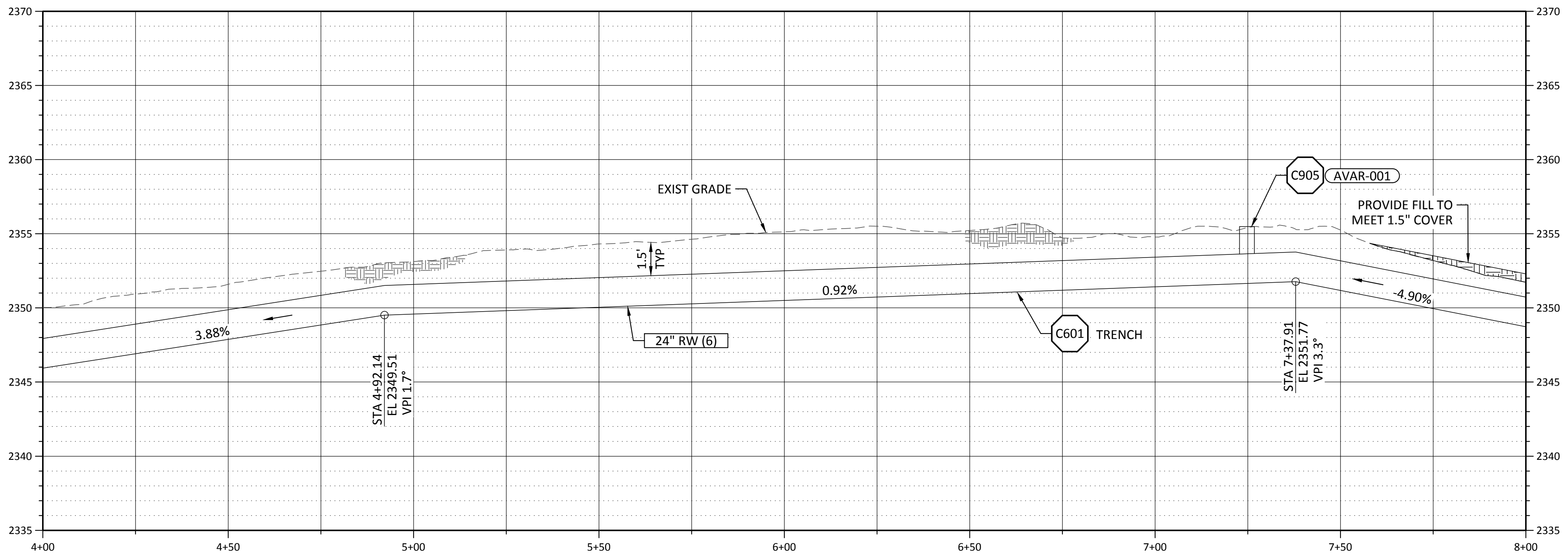


PLAN

SCALE: 1"= 20'

0' 20' 40'

1
C001



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

0' 20' 40'
0' 5' 10'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
TEMPORARY WATERLINE PLAN AND PROFILE 2

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

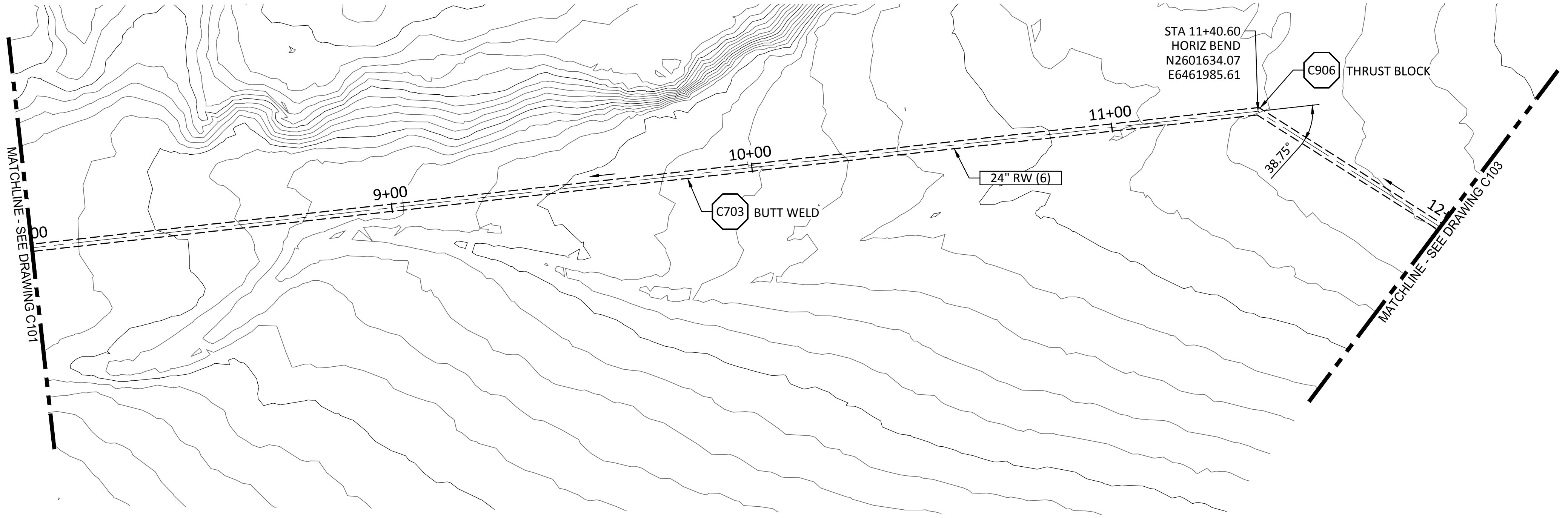
DRAWING
C101

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C101.dwg Plot date: Feb 05, 2021 05:00pm, CAD User: rooney

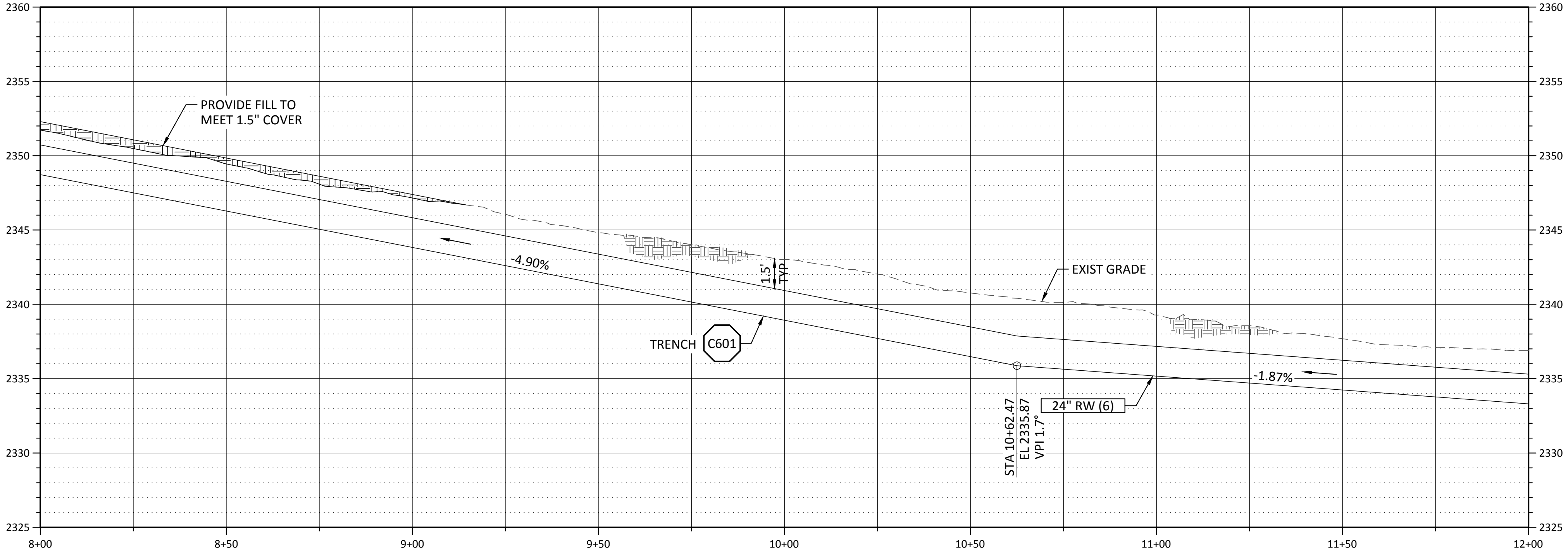
SHEET NOTES:

1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.



PLAN

SCALE: 1"= 20'



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
TEMPORARY WATERLINE PLAN AND PROFILE 3

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

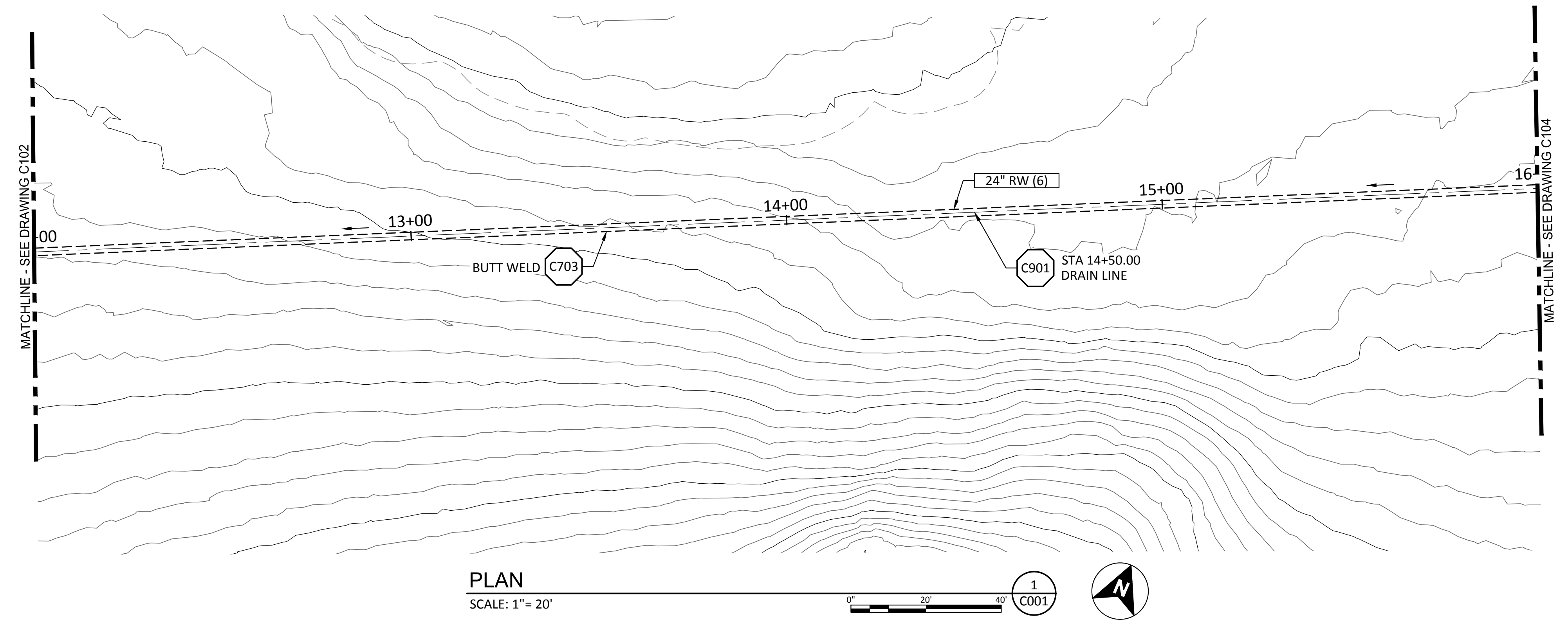
DRAWING
C102

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C102.dwg Plot date: Feb 05, 2021 05:00pm, CAD User: rooney

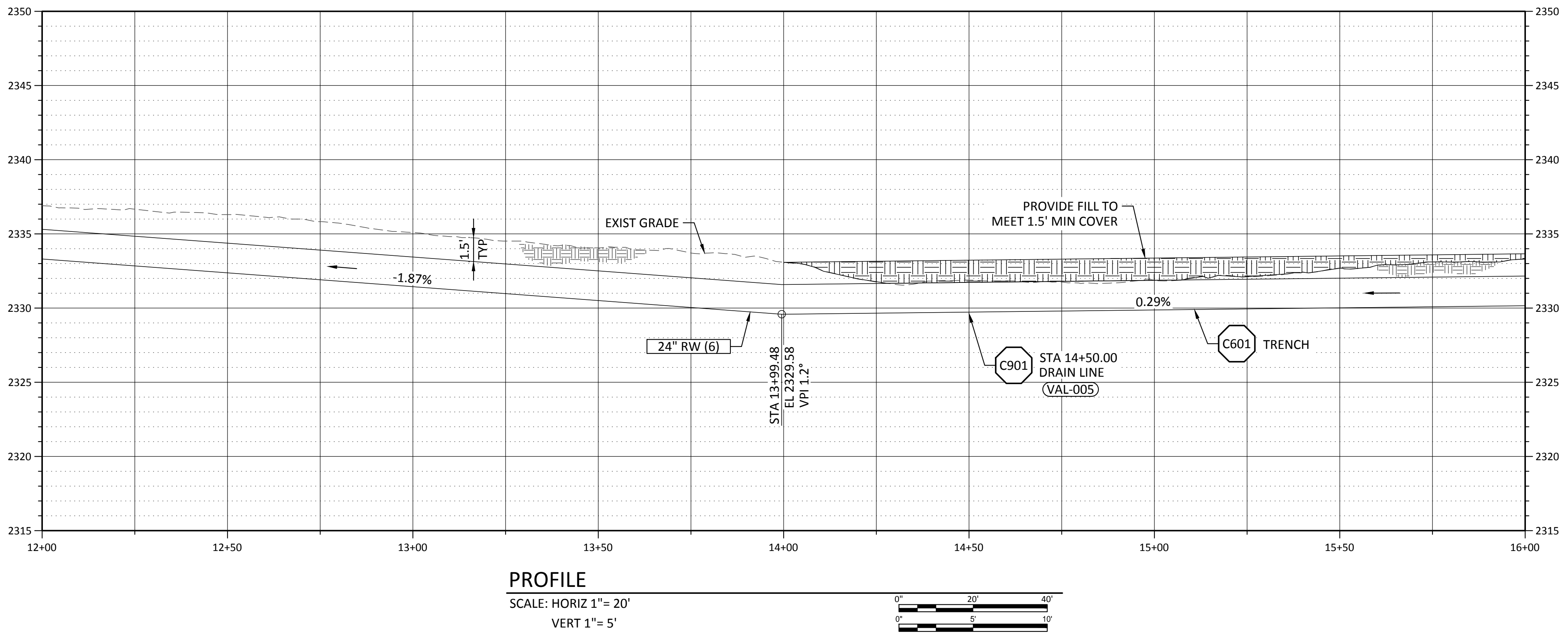
SHEET NOTES:

1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.



PLAN

SCALE: 1"= 20'



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

TEMPORARY WATERLINE PLAN AND PROFILE 4

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

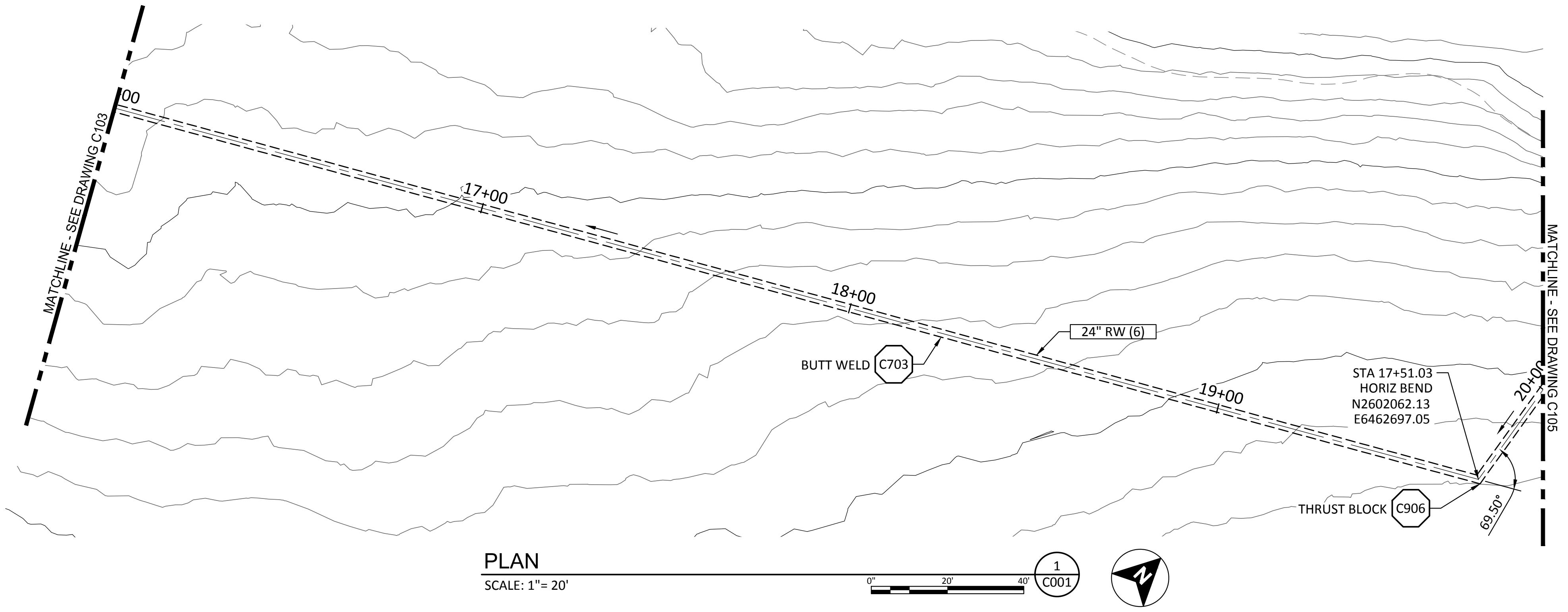
DRAWING
C103

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C103.dwg Plot date: Feb 05, 2021 05:01pm, CAD User: rooney

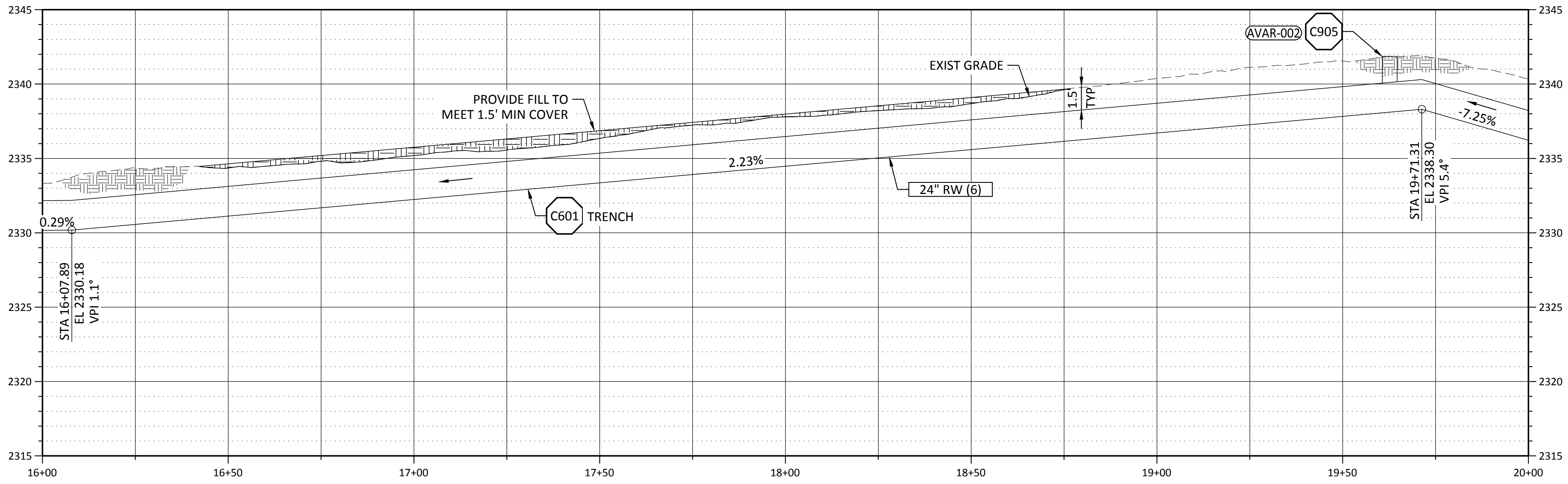
SHEET NOTES:

1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.



PLAN

SCALE: 1"= 20'



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE
TEMPORARY WATERLINE PLAN AND PROFILE 5

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

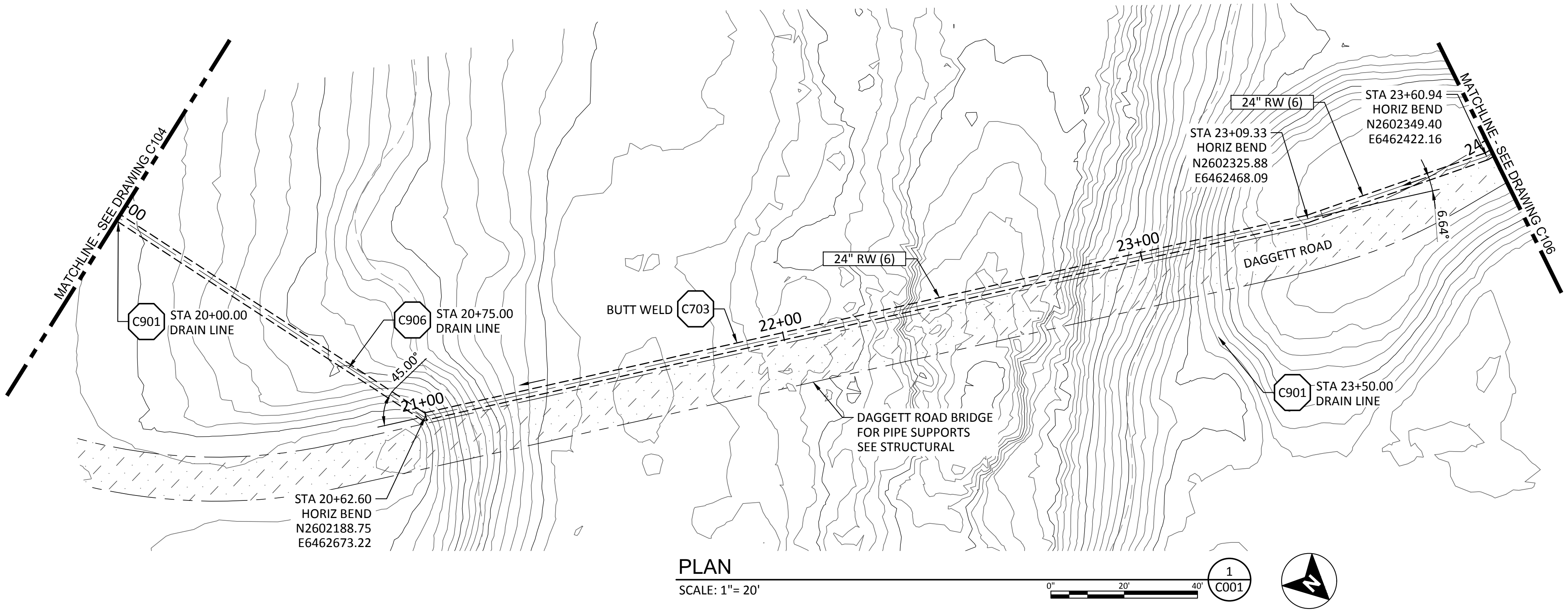
DRAWING
C104

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C104.dwg Plot date: Feb 05, 2021 05:02pm, CAD User: rooney

JOB NO: 000000

SHEET NOTES:

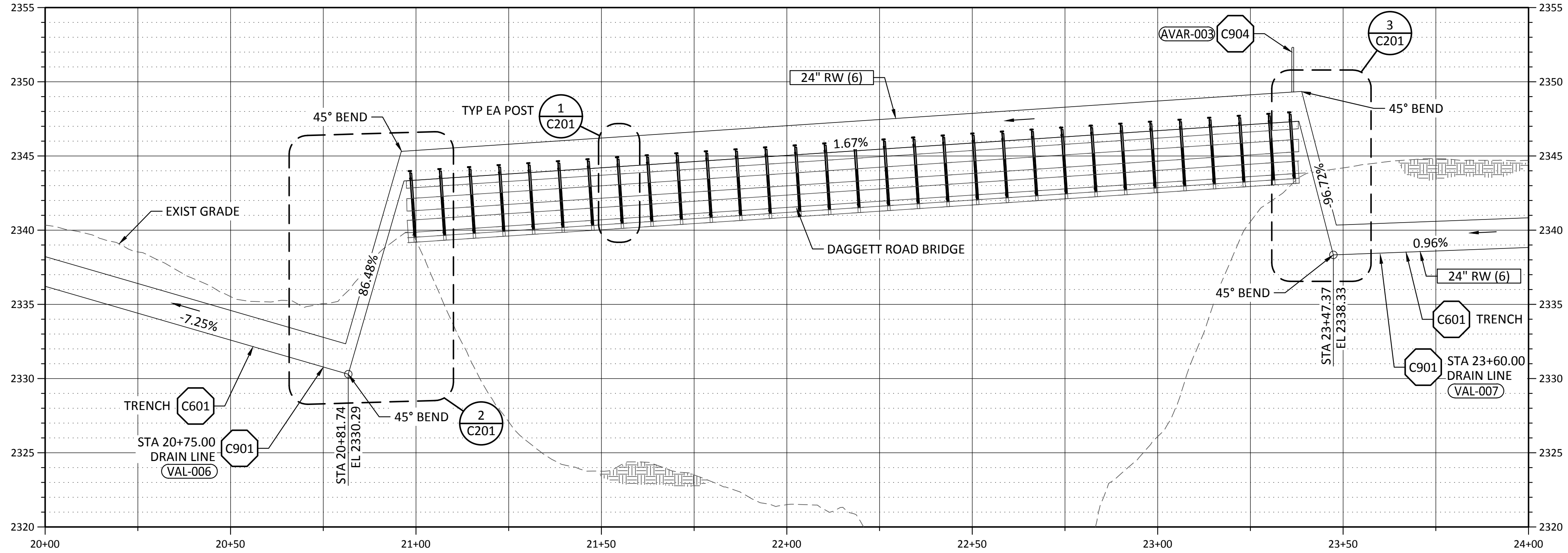
1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.



PLAN

SCALE: 1"= 20'

1 / C001



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

CITY OF YREKA WATER LINE

TEMPORARY WATERLINE PLAN AND PROFILE 6

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

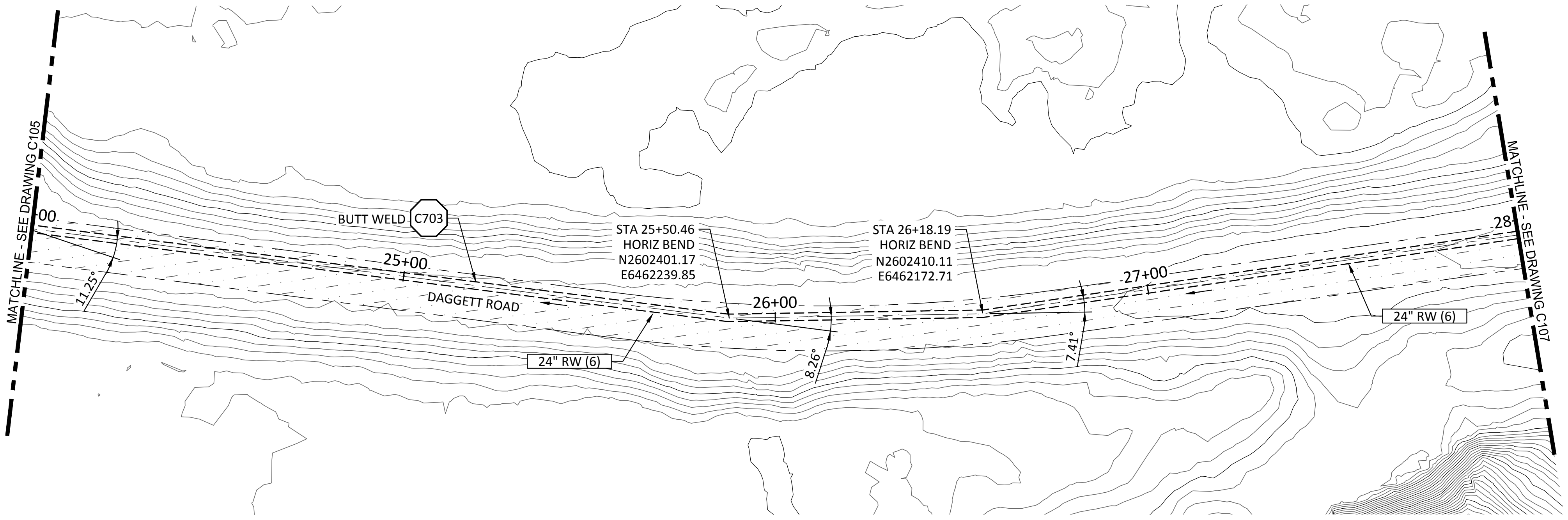
DRAWING
C105

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C105.dwg Plot date: Feb 05, 2021 05:02pm, CAD User: rooney

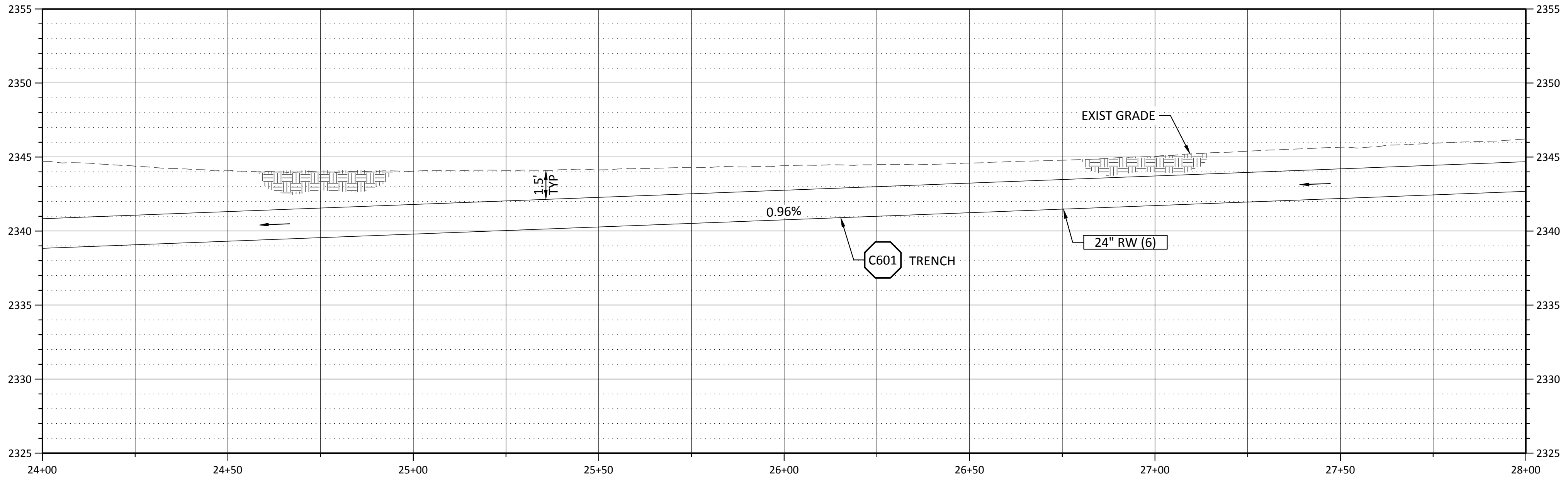
SHEET NOTES:

1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.



PLAN

SCALE: 1"= 20'



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

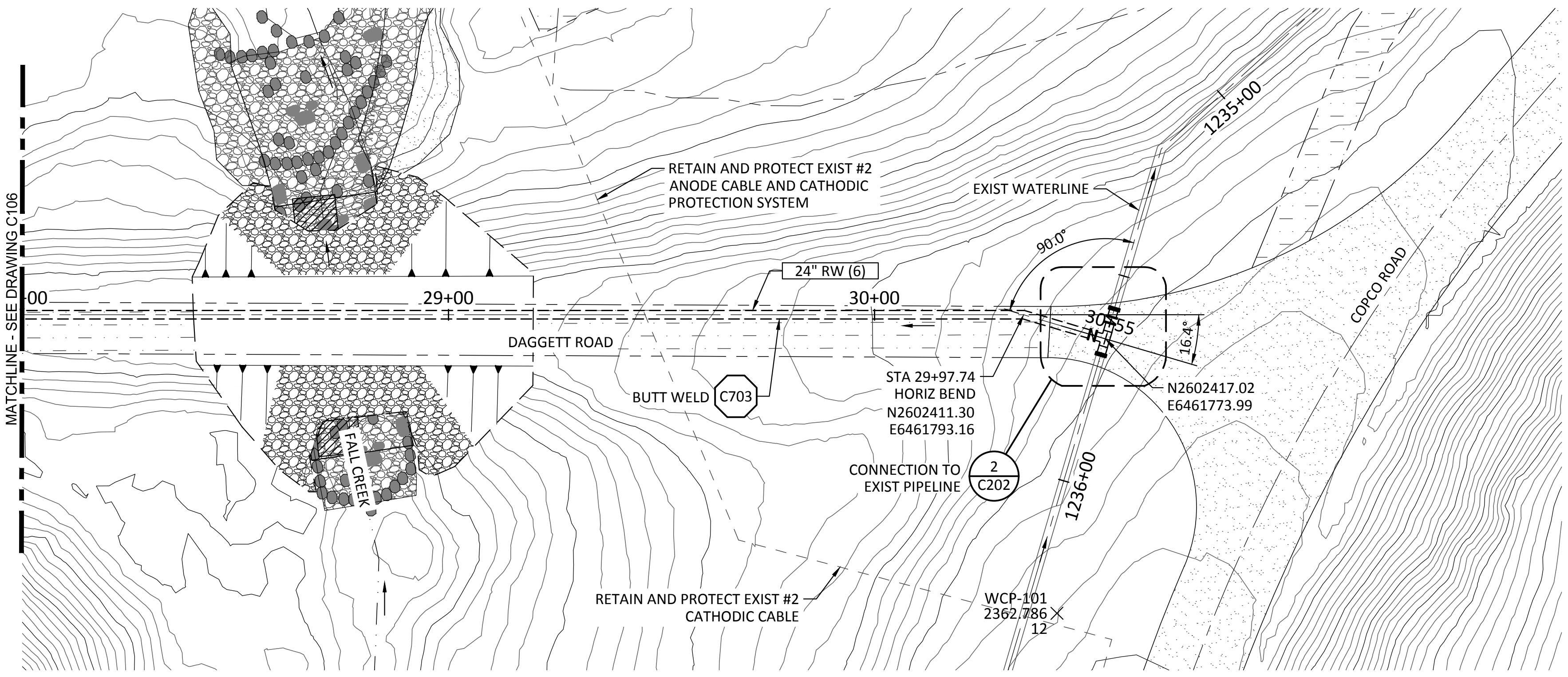
TEMPORARY WATERLINE PLAN AND PROFILE 7

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
C106

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C106.dwg Plot date: Feb 05, 2021 05:03pm, CAD User: rooney

JOB NO: 000000



PLAN

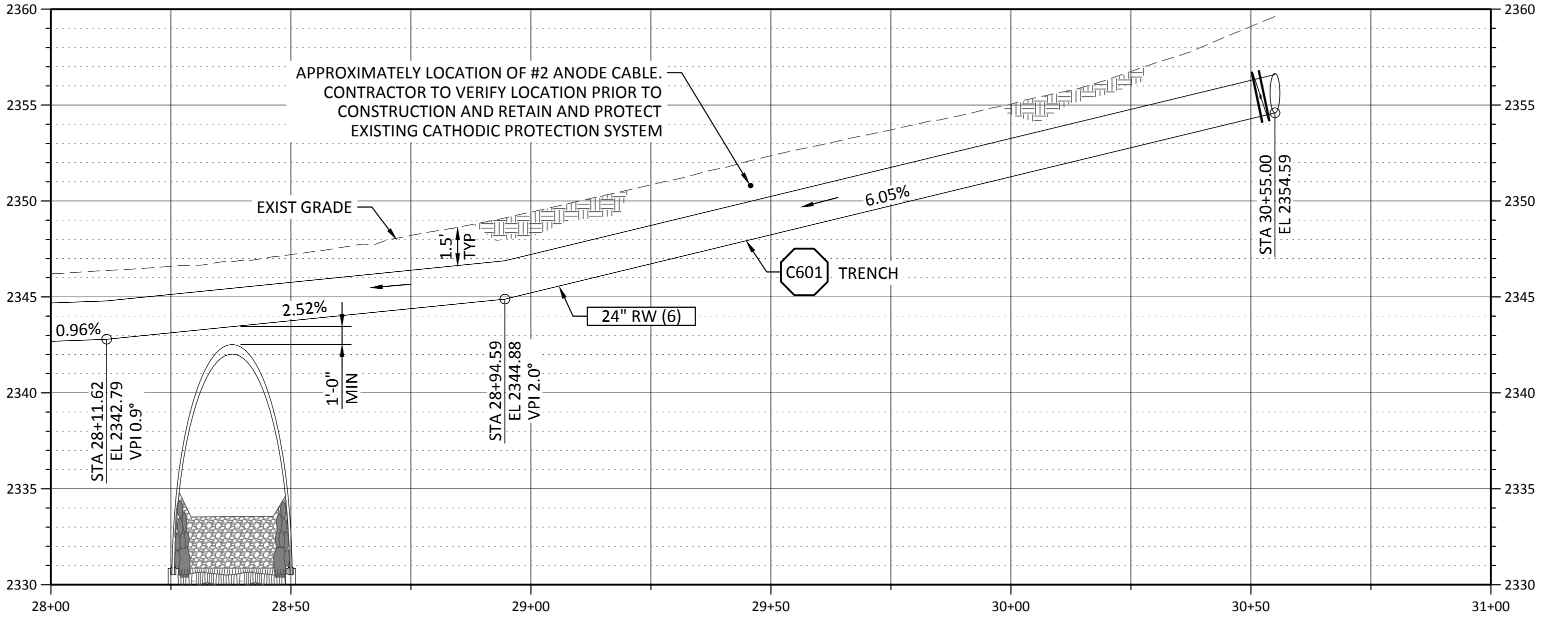
SCALE: 1"= 20'

0' 20' 40'

1
C001

SHEET NOTES:

1. SEE EC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO PROVIDE A MINIMUM OF 1.5FT OF COVER OVER TEMPORARY PIPELINE.



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 5'

0' 20' 40'
0' 5' 10'

B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL
REV	DATE	BY	DESCRIPTION

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

TEMPORARY WATERLINE PLAN AND PROFILE 8

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

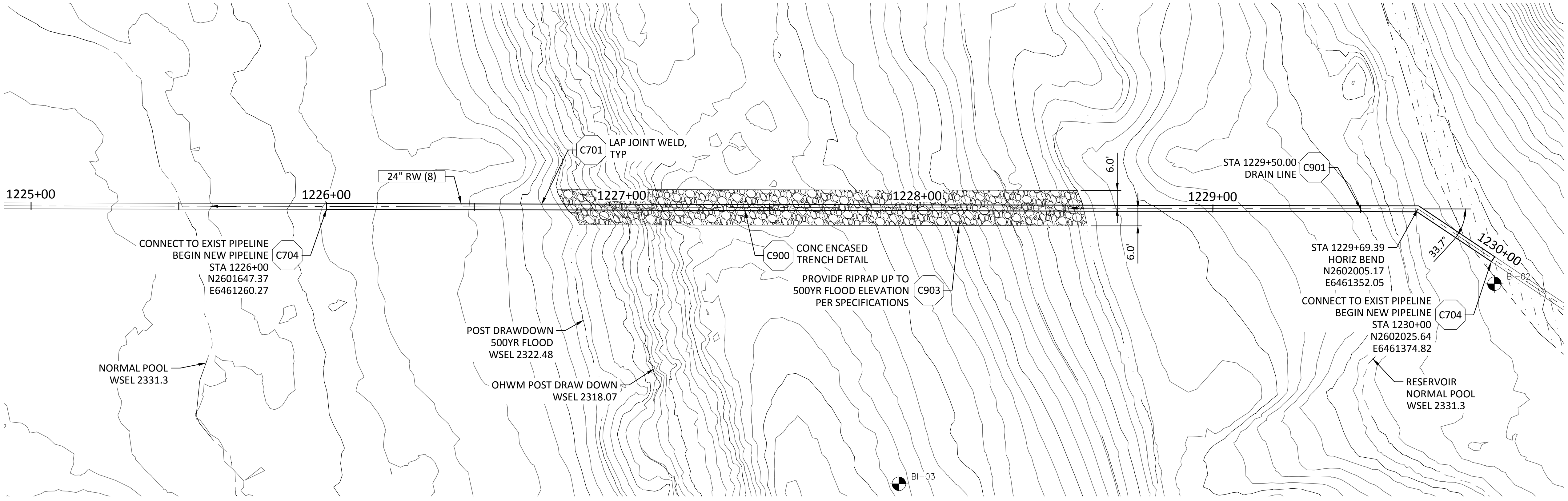
DRAWING
C107

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C107.dwg Plot date: Feb 05, 2021 05:04pm, CAD User: rooney

SHEET NOTES:

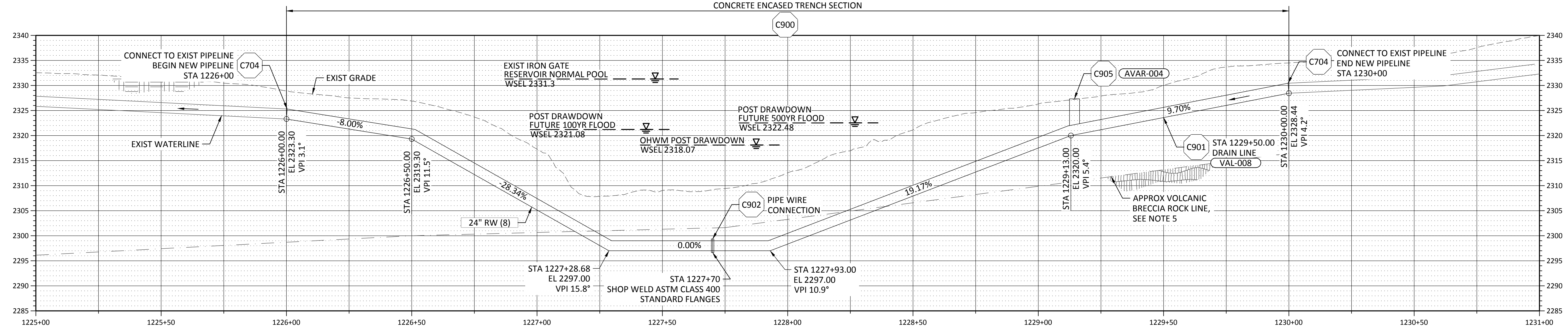
1. SEE ESC DWGS FOR EROSION AND SEDIMENT CONTROL MEASURES.
2. PROVIDE A MINIMUM OF 3-FT COVER.
3. ELEVATIONS SHOWN IN PIPELINE PROFILE ARE TO INVERT (FLOWLINE) OF PIPELINE UNLESS OTHERWISE NOTED.
4. STRAIGHT SLOPES SHALL BE MAINTAINED BETWEEN PIPE INVERTS SHOWN OR SPECIFIED.
5. THE EXISTING ROCKLINE IS BASED SOLELY UPON EXISTING BORINGS COMPLETED FOR THE PROJECT. SEE SPECIFICATIONS FOR DETAILED BORING INFORMATION. CONTRACTOR SHALL VERIFY THE LOCATION OF ROCK LINE PRIOR TO CONSTRUCTION OF THE NEW 24-INCH DIAMETER PERMANENT PIPELINE.



PLAN

SCALE: 1"= 20'

1 / -



PROFILE

SCALE: HORIZ 1"= 20'
VERT 1"= 10'

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

PERMANENT WATERLINE PLAN AND PROFILE

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

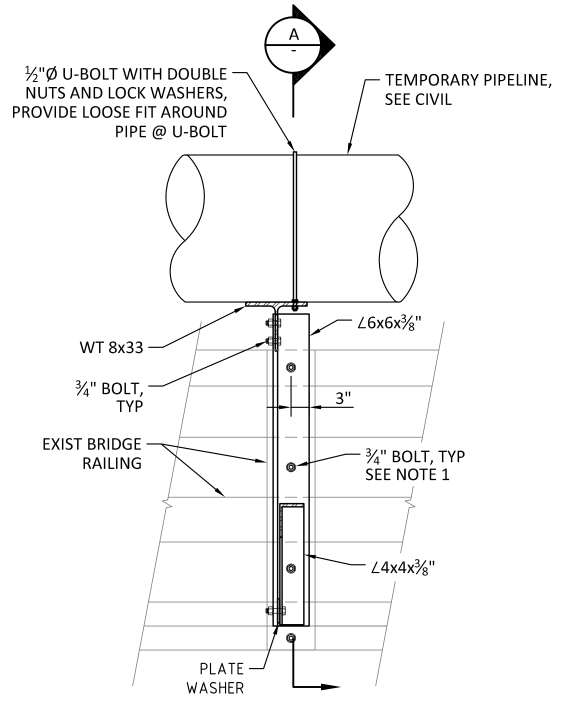
DRAWING
C200

JOB NO: 000000

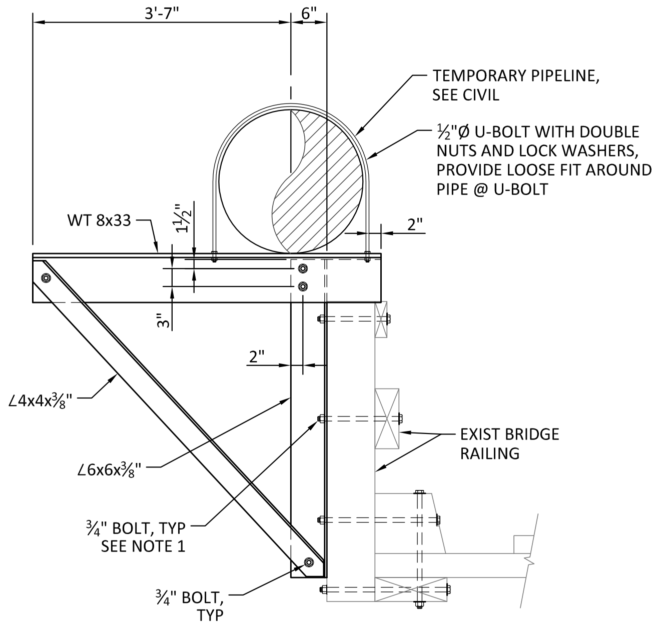
Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C200.dwg Plot date: Feb 05, 2021 05:05pm, CAD User: rooney

SHEET NOTES:

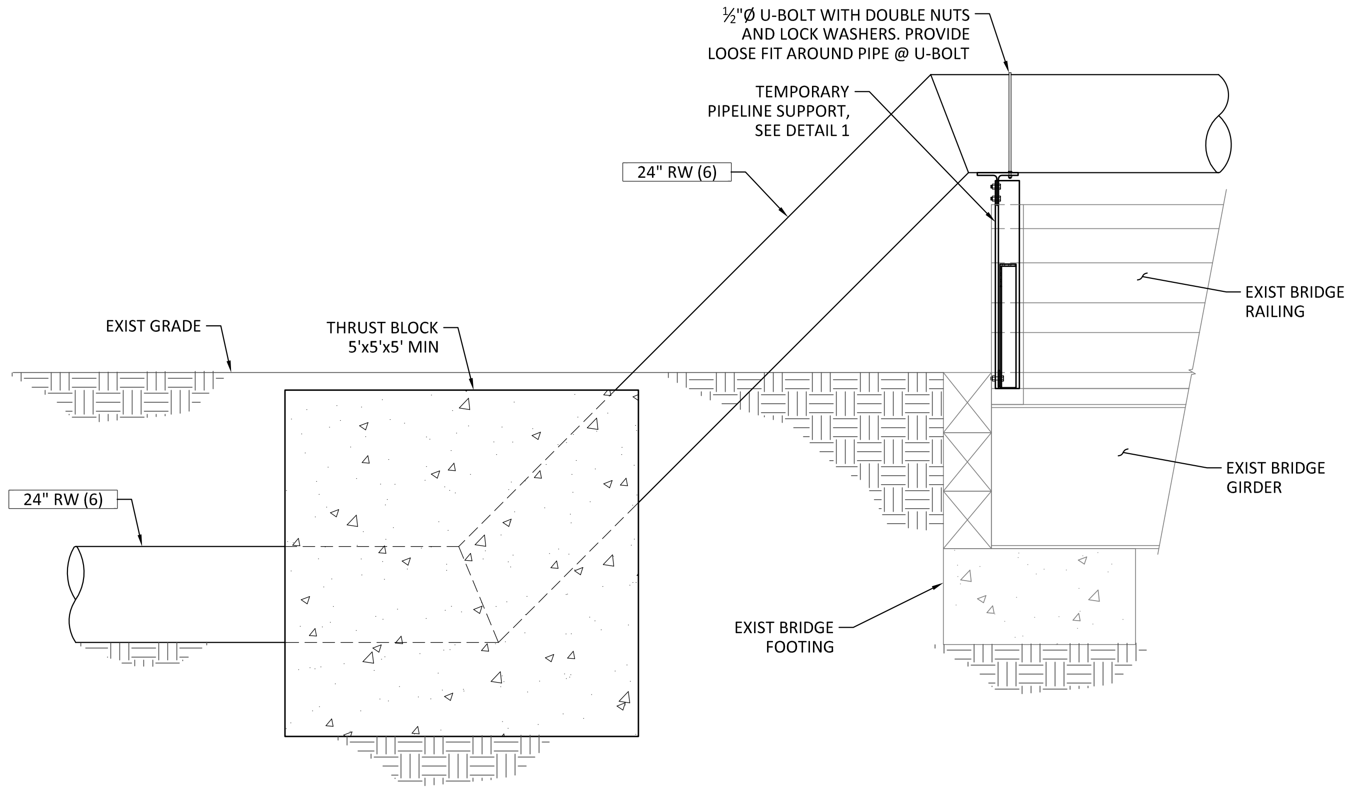
1. ALL EXISTING BOLTS SHALL BE REPLACED WITH NEW 3/4-INCH GALV BOLTS. PROVIDE ¼"x4"x4" MIN PLATE WASHERS AT LOCATIONS ADJACENT TO WOOD.



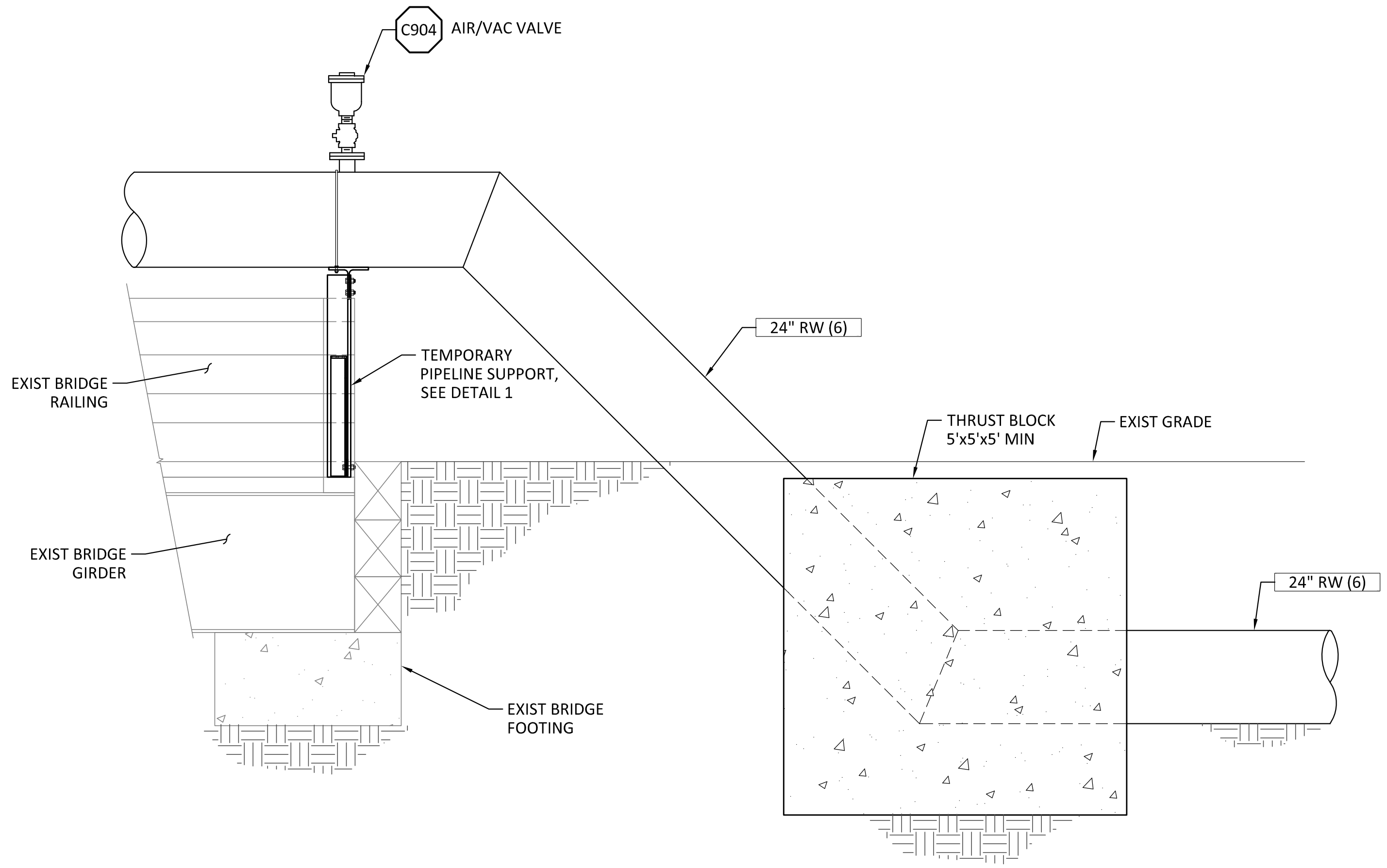
DETAIL 1 C105
SCALE: 3/4"= 1'-0"



SECTION A -
SCALE: 3/4"= 1'-0"



DETAIL 2 C105
SCALE: 1/2"= 1'-0"



DETAIL 3 C105
SCALE: 1/2"= 1'-0"

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

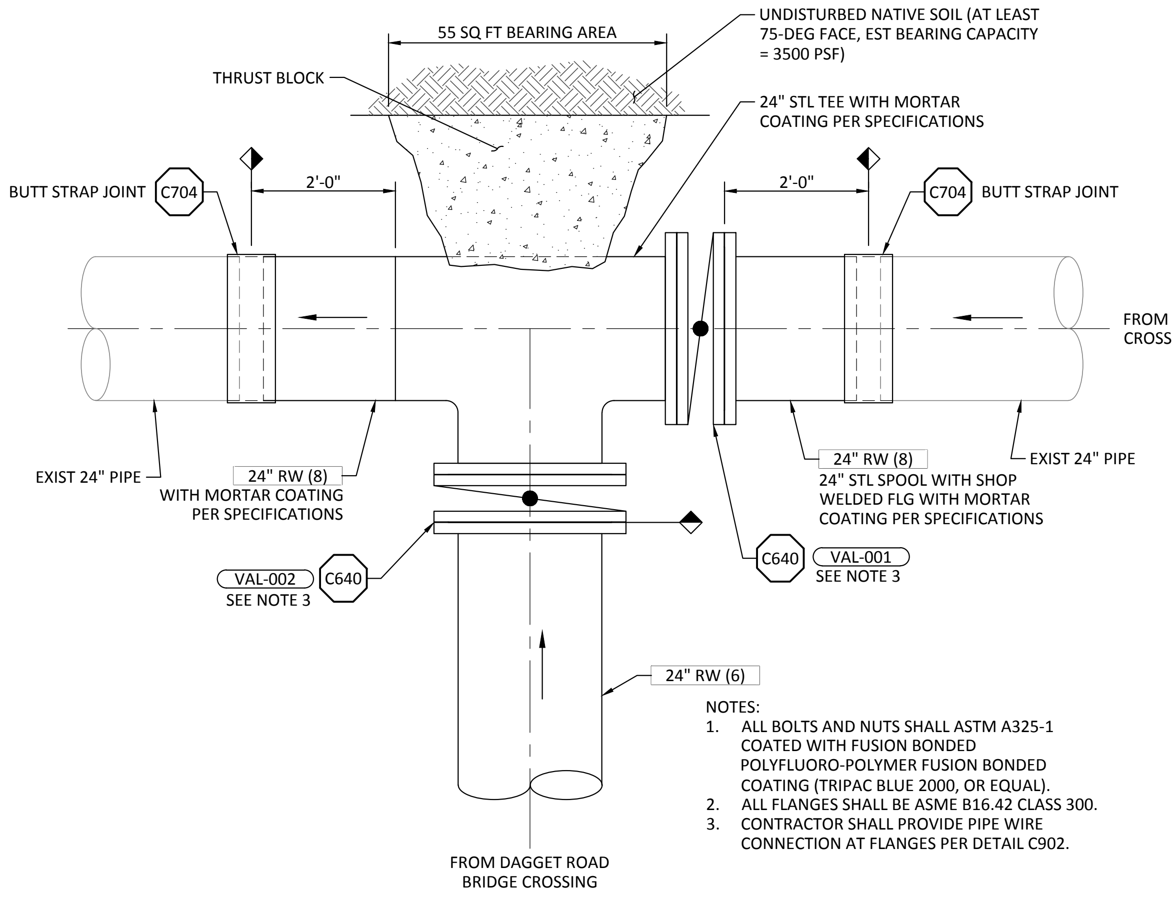
CIVIL SECTIONS AND DETAILS 1

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
C201

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C201.dwg Plot date: Feb 08, 2021 02:13pm, CAD User: wood

JOB NO: 000000



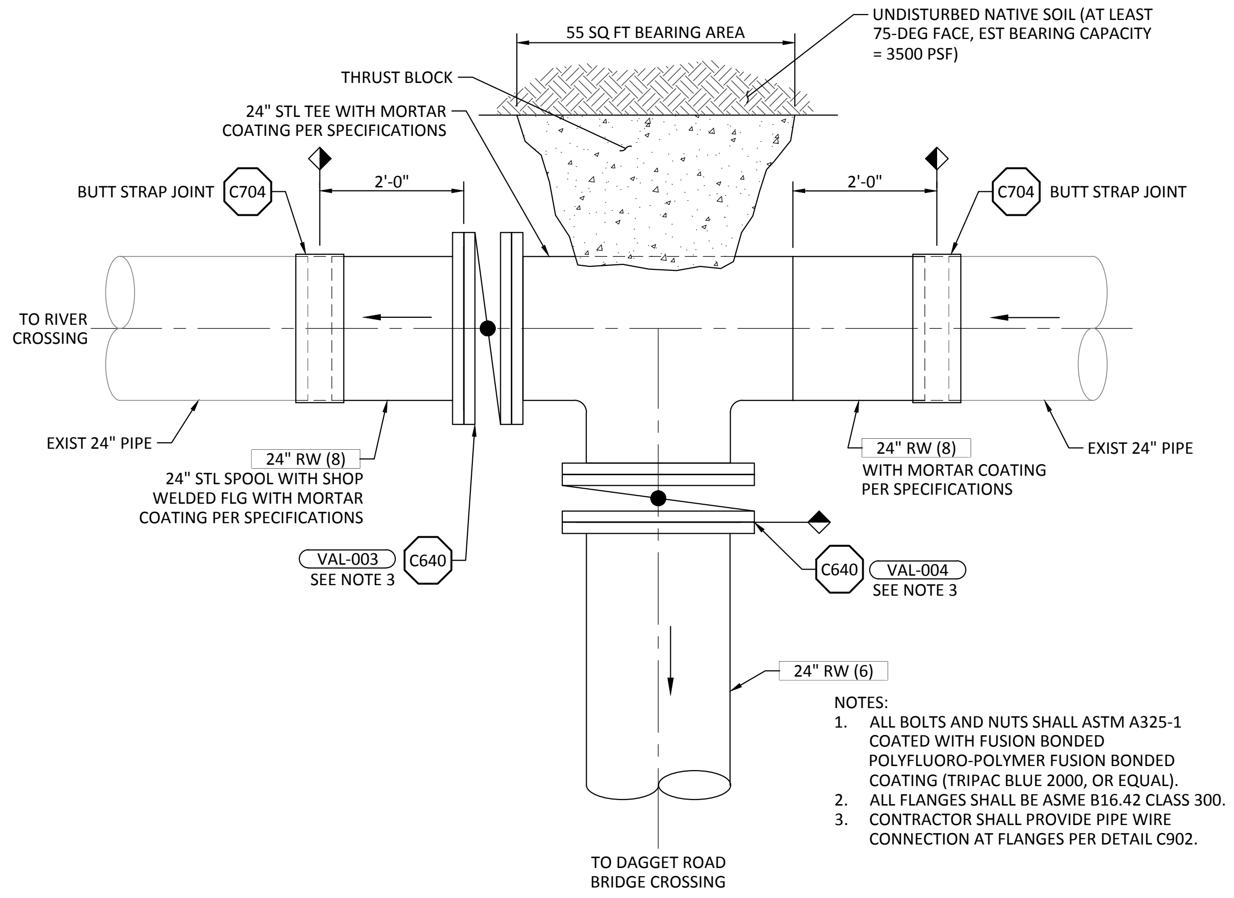
NOTES:
1. ALL BOLTS AND NUTS SHALL ASTM A325-1 COATED WITH FUSION BONDED POLYFLUORO-POLYMER FUSION BONDED COATING (TRIPAC BLUE 2000, OR EQUAL).
2. ALL FLANGES SHALL BE ASME B16.42 CLASS 300.
3. CONTRACTOR SHALL PROVIDE PIPE WIRE CONNECTION AT FLANGES PER DETAIL C902.

DOWNSTREAM TEMPORARY PIPELINE CONNECTION

SCALE: 3/4"= 1'-0"

0' 1' 2'

1
C100



NOTES:
1. ALL BOLTS AND NUTS SHALL ASTM A325-1 COATED WITH FUSION BONDED POLYFLUORO-POLYMER FUSION BONDED COATING (TRIPAC BLUE 2000, OR EQUAL).
2. ALL FLANGES SHALL BE ASME B16.42 CLASS 300.
3. CONTRACTOR SHALL PROVIDE PIPE WIRE CONNECTION AT FLANGES PER DETAIL C902.

UPSTREAM TEMPORARY PIPELINE CONNECTION

SCALE: 3/4"= 1'-0"

0' 1' 2'

2
C107

Path: C:\Vault20\Klamath River Renewal Corp\City of Yreka Water Line\C202.dwg Plot date: Feb 05, 2021 05:05pm, CAD User: rooney

REV	DATE	BY	DESCRIPTION
B	02/05/21	MDM	100% DESIGN SUBMITTAL
A	12/18/20	MDM	50% DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

WARNING
0 1/2 1
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
CITY OF YREKA WATER LINE

CIVIL SECTIONS AND DETAILS 2

DESIGNED J. BURNS
DRAWN R. WOOD
CHECKED M. MCMILLEN
PROJECT DATE 02/05/21

DRAWING
C202

JOB NO: 000000

City of Yreka Waterline Modification Technical Specifications

KLAMATH
RIVER RENEWAL
CORPORATION

Klamath River Renewal Project

City of Yreka Waterline Modification Project— Technical Specifications

100% Design Submittal

DRAFT
Revision No. 00

McMILLEN
JACOBS
ASSOCIATES

February 2021

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CITY OF YREKA WATERLINE MODIFICATION
TECHNICAL SPECIFICATIONS

100% DESIGN
TABLE OF CONTENTS

SECTION 01 11 00 - SUMMARY OF WORK

PART 1 -- GENERAL

1.1 SUMMARY

A. The WORK to be performed under this Contract shall consist of furnishing tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the OWNER.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The WORK of this Contract comprises the demolition of the existing 24-inch diameter steel pipe that is minimally buried in the Iron Gate Reservoir bed, construction of a new 24-inch diameter steel pipe across the Klamath River within bedrock, and construction of a 24-inch diameter steel temporary pipeline to keep the City of Yreka’s waterline in service during construction of the new steel pipeline across the Klamath River.

B. The WORK is located in Siskiyou County northeast of Iron Gate Dam near Hornbrook, California. The Project is located near the intersection of Copco Road and Daggett Road southwest of the Daggett Road Bridge crossing the Klamath Reservoir.

1.3 OTHER WORK

A. Where two or more projects are being performed at one time on the same site or adjacent land in such manner that work may interfere with work under another, the CONTRACTOR shall determine the sequence and order of the Work in either or both projects. When the Site of one project is the necessary or convenient means of access for performance of work under another, the OWNER may grant privilege of access or other reasonable privilege to the contractor so desiring, to the extent, amount , and in manner and at time that the OWNER may determine. No OWNER determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The CONTRACTOR shall conduct its operations so as to cause a minimum of interference with the work of such other contractors, and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

B. **Interference With Work On Utilities:** The CONTRACTOR shall cooperate fully with all utility forces of the OWNER or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the WORK, and shall schedule the WORK so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.4 WORK SEQUENCE

A. The CONTRACTOR's attention is directed to the fact that during the period of construction there shall be no interruption in the City or Yreka’s flow can be accommodated, and the CONTRACTOR shall so schedule its construction operations that no interference with the operation of the water system will occur during this critical period.

1.5 CONTRACTOR USE OF SITE

A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

1.6 OUTAGE PLAN AND REQUESTS

A. Unless the Contract Documents indicate otherwise, the CONTRACTOR shall not remove from service, de-energize, or modify settings for any existing operating tank, pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the OWNER.

B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall submit a detailed outage plan and schedule for the ENGINEER'S approval a minimum of two (2) weeks in advance of the time that such outage is planned.

C. Construction activities shall be scheduled and sequenced to ensure continuous operation of the existing waterline to the greatest extent possible. The City has stated that they have enough storage capacity to meet City water demands and the waterline can be turned off for up to 20 hours in the summer months (May through October) and up to 60 hours in the winter months (November through April).

D. A completed System Outage Request form shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents. The outage plan shall describe the CONTRACTOR's estimated length of time required to complete said operation; any necessary temporary power, controls, instrumentation or alarms required to maintain control, monitoring, and alarms for the processes; and the manpower and equipment which the CONTRACTOR will furnish. All costs for preparing and implementing the outage plans shall be at no increase in cost to the OWNER.

E. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.

F. The CONTRACTOR shall provide written confirmation of the shutdown date and time two (2) working days prior to the actual shutdown.

1.7 PROJECT MEETINGS

A. **Preconstruction Conference**

1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR'S Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:

    a. ENGINEER and the Resident Project Representative.

    b. Representatives of OWNER.

    c. Governmental representatives as appropriate.

    d. Others as requested by CONTRACTOR, OWNER, or ENGINEER.

2. The CONTRACTOR shall bring the preconstruction conference submittals in accordance with Section 01 33 00 - Contractor Submittals.

3. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.

    a. Status of CONTRACTOR's insurance and bonds.

    b. CONTRACTOR's tentative schedules.

    c. Transmittal, review, and distribution of CONTRACTOR's submittals.

    d. Processing applications for payment.

    e. Maintaining record documents.

    f. Critical work sequencing.

    g. Field decisions and Change Orders.

    h. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.

    i. Major equipment deliveries and priorities.

    j. CONTRACTOR's assignments for safety and first aid.

    k. Daily Report Form which the ENGINEER will furnish.

    l. Submittal Transmittal Form which the ENGINEER will furnish.

4. The ENGINEER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

5. The CONTRACTOR and its subcontractors should plan on the conference taking no less than one (1) full working day. The meeting will cover the items listed in

paragraphs 2 and 3, and reviewing the Drawings and Specifications, in extensive detail, with the ENGINEER and the OWNER.

B. **Progress Meetings**

1. The ENGINEER will schedule and hold regular on-Site progress meetings at least biweekly and at other times as requested by CONTRACTOR or as required by progress of the WORK. The CONTRACTOR, ENGINEER, and all subcontractors active on the Site shall attend each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.

2. The ENGINEER will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the WORK, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the CONTRACTOR shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01 12 00 - HYDROLOGY AND HYDRAULICS

PART 1 -- GENERAL

1.1 OVERVIEW

A. This Section describes: the hydrologic data of the Klamath River pre and post-drawdown at the location of the City of Yreka Waterline crossing.

B. This Section is provided for information only and does not guarantee specific hydrology or hydraulics.

1.2 DEFINITIONS

A. In-Water Work (IWW): Work that is performed within the limits of the Ordinary High Water Mark (OHWM), as defined on the Contract Drawings. This definition does not imply that work outside of the OHWM will not be impacted by extreme events. Some areas not designated IWW are within the channel floodplain.

1.3 AREAS FOR IN-WATER WORK (IWW)

A. There exist one location as part of the Work defined for this Project for which IWW is expected:

1. City of Yreka waterline crossing – Work in Klamath River is expected to demolish the existing 24-inch diameter waterline and construct the new 24-inch diameter waterline.

1.4 COFFERDAM AND DESIGN WATER LEVELS DURING CONSTRUCTION

A. The cofferdam design shall be per Specification Section 02 15 00 – Cofferdam and Protective Works.

B. CONTRACTOR shall take into account the below design and overflow levels in planning and scheduling construction activities. Provisions for all cofferdams shall be CONTRACTOR’s responsibility.

1.5 PROJECT HYDROLOGY RECORDS

A. Knight Piésold (2020) analyzed the annual peak floods for the Klamath River Renewal Project, 90% Design Report. They analyzed the historic USGS data and the 2019 BiOp data.

B. Table 01 12 00 – 01 presents a summary of the design flood events for the Klamath River.

Table 01 12 00 – 01. Klamath River Design Flood Events.

Probability (%)	Return Period	Flow (cfs)
50%	2-yr	7,500

Probability (%)	Return Period	Flow (cfs)
20%	5-yr	10,900
10%	10-yr	14,900
5%	20-yr	19,300
2%	50-yr	25,700
1%	100-yr	31,200
0.5%	200-yr	37,100
0.2%	500-yr	45,800

Source: Table 3.2, Appendix A-6 (Knight Piésold, 2020)

C. The ordinary high-water mark (OHWM) is defined as the point on a stream bank at which the presence and action of surface water is so continuous as to leave a distinct erosion mark, destruction or prevention of woody terrestrial vegetation, predominance of aquatic vegetation, or other easily recognized characteristics. Therefore, the OHWM defines the jurisdictional boundary between upland and riparian areas subject to permitting requirements. The OHWM is often defined as the 2-year flood elevation.

1. The Klamath River OHWM Post Drawdown is at elevation 2318.07 feet.

D. The HEC-RAS station closest to the waterline and the sections upstream and downstream are shown in Figure 1. The total flow, flow depth, velocity, stream power, and shear stress are reported for each cross-section in Table 2. The HEC-RAS station, 489524, closest to the Yreka waterline crossing has the lowest stream power when compared to the cross-sections upstream and downstream. The higher the stream power, the more erosion potential. The proposed Yreka waterline crossing is located basically in a pool area with strong riffles upstream and a mild riffle downstream.

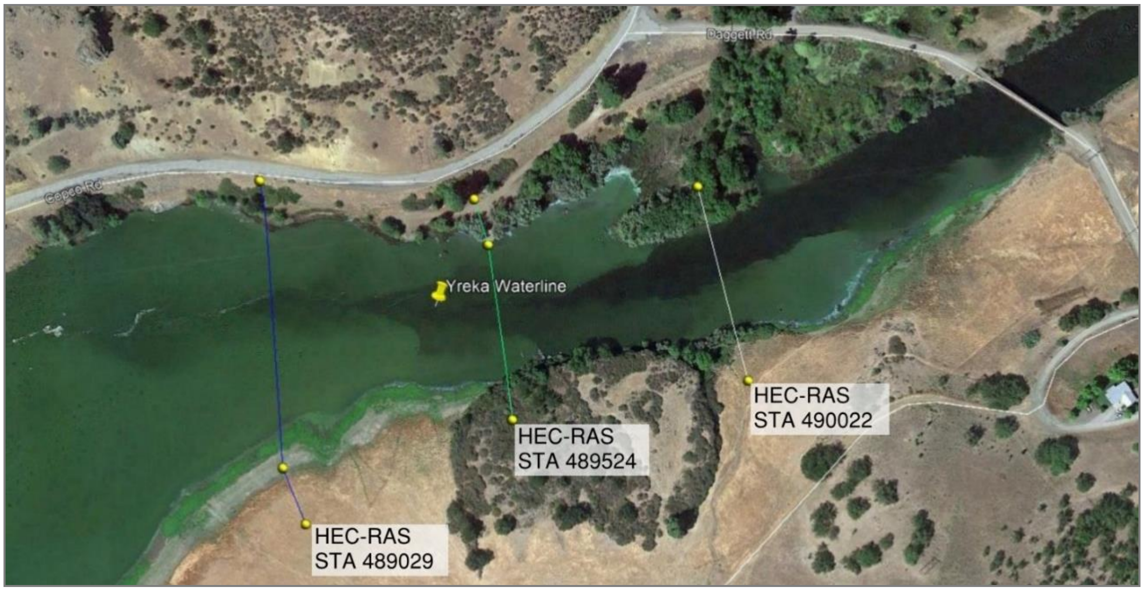

Figure 01 12 00 – 01. HEC-RAS Cross-Section Location and Waterline Location.

Table 01 12 00 – 02. Cut and Cover Crossing Data from HEC-RAS.

A. Description	River Station			River Station		
	490022	**489524**	**489029**	**490022**	**489524**	**489029**
	50-year Flood			***100-year Flood***		
Total Flow (cfs)	25,700			31,200		
Max Channel Depth (ft)	14.36	23.12	17.34	15.84	24.05	18
Velocity (ft/s)	18.91	11.27	11.81	19.91	12.9	13.6
Stream Power (lb/ft·s)	132.58	24.93	30.13	149.05	36.74	45.36
Shear Strees (lb/ft²)	7.01	2.21	2.55	7.49	2.85	3.34
	200-year Flood			***500-year Flood***		
Total Flow (cfs)	37,100			45,800		
Max Channel Depth (ft)	16.95	25.3	19.13	18.85	26.81	20.36
Velocity (ft/s)	21.48	14.16	14.9	22.96	15.89	16.88
Stream Power (lb/ft·s)	182.48	47.64	58.31	214.12	65.69	82.87
Shear Strees (lb/ft²)	8.5	3.36	3.91	9.33	4.13	4.91

1.6 WATER SURFACE ELEVATIONS

A. Water surface elevations at the locations of IWW will be impacted by the CONTRACTOR’s use of cofferdam systems, protective works, dewatering and bypass infrastructure, and construction staging. Therefore, predictions of design water surface levels cannot be accurately made prior to the development of cofferdam and dewatering plans, and it shall be incumbent upon the CONTRACTOR to perform calculations and make determinations regarding the design water surface levels during construction. Hydrologic data has been provided to aid the CONTRACTOR in making such determinations.

B. The 500-year Post Drawdown Flood Elevation is at elevation 2322.48 feet.

1.7 AREA WEATHER

A. Precipitation and Temperature records were collected from the nearby NOAA station in Montague, CA at the Siskiyou Airport, and are provided below for the CONTRACTOR’s reference.

B. Precipitation varies throughout the year with the highest average monthly precipitation during November and the lowest during August. The average rainfall in the Montague, CA for each month is listed in Table 01 12 00 – 03.

Table 01 12 00 – 03. Average Precipitation and Temperature Records

Month	Precipitation (inches)	Temperature (°F)	
		High	**Low**
January	2.2	45	26
February	2.0	51	28
March	2.3	56	30
April	1.6	61	33

Month	Precipitation (inches)	Temperature (°F)	
		High	Low
May	1.4	72	40
June	0.7	80	47
July	0.5	91	54
August	0.3	90	52
September	0.6	81	43
October	1.2	68	36
November	3.0	50	29
December	2.7	44	26

C. Temperature and other weather conditions at the site vary throughout the year and should be carefully factored into the construction work. CONTRACTOR shall comply with all applicable cold weather construction practices and requirements.

1.8 CONSTRUCTION LIMITATION

A. Construction activities must not impede the City of Yreka obtaining its full water right of 15 cfs throughout the entire construction period.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 CONSTRUCTION PLANNING AND SCHEDULING

A. CONTRACTOR shall take account the above described hydrology, hydraulic design, and weather conditions when planning and scheduling all construction activities. CONTRACTOR shall ensure the work is carried out in a safe manner, protected from damage, and in accordance with standard accepted construction practice.

- END OF SECTION -

SECTION 01 33 00 - CONTRACTOR SUBMITTALS

PART 1 -- GENERAL

1.1 SUMMARY

A. Wherever submittals are required in the Contract Documents, submit them to the OWNER or OWNER's Resident Representative as directed.

B. Within seven (7) Days after the date of commencement as stated in the Notice to Proceed, the CONTRACTOR shall submit the following items for review:

1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("Or-Equal") submittals listed in the Bid. The schedule of submittals shall be based on CONTRACTOR's priority, planned construction sequence and schedule, long lead items, and size of submittal package. Allow time for resubmittals.

2. A list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

1.2 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference of Section 01 11 00 - Summary of Work, the submit the following items to the OWNER for review:

1. A revised schedule of Shop Drawings, Samples, and proposed Substitute ("Or-Equal") submittals listed in the Bid.

2. A list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

3. A preliminary schedule of values in accordance with Section 01 29 00 - Schedule of Values.

4. A 60-Day plan of operation in accordance with Section 01 32 15 - CPM Construction Schedule.

5. A detailed layout of the field office required under Section 01 52 00 - Field Office, Equipment, and Services. The office shall not be shipped to the Site until the layout is approved.

1.3 SHOP DRAWINGS

A. All shop drawing submittals along with the shop drawing transmittal form, shall be made electronically in ".pdf" format and distributed by email from the CONTRACTOR to the OWNER's Resident Project Representative (RPR). The OWNER'S RPR shall be responsible to distribute each shop drawing to all reviewers and to receive and compile all review comments generated.

B. Wherever called for in the Contract Documents or where required by the ENGINEER, the CONTRACTOR shall furnish a clear (non-scanned) electronic version, of each Shop Drawing submittal. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items. Whenever the CONTRACTOR is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in the appropriate branch and in the state wherein the project is located, unless otherwise indicated.

C. Shop Drawing submittals shall be accompanied by the OWNER's standard submittal transmittal form, an electronic copy of which is available from the OWNER. A submittal without the form or where applicable items on the form are not completed will be returned for resubmittal.

D. **Organization**

1. A single submittal transmittal form shall be used for each technical specification section or item or class of material or equipment for which a submittal is required. A single submittal covering multiple sections will not be acceptable, unless the primary specification references other sections for components.

2. On the transmittal form, index the components of the submittal and insert tabs in the submittal to match the components. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, as applicable.

3. Unless indicated otherwise, terminology and equipment names and numbers used in submittals shall match those used in the Contract Documents.

E. **Format**

1. Minimum sheet size shall be 8-1/2 inches by 11-inches. Maximum sheet size shall be 11-inches by 17-inches. Every page in a submittal shall be numbered in sequence. All sheets shall be submitted on one (1) pdf file and arranged.

2. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Sufficient level of detail shall be presented for assessment of compliance with the Contract Documents.

3. Each submittal shall be assigned a unique number. Submittals shall be numbered sequentially, and the submittal numbers shall be clearly noted on the transmittal. Original submittals shall be assigned a numeric submittal number followed by a decimal point and a “1” to indicate it is an original (first) submittal. (For example, if submittal number 16.1 requires a resubmittal, that resubmittal will bear the designation “16.2”. A further resubmittal would bear the designation “16.3”, etc.

F. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.

G. Except as may otherwise be indicated, the ENGINEER will return email comments (in pdf format) of each submittal to the OWNER's RPR with comments noted thereon, within 14 calendar Days following receipt by the ENGINEER. The OWNER's RPR will compile all comments and return the complete submittal (in pdf format), within 21 calendar days following original receipt by the OWNER's RPR. It is considered reasonable that the CONTRACTOR will make a complete and acceptable submittal to the OWNER's RPR by the first resubmittal on an item. The OWNER reserves the right to withhold monies due to the CONTRACTOR to cover additional costs of the ENGINEER's review beyond the first resubmittal. The ENGINEER's and OWNER RPR's combined maximum review period for each submittal or resubmittal will be 21 calendar Days. Thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 63 calendar Days.

H. **Submittal Review Marking**

1. **NO EXCEPTIONS TAKEN**. If a submittal is returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.

2. **MAKE CORRECTIONS NOTED**. If a submittal is returned marked "MAKE CORRECTIONS NOTED," CONTRACTOR shall make the corrections on the submittal, but formal revision and resubmission will not be required.

3. **REVISE-RESUBMIT.** If a submittal is returned marked "REVISE-RESUBMIT," the CONTRACTOR shall revise it and shall resubmit the required number of copies. Resubmittal of portions of multi-page or multi-drawing submittals will not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "REVISE - RESUBMIT," the submittal as a whole is deemed "REVISE - RESUBMIT," and all 10 drawings are required to be resubmitted.

4. **REJECTED-RESUBMIT**. If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 - Products, Materials, Equipment, and Substitutions. In the first 2 cases, the CONTRACTOR shall prepare a new submittal and shall resubmit. In the latter case, the CONTRACTOR shall submit the substitution request according to Section 01 60 00.

I. Resubmittal of rejected portions of a previous submittal will not be allowed. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

J. Fabrication of an item may commence only after the ENGINEER has reviewed the pertinent submittals and returned copies to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED." Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.

K. Submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR prior to submission to the ENGINEER. Each submittal shall be dated and signed by the CONTRACTOR as being correct and in strict conformance with the

Contract Documents. In the case of Shop Drawings, each sheet shall be so dated and signed. Any deviations from the Contract Documents shall be noted on the transmittal sheet. The ENGINEER will only review submittals that have been so verified by the CONTRACTOR. Non-verified submittals will be returned to the CONTRACTOR without action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.

L. Corrections or comments made on the CONTRACTOR's Shop Drawings during review do not relieve the CONTRACTOR from compliance with Contract Drawings and Specifications. Review is for conformance to the design concept and general compliance with the Contract Documents only. The CONTRACTOR is responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating WORK with the trades, and satisfactory and safe performance of the WORK.

1.4 SAMPLES

A. The CONTRACTOR shall submit the number of samples indicated by the Specifications. If the number is not indicated, submit not less than three (3) samples. Where the amount of each sample is not indicated, submit such amount as necessary for proper examination and testing by the methods indicated.

B. Samples shall be individually and indelibly labeled or tagged, indicating the salient physical characteristics and manufacturer's name. Upon acceptance by the ENGINEER, one set of the samples will be stamped and dated by the ENGINEER and returned to the CONTRACTOR, one set of samples will be retained by the OWNER, and one set shall remain at the Site in the OWNER RPR’s field office until completion of the WORK.

C. Unless indicated otherwise, the OWNER will select colors and textures from the manufacturer's standard colors and standard materials, products, or equipment lines. If certain samples represent non-standard colors, materials, products, or equipment lines that will require an increase in Contract Times or Price, the CONTRACTOR shall clearly state so on the transmittal page of the submittal.

1.5 TECHNICAL MANUAL

A. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual. It shall be written so that it can be used and understood by the OWNER's operation and maintenance staff.

B. **Organization.** The Technical Manual shall be subdivided first by specification section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):

1. **Category 1 - Equipment Summary**

    a. Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

b. Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.

2. **Category 2 - Operational Procedures**

a. Operational and Maintenance procedures shall be written in Microsoft ™ Word document format for the startup, operation, maintenance, emergency situations and shutdown for all facility systems. The procedures shall be written in a step by step method for proper operation or maintenance of each individual system. [For example, the startup procedure for a water supply system shall include operations of pumps, valves, gates, meters, HMI procedures, etc to bring the system online and functioning properly.]

b. Manufacturer-recommended procedures on the following shall be included in Part 2:

1) Installation

2) Adjustment

3) Startup

4) Location of controls, special tools, equipment required, or related instrumentation needed for operation

5) Operation procedures

6) Load changes

7) Calibration

8) Shutdown

9) Troubleshooting

10) Disassembly

11) Reassembly

12) Realignment

13) Testing to determine performance efficiency

14) Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices

15) List of all electrical relay settings including alarm and contact settings

3. **Category 3 - Preventive Maintenance Procedures**

   a. Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

   b. Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

4. **Category 4 - Wiring and Loop Diagrams**

   a. Diagrams: This category includes complete internal and connection wiring diagrams for electrical and instrumentation equipment items.

5. **Category 5 - Shop Drawings**

   a. Drawings: This category includes approved shop or fabrication drawings with ENGINEER comments and corrections incorporated, complete with dimensions.

6. **Category 6 - Parts List**

   a. Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

   b. Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

7. **Category 7 - Safety**

   a. Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

8. **Category 8 – Documentation & Warrantees**

   a. Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

C. **Format**

1. Each Technical Manual shall be bound in standard size 3 ring hardcover binders labeled on the spine and cover with project name, OWNER's project number, specification section number, equipment name, and equipment identification number

2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.

3. Documents in binders shall be 3-hole punched, no text shall be punched out, and pages larger than 8-1/2 inches by 11-inches shall be folded to 8-1/2 inches by 11-inches. Binder ring size shall not exceed 2.5-inches in diameter.

4. Each final set of Technical Manuals shall include a CD/DVD with electronic files:

   a. Project specific files created in Microsoft Office, AutoCAD, latest version, Adobe Acrobat portable document format, or other software required by the specifications.

   b. Manufacturer literature in Adobe Acrobat portable document format (pdf).

D. **Technical Manual Review Process**

1. The CONTRACTOR shall furnish three (3) draft Technical Manuals for each Specification Section that requires a Manual. The OWNER's RPR will retain one (1) copy, will forward one (1) copy to the OWNER, and will return one (1) copy to the CONTRACTOR with review comments.

2. The CONTRACTOR shall incorporate all comments into the draft and shall submit five (5) identical hard copies of the final Manual, bound in 3-ring binders, for acceptance.

E. **Schedule**

1. Except where indicated otherwise, Technical Manuals shall be submitted in final form to the OWNER's RPR not later than the 80 percent of construction completion date. Discrepancies found by the OWNER or ENGINEER shall be corrected within 30 Days from the date of written notification by the OWNER's RPR.

2. WORK under this Contract involves start-up and commissioning of an existing water system. Manuals shall be complete for each piece of equipment prior to final acceptance of the equipment by the OWNER. Except where indicated otherwise, manuals shall be submitted for review in final form a minimum of 30 Days prior to the start of performance testing for each piece of equipment. Discrepancies found by the OWNER or ENGINEER shall be corrected within 30 Days from the date of written notification by the OWNER's RPR.

1.6 SPARE PARTS LIST

A. The CONTRACTOR shall furnish to the OWNER spare parts information for mechanical, electrical, and instrumentation equipment. The spare parts list shall include those spare parts that each manufacturer recommends be maintained by the OWNER in inventory.

1. **Sources and Pricing**: The spare parts list shall include a current list price of each spare part. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to assist the OWNER in ordering.

2. **Format**: The CONTRACTOR shall cross-reference spare parts lists to the equipment numbers designated in the Contract Documents. The spare parts lists

shall be bound in standard size, 3 ring, loose-leaf, vinyl plastic hard cover binders suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches.

1.7 RECORD DRAWINGS

A. The CONTRACTOR shall maintain one set of Drawings at the Site for the preparation of record drawings. On these, it shall mark every project condition, location, configuration, and any other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.

B. The record drawings shall be supplemented by any detailed sketches as necessary or as CONTRACTOR is directed, to fully indicate the WORK as actually constructed. These record drawings are the CONTRACTOR's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up-to-date during the progress of the WORK. Red ink shall be used for alterations and notes. Notes shall identify relevant Change Orders by number and date.

C. 11-inch x 17-inch size paper copies of the record drawings shall be submitted to the OWNER’s RRP at 120 day intervals, staring after the date of the Notice to Proceed, and also at completion of WORK. Failure to submit complete record drawings on or before these dates will enact the liquidated damages clause for interim record drawing submittals described in Division 00 Contract Specifications.

D. In the case of those drawings that depict the detail requirement for equipment to be assembled and fabricated in the factory, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final Shop Drawings, and by including appropriate reference information describing the change orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.

E. Disorganized or incomplete record drawings will not be accepted. The CONTRACTOR shall revise them and resubmit the drawings for review.

F. Record drawings shall be accessible to the OWNER’s RPR during the construction period.

G. Final payment will not be acted upon until the record drawings have been completed and delivered to the OWNER’s RPR. Said up-to-date record drawings shall be in the form of a set of prints with carefully plotted information overlaid on the Contract Drawings.

H. Information submitted by the CONTRACTOR will be assumed to be correct, and the CONTRACTOR shall be responsible for the accuracy of such information

1.8 QUALITY CONTROL (QC) SUBMITTALS

A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the OWNER and ENGINEER that the CONTRACTOR has satisfied certain requirements of the Contract Documents.

B. Unless otherwise indicated, QC submittals shall be submitted:

    1. Before delivery and unloading, for the following types of submittals:

        a. Manufacturers' installation instructions

        b. Manufacturers' and Installers' experience qualifications

        c. Affidavits and manufacturers' certification of compliance with indicated product requirements

        d. Laboratory analysis results

        e. Factory test reports

        f. Ready mix concrete delivery tickets

        g. Design calculations

    2. Within 30 Days of the event documented for the following types of submittals:

        a. Manufacturers' field representative certification of proper installation

        b. Field measurement

        c. Field test reports

        d. Receipt of permit

        e. Receipt of regulatory approval

C. The OWNER’s RPR and ENGINEER will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

1.9 INFORMATIONAL SUBMITTALS

A. Informational submittals, such as Requests for Information (RFI), Deviation Request (DR), Change Order Proposals (COR), etc. formalize the flow of information between the CONTRACTOR and the ENGINEER. The OWNER’s standard forms will be employed for such purpose. Electronic copies of all standard Construction Management forms shall be provided by the OWNER to the CONTRACTOR.

1.10 CONSTRUCTION PHOTOGRAPHS

A. The CONTRACTOR shall be responsible to take digital construction photographs, no less than once per week, showing the progress of the WORK, including documentation of all buried utilities encountered during construction as well as installation of new buried utilities and buried WORK required by the Contract.

B. Upon completion of the WORK and before final payment, the CONTRACTOR shall electronically submit all photographs to the OWNER on a CD or other electronic media with each photograph's file name identified by location and date it was taken.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01 42 10 - REFERENCE STANDARDS

PART 1 -- GENERAL

1.1 GENERAL

A. **Titles of Sections and Paragraphs:** Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.

B. **Applicable Publications:** Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.

C. **Specialists, Assignments:** In certain instances, specification text requires (or implies) that specific WORK is to be assigned to specialists or expert entities who must be engaged to perform that WORK. Such assignments shall be recognized as special requirements over which the CONTRACTOR has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the WORK; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of WORK is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the CONTRACTOR.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The CONTRACTOR shall construct the WORK in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.

B. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the ENGINEER for clarification and direction prior to ordering or providing any materials or furnishing labor. The CONTRACTOR shall bid for the most stringent requirements.

C. References to "OSHA Regulations for Construction" shall mean **Title 29, Part 1926, Construction Safety and Health Regulations,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

D. References to "OSHA Standards" shall mean **Title 29, Part 1910, Occupational Safety and Health Standards,** Code of Federal Regulations (OSHA), including all changes and amendments thereto.

E. **Applicable Safety Standards**: References to "Cal-OSHA" shall mean State of California, Department of Industrial Relations, Construction Safety Orders, as amended to date, and all changes and amendments thereto.

1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. The CONTRACTOR shall be responsible that all WORK included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist and the OWNER has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01 74 30 - PRESSURE PIPE TESTING

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall test raw water pipelines and appurtenant piping, in accordance with the Contract Documents.

B. The CONTRACTOR shall be responsible for obtaining permits for discharging excess testing water if required to satisfy permit limits.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. **Furnish:**

1. A testing plan and schedule, including method for water conveyance, and control, disposal shall be submitted in writing for approval.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. All test equipment, temporary valves, bulkheads, and other water control equipment shall be as determined by the CONTRACTOR. No materials shall be used which would be injurious to the WORK.

PART 3 -- EXECUTION

3.1 GENERAL

A. Water for testing water pipelines will be furnished by the OWNER; however, the CONTRACTOR shall convey the water from the OWNER-designated source to the points of use.

B. All pressure pipelines shall be tested. All testing operations shall be performed in the presence of the ENGINEER.

C. Disposal of flushing water and water containing chlorine shall be by methods acceptable to the ENGINEER.

3.2 PIGGING

A. The CONTRACTOR shall clean the system thoroughly by pigging to remove sand, grit, gravel, stones, fluids, construction waste, and all material which would not be found in a properly cleaned pipeline. Pigging shall obtain a smooth interior pipe surface free from any material or fluid not used in cleaning.

B. Pigging shall be defined as passage of a sufficient number of pigs through the pipeline to achieve the clean conditions required. Flushing will not be acceptable as a substitute for pigging.

C. Provision for pig access and egress points and disposal of water and materials shall be the CONTRACTOR's responsibility.

D. Pigs shall be individually marked and their location shall be controlled and monitored so that no pigs remain in the system after cleaning.

E. Pigging may be done in conjunction with initial filling for the hydrostatic test.

3.3 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. The CONTRACTOR shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, the CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that do not have isolation valves shall be tested in approximate one-mile segments. Sections that have a zero leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. The CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

B. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.

C. The hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of 4 hours. The test pressure for yard piping shall be as indicated on the Piping Schedule measured at the lowest point of the pipeline section being tested. No pressure test will be required for a reservoir overflow line. Visible leaks that appear during testing shall be repaired in a manner acceptable to the ENGINEER. Add water to restore the test pressure if the pressure decreases 5-psi below test pressure during the test period.

D. Pipe with welded joints shall have no leakage. Exposed piping shall show no visible leaks and no pressure loss during the test. In the case of pipelines that fail to pass the leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

- END OF SECTION -

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SECTION 02 15 00 - COFFERDAMS AND PROTECTIVE WORKS

PART 1 -- GENERAL

1.1 SUMMARY

A. The WORK includes furnishing all design, labor, and equipment necessary to construct and maintain in good working order all cofferdams and protective works necessary during construction of facilities located in or adjacent to static or moving bodies of water as specified herein.

B. All cofferdam and related protective work shall be located within the approved disturbance area limits as shown on the Contract Drawings.

C. Remove all temporary cofferdams or other temporary protective works upon completion of the facilities located in or adjacent to bodies of water.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit a proposed plan for cofferdams and protective works in accordance with the requirements of Section 01 33 00 – Contractor Submittals which shall address, as a minimum, the following items:

1. Type of cofferdam or other protective works to be used.
2. Sequence of construction for cofferdam or other protective works-related Work items.
3. Description of provisions for limiting siltation or other effects on the river.
4. Description of provisions for removal of temporary cofferdams or protective works and replacement or grading to design elevations shown on the Contract Documents following removal.
5. Description of provisions for excavating and dewatering insides of the cofferdams or protective works, in accordance with Section 31 23 19 – Dewatering.
6. Regulatory requirements for cofferdam and cofferdam-related activities.
7. All calculations, assumptions, material properties, and other data required to substantiate the design of the cofferdam and protective works.

B. The submittal shall be prepared and sealed by a Professional Engineer registered in the State of California experienced with cofferdam and related design.

C. The plan shall be submitted for review a minimum of sixty (60) calendar days prior to beginning planned cofferdam work, shall be subject to review, permitting, and acceptance by governing authorities and the owners of any facilities utilized for water conveyance; as well as OWNER. However, these reviews shall not relieve the CONTRACTOR of full responsibility for the adequacy and stability of the cofferdams and protective works.

D. Additionally, the CONTRACTOR shall submit a fish salvage plan concurrent with the cofferdam and protective works plan, describing:

1. The anticipated order of activities for fish salvage operations behind the cofferdams prior to dewatering.
2. The qualified, subcontracted biologists intended to carry out fish salvage operations.
3. Equipment specifications intended for use in the fish salvage operations.

1.3 QUALIFICATIONS

A. The CONTRACTOR shall demonstrate a minimum of ten (10) years' experience in the construction of shoring walls, in-water work, and cofferdams including, but not necessarily limited to experience with sheet piles, H piles, soldier pile walls, segmental (block) walls, earth fill cofferdams, and the associated planning, staging, and dewatering aspects thereof.

1.4 DEFINITIONS

A. **Existing Ground**. The elevation of the existing ground surface before construction (including existing ground surfaces under water).

B. **Finish Grade**. Represents the grade required by the Contract Documents to be the finished ground surface upon completion of construction.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The type of construction used for cofferdams or other protective works (e.g., double-walled sheetpile cofferdams, tremie concrete, construction concrete block, or sandbag cofferdam) shall be at the choice of the CONTRACTOR, provided that the selected alternative fulfills the requirements of project permits and the Contract Documents. Cofferdam designs, configurations, or staging sequences that are substantially different than those shown on the Contract Documents require the CONTRACTOR to submit alternate design concepts such that the design and ownership team can evaluate design and permitting impacts.

B. Cofferdams or other protective works shall be constructed, maintained, and removed using materials and methods that do not produce siltation or other degradation of the water quality of the creek which exceeds the limits of applicable federal, state, and local regulations.

C. Cofferdams shall be designed and constructed of such a size that in no instance do they encroach within 10 feet of disturbed areas for other work.

D. Sheeting or any other methods requiring disturbance below original ground surface may not be used in any archeologically sensitive areas.

2.2 WOOD SHEETING

A. Wood used for sheeting, shoring, and bracing will be sound; straight grained; free from shakes, loose knots, and other defects liable to impair its strength or durability; and will be Yellow Pine, Douglas Fir, or equivalent and will be either tongue-and-grooved or splined. Wood sheeting will not be less than nominal 2 inches thick.

2.3 STEEL SHEETING

A. Steel sheeting will conform to ASTM A 328.

2.4 STRUCTURAL STEEL

A. Temporary structural steel channels, angles, plates, and bars shall conform to ASTM A 36.

B. Temporary structural steel W-Beams shall conform to ASTM A 992.

C. Temporary structural steel rectangular HSS sections shall conform to ASTM A 500 Grade B.

D. Temporary structural steel pipe sections shall conform to ASTM A 53 Grade B.

2.5 SANDBAGS IN WATER

A. All temporary sandbags placed in water will conform to all applicable federal, state, and local laws and regulations.

2.6 CONSTRUCTION CONCRETE BLOCKS

A. Construction concrete blocks shall be Ultrablock, Inc. or equivalent.

PART 3 -- EXECUTION

3.1 COFFERDAMS

A. Cofferdams shall be designed by the CONTRACTOR and construction methods will be selected by the CONTRACTOR. The design of the cofferdams will take into account the range of river elevations which can be expected during the time allowed for in-water construction. The CONTRACTOR shall review available flow records to make this determination.

B. Once the cofferdam is installed, the CONTRACTOR shall coordinate with their subcontracted biologists to perform a fish salvage process. The salvage will remove fish from behind the cofferdam or between cofferdams to be released back into the river. This will allow the area between cofferdams or behind a cofferdam to be completely dewatered during the river low flow periods. The CONTRACTOR shall follow the fish salvage plan that has been submitted and approved by the OWNER or ENGINEER and CDFW. The general process is assumed to be as follows:

1. Prior to the cofferdam installation the fish salvage team shall use electro-fishers on a very low setting (non-stunning and moving downstream), to herd without capture.

Once the cofferdam is constructed the fish salvage team shall begin multiple pass shocking whining confined area to stun and remove all species of fish encountered. Species expected to encounter shall be *O. mykiss*, sculpin, suckers, and lamprey.

2. Site evaluation on arrival (weather / air and water temperatures).

3. All crew members participating will be outfitted with waterproof waders and rubber neoprene gloves to protect against electric shock.

4. Prior to sampling, stream temperature and conductivity will be recorded and used to set electro-fisher parameters (voltage, frequency, pulse) to manufacturer's recommended guidelines.

5. Two netters will collect stunned fish and hold them in a 5-gallon bucket with bubble aerator. Fish are allowed to fully recover in the bucket before release downstream of the removal area.

6. The fish salvage team will record total number of salmonids handled (by spp.) and total mortality for reporting, which is required for the project permit.

7. Upon completion of each fish salvage event, the fish salvage team shall provide a report outlining the process and summarize the activity along with tabulated results of fish captured.

C. Cofferdam areas shall be dewatered such that the bottoms of the excavations within the cofferdams are firm, free of standing water, and in all respects acceptable to the OWNER as foundation. The dewatering methods used shall prevent boiling, quick conditions, or softening of foundation strata and shall maintain the bottom of the excavation in a condition so that every phase of the WORK can be performed in the dry, with the exception of in-water work related to cofferdams and protective works as specified in the Contract Documents. Dewatering shall be performed in accordance with the requirements of Section 31 23 19 - Dewatering.

D. After construction, the cofferdams shall be removed after areas are graded to finished grade, where indicated, or otherwise returned to existing grades; however, removal of cofferdams will not occur prior to the installation and backfill of all buried utilities which lie within 30 feet of the cofferdam areas. If options have been selected with below grade construction, it may be possible to cut off the structures at grade if the CONTRACTOR obtains approval of the appropriate jurisdictional authority.

E. Any loss of water and any damage to ground, structures, facilities, fishery resources, or any other existing items that may be affected by the CONTRACTOR'S cofferdam operations, shall be the responsibility and liability of the CONTRACTOR and will be repaired or restored by the CONTRACTOR as required, to the OWNER'S satisfaction. Any damage or injury to a person directly or indirectly caused by the CONTRACTOR'S cofferdam operations shall be the responsibility of the CONTRACTOR.

F. It is the CONTRACTOR's responsibility to design, install, and maintain functionally effective and structurally sound cofferdams. The failure of the cofferdam either in function or structurally for any reason, subsurface conditions inclusive, and the consequences of such a failure and liability for such a failure, will be the responsibility of the CONTRACTOR.

In the event the cofferdam has failed or is not functional as designed, the CONTRACTOR shall repair or rebuild the cofferdam at no additional cost to OWNER. Repairs or modifications to the cofferdams require additional design and construction submittals subject to the requirements of the Cofferdams and Protective Works Plan shown in this specification.

- END OF SECTION -

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SECTION 02 22 00 - SITE CONDITIONS ASSESSMENT

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall conduct thorough pre-construction and post-construction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs, video recordings, and topographic mapping.

1.2 CONTRACTOR SUBMITTALS

A. Video surveys, photographs, and other data of the preconstruction conditions shall be submitted to the ENGINEER for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

B. Except as otherwise indicated, post-construction topographic mapping shall be submitted to the ENGINEER within 60 days of completing WORK.

C. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the OWNER and ENGINEER.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 PHOTOGRAPHS AND VIDEO RECORDINGS

A. CONTRACTOR, as a minimum, shall document pre- and post-construction conditions by preparing video surveys of the following:

1. Roadways used to access the Site or haul materials and equipment to the Site.
2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.
3. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.
4. Driveways, sidewalks, and buildings which might be affected by the WORK.

B. Supplement video surveys with photographs and spot elevation surveys as required to thoroughly document the original condition and location of existing features and facilities.

3.2 TOPOGRAPHIC MAPPING

A. Topographic mapping shall be developed using the Project coordinates, shall be referenced to the Project base lines and bench marks, and shall be adequate to ascertain pre-construction and post-construction elevations of all public and private property within and adjacent to the construction limits

B. Topographic mapping shall be conducted to document the post-construction topography of the Site:

C. Spot elevation surveys used to document the elevation on abutting roadways, drives, and walks shall be taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the WORK.

D. All pre- and post-construction topographic mapping and other data, including spot elevations, shall be prepared and sealed by a Professional Land Surveyor in the State of California.

E. All pre- and post-construction survey data shall be furnished as follows:

1. Site mapping shall be submitted as a separate electronic drawing in the latest version of AutoCAD.

2. Each AutoCAD site map shall also be submitted in PDF format.

3. ENGINEER will review PDF plots for accuracy relative to the indicated requirements.

4. CONTRACTOR shall amend mapping files as required, based on ENGINEER's comments.

5. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of 1"=20' horizontal and 1-foot contour intervals as specified for National Map Accuracy Standards.

6. Electronic mapping files shall be three-dimensional.

7. Submit points lists for all topographic surveys in ASCII text file format.

- END OF SECTION -

SECTION 02 41 00 – DEMOLITION, SALVAGE, AND REHABILITATION

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall demolish and reconstruct existing civil, structural, mechanical, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.2 COORDINATION

A. The CONTRACTOR shall carefully coordinate the WORK in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The WORK as indicated is not all inclusive, and the CONTRACTOR shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The CONTRACTOR shall comply with sequencing requirements in Section 01 11 00 – Summary of Work.

B. The CONTRACTOR shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. These record drawings have been reproduced to show existing conditions and to clarify the scope of WORK as much as possible. Prior to bidding, the CONTRACTOR shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of WORK, and the extent of auxiliary utilities. A complete set of record drawings is available for review at the Project site.

C. While demolition and reconstruction are being performed, the CONTRACTOR shall provide adequate access for the continued operation and maintenance of equipment. The CONTRACTOR shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the CONTRACTOR's employees and the OWNER's personnel. The CONTRACTOR shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the ENGINEER.

1.3 CONTRACTOR SUBMITTALS

A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the ENGINEER for approval. The procedures shall provide for safe conduct of the WORK, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.4 DEMOLITION

A. Existing pavement, structures, equipment, piping, valves, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the WORK shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the CONTRACTOR.

B. Items to be removed include:

Item	**Description**
Existing 24-inch diameter waterline from STA 1226+00 to STA 1230+00	Steel pipe with cement mortar lining. Coal tarn enamel with additional 3-inch cement mortar coating. Pipe includes welded and gasketed joints, per Contract Drawings.
Existing Thrust Blocks	Two - 7 ft x 6 ft x 3.6 ft Concrete Blocks
Exiting Underwater Riprap	¼ ton riprap cover over existing pipe

1.5 SALVAGE

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location directed by the ENGINEER. The CONTRACTOR shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.

B. No items have been identified to be salvaged.

1.6 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated shall be removed without any degradation in condition from that prior to removal. The CONTRACTOR shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

B. No items have been identified to be relocated.

1.7 ABANDONMENT

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be abandoned shall be prepared by the CONTRACTOR as indicated.

B. No items have been identified to be abandoned.

1.8 REHABILITATION

A. Existing civil, landscaping, structural, mechanical, electrical, and instrumentation WORK disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

1.9 DISPOSAL

A. The CONTRACTOR shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall coordinate demolition and reconstruction WORK with the OWNER and ENGINEER. Unless otherwise indicated, the CONTRACTOR shall be responsible for the sequence of activities. WORK shall be performed in accordance with applicable safety rules and regulations.

B. The CONTRACTOR shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.

C. The CONTRACTOR shall take precautions to avoid damage to adjacent facilities and to limit the WORK activities to the extent indicated. If reconstruction beyond the scope indicated is required, the CONTRACTOR shall obtain approval from the ENGINEER prior to commencing.

3.2 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the CONTRACTOR shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the WORK. Existing facilities not subject to reconstruction shall be protected and maintained. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Structural elements shall not be overloaded. The CONTRACTOR shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of WORK performed under this Section. The CONTRACTOR shall remove temporary protection when the WORK is complete or when so authorized by the ENGINEER.

D. The CONTRACTOR shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the CONTRACTOR shall consult with the ENGINEER prior to the placement of such equipment or material.

3.3 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The CONTRACTOR shall verify the scope of the WORK to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01 11 00 – Summary of Work. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.

2. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.

3. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 00 00 - Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.

4. When existing pipe is removed, the CONTRACTOR shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug, as required, until the new pipe connection is made.

5. Electrical reconstruction shall be conducted by the CONTRACTOR in a safe and proper manner to avoid injury from electrical shock to the OWNER's and CONTRACTOR's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections which are energized or could become energized be accessible to CONTRACTOR, OWNER, or other personnel without suitable protection or warning signs.

B. The CONTRACTOR shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The CONTRACTOR shall inform the ENGINEER in writing a minimum of 5 Days prior to the functional testing in order for the OWNER and ENGINEER to witness the test. If, in the opinion of the ENGINEER, the relocated equipment does not function in a satisfactory manner, the CONTRACTOR shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the OWNER.

3.4 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the CONTRACTOR shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.

3.5 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by WORK necessary to complete modifications under this Contract. The CONTRACTOR shall be responsible to rehabilitate those areas affected by its construction activities.

B. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

C. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the CONTRACTOR shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

D. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 96 00 - Protective Coatings to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with Section 09 96 00 - Protective Coatings.

3.6 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the OWNER. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.7 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The CONTRACTOR shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.8 CLEANING

A. During and upon completion of WORK, the CONTRACTOR shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by WORK in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the ENGINEER or governing authorities, and adjacent areas shall be returned to condition existing prior to start of WORK.

C. The CONTRACTOR shall clean and sweep the street and road daily.

- END OF SECTION -

SECTION 03 11 13 – CONCRETE FORMWORK

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework, all in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Manufacturer's information demonstrating compliance with requirements for the following:

1. Form ties and related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

3. Form release agent, including NSF certification if not using mineral oil.

1.3 QUALITY CONTROL

A. **Tolerances:** The variation from required lines or grade shall not exceed 1/4-inch in 10-feet, non-cumulative, and there shall be no offsets or visible waviness in the finished surface. Other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

PART 2 -- PRODUCTS

2.1 GENERAL

A. Except as otherwise expressly accepted by the ENGINEER, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Thrustblock	Plywood

B. **NSF-61 Compliance**. Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

2.2 FORM AND FALSEWORK MATERIALS

A. **Materials.** Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

4. Steel leave in place forms shall not be used.

2.3 FORM TIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form tie fasteners having a circular cross-section shall not exceed 1.5 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be **ST Snap Ties** by **MeadowBurke; A3 Snap Ties** by **Dayton Superior,** or approved equal.

B. Removable taper ties may be used when approved by the ENGINEER. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie**.** Use **Taper Ties** by **MeadowBurke, D9 Taper Ties** by **Dayton Superior,** or approved equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. **Design Responsibility**. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced.

1. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained.

2. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes.

3. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations.

4. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. **Quality Control & Bracing**. Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

C. All forms shall be removed, after the appropriate curing times have been obtained, unless approved otherwise by the ENGINEER.

3.2 FORM DESIGN

A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete.

1. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete.

2. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1.0- to 1.5-inch diameter polyethylene rod held in position to the underside of the wall form.

3. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the ENGINEER.

4. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 30 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the ENGINEER.

3.3 CONSTRUCTION

A. **Vertical Surfaces:** Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. **Construction Joints:** Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. **Form Ties**

1. **Embedded Ties**: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. **Removable Ties**: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

3.5 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.

1. For roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28 Day strength in Section 03 30 00 - Cast-in-Place Concrete. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28 Day strength and has been in place for a minimum of 7 Days. The time required to establish said strength shall be as determined by the ENGINEER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7 Day minimum, then that time shall be used as the minimum length of time.

2. For vertical walls of water holding structures, forms shall remain in place at least 36 hours after the concrete has been placed.

3. For parts of the WORK not specifically mentioned herein, forms shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

3.6 MAINTENANCE OF FORMS

A. **General Condition**. Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned.

B. **Form Oil.** The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least 2 weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.7 FALSEWORK

A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction.

B. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and be protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20-tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

- END OF SECTION -

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide cast-in-place concrete in accordance with the Contract Documents.

B. The term "hydraulic structure" used in these Specifications means environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, other fluids, or gases.

C. The following types of concrete are covered in this Section:

1. **Structural Concrete**

    a. Regular Mix: Thrustblocks and other concrete items not indicated otherwise in the Contract Documents.

2. **Sitework Concrete**: Concrete to be used for curbs, gutters, catch basins, sidewalks, fence and guard post embedment, underground duct bank encasement, and other concrete appurtenant to electrical facilities unless otherwise indicated.

3. **Lean Concrete**: Concrete to be used for thrust blocks, pipe trench cut-off blocks, and cradles that are indicated on the Drawings as unreinforced. Lean concrete shall be used as protective cover for dowels intended for future connections.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Contractor Submittals.

B. **Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amount of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

C. **Additional Submittals**. Test data relating to the cement, aggregate, and admixtures shall be less than 6 months old. Furnish the following submittals in accordance with ACI 301 – Structural Concrete:

1. Mill tests for cement.

2. Admixture certification. Chloride ion content shall be included.

3. Aggregate gradation test results and certification.

1.3 QUALITY CONTROL

A. **General**

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated. Tests for determining slump shall be in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

2. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness, according to ASTM C 33 – Concrete Aggregates.

3. Concrete for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material.

B. **Field Compression Tests**

1. Each set of specimens shall be a minimum of 5 cylinders.

2. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field. Specimens shall be 6-inches diameter by 12-inches tall cylinders.

3. Frequency of Testing

    1) Sampling frequency and testing for each class of concrete shall be in accordance with ACI 350 section 5.5 ACI 318 section 5.6 as follows:

    2) Frequency of testing may be changed at the discretion of the ENGINEER.

4. Compression tests shall be performed in accordance with ASTM C 39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens. One test cylinder will be tested at 7 Days and 2 at 28 Days. The remaining cylinders will be held to verify test results, if needed.

C. **Evaluation and Acceptance of Concrete**

1. Evaluation and acceptance of the compressive strength of concrete will be according to ACI 318 – Building Code Requirements for Reinforced Concrete, Chapter 5 "Concrete Quality," and as indicated.

2. A statistical analysis of compression test results will be performed according to ACI 214 – Recommended Practice for Evaluation of Strength Test Methods. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.

3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.

4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.

5. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement.

D. **Aggregate Testing:** Aggregate testing shall be performed within 12 months of the start of construction and every 12 months during construction to determine continued compliance.

E. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances. Surface defects and irregularities are defined as finishes and are different from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117 – Standard Tolerance for Concrete Construction and Materials.

1. The following non-cumulative construction tolerances apply to finished walls and slabs unless otherwise indicated:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from the level or from the grades indicated.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from plumb	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch
Variation in the locations and sizes of slabs and wall openings	Plus or minus 1/4-inch

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. **General**

1. Ready-mix concrete shall conform to the requirements of ASTM C 94 – Ready Mixed Concrete.

2. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.

3. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments.

B. **Materials.** Materials for concrete shall comply with ACI 301 and shall conform to the following requirements:

   1. **Cement.** Cement shall be standard brand portland cement conforming to ASTM C 150 –Portland Cement, for Type I/II or Type V. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the ENGINEER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with the Specifications.

   2. **Water**. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (greater than 1000 mg/l TDS) shall not be used.

   3. **Aggregates.** Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33 – Concrete Aggregates. Maximum size of coarse aggregate shall be as indicated. Substituting lightweight sand for fine aggregate will not be permitted.

      a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof. The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined.

      b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable. When tested in accordance with ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2. The fineness modulus of sand used shall not be over 3.1.

c. Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

d. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

e. When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

f. When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.

g. When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

4. **Flyash**. If used, flyash shall be Class F and meet ASTM C618.

5. **Admixtures**. Admixtures shall be compatible and be furnished by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

   a. **Air-entraining agents:** Agents shall meet the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used. Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement. Air-entraining admixture shall be approved by the ENGINEER prior to use.

   b. **Set controlling and water reducing admixtures**: Admixtures may be added at the CONTRACTOR's option, subject to the ENGINEER's approval, to control the set, effect water reduction, and increase workability. The cost of adding an admixture shall be the CONTRACTOR's responsibility. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. Admixtures shall conform to ASTM C 494 – Chemical Admixtures for Concrete. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

      1) Concrete shall not contain more than one water reducing admixture.

2) Set controlling admixture may be either with or without water-reducing properties. Admixture shall be appropriate for the air temperature at time of placement. Set controlling admixture shall be approved by the ENGINEER prior to use.

3) Normal range water reducer shall conform to ASTM C 494, Type A. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations. Normal range water reducing admixtures shall be approved by the ENGINEER prior to use.

4) High range water reducer shall conform to ASTM C 494, Type F or G. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating the water/cement ratio. High range water reducing admixtures shall be approved by the ENGINEER prior to use.

5) If the high range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3-inches plus or minus 1/2-inch prior to adding the high range water reducing admixture at the Site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the primary system.

6) Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high range water reducer, unless recommended otherwise by the manufacturer.

6. **Lithium Additives**: Lithium additives shall not be used in concrete mix design for water bearing structures.

7. Fine and coarse aggregates to be used in all concrete shall be evaluated individually and tested for alkali-aggregate reactivity, according to ASTM C1260**.** The average expansion of the mortar bars for the fine aggregate test according to ASTM C1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution. Likewise, the average expansion of the mortar bars for the coarse aggregate test according to ASTM C1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution.

8. If either of the aggregates do not pass the ASTM C1260 test requirements as described above, CONTRACTOR shall provide information to the CONTRACTOR that the proposed fine and course aggregate is the best (i.e. least reactive) locally available material within [[50]] [[100]]-miles of the project site. In addition, the CONTRACTOR shall provide additional testing of the proposed aggregates (fine and course) along with approved mitigating additives (i.e. fly ash, class N pozzolan, GGBF slag, silica fume or other approved additives) to the concrete mix design, according to the requirements of ASTM C1567 and the following requirements:

a. The concrete mix design parameters used in the ASTM C1567 expansion test shall be within the allowable ranges of mix design parameters as specified under Part 2.5.D of this Section. After 16-days of immersion in a 1N NaOH solution, the average expansion of the three mortar bars shall not exceed 0.10% as measured according to ASTM C1567 standards and protocol.

b. ASR test on both the fine and course aggregate and concrete mix additives (i.e. flyash, pozzolan, or other approved additives), sample bar preparation, testing and all analytical methods shall meet the ASTM C1567 testing procedural requirements.

c. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.

d. Results of the ASR test show that expansion of the concrete sample is less than 0.10% at 16-days after the start of the expansion test procedure.

e. Test results shall be reported to the CONTRACTOR and Design Engineer at 7-days, 11-days, and 16-days.

f. The Concrete Supplier is still actively mining and using aggregate from the same representative portion of the aggregate pit from which the aggregate samples were taken for testing.]]

9. In lieu of the ASR testing above the aggregate may be tested in accordance with the requirements of ASTM C1293.

a. The concrete mix design parameters used in the ASTM C1293 expansion test shall be within the allowable ranges of mix design parameters as specified under Part 2.5.D of this Section.

b. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.

c. Results of the test, in accordance with ASTM C33, shall indicate less than 0.04% expansion at 1-year for cement aggregate combinations to demonstrate aggregates to be non-reactive.

d. Results of the test, in accordance with ASTM C33, shall indicate less than 0.04% expansion at 2-years for cement aggregate combinations with pozzolan or slag to demonstrate aggregates to be non-reactive

2.2 CURING MATERIALS

A. Curing compounds shall be resin-based and compliant with local VOC requirements.

1. Regular curing compounds shall be white pigmented and conform to ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, Class B. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be approved by the ENGINEER prior to use.

2. When curing compound must be removed for finishes or grouting, compounds shall be a dissipating type meeting ASTM C 309, type 1 or 2, Class B. Concrete curing compound shall be approved by the ENGINEER prior to use.

B. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6-mils. The loss of moisture when determined in accordance with ASTM C 156 – Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.

C. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, have a nominal thickness of 2-mils, and be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant). The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

D. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mils thick with white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

E. Curing mats for use in Curing Method 6 below shall be heavy shag rugs or carpets or cotton mats quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

F. Evaporation retardant shall be a material such as **MasterKure ER 50** by **BASF**, **Eucobar** by **Euclid Chemical Company, L&M E-CON** by **Laticrete**, or equal.

2.3 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. Preformed joint filler shall be a non-extruding neoprene sponge or polyurethane type conforming to Section 03290 - Joints in Concrete.

2. Elastomeric joint sealer shall conform to Section 07920 - Sealants and Caulking.

3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement from expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth below, if testing is required by the ENGINEER.

2.4 MISCELLANEOUS MATERIALS

2.5 CONCRETE DESIGN REQUIREMENTS

A. **General:** Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results. Changes shall be subject to review by the ENGINEER.

B. **Fine Aggregate Composition:** In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table.

FINE AGGREGATE	
Fineness Modulus	**Maximum Percent**
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

1. For other concrete, the maximum percentage of fine aggregate of total aggregate by weight shall not exceed 50.

C. Duct bank concrete shall contain an integral red-oxide coloring pigment. Concrete shall be dyed red throughout. Surface treatment to color duct banks will not be acceptable.

D. **Water/Cement Ratio W/C**: The water/cement ratio indicated is for saturated-surface dry condition of aggregate. Every Day, throughout the day, the batch water added shall be adjusted for the total free water in the aggregates.

1. Total free moisture of aggregates shall be determined by:

   a. Starting with the total moisture content of all aggregate, calculated by ASTM C 566 -Test Method for Total Moisture Content of Aggregate by Drying

   b. Subtracting the moisture absorbed by the coarse aggregate, calculated by ASTM C 127 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

   c. Subtracting the moisture absorbed by the fine aggregate, calculated by ASTM C 128 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate

E. **Concrete Property Tables**

Structural Concrete			
Type of WORK	**Regular Mix** (Thrustblocks)	**Not Used**	**Not Used**
Min 28 Day Compressive Strength, psi	4500		
Max Aggregate Size, in	1		
Cement Content, lbs /cubic yard,	564 to 600		
Max Allowable Fly Ash Content (FA); lbs/cubic yard	(i.e upto 15 % max of cement content)		
Max W/C Ratio by weight	0.42		
Total Air Content, percent	4.5 to 7.5		
Slump, in	3-in +/- 1-in with high range water reducer 7-in +/- 2-in		

NOTE: The CONTRACTOR is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability and strength.

F. **Adjustments to Mix Design:** The CONTRACTOR may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the CONTRACTOR shall be entitled to no additional compensation because of such changes. Any changes to the accepted concrete mix design shall be submitted to the ENGINEER for review and shall be tested again in accordance with these Specifications.

2.6 CONSISTENCY

A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete. The slumps shall be as indicated with the concrete properties.

B. **Compressive Strength Testing**. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured, and tested in accordance with ASTM C 192 - Practice for Making and Curing Concrete Test Specimens in the Laboratory and ASTM C 39. Three compression test cylinders will be tested at 7 Days and 3 at 28 Days. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall not be less than 125 percent of the indicated compressive strength.

2.7 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER. Weighing tolerances for the materials shall be a maximum of that given below.

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

2.8 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any required amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism shall prevent leakage when the valves are closed.

2.9 READY-MIXED CONCRETE

A. At the CONTRACTOR'S option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, and placing indicated herein and is in accordance with ASTM C 94, including the following supplementary requirements.

B. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever occurs first.

C. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be the resettable, recording type and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. Materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one-inch when the required slump is 3-inches or less, or if they differ by more than 2-inches when the required slump is more than 3-inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

F. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket that is furnished to the ENGINEER in accordance with the Paragraph above entitled "Delivery Tickets."

G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

A. **Proportioning:** Proportioning of the mix shall conform to ACI 301.

B. **Mixing:** Mixing shall conform to ACI 301.

C. **Slump:** Slumps shall be as indicated.

D. **Retempering:** Retempering of concrete or mortar that has partially hardened shall not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

3.3 HANDLING, TRANSPORTING, AND PLACING

A. **General:** Placing of concrete shall conform to the applicable portions of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

B. **Non-Conforming WORK or Materials:** Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the WORK. Concrete that is not placed in accordance with these requirements or which is of inferior quality shall be removed and replaced.

C. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of placement of any concrete.

D. **Placement in Wall and Column Forms:** Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4-feet in walls and 8-feet in columns. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6-feet in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of forms so that the concrete at the places of deposit is visible from the deck or runway.

E. **Conveyor Belts and Chutes:** Ends of chutes, hopper gates, and other points of concrete discharge throughout the CONTRACTOR's conveying, hoisting, and placing system shall be designed and arranged so that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER. Chutes longer than 50-feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. Conveyor belts and chutes shall be covered.

F. **Placement in Slabs:** Concrete placement in sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement. As the WORK progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

G. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 50 degrees F. For sections less than 12-inches thick the temperature of concrete when placed shall be not less than 55 degrees.

1. If required by ENGINEER, CONTRACTOR shall submit detailed procedures for production, transportation, placement, protection, curing, and temperature monitoring of concrete during hot or cold weather. The submittal shall include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

2. CONTRACTOR shall not be entitled to additional compensation for satisfying the hot weather placement or the cold weather placement requirements below.

H. **Hot Weather Placement**

1. If the temperature of the concrete is 85 degrees F or greater, the time between introducing the cement into the aggregates and discharge shall not exceed 45 minutes.

2. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, CONTRACTOR shall employ effective means such as precooling of aggregates and using ice as mixing water or placing at night as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.

3. During the curing period, the maximum temperature decrease measured at the surface of the concrete shall not exceed 50 degrees F in 24 hours nor 5 degrees F in one hour.

I. **Cold Weather Placement**

1. Placement of concrete shall conform to ACI 306.1 - Cold Weather Concreting, and the following.

2. Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6-inches. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

3. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.

4. Concrete ingredients shall not be heated more than necessary to prevent the temperature of the mixed concrete, as placed, from falling below the minimum temperature criterion.

3.4 PUMPING OF CONCRETE

A. **General:** If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. **Pumping Equipment:** The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.

C. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R – Placing Concrete by Pumping Methods.

D. Pumping equipment and hose conduits that are not functioning properly shall be replaced.

E. Aluminum conduits for conveying the concrete shall not be permitted.

F. **Field Control:** Concrete samples for slump, air content, and test cylinders will be taken at the placement end of the hose.

3.5 ORDER OF PLACING CONCRETE

A. The order of placing concrete in the WORK shall be acceptable to the ENGINEER. To minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 Days for hydraulic structures and 2 Days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 Days for hydraulic structures and 4 Days for all other structures.

B. The surface of the concrete shall be level whenever a run of concrete is stopped. For a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

3.6 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be Group 3 per ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER.

B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.

C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.7 FINISHING CONCRETE SURFACES

A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are defined as tolerances and are indicated above. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

3.8 CURING AND DAMPPROOFING

A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	**Method**
Encasement and ductbank concrete and thrust blocks	3

B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6 below.

C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. **Method 3:** The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of concrete.

E. **Method 4:** The surface shall be sprayed with a liquid curing compound.

1. Compound shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.

2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is damaged or broken before expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms. Repairs to formed surfaces shall be made within the 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.

5. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6-feet of the joint and to any other location where the curing membrane has been disturbed.

6. Prior to final acceptance of the WORK, visible traces of curing compound shall be removed in such a manner that does not damage the surface finish.

F. **Method 5:**

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4 above. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting, or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3-inches and fastened together with a waterproof cement to form a continuous watertight joint.

2. The curing blankets shall be left in place during the 7 Day curing period and shall not be removed until after concrete for adjacent WORK has been placed. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain concrete surfaces damp.

G. **Method 6:** This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days beginning immediately after the concrete has reached final set or forms have been removed.

2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent dislodging by wind or any other causes. Edges shall be continuously held in place.

4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4 above.

6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.

- END OF SECTION -

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide structural steel framing and appurtenant metal parts required for permanent connection of the structural steel system, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. References herein to "Building Code" shall mean the International Building Code of the International Code Council (ICC). The edition of the codes adopted as of the date of award of this contract shall apply to the WORK herein.

B. Federal Specifications and Commercial Standards

AISC	Code of Standard Practice for Steel Buildings and Bridges
AISC	Structural Steel Buildings-Allowable Stress Design and Plastic Design
AISC	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts approved by the Research Council on Structural Connections of the Engineering Foundation
ASTM A 36	Structural Steel
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 307	Carbon Steel Bolts and Studs
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105-ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 992	Steel for Structural Shapes for Use in Building Framing
AWS D1.1	Structural Welding Code – Steel

1.3 CONTRACTOR SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings shall conform to AISC recommendations and specifications and shall show all holes, etc. required for other work. Drawings shall include complete details showing members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.

C. Testing laboratory certifications for shop and field welders shall be submitted in triplicate directly to the ENGINEER with copies to the CONTRACTOR and others as required.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. **Structural steel**

Wide Flange Shapes	ASTM A 992
Other Shapes, Plates, Bars	ASTM A 36

B. Bolts for connections shall be ASTM A 325, unless indicated otherwise. Bolts used to connect dissimilar metals shall be ASTM A 193 and A 194, Type 316 stainless steel.

C. Structural steel shall be non-coated.

PART 3 -- EXECUTION

3.1 MEASUREMENT

A. The CONTRACTOR shall verify dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of WORK. The CONTRACTOR shall review the Drawings, and any discrepancies shall be reported to the ENGINEER for clarification prior to starting fabrication.

3.2 FABRICATION

A. Structural steel shall be fabricated in accordance with the Drawings, AISC Specifications, and the Shop Drawings.

B. Materials shall be properly marked and match-marked for field assembly.

C. Where finishing is required, assembly shall be completed including bolting and welding of units, before start of finishing operations.

3.3 CONNECTIONS

A. Shop and field connections shall be bolted as indicated. Connections shall develop full strength of members joined and shall conform to AISC standard connections.

B. Unless otherwise indicated, welds shall conform to AISC LRFD Specification for Structural Steel Buildings.

3.4 HOLES FOR OTHER WORK

A. Holes shall be provided as necessary or as indicated for securing other WORK to structural steel framing, and for the passage of other WORK through steel framing members. No torch cut holes will be permitted.

3.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

3.6 FIELD ASSEMBLY

A. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastening. Bearing surfaces and other surfaces that will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.

B. Individual members of the structure shall be leveled and plumbed within AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of the structure.

3.7 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in bolting are encountered, the ENGINEER shall be immediately notified. The CONTRACTOR shall submit a method to remedy the misfit for review by the ENGINEER. The ENGINEER will determine whether the remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

C. Correction of misfits is part of the WORK.

3.8 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in the structural framing, except when approved by the ENGINEER. Gas-cut sections shall be finished equal to a sheared appearance.

3.9 TOUCH-UP PAINTING

A. Immediately after erection, field welds, bolted connections, and abraded areas shall be cleaned of the shop paint primer. Touch-up paint primer applied by brush or spray shall be the same thickness and material as used for the shop coat. Galvanized surfaces that have been field welded or damaged shall be repaired in accordance with Section 05 50 00.

B. Finish coating of structural steel shall be as indicated in Section 09 96 00.

- END OF SECTION -

SECTION 31 00 00 - EARTHWORK

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit samples of materials proposed for the WORK in conformance with the requirements of Section 01 33 00 – Contractor Submittals. Sample sizes shall be as determined by the testing laboratory

B. CONTRACTOR's Detailed Excavation Plan

1. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or deeper, shall submit to the OWNER and shall be in receipt of the OWNER's written acceptance of the CONTRACTOR's detailed plan showing the design of shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation.

2. The CONTRACTOR’s plan shall be prepared and signed and sealed by a Professional Engineer experienced in the field of geotechnical engineering and licensed in the State where the WORK is being performed.

3. The OWNER’s acceptance of said plan will be for verification of submittal of the plan with this requirement.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

A. **General**

1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.

2. Fill and backfill materials that are to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

B. **Suitable Materials**

1. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.

2. If acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.

3. Mixing or blending of materials to obtain a suitable composite is the CONTRACTOR's option but is subject to the approval of the ENGINEER.
4. The CONTRACTOR shall submit certification to the ENGINEER that the chloride concentration in imported materials within the pipe zone does not exceed 100 ppm, when tested in accordance with the requirements of AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.
5. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.
6. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK.

C. **Types of Suitable Materials**. The following types of suitable materials are defined:

Type AS (Aggregate Subbase): Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. This material is often specified and required underneath the base course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 3-inch maximum size or 2-inch maximum size gradation shall be used. The sand equivalent value shall be greater than 20. Crushed rock aggregate subbase material shall meet one of the following gradation requirements, as shown on the Drawings or approved by the OWNER:

Sieve Size	**Percentage Passing (3-inch Max)**	**Percentage Passing (2-inch Max)**
3-inch	100	100
2.0 inch	90 - 100	100
1.5 inch	-	95 - 100
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	0 - 20	0 - 20

Type C (Civil Fill) (Not for use beneath concrete foundations): Civil Fill may consist of imported materials or natural on-site materials. Civil Fill may be a combination of Type AS material, Type GF, or Type SF material, or any mixture thereof, except as shown. Some mixing, removal of oversized particles (greater than 4-inch diameter) and/or removal of other unsuitable material may be required. On site sources of this material may consist of forest duff/topsoil 1 ft to 2 ft below ground surface (bgs), silty sand (Qal) between 2 ft to 10 ft bgs, poorly graded gravel with sand/silt (Qal) to 75 ft bgs (very dense, ~15-inch to 2-ft cobbles observed).

Type CLSM (Controlled Low Strength Material): Controlled low strength material (CLSM) shall be in accordance with Section 31 23 00 - Controlled Low Strength Material.

Type DRC (Drain-rock Coarse): Crushed rock or gravel meeting the following gradation requirements.

Sieve Size	**Percentage Passing**
2-inch	100
1.5-inch	90 - 100
1-inch	20 - 55
3/4-inch	1 - 15
No. 200	0 - 3

Type DRG (Drain-rock Graded): Drain-rock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The drainrock shall have a sand equivalent value greater than 75. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	**Percentage Passing**
1-inch	100
0.75-inch	90 – 100
0.375-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

The finish graded surface of the drain rock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs.

Type EF (Embankment Fills from on-site materials): Embankment Fill for the gravel lot portions of the project may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported materials comprised of mixtures of Type AS, Type DRG, Type GF, or Type S material. If on-site material is used for embankments, it may require moisture conditioning to facilitate compaction. Drying of the embankment fill material may not be practical during cold or wet periods of the year. Acceptable embankment material shall meet or exceed the compaction density of 95 percent as determined by ASTM D-1557.

Type GF (Granular Fill 0.75-inch minus): Angular crushed rock, stone or gravel, and sand conforming to the requirements listed below. Do not use pea gravel as granular backfill: The material shall have a maximum liquid limit of 35 and a maximum plasticity index of 10. The material shall have a sand equivalent value greater than 75. (This material is also known as Class I crushed stone.)

Sieve Size	Percentage Passing
0.75-inch	100
No. 4	30 - 50
No. 200	0 - 6

Type PG (Pea Gravel fill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a Number 4 sieve.

Type SF (Structural Fill / Foundation Base): Crushed rock structural fill material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for fill material required beneath concrete foundations. This material is often specified and required directly underneath the finish course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 1.5 inch maximum size or 0.75-inch maximum size gradation may be used material beneath concrete foundations. The sand equivalent value shall be greater than 22. The material shall meet the following gradation requirements:

	Percentage Passing	
Sieve Size	1.5 inch Max Gradation	0.75-inch Max Gradation
2-inch	100	-
1.5-inch	90 - 100	-
1-inch	-	100
0.75-inch	81 - 91	90 – 100
No. 4	43 - 53	55 – 67
No. 16	23 - 29	28 – 38
No. 200	4 - 10	4 – 10

Type SNF (Sand Fill): Sand material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
0.375-inch	100
No. 4	90 - 100
No. 16	50 - 80
No. 50	5 - 25
No. 200	0 - 5

Type T (Topsoil): Stockpiled topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Type X-CTF (Cement-Treated fill): Material which consists of Type AS material, or any mixture of other approved materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901 - Standard Test Method for Cement Content of Freshly Mixed Soil Cement. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil - Cement Cylinders.

Schedule: Earth materials shall be as indicated in the Contract Drawings. Where clear definition in the drawings is not defined, the following schedule may be used to define acceptable fill materials.

Civil Work Area	Material Type
Embankment Fills – (Solids Settling Basins & other Embankments)	Type EF material, or Mixture of A thru H materials that meet Type EF gradation requirements.
Bedding for all pipes	SNF
Pipe Zone Fills (unless indicated as Trench Zone)	
Dielectrically / epoxy coated steel, polyethylene encased, non-mortar (rock-shield) coated	GF
Small PVC (< 6-inch dia), HDPE (ADS) Drain Pipe, & other pipes < 3-inch dia.	GF, SN
Other PVC, VCP, HDPE Pipe	GF
Pipes on grades >4% where backfills are graded with <10% passing No. 4 sieve	(CLSM) w/trench plugs of types J, L, or N at intervals of 200 feet

Civil Work Area	Material Type
	or less.
Trench zone backfill except as identified below	X, C, EF or an approved mixture thereof.
Final backfill for irrigated unpaved areas	T
Trench zone and final backfill under structures	Same as pipe zone except where concrete encasement is required
Replace pipeline trench over excavation	DRC with 6-inch top layer of PG, or non-woven filter fabric, or same as pipe zone backfill if trench is above water table.
Asphalt & Concrete Pavement Aggregate base & Gravel Road base materials	DRG, DRC
Asphalt & Concrete Pavement Aggregate subbase & Gravel Road subbase materials	AS
Backfill around structures (including berms)	C, EF, or an approved mixture
Under hydraulic or water retaining structures with underdrains	DRG
Under structures where ground water is removed to allow placement of concrete	DRC, underlain by non-woven filter fabric
All other structures	DRG,
Top 6-inches of embankment fills, or backfills around structures	T

D. **Unsuitable Materials.**

1. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of PT, OH, CH, MH, or OL shall be classified as unsuitable materials.

2. In addition to the materials identified as unsuitable in the table above, a material shall be classified as unsuitable if one of the following conditions is present;

    a. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.

    b. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

2.2 MATERIALS TESTING

A. **Samples**

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the CONTRACTOR’s expense.

2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

B. **Particle Size Analysis**. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. **Sand Equivalent Value**. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. **Unified Soil Classification System**

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.

2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

E. Testing for sulfate, resistivity, and pH shall be performed in accordance with AASHTO Test Methods T 288 and T 289.

F. Testing for chloride shall be performed in accordance with AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.

2.3 IDENTIFICATION TAPE

A. Unless otherwise indicated, identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part.

B. Identification tape shall be as specified in Section 40 23 01 – Piping Identification.

PART 3 -- EXECUTION

3.1 EXCAVATION AND BACKFILLING - GENERAL

A. General

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions that would interfere with the proper execution and completion of the WORK.

2. The removal of such materials shall conform to the lines and grades indicated or ordered.

3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.

4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.

5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.

7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the state where the Site is located.

B. Removal and Exclusion of Water

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavations.

2. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation WORK begins at each location.

3. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed.

3.2 OVER-EXCAVATION

A. **Indicated**

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

B. **Not Indicated**

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

C. **Neither Indicated nor Ordered**

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

3.3 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled in order to preserve it for replacement.

B. Excavated material may be placed on the lawn, provided that a drop cloth or other suitable method is employed to protect the lawn from damage, but the lawn shall not remain covered for more than 72 hours.

C. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner as to restore the lawn as near as possible to its original condition.

D. The CONTRACTOR shall provide new sod if the stockpiled sod has not been replaced within 72 hours.

3.4 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations.

B. No tree roots larger than 2 inches in diameter shall be cut without the express permission of the ENGINEER.

C. Trees shall be supported during excavation by any means previously reviewed and accepted by the ENGINEER.

3.5 ROCK EXCAVATION

A. **Normal Excavation**. Nearly all excavation, except where indicated in the Contract Drawings shall be considered normal excavation, and may be accomplished using conventional equipment as follows:

1. For general excavation, a D-9N Caterpillar tractor with a single shank ripper, or equivalent equipment, is considered conventional equipment, if it can rip at a production rate of at least 300 bank cubic yards per hour.

2. For trench excavation, a 235C Caterpillar excavator with a medium stick and a rock ripping bucket, or equivalent equipment, is considered conventional equipment, if it can excavate at a production rate of at least 30 bank cubic yards per hour.

3. If material is encountered which the CONTRACTOR believes cannot be excavated by conventional equipment, the ENGINEER shall be notified immediately. The CONTRACTOR shall provide performance tests of the specified conventional or equivalent equipment. If the ENGINEER confirms in writing that the conventional equipment cannot perform at the production rates indicated, the excavation will be considered rock excavation.

B. **Rock Excavation**. Rock excavation shall include removal and disposal of the following items:

1. Boulders measuring 1/3 of a cubic yard or more in volume;

2. Rock material in ledges, bedding deposits, and un-stratified masses that cannot be removed using conventional equipment as defined herein and which require systematic drilling and blasting for removal;

3. Concrete or masonry structures that have been abandoned; and,

4. Conglomerate deposits that are so firmly cemented that they possess the characteristics of solid rock and cannot be removed using conventional equipment as herein defined and require systematic drilling and blasting for removal.

C. **Scope and Payment for Rock Excavation**

1. Rock excavation shall be performed by the CONTRACTOR, provided that if the quantity of rock excavation is affected by any change in the scope of the WORK an appropriate adjustment of the Contract Price will be made. Payment for rock excavation shall be as set forth in the Bid form as a unit price item. If a unit price item for rock excavation is not provided in the Bid form, the extra cost for excavation of rock will be treated as a change.

2. Otherwise, payment will be made in accordance with a negotiated price.

D. **Explosives and Blasting**. Blasting will not be permitted on the project site.

3.6 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.

B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.

C. The CONTRACTOR shall remove and dispose of excess excavated material at a location selected by the CONTRACTOR and as approved by the ENGINEER or at an off-Site location selected and arranged for by the CONTRACTOR.

D. The CONTRACTOR shall obtain required permits and landowner and agency approvals for disposal of excess excavated material on-Site or off-Site and shall submit copies of related documents to the ENGINEER for information prior to disposal. CONTRACTOR shall pay costs associated with the removal and disposal

3.7 BACKFILL

A. **General**

1. Backfill shall not be dropped directly upon any structure or pipe.

2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.

3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. **Pre-Placement Conditions**

1. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall not be placed until water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction

2. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.

3. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

C. **Layering**

1. Backfill materials shall be placed and spread evenly in layers. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.

2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 6 inches in thickness.

D. **Moisture Content**

1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

3.8 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION AND BACKFILL

A. **Excavation Beneath Structures and Embankments**

1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 6 inches below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.

2. The area where a fill or embankment is to be constructed shall be cleared of vegetation, roots, and foreign material.

3. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.

4. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched.

5. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.

6. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Concrete Reservoirs

1. Excavation under reservoirs shall extend to the bottom of the drainrock layer.

2. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock.

3. Areas under the reservoir upon which fill, not drain rock, is to be placed, shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density.

C. Excavation Beneath Paved Areas

1. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness.

2. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement.

4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of ENGINEER

1. The CONTRACTOR shall notify the ENGINEER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

E. Compaction of Fill, Backfill, and Embankment Materials

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.

2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.

3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

F. **Heavy Equipment**

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.

2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

G. **Layering**

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.

2. Each layer shall be moistened and aerated as necessary.

3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.

4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

H. **Embankments and Fills on Slopes**

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.

2. A minimum of 12 inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.

3. Material thus cut shall be re-compacted along with the new material.

4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

I. **Compaction Requirements**

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) where the material is graded such that 10 percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve:

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath paved areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Topsoil	80	NA
Aggregate base or subbase	95	NA

3.9 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL

A. **General**

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated.

B. **Trench Bottom**

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.
2. Excavations for pipe bells and welding shall be made as required.
3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

C. **Open Trenches**

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.
2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.
3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

D. **Embankments, Fills and Structural Backfills**

1. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

2. Upon completion of the embankment or structural backfill, a trench conforming to the appropriate detail may be excavated and the pipe may be installed.

E. **Trench Shield**

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.

2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.

4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

F. **Placing and Spreading of Backfill Materials**

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.

2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of one-half the diameter of the pipe; or 24 inches, measured in the uncompacted state.

3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24 inches or not.

4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.

5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.

6. The material shall be placed in lifts that will not exceed 6 inches when compacted to the required density.

G. **Mechanical Compaction**

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.

2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

H. **Pipe and Utility Trench Backfill**

1. Definitions

   a. **Bedding**. The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.

   b. **Pipe Zone**. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.

   c. **Trench Zone**. The trench zone (located above the pipe zone) is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

   d. **Final Backfill**. Final backfill is defined as backfill in the trench cross-sectional area within 6, 12, or 18 inches of finished grade, or if the trench is under pavement, backfill within 18 inches of the roadway subgrade.

2. Pipe Zone Backfill

   a. Final Trim

      1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.

      2) Excavation for pipe bells and welding shall be made as required.

   b. The pipe zone shall be backfilled with the indicated backfill material.

   c. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.

   d. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

3. Trench Zone Backfil

a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.

I. **Identification Tape**

1. Install identification tape as indicated.

2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.

3. The termination box shall be covered with a cast iron lid.

4. The box shall be located at grade in paved areas or 6 inches above grade in unpaved areas.

J. **Trench Shield**

1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.

2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

K. **Compaction Requirements**

1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density
Pipe embedment backfill for flexible pipe.	> 90
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	> 90
Pipe embedment backfill for steel yard piping	> 90
Pipe zone backfill portion above embedment for flexible pipe	> 90
Final backfill, beneath paved areas or structures.	> 95
Final backfill, not beneath paved areas or structures.	> 90

Trench zone backfill, beneath paved areas and structures, including trench plugs.	> 95
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	> 85

3.10 FIELD TESTING

A. **General**:

1. Field soils testing will be performed by a testing laboratory of the OWNER's choice at the CONTRACTOR's expense, except as indicated below.

B. **Density**

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.

2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.

3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. **Remediation**

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.

2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. **CONTRACTOR's Responsibilities**

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.

2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.

3. Lawn areas destroyed by test trenching and excavation shall be regraded and relandscaped with hydroseeding.

- END OF SECTION -

SECTION 31 05 19 - GEOTEXTILES

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide geotextiles, complete and in place, in accordance with the Contract Documents.

B. **Definitions:** The following definitions apply to the WORK of this Section:

1. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.
2. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.
3. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.
4. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.
5. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.
6. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.
7. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.
8. Nonwoven geotextile: A geotextile fabric composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The following standards are referenced in this Section:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer material specifications and product literature.

2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.

3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

C. Samples

1. Geotextile: One-piece, minimum 18-inches long, taken across full width of roll of each type and weight of geotextile. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.

2. Field Sewn Seam: 5-foot length of seam, 12-inches wide with seam along center, for each type and weight of geotextile.

3. Securing Pin and Washer: 1 each.

D. Certifications

1. Certification from geotextile manufacturer that products satisfy the indicated requirements.

2. Field seam efficiency test results.

PART 2 -- PRODUCTS

2.1 WOVEN GEOTEXTILE

A. Woven geotextile shall be composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

B. Polymeric yarn shall be long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. **Sheet Edges:** Selvaged or finished to prevent outer material from separating from sheet.

D. Unseamed Sheet Width: Minimum 6 feet.

E. Nominal Weight per Square Yard: 6.

F. Physical Properties: Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR WOVEN GEOTEXTILE

Property	Requirement	Test Method
Apparent Opening Size (AOS)	No. 10 to No. 100 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	0.02 to 3.34 sec.$^{-1}$, MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	10 to 150 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	60 to 1,500 lb/in.-width, MinARV	ASTM D 4595
Wide Width Strip Elongation	14 to 60 percent, MaxARV	
Trapezoidal Tear Strength	30 to 200 lb, MinARV	ASTM D 4533
Puncture Strength	50 to 250 lb, MinARV	ASTM D 4833
Abrasion Resistance	5 to 25 percent loss, 250 cycles, MaxARV	ASTM D 4886
Ultraviolet Radiation Resistance	70 to 90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2.2 NONWOVEN GEOTEXTILE

A. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

B. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. **Geotextile Edges:** Selvaged or finished to prevent outer material from separating from sheet.

D. **Unseamed Sheet Width:** Minimum 6-feet.

E. **Nominal Weight per Square Yard:** 12 ounces.

F. **Physical Properties:** Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE

Property	Requirement	Test Method
Apparent Opening Size (AOS)	No. 100 to No. 140 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	1.2 sec.$^{-1}$, MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	90 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	300 MinARV	ASTM D 4595
Wide Width Strip Elongation	70 percent, MaxARV	ASTM D 4595
Trapezoidal Tear Strength	120 lb, MinARV	ASTM D 4533
Puncture Strength	130 lb, MinARV	ASTM D 4833
Ultraviolet Radiation Resistance	90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2.3 SEWING THREAD

A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

2.4 SECURING PINS

A. Securing pins shall be steel rods or bars conforming to the following:

1. 3/16-inch diameter.

2. Pointed at one end; head on other end, sufficiently large to retain washer.

3. Minimum Length: 12-inches.

B. Steel washers for securing pins shall be:

1. Outside Diameter: Not less than 1-1/2 inches.

2. Inside Diameter: 1/4-inch.

3. Thickness: 1/8-inch.

C. Steel Wire Staples

1. U-shaped.

2. 10-gauge.

3. Minimum 6-inches long.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

3.2 LAYING GEOTEXTILE

A. Notify the ENGINEER whenever geotextiles are to be placed. Do not place geotextile prior to obtaining ENGINEER's approval of underlying materials.

B. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.3 ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18-inches beyond toe of slope.

3.4 JOINTS

A. Unseamed Joints

1. Unseamed joints shall be overlapped to the following dimensions unless otherwise indicated:

    a. Foundation/Subgrade Stabilization: Minimum 18-inches.

    b. Riprap: Minimum 18-inches.

    c. Drain Trenches: Minimum 18-inches, except overlap shall equal trench width if trench width is less than 18-inches.

    d. Other Applications: Minimum 12-inches.

B. Sewn seams shall be used wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by ENGINEER, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam efficiency shall be minimum 70 percent, verified by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided. Test according to ASTM D 4884.

2. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.

3. Stitch Count: Minimum 3 to maximum 7 stitches per inch.

4. Stitch Type: Double-thread chain stitch, Type 401, Federal Standard No. 751a.

5. Stitch Location: 2-inches from geotextile sheet edges, or more if necessary to develop required seam strength.

6. Sewing Machines: Capable of penetrating 4 layers of geotextile.

3.5 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sand bags or other means approved by ENGINEER.

B. Securing Pins

1. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6-inches from free edges.

2. Spacing

Slope	**Maximum Pin Spacing, feet**
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

3. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.

4. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

3.6 PLACING PRODUCTS OVER GEOTEXTILE

A. Notify ENGINEER before placing material over geotextile. Do not cover installed geotextile prior to receiving authorization from the ENGINEER to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

3.7 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way that will completely envelope granular drain material to be placed in trench and with indicated overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to grade, fold geotextile over top of granular drain material, unless otherwise indicated. Maintain overlap until overlying fill or backfill is placed.

3.8 RIPRAP APPLICATIONS

A. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet.

B. Sew joints where wave runup may occur.

3.9 GEOTEXTILE-REINFORCED EARTH WALL APPLICATIONS

A. Sew exposed joints; extend sewn seams minimum 3-feet behind face of wall.

B. Protect exposed geotextile from damage and deterioration until permanent facing is applied.

3.10 SILT FENCE APPLICATIONS

A. Install geotextile in one piece or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

C. Securely fasten geotextile to a wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

D. Promptly repair or replace silt fence that becomes damaged.

3.11 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18-inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by ENGINEER.

3.12 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in ENGINEER's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

- END OF SECTION -

SECTION 31 11 00 - SITE PREPARATION

PART 1 -- GENERAL

1.1 SUMMARY

A. In its initial move onto the Site, the CONTRACTOR shall protect existing fences, houses and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents.

1.2 SITE INSPECTION

A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the Site and off-Site pipeline routes and facilities delineating the OWNER's property and right-of-way lines.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 PRIMARY SITE ACCESS

A. The CONTRACTOR shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.

B. **Utility Interference:** Where existing utilities interfere with the WORK, notify the utility owner and the ENGINEER before proceeding in accordance with the General Conditions.

3.2 CLEARING, GRUBBING, AND STRIPPING

A. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

C. The entire area to be affected by construction shall be stripped to a depth of 2.5-feet below the existing ground contours. The stripped materials shall be stockpiled and incorporated into landscaped areas or other non-structural embankments.

D. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base shall not be removed without the ENGINEER's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the WORK.

3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require over-excavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site. The over-excavated volumes to a level 2.5-feet below the existing ground contours shall be backfilled.

- END OF SECTION -

SECTION 31 23 00 - CONTROLLED LOW STRENGTH MATERIAL

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide Controlled Low Strength Material (CLSM), complete and in place, in accordance with the Contract Documents.

B. CLSM shall be placed where indicated and may be used, if the ENGINEER approves, for the following purposes:

1. Normal CLSM with high slump, non-segregating consistency that readily flows and fills voids and difficult to reach places: pipe zone fill, trench zone fill, pipe abandonment, structure backfill, and structure cavity fill.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings:

1. CLSM mix designs which show the proportions and gradations of materials proposed for each type of CLSM indicated. Each mix design shall be accompanied by independent laboratory test results of the indicated properties.

2. If the CONTRACTOR proposes to provide lower strength CLSM with aggregates that do not conform to ASTM C 33 - Concrete Aggregate, Shop Drawings shall include a testing program that will be used to control the variability of the aggregates. The testing program shall be acceptable to the Engineer.

1.3 QUALITY CONTROL

A. Testing will be performed by a testing laboratory selected by the OWNER at the OWNER's expense, except as otherwise indicated.

B. If tests of the CLSM show non-compliance with the specifications, the CONTRACTOR shall make changes as may be required to achieve compliance. Performing and paying for subsequent testing to show compliance shall be the CONTRACTOR's responsibility.

C. Correlation Tests

1. The CONTRACTOR shall perform a field correlation test for each mix of CLSM used in pipe zone, trench zone, or backfill used in amounts greater than 100-cubic yards or when CLSM is required to support traffic or other live loads on the fill less than 7 Days after placing CLSM.

2. Field correlation tests shall be performed in a test pit similar in cross section to the WORK and at least 10-feet long at a location near the WORK. The proposed location shall be acceptable to the ENGINEER.

3. Laboratory and field tests shall be performed on samples taken from the same CLSM batch mix. Tests shall be performed by a laboratory at the CONTRACTOR's expense.

4. Testing shall be performed once each 2 hours during the first 8 hours, once each 8 hours during the first week, and once each 24 hours until the CLSM mix reaches the maximum design strength.

   a. Compression testing shall be in accordance with ASTM D 4832 - Preparation and Testing of Soil-Cement Slurry Test Cylinders.

   b. Setting test shall be in accordance with ASTM C 403 - Time of Setting of Concrete Mixtures by Penetration Resistance

   c. Density tests shall be in accordance with ASTM C 138 - Unit Weight, Yield and Air Content (Gravimetric) of Concrete.

PART 2 -- PRODUCTS

2.1 CONTROLLED LOW STRENGTH MATERIAL

A. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C 94 - Ready Mixed Concrete.

B. **Composition:** The following parameters shall be within the indicated limits and as necessary to produce the indicated compressive strengths.

   1. Mix proportions as necessary

   2. Entrained air content shall be between 20 percent minimum and 30 percent maximum.

   3. Water reducing agent content as necessary

C. Properties

   1. Density shall be between 120 PCF minimum and 145 PCF maximum

   2. Slump shall be as required by the CONTRACTOR's methods, but shall not promote segregation nor shall slump exceed 9 inches.

   3. Compressive strength at 28 Days:

      a. Normal CLSM: Between 100 psi minimum and 300 psi maximum. Unless specifically indicated otherwise, CLSM shall be Normal CLSM.

2.2 CEMENT

A. Cement shall be Type I or II in accordance with ASTM C 150 - Portland Cement.

2.3 POZZOLAN

A. Pozzolan shall be Type F or C in accordance with ASTM C 618 – Fly ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete. Pozzolan content, by weight, in Normal CLSM shall not be greater than cement content.

2.4 AGGREGATE

A. Aggregate shall consist of a well graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8-inch. One hundred percent shall pass the 1/2-inch sieve; no more than 30 percent shall be retained on the 3/8-inch sieve; and no more than 12 percent shall pass the number 200 sieve. If more than 5 percent of the aggregate passes the number 200 sieve, the material passing the number 200 sieve shall have a plasticity index of less than 0.73 (liquid limit-20), when tested in accordance with ASTM D 4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils. Aggregate shall be free from organic matter and shall not contain more alkali, sulfates, or salts than the native materials at the Site.

2.5 ADMIXTURES

A. Air entraining admixtures shall be in accordance with ASTM C 260 - Air-Entraining Admixtures for Concrete.

B. Water reducing admixtures shall be in accordance with ASTM C 494 - Chemical Admixtures for Concrete.

2.6 WATER

A. Water shall be potable, clean, and free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Subgrade and compacted fill to receive CLSM shall be prepared according to Section 31 00 00 - Earthwork.

3.2 BATCHING, MIXING AND DELIVERY

A. Batching, mixing, and delivery of CLSM shall conform to ASTM C 94. CLSM shall be mixed at a batch plant acceptable to the ENGINEER and shall be delivered in standard transit mix trucks.

3.3 PLACEMENT

A. CLSM shall be placed by tailgate discharge, conveyor belts, pumped, or other means. CLSM shall be directed in place by vibrator, shovel, or rod to fill crevices and pockets. Avoid over-consolidation which causes separation of aggregate sizes.

B. CLSM shall be continuously placed against fresh material unless otherwise approved by the ENGINEER. When new material is placed against existing CLSM, the placement area shall be free from loose and foreign material. The surface of the existing material shall be soaked a minimum of one hour before placement of fresh material but no standing water shall be allowed when placement begins.

C. Temperature of the CLSM shall be between 50 and 90 degrees F, when placed. CLSM shall not be placed when the air temperature is below 40 degrees F. No CLSM shall be placed against frozen subgrade or other materials having temperature less than 32 degrees F.

3.4 FINISHING

A. The finish surface shall be smooth and to the grade indicated or directed by the ENGINEER. Surfaces shall be free from fins, bulges, ridges, offsets, and honeycombing. Finishing by wood float, steel trowel, or similar methods is not required.

3.5 CURING

A. CLSM shall be kept damp for a minimum of 7 Days or until final backfill is placed.

3.6 PROTECTION

A. CLSM shall be protected from freezing for 72 hours after placement.

B. No fill or loading shall be placed on CLSM until probe penetration resistance, as measured in accordance with ASTM C 803 - Standard Test Method for Penetration Resistance of Hardened Concrete, exceeds 650 psi.

C. CLSM shall be protected from running water, rain, and other damage until the material has been accepted and final fill completed.

- END OF SECTION -

SECTION 31 23 19 - DEWATERING

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall dewater trench and structure excavations, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section of the Specifications.

1.2 CONTRACTOR SUBMITTALS

A. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations. The CONTRACTOR may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The CONTRACTOR's dewatering plan is subject to review by the ENGINEER.

1.3 QUALITY CONTROL

A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.

C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

F. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

G. Flotation shall be prevented by the CONTRACTOR by maintaining a positive and continuous removal of water. The CONTRACTOR shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the CONTRACTOR shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

I. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.

J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

- END OF SECTION -

SECTION 31 35 00 - EROSION AND SEDIMENT CONTROL GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

A. Work includes furnishing all labor, materials and equipment required for the installation and maintenance of both permanent and temporary erosion and sediment control measures as shown on the drawings and as specified herein.

B. Erosion and sediment control measures shall remain in place while potential for erosion exists from construction activities at the site and disposal area, during the duration of the contract and warranty period;

1. Protect and stabilize soils susceptible to erosion. This includes areas were vegetative cover cannot be achieved due to soils, slopes or time of year. The contractor shall be aware of and conform to measures necessary for the control of erosion and sediment runoff according to applicable regulations.

2. Prevent sediment or sediment laden water from entering all creeks and the storm drain systems or to be discharged from the construction site in accordance with the California State Water Resources Control Board, USEPA and other applicable regulations.

C. All temporary erosion and sediment control measures shall be installed prior to commencement of construction.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

U.S. DEPARTMENT OF AGRICULTURE (USDA) AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

California State Water Resources Control Board, Best Management Practices for Erosion and Sediment Control

1.3 SUBMITTALS

A. Submit Erosion and Sediment Control Plans for acceptance in accordance with the provisions of Section 01 33 00 – Contractor Submittals.

1. Submit an Erosion and Sediment Control Plan for work during construction, signed and stamped by a registered Civil Engineer prior to the start of construction. Plan shall meet all federal, state, and local requirements.

2. Submit Notice of Intent (NOI).

PART 2 – PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install erosion and sediment control measures per manufacturer's directions or as illustrated on the contract drawing or as identified in Section 31 35 20 – Erosion Control Barriers, Section 31 35 30 – Erosion Control Vegetative, Section 31 35 29 – Erosion Control Turbidity Curtain.

3.2 MAINTENANCE AND REMOVAL

B. Repair and reinstall temporary soil erosion control measures as necessary to ensure proper function for the duration of ground disturbing activities and through the warranty period.

C. Temporary erosion control devices shall be removed only after they have performed their intended function.

D. All pipes, end sections, drainage curbs, sand bags, sediment fences and other materials which are removed from temporary erosion control devices and not incorporated into the permanent work shall become the property of the Contractor and shall be removed from the area.

- END OF SECTION -

SECTION 31 35 20 - EROSION CONTROL BARRIER

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide erosion control barriers, complete and in place, in accordance with the Contract Documents

1.2 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals.

B. **Product Data:** Manufacturer's catalog sheets on geotextile fabrics.

PART 2 -- PRODUCTS

2.1 FABRIC

A. Fabric may be woven or non-woven, made from polypropylene, polyethylene, or polyamid, and shall contain sufficient UV inhibitors so that it will last for 2 years in outdoor exposure.

B. Fabric shall have the following properties:

Parameter	**Standard Method**	**Value**
Grab tensile strength	ASTM D 4632	100 lb
Burst strength	ASTM D 3786	200 psi
Apparent opening size	ASTM D 4751	Between 200 and 70 sieve size

C. Fabric Manufacturer, or equal

1. **Mirafi**

2.2 POSTS

A. Posts shall be wood, at least 2 inches by 2 inches, at least 6 feet long.

B. Posts shall be steel, 1 1/2-inch, T-shaped, at least 6 feet long with protective coating.

2.3 FENCING

A. Woven wire fabric fencing shall be galvanized, mesh spacing of 6 inches, maximum 14-gauge, at least 30 inches tall.

2.4 FASTENERS

A. Fasteners to wood posts shall be steel, at least 1 1/2 inches long.

B. Fasteners to steel posts shall be galvanized clips.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Provide erosion control barriers at the indicated locations and as required to prevent erosion and silt loss from the Site.

B. CONTRACTOR shall not commence clearing, grubbing, earthwork, or other activities which may cause erosion until barriers are in place.

3.2 INSTALLATION

A. Barrier systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

B. Attach the woven wire fencing to the posts that are spaced a maximum of 6 feet apart and embedded a minimum of 12 inches. Install posts at a slight angle toward the source of the anticipated runoff.

C. Trench in the toe of the filter fabric barrier with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow. Lay fabric along the edges of the trench. Backfill and compact.

D. Securely fasten the fabric materials to the woven wire fencing with tie wires.

E. Reinforced fabric barrier shall have a height of 18 inches.

F. Provide the filter fabric in continuous rolls and cut to the length of the fence to minimize the use of joints. When joints are necessary, splice the fabric together only at a support post with a minimum 6-inch overlap and seal securely.

3.3 MAINTENANCE

A. Regularly inspect and repair or replace damaged components of the barrier. Unless otherwise directed, maintain the erosion control system until final acceptance; then remove erosion and sediment control systems promptly.

B. Remove sediment deposits when silt reaches a depth of 6 inches or 1/2 the height of the barrier, whichever is less. Dispose of sediments on the Site, if a location is indicated on the Drawings, or at a site arranged by the CONTRACTOR which is not in or adjacent to a stream or floodplain.

- END OF SECTION -

SECTION 31 35 29 - EROSION AND SEDIMENT CONTROL TURBIDITY CURTAIN

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide instream trapping devices specifically designed to limit sediment transport impacts within a body of water. Turbidity curtains and other instream sediment trapping devices shall provide sedimentation protection for in-stream, bank, or upslope ground disturbance or from dredging or filling within a waterway.

B. WORK shall include furnishing all labor, materials, and equipment required for the installation and maintenance of instream sediment trapping devices, complete and in place, in accordance with the Contract Documents

C. CONTRACTOR shall be responsible for following all applicable Federal, State, and local codes and regulations, including the California State Water Resources Control Board requirements and best management practices.

1.2 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals.

B. **Product Data:** Manufacturer's catalog sheets on turbidity curtain fabrics.

PART 2 -- PRODUCTS

2.1 FABRIC

A. Strong heavy-weight material with ultraviolet light (UV) inhibitors.

B. Tensile strength shall be sufficient to withstand predicted flows.

C. Seams and line attachments shall be sewn or vulcanized welded into place.

D. Flotation devices shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain.

2.2 ANCHORS

A. In-stream anchors shall have a floating anchor buoy or other identifying mark.

B. Shoreline turbidity curtain anchors shall be 2- by 4-inch or 1.33-lbs/lineal foot metal stakes.

C. Bottom anchors shall hold the curtain in position and may be any of the following types: plow, fluke, mushroom, or a grappling hook.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Provide erosion control barriers at the indicated locations and as required preventing erosion and silt loss from the Site.

B. CONTRACTOR shall not commence clearing, grubbing, earthwork, or other activities which may cause erosion until barriers are in place.

3.2 INSTALLATION

A. For manufactured products, install per manufacturer’s instructions.

B. Install turbidity curtains parallel to flow of the watercourse.

C. Turbidity curtain shall extend the entire depth of the watercourse.

D. In areas heavily impacted by wind generated wave action; turbidity curtains should have slack to follow the rise and fall of the water level without submerging.

E. Set upstream anchor points first, then unfurl the fabric, letting the flow carry the fabric to the downstream anchor points.

3.3 MAINTENANCE AND REMOVAL

A. Follow manufacturer instructions for fabric and material repair.

B. Remove materials at low flows and in a manner to scoop and trap sediments within the fabric.

C. Regularly inspect and repair or replace damaged components of the barrier. Unless otherwise directed, maintain the erosion control system until the disturbed area is permanently stabilized or upon final acceptance; then remove erosion and sediment control systems promptly.

D. Dewater and dispose of sediments on the Site, if a location is indicated on the Drawings, or at an approved site arranged by the CONTRACTOR which is not in or adjacent to a stream or floodplain.

- END OF SECTION -

SECTION 31 35 30 - EROSION CONTROL (VEGETATIVE)

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide erosion protection including fertilizing, seeding, and mulching for all disturbed areas that are not to be paved or otherwise treated in accordance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. **Fertilizer:** Fertilizer shall be a commercial, chemical type, uniform in composition, free-flowing, conforming to state and federal laws and suitable for application with equipment designed for that purpose. Commercial fertilizer should conform to the requirements of the California Food and Agricultural Code.

B. **Seed:** Seed shall be delivered in original unopened packages bearing an analysis of the contents. Seed shall be guaranteed 95 percent pure with a minimum germination rate of 80 percent, and shall meet California State Seed Law.

1. Seed mix shall consist of brome, perennial ryegrass, barley, fescue, wheatgrass, and clover native to the Upper Klamath watershed, or some combination of two or more of the above.
2. The seed mix shall conform to the final seed mix selected in the SWPPP.
3. The seed mix shall have weed-free certifications and Phytophthora-free certifications.
4. Seed mix shall be fast growing species that can be established with normal rainfall and without supplemental irrigation.
5. Seed mix shall be subject to the approval of the OWNER and ENGINEER.

C. **Mulch:** Mulch shall be a fibrous, wood cellulose product produced for this purpose. It shall be dyed green and shall contain no growth or germination inhibiting substances, and shall be manufactured so that when thoroughly mixed with seed, fertilizer, and water, in the proportions indicated it will form a homogenous slurry which is capable of being sprayed. The mulch shall be **Silva Fiber** as manufactured by **Weyerhaeuser Company; Conwood Fiber** as manufactured by **Consolidated Wood Conversion Corp.;** or equal.

D. Erosion Control Fabric: Erosion control fabric shall be used on all slopes 4H:1V and steeper.

1. Materials: Erosion control fabric shall be rolled, fiber matrix between biodegradable or photodegradable polypropylene nets, and shall have a design life of 12 months or greater.

2. Anchorage Devices: 6-inch biodegradable stakes from the manufacturer or staples of the proper length as recommended by the manufacturer for specific soil condition.

E. Manufacturers**,** or Equal

1. **North American Green**

PART 3 -- EXECUTION

3.1 GENERAL

A. **Weather Conditions:** Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable condition.

B. **Soil Preparation:** The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.

C. **Method of Application:** Fertilizer, seed, and mulch may be applied separately (Dry Method), or they may be mixed together with water and the homogeneous slurry applied by spraying (Hydraulic Method), except that all slopes steeper than 3 units horizontal to 1 unit vertical shall be stabilized by the Hydraulic Method.

3.2 DRY METHOD

A. **Fertilizing:** The fertilizer shall be spread uniformly at the rate recommended by the seed supplier for the selected seed mix. The fertilizer shall be raked in and thoroughly mixed with the soil to a depth of approximately 2-inches prior to the application of seed or mulch.

B. **Seeding:** The seed shall be broadcast uniformly at the rate of 44 lbs/acre (approximately 1 lb per 1,000 sq ft), or as recommended by the seed supplier. After the seed has been distributed it shall be incorporated into the soil by raking or by other approved methods.

C. **Mulch Application:** Mulch shall be applied at the rate of 1,500 lb (air dried weight) per acre (approximately 1 lb per 30 sq ft).

3.3 HYDRAULIC METHOD

A. The hydraulic method consists of the uniform application by spraying of a homogeneous mixture of water, seed, fertilizer, and mulch. The slurry shall be prepared by mixing the ingredients in the same proportions as indicated above. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. Mixing time of materials shall not exceed 45 minutes from the time the seeds come into contact with the water in the mixer to the complete discharge of the slurry onto the slopes, otherwise the batch shall be recharged with seed. The mixture shall be applied using equipment containing a tank having a built-in, continuous agitation and recirculation system, and a discharge system which will allow application of the slurry to the slopes at a continuous and uniform rate. The application rates of the ingredients shall be the same as those specified for the Dry Method. The nozzle shall produce a spray that does not concentrate the slurry nor erode the soil.

3.4 EROSION CONTROL BLANKET

A. Placement

1. Biodegradable erosion control blanket shall be used on all slopes 4H:1V and steeper.

2. The erosion control shall be spread only on prepared, fertilized and seeded surfaces.

3. On all slopes, the erosion control blanket shall be laid up-and-down the slope in the direction of water flow.

4. Waste of erosion control material shall be minimized by limiting overlaps as specified and by utilizing the full length of the netting at roll ends.

B. Anchorage

1. Ends and sides of adjoining pieces of material shall be overlapped 6-inches and 4-inches respectively, and stapled. Six anchors shall be installed across ends. A common row of staples shall be used at side joints. Staple through both blankets, placing staples approximately 6-inches apart.

2. The top edge of the erosion control blanket shall be anchored in a 6-inch deep by 6-inch wide trench. Backfill and compact trench after stapling.

3. Anchorage shall be by means of 9-inch long, 2-legged staples driven vertically and full-length into the ground. The legs shall be spread 3-inches to 4-inches apart at the ground to improve resistance to pull-out. In loose soils the use of 18-inch metal/washer pins may be required to properly anchor the blankets.

4. All slopes which are 3:1 or greater shall be stapled with 2 staples per square yard in a triangular pattern. Staples shall be installed per the manufacturer's recommended staple pattern guide.

5. The erosion control blanket shall not be stretched, but should be laid loosely over the ground to avoid pulling the blanket downslope.

6. The erosion control blanket shall not be rolled out onto ground containing frost within the 9-inch penetration zone of the anchorage staples. Further, no stapling shall be undertaken while any frost exists within the staple penetration zone.

3.5 WATERING

A. Upon completion of the erosion control seeding, the entire area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by a sprinkling system on the Site during dry weather or whenever necessary for proper establishment of the planting until final project acceptance. At no time shall the planting be allowed to dry out. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR.

3.6 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary, and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

3.7 MAINTENANCE AFTER FINAL ACCEPTANCE

A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary, and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

- END OF SECTION -

SECTION 31 37 00 - RIPRAP

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide riprap, including associated earthwork, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 535	Standard Test Method for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
AASHTO T 85	Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
AASHTO T 210	Method of Test for Aggregate Durability Index.

1.3 CONTRACTOR SUBMITTAL

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Testing certificates from a qualified testing agency shall be submitted prior to acceptance of the rock source to verify the conformity to the requirements of the Contract Documents.

PART 2 -- PRODUCT

2.1 STONES FOR RIPRAP

A. Stones shall be graded in size to produce a reasonably dense mass. Riprap shall consist of dense, natural rock fragments. Stones shall be resistant to weathering and to water action; free from overburden, spoil, shale, and organic material; and shall meet the gradation requirements below. Shale and stones with shale seams are not acceptable.

B. Riprap shall conform to the size types as follows:

1. Type I (6-inch Average Size):

Diameter	Percentage Passing
12-inch	95 - 100
6-inch	25 - 75

3-inch	0 - 10

2. Type II (12-inch Average Size):

Diameter	**Percentage Passing**
18-inch	95 - 100
12-inch	25 - 75
6-inch	0 - 5

3. Type III (18-inch Average Size):

Diameter	**Percentage Passing**
24-inch	95 - 100
18-inch	25 - 75
13-inch	0 - 5

4. Type IV (24-inch Average Size):

Diameter	**Percentage Passing**
30-inch	95 - 100
24-inch	25 - 75
18-inch	15 - 25
12-inch	0 - 5

C. The greatest dimension of 50 percent of the stones shall be at least two-thirds but not more than 1-1/2 times the diameter of the average size. Neither the breadth nor thickness of any piece of riprap shall be less than one-third its length. Material shall be of shapes which will form a stable protection structure of required depth. Rounded boulders or cobbles shall not be used.

D. Stones shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

Durability Absorption Ratio	Acceptability
Greater than 23	Passes
10 to 23	Passes only if Durability Index is 52 or greater
Less than 10	Fails
Durability Absorption Ratio	$\frac{\text{Durability Index (Coarse)}}{\text{\% absorption + 1}}$

E. The durability index and percent absorption shall be determined by AASHTO T 210 and AASHTO T 85, respectively. The minimum apparent specific gravity of the stones shall be 2.5 as determined by AASHTO T 85.

F. Stones shall have less than 10 percent loss of weight after five cycles, when tested per ASTM C 88.

G. Stones shall have a wear not greater than 40 percent, when tested per ASTM C 535.

H. Control of gradation shall be by visual inspection. The CONTRACTOR shall furnish a sample of the proposed gradation of at least 5 tons or 10 percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap.

I. The acceptability of the stones will be determined by the ENGINEER prior to placement. Any difference of opinion between the ENGINEER and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truckloads of stones. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking gradation shall be the CONTRACTOR's responsibility.

2.2 GEOTEXTILE FABRIC

A. Geotextile fabric shall conform to the requirements of Section 31 05 19 - Geotextiles.

2.3 FILTER MATERIAL

A. Filter material shall be clean and free from organic matter. It shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformity graded and shall conform to the following gradation:

1. Type 1

Size	Percentage Passing
3-inch	85 – 100

1-1/2 inch	45 – 75
3/4-inch	10 – 25

PART 3 -- EXECUTION

3.1 SURFACE PREPARATION

A. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and other objectionable material, and shall be brought to the line and grade indicated.

B. If a boulder is encountered during excavation of areas where large riprap is to be placed, the CONTRACTOR shall excavate around the boulder. If the boulder is larger than the largest allowable stone size for that area, the CONTRACTOR shall break up the boulder to an acceptable size or remove it entirely.

C. Prior to placement of the geotextile, the surface shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile. The geotextile shall be overlapped a minimum of 2-feet at longitudinal and transverse joints. Upstream sheets shall overlap downstream sheets. For slope placement, each strip shall overlap the next downhill strip. The geotextile shall be anchored using key trenches or aprons at the crest and toe of the slope. Pins may be used in securing the geotextile during installation. In no instance shall the geotextile be left exposed to sunlight longer than 7 Days. Overexposed geotextile shall be removed and replaced.

3.2 PLACEMENT OF FILTER BLANKET

A. Area of riprap placement shall be excavated to the bottom of the filter blanket as indicated and in accordance with Section 31 00 00 – Earthwork. After the excavation has been completed, the top 12-inches of exposed surface shall be scarified, brought to optimum moisture content, and compacted to 95 percent of maximum density. The finished grade shall be even, self-draining, and in conformance with the slope of the finished grade.

B. Placement of filter material shall be in accordance with Section 31 00 00. Filter material shall be placed, spread, and compacted in lifts not to exceed 12-inches.

C. The CONTRACTOR shall remove any portion of the filter blanket that has been disturbed to the degree that the layers become mixed. Replace the removed portion with the required sizes.

D. Filter material shall be placed as follows, unless otherwise indicated.

   1. For Type II, III and IV riprap, use 12-inches of Type 1 filter material.

   2. For Type I riprap, use 6-inches of Type 2 filter material.

E. No filter material is required if riprap is placed directly on bedrock.

3.3 PLACEMENT OF RIPRAP

A. Placement of riprap shall begin at the toe of the slope and proceed up the slope. The stones may be placed by dumping and may be spread by bulldozers or other suitable equipment as long as the underlying material is not displaced. Stones shall be placed so as to provide a minimum of voids. Smaller stones shall be uniformly distributed throughout the mass. Sufficient hand work shall be done to produce a neat and uniform surface, true to the lines, grades, and sections indicated.

B. Where riprap is placed over a geotextile fabric, the riprap shall be placed so as to avoid damage to the geotextile. Stones shall not be dropped from a height greater than 3-feet, nor shall large stones be allowed to roll downslope.

3.4 GROUTED RIPRAP

A. After the riprap has been placed, sand or fine gravel shall be swept into the interstices to fill them to within 4-inches of the average surface of the riprap. After wetting the stones, the remaining volume of the interstices shall be filled with a well-mixed grout composed of 1 part Portland cement and 3 parts of sand, mixed to a workable consistency. The grout shall be kept wet by sprinkling or covering with wet material for at least 3 Days. The grout shall be protected from stream water or any other disturbance during this curing period, and shall not be placed in freezing weather or when conditions are unfavorable.

- END OF SECTION -

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SECTION 32 11 13 - A.C. PAVEMENT AND BASE

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide A.C. pavement and base, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 320	Standard Specification for Performance-Graded Asphalt Binder
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf per cu ft)
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
ASTM D 6373-16	Standard Specification for Performance Graded Asphalt Binder
AI MS-2	Asphalt Mix Design Methods, 7th Edition (*Asphalt Institute*)

B. State Standards

State of California Department of Transportation (CalTrans). *Standard Specifications 2018*.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals. Include job-mix formulas and other pertinent information satisfactory to the ENGINEER.

B. **Suitability Tests of Proposed Materials:** Tests for conformance with the Specifications shall be performed prior to start of the WORK. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the WORK where the material represented by the sample is to be used. Results of all tests shall be submitted to the ENGINEER for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

PART 2 -- PRODUCTS

2.1 AGGREGATE BASE

A. Materials for aggregate base shall be Type GF material in accordance with Section 31 00 00 - Earthwork.

2.2 PRIME COAT

A. Prime coat shall be Type RS-2 liquid asphalt complying with the requirements of AASHTO M 82 (ASTM D 2027) and Caltrans Standard Specifications, Section 94, Asphaltic Emulsions.

2.3 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt grade 64-22. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.4 ASPHALT CEMENT

A. Asphalt Cement shall be Performance Grade 64-22 complying with the requirements of AASHTO M320 (ASTM D 6373-16).

2.5 MINERAL AGGREGATE

A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of two or more of these materials. Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

B. Mineral filler shall comply with ASTM D 242.

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.6 ASPHALT-AGGREGATE MIXTURE

A. Asphalt-aggregate mix shall be Performance Grade 64-22, 1/2” maximum aggregate size Type A HMA per CalTrans specifications 39-2.02B(4)(b) and shall comply with Superpave HMA mix design, material specifications, and testing as described in MS-2 Asphalt Mix Design Methods by the *Asphalt Institute*.

2.7 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability.

PART 3 -- EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 00 00 - Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.

3.2 AGGREGATE BASE

A. Aggregate base shall be provided where indicated to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6-inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6-inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6-inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the indicated grade or cross-section.

3.3 PRIME COAT

A. Prior to placing of pavement a prime coat of cutback asphalt shall be applied to the compacted base or subgrade at a rate between 0.10 and 0.25 gal/sq yd.

3.4 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.5 ASPHALT CONCRETE

A. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.

C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the ENGINEER may waive the self-propelled requirement.

E. Spreading, once commenced, shall be continued without interruption.

F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

3.6 PAVEMENT MARKING

A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions indicated. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the ENGINEER.

- END OF SECTION -

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SECTION 33 05 00 - PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide precast concrete manholes and vaults, complete and in place, in accordance with the Contract Documents.

1.2 SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 890	Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.3 CONTRACTOR SUBMITTALS

A. **General:** Furnish submittals in accordance with Section 01 30 00 - Contractor Submittals.

B. **Shop Drawings**

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
2. Structural design calculations for vaults, signed by a registered engineer.

E. Manufacturer’s Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

1.4 QUALITY CONTROL

A. **Inspection:** After installation, the CONTRACTOR shall demonstrate that manholes and vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2-- PRODUCTS

2.1 MANHOLES

A. The CONTRACTOR shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

C. Conical sections shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

D. Where the manhole barrel diameter is greater than 48-inches, a flat slab-transition, either concentric or eccentric, shall be used to transition to 48-inch diameter riser sections. Underside of the transition shall be at least 7-feet above the top of the bench.

E. **Design Criteria:** Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.

2. Unit weight of soil of 120 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.

4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the base and transition.

6. Additional reinforcing steel in walls to transfer stresses at openings.

7. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

F. Joints shall be sealed with O-ring gaskets conforming to ASTM C 443.

G. Concrete for base and channel formation shall be 4,000 psi concrete conforming to Section 03 30 00 - Cast-In-Place Concrete.

H. Barrel section to sewer pipe connections shall be sealed with resilient connectors complying with ASTM C 923. Mechanical devices shall be stainless steel.

I. Manhole Manufacturers, or Equal

1. **Atlantic Concrete Products, Inc., Cockeysville, MD**
2. **Hanson Concrete Products, Inc., Milpitas, CA**
3. **Hardwall Fabricators, Inc., N. Miami, OK**
4. **Teichert Precast, Sacramento, CA**

2.2 FRAMES AND COVERS

A. **Castings:** Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter, with embossed lettering saying to meet the requirements of the City or the local utility company. Frame and cover shall be designed for H-20 traffic loading.

B. Castings Manufacturers, or Equal

1. **Alhambra Foundry Co., Ltd.**
2. **Neenah Foundry Co.**
3. **Vulcan Foundry, Inc**

2.3 VAULTS

A. The CONTRACTOR shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V Portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

L = 90 h, plus surcharge of 240 psf in areas of vehicular traffic

Where L = loading in psf

h = depth of fill in feet

D. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

E. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

E. Covers for access openings shall be provided. Frames for covers shall be fabricated from steel, galvanized after fabrication, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

E. Where penetration of the pre-cast concrete vault are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. Vaults need not be designed to resist thrust from piping passing through the vault.

E. Warning Signs

1. The entrance to every manhole and vault shall be fitted with a permanently affixed, plastic warning sign, located above and centered on the top step. Each sign shall be in accordance with Section 10 14 00 - Signage.

2. Sign Manufacturer, or Equal

   a. **W. H. Brady Company**
   b. **Seton Nameplate Corporation**

PART -- EXECUTION

3.1 GENERAL

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer’s written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the CONTRACTOR shall follow the manufacturer’s recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Prior to backfilling, all cracks and voids in pre-cast concrete vaults shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant. With the authorization of the ENGINEER, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

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SECTION 33 11 11 - STEEL PIPE, SPECIALS, AND FITTINGS (AWWA C200, MODIFIED)

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide steel pipe, specials, and fittings, complete and in place, in accordance with the Contract Documents.

B. A single pipe manufacturer shall be made responsible for furnishing steel pipe, specials, fittings, and appurtenances such as bolts and gaskets for the WORK.

C. **Pipe Material Group No. 8**. The piping system defined in this section is referred to in the Pipe Schedule on Contract Sheet G007 as Piping Material Group No. 8. **(Note that steel Pipe of 14-inch diameter and larger, as called out on the Contract Drawings, shall be based upon innrt diameter dimensions, per Part 2.1.A of this Section.)**

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Furnish the following information with Shop Drawings:

1. Certified dimensional drawings of fittings and appurtenances
2. Joint and pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; coating and lining holdbacks, manufacturing tolerances, and other pertinent information required for the manufacture of the product
3. Joint details where deep bell or butt strap joints are required for control of temperature stresses
4. Details for elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials that indicate amount and position of reinforcement
5. Fittings and specials, showing proper reinforcement to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions as indicated
6. Material lists and steel reinforcement schedules that describe materials to be utilized, including metallurgical, chemical, and physical test reports from each heat of steel to verify the steel conforms to the indicated requirements
7. Line layout and marking diagrams which indicate the specific number of each pipe and fitting, the location of each pipe, the direction of each fitting in the completed line, and the following:
   a. the pipe station and invert elevation at every change in grade or horizontal alignment

    b. the station and invert elevation to which the bell end of each pipe will be laid

    c. elements of curves and bends, both in horizontal and vertical alignment

    d. the limits within each reach of restrained and/or welded joints or of concrete encasement

    e. location and dimensional allocations for each indicated valve, fitting, and appurtenance

8. Welds

    a. Submit full and complete information regarding location, type, size, and extent of welds.

    b. The Shop Drawings shall distinguish between shop and field welds.

    c. Shop Drawings for field welds shall indicate by welding symbols or sketches the details of the welded joints and the preparation of parent metal required to make them. Submittal shall include a complete Welding Procedure Specification (WPS) guide sheet for each category of weld (fillet weld, single-bevel butt weld, double-bevel butt weld, etc.) that defines all specific details for the supplied weld including:

        1) Welding Procedure Specification (WPS) which identifies characteristics including joint and backing ring (if applicable) geometry, base metal and filler metal characteristics, pre-heating and post-heating requirements, electrical characteristics, welding technique, and a welding parameter sheet.

        2) Propose Welding Procedure Qualification (WPQ) process,

        3) Proposed inspection and non-destructive examination (NDE) requirements to meet the requirements of this Section.

    d. Joints or groups of joints in which welding sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

9. Rubber gasket joint design and details

10. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining

11. Details and locations of closures for length adjustment and for construction convenience

12. Detail drawings indicating the type, number, and other pertinent details of the slings, strutting, and other methods proposed for pipe handling during manufacturing, transport, and installation

13. Manufacturer's Written Quality Assurance/Control Program

C. Certifications

1. The CONTRACTOR shall furnish a certified affidavit of compliance for pipe and other products or materials in AWWA C200 - Steel Water Pipe 6 in and Larger, AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in and Larger-Shop Applied, AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In Through 144 In, AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings, AWWA C210 - Liquid–Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines, AWWA C213 - Fusion-Bonded Epoxy Coatings for the Interior and Exterior of Steel Water Pipelines, and C222 - Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings, and the following supplemental requirements:

   a. physical and chemical properties of steel

   b. hydrostatic test reports

   c. results of production weld tests

   d. sand, cement, and mortar tests

   e. rubber gasket tests

   f. coating adhesion test

   g. records of coating application

2. Performance and payment for sampling and testing necessary for certification are the CONTRACTOR's responsibility as part of the WORK.

D. Manufacturer’s Qualifications

1. Furnish a copy of manufacturer’s certification to ISO 9000, SPFA, or LRQA, and documentation of manufacturer’s experience in fabricating AWWA C200 pipe.

E. Design Calculations of Fittings and Specials

1. Furnish a copy of the design calculations for fittings and specials including miters, welds, and reinforcement, prior to manufacture of the pipe, fittings, and specials.

1.3 QUALITY CONTROL

A. Pipe Manufacturer Qualifications

1. The pipe manufacturer shall be certified to ISO 9000, the Steel Plate Fabricator’s Association (SPFA), or Lloyd’s Register Quality Assurance (LRQA), and shall be experienced in fabrication of AWWA C200 pipe of similar diameters, lengths, and wall thickness to this WORK.

2. Experience shall be in the production facilities and personnel, not the name of the company that owns the production facility or employs the personnel.

B. Inspection

1. Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of AWWA C200, C205, and C214, as supplemented by the indicated requirements.

2. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing start date not less than 14 Days prior to the start of any phase of the pipe manufacture.

C. Tests

1. Except as indicated otherwise, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of AWWA C200, C205, and C214 as follows and as applicable:

    a. Joint gaskets shall be tested in accordance with AWWA C200.

    b. Shop Tests

        1) After the joint configuration is completed and prior to lining with cement mortar, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 75 percent of the yield strength of the steel.

        2) The test pressure shall be held for 2 minutes and the pipe visually inspected to confirm that welds are sound and leak-free.

    c. In addition to the tests required in AWWA C200, weld tests shall be conducted on each 5,000-feet of production welds and at any other times there is a change in the grade of steel, welding procedure, or welding equipment.

    d. Fittings fabricated from straight pipe previously passing a hydrostatic test need not have an additional hydrostatic test, provided that the welds are tested by nondestructive means and are demonstrated to be sound.

D. Shop Testing of Steel Plate Specials

1. If any special has been fabricated from straight pipe not previously tested and is of the type listed herein (bends, wyes, crosses, tees with side outlet diameter greater than 30 percent of the main pipe diameter, and manifolds), the special shall be hydrostatically tested with a pressure equal to 1.5 times the design working pressure.

2. Specials not required to be hydrostatically tested shall be tested by liquid dye penetrant inspection method in accordance with ASTM E 165 - Standard Test Methods for Liquid Penetrant Examination, Method A, or the magnetic particle method in ASME Section VIII, Division 1, Appendix VI.

3. Reinforcing plates shall be tested by the solution method using approximately 40 psig air pressure introduced between the plates through a threaded test hole; the test hole shall be properly plugged following successful testing.

4. Weld Imperfections

    a. Weld defects, cracks, leaks, distortion, or signs of distress during testing shall require corrective measures.

    b. Weld defects shall be gouged out and re-welded.

    c. After corrections, the special shall be retested.

5. Test Heads

    a. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special.

    b. After the removal of each test head, the special shall be trimmed back to the design points with finished plate edges ground smooth, straight, and prepared for the field joint.

6. Testing shall be performed before joints have been coated or lined.

7. Ultrasonic examination shall be performed in accordance with the following:

    a. Steel plate that will be in welded joints or welded stiffener elements shall be examined ultrasonically for laminar discontinuities where both of the following conditions exist:

        1) any plate in the welded joint has a thickness exceeding 0.50 inches.

        2) any plate in the welded joint is subject to transverse tensile stress through its thickness during the welding or service

    b. Ultrasonic examination may be waived where joints are designated to minimize potential laminar tearing.

    c. The ultrasonic examination shall be in accordance with ASTM A 578 - Straight Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications, with a Level I acceptance standard.

8. Plates that are not in conformance with the acceptance criteria in ASTM A 578 may be used in the WORK if the areas that contain the discontinuities are a distance at least 4 times the greatest dimension of the discontinuity away from the weld joint.

E. The CONTRACTOR shall be responsible for performing and paying for the indicated material tests.

F. The ENGINEER has the right to witness testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER.

G. Additional Testing

1. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including mortar lining and coating for testing by the OWNER.

2. The additional samples shall be furnished as part of the WORK.

H. Field Testing

1. Field testing shall be in accordance with the requirements of Section 01 74 30 Pressure Pipeline Testing and Disinfection.

I. Welding Requirements

1. Welding procedures used to fabricate and install pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code-Steel, and the ASME Boiler and Pressure Vessel Code, Section IX.

2. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

J. Welder Qualifications

1. Welding shall be performed by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used.

2. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section IX by an independent local, approved testing agency not more than 6 months prior to commencing WORK on the pipeline.

3. Machines and electrodes similar to those used in the WORK shall be used in qualification tests.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Lined and coated steel pipe and specials shall conform to AWWA C200, C205, C210, C213, and C222, subject to the following supplemental requirements:

1. The pipe, specials, and fittings shall be of the diameter and class indicated and shall be provided complete with rubber gaskets or welded joints as indicated.

2. **Steel Pipe of 14-inch Diameter and Larger Based upon Inside Diameter Dimension. For pipe, specials, and fittings of 14-inch diameter and larger, the pipe diameter as indicated on the Contract Drawings is the required minimum <u>inside</u> diameter of the pipe, as measured from the inside face of the steel sheet to the inside face of the steel shell**. Use of standard outside diameter steel

pipe dimensions is acceptable for pipe classified as pipe material No. 8 on the Contract Drawings.

3. When indicated as a minimum, wall thickness tolerance shall be as allowed by AWWA C200 or the ASTM nominal sheet or plate tolerance, whichever is less.

B. Markings

  1. The manufacturer shall legibly mark pipe, specials, and fittings in accordance with the laying schedule and marking diagram.

  2. Each pipe, special, and fitting shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation.

  3. Each pipe, fitting, and special shall be marked at each end with top field centerline.

C. Handling and Storage

  1. The pipe, specials, and fittings shall be handled by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating and exterior.

  2. The use of chains, hooks, or other equipment that might injure the pipe coating or exterior will not be permitted.

  3. Stockpiled pipe, specials, and fittings shall be supported on padded skids, sand or earth berms free of rock exceeding 3 inches in diameter, sandbags, or suitable means so that the pipe including coating and lining coating will not be damaged.

  4. Pipe, specials, and fittings shall not be rolled and shall be secured to prevent accidental rolling.

D. The CONTRACTOR shall replace or repair damaged pipe, specials, and fittings.

E. Strutting

  1. Adequate strutting shall be provided on specials, fittings, and straight pipe in order to avoid damage to the pipe, specials, and fittings during handling, storage, hauling, and installation.

  2. For mortar-lined steel pipe, specials, or fittings the following requirements shall apply:

    a. The strutting shall be placed as soon as practicable after the mortar lining has been applied and shall remain in place while the pipe, special, or fitting is loaded, transported, unloaded, installed, and backfilled at the Site.

    b. The strutting materials, size, and spacing shall be adequate to support the earth backfill plus any greater loads that may be imposed by the backfilling and compaction equipment.

c. Any pipe, special, or fitting damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

F. Laying Length

1. The maximum pipe laying length shall be 48 feet, with shorter lengths to be provided as indicated and required.

G. Lining

1. The pipe, specials, and fittings shall have smooth, dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

H. Closures and Correction Pieces

1. Closures and correction pieces shall be provided as required such that closures may be made due to different headings in the pipe laying operation and such that corrections may be made to adjust the pipe laying to conform to the indicated pipe stationing.

2.2 MATERIALS

A. Mortar

1. Materials for mortar shall conform to the requirements of AWWA C205; mortar lining shall be Type II or V.

2. Cement in mortar lining shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement.

3. Admixtures shall contain no calcium chloride.

B. Steel for Cylinder and Fittings

1. Pipe, specials, and fittings manufactured under AWWA C200 shall satisfy the following requirements:

    a. minimum yield strength of steel: 50,000 psi for medium to high pressure pipe.

    b. manufactured by a continuous casting process

    c. fully kilned

    d. fine grain practice

    e. maximum carbon content: 0.25 percent

    f. maximum sulfur content: 0.015 percent

    g. minimum elongation: 22 percent in a 2-inch gauge length

    h. in accordance with one of the following Standards:

1) ASTM A1011 - Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

2) ASTM A572 - High Strength Low-Alloy Columbium-Vanadium Structural Steel

3) ASTM A1018 - Steel, Sheet and Strip, Heavy Thickness Coils, Hot-Rolled Carbon, Structural, High-Strength Low-Alloy Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability

2. Testing

   a. Steel equal to or greater than 0.5 inch thick used in fabricating pipe shall be tested for notch toughness using the Charpy V-Notch test in accordance with ASTM A 370 - Test Methods and Definitions for Mechanical Testing of Steel Products.

   b. The frequency of testing shall be one impact test (set of 3 specimens - transverse, not longitudinal) for each coil used in manufacturing the pipe.

   c. The testing frequency for sheets and plates shall be one impact test (set of 3 specimens) for each 50 tons of product.

   d. The steel shall withstand a minimum impact of 25 ft-lb at a temperature of 30 degrees F.

2.3 DESIGN OF PIPE

A. General

1. The pipe shall be suitable to transmit raw water under the indicated conditions.

2. The steel pipe shall have rubber-gasketed or field-welded joints as indicated on the Contract Drawings.

3. The pipe shall consist of a steel cylinder, shop-lined with Portland cement mortar and exterior coated with an Epoxy Liquid System per AWWA C210.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements as indicated and, except as indicated, shall conform to AWWA C200.

C. Pipe Dimensions

1. The pipe shall be of the diameter and minimum wall thickness indicated on the Contract Mechanical and Civil Drawings.

D. Fitting Dimensions

1. Fittings shall be of the diameter and class indicated.

E. Joint Design

1. Butt-strap joints or field welded butt-joints shall be used only where required for closures or where indicated.

2. Unless indicated otherwise, the standard joint design for all steel straight pipe and fittings shall be lap joint field welds and factory butt welds, where applicable. ANSI B16.42 Class 300 steel flanges shall be used for connection to valves, flow meters, and other specials as shown on the Contract drawings.

F. Lap Joints for Field Welding

1. Lap joints prepared for field welding shall be in accordance with AWWA C200.

2. The method used to form, shape, and size bell ends shall be such that the physical properties of the steel are not substantially altered.

3. Unless otherwise approved by the ENGINEER, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape.

4. Faying surfaces of the bell and spigot shall be essentially parallel except for mitered bells, but the bell slope shall not vary more than 2 degrees from the longitudinal axis of the pipe.

5. Provide air test tap holes for double-welded (interior and exterior) lap joints.

G. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe on field butt strap welds as indicated or as otherwise acceptable to the ENGINEER.

H. Restrained Joints

1. Restrained joints shall be located where indicated

2. Restrained joints shall be field-welded joints, either single, or inside and outside lap-weld, or butt-weld, or butt-straps as indicated.

3. Designs shall include stresses created by the greater of:

   a. a temperature differential of 40 degrees F plus Poisson's effect in combination with hoop stress, or;

   b. thrust due to bulkheads, bends, reducers, and line valves resulting from working pressure in combination with hoop stress.

4. For field-welded joints, design stresses shall not exceed 50 percent of the specified minimum yield strength of the grade of steel utilized, or 21,000 psi, whichever is less, for the part being examined when longitudinal thrust is assumed to be uniformly distributed around the circumference of the joint

2.4 SPECIALS AND FITTINGS

A. **Design**

1. Except as otherwise indicated, materials, fabrication and shop testing of specials and fittings shall conform to the requirements stated above for pipe and shall conform to the dimensions of AWWA C208.

2. The minimum thickness of plate for pipe from which specials are to be fabricated shall be a minimum as shown on the Contract drawings and the greatest of those determined by the following 3 criteria:

   a. Working and Transient Pressure Design

$$T = \frac{P_w D/2}{Y/S_w} \qquad T = \frac{P_t D/2}{Y/S_t}$$

Where:

T = Steel cylinder thickness in inches
D = Outside diameter of steel cylinder in inches
P_w = Design working pressure in psi
P_t = Design transient pressure in psi
Y = Specified minimum yield point of steel in psi
S_w = Safety factor of 2.5 at design working pressure
S_t = Safety factor at design transient pressure; for elbows 1.875 and 2.0 for other specials

   b. Mainline Pipe Thickness: Plate thickness for specials shall be not less than the adjacent mainline pipe.

   c. Thickness Based on Pipe Diameter

Nominal Pipe Diameter, inches	Pipe Manifolds Piping Above Ground Piping Structures
24 and under	1/4 inch

B. **Specials**

1. Specials installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi.

2. Design shall be in accordance with the provisions of Chapter 7 of AWWA Manual M11.

C. **Deflections and Angles**

1. Moderate deflections and long radius curves may be constructed by means of beveled joint rings, by pulling standard joints, by using short lengths or pipe, or a combination of these methods provided that pulled joints shall not be used in combination with bevels.

2. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint.

3. Bevels shall be provided on the bell ends.

4. Mitering of the spigot ends will not be accepted.

5. The maximum allowable angle for pulled joints shall be in accordance with the manufacturer's recommendations, or the angle which results from a 3/4-inch pull-out from normal joint closure, whichever is less.

6. Horizontal deflections or fabricated angles shall fall on the alignment.

7. Vertical Deflections

   a. Vertical deflections shall fall on the alignment and shall be at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures.

   b. The pipe angle points shall match the indicated angle points.

D. **Outlets, Tees, Wyes, Crosses, and Nozzles**

1. Outlets 12 inches and smaller may be fabricated from Schedule 30 or heavier steel pipe in the standard outside diameters, that is, 12-3/4-inch, 10-3/4-inch, 8-5/8-inch, 6-5/8-inch, and 4-1/2-inch.

2. The minimum plate thickness for reinforcements shall be 10-gauge.

3. The outlet reinforcement design shall be in accordance with the procedures given in Chapter 13 of AWWA Manual M11, and the design pressures and factors of safety indicated above.

4. In lieu of saddle or wrapper reinforcement as provided by the design procedure in Manual M11, pipe or specials with outlets may be fabricated entirely of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.

5. Where Manual M11 requires the design procedure for crotch plate reinforcement, such reinforcement shall be provided.

6. Reinforcing Plates

   a. Outlets shall be fabricated such that there is always at least a 12-inch distance between the outer edge of the reinforcing plate and any field-welded joints.

   b. For outlets without reinforcing plates, outlets shall penetrate the steel cylinders so that there is at least a 12-inch clearance between the outlet and any field-welded joints.

7. Tees, wyes, crosses, elbows, and manifolds shall be fabricated such that the outlet clearances and reinforcing plates from any weld joints are a minimum of 5 times cylinder thickness or 2 inches, whichever is greater.

8. Longitudinal weld joints in adjacent cylinder sections shall be oriented such that there is a minimum offset of 5 times cylinder thickness or 2 inches, whichever is greater.

9. Reinforcement

   a. Reinforcement for wyes, tees, outlets, and nozzles shall be designed in accordance with AWWA Manual M11.

   b. Reinforcement shall be designed for the design pressure indicated and shall be as indicated.

10. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe.

11. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees.

E. **Welded Fittings**. Steel welding fittings shall conform to ASTM A 234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

F. **Ends for Mechanical-Type Couplings**

1. Except as otherwise indicated, where mechanical-type couplings are indicated the ends of pipe shall be banded with Type C collared ends using double fillet welds.

2. Where pipe 12-inch and smaller is furnished in standard schedule thickness and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved.

2.5 PIPE INTERIOR LINING

A. The lining system required for each portion of the pipeline shall be as indicated on the **Pipe Schedule** given on Contract Drawing G007.

B. **Cement-Mortar Lining for Shop Application**

1. Unless indicated otherwise, interior surfaces of pipe, specials, and fittings shall be cleaned and lined in the shop with cement mortar lining applied centrifugally in conformity with AWWA C205.

2. During the lining operation and thereafter, the pipe, specials, and fittings shall be maintained in a round condition by suitable bracing or strutting.

3. The lining machines shall be of a type that has been used successfully for similar WORK.

4. Every precaution shall be taken to prevent damage to the lining.

5. If the lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to the indicated requirements.

C. The progress of the application of mortar lining shall be regulated in order that handwork, including the repair of defective areas, is cured in accordance with the provisions of AWWA C205.

D. Cement mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

E. Cement-Mortar Lining for Field Application

    1. Unless otherwise indicated, steel pipe shall be mortar-lined.

    2. The materials and design of in-place cement mortar lining shall be in accordance with AWWA C602 and the following supplementary requirements:

        a. Pozzolanic material shall not be used in the mortar mix.

        b. Admixtures shall contain no calcium chloride.

        c. The minimum lining thickness shall be as indicated for shop-applied cement mortar lining, and finished inside diameter after lining shall be as indicated.

        d. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired, whereas pipe, specials, or fittings with mortar cracks wider than 1/16 inch shall be rejected.

F. The minimum lining thickness and tolerance shall be in accordance with AWWA C205.

G. **Field Joints**

    1. The pipe shall be left bare as indicated where field welding joints occur, with lining holdbacks as indicated either in AWWA C210 or as shown on the drawing details.

    2. Ends of the linings shall be left square and uniform.

    3. Feathered or uneven edges will not be accepted.

H. **Defective Linings**

    1. Defective linings, as determined by the ENGINEER, shall be removed from the pipe wall and shall be replaced to the full thickness required.

    2. Defective linings shall be cut back to a square shoulder in order to avoid feather-edged joints.

I. **Hand-Applied Linings**

1. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials as used for the pipe and in accordance with the applicable AWWA or ASTM standards and as indicated.

2. Coating and lining applied in this manner shall provide protection equal to that for the pipe.

3. Fittings may be fabricated from pipe that has been mechanically lined and/or coated.

4. Areas of lining and coating that have been damaged by such fabrication shall be repaired by hand-application.

J. **Protection of Pipe Lining/Interior**

1. For pipe, specials, and fittings with plant-applied cement-mortar linings, the CONTRACTOR shall provide a 12-mil polyethylene sheet or other suitable bulkhead on the ends of the pipe and on each opening to prevent the lining from drying out.

2. Bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 PIPE EXTERIOR COATING

A. **Shop Applied Prime Coating for Concrete Encased Pipe**

1. For the concrete encased portion of the permanent pipeline (Drawing C200), the exterior surfaces of pipe, fittings, and specials shall be given a shop coat of primer. The final applied primer coating shall be per the requirements of AWWA C210 and as specified in this Section, and shall be shop-applied under atmospheric / environmental conditions as required by the prime coat manufacturer. Prime coat shall meet the following:

   a. Surface Preparation: grit blast to near white metal condition, SSPC SP 10

   b. Application: two or more coats of the two-part, chemically cured epoxy primer.

   c. Inspection and testing of the lining shall be per AWWA C210 and the product Manufacturer's recommendations.

   d. During the coating operation and thereafter, the pipe, specials, and fittings shall be maintained in a round condition by suitable bracing or strutting.

   e. The coating machines shall be of a type that has been used successfully for similar Work.

   f. No holdback of primers shall be allowed on the exterior of any pipe.

B. **Exterior Coating of Buried Piping**

1. Pipe for buried service that will not be encased in concrete, including bumped heads, shall be coated with a minimum one-inch thickness of reinforced cement-mortar coating.

2. Unless otherwise indicated, exterior surfaces of pipe or fittings passing through structure walls shall be cement-mortar coated from the center of the wall or from the wall flange to the end of the underground portion of pipe or fitting.

3. The coating shall be reinforced with a spiral wire reinforcement or welded wire fabric in accordance with AWWA C205.

4. The welded wire fabric shall be securely fastened to the pipe with welded clips or strips of steel.

5. The wire shall be spaced 2 inches on centers and shall extend circumferentially around the pipe.

6. The ends of reinforcement strips shall be lapped 4 inches, and the free ends shall be tied or looped to assure continuity of the reinforcement.

2.7 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of Division 33.

B. Access manways shall be as indicated on the Contract Drawings. Precast concrete access manholes with covers shall be as indicated in the Contract Drawings.

C. Threaded outlets shall be forged steel suitable for 3,000-psi service, and shall be as manufactured by **Vogt**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. **Handling and Storage**

1. Pipe, specials, and fittings shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, and impact shocks and free fall.

2. Pipe, specials, and fittings shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe against injury whenever stored at the Site or elsewhere.

3. Pipe, specials, and fittings shall be handled and stored at the Site in accordance with the requirements indicated in Part 2, above.

4. No pipe shall be installed when the lining or coating, or interior or exterior surfaces show cracks that may be harmful as determined by the ENGINEER.

5. Such damaged lining and coating, and interior and exterior surfaces shall be repaired or a new undamaged pipe, special, or fitting shall be provided.

B. Pipe damaged prior to Substantial Completion shall be repaired or replaced.

C. The CONTRACTOR shall inspect each pipe, special, and fitting for damage.

D. The CONTRACTOR shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe, special, or fitting.

E. **Cleaning**

1. Before the placement of pipe, specials, or fittings in the trench, each shall be thoroughly cleaned of any foreign substance that may have collected thereon and shall be kept clean thereafter.

2. For this purpose, the openings of pipes, specials, and fittings in the trench shall be closed during any interruption to the WORK.

F. **Placement**

1. CONTRACTOR shall avoid all laying procedures which create concentrated loads on the steel pipe. Pipe, specials, and fittings shall be laid directly:

   a. On the imported and properly compacted bedding material, or

   b. If CLSM is being utilized in the pipe zone and pipe bedding area, on soil pads or other approved compressible material such as extruded polystyrene foam insulation. Soil pads shall maintain horizontal and vertical alignment during backfilling operation, and shall have a lower compressible strength than the surrounding CLSM material

2. Only compressible blocking as specified will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe, special, or fitting.

3. Excavations shall be made as needed to facilitate removal of handling devices after the item has been laid.

4. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings.

5. Excavation outside the normal trench section shall be made at field joints as needed to permit adequate access to the joints for field connection operations and for application of coating on field joints.

6. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill if on grades exceeding 10 percent.

7. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement.

8. Bends shall be installed as indicated.

G. **Installation Tolerances**

1. Each section of pipe, special, or fitting shall be laid in the order and position on the laying diagram and in accordance with the following:

    a. Each section of pipe, special, or fitting having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus one inch vertical deviation.

    b. Each section of pipe, special, or fitting having nominal diameter 48 inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.

    c. In addition to the horizontal and vertical tolerances above, the pipe shall be laid so that no high or low points other than those on the laying diagram are introduced.

    d. After installation, the pipe, specials, and fittings shall not show deflection greater than:

        1) flexible-lined and flexible-coated or bare pipe, specials, and fittings: 3.0 percent

        2) flexible-lined and mortar-coated (rock-shielded) pipe, specials, and fittings: 2.25 percent

        3) mortar-lined and mortar-coated pipe, specials, and fittings: 1.5 percent

    e. The allowable deflection shall be based on the design inside diameter.

H. **Test Section**

1. At the beginning of pipe laying operations, the CONTRACTOR shall perform a test section to demonstrate that the methods and materials to be used will satisfy the pipe zone backfill compaction and pipe deflection criteria.

2. The maximum length of the test section shall be 500 feet.

3. The CONTRACTOR shall not proceed with production pipe laying beyond the test section without the ENGINEER's approval.

4. The entire test section length that does not comply with the Contract Documents shall be reworked as necessary to comply.

5. The ENGINEER will observe construction of the test section.

6. The OWNER will take measurements and keep records for quality assurance purposes.

7. Any change in means, methods, and trench conditions, including excavation, bedding, and pipe zone materials, in situ soils, water conditions, and backfill and compaction methods shall require another successful test section before additional production pipe installation.

I. **Changes in Alignment and/or Grade**

1. Where necessary to raise or lower the pipe, specials, or fittings due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grade.

2. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings, although in no case shall the deflection in a joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer.

3. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

4. In each case the joint opening, before finishing with the protective mortar inside the pipe, or prior to applying in-place mortar lining, shall be the controlling factor.

J. **Struts**

1. Struts in pipe 42-inch diameter and larger shall be left in place until backfilling operations have been completed.

2. Struts in pipe smaller than 42-inch may be removed immediately after laying.

3. A laboratory selected and paid by the OWNER may monitor pipe deflection by measuring pipe inside diameter before struts are removed and 24 hours after struts are removed.

4. Pipe deflection shall not exceed 1.5 percent 24 hours after the struts have been removed.

5. After the backfill has been placed, the struts shall be removed and shall remain the property of the CONTRACTOR.

K. **Cold Weather Protection**

1. No pipe, special, or fitting shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation.

2. No pipe, special, or fitting shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

L. **Pipe, Specials, and Fitting Protection**

1. The openings of pipe, specials, and fittings with shop-applied mortar lining shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water, or any undesirable substance.

2. The bulkheads shall be designed to prevent the drying out of the interior of the pipe, specials, and fittings.

3. The CONTRACTOR shall introduce water into the pipe to keep the mortar moist if moisture has been lost due to damaged bulkheads.

4. Means shall be provided to prevent the pipe from floating due to water in the trench from any source.

5. Pipe that has floated shall be repaired, including restoration to original condition and profile.

M. **Pipe Cleanup**

1. As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of debris.

2. The CONTRACTOR shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints, and any necessary interior repairs prior to testing and disinfecting of the completed pipeline.

3.2 WELDED JOINTS

A. **General**

1. CONTRACTOR shall submit a Welding Procedure Specification (WPS) in accordance with ASME Section IX to define the parameters of the weld and welding procedure for each major type of weld provided for the project.

2. Prior to beginning the welding procedure, any tack welds used to position the pipe during laying shall be removed.

3. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means.

4. Where more than one pass is required, each pass except the first and final ones shall be peened to relieve shrinkage stresses, and dirt, slag, and flux shall be removed before the succeeding bead is applied.

5. Prior to butt welding, the pipe and joint shall be properly positioned in the trench using line up clamps so that, in the finished joint, the abutting pipe sections shall not be misaligned more than 1/16 inch.

6. Unless double fillet welds are indicated, field welded lap joints may, at the CONTRACTOR'S option, be made on either the inside or the outside of the pipe.

7. Field welded joints shall be in accordance with AWWA C206 - Field Welding of Steel Water Pipe.

8. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.

9. Butt straps shall be as indicated.

10. A heat resistant shield shall be draped over at least 24-inches of coating beyond the holdback on both sides of the weld during welding to avoid damage to the coating by hot weld splatter.

11. Welding grounds shall not be attached to the coated part of the pipe.

12. Back-gouging of welds is not required for pipe applications. Interior of all V-groove welds shall be ground smooth to allow for proper field application of liner over the joint, and to prevent hydraulic vortices from forming when water passes over the weld zone.

13. Following hydraulic tests of the welded joint, the exterior joint spaces shall be field coated as indicated.

B. **Butt Weld Joints for Beveled-end Pipe (Single V-Groove Bevel)**

1. Single V-groove bevels may be used on steel pipe with wall thicknesses up to 0.625 inches. V-groove shall be developed for either interior or exterior joint welding, as required by the Contract Documents.

2. Single V-groove bevel end joints shall be such as to provide a complete joint penetration (CJP) weld. CONTRACTOR may utilize *Prequalified* welded joints for CJPs as defined in Part 8 of the AISC Steel Construction Manual or in the appropriate Section of the ASME Boiler & Pressure Vessel Code.

3. Bevel angles shall be between 30 and 35 degrees maximum. Total included angle shall be between 60 and 70 degrees.

4. Geometry of the root (face height and width opening) shall be determined by the CONTRACTOR, but shall be no less than 1/16-inch each dimension.

5. Use of backing rings for these joints is at the option of the CONTRACTOR. If no backing rings are utilized, CONTRACTOR shall provide certifications showing that Welders have the required experience in welding the “open-style” bevel joints without backing rings.

6. For pipes larger than 24-inch diameter where exterior welding is required and in cases where no backing rings are utilized, the CONTRACTOR shall provide two qualified welders to work on weld passes #1 and #2 on opposite sides of the joint, simultaneously. After weld pass #2 is completed, successive weld passes can be completed by use of only one qualified welder working on a joint at one time.

C. **Lap-Weld Joints for Bell and Spigot, "Weld Bell" End Pipe (Single or Double Fillet welds)**

1. Where single lap-weld joints are utilized (on either the pipe interior or exterior), the opposite side of the joint shall be finished with a complete, single pass circumference weld to prevent water from migrating into the interface of the joint.

2. Joint "pull deflections" at each joint for alignment purposes shall not exceed 1.0% angle or the Manufacturer's recommended maximum pull, whichever is less.

3. Others – type here

D. **Trench Backfilling after Joint Welding**

1. After the pipe and joint are properly positioned in the trench, the length of pipe between joints shall be backfilled to at least one foot above the top of the pipe.

2. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the joint.

E. **Temperature Stresses**

1. To control temperature stresses, the unbackfilled joint areas of the pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials for a minimum period of 2 hours prior to the beginning of the welding operation and until the weld has been completed.

2. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe.

3. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.

F. **Shrinkage Control Joints**

1. At intervals not exceeding 250 feet along welded reaches of the pipeline and at the first regular lap-welded field joints outside concrete encasements and structures, the pipe shall be laid with an initial lap of not less than one inch greater than the minimum lap dimension.

2. The welding of each such shrinkage control joint shall be performed when the temperature is approximately the lowest during the 24 hour day, after at least 250 feet of pipe have been laid and the joints have been welded ahead of and in back of the shrinkage control joint, and after backfill has been completed to at least one foot above the top of the pipe ahead of and in back of the shrinkage control joint.

3. Where shrinkage control joints occur in a traveled roadway or other inconvenient location, the location of the shrinkage control joint may be adjusted, as acceptable to the ENGINEER.

4. The shrinkage control joints for the lap-welded sections of the pipeline shall be per Part 3.3.D of Section 33 11 11.

5. For the Butt-joint, single outside weld connections to existing pipe, shrinkage control joints utilizing a butt strap or other approved closure piece shall be applied, to control temperature shrinkage per the requirements of Part 3.3.D of Section 33 11 11. These butt straps shall not be placed when temperatures are above 50 degrees Fahrenheit.

G. **Inspection of Field-Welded Joints**

1. An independent testing laboratory acceptable to the ENGINEER but paid by the CONTRACTOR shall inspect the joints.

2. Inspection shall be as soon as practicable after the welds are completed.

3. Fillet welds shall be tested by the Magnetic Particle Inspection Method in accordance with ASME Section VIII, Division 1, Appendix VI.

4. Single Bell and Spigot, Lap-Weld Joints

    a. Single-welded lap joints refer to those joints where only an interior or exterior fillet weld is required by the Contract Drawings. If a single fillet weld only is applied to a lap joint, than all such joints shall have their opposing surface seem covered with a single pass weld to seal off the seam from water intrusion during normal operations.

5. Double Bell and Spigot, Lap-Weld Joints

    a. Double-welded lap joints refer to those joints where both an exterior fillet weld and full interior fillet weld are required. Such joints shall be air-tested by shop drilling and tapping for 1/4-inch national pipe thread access port in the lap or bell end of the pipe.

    b. Apply 50 psig of air or other satisfactory gas into the connection between the 2 fillet welds.

    c. Test pressure shall be measured with a minimum 4-inch diameter pressure gauge with a range no greater than 0 to 120 psig.

    d. The air test shall consist of holding the test pressure undiminished for 5 minutes.

    e. If the air test fails, paint the welds with a soap solution and mark any leaks indicated by the escaping gas bubbles.

    f. Leaking portions of the welds or defective welds shall be removed and re-welded.

    g. The amount of material removed shall be limited to that required to correct the defect.

        h. After the repair is made, the joint shall be checked by repeating the original test procedure.

        i. Close the threaded openings with pipe plugs or by welding.

    6. Butt weld joints shall be inspected by Non-destructive Examination (NDE) processes utilizing either radiographic methods in accordance with API Standard 1104, or approved ultrasonic testing methods.

H. **Repair of Welds**

1. Defective welds shall be repaired by the CONTRACTOR to meet the indicated requirements.

2. Defects in welds or defective welds shall be removed, and that section of the joint shall then be re-welded.

3. Only sufficient removal of defective material that is necessary to correct the defect shall be required.

4. After the repair is made, the joint shall be checked by repeating the original test procedure.

5. Welds deficient in size shall be repaired by adding weld metal.

3.3 PREPARATION FOR FIELD COATING

A. **General:** Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The CONTRACTOR shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Care shall be exercised not to damage adjacent Work during blasting operations. Spraying shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent Work or adjoining property occurring from blasting or coating operations.

C. **Protection of Painted Surfaces:** Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces, or likewise harm existing surfaces.

3.4 SURFACE PREPARATION STANDARDS

A. **Steel Structures Painting Council (SSPC) Standards.** The following referenced standards for surface preparation according to specifications of the Steel Structures Painting Council (SSPC) shall form a part of this specification:

1. **SSPC SP1 - Solvent Cleaning**: Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. **SSPC SP2 - Hand Tool Cleaning:** Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. **SSPC SP3 - Power Tool Cleaning**: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. **SSPC SP5 - White Metal Blast Cleaning**: Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. **SSPC SP6 - Commercial Blast Cleaning**: Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. **SSPC SP7 Brush-Off Blast Cleaning**: Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. **SSPC SP10 Near-White Blast Cleaning** : Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. **SSPC-SP13 Surface Preparation of Concrete**: Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.5 JOINT COATING AND LINING

A. **General**

1. The interior and exterior joint recesses shall be thoroughly wiped clean.

2. Remove water, loose scale, dirt, and other foreign material from the inside surface of the pipe.

B. **Testing**

1. The ENGINEER will test each joint with an electrical detector, furnished by the CONTRACTOR and capable of at least a 12,000 volt output.

2. The tests will be performed using 6,000 to 7,000 volts.

3. The CONTRACTOR shall repair any holidays.

4. Re-Testing

a. When a visual inspection indicates that a portion of the coating system has sustained physical damage, the CONTRACTOR shall perform an electrical holiday test of 6,000 to 7,000 volts.

b. When the test indicates no holiday, a notation shall be applied to the area indicating the test is satisfactory.

C. **Coating Repair**

1. Prime Coated Pipe: Perform coating repairs on prime coated pipe in accordance with the Manufacturer’s recommendations and the requirements of AWWA C210, satisfying both requirements at a minimum.

2. Rock Shield / Mortar-Coated Pipe: Perform coating repairs on mortar-coated pipe in accordance with the requirements of AWWA C205.

D. **Coating of Fittings and Specials**: Fittings and specials shall be coated in accordance with AWWA C205 and C210 and the requirements specified herein.

E. **Joint Lining**

1. Materials of construction for mortar shall be in accordance with the requirements of AWWA C602.

2. The mortar shall be tightly packed into the joint recess and troweled flush with the interior surface, and excess shall be removed.

3. At no point shall there be an indentation or projection of the mortar exceeding 1/16 inch.

4. With pipe smaller than 24-inch in diameter, before the spigot is inserted into the bell, the bell shall be daubed with mortar.

5. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out. Visual inspection shall occur and the CONTRACTOR shall remove any loose scale, dirt, and other foreign material from the inside surface of the pipe.

6. The lap weld should be tack welded immediately after assembly to minimize movement of the joint. The CONTRACTOR shall allow the cement mortar patch to cure for a minimum of 8 hours prior to completing the required weld.

3.6 INSTALLATION OF PIPE APPURTENANCES

A. **Protection of Appurtenances**: Where the joining pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with Section 09 96 11 – Polyethylene Tape Coating.

B. **Installation of Valves**

1. Valves shall be handled in a manner to prevent any injury or damage to the valve or any part of it.

2. Joints shall be thoroughly cleaned and prepared prior to installation.
3. The CONTRACTOR shall adjust stem packing and operate each valve prior to installation to verify proper operation.
4. Valves shall be installed so that the valve stems are plumb and in the location indicated.
5. Buried valves and flanges shall be coated and protected in accordance with Section 09 96 00 – Protective Coatings.

C. **Installation of Flanged Joints**

1. Before the joint is assembled, the flange faces shall be thoroughly cleaned of foreign material with a power wire brush.
2. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges.
3. Bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable and calibrated torque wrench.
4. Clamping torque shall be applied to the nuts only.
5. Full-face reinforced rubber gaskets shall be applied to the inside face of blind flanges with adhesive.

D. **Insulated Joints**

1. Insulated joints and appurtenant features shall be provided as indicated.
2. The CONTRACTOR shall exercise special care when installing these joints in order to prevent electrical conductivity across the joint.
3. After the insulated joint is completed, an electrical resistance test shall be performed by the CONTRACTOR.
4. If the resistance test indicates a short circuit, the CONTRACTOR shall remove the insulating units to inspect for damage, replace all damaged portions, and reassemble the insulating joint.
5. The insulated joint shall then be retested to assure proper insulation.

E. **Flexible Coupled Joints**

1. When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings, and gaskets are clean and free of dirt and foreign matter, with special attention given to the contact surfaces of the pipe, gaskets, and couplings.
2. The couplings shall be assembled and installed in conformance with the recommendations and instructions of the coupling manufacturer.

F. **Bolting**

1. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer.
2. Coupling bolts shall be tightened in such a manner as to secure a uniform annular space between the follower rings and the body of the pipe.
3. Bolts shall be tightened approximately the same amount.
4. Diametrically opposite bolts shall be tightened progressively and evenly.
5. Final tightening shall be performed with a suitable and calibrated torque wrench set for the torque recommended by the coupling manufacturer.
6. Clamping torque shall be applied to the nut only.

3.7 CORROSION CONTROL

A. **Joint Bonding/Electrolysis Test Stations**

1. Except where otherwise indicated, joints shall be bonded for any pipe joints that are non-welded joints.
2. The pipe shall be cleaned to bare bright metal at the point where the bond is to be installed.
3. Electrolysis test stations shall be installed where indicated on Drawings.

B. Cathodic Protection: Corrosion mitigation and testing materials, such as an impressed current cathodic protection system, magnesium anodes, reference electrodes, and test lead wires shall be provided where indicated.

- END OF SECTION -

SECTION 33 11 12 – API STEEL PIPELINES

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR has the option to provide API steel pipe as an alternate pipe material to ASTM A53 for the temporary pipeline, also discussed in Section 40 23 15 – Steel Pipe (ASTM A53).

B. CONTRACTOR shall provide field-welded pipe joints as specified. All welding shall comply with 49 CFR 192 Subpart E and Washington Administrative Code WAC 480-93.

C. CONTRACTOR shall perform hydrostatic testing of each of the installed pipelines. At CONTRACTOR'S option, hydrostatic testing may be performed on the entire installed length, or on smaller, discrete segments. Each pipe segment and each welded joint shall be subject to at least one hydrostatic test.

D. CONTRACTOR shall assist with commissioning of the pipelines, as specified herein.

E. The requirements of Section 40 23 00 – Piping General apply to the Work of this Section.

1.2 REFERENCES

A. The publications listed below form a part of this Section to the extent referenced. Publications are referenced by the basic designation only.

B. AMERICAN PETROLEUM INSTITUTE (API)

1. API 5L– Specification for Line Pipe
2. API 6D – Specification for Pipeline Valves
3. API 1104 – Welding of Pipelines and Related Facilities

C. ASTM INTERNATIONAL (ASTM)

1. ASTM A193 – Standard specification for alloy steel or stainless steel bolts.
2. ASTM A194 – Standard specification for alloy steel or stainless steel nuts
3. ASTM A449 – Standard specification for heat-treated steel bolts and studs.

D. ASME INTERNATIONAL (ASME)

1. ASME B16.5 – Pipe Flanges and Flanged Fittings, NPS ½ through 24 inch
2. ASME B31.8 – Gas Transmission and Distribution Piping Systems
3. ASME B16.9 – Standard for Factory-Made Wrought Steel Butt-welding Fittings

4. ASME B16.11 – Forged Fittings, Socket Welded and Threaded

5. ASME B16.49 – Butt-Welded Induction Bends $^{\text{ADDENDUM 3}}$

E. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

1. 49 CFR 192 – Title 49 of Code of Federal Regulations, Part 192 – Minimum Federal Safety Standard for Natural Gas Pipelines

F. WASHINGTON ADMINISTRATIVE CODE (WAC)

1. WAC 480-93 – Gas Company Safety Rules

1.3 DESIGN CRITERIA

A. The maximum allowable operating pressure (MAOP) shall be as shown on the Design Criteria on Contract Drawing GC001. The design pressure has been determined by 49 CFR 192.

B. The pipeline operating temperature shall be as shown on the Design Criteria contract drawing.

C. The location class of pipelines shall be as shown on the Design Criteria contract drawing.

D. The pipelines shall be capable of being pigged with inline inspection (ILI) tools or “smart pigs” as well as being pigged for cleaning.

1.4 SUBMITTALS

A. Submit the following, in accordance with Section 01 33 00 – Contractor Submittals.

1. Line layout diagrams that indicate the specific number and length of each pipe segment, the location of each pipe, the direction of each fitting or bend in the completed pipeline, and the following:

    a. The pipe station and elevation at every change in grade or horizontal alignment.

    b. Elements of curves and bends, both in horizontal and vertical alignment.

    c. Weld map drawing showing field welds, indicated by welding symbols per AWS D2.4. The weld map shall assign each weld a unique identifier that correlates the weld with the testing company’s report, which shall also use the same unique identifier for each weld. Weld maps shall include: the weld location in reference to a common location, welder(s), procedure used, results of radiographic inspection, and details of any weld repairs made or cut out.

2. Mill test reports (MTRs) for pipe and pipe flanges, showing steel grade, mechanical properties, and chemical composition. Provide mill certificates from each heat of steel to be used.

3. Detailed dimensioned drawings of flanges, elbows, and other fittings.

4. Gasket product data.

5. Pipe manufacturer's and CONTRACTOR'S weld procedure specifications (WPS), weld procedure qualification reports (PQRs), and welder performance qualification report (WPQR). Submit joint design, transition designs, and all documents required by WAC 480-93-080.

6. CONTRACTOR'S weld inspection and non-destructive testing (NDT) procedures.

7. Pipe manufacturer's and CONTRACTOR'S hydrostatic test reports

8. Weld procedure specification (WPS), WPS qualification report, welder performance qualification report, field weld inspection reports, weld Inspector qualifications.

9. Weld NDT reports. Also submit X-ray films of weld radiography to OWNER.

1.5 QUALITY ASSURANCE

A. Welding

1. Welding, weld procedures, and welders performing welds shall conform to the requirements of API 1104 and 49 CFR 192. Joint design bevel angle, preheating, stress relieving shall be accordance with those codes. Requirements shall conform to piping systems operating with a hoop stress of 25% or more of the specified minimum yield strength.

2. Additionally, weld procedures and welder qualifications shall conform to WAC 480-93-080.

3. Welders shall have been qualified by an independent, ENGINEER-approved testing agency not more than 6 months prior to commencing Work on the pipeline, in accordance with 49 CFR 192

4. Welding equipment and electrodes similar to those used in the Work shall be used in the qualification tests.

5. Welding shall be in accordance with approved WPSs. Welding shall be performed by qualified welders. CONTRACTOR (for field welds) shall submit WPSs, PQRs, and WPQRs for review and approval.

6. Shielded metal-arc welding shall be used for all manual welding. Gas metal-arc and submerged metal-arc welding may be used with approval from ENGINEER prior to weld installations. Welding Backer plates / alignment rings shall not be used.

B. X-Ray Weld Inspection

1. 100% of butt welds shall be visually and radiographically tested. Submit X-ray films to the OWNER. OWNER intends to keep the X-ray films indefinitely after completion of the Contract.

2. CONTRACTOR shall furnish an independent Weld Inspector to be present whenever field welding is being performed. Weld Inspector qualifications shall be reviewed and approved by the ENGINEER. CONTRACTOR'S Weld Inspector shall submit qualifications of its testing personnel for ENGINEER review and approval. Contractor shall pay all costs of providing the independent Weld Inspector.

3. Weld Inspector shall oversee weld procedure qualification and welder performance qualification and assure that both are in full compliance with the requirements of this specification. Weld inspector shall certify compliance with the requirements of the specification.

4. Inspection of field welds shall be in conformance with 49 CFR 192 and API 1104. Acceptance criteria shall be as specified in 49 CFR 192 and API 1104.

C. Weld Repair

1. Each weld that is unacceptable under 49 CFR 192 shall be removed or repaired. Cracks shall be removed, not repaired. Arc burn shall be removed, not simply repaired.

2. Each weld to be repaired shall have the defect removed down to sound metal and the segment to be repaired shall be preheated if conditions exist that would adversely affect the quality of the weld repair. After repair, the repaired weld must be inspected to ensure its acceptability.

3. Weld repair shall be in accordance with written weld repair procedures that have been qualified under 49 CFR 192. Repair procedures shall provide a repaired weld with the same minimum mechanical properties as those specified by the original weld procedure.

D. Safety Standards

1. Comply with the safety standards specified in 49 CFR 192 and WAC 480-93.

PART 2 -- PRODUCTS

2.1 PIPE MATERIAL AND CONSTRUCTION

A. The delivery line and return line pipe shall be API 5L steel pipe, Product Specification Level (PSL) 2, Grade X52. Size shall be as shown on the Drawings. Thickness shall be Schedule 10:

1. 24-inch Schedule 10 shall have 0.250-inch wall.

2. Longitudinal joints shall be electric resistance welded (ERW) or the pipe shall be seamless.

B. CONTRACTOR may select the PSL 2 seamless pipe to replace the PSL 2 ERW pipe specified, at the OWNER's option.

C. Pipe ends shall be furnished with single-bevels from the factory for field welding. Submit certificates of conformance demonstrating that the pipe conforms with API specification 5L.

D. Submit mill test reports (MTRs)

2.2 PIPE JOINTS

A. Pipe joints shall be field-welded in accordance with Part 3 of this Section. As such, ends of shop-fabricated pipe segments shall be beveled for welding.

B. Flanged joints shall be used where indicated on the Drawings. Flanged joints shall be in accordance with Section 40 23 00 – Piping General.

2.3 PIPE FITTINGS

A. Bends in piggable segments of the pipeline shall be induction bends in accordance with ASME B16.49. Minimum bend radius of piggable segments shall be 3.0 times the nominal diameter. Bends to be cut in the field shall be segmentable, meaning they shall meet diameter and ovality tolerances throughout the elbow, not just at the ends.

B. Bends in non-piggable segments of the pipeline may be either induction bends per ASME B16.49, or forged steel elbows in accordance with ASME B16.9. Minimum bend radius of non-piggable segments shall be 1.5 times the nominal diameter.

C. Tees shall be in accordance with ASME B16.9.

2.4 SHOP HYDROSTATIC TESTS

A. Pipe shall be hydrostatically tested in the shop in accordance with API 5L.

2.5 IDENTIFICATION LABELS FOR ABOVE-GROUND PIPING

A. CONTRACTOR shall provide printed labels to identify content of pipe and arrows to show direction of flow. Labels shall be made of plastic sheet and mounted to the piping with pressure-sensitive adhesive. Labels shall be in accordance with the requirements of 49 CFR 192.707.

2.6 LINING AND COATING SYSTEMS

A. Pipelines shall not be internally lined or coated.

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. **Delivery, Storage, and Handling**

1. Plug or cap pipe ends during transportation and storage to minimize dirt and moisture entry. Pipe shall not be subject to abrasion or concentrated external loads. Dented pipe segments shall be discarded and not used.

2. Pipe shall be handled by wide slings, padded cradles, or other devices designed to prevent damage to the pipe. Chains, hooks, or other equipment that might injure the pipe will not be permitted.

3. Pipe shall be supported on padded skids, sandbags, or other suitable supports so that the pipe will not be damaged. Pipe shall not be rolled and shall be secured to prevent accidental rolling.

4. CONTRACTOR shall repair or replace damaged pipe segments.

B. **General**: Install pipeline in accordance with 49 CFR 192 and WAC 480-93. For buried pipe, depth of cover below grade shall be no less than 18 inches.

C. **Excavating and Backfilling**:

1. Perform excavating and backfilling of pipe trench in accordance with Contract Drawings and Section 31 00 00 – Earthwork.

D. **Cleaning**: Before placement of pipe in the trench, pipe shall be thoroughly cleaned of any foreign substances in or on the pipe. As pipe laying progresses, CONTRACTOR shall keep the pipe interior free of debris. Pipe openings in the trench shall be closed during any interruption to the Work.

E. **Pipe Laying:**

1. Cut pipe to actual dimensions and assemble to prevent residual stresses.

2. Piping cold-bent in the field shall be bent to a minimum radius of 18D, where “D” is the nominal pipe diameter. The pipe shall be bent no more than 2 degrees in any individual bending action (“bite”) and multiple bites shall be at least 3 inches apart. The pipe shall not wrinkle or kink when bent.

F. **Test Section:**

1. At the beginning of pipe laying operations, CONTRACTOR shall install a test section to demonstrate that his/her proposed methods and materials will satisfy the pipe zone backfill compaction and pipe deflection criteria.

2. The maximum length of test section shall be 500 feet. The ENGINEER will observe construction of the test section.

3. CONTRACTOR shall not proceed with production pipe laying beyond the test section without ENGINEER’S approval.

G. **Field Welding:**

1. Submit welders’ qualifications. Submit WPSs, PQRs, and WPQRs

2. Each welding procedure shall be recorded in detail, including the results of the qualifying tests. This record must be retained and followed whenever the procedure is used.

3. Prior to beginning the welding procedure, any tack welds used to position the pipe during laying shall be removed.

4. Prior to butt welding, the pipes shall be properly positioned so that the abutting pipe sections in the finished joint shall meet the alignment requirements of API 1104.

5. Field welds shall be tested in accordance with Part 3.5 of this Section.

3.2 INSPECTION AND FIELD TESTING

A. **Field Weld Inspection**

1. Field butt welds shall be inspected by the CONTRACTOR's weld inspector using an ENGINEER-approved visual and radiographic non-destructive testing procedure.

2. Repair and removal of any defects shall be as authorized by the ENGINEER. Arc burn shall be removed, not simply repaired. Cracks shall be ground out and re-welded.

3. Submit weld inspectors' qualifications. Submit weld NDT reports.

B. **Field Hydro Testing:** Pipe shall be leak tested and hydrostatically tested in accordance with Section 01 74 00 – Pressure Pipeline Testing

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SECTION 40 23 00 - PIPING, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide the piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all piping sections in Divisions 33 and 40.

C. **Pipe Fabrication Drawings**. The Contract Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The contract drawings are **not** pipe construction or fabrication drawings. The CONTRACTOR shall provide detailed pipe fabrication and pipe laying submittals in accordance with the requirements of the individual pipe material specification sections.

D. **Pipe Supports and Spacing**. Where pipe supports and spacing are indicated on the Drawings and are referenced to a standard detail, the CONTRACTOR shall use that detail. Where pipe supports are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to develop the details necessary to design and construct piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall contain information as required in the individual pipe material specification section as well as the following information:

1. Layout and Fabrication Drawings: Layout drawings including necessary details, dimensions, and material lists for pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, and guides. Fabrication drawings shall indicate spacers, pipe adapters and couplings, connectors, fittings, and location of pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Modular Seals for Pipe Penetrations: Manufacturer's information sheets showing materials and installation procedures.

3. Where applicable, all pipe coupling systems, including standard sleeve couplings, flange coupling adaptors, welded-ring restrained couplings, and /or grooved joint products shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Manufacturer’s style or series number.

C. **Samples:** The CONTRACTOR shall provide and pay for any pipe material sampling and product testing as necessary and as required in the individual pipe material specifications.

D. **Certifications**

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that each pipe length will be manufactured subject to the fabricator's or a recognized Quality Control Program. An outline of the Quality Control Program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Extent of Work:** Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

B. **Pipe Supports:** Pipes shall be adequately supported, restrained, and anchored in accordance with Section 40 23 02 - Pipe Supports, and as indicated on the Contract Drawings.

C. **Interior Linings:** Application, thickness, and curing of pipe interior linings shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated.

D. **Exterior Coatings:** Application, thickness, and curing of exterior coatings on buried pipe shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated. For pipes above ground or in structures, exterior coatings of such pipe shall be in accordance with the applicable Sections of Division 33 and those coating systems as identified in Section 09 96 00 - Protective Coatings.

E. **Pressure Rating:** Piping systems shall be designed for the maximum expected pressure as defined in Section 01 74 30 - Pressure Pipe Testing and Disinfection, or as indicated on the Contract Drawing, Piping Schedule, whichever is greater.

F. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. During the manufacture, the OWNER and ENGINEER shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

G. **Tests:** Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. The CONTRACTOR shall be responsible for performing material tests.

H. **Welding Requirements:** Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of AWS D1.1 - Structural Welding Code. Welding procedures shall be submitted for the ENGINEER's review.

I. **Welder Qualifications:** Welding shall be done by skilled welders and welding operators who have adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, by an independent local, approved testing agency not more than 6 months prior to commencing WORK on the piping. Machines and electrodes similar to those used in the WORK shall be used in qualification tests. Qualification testing of welders and materials used during testing is part of the WORK.

2.2 PIPE FLANGES

A. **General:** Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated. Attachment of the flanges to the pipe shall conform to the applicable requirements of AWWA C207. Flange faces shall be perpendicular to the axis of the adjoining pipe. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for these pipes.

B. **Pressure Ratings**

1. 150 psi or less: Flanges shall conform to either AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ASME B16.5 - Pipe Flanges and Flanged Fittings, 150 lb class.

2. 150 psi to 275 psi: Flanges shall conform to either AWWA C207 Class E or Class F, or ASME B16.5 150 lb class.

3. 275 psi to 700 psi: Flanges shall conform to ASME B16.5, 300 lb class.

4. Selection based on test pressure: AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected.

C. **Blind Flanges:** Blind flanges shall be in accordance with AWWA C207, or as indicated for miscellaneous small pipes. Blind flanges for pipe sizes 10-inches and greater shall be provided with lifting eyes in the form of welded or screwed eye bolts.

D. **Flange Coating:** Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. **Flange Bolts:** Bolts and nuts shall conform to Section 05 50 00 - Miscellaneous Metalwork, unless noted otherwise on the Contract Drawings. All-thread studs may be used on valve flange connections where space restrictions preclude the use of regular bolts.

F. **Insulating Flange Sets:** Insulating flange sets shall be provided where indicated. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1.5 inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1.5 inches, insulating sleeves and washers shall be 2 piece and shall be made of polyethylene or phenolic material.

1. Steel washers shall be in accordance with ASTM A 325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

2. Insulating gaskets shall be full-face.

3. Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter.

4. Insulating flange sets shall be as manufactured by **JM Red Devil, Type E**, **Maloney Pipeline Products Co**, **PSI Products, Inc.,** or equal

G. **Flange Gaskets**

1. Gaskets for flanged joints used in general water and wastewater service shall be full-faced type, with material and thickness in accordance with AWWA C207, suitable for temperatures to 700 deg F, a pH of one to 11, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted unless otherwise indicated. Flange gaskets shall be as manufactured by **John Crane, Style 2160, Garlock, Style 3000,** or equal**.**

2. Gaskets for flanged joints used in chemicals, air, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature.

3. Gaskets for flanged joints used in water with chloramines shall be **Gylon, Style 3500** as manufactured by **Garlock,** by **Crane**, or equal.

2.3 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. **General:** Cast mechanical-type couplings shall be provided where indicated. The couplings shall conform to the requirements of AWWA C606 - Grooved and Shouldered Joints. Bolts and nuts shall conform to the requirements of Section 05 50 00. Gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of grooved piping shall conform to the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid excessive load on equipment caused by pipe movement due to steady state or transient pressure conditions, equipment connections with mechanical-type couplings shall have rigid grooved couplings or flexible type coupling with harness in sizes where rigid type couplings are not available, unless thrust restraint is provided by other means. Mechanical type couplings shall be bonded. The CONTRACTOR shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, grooved fittings, couplings, and valves shall be furnished by the same manufacturer as the coupling. Grooving tools shall be from the same manufacturer as the grooved components.

B. **Manufacturers of couplings for steel pipe**, or equal

1. Victaulic Style 41 or 44 (banded, flexible)

2. Victaulic Style 177N (grooved, flexible, for sizes 2 to 8 inch)

3. Victaulic Style 77 (grooved, flexible, for sizes 10 to 12 inch)

4. Victaulic Style AGS W77 (grooved, flexible, for sizes 14 to 72 inch)

5. Victaulic Style 107N or HP-70 (AGS grooved, rigid, for sizes 2 to 12 inch)

6. Victaulic Style AGS W07 (AGS grooved, rigid, for sizes 14 to 48 inch)

2.4 SLEEVE-TYPE COUPLINGS

A. **General:** Sleeve-type couplings shall be provided where indicated. The CONTRACTOR will not be allowed to substitute a sleeve-split coupling, or any other type in lieu of sleeve coupling unless approved by the ENGINEER.

B. **Construction:** Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe. Couplings shall be steel with steel bolts, without pipe stop. Couplings shall be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The coupling shall be either 5- or 7-inches long for sizes up to and including 30-inches and 10-inches long for sizes greater than 30-inches, for standard steel couplings, and 16-inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05500. Buried sleeve-type couplings shall be epoxy-coated at the factory as indicated.

C. **Pipe Preparation:** Where indicated, the ends of the pipe shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12-inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

D. **Gaskets**

1. Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:

    a. Color: Black

    b. Surface: Non-blooming

    c. Durometer Hardness: 75 ± 5

    d. Tensile Strength: 1,000 psi minimum

e. Elongation: 175 percent minimum

2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. Gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. Where sleeve couplings are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.

3. Gasket materials used in water with chloramines shall be **Gylon Style 3500** by **Garlock** or by **Crane,** or equal.

E. **Piping Connection to Equipment:** Where piping connects to mechanical equipment such as pumps, compressors, and blowers, the piping shall be brought to the equipment connection aligned and perpendicular to the axis of the flange or fitting for which the piping is to be connected. The piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment. The CONTRACTOR shall assign the responsibility to the equipment manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.

F. **Insulating Sleeve Couplings:** Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

G. **Restrained Joints:** Sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation to prevent misalignment of the pump imparted by the thrust within the piping system.

H. **Manufacturers,** or equal

1. Dresser, Style 38

2. Ford Meter Box Co., Inc., Style FC1 or FC3

3. Smith-Blair, Style 411

2.5 SLEEVE SPLIT-TYPE COUPLINGS (**Victaulic Depend-O-Lok,** or equal)

A. **General:** Where indicated sleeve-split type couplings shall be furnished.

B. **Construction:** Couplings shall be split-type, consisting of one or 2 piece housing, gasket assembly, bolts and nuts, and end rings. The double arch cross section that closes around the pipe ends shall be smooth to allow for expansion or contraction requirements. The pipe ends with steel end rings affixed shall provide restraint requirements. As the coupling closes, it shall confine the elastomeric gasket beneath the arches of the sleeve to create a radial seal. The axial seal shall squeeze the closure plates as the bolts pull the coupling snug around the pipe. The coupling shall permit angular pipe deflection, flexibility, contraction and expansion as designed by the manufacturer. The coupling housing shall be designed for internal pressure and external loads as determined by the design procedures of AWWA M-11. The coupling shell thickness of the steel coupling shall be calculated using the formula:

$$T=PwDy/2Fs$$

where:

T = steel coupling thickness, inches

Dy = pipe outside diameter, inches

Pw = Design working pressure, psi

Fs = 50 percent of minimum yield point of steel, psi

1. Coupling design calculations shall be stamped and signed by a registered engineer and shall be included in the Shop Drawing submittal for couplings.

2. The sealing members shall comprise of two “O”-ring gaskets and an elastomer sealing pad bonded to sealing plate. Internal pressure shall not be required to make the seal.

C. **Materials**

1. Unless otherwise indicated, coupling housing material shall be the same material as the piping. Carbon steel couplings shall be fabricated from ASTM A 36. Stainless steel couplings shall be fabricated from ASTM A 240, T-304, 304L, 316, or 316L.

2. Carbon steel end rings shall conform to ASTM A 108 Grade 1018. Stainless steel end rings shall conform to ASTM A 276 T-316L.

3. Bolts and nuts shall be in conformance with Section 05 50 00.

4. Gaskets shall be EPDM conforming to ASTM D 2000 for air service up to 240 degrees F. Gaskets for general water or sewerage service within the temperature range of –20 to 180 degrees F shall be isoprene or EPDM conforming to ASTM D 2000.

5. Carbon steel couplings shall be fusion bond epoxy coated inside and outside of the coupling in accordance with Section 09 96 00. Couplings installed underground shall be provided with **Depend-O-Wrap** tape or equal. Application of wrapping material shall be in conformance with AWWA C209.

D. **Pipe Preparation**

1. Ends of pipes shall be prepared for the flexible split sleeve type couplings inspected and approved by the coupling manufacturer. The pipe outside diameter and roundness tolerances shall comply with tolerances listed in AWWA C219.

2. Plain ends for use with couplings shall be smooth and round for a distance of 12-inches from end of the pipe.

3. End rings shall be furnished with couplings when restraint is required. Carbon steel end rings shall be ASTM A 108 Grade 1018. Stainless steel end rings shall conform to ASTM A 276 T-316L.

4. Where the split-type coupling is used to take up thermal expansion or contraction (**Depend-O-Lok Style 230**) at the pipe joint, one end ring shall be fixed to one end of the pipe to keep the coupling in the proper location.

5. Where the split-type coupling is used for a fully restrained pipe joint (**Depend-O-Lok Style 232**) at the pipe joint, one end ring shall be welded to each of the pipe ends to fit beneath the coupling and shall be protected by the coating. Welding design and specification shall be in conformance with the coupling manufacturer's recommendation.

E. **Manufacturer,** or equal

   1. Victaulic, Depend-O-Lok

2.6 FLANGE COUPLING ADAPTERS

A. Flange coupling adapters shall be provided where indicated. The CONTRACTOR will not be allowed to substitute any other type in lieu of flange coupling adapter unless approved by the ENGINEER. The coupling shall be rated as indicated.

B. **Construction**: Flange coupling adapter body shall be fabricated from steel ASTM A 512 - Cold-Drawn Buttweld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing with steel bolts, without pipe stop. Flange shall be in accordance with AWWA C207. Couplings shall be of sizes to fit the pipe and fittings indicated. The body shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Flange coupling adapters installed in piping system rated for positive pressure, the coupling shall be restrained with harness bolts or tie rods. Other means of restraining the coupling such as set screws will not be acceptable. Bolts and nuts shall conform to the requirements of Section 05 50 00. Buried couplings shall be epoxy-coated at the factory as indicated.

C. **Gaskets**: Gaskets for flange coupling adapters shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60 NSF approved, or equivalent suitable elastomer.

   1. The rubber in the gasket shall meet the following specifications:

      a. Color - Jet Black

      b. Surface - Non-blooming

c. Durometer Hardness - 74 ± 5

d. Tensile Strength - 1,000 psi Minimum

e. Elongation - 175 percent Minimum

2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. Gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. Where flange coupling adapters are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.

3. Gasket materials used in water with chloramines shall be **Gylon Style 3500** by **Garlock** or by **Crane,** or equal.

D. **Piping Connection to Equipment:** Where piping connects to mechanical equipment such as pumps, compressors, and blowers, the piping shall be brought to the equipment connection aligned and perpendicular to the axis of the flange or fitting for which the piping is to be connected. The piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment. The CONTRACTOR shall assign the responsibility to the equipment manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.

E. **Restrained Joints:** Flange coupling adapters on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation to prevent misalignment of the pump imparted by the thrust within the piping system.

F. **Manufacturers,** or equal

1. Smith-Blair, Model 975

2. JCM, Model 309

2.7 EXPANSION JOINTS

A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be flanged end, stainless steel, Monel, rubber, or other materials best suited for each individual service. The CONTRACTOR shall submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature, and pressure ratings.

2.8 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 deg F, and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

1. Links shall be assembled with type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

2. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

3. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

4. Modular mechanical seals for pipe penetrations shall be **Link Seal** by **Thunderline Corporation,** or equal

PART 3 -- EXECUTION

3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. Defective or damaged materials shall be replaced with new materials.

3.2 GENERAL

A. Piping, fittings, and appurtenances shall be installed in accordance with the requirements of applicable Sections of Division 33 and Division 40. Proprietary manufactured couplings shall be installed in accordance with the coupling manufacturer's recommendation.

B. Care shall be taken to insure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Each gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

3. Bolts shall be initially hand-tightened with the piping connections properly aligned. Bolts shall be tightened with a torque wrench in a staggered sequence to the AISC recommended torque for the bolt material.

4. After installation, joints shall meet the indicated leakage rate. Flanges shall not be deformed nor cracked.

C. **Lined Piping Systems:** The lining manufacturer shall take full responsibility for the complete, final product and its application. Pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.

D. **Protective Coatings for Buried Couplings (rigid and flexible).** Where pipe couplings are buried, all such couplings shall be given a liquid epoxy coating in the factory (unless otherwise specified) and shall be protected in the ground with a field applied use of a cross-linked polyolefin backed, heat-shrinked protective wrapping (*Canusa Aqua-Shield* or equal).

E. **Core Drilling:** Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and reinforcing bars.

F. **Cleanup:** After completion of the WORK, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be handed over in a clean and functional condition.

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SECTION 40 23 01 - PIPING IDENTIFICATION

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide identification for exposed piping and valves, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI A13.1	Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. **Shop Drawings**: A list of suggested wording for each valve tag, prior to fabrication.

C. Samples

1. One sample of each type of identification device.

2. Sample of each proposed color required by the pipe color schedule.

PART 2 -- PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Except as indicated below for very short pipe lengths, identify exposed piping larger than 2-inches nominal size for the pipe contents and direction of flow.

1. Marker Type

    a. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

2. Marker Area: Sized per pipe size according to ANSI A13.1; color from the table below.

3. Lettering: Sized per pipe size according to ANSI A13.1; color from the table below.

4. Arrows: at least 2 arrows at each marker area, showing direction of flow.

B. Pipe identification shall be as manufactured by **Brady, Seton,** or equal.

2.2 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the CONTRACTOR shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the indicated system.

2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Identifying devices for valves and the sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

C. Wording on the valve tags shall describe the exact function of each valve.

PART 3 -- EXECUTION

3.1 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.2 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.3 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.
2. Within 2-feet of turns, elbows, and valves.
3. On the upstream side of tees, branches, and other distribution points.

3.4 IDENTIFICATION COLORS

A. Conform to the following color codes.

Color Schedule

Pipe Contents		Pipe Color	Marker Color	Letter Color
Abbreviation	**Identification**			
RW	Raw water		green	white

- END OF SECTION -

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SECTION 40 23 15 - STEEL PIPE (ASTM A53 / A106, MODIFIED)

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide A53 steel pipe and appurtenances for the temporary pipeline, complete and in place, in accordance with the Contract Documents.

B. The CONTRACTOR may provide API Steel Pipe as an alternate pipe material to ASTM A53 for the temporary pipeline per Section 33 11 12.

C. The requirements of Section 40 23 00 - Piping, General apply to the WORK of this Section.

D. **Pipe Material Group No. 6**. The piping system defined in this section is referred to in the Pipe Schedule on Contract Sheet G007 as Piping Material Group No. 6.

PART 2 -- PRODUCTS

2.1 PIPE MATERIAL

A. **Temporary Water Service:** Unless otherwise indicated, black steel pipe shall conform to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A 106 - Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 10, as indicated in the Piping Schedule.

2.2 PIPE JOINTS

A. Black steel pipe for general service shall have welded joints, or flanged joints. Where indicated, black steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

B. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

2.3 FITTINGS

A. **Common Use:** The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:

1. Butt welding fittings conforming to ASME B 16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 10, as indicated.

2. Flanged cast iron fittings conforming to ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.

3. Flanged steel fittings conforming to ASME B 16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

B. Special Applications

1. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions. Unions shall be rated for 500 lb. CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment. Unions shall be as manufactured by **Henry Valve Company, Vogt Valve Co.,** or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** Pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be free from defects.

B. **Supports and Anchors:** Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 23 02 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. **Valves and Unions:** Water piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Fittings shall be equally cleaned before assemblage.

3.3 PIPE JOINTS

A. **Welded Joints:** Welded joints shall conform to the specifications and recommendations of ASME B 31.1 - Power Piping. Welding shall be done by skilled and qualified welders per Section 40 23 00 - Piping, General.

3.4 INSPECTION AND FIELD TESTING

A. **Inspection:** Finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damage shall be repaired.

B. **Field Testing:** Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than one hour without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices as part of the WORK. For additional testing requirements, refer to Section 01 74 30 - Pressure Pipe Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

- END OF SECTION -

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SECTION 43 25 00 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

C. Where a valve is to be supported by means other than the piping to which it is attached, the CONTRACTOR shall obtain from the valve manufacturer a design for support and foundation. The design, including drawings and calculations sealed by an engineer, shall be submitted with the Shop Drawings. When the design is approved, the support shall be provided.

D. **Unit Responsibility:** A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.

E. **Single Manufacturer:** Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. **Shop Drawings:** Shop Drawings shall contain the following information:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.

2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.

3. Cavitation limits for control valves.

4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Valve Labeling: A schedule of valves to be provided with stainless steel tags, indicating in each case the valve location and the proposed wording for the tag.

C. **Technical Manual:** The Technical Manual shall contain the required information for each valve.

D. **Spare Parts List:** A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. **Factory Test Data:** Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 -- PRODUCTS

2.1 PRODUCTS

A. **General:** Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.

B. **Protective Coating:** The exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated with Fusion Bonded Epoxy (FBE). The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

C. **Valve Labeling:** Except when such requirement is waived by the ENGINEER in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 40 23 01 - Piping Identification, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.

D. **Valve Testing:** As a minimum, unless otherwise indicated or recommended by the reference standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. **Hydrostatic Testing:** Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valve rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.

2. **Seat Testing:** Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage.

Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves. Resilient-seated valves shall be drop-tight.

3. **Performance Testing:** Valves shall be shop-operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.

E. **Certification:** Prior to shipment, the CONTRACTOR shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

F. **Valve Marking:** Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. **General:** Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:

1. **Cast Iron:** Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. **Ductile Iron:** ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

3. **Steel:** ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.

4. **Bronze:** ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

5. **Stainless Steel:** Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.

6. **PVC:** Poly vinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.

7. **CPVC:** Chlorinated poly vinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.

8. **NSF Standard 14:** Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

A. **Bodies:** Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

B. **Valve End Connections:** Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.

C. **Bonnets:** Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

D. **Stems:** Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Where subject to dezincification, bronze valve stems shall conform to ASTM B 62, containing not more than 5 percent of zinc or more than 2 percent of aluminum, with a minimum tensile strength of 30,000 psi, a minimum yield strength of 14,000 psi, and an elongation of at least 10 percent in 2 inches. Where dezincification is not a problem, bronze conforming to ASTM B 584 may be used, except that zinc content shall not exceed 16 percent.

E. **Stem Guides:** Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.

F. **Internal Parts:** Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

G. **Nuts and Bolts:** Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 - Miscellaneous Metalwork.

2.4 VALVE ACCESSORIES

A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. The CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the OWNER, after expiration of the correction of defects period.

2.6 MANUFACTURERS

A. **Manufacturer's Qualifications:** Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION

A. **General:** Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. **Access:** Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are indicated, the CONTRACTOR shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

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SECTION 43 25 02 - BUTTERFLY VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 25 00 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.

2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.

3. Dynamic seating and unseating torque for motor actuated valves.

4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.

5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 -- PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES, 300 PSI SERVICE (AWWA)

A. **General:** Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 300 psi and for freshwater service having a pH range from 6 to 10 and temperature range from 33 to 125 degrees F shall conform to AWWA C504. Valves shall be designed and manufactured in accordance with the intent of AWWA C504 except valves shall be suitable for 300 psi service and as indicated herein.

B. Valves shall be of the body type, pressure class, end joint, and actuator indicated.

C. One prototype for each size of valve to be provided shall be subjected to proof-of-design tests in accordance with the procedures established by AWWA C504. Results of proof-of-design tests and certification by a company officer shall be submitted to the ENGINEER with the Shop Drawings.

D. **Construction:** Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. The seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Designation	Materials Standards
Valve Bodies	Ductile Iron, ASTM A536 Gr. 65-45-12
End flanges	Same material as valve bodies. Flanged connections shall have flange drilling in accordance with ASNI B16.42 for Class 300 iron flanges or AWWA C207 Class F.
Valve shafts	Stainless steel, ASTM A564 17-4 PH Stainless Steel
Valve discs	Same material as valve bodies.
Rubber seats	Resilient sheets shall be reinforced Buna-N
Seat mating surfaces	Stainless steel, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Thrust bearings shall be factory-set bronze thrust bearing. Shaft and sleeve bearings shall be self-lubricated Teflon-lined, fiberglass-backed bearings.
Shaft seals	Shaft seals shall be of the V-type secured with a bolted gland plate to allow actuator servicing.
Painting and coating	Coated internally and externally with fusion bonded epoxy.

E. **Manual Actuators:** Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches in diameter and larger.

F. **Worm Gear Actuators**: Valves 30-inches and larger, as well as submerged and buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

G. **Manufacturers, or Equal**

1. VALMATIC BFV 2700HP

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 43 25 00 – Valves, General.

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SECTION 43 25 42 – MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 25 00 – Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

A. **Air and Vacuum Valves:** Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 300 psi water-working pressure, unless otherwise indicated.

B. **Air-Release Valves:** Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 300 psi, unless otherwise indicated.

C. **Combination Air Valves:** Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.

D. Manufacturers, or Equal

1. **APCO (Valve and Primer Corporation)**
2. **Crispin Valves**
3. **GA Industries**
4. **Val-Matic (Valve and Manufacturing Corporation)**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 43 25 00.

B. Air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

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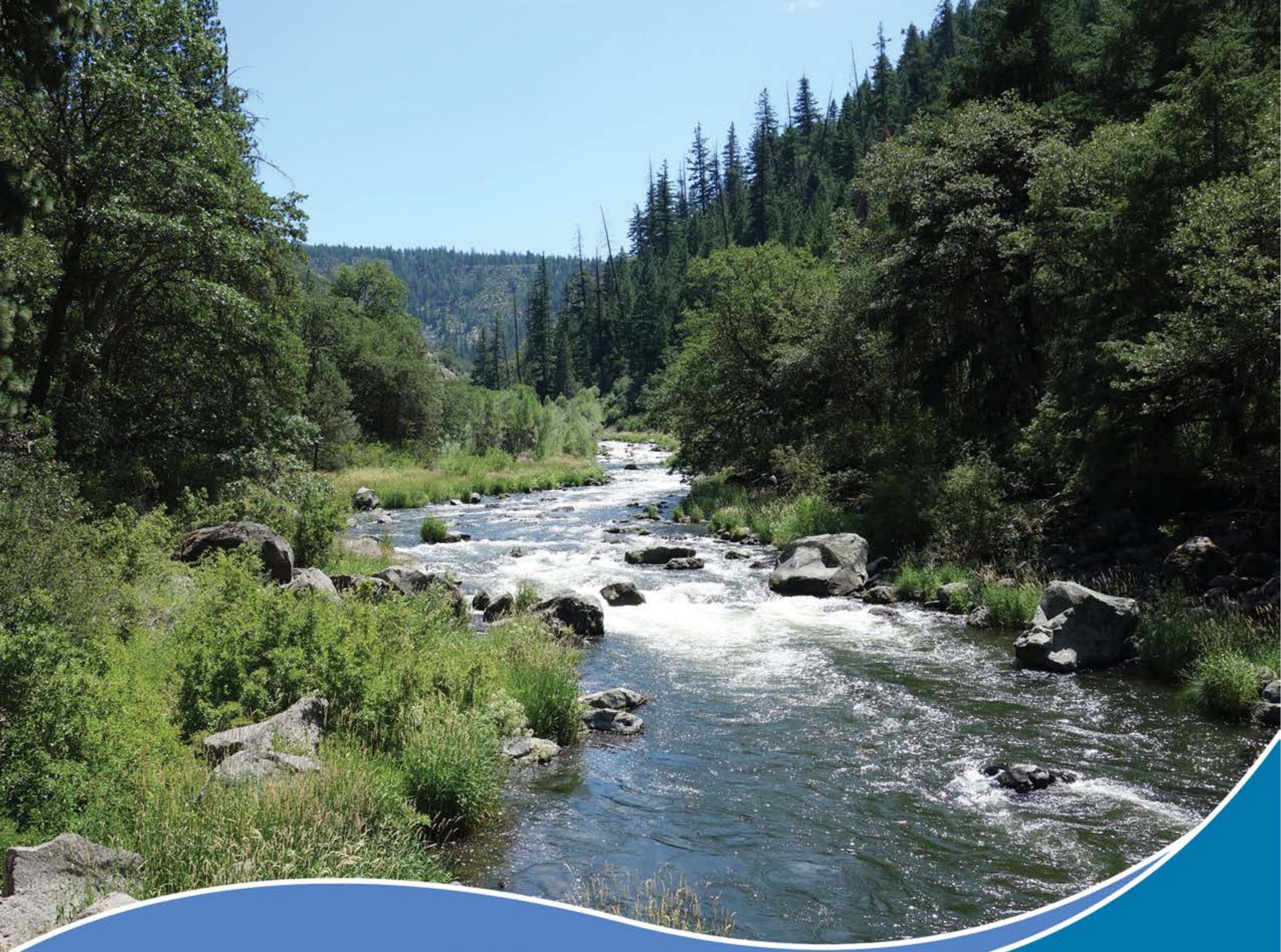

Klamath River Renewal Project

Geotechnical Data Report

KLAMATH
RIVER RENEWAL
CORPORATION

June 2019

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Acronyms and Abbreviations

GDR	Geotechnical Data Report
psi	pound(s) per square inch
SPT	Standard Penetration Test
bgs	below ground surface
KRRP	Klamath River Renewal Project
ModCal	Modified California
HDD	horizontal directional drilling

Chapter 1: Introduction

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1. INTRODUCTION

1.1 Purpose and Scope

This Geotechnical Data Report (GDR) includes the results of the field investigation conducted from February 2018 through January 2019, and associated laboratory and geophysical testing.

1.2 Report Organization

After this introductory section, the GDR is organized as follows:

- Section 2: Describes the investigations at Copco and Iron Gate Reservoirs, at Jenny Creek, Camp Creek, Lakeview, Dry Creek, Fall Creek, and Scotch Creek Bridges, and along the proposed City of Yreka replacement water line. The investigations included soil and rock borings, piezometer construction, downhole geophysical testing, and field hydraulic conductivity testing.
- Section 3: Describes the laboratory testing.
- Section 4: Discusses the limitations of the work.

The data collected during the investigations is presented in Appendices A through E.

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Chapter 2: Field Investigations

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2. FIELD INVESTIGATIONS

2.1 Subsurface Investigations

AECOM performed geotechnical investigations for the Klamath River Renewal Project between February 2018 and January 2019. The geotechnical investigations are described below. The field investigations were conducted in general conformance with the following ASTM standards:

1. Rock core drilling, ASTM D2113
2. Soil logging, ASTM D2488
3. Standard penetration test (SPT) sampling, ASTM D1586
4. Thin-walled (Shelby) tube sampling, ASTM D1587
5. Preserving and transporting of soil samples, ASTM D4220

2.1.1 Soil and Rock Borings

Forty-eight soil and/or rock core borings were drilled between February 1, 2018 and January 23, 2019. Boring locations are shown on Figure 1 Sheets 1 through 8 and summarized in Table 1 – Borings Summary Table.

The borings were drilled by Taber Drilling of West Sacramento, California, Gregg Drilling of Martinez, California, and/or Pitcher Drilling of East Palo Alto, CA. The locations of the borings were surveyed with a hand-held GPS unit with an approximate accuracy of ±15 feet. The coordinate locations for the borings are shown on the boring logs in State Plane Zone 1 coordinates.

Drilling footage totaled 2163.4 linear feet at the Copco Reservoir, Iron Gate Reservoir, City of Yreka Water line, and bridge abutment borings. The borings ranged in depth from 10.5 to 120 feet below ground surface (bgs). All but two borings were drilled vertically; two borings (B-202 and B-206) were drilled at an angle of 60° below horizontal.

The 2.5-inch HQ-3 core, 1.375-inch I.D. Standard Penetration Test (SPT), 2.5-inch I.D. Modified California (ModCal), and 2.0-inch I.D. California drive samples were photographed, labeled, bagged, or boxed (for rock cores), and stored onsite prior to transport of the samples to Tonon USA in Austin, TX, Cooper Testing Laboratory in Palo Alto, CA, or Inspection Services Inc. of Berkeley, CA. Pitcher barrel, Osterberg, and Shelby Tube samples were sealed with paraffin and carefully transported to the laboratory for testing.

City of Yreka Water Line Borings

Nine borings (B-201 to B-203, B-205 through B-208, BI-02 and BI-03) totaling 696.2 linear feet were drilled along a proposed tunnel alignment to determine subsurface geologic conditions for the replacement of the existing City of Yreka waterline by Horizontal Directional Drilling (HDD) or micro tunnel drilling. These boring locations are shown on Figure 1, Sheet 4, and the boring logs are presented in Appendix A.

The borings were drilled from February 21st to 23rd, August 14th to September 21st, 2018, and January 8th to January 11th, 2019. The boring logs and core box photographs are presented in Appendix A and Appendix E, respectively. Borings were advanced using hollow stem auger, rotary wash, and/or rock core drilling methods, and sampling methods included HQ-3 core, SPT, and a ModCal drive sampler. Blows per each 6-inches of driven sample were recorded.

Three of the borings (B-201, B-202, and B-206) were drilled by Pitcher Drilling Company of East Palo Alto, CA with a track-mounted Fraste XL drill rig. Three additional borings (B-205, B-207, and B-208) were drilled by Gregg Drilling of Martinez, CA with a truck-mounted B-53 drill rig. Three borings (BI-02, BI-03, and B-203) were drilled by Taber Drilling of West Sacramento, CA with BI-02 being drilled using a truck-mounted CME-55 and BI-03 and B-203 being drilled using a barge-mounted CME-45 drill rig.

Copco No. 1 Rim Stability

A subsurface investigation with laboratory testing was performed at Copco No. 1 reservoir to characterize and analyze the stability of the fluvio-lacustrine terrace deposits (diatomite) present around the reservoir rim and within the reservoir bed. Twenty-one hollow stem auger and rotary wash borings, described below, were completed as part of the rim stability investigation. The boring locations are shown on Figure 1, Sheets 6 through 8, and boring logs are presented in Appendix A.

Eleven rotary wash borings, BC-01 through BC-10 and BC-8a, were performed by Taber Drilling using a barge-mounted CME 45 between February 1st and 14th, 2018. The boring depths ranged from 11.5 to 96.5 feet below ground surface.

On land, along the Copco Reservoir Rim, five borings (BC-11 through BC-15) were drilled by Gregg Drilling, between October 2nd and 18th, 2018,using a truck-mounted Mobile B-53 (BC-13 through BC-15) and a track-mounted Geoprobe (BC-11 and BC-12). The borings were advanced to bedrock (10.5 to 42 feet bgs). BC-15 encountered bedrock within 1 foot of the surface; where the boring was terminated, and no boring log or laboratory test data is included as part of this GDR.

Soil samples were obtained in BC-01 to BC-15 using SPT, ModCal, and 3-inch diameter thin-walled Shelby tubes. The tubes were advanced by direct push or with a hydraulically activated piston sampler (Osterberg). Blows per each 6-inches of driven sample and hydraulic gage down pressure for undisturbed samples were recorded.

Five additional over-water borings (BC-16 through BC-20) were completed between January 13th and 14th, 2019. BC-16 through BC-20 were drilled without sampling to bedrock, with the goal of identifying the top of bedrock. Bedrock was inferred when the driller noted significantly harder drilling conditions. Bedrock was sampled with an SPT sampler at the bottom of each exploration to confirm that bedrock was encountered.

Iron Gate Rim Stability

One boring, BI-01 shown on Figure 1, Sheet 3, was completed to characterize landslide history of a feature identified in aerial photograph at Iron Gate reservoir. Two other borings, BI-02 and BI-03 shown on Figure 1, Sheet 4, provided data for the rim stability analysis of Iron Gate, and are described in the City of Yreka Water Line section above.

The one rotary wash boring was drilled on February 20th, 2018 to 22.2 feet below ground surface with a barge-mounted CME-45 by Taber Drilling. The material was sampled with a ModCal or SPT; blows per 6-inches were recorded.

Bridge Abutment Borings

Seventeen borings were planned at the abutments of bridges requiring replacement or improvement during the Klamath River Renewal Project:

- Camp Creek Bridge (four borings, BC-01, BC-02, BC-03, and BC-20), See Figure 1, Sheet 2
- Jenny Creek Bridge (four borings, BC-04, BC-05, BC-06, and BC-07), See Figure 1, Sheet 3
- Lakeview Bridge (two borings, B-08 and B-10), See Figure 1, Sheet 1
- Fall Creek Bridge (two borings, B-13 and B-14), See Figure 1, Sheet 5
- Daggett Bridge (three borings, B-15, B-16, and B-17), See Figure 1, Sheet 4
- Scotch Creek Bridge (two borings, B-18 and B-19), See Figure 1, Sheet 2

The boring locations are shown on Figure 1, Sheets 1 through 5, and boring logs are presented in Appendix A.

Fourteen of the borings were drilled by Gregg Drilling between September 25 and October 18, 2018 with a truck-mounted Mobile B-53 drill rig to depths between 21.2 and 56.9 feet below ground surface. The borings were advanced with hollow stem auger, rotary wash, and/or HQ-3 rock coring. Soil was sampled with a ModCal or SPT; blows per 6 inches of driven sample were recorded.

Three additional borings, B-15 through B-17, were drilled by Taber Drilling with a barge-mounted CME-45 drill rig and a truck-mounted CME-75 between January 12th and 23rd, 2019. The depths of these borings ranged from 24.5 to 51.5 feet below grade. The borings were advanced using solid stem auger, rotary wash, and HQ-3 rock coring. Soil was sampled with a ModCal or SPT; blows per six inches of driven sample were recorded.

2.1.2 Piezometers

Two vibrating wire piezometers (VWP) were installed in each of the inclined borings B-202 and B-206, as shown in Table 1. In B-202, the VWPs were installed at 24.2 feet and at 62.4 bgs (28 and 72 lineal feet on boring trajectory). The VWPs were installed at 21.7 feet and another at 79.7 feet (at 25 and 92 lineal feet on boring trajectory) in B-206. All four VWPs were installed with recording dataloggers. Groundwater level data from the VWPs will be reported as an addendum to this report.

Borings were tremie-backfilled with neat cement grout to the ground surface without installation of a screen or sand sock.

2.1.3 Field Hydraulic Conductivity (Packer) Testing

Nine hydraulic conductivity (packer) tests were performed as part of the geotechnical investigation: seven by Taber Drilling with one in each of borings BI-02 and BI-03, and five in boring B-203 and two by Pitcher Drilling in boring B-206.The tests were performed to characterize hydraulic conductivities of the rock along the new HDD or micro-tunnel alignment for the City of Yreka water line. Results of the packer tests are presented in Appendix B.

Single Pneumatic Packer Tests

For borings BI-02, BI-03, and B-203, testing with a single pneumatic packer was used in a down-stage method, meaning that each successive packer test was performed as the hole was drilled deeper. An In-situ Level Troll 300 water pressure data logger installed in the packer assembly with a surface readout was used to monitor water pressures within the test intervals of the boreholes. Test interval lengths were 20.0 feet.

Prior to conducting the hydraulic conductivity testing, each borehole was conditioned by circulating clear water to remove cuttings and traces of polymer-based drilling fluid. Drill rods were then lifted off the bottom of the hole approximately 20 feet to expose the test section of the borehole.

For each interval a maximum test pressure (P_{max}) of 1 psi/foot of depth to the center of the test section was used to reduce the potential for hydrofracturing of the formation. When the packer assembly was in place and inflated, the testing commenced. Testing generally consisted of a five-step test at varying pressures approximately equal to ½ P_{max}, ¾ P_{max}, P_{max}, ¾ P_{max}, and ½ P_{max}. At each step, the pressure was held constant until a steady rate of flow could be maintained, which was then monitored for approximately five minutes. At the completion of the fifth step, the packer was deflated, removed from the borehole and drilling resumed.

Double Pneumatic Packer Tests

For boring B-206, an upstage technique was used after completion of drilling, with two pneumatic packers sealing off 10-foot intervals of the borehole for testing. A vibrating wire pressure transducer installed in the packer assembly with a surface readout was used to monitor water pressure during the test. Clean water was circulated in the boring after drilling to remove cuttings and traces of drilling fluid.

As for the single pneumatic packer tests discussed above, the maximum test pressure (P_{max}) of 1 psi/foot of depth to the center of the test section was used to prevent hydrofracturing of the formation. Due to poor performance of the flow metering equipment and hydraulic response of the formation at the test intervals, testing consisted of a one-step test at P_{max}. The pressure was held constant until a steady rate of flow could be maintained, which was then monitored for approximately five minutes. After the two consecutive tests (85 to 95 feet, and then 75 to 85 feet), the packer was deflated and removed from the borehole. Additional tests were not performed in this borehole due to failure of the pressure monitoring equipment. The boring was subsequently backfilled by tremie-grouting.

2.1.4 Borehole Geophyiscal Surveys

Televiewer Logging

To identify the orientation and width of planar geologic structural features encountered by the borings, borehole acoustic televiewer logging was performed in two borings drilled along the proposed water tunnel alignment (B-202 and B-206). Televiewer logging was performed by NORCAL Geophysical Consultants, Inc. and the results of which are presented in Appendix C.

Chapter 3: Laboratory Testing

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3. LABORATORY TESTING

Representative soil samples obtained from the exploratory borings were tested by Cooper Testing Labs in Palo Alto, California and Inspection Services Inc. in Berkeley, California. Representative rock samples were also obtained from the borings and tested by Tonon Laboratory in Austin, Texas and Cooper Testing Labs in Palo Alto, California. Laboratory test reports are presented in Appendix D.

The following geotechnical tests were performed on soils samples from borings:

1. Moisture Content, ASTM D2216
2. Atterberg Limits, ASTM D4318
3. Consolidated Undrained triaxial Compression Strength Tests, ASTM D4767
4. Unconsolidated Undrained triaxial Compression Strength Tests, ASTM D2850
5. Consolidation, ASTM D2435
6. Grain-Size Distribution Analysis, ASTM D422
7. Percent Passing No. 200, ASTM D1140
8. Moisture-Density tests, ASTM D7263b
9. X-rays of Samples
10. Corrosion Testing (pH and Minimum Resistivity (CT 643), Sulfate (CT 147), and Chloride (CT 422))

The following geotechnical tests were performed on rock core samples from borings:

1. Brazilian Tensile Strength Test, ASTM D3967
2. Moisture Content, ASTM D2216
3. Cerchar Abrasiveness tests, ASTM D7625
4. Point Load tests, ASTM D5731
5. Mohs Hardness
6. Unconfined Compressive Strength tests, ASTM D7012

7. Punch Penetration testing, Colorado Schools of Mines – 13
8. Bulk Density tests, ISRM 1977
9. Petrographic Analyses

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Chapter 4: Limitations

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4. LIMITATIONS

This GDR references geotechnical data obtained from various phases of geotechnical investigation programs and serves as a source of geotechnical information for the Klamath River Renewal Project.

Groundwater levels presented reflect conditions observed at the time of measurement and are expected to vary over time. The conditions indicated in boring logs and geophysical surveys represent only the subsurface conditions at the locations of the borings. The actual subsurface conditions are expected to vary between those locations.

This report does not interpret the available data. It is the Contractor's responsibility to become familiar with the data in this GDR. The Contractor shall make its own interpretation of this data and shall assume full responsibility for its interpretation.

AECOM represents that the work described in this GDR were conducted in a manner consistent with the standard of care ordinarily applied as the state of practice in the profession within the limits prescribed by our client. No other warranties, either expressed or implied, are included or intended in this GDR.

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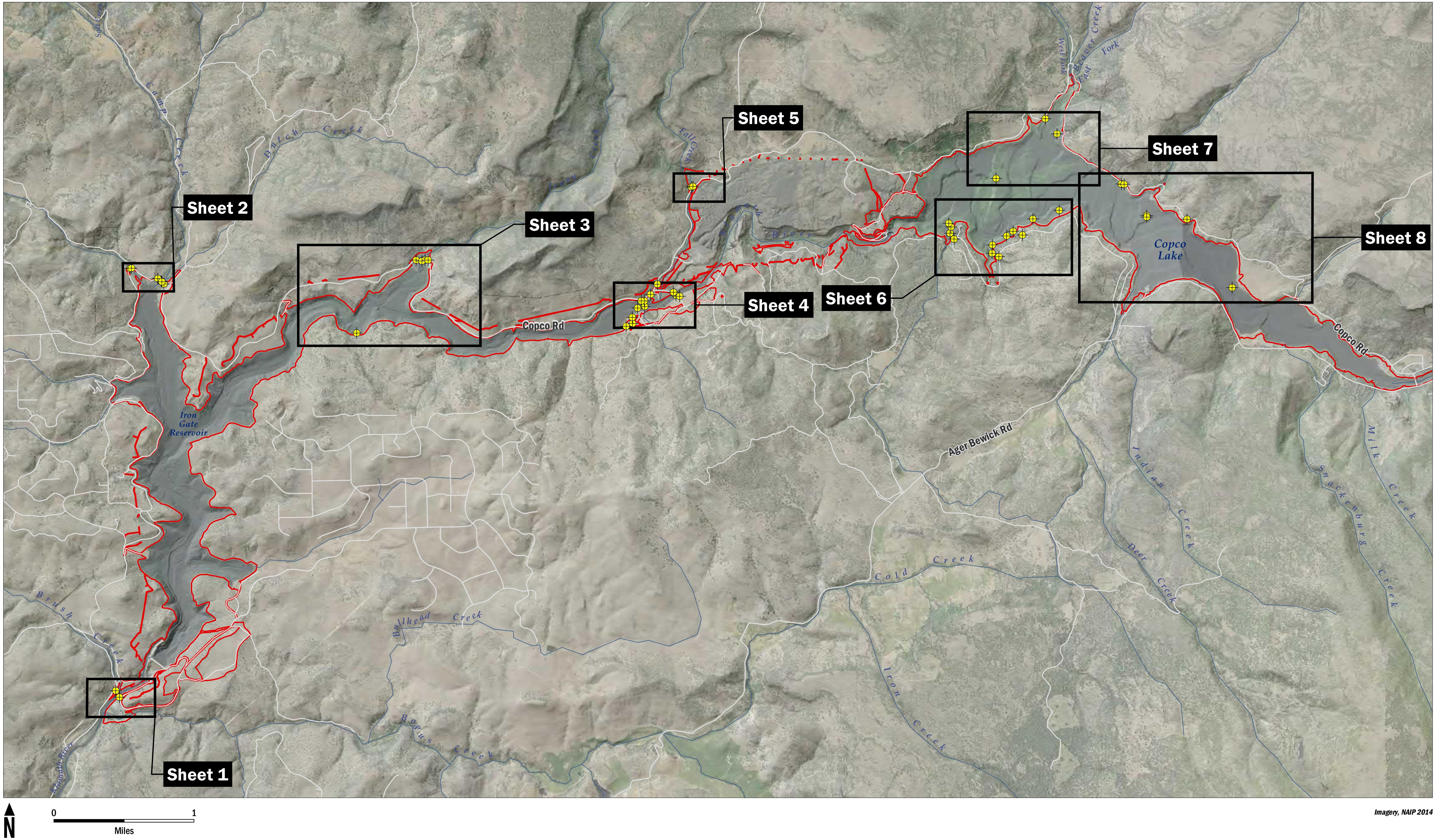
TABLE 1

BORING NUMBER	LOCATION	BORING TYPE	DEPTH (feet)	BEARING/ PLUNGE	PIEZO INSTALLED	IN-SITU TESTING	GOAL
B-01	Camp Creek	soil/core	25.5	Vertical	NA	NA	Bridge Foundation
B-02	Camp Creek	soil	31.4	Vertical	NA	NA	Bridge Foundation
B-03	Camp Creek	soil/core	27.3	Vertical	NA	NA	Bridge Foundation
B-04	Jenny Creek	soil/core	31.5	Vertical	NA	NA	Bridge Foundation
B-05	Jenny Creek	soil/core	50.0	Vertical	NA	NA	Bridge Foundation
B-06	Jenny Creek	soil/core	56.9	Vertical	NA	NA	Bridge Foundation
B-07	Jenny Creek	soil/core	31.8	Vertical	NA	NA	Bridge Foundation
B-08	Lakeview Bridge	soil/core	52.8	Vertical	NA	NA	Bridge Foundation
B-10	Lakeview Bridge	soil/core	52.2	Vertical	NA	NA	Bridge Foundation
B-13	Fall Creek	core	21.1	Vertical	NA	NA	Bridge Foundation
B-14	Fall Creek	core	28.6	Vertical	NA	NA	Bridge Foundation
B-15	Daggett Bridge	soil/core	51.5	Vertical	NA	NA	Bridge Foundation
B-16	Daggett Bridge Over Water	soil/core	24.5	Vertical	NA	NA	Bridge Foundation
B-17	Daggett Bridge	soil/core	41.5	Vertical	NA	NA	Bridge Foundation
B-18	Scotch Creek	soil	28.3	Vertical	NA	NA	Bridge Foundation
B-19	Scotch Creek	soil/core	37.5	Vertical	NA	NA	Bridge Foundation
B-20	Camp Creek	soil/core	47.0	Vertical	NA	NA	Bridge Foundation
B-201	Upper Irongate	soil/core	50.5	Vertical	NA	NA	Water Line
B-202	Upper Irongate	soil/core	100.5	30/205	VWP	T	Water Line
B-203	Upper Irongate	soil/core	120.0	Vertical	NA	HC	Water Line
B-205	Upper Irongate - Copco Road	soil/core	62.0	Vertical	NA	NA	Water Line
B-206	Upper Irongate - Copco Road	soil/core	100.0	30/295	VWP	T, HC	Water Line
B-207	Upper Irongate - Copco Road	soil/core	81.1	Vertical	NA	NA	Water Line
B-208	Upper Irongate	soil/core	80.0	Vertical	NA	NA	Water Line
BC-01	Copco - Over Water	soil	30.4	Vertical	NA	NA	Rim Stability
BC-02	Copco - Over Water	soil	64.6	Vertical	NA	NA	Rim Stability
BC-03	Copco - Over Water	soil	96.5	Vertical	NA	NA	Rim Stability
BC-04	Copco - Over Water	soil	73.5	Vertical	NA	NA	Rim Stability
BC-05	Copco - Over Water	soil	20.5	Vertical	NA	NA	Rim Stability
BC-06	Copco - Over Water	soil	15.4	Vertical	NA	NA	Rim Stability
BC-07	Copco - Over Water	soil	15.9	Vertical	NA	NA	Rim Stability
BC-08	Copco - Over Water	soil	11.5	Vertical	NA	NA	Rim Stability
BC-08a	Copco - Over Water	soil	85.2	Vertical	NA	NA	Rim Stability
BC-09	Copco - Over Water	soil	70.5	Vertical	NA	NA	Rim Stability
BC-10	Copco - Over Water	soil	43.0	Vertical	NA	NA	Rim Stability
BC-11	Copco Road	soil	10.5	Vertical	NA	NA	Rim Stability
BC-12	Copco Road	soil	16.5	Vertical	NA	NA	Rim Stability
BC-13	Copco Road	soil	42.0	Vertical	NA	NA	Rim Stability
BC-14	Copco Road	soil	15.4	Vertical	NA	NA	Rim Stability
BC-15	Copco Road	soil	1.0	Vertical	NA	NA	Rim Stability
BC-16	Copco Rim	soil	64.8	Vertical	NA	NA	Rim Stability
BC-17	Copco Rim	soil	37.4	Vertical	NA	NA	Rim Stability
BC-18	Copco Rim	soil	34.5	Vertical	NA	NA	Rim Stability
BC-19	Copco Rim	soil	37.5	Vertical	NA	NA	Rim Stability
BC-20	Copco Rim	soil	19.0	Vertical	NA	NA	Rim Stability
BI-01	Irongate Rim - Over Water	soil	22.2	Vertical	NA	NA	Rim Stability
BI-02	Irongate - Fall Creek	soil/core	67.0	Vertical	NA	HC	Water Line
BI-03	Irongate - Over Water	soil/core	35.1	Vertical	NA	HC	Water Line
NOTES:	1) HC = hydraulic conductivity, T = televiewer, VWP = vibrating wire piezometer, NA = not applicable						



Imagery, NAIP 2014

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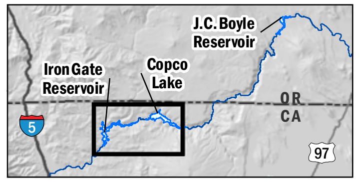
Klamath River Renewal Project



◆ As-Drilled Boring

Road

▭ Detail Sheet Extent

▭ Limits of Work

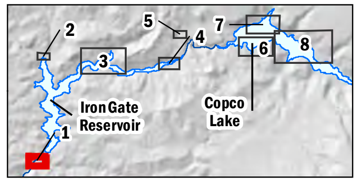
FIGURE 1

Planned and Completed Geotechnical Borings Overview

AECOM Oakland CA 6/18/2019 USER alexander.remar PATH \\Oakland\Oakland\Projects\Secure\Water\Klamath Dam\400-Technical\440 GIS\02_Maps\02_Map_Production_and_Reports\Geotechnical_WorkPlan\Figure 1 Planned and Completed Geotechnical Borings Mapbook.mxd

Imagery, NAIP 2014

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project



⌖ As-Drilled Boring

▭ Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 1 of 8

AECOM Oakland CA 6/19/2019 USER alexander.remar PATH \\Oakland\Oakland\Projects\Secure\Water\Klamath Dam\400-Technical\440 GIS\02_Maps\02_Map_Production_and_Reports\Geotechnical_WorkPlan\Figure 1 Planned and Completed Geotechnical Borings Mapbook.mxd

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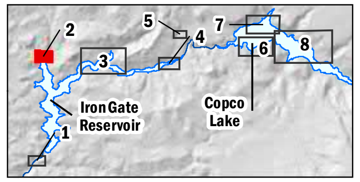


⊕ As-Drilled Boring

▭ Project Boundary

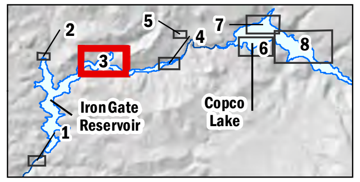
FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 2 of 8

Imagery, NAIP 2014

AECOM
Klamath River Renewal Corporation
Klamath River Renewal Project

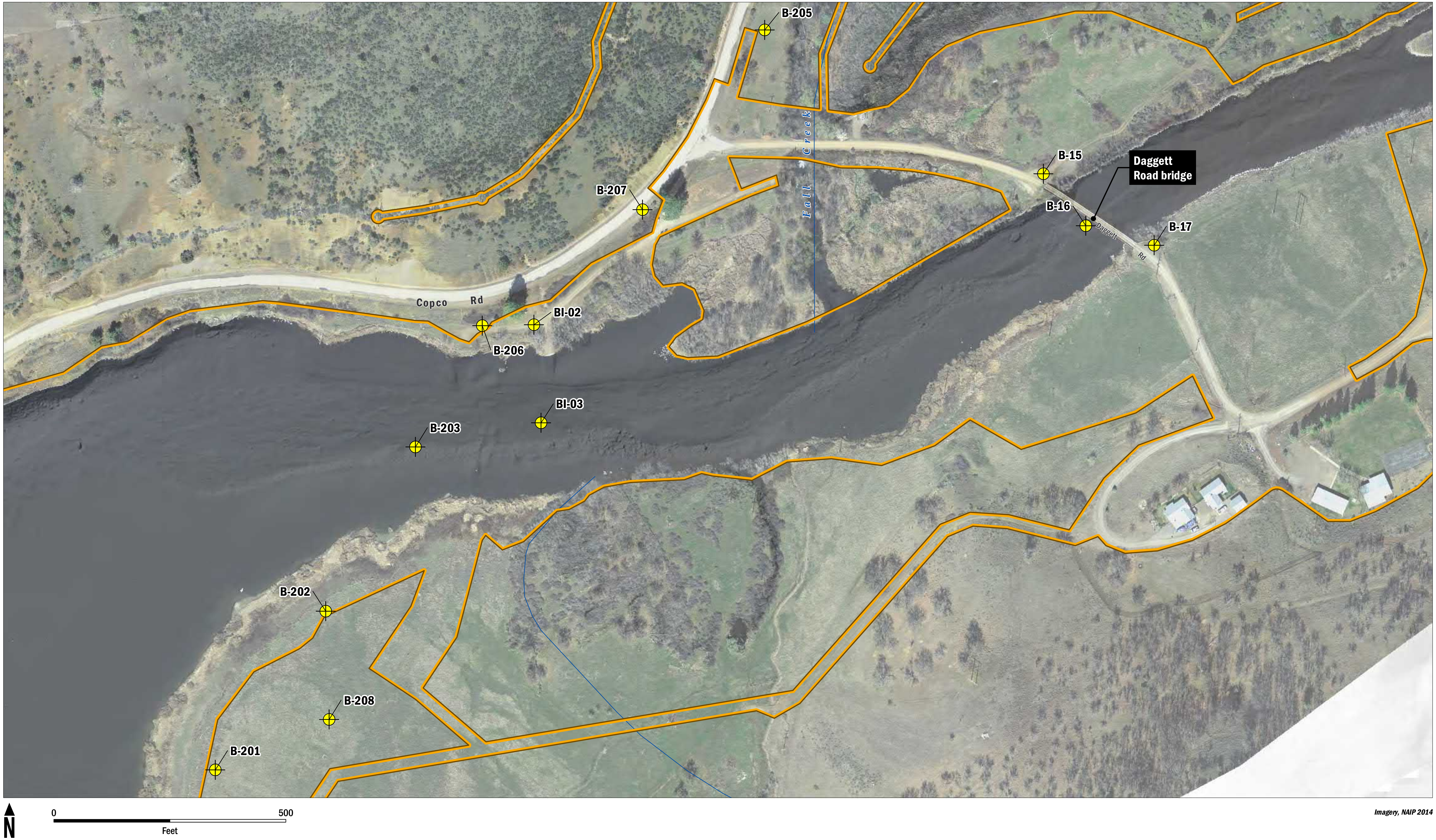


- As-Drilled Boring
- Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 3 of 8



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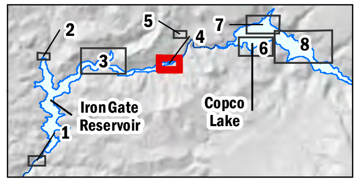
Klamath River Renewal Corporation
Klamath River Renewal Project



⊕ As-Drilled Boring

▭ Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings
Sheet 4 of 8

AECOM Oakland CA 6/18/2019 USER alexander.remar PATH \\Oakland\Oakland\Projects\Secure\Water\Klamath Dam\400-Technical\440 GIS\02_Maps\02_Map_Production_and_Reports\Geotechnical_WorkPlan\Figure 1 Planned and Completed Geotechnical Borings Mapbook.mxd

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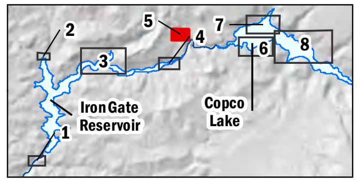
AECOM

Klamath River Renewal Corporation

Klamath River Renewal Project



⌖	As-Drilled Boring
▭	Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 5 of 8

Imagery, NAIP 2014

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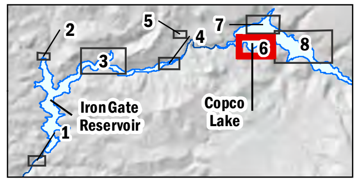
Klamath River Renewal Corporation

Klamath River Renewal Project



● As-Drilled Boring

▭ Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 6 of 8

Imagery, NAIP 2014

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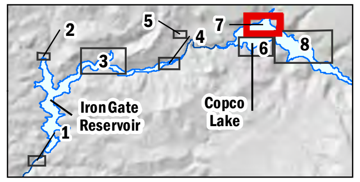
Klamath River Renewal Corporation

Klamath River Renewal Project



⊕ As-Drilled Boring

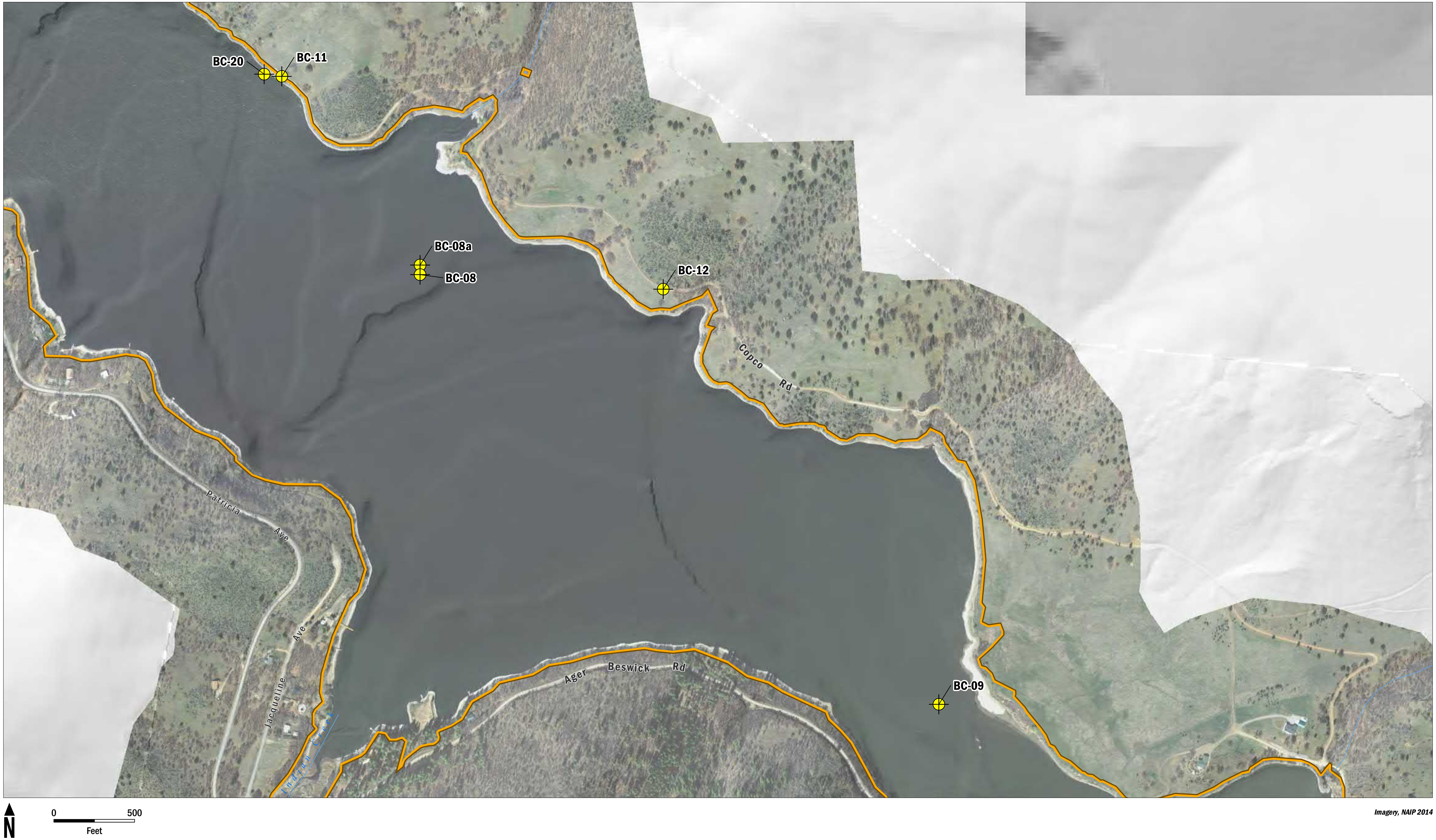
▭ Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 7 of 8

AECOM Oakland CA 6/18/2019 USER alexander.remar PATH \\Oakland\Oakland\Projects\Secure\Water\Klamath Dam\400-Technical\440 GIS\02_Maps\02_Map_Production_and_Reports\Geotechnical_WorkPlan\Figure 1 Planned and Completed Geotechnical Borings Mapbook.mxd



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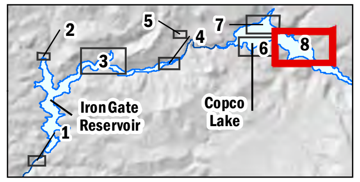
Klamath River Renewal Project



⊕ As-Drilled Boring

▭ Project Boundary

FIGURE 1

Planned and Completed Geotechnical Borings

Sheet 8 of 8

APPENDIX A BORING LOGS

Project: Klamath River Dam Removal Project
Project Location: Klamath River
Project Number: 60537920

Key to Log of Soil Boring

Sheet 1 of 4

Elevation feet	Depth, feet	SAMPLES				Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight (pcf)	Fines Content (% <200 Sieve)	REMARKS AND OTHER TESTS
		Type	Number	Sampling Resistance blows/6-in.	Recovery (inches)						
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation in feet referenced to specified datum.

2 **Depth:** Depth in feet below the ground surface.

3 **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

4 **Sample Number:** Sample identification number.

5 **Sampling Resistance:** Number of blows required to advance driven sampler 12 inches beyond first 6-inch interval, or distance noted, using a 140-lb hammer with a 30-inch drop; or down-pressure for pushed sampler.

6 **Recovery:** Percentage of driven or pushed sample length recovered; "NA" indicates data not recorded.

7 **Graphic Log:** Graphic depiction of subsurface material encountered; typical symbols are explained below.

8 **Material Description:** Description of material encountered; may include density/consistency, moisture, color, and grain size.

9 **Water Content:** Water content of soil sample measured in laboratory, expressed as percentage of dry weight of specimen.

10 **Dry Unit Weight:** Density of soil as measured in the laboratory, in pounds per cubic foot

11 **Fines Content** Percentage passing the #200 sieve as measured in the laboratory

12 **Remarks and Other Tests:** Comments and observations regarding drilling or sampling made by driller or field personnel.

TYPICAL MATERIAL GRAPHIC SYMBOLS

▨ FAT CLAY (CH)	▨ FAT CLAY with SAND (CH)	▨ SANDY FAT CLAY with GRAVEL (CH)	▨ SANDY FAT CLAY (CH)
▨ LEAN CLAY WITH ORGANICS (CL)	▨ SANDY LEAN CLAY (CL)	▨ LEAN CLAY with GRAVEL and SAND (CL)	▨ GRAVELLY LEAN CLAY (CL)
▨ LEAN CLAY with SAND (CL)	▨ SANDY LEAN CLAY with GRAVEL (CL)	▨ CLAYEY GRAVEL (GC)	▨ CLAYEY GRAVEL with SAND (GC)
▨ POORLY GRADED GRAVEL (GP)	▨ POORLY GRADED GRAVEL with SAND (GP)	▨ POORLY GRADED GRAVEL with CLAY (GP-GC)	▨ WELL GRADED GRAVEL WITH SAND (GW)

TYPICAL SAMPLER GRAPHIC SYMBOLS

◪ 2.5-inch I.D. Modified California	▯ Standard Penetration Test
☒ Shelby Tube	▥ 2.0-inch I.D. California

GENERAL NOTES

-**Check By:** Soil and core samples reviewed in-person by Project Geologist.

-**Reviewed By:** Soil and core samples reviewed via run photos or core box photos in office by Project Engineer.

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Key to Log of Soil and Core Boring

Sheet 2 of 4

		ROCK CORE									SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation (in feet) referenced to North American Vertical Datum of 1988 (NAVD88).

2 **Depth:** Distance (in feet) below the collar of the borehole.

3 **Run No.:** Number of the individual coring interval.

4 **Box No.:** Number of the core box which contains core from the corresponding runs.

5 **Recovery:** Amount in percent of core recovered from coring interval; calculated as length of core recovered divided by length of run.

6 **Fractures per Foot:** (Fracture Frequency) The number of naturally occurring fractures in each foot of core; does not include mechanical breaks (induced by drilling) or healed fractures. "NA" indicates not applicable due to lack of core recovery or soil-like nature of rock.

7 **R Q D:** (Rock Quality Designation) Amount (in percent) of intact core (pieces of sound core greater than 4 inches in length) in each coring interval; calculated as the sum of lengths of intact core divided by length of core run.

8 **Fracture Drawing:** Sketch of the naturally occurring fractures and mechanical breaks, showing the angle of the fractures relative to the cross-sectional axis of the core. "NR" indicates no recovery.

9 **Fracture Number:** Location of each naturally occurring fracture (numbered) and mechanical break (labeled "M"). Naturally occurring fractures are described in Column 11 (keyed by number) using descriptive terms defined on Sheet 2 (Items a through g).

10 **Lithology:** Graphic depiction of subsurface material encountered, typical symbols are explained below

11 **Description:** Lithologic description in this order: rock type, color, grain size, texture, weathering, strength, and other features; descriptive terms are defined on Sheet 2. Also, abbreviated description of fractures numbered in Column 9 using terms defined on Sheet 2.

12 **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

13 **Sample Number:** Sample identification number.

14 **Blows / 6 in.:** Number of blows to advance driven sampler each 6-inch drive interval, or distance noted, using a 140-lb hammer with a 30-inch drop (unless otherwise noted).

15 **Recovery:** Actual soil recovery in driven sampler as a percentage of the sampler penetration.

16 **Drill Time [Rate]:** Time (in 24-hour clock) marking start and finish of each run; drill rate (in feet per hour) is reported in brackets.

17 **Field Notes and Tests Results:** Comments and observations regarding drilling or sampling made by driller or field personnel.

OTHER GRAPHIC SYMBOLS

TYPICAL MATERIAL GRAPHIC SYMBOLS

▨	SILT with SAND and GRAVEL (ML)	▨	SANDY SILT (ML)	▨	ORGANIC SILT WITH SAND (OL)	▨	GRAVELLY FAT CLAY with SAND (CH)
▨	CLAYEY SAND to SANDY LEAN CLAY (SC-CL)	▨	CLAYEY SAND with GRAVEL (SC)	▨	SILTY SAND (SM)	▨	SILTY to CLAYEY SAND with GRAVEL (SM-SC)
▨	SILTY SAND with GRAVEL (SM)	▨	POORLY GRADED SAND (SP)	▨	POORLY GRADED SAND with GRAVEL (SP)	▨	POORLY GRADED SAND with SILT (SP-SM)
▨	WELL GRADED SAND with GRAVEL (SW)						

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Key to Log of Core Boring

Sheet 3 of 4

		ROCK CORE										
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	13	14

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation (in feet) referenced to mean sea level (MSL).

2 **Depth:** Distance (in feet) below the collar of the borehole.

3 **Run No.:** Number of the individual coring interval.

4 **Box No.:** Number of the core box which contains core from the corresponding run.

5 **Recovery:** Amount (in percent) of core recovered from the coring interval; calculated as length of core recovered divided by run length.

6 **Fractures per Foot:** (Fracture Frequency) The number of naturally occurring fractures in each foot of core; does not include mechanical breaks (induced by drilling) or healed fractures. "NA" indicates not applicable due to lack of core recovery.

7 **R Q D:** (Rock Quality Designation) Amount (in percent) of intact core (pieces of sound core greater than 4 inches in length) in the coring interval; calculated as the sum of lengths of intact core divided by the run length. RQD value with "*" indicates moderately weathered / altered rock that does not meet soundness requirements, but provides an indication of rock quality with respect to degree of fracturing.

8 **Fracture Drawing:** Sketch of the naturally occurring fractures and mechanical breaks, showing the angle of the fractures relative to the cross-sectional axis of the core. "NR" indicates no recovery.

9 **Fracture Number:** Location of each naturally occurring fracture (numbered) and mechanical break (labeled "M"). Naturally occurring fractures are described in Column 11 (keyed by number) using descriptive terms defined on Sheet 2 (Items a through g).

10 **Lithology:** A graphic log of material encountered using symbols to represent differing soil and rock types; symbols are explained below.

11 **Description:** Lithologic description in this order: rock type, color, texture, grain size, weathering, strength, and other features; descriptive terms are defined on Sheet 2. A detailed description of overburden material is not necessarily provided. Also, abbreviated description of fractures numbered in Column 9 using terms defined on Sheet 2.

12 **Drill Time [Rate]:** Time (in 24-hour clock) marking start and finish of each run; drill rate (in feet per hour) is reported in brackets.

13 **Field Notes and Other Tests:** Comments regarding drilling and sampling made by driller or field personnel. Tested rock specimen intervals and a record of tests performed using the abbreviations listed below.

TYPICAL MATERIAL GRAPHIC SYMBOLS

■	ASPHALT	▨	ANDESITE	▨	BASALT	▨	BOULDERS and COBBLES
▨	BOULDER	○	DIATOMITE	▨	DIATOMITE WITH ELASTIC SILT	△	VOLCANIC BRECCIA
▨	VOLCANIC CINDER	▤	VOLCANIC CLAYSTONE	▨	VOLCANIC CONGLOMERATE	▤	VOLCANIC MUDSTONE
▨	VOLCANIC SANDSTONE	▤	VOLCANIC SILTSTONE/CLAYSTONE	▤	VOLCANIC SILTSTONE	▤	VOLCANIC SILTY SANDSTONE

OTHER GRAPHIC SYMBOLS

▽ Static Water Level

▼ First water encountered at time of drilling

– – – Inferred or transitional contact

↓ Change in material properties within a stratum

LABORATORY TEST ABBREVIATIONS

PL:	Point Load Index Test (psi)
UC:	Unconfined Compressive Strength test (psi)

Material descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced, and are not warranted to be representative of subsurface conditions at other locations or times.

Project: Klamath River Dam Removal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Key to Log of Boring

Sheet 4 of 4

KEY TO DESCRIPTIVE TERMS USED ON CORE LOGS

DISCONTINUITY DESCRIPTORS

a Dip of discontinuity, measured relative to a plane normal to the core axis.

b **Discontinuity Type:**

F - Fault
J - Joint
Sh - Shear
Fo - Foliation
V - Vein
B - Bedding

c **Aperture (inches):**

W - Wide (0.5-2.0)
MW - Moderately Wide (0.1-0.5)
N - Narrow (0.05-0.1)
VN - Very Narrow (<0.05)
T - Tight (0)

d **Type of Infilling:**

Bi - Biotite
Cl - Clay
Ca - Calcite
Ch - Chlorite
Ep - Epidote
Fe - Iron Oxide
H - Healed
My - Mylonite
CR - Crushed Rock
Mn - Manganese
No - None
Py - Pyrite
Qz - Quartz
Sd - Sand
Se - Serpentine
Si - Silty
Uk - Unknown

e **Amount of Infilling:**

Su - Surface Stain
Sp - Spotty
Pa - Partially Filled
Fi - Filled
No - None

f **Surface Shape of Joint:**

Pl - Planar
Wa - Wavy
St - Stepped
Ir - Irregular

g **Roughness of Surface:**

Slk - Slickensided [surface has smooth, glassy finish with visual evidence of striations]
S - Smooth [surface appears smooth and feels so to the touch]
SR - Slightly Rough [asperities on discontinuity surfaces are distinguishable and can be felt]
R - Rough [ridges and side-angle steps are evident; asperities are clearly visible; surface feels very abrasive]
VR - Very Rough [near-vertical steps and ridges occur on discontinuity surface]

ROCK FRACTURING

Description	Recognition
Intensely Fractured	Fractures spaced less than 2 inches apart
Highly Fractured	Fractures spaced 2 inches to 1 foot apart
Moderately Fractured	Fractures spaced 1 foot to 3 feet apart
Slightly Fractured	Fractures spaced 3 feet to 10 feet apart
Massive	Fracture spacing greater than 10 feet

ROCK WEATHERING / ALTERATION

Description	Recognition
Residual Soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand
Completely Weathered/Altered	Original minerals of rock have been almost entirely decomposed to secondary minerals, although original fabric may be intact; material can be granulated by hand
Highly Weathered/Altered	More than half of the rock is decomposed; rock is weakened so that a minimum 2-inch-diameter sample can be broken readily by hand across rock fabric
Moderately Weathered/Altered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 2-inch-diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered/Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh/Unweathered	Rock shows no discoloration, loss of strength, or other effect of weathering/alteration

ROCK STRENGTH

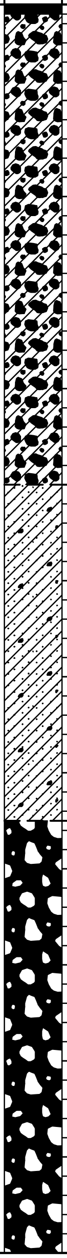
Description	Recognition	Approximate Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 - 150
Very Weak Rock	Can be peeled by pocket knife	150 - 700
Weak Rock	Can be peeled with difficulty by pocket knife	700 - 3,600
Moderately Strong Rock	Can be indented 5 mm with sharp end of pick	3,600 - 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 - 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 - 36,000
Extremely Strong Rock	Can only be chipped with hammer blows	>36,000

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-01

Sheet 1 of 2

Date(s) Drilled	**9/27/2018**	Logged By	**S. Janowski**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, HQ-3 wireline diamond bit**	Total Depth of Borehole	**25.5 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2346 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID ModCal; SPT; HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek Bridge**	Coordinate Location	**N 2602866 E 6443027**



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								2-inches GRAVEL roadway						Start 9:00 9/27/2018; hang auger 0.0-5.0ft.
									CLAYEY GRAVEL (GC); very stiff; yellowish brown (10YR 5/6); 60% subangular GRAVEL to 1-inch; 30% low plasticity FINES; 10% fine grained SAND; moist --ROAD FILL--						
	1														
2344	2														
	3														
2342	4														pp = 2.75 tsf
	5								LEAN CLAY with GRAVEL and SAND (CL); very stiff; dark yellowish brown (10YR 4/4); 80% medium plasticity FINES; 10% fine grained SAND; 10% subangular GRAVEL to 1/2-inch; moist --ALLUVIUM--			6			Hollow stem auger 5.0ft. to 9.0ft.
2340	6										S-01	7	0		pp = 2.25 tsf
												8			
	7											6			
											S-02	7	0		
2338	8											8			
									GRAVEL and COBBLES in a SANDY LEAN CLAY matrix; GRAVEL and COBBLES are subrounded Basalt						
	9		1									19		1014	Auger refusal at 9.0ft.; advance 4.5-inch casing to 9.0ft. and switch to rotary wash drilling with 3 7/8-inch tricone bit.
2336		1		80	NA	NA					S-03	17	11	[13]	
	10				NA							10		1021	
														1037	
	11	2		100		NA								[9]	
					NA			m						1044 1056	
2334	12														75% fluid circulation
		3		60	NA	NA								[25]	
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-01

Sheet 2 of 2

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13		1		NA			GRAVEL and COBBLES in a SANDY LEAN CLAY matrix; GRAVEL and COBBLES are subrounded Basalt --ALLUVIUM--*(continued)*						75% fluid circulation
2332														
	14	4		80	NA	NA							1102 1112 [9] 1119	
	15	5		87	NA	NA		VOLCANIC BRECCIA; dark reddish brown (10R 3/4); highly weathered; very weak; highly fractured; friable --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--					1124 [23]	
2330	16				NA		m	Becomes yellowish grey (5Y 7/2), moderately weathered					1128	
		6		94		88*							1136	
	17				0									
2328	18							Becomes greyish brown (5YR 3/2)						
					>6		m m	Intensely fractured						
	19												[16]	*Rock does not meet soundness criteria for RQD calculation
2326					0		1	1: 15, V, T-VN, H+Uk, Fi, Pl, ?						
	20				1		2	2: 60, J, N-W, Sd, Fi, Wa, ?						
	21						m m						1155	
2324	22	7		70	NA	0	m m						1244 [15] 1248	
	23	8		0	NA	0							1254 [12] 1259	
2322	24	9		50	NA NA	0							1304 [12]	
	25				>6								1314	
2320	26							TOTAL DEPTH = 25.5 FEET						
	27													
2318	28													
	29													

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring B-02

Sheet 1 of 2

Date(s) Drilled	**10/12/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**31.4 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2340 feet**
Groundwater Level(s)	**13.5 feet below ground surface 10/12/2018**	Sampling Method(s)	**SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek Bridge**	Coordinate Location	**N 2602747 E 6443180**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
2340	0						2-inches GRAVEL roadway POORLY GRADED GRAVEL (GP); dense; fine to coarse GRAVEL and COBBLES; fine to corase grained SAND; little no plasticity FINES; moist --FILL--				Start 9:00 9/27/2018; hollow stem auger 0-31ft.
							LEAN CLAY (CL); medium stiff; brown; medium plasticity FINES; trace fine grained SAND; occasional GRAVEL and COBBLE				
2335	5										Logged from auger cuttings and rig chatter
2330	10										
							∇				
2325	15										
2320	20						POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse GRAVEL to BOULDERS; fine to coarse grained SAND; some no plasticity FINES --ALLUVIUM--				Rig chatter indicated rocky layer
							BOULDER, basalt				
2315	25										
							BOULDER, basalt				
			S-01	14 14 44	100		SILTY SAND with GRAVEL (SM); very dense; GRAVEL up to 1-inch; fine to coarse grained SAND; no plasticity FINES --ALLUVIUM--	14		15	SA: G=32%; S=53%; F=15%
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring B-02

Sheet 2 of 2

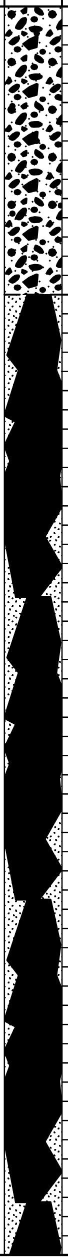
Elevation feet	Depth, feet	SAMPLES				Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
		Type	Number	Sampling Resistance	Recovery (feet)						
2310	30		S-02	50/0	0		[As Above] --ALLUVIUM--*(continued)*				S-02 attempted at 31.4; logged from flake in shoe
							BASALT; dark grey; slightly weathered to fresh; moderately strong --TERTIARY to QUATERNARY INTRUSIVE BASALT-- **TOTAL DEPTH = 31.4 FEET**				
2305	35										
2300	40										
2295	45										
2290	50										
2285	55										
2280	60										
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-03

Sheet 1 of 2

Date(s) Drilled	**10/12/2018-10/16/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, 3 7/8-inch tricone, 3 7/8-inch diamond core bit**	Total Depth of Borehole	**27.3 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2341 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek**	Coordinate Location	**N 2602664 E 6443265**



Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse GRAVEL to BOULDERS; fine to corase grained SAND; some no plasticity FINES; dry to moist --FILL--						Start 12:00 10/12/2018; hang auger 0.0-5.0ft.
2340															
	1														
	2														
2338															
	3								BOULDER and COBBLES; 3.0-4.8ft.: BOULDER --ALLUVIUM--						
	4														End of day 10/12/2018 Begin day 10/15/2018
2336															
	5								BOULDER						Switch to rotary wash drilling with 3 7/8-inch tricone bit
	6														
2334									BOULDERS and COBBLES						
	7														Advance 4.5-inch casing to 5ft.
	8														
2332															
	9														
	10								BOULDERS and COBBLES						
2330															
	11														
	12														
2328															
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-03

Sheet 2 of 2

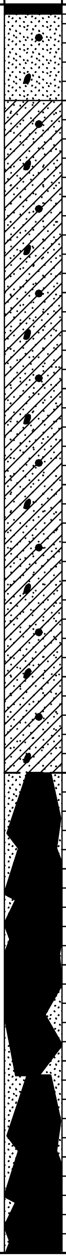
Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13									BOULDER and COBBLES --ALLUVIUM--*(continued)*						Reddish clay cuttings
	14									VOLCANIC SILTSTONE; reddish brown to olive grey; moderately to highly weathered; very weak to weak; very thinnly laminated; locally clayey --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
2326																
	15												14			S-01 One liner retained (16-16.5ft.)
												S-01	19			
	16												23			
2324																
	17															
	18															
2322																
	19															
	20												27			Rig chatter at 20ft. indicates rocky layer
2320												S-02	31			
	21												46			S-02 One liner retained (21-21.5ft.)
	22															End of day 10/15/2018
			1		NA		NR			becomes moderately weathered; weak					0810	Begin day 10/16/2018
2318								m								
	23							m								Advance 4.5-inch casing to 22ft. Switch to HQ-3 rock coring at 22.3ft.
					1			1								
	24							m		1: J, 30, N, Cl, Fi, Pl, S-SR (dissolution voids along joint) 2: J, 10-15, VN, Cl, Fi, Pl-Wa, S-SR						
					1			m m m 2								
2316		1		82		78*									[7]	
	25															
					0		NR									
	26							m								
					0											26.3-27.3ft. driller reports harder drilling condition
2314																
	27				NA		NR	m m							0852	
										TOTAL DEPTH = 27.3 FEET						
	28															
2312																
	29															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

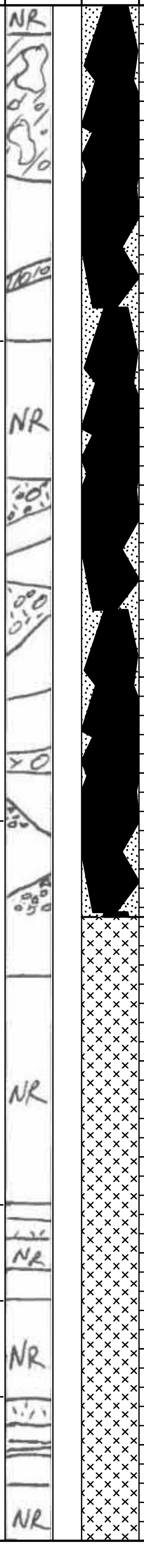
Log of Soil and Core Boring B-04

Sheet 1 of 3

Date(s) Drilled	**9/25/2018**	Logged By	**S. Janowski**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, HQ-3 wireline diamond bit**	Total Depth of Borehole	**31.5 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2343 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID Mod Cal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Jenny Creek Bridge**	Coordinate Location	**N 2603560 E 6452773**



Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0							2-inches ASPHALT roadway POORLY GRADED SAND with GRAVEL (SP); greenish grey (10G 5/1); 40% subangular GRAVEL up to 1-inch; 60% medium grained SAND; moist --ROAD BASE--						Start 9:30 9/25/2018 Hand Auger 0-5ft.
2342														
	1							SANDY LEAN CLAY with GRAVEL (CL); very stiff to hard; brown (10YR 4/3); 60% low plasticity FINES; 20% subangular gravel up to 2-inches; 20% fine grained SAND; moist --ROAD FILL--						pp = 3.25 tsf
	2													
2340	3													
	4													pp = 4.25 tsf
2338	5							Becomes brown (10YR 5/3 with subangular to subrounded GRAVEL up to 1 1/2-inches, effervescent, with rootlets		S-01	15 13 11	67		Hollow Stem Auger 5-9.5 ft. pp = >4.5 tsf
2336	6 7													
	8							CLAYEY GRAVEL with SAND (GC); very stiff; brown (10YR 4/3); 60% subrounded COBBLES and GRAVELS; 30% low plasticity FINES; 10% medium grained SAND --ALLUVIUM--						
2334	9							Becomes basalt COBBLES up to 5 inches in a clayey matrix		S-02	21 13 50	89		Auger refusal at 9.5ft.; advance 4.5-inch casing to 9.5ft. pp = 3.0 tsf
2332	10						0							
	11	1	1	100	NA	NA	m						1147	Switch to HQ coring at 11ft. with wireline diamond bit; advance 4.5-inch casing to 9.0ft.
2330	12 13	2		64	NA	NA	NR							



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13		1		NA		CLAYEY GRAVEL with SAND (GC); very stiff; brown (10YR 4/3); 60% subrounded COBBLES and GRAVELS; 30% low plasticity FINES; 10% medium grained SAND --ALLUVIUM--*(continued)*						Driller indicated good fluid return while pump running but rapid fluid level drop between runs
	14	2		64		NA						[30]	
					NA								
2328							Becomes greyish red (5YR 4/2) to brownish black (5YR 2/1), basalt BOULDERS with minor matrix and subrounded GRAVELS infilling void spaces with some vesicles up to 3/4-inches.						
	15				NA								
	16				NA							1157 1206	
2326													
	17				NA								
	18				NA								
2324													
	19	3		72	NA	NA						[21]	
	20				NA								
2322													
	21				NA							1220 1232	
	22				NA		BASALT; olive grey (5Y 3/2); completely weathered; very weakly decomposed and easily friable by hand --TERTIARY to QUATERNARY INTRUSIVE BASALT--						
2320	23	4		40	NA	0						[13]	
	24				NA								
2318	25				NA		Becomes dusky yellow green (5Y 5/2) and pale reddish brown (10Y 5/4), highly to completely weathered, highly to intensely fractured					1250 1257	Bit blocked off during run
	26	5		70		0						[10]	
					NA							1303 1310	
2316	27	6		0		0						[7]	
					NA							1319 1431	Bit blocked off during run
	28	7		30	NA	0							
2314	29												

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-04

Sheet 3 of 3

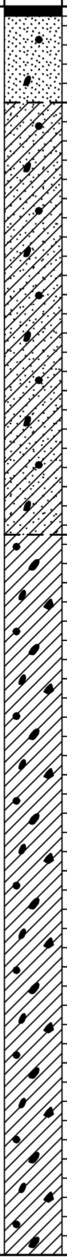
Elevation, feet	Depth, feet	ROCK CORE						Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number			Type	Number	Blows / 6 in.	Recovery, %		
	29 30	7	1	30	NA NA	0	NR	▨	BASALT; dusky yellow green (5Y 5/2) and pale reddish brown (10Y 5/4); highly to completely weathered; highly to intensely fractured; very weak; No Recovery likely in completely weathered zones --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*					[13] 1445	
2312	31	8		0	NA	0	NR	▨						1455 [7] 1504	Bit blocked off during run
	32								**TOTAL DEPTH = 31.5 FEET**						
2310	33														
	34														
2308	35														
	36														
2306	37														
	38														
2304	39														
	40														
2302	41														
	42														
2300	43														
	44														
2298	45														

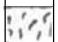
Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-05

Sheet 1 of 4

Date(s) Drilled	**9/26/2018**	Logged By	**S. Janowski**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, HQ-3 wireline diamond bit**	Total Depth of Borehole	**50.0 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2342 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID ModCal; SPT; HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Jenny Creek Bridge**	Coordinate Location	**N 2603527 E 6452997**



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								2-inches ASPHALT roadway						Start 8:30 9/26/2018 hand auger 0-5ft.
2342									POORLY GRADED SAND with GRAVEL (SP); greenish grey (10G 5/1); 60% medium grained SAND; 40% subangular GRAVEL up to 1-inch; moist --ROAD BASE--						
	1								SANDY LEAN CLAY (CL); very stiff; brown (10YR 1/3); low plasticity FINES; fine to medium grained SAND; subangular GRAVEL up to 2-inches; moist --ROAD FILL--						
	2														Pocket Pen = 3.5 tsf
2340															
	3														
	4														
2338															
	5								Becomes dark yellowish brown (10YR 4/4); dry to moist			5			Hollow stem auger 5-7.5 ft. SA: G=7%; S=25%; F=68% pp = 1.5 tsf
									LEAN CLAY with GRAVEL (CL); stiff; brown (10YR 4/3); 75% medium plasticity FINES; 15% subangular to subrounded GRAVEL up to 3/4-inch; 10% fine grained SAND; moist; with rootlets --ALLUVIUM--		S-01	4	72		
2336	6											9			
	7		1		NA									1019	
									With pulverized GRAVEL (from drive sampler); increased GRAVEL to 25% up to 1-inch			32			Auger refusal at 7.5ft.
2334	8				NA		NR				S-02	12	72		pp = 2.75 tsf
	9	1		15		NA						7		[48]	Advance 4.5-inch casing to 7.5 ft.; switch to HQ coring at 7.5ft. with wireline diamond bit
					NA				With greyish black (N2), aphanitic basalt COBBLES and GRAVELS in a washed-out CLAY matrix						
2332	10				NA		NR								
	11				NA							4		1024 1104	pp = 1.5 tsf
2330	12	2		20		NA	NR				S-03	8	39		
					NA							4			
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-05

Sheet 2 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13		1						COBBLES and GRAVELS in a washed-out CLAY matrix; brown (10YR 4/3) --ALLUVIUM--*(continued)*						50-75% drill fluid return
		2		20	NA	NA								[38]	
	14														
2328					NA		NR								
	15														
					NA										
	16													1112 1115	
2326					NA		NR								
	17	3		40		NA								[24]	
					NA										Bit blocked off during run
	18													1120 1126	
2324					NA										
	19						NR								
		4		50	NA	NA			Basalt BOULDER; greyish red (5RP 4/2); slightly weathered; strong					[60]	UCS = 14975 psi
	20														
2322					NA										
	21						NR		COBBLES and GRAVELS in a washed-out CLAY matrix; very dark grey (10YR 3/1)					1129 1134	
					NA										
	22	5		80		NA								[17]	
2320					NA										
	23								Basalt COBBLES and BOULDERS are non vesiculated to vesiculated with vesicles up to 1/2-inch					1141 1156	
					NA										
	24														
2318		6		73	NA	NA								[30]	
	25														
					NA		NR								
	26													1202 1236	
2316					NA		NR								
	27	7		43		NA								[20]	
					NA										
	28													1242 1331	
2314		8		43	NA	NA									
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-05

Sheet 3 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	8	1	43	NA	NA	NR			COBBLES and GRAVELS in a washed-out CLAY matrix; brown (10YR 4/3) --ALLUVIUM--*(continued)*					[30]	0% Fluid return
2312	30				NA											
	31	9		20	NA	NA	NR								1337 1344	
2310	32				NA										[19]	
	33				NA										1352 1401	
2308	34	10		20	NA	NA	NR								[21]	
	35				NA											
2306	36	11		85	NA	NA	NR					S-04	12 11 11	0	1408 1439 [20]	
	37		2		NA											
2304	38	12		43	NA	NA	NR								1445 1528 [36]	
	39				NA											
2302	40				NA											
	41	13		45	NA	NA	NR								1533 1600 [20]	
2300	42				NA											
	43	14		57	NA	NA	NR								1606 1611	
2298	44				NA										[20]	
	45															

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-05

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-05

Sheet 4 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	14	2	57	NA	NA			COBBLES and GRAVELS in a washed-out CLAY matrix; brown (10YR 4/3) --ALLUVIUM--*(continued)*						0% Fluid return
2296	46	15		65	NA NA NA	NA	NR							1620 1626 [15]	
2294	48	16		0	NA NA NA	NA	NR							1634 1711 [20] 1717	Bit blocked off during run
2292	50								**TOTAL DEPTH = 50.0 FEET**						
	51														
2290	52														
	53														
2288	54														
	55														
2286	56														
	57														
2284	58														
	59														
2282	60														
	61														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-06

Sheet 1 of 4

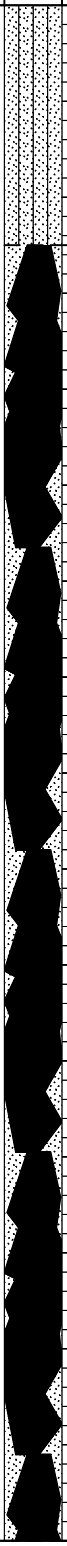
Date(s) Drilled	**10/8/2018-10/9/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch diamond core bit**	Total Depth of Borehole	**56.9 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2339 feet**
Groundwater Level	**13.7 feet below ground surface 10/8/2018**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Jenny Creek**	Coordinate Location	**N 2603580 E 6453115**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								SANDY LEAN CLAY (CL); stiff; yellowish brown; >50% medium plasticity FINES; fine to coarse grained SAND; GRAVEL up to 2-inches; dry to moist --FILL--						Start 9:10 10/8/2018; hollow stem auger 0-16.5ft.
2338															
	1														
	2														
2336															
	3														
	4														
2334															
	5										S-01	3 6 4			S-01 One liner retained (5-5.5ft.)
	6														
2332															
	7														
	8														
2330															
	9								SILTY SAND (SM); loose; brownish grey; fine to medium grained SAND; little coarse grained SAND and wood fragments; wet --ALLUVIUM--						Smoother drilling at 9.0ft.
	10										S-02	2 1 3			S-02 One liner retained (10.5-11ft.) SA: S=75%; F=25%
2328															
	11														
	12														
2326															
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-06

Sheet 2 of 4



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13							SILTY SAND (SM); loose; brownish grey; fine to medium grained SAND; little coarse grained SAND and wood fragments; wet ∇ --ALLUVIUM--*(continued)*						
	14													
2324														
	15								▨		19			S-03 One liner retained (16-16.5ft.)
	15.5							POORLY GRADED GRAVEL (GP); medium dense; brownish grey; rounded GRAVEL, COBBLES, and BOULDERS; SAND and CLAY infilling; wet		S-03	29			
	16										18			
2322														Switch to rotary wash drilling with 3 7/8-inch tricone bit; advance 4.5-inch casing to 19ft.
	17													
	18							BOULDER						
2320														
	19													
	20													
2318								CLAY, yellowish brown						
	21													Logged from cuttings
	22							CLAY, yellowish brown						
2316														
	23													30-60% Fluid return (higher in boulders)
	24													
2314														
	25							BOULDER						
	26													
2312														
	27							CLAY, reddish brown						
	28													
2310														
	29													

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-06

Sheet 3 of 4

Elevation, feet	Depth, feet	ROCK CORE						Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number			Type	Number	Blows / 6 in.	Recovery, %		
	29								CLAYEY GRAVEL with SAND (GC); medium dense; brownish grey; rounded GRAVEL, COBBLES, and BOULDERS; SAND and CLAY infilling; wet --ALLUVIUM--						
	30											22			S-04 One liner retained (31-31.5ft.) SA: G=53%; S=22%; F=25%
2308											S-04	16			
	31											14			
															Advance 4.5-inch casing to 30ft.
	32														
2306															
	33														
	34														
2304									BOULDER, basalt						
	35														On boulder; no drive sample attempted
	36														
2302															
	37								BOULDER, basalt						
	38														
2300															
	39														
	40											13			S-05 One liner retained (41-41.4ft.)
2298											S-05	27			
	41											50/5			
															Advance 4.5-inch casing to 40ft.
	42														
2296									BOULDER, basalt						
	43														
	44														Total fluid loss at 44ft. (0% fluid return)
2294															
	45														

Log of Soil and Core Boring B-06

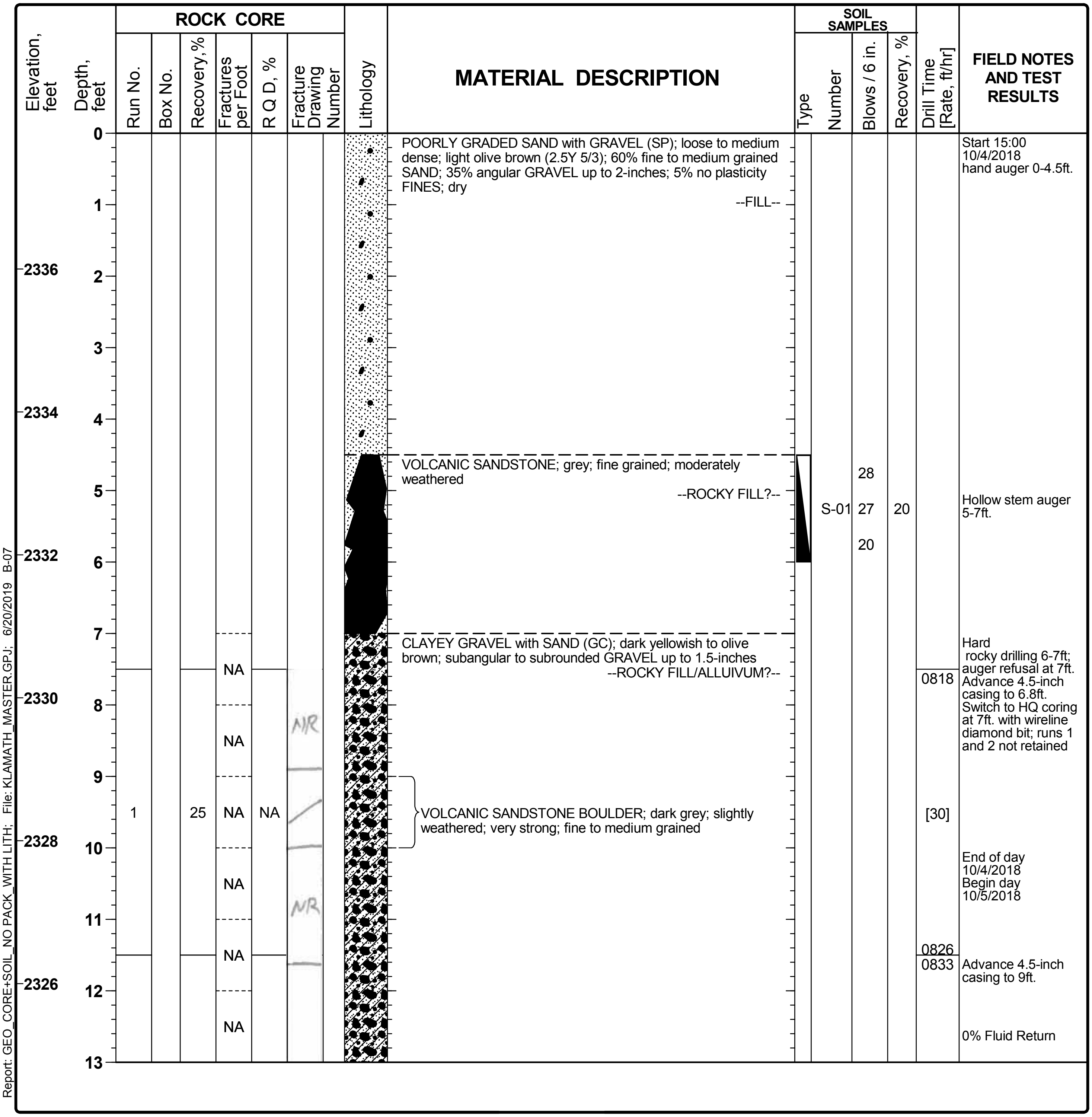
Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45							POORLY GRADED GRAVEL (GP); medium dense; brownish grey; rounded GRAVEL, COBBLES, and BOULDERS; SAND and CLAY infilling; wet --ALLUVIUM--		S-06	7 10 36			S-06 One liner retained (46-46.5ft.) SA: G=93%; S=7%
2292	46													Advance 4.5-inch casing to 45ft.
	47.5							VOLCANIC SILTSTONE/CLAYSTONE; olive grey; moderately to highly weathered; weak; thinly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
2290	49													Hole caving; End of day 10/8/2018 Begin day 10/9/2018
2288	50									S-07	31 40 36			S-07 Two liner retained (50.5-51.0 51.0-51.5ft.) Advance 4.5-inch casing to 50ft.; driller reports consistent olive grey clayey cuttings at 47.5ft.; switch to HQ-3 rock core at 52ft.
	51.3							VOLCANIC SILTY SANDSTONE; light yellowish brown; highly to moderately weathered; weak to moderately strong; fine to medium grained; becomes bluish grey at 51.8ft.						
2286	52	1	1	75	>6 >6 NA	0		VOLCANIC SILTSTONE/CLAYSTONE; reddish brown; moderately weathered; very weak to weak; thinly laminated					1204 [13] 1217	
2284	55	2		40		0							1230 [6] 1235	Formation pressurized; fluid continued to flow from hole after pump stopped; advanced 4.5-inch casing to 55ft; reddish brown clayey cuttings 55.4-56.6 ft.
	56	3		0	NA	0							1253 [7] 1304	
2282	56.5	4		100	NA	0		BASALT; slightly weathered; moderately strong --TERTIARY to QUATERNARY INTRUSIVE BASALT--					1309 [3] 1316	
	57							**TOTAL DEPTH = 56.9 FEET**						
2280	58													
2278	60													

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-07

Sheet 1 of 3

Date(s) Drilled	**10/4/2018-10/5/2018**	Logged By	**B. Kozlowicz**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, 3 7/8-inch diamond core bit**	Total Depth of Borehole	**31.8 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2338 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Jenny Creek**	Coordinate Location	**N 2603568 E 6453234**



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								POORLY GRADED SAND with GRAVEL (SP); loose to medium dense; light olive brown (2.5Y 5/3); 60% fine to medium grained SAND; 35% angular GRAVEL up to 2-inches; 5% no plasticity FINES; dry --FILL--						Start 15:00 10/4/2018 hand auger 0-4.5ft.
	1														
2336	2														
	3														
2334	4														
	4.5								VOLCANIC SANDSTONE; grey; fine grained; moderately weathered --ROCKY FILL?--			28			
	5										S-01	27	20		Hollow stem auger 5-7ft.
2332	6											20			
	7								CLAYEY GRAVEL with SAND (GC); dark yellowish to olive brown; subangular to subrounded GRAVEL up to 1.5-inches --ROCKY FILL/ALLUIVUM?--						Hard rocky drilling 6-7ft; auger refusal at 7ft.
	7.5				NA									0818	Advance 4.5-inch casing to 6.8ft. Switch to HQ coring at 7ft. with wireline diamond bit; runs 1 and 2 not retained
2330	8				NA		NR								
	9	1		25	NA	NA			VOLCANIC SANDSTONE BOULDER; dark grey; slightly weathered; very strong; fine to medium grained					[30]	
2328	10				NA		NR								End of day 10/4/2018 Begin day 10/5/2018
	11													0826	
	11.5				NA									0833	Advance 4.5-inch casing to 9ft.
2326	12				NA										0% Fluid Return
	13														

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13				NA			CLAYEY GRAVEL with SAND (GC); dark yellowish to olive brown; subangular to subrounded GRAVEL up to 1.5-inches --ROCKY FILL/ALLUIVUM?--						Contintued 0% Fluid Return
2324	14	2		0		NA							[75]	
					NA		NR							
	15				NA									
2322	16				NA			SILTY SAND (SM); medium dense; very dark grey (10YR 3/1); 80% fine grained SAND; 20% no to low plasticity FINES --ALLUVIUM--			9		0837	SA: G=4%; S=55%; F=41%
	17				NA			VOLCANIC CLAYSTONE; dusky red (10R 3/3); highly weathered; very weak --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		S-02	37 50/5	100		
2320	18	3		0	NA	NA	NR						0859 [20] 0902	
	19		1		NA		NR	Broken, likely NR zone					0910	
2318	20	4		82	2	36		Becomes slightly to moderately weathered, highly fractured, with occasional small, angular GRAVEL					[12]	
	21				3								0924	
2316	22				5			Becomes mostly moderately weathered, with various amounts of fine to coarse grained SANDSTONE and trace small, subangular GRAVEL, with weak, subhorizontal bedding					1048	
	23				3									
2314	24	5		100	4	10		All Fractures: ?, J, N-VN, No, No, Pl, SR					[17]	
	25				5									
2312	26				6								1106	
	27				4			VOLCANIC SANDSTONE; dark reddish brown (2.5YR 3/4) to dark red (2.5YR 3/6), grades to fine to medium grained					1119	*Rock does not meet soundness criteria for RQD calculation
2310	28				3									
	29													

Log of Soil and Core Boring B-07

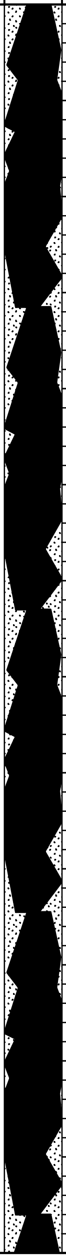
Elevation, feet	Depth, feet	ROCK CORE							Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number			Type	Number	Blows / 6 in.	Recovery, %		
	29	6	1	100	3	16*			▒	VOLCANIC SANDSTONE; dark reddish brown (2.5YR 3/4) to dark red (2.5YR 3/6), grades to fine to medium grained --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[16]	
2308	30				4											
	31				NA					Shoe disturbed					1138	
2306	32									**TOTAL DEPTH = 31.8 FEET**						
	33															
2304	34															
	35															
2302	36															
	37															
2300	38															
	39															
2298	40															
	41															
2296	42															
	43															
2294	44															
	45															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-08

Sheet 1 of 4

Date(s) Drilled	**10/16/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch diamond HQ bit**	Total Depth of Borehole	**52.8 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2194 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.0-inch ID California Sampler, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Lakeview Bridge**	Coordinate Location	**N 2587323 E 6441439**



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2194	0								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry --FILL--						Start 11:30 10/16/2018; hollow stem auger 0-3ft.
	1														
2192	2														
	3														Switch to rotary wash drilling at 3ft.
2190	4														
	5														
2188	6														
	7														
2186	8														
	9														
2184	10														Advance 4.5-inch casing to 10ft.
	11														
2182	12														
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-08

Sheet 2 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13								GRAVELLY FAT CLAY with SAND (CH); very stiff; olive brown; medium to high plasticity FINES; trace fine grained SAND; occasional fine to coarse GRAVEL; wet --FILL--*(continued)*		S01	4 7 13			LL= 69; PL=22
2180	14														
	15								Rocky layer Becomes greyish green						Rig chatter with grayish green cuttings
2178	16								SILT with SAND (ML); very soft; olive brown; low plasticity FINES; trace fine to coarse grained SAND; occasional fine GRAVEL; wet --FILL--		S02	0 0 0			S-02 advanced with weight of hammer to 8-inches then pushed to 18-inches with 100 psi without liners SA: G=8%; S=12%; F=80%
	17														
2176	18														
	19														
2174	20										S03	7 3 3			Advance 4.5-inch casing to 20ft; bluish grey cuttings; S-03 driven without liners
	21								Rocky layer						
2172	22														
	23								Rocky layer POORLY GRADED GRAVEL with SAND (GP) to POORLY GRADED SAND with GRAVEL (SP); dense; brown; fine to medium, locally coarse grained SAND; fine to coarse GRAVEL; wet --ALLUVIUM--						Driller notes smooth drilling below 23.5ft.
2170	24														
	25										S04	50/5			Advance 4.5-inch casing to 25ft.
2168	26														
	27								VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; highly fractured; fine grained with rounded clasts up to 2 1/2-inches; well cemented with mechanical breaks along fractures --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						Basalt chip in cuttings; steady drilling
2166	28														
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-08

Sheet 3 of 4

		ROCK CORE								SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29								VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; highly fractured; fine grained with rounded clasts up to 2 1/2-inches; well cemented with mechanical breaks along fractures --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
2164	30														
	31														
2162	32														
	33														
2160	34														
	35	1	1	100	0	89	m m m m							1512	Switch to HQ-3 rock coring at 35ft.
2158	36				0		m m,m m m m							[15]	
	37				NA		m 1		1: 70, J, VN, Ch?, Pa, Pl-Wa, SR					1523	
2156	38	2		100	1	95	m m							1532	
	39				1		1 1 m m		VOLCANIC SANDSTONE; light to medium grey; slightly weathered to fresh; moderately strong; highly fractured; fine grained with angular, white clasts up to 5 mm						
2154	40				1		m,m m 2 m 2							[16]	
	41				1				1: 40, J, VN-N, No, No, Wa, SR 2: 20, J, N, Cl, Pa, Wa, SR 3: 80, J, N-MW, Ca, Fi, Wa, SR						
2152	42				1		m 3							1551	
	43				1		m m 1 m,m m		1: 80-90, J, N-MW, Ca, Fi, Wa, SR					1600	
2150	44				0		m								
	45														

Log of Soil and Core Boring B-08

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	3	1	100	1	70	2		VOLCANIC SANDSTONE; light to medium grey; slightly weathered to fresh; moderately strong; highly fractured; fine grained with angular, white clasts up to 5 mm --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[21]	
2148	46				0		m		2: 60, J, Vn, Ch/Cl, Fi, Pl, SR						UCS = 15268 psi
	47				0		m m							1614	
2146	48		2		2		1 2		VOLCANIC CONGLOMERATE 1: 5-15, J, VN-N, Cl, Pa, Wa, SR 2: 40, J, VN, Fe, Su, Pl, S 3: 50-60, J, Vn, Qz, Su, Pl, S					1622	
	49				3		1 3 4		VOLCANIC CONGLOMERATE						
2144	50	4		100	3	42	4 5,6 6		VOLCANIC CONGLOMERATE 4: 30, J, VN, Qz, Pa/Su, Pl-Wa, S-SR 5: 40, J, VN, Qz, Su/Pa, Pl-Wa, S-SR 6: 40, J, VN, Qz, Su/Pa, Pl-Wa, S-SR 7: 10, J, T, H+Uk, Uk, Wa, SR 8: 60, J, VN, Qz, Su, Pa, Pl, S					[17]	
	51				3		7 1,6		VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; highly fractured; fine grained with rounded clasts up to 2 1/2-inches; well cemented with mechanical breaks along fractures						
2142	52				NA		8, 4							1640	
	53								TOTAL DEPTH = 52.8 FEET						
2140	54														
	55														
2138	56														
	57														
2136	58														
	59														
2134	60														
	61														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-10

Sheet 1 of 4

Date(s) Drilled	**10/17/2018-10/18/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch diamond HQ bit**	Total Depth of Borehole	**52.2 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2194 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Lakeview Bridge**	Coordinate Location	**N 2587076 E 6441583**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry --FILL--						Start 10:10 10/17/2018; rotary wash drilling 0-29.5
	1														
2192															
	2														
	3														
2190									CLAYEY SAND (SC); medium dense; reddish brown; fine to coarse grained SAND; medium to high plasticity FINES; trace to some GRAVEL; moist		S01	10 6 4	0		
	4														
	5														
2188									POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry						
	6														
	7														
2186															
	8														
	9														
2184															
	10														Too cobbley for drive sample at 10ft.
	11														
2182															
	12														
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-10

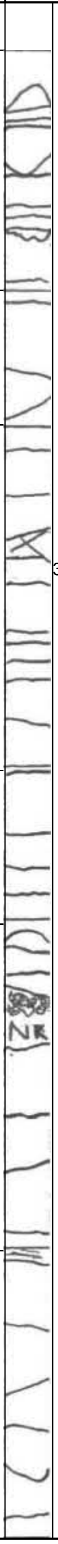
Sheet 2 of 4

Elevation, feet	Depth, feet	ROCK CORE						Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number			Type	Number	Blows / 6 in.	Recovery, %		
	13								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; greyish brown; fine to coarse grained SAND; fine to coarse, angular to rounded GRAVEL with COBBLES and BOULDERS; dry --FILL--*(continued)*						
2180															
	14														
	15														
2178															
	16														
	17														
2176															
	18														
	19														
2174															
	20														
	21														
2172															
	22														
	23														
2170															Advance 4.5-inch casing to 23.5ft.
	24														
	25														
2168												12			
	26										S02	20			S-02 bagged
												26			
	27														
2166									VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; rounded clasts up to 2 1/2-inches in a fine grained matrix; moderately fractured with mechanical breaks around clasts; well cemented --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
	28														
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-10

Sheet 3 of 4



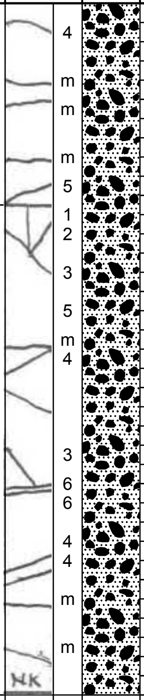
Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29							VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; rounded clasts up to 2 1/2-inches in a fine grained matrix; moderately fractured with mechanical breaks around clasts; well cemented --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
2164			1		NA								1305	Switch to HQ-3 rock coring at 29.5ft.
	30						1 2 m m							
		1		100	1	72	3 m m	1: 60, J, VN, No, No, Pl, S 2: 10, J, VN, Qz, Sp, Pl, S 3: 40, J, VN, Fe, St, Pl, S					[15]	
	31				0		m m m m							
2162	32						m						1315 1335	
		2		100	1	86		1: 35, J, VN, No, No, Pl-Wa, SR 2: 45, J, VN, Fe, St, Wa, S-SR					[14]	
	33						1 2	VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm					1341 1355	Driller reports hard drilling at 33.4ft.
2160					NA		m							
	34				3		m 1 2 3,m	VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm						
	35	3		94	0	78	m m m m m	1: 20, J, VN, No, No, Pl-Wa, SR 2: 40, J, VN, No, No, Pl-Wa, SR 3: 60, J, VN, No, No, Wa, SR 4: 20, J, VN, Qz, Sp, Pl-Wa, SR					[6]	
2158	36				1		4							
	37						m						1430 1442	
2156		4		100	0	100	m m m						[4]	
	38				NA								1505 1525	
	39				1		1 2 m 3	VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm						
2154	40	5		91	0	71	m m	1: 30, J, VN, No, No, Pl-Wa, SR 2: 20, J, VN-N, Fe, St, Pl, SR 3: 60, J, MW, Qz, Pa-Sp, Wa, SR-R 4. 30, J, N-MW, Qz, Sp, Wa-Pl, SR					[8]	
	41				1		4 m m	VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm						
2152	42				2		1						1550 0755	End of day 10/17/2018 Begin day 10/18/2018
	43				2		2	1: 10-15, J, N, Fe, St, Pl-Wa, SR 2: 30, J, T-VN, Fe, St, Pl, S 3: 55, J, N-MW, Fe, St, Wa-Pl, S-SR						
2150	44	6	2	100	1	69	1 3 m						[9]	
	45													

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-10

Sheet 4 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45–46		2		1		4 m m						
2148	46–47				1		m 5					0830	
2146	47–48	7		82	NA	71	1 2 3					0847	
	48–49				2		5 m 4						
2144	49–50				2		3 6					[9]	
	50–51				3		6 4 4						
2142	51–52.2				NA		m m					0920	



Lithology / MATERIAL DESCRIPTION

VOLCANIC CONGLOMERATE; medium grey; slightly weathered to fresh; moderately strong to strong; rounded clasts up to 2 1/2-inches in a fine grained matrix; moderately fractured with mechanical breaks around clasts; well cemented
--TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*

4: 20, J, T, No, No, Pl, S
5: 60, J, N, Fe, St, Wa-St, SR-R

1: 85-90, J, T, H+Uk, Pl-Wa, SR
2: 50, J, N, Fe, St, Wa, SR
3: 60, J, N-MW, Fe, St, Pl-Wa, SR
4: 60, J, VN, Fe, St, Pl-Wa, SR
5: 50, J, VN, Fe, St, Wa, SR
6: 10, J, VN-N, Fe, St, Pl, SR

VOLCANIC SANDSTONE; light to medium grey; slightly weathered; strong; fine grained with white clasts up to 6 mm

TOTAL DEPTH = 52.2 FEET

Depth scale, feet: 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61
Elevation scale, feet: 2148, 2146, 2144, 2142, 2140, 2138, 2136, 2134

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-13

Sheet 1 of 2

Date(s) Drilled	**10/3/2018**	Logged By	**B. Kozlowicz**	Reviewed By	**B. Aldridge**
Drilling Method	**HQ-3 Rock Core**	Drill Bit Size/Type	**3 3/4-inch diamond core bit**	Total Depth of Borehole	**21.1 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2494 feet**
Groundwater Level	**Not encountered before HQ rock coring**	Sampling Methods	**HQ Core Barrel**	Inclination from Horizontal/True North Bearing	**Vertical**
Borehole Completion	**Bentonite cement grout to ground surface**	Location	**Fall Creek**	Coordinate Location	**N 2606346 E 6463221**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
2494	0								1-inch ASPHALT WELL GRADED SAND with GRAVEL (SW); medium dense to dense; dark yellowish brown (10YR 4/4); fine to coarse grained SAND; angular to rounded GRAVEL up to 2-inches			Start 12:00 10/3/2018 hand auger 0-3.5ft.
	1								--ROAD BASE--			
2492	2	1	1	60	NA	0			BASALT; very dark grey to black; slightly to moderately weathered; strong; highly fractured with iron staining along fracture surfaces; porphyritic; vesicular; with plagioclase phenocrysts up to 1/4-inch and irregular vesicles up to 1/2-inch		1252 [23]	
	3				>6				--TERTIARY to QUATERNARY INTRUSIVE BASALT--		1256 1324	Auger refusal at 3.5ft.; switch to HQ rock coring with 3 3/4-inch diamond bit
2490	4				NA				Becomes dark yellowish brown, locally highly weathered with CLAYEY SAND, with rootlets			0% fluid return
	5	2		28	NA	0					[29]	
2488	6				NA				Becomes highly to locally completely weathered to a CLAYEY SAND/SANDY CLAY with trace small gravel and strong, slightly weathered corestones of BASALT		1330 1338	
	7				>6				CLAYEY SAND/SANDY CLAY			
2486	8				>6							
	9	3		66	NA	0					[20]	
2484	10				NA							
	11				NA						1353 1405	
2482	12	4		68	>6	19			highly fractured with SANDY CLAY infilling			
	13											

Report: GEO_CORE_OAK_C; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-13

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-13

Sheet 2 of 2

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	13	4	1	68	5	19				BASALT; very dark grey to black; slightly to locally completely weathered; strong; highly to intensely fractured; porphyritic; vesicular; with plagioclase phenocrysts up to 2/5-inches and irregular vesicles up to 1/2-inch; fractures are wide and infilled with CLAYEY SAND/SANDY CLAY and small GRAVEL --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*		[28]	Continued 0% fluid return
2480	14				NA								
	15				NA							1415	
2478	16	5		70	>6	18						1424	Bit blocked off during run
	17				4								UCS = 6528 psi
2476	18				3					CLAYEY SAND and GRAVEL with roots		[30]	
	19				NA								
2474	20				NA							1434	
	21									**TOTAL DEPTH = 21.1 FEET**			
2472	22												
	23												
2470	24												
	25												
2468	26												
	27												
2466	28												
	29												

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-14

Sheet 1 of 2

Date(s) Drilled	**10/4/2018**	Logged By	**B. Kozlowicz**	Reviewed By	**B. Aldridge**
Drilling Method	**HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, 3 3/4-inch diamond coring bit**	Total Depth of Borehole	**28.6 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2494 feet**
Groundwater Level	**Not encountered before HQ rock coring**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Fall Creek**	Coordinate Location	**N 2606321 E 6463161**

		ROCK CORE								SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2494	0								WELL GRADED GRAVEL with SAND (GW); loose to medium dense; dark yellowish brown (10YR 4/4); angular to subangular GRAVEL up to 3-inches; fine to coarse grained SAND; trace no plasticity FINES --ROAD FILL--						Start 9:00 10/4/2018 hand auger 0-2ft.
	1								SANDY LEAN CLAY (CL); stiff; very dark brown (7.5YR 2.5/3); 60% low plasticity FINES; 40% fine to medium grained SAND; trace angular, coarse grained SAND; trace fine GRAVEL --ALLUVIUM/COLLUVIUM?--						
2492	2		1						At 2.3ft.: Cored 4-inch cobble of dark grey, VOLCANIC SANDSTONE, fine to medium grained, with dark yellowish brown SANDY CLAY and 1-inch root					0920	Auger refusal at 2.3ft.; switch to HQ rock coring with 3 3/4-inch diamond bit
	3				NA										
2490	4	1		12	NA	0	NR							[27]	Run 1 bagged
	5				NA										
2488	6				NA				FAT CLAY with SAND (CH); very stiff; dark brown (7.5YR 3/3); medium plasticity FINES; fine to medium SAND; rare angular GRAVEL			8		0929	SA: G=1%; S=29%; F=70% LL=62; PL=22
	7				NA						S-01	17 17	60		Two liners retained
2486	8	2		40	NA	0	NR		COBBLES and BOUDLERS with CLAYEY SAND and GRAVEL; dark greenish grey and olive to reddish brown; slightly weathered, moderately strong volcanic sandstone COBBLES --CHANNEL ALLUVIUM-- Becomes grey, volcanic sandstone COBBLE with rounded upper terminus					1026 [18] 1031	
2484	10	3		60	NA NA	25	NR		COBBLES and BOUDLERS become dusky red, fine grained, slightly weathered, very strong intrusive volcanic					1040 [13] 1049	80-100% fluid return
2482	12	4		7	NA NA	0								1058 [18] 1103	Coarse grained SAND in cuttings
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-14

Sheet 2 of 2

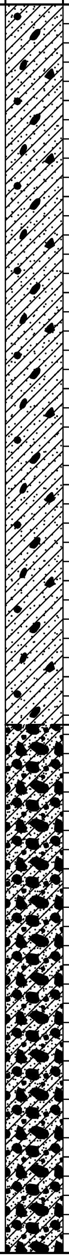
Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13	5	1	100	1	0			PORPHYRITIC ANDESITE; very dark greyish brown (10YR 3/2); highly weathered; very weak; locally friable; with steeply dipping vein infilled with very pale yellow, fine grained SAND --TERTIARY VOLCANICS, undifferentiated--					1103 [6] 1109 1124	100% fluid return
2480	14				0				Becomes dark reddish brown and very pale yellow, weak to extremely weak, highly to completely altered; with irregular chlorite alteration and vitreous quartz crystals up to 1/4-inch						
	15				0										
2478	16	6		70	0	0								[18]	
	17				NA		NR								
2476	18				NA									1141 1149	Fast drilling 18.6 to 20.5ft likely no recovery zone
	19				NA		NR*								
2474	20				NA										
	21	7		62	0	0								[19]	
2472	22				0										
	23				0									1205 1215	
2470	24	8		80	NA	0	NR							[12] 1220 1228	
	25				4				Becomes moderately to locally highly weathered, moderately strong, highly fractured						
2468	26	9		63	3	0								[17]	
	27				NA				Becomes highly to completely weathered, extremely weak, friable						
2466	28				NA		NR							1242	
									TOTAL DEPTH = 28.6 FEET						
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-15

Sheet 1 of 4

Date(s) Drilled	**1/22/2019-1/23/209**	Logged By	**S. Janowski**	Checked By	**P. Respess**
Drilling Method	**Solid Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch solid stem auger, 4-inch diamond coring bit**	Total Depth of Borehole	**51.5 feet**
Drill Rig Type	**Truck Mounted CME 75**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2344 feet**
Groundwater Level	**11.7' 1/23/2019**	Sampling Methods	**2.5-inch ID ModCal, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**North end of Daggett Road Bridge**	Coordinate Location	**N 2602349 E 6462482**



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2344	0								SANDY LEAN CLAY with GRAVEL (CL); very stiff; moist; dark brown (10yr3/3); 20% subrounded to rounded GRAVEL to 3/4"; 20% fine- to medium-grained SAND; 60% medium plasticity FINES --FILL--						
	1														
2342	2														
	3														
2340	4														
	5											6			pp=3.0 tsf
2338	6										1-1 1-2	6	78		
												8			
	7														
									CLAYEY GRAVEL with SAND (SC); very dense; moist; yellowish brown to dark brown; interbedded layers of gravel with clay and sand --ALLUVIUM--						Fill estimate based on height of slope embankment
2336	8														
	9														
2334	10										2	100/1"	100		
	11								▼						
2332	12														
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-15

Sheet 2 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13									CLAYEY GRAVEL with SAND (SC); very dense; moist; yellowish brown to dark brown; interbedded layers of gravel with clay and sand --ALLUVIUM-- *(continued)*						
2330	14															
	15												16			SA: G=42%; S=27%; F=31%
												3	20	78		
													34			
2328	16															
	17									BASALT BOULDERS and COBBLES in SAND & GRAVEL matrix; medium dark gray (N4) to dark gray (N3), strong, some boulders are scoriaceous, matrix washed out --ALLUVIUM--						Rig chatter
2326	18															
	19															
2324	20												17			
												4	50	61		
	21	1	1	100		0							50		0921 [6] 0926	End of day 1/22/2019
					NA										0933	Begin day 1/23/2019; AM water level=11.7' bgs Switch to HQ rock core
2322	22															
					NA											
	23															
					NA		NR									
2320	24	2		2		0									[100]	
					NA											
	25															
					NA											
2318	26															
					NA										0936	
												5	65	100		
	27														0956	
					NA											
2316	28	3		71		27*	NR									*Rock does not meet soundness criteria for RQD calculation
					NA					VOLCANICLASTIC BRECCIA --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
	29															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-15

Sheet 3 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	3	1	71	5	27*	1,1 1 1	△ △	VOLCANICLASTIC BRECCIA; light olive gray (5Y5/2); moderately weathered; weak; highly to intensely fractured; angular clasts to 1/2" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--					[68]	
2314	30				6		1 1	△ △	1: 20°, J, MW, Sd, Sp, Wa, R Becomes grayish blue-green (5BG5/2); slightly weathered; moderately strong						*Rock does not meet soundness criteria for RQD calculation
	31				0		M	△ △						1000 1008	
2312	32				3		1 1 M 1 M	△ △	1: 30°, J, MW, Sd+Fe, Sp+Su, Wa, R						
	33				1		M 1	△ △							
2310	34	4		100	0	82		△ △	Becomes slightly fractured					[60]	
	35				0			△ △							
2308	36				0		M	△ △						1013 1017	
	37				0		M M	△ △							
2306	38				0		M M	△ △	Becomes light olive gray (5Y5/2); moderately weathered; weak; highly fractured						
	39	5		100	1	96*	1	△ △	1: 15°, J, MW, Fe, Su, Wa, VR					[75]	*Rock does not meet soundness criteria for RQD calculation
2304	40		2		1		M M 2	△ △	2: 60°, J/Sh, MW, Fe+Mn+Sd, Su+Sp, Wa, R						
	41				2			△ △	Becomes grayish blue-green (5BG5/2); slightly weathered 1: 20°, J, MW, No, No, Wa-St, VR					1021 1024	
2302	42				1		1 1 M	△ △	Becomes moderately fractured						
	43				0			△ △							
2300	44	6		100	0	72	M	△ △						[43]	
	45						M	△ △	Becomes weak to very weak						

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-15

Sheet 4 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	6	2	100	4	72	1 1	△ △	VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); slightly weathered; weak to very weak; highly fractured; angular clasts to mostly to 1/2", occasionally to 1.5" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
2298	46				0		M M	△ △							
	46.5	7		100		94	M	△ △						1031 1035	UCS = 1546 psi
	47				0		M	△ △							
2296	48				1		1	△ △	1: 20°, J, MW, No, No, Wa, R 2: 15°, J, N-VN, Sd+Si, So-Pa, Pl, R-SR						
	49				2		2,2	△ △						[43]	
2294	50				2		2 2	△ △							
	51				0		M	△ △						1042	
	51.5								**TOTAL DEPTH = 51.5 FEET** **Grout mix: 30 gallons of water, six 47# bags of cement, no bentonite**						
2292	52														
	53														
2290	54														
	55														
2288	56														
	57														
2286	58														
	59														
2284	60														
	61														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-16

Sheet 1 of 2

Date(s) Drilled	**1/12/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3-7/8-inch tricone, 3 3/4-inch diamond coring bit**	Total Depth of Borehole	**24.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2319 feet**
Groundwater Level	**12 feet above ground surface**	Sampling Methods	**SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**12' downstream of Daggett Road bridge**	Coordinate Location	**N 2602237 E 6462573**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0							△ △	VOLCANICLASTIC BRECCIA; gray-green; completely weathered; extremely weak; fine-grained matrix; dark gray-black angular clasts up to 1/4"-1/2"; slightly fractured with widely-spaced natural fractures; numerous mechanical breaks --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--	▯		3			12' of water in river at time of drilling
								△ △			1	5			
2318	1							△ △				15			5" HWT casing driven to 14' (refusal) Tricone to 15' and continue with HQ core High Water Circulation Return (WCR)
	2							△ △							
2316	3		1				M	△ △	▼ Becomes moderately to slightly weathered; moderately strong; slightly fractured; multi-colored clasts up to 2"					1024	
					0		M M	△ △	Broken mechanical						
		1		100		100		△ △						[90]	
	4						M	△ △							
					0		M M	△ △						1025 1029	
2314	5							△ △							
					0			△ △							
	6						M	△ △							
					0			△ △							
2312	7	2		100		100	1	△ △	1: 20°, J, N, No, No, Wa, SR					[150]	
					1		M	△ △							
	8							△ △							
					0			△ △							
2310	9							△ △							
					0		M	△ △						1031 1034	
	10							△ △							
					0		M	△ △							
2308	11							△ △							
					0			△ △							
	12	3		100		100	M	△ △						[100]	
					0		M	△ △							
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-16

Sheet 2 of 2

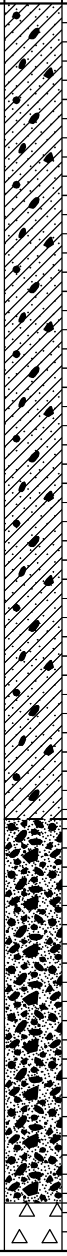
Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2306	13	3	1	100	0	100	M	VOLCANICLASTIC BRECCIA; gray-green; moderately to slightly weathered; moderately strong; slightly fractured; multi-colored clasts up to 2"; numerous mechanical breaks. Becomes clasts up to 3-4" at 13.8' --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						High WCR
	14				0		M						1037 1040	
2304	15		2		0		M M							
	16				1		1	1: 30°, J, N, No, No, Pl-Wa, SR						
2302	17	4		100	0	100	M						[150]	
	18				0		M M							
2300	19				0		M M						1042 1045	
	20				0									
2298	21				0		M							
	22	5		96	0	96	M M						[75]	
2296	23				0		1							
	24				NA		NR						1049	
	24.5							**TOTAL DEPTH = 24.5 FEET** **15 gallons of grout: 6 sack mix with 5% bentonite**						
2294	25													
	26													
2292	27													
	28													
	29													

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-17

Sheet 1 of 3

Date(s) Drilled	**1/22/2019**	Logged By	**S. Janowski**	Checked By	**P. Respess**
Drilling Method	**Solid Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch solid stem auger, 4-inch diamond coring bit**	Total Depth of Borehole	**41.5 feet**
Drill Rig Type	**Truck Mounted CME 75**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2341 feet**
Groundwater Level	**Not encountered before HQ rock coring**	Sampling Methods	**2.5-inch ID ModCal, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**South end of Daggett Road Bridge**	Coordinate Location	**N 2602195 E 6462721**

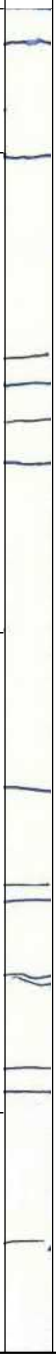


Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								GRAVELLY CLAY with SAND (CL); stiff; moist; dark brown (7.5YR3/3); subangular to subrounded GRAVEL to 1/2"; medium-grained SAND; medium plasticity FINES --FILL--						
2340															
	1														
	2														
2338															
	3														
	4														
2336															
	5										1-1	5	100		pp=1.0 tsf Driller adds water to facilitate advancement
											1-2	50/5"			
	6														
2334															
	7														
	8														
2332									SANDY GRAVEL (GP); very dense; moist; brown; subangular to subrounded GRAVEL to 2.25"; medium- to coarse-grained SAND --ALLUVIUM--						
	9														
	10										2-1	42	100		
											2-2	50/4"			
2330															
	11														
	12														
2328									VOLCANICLASTIC BRECCIA --TERTIARY VOLCANICS--						Driller felt change during advancement
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-17

Sheet 2 of 3



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13								VOLCANICLASTIC BRECCIA; greenish-gray (5G6/1); slightly weathered; moderately strong; slightly fractured; angular clasts to 1/2" in fine matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
	14														
2326															
	15		1							‖	3	50/4"	100	1110	Switch to HQ core
							M								
					0										
		1		100		100								[45]	
	16														
2324					0		M							1112 1147	
	17														
					0										
	18														UCS = 2130 psi
2322					0		M								
							M								
	19	2		100		100								[75]	
							M								
					0		M								
	20														
2320					0										
	21														
					0									1151 1216	
	22														
2318					0										
	23						1		Very weak 1: 20°, J, VN, Cl+Sd, Sp, Pl, S-SR						
					1										
	24	3		100		84	1 1		Weak					[100]	
2316					2										
	25						M								
					0										
	26						M M								
2314					0									1219 1223	
	27														
					0										
		4		100		100	M							[75]	
	28														
2312					0										
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-17

Sheet 3 of 3

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29		2		0			VOLCANICLASTIC BRECCIA; greenish-gray (5G6/1); slightly weathered; moderately strong; slightly fractured; angular clasts to 1/2" in fine matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*		
2310	30	4		100	0	100			[75]	
	31				0		M	Coarser clasts to 2"	1227 1231	
2308	32				0					
	33				0					
2306	34	5		100	1	86			[100]	
	35				3		1	Light brownish gray (5YR6/1); moderately weathered; weak; highly fractured 1: 60°, J/Sh, W, Ca+Mn+Fe, Pa+Su IR, VR-Slk (rough grooves)		
2304	36				0		M	Abundant mechanical fractures	1234 1239	
	37				0		M M			
2302	38				0		M			
	39	6		100	0	100			[75]	
2300	40				0		M	1.5" Clast		UCS = 2985 psi
	41				0				1243	
								TOTAL DEPTH = 41.5 FEET **Grout mix: 20 gallons of water, five 47# bags of cement, no bentonite**		
2298	42									
	43									
2296	44									
	45									

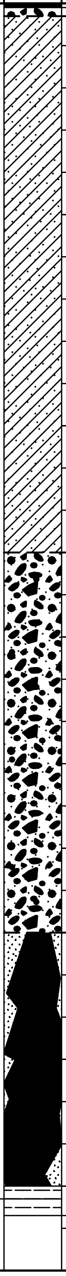
SOIL SAMPLES: Type | Number | Blows / 6 in. | Recovery, %

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring B-18

Sheet 1 of 1

Date(s) Drilled	**10/11/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**28.3 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2347 feet**
Groundwater Level(s)	**15.0 feet below ground surface (10/11/2018)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Scotch Creek**	Coordinate Location	**N 2603250 E 6441988**



Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0					2.5-inches ASPHALT roadway GRAVEL SANDY LEAN CLAY (CL); medium stiff to stiff; reddish brown; 80-90% medium plasticity FINES; 10-20% fine to coarse grained SAND; occasional GRAVEL and COBBLE --FILL--				Start 10/11/2018; hollow stem auger 0-28ft. Smooth drilling
2345										
	5					GRAVEL				Rig chatter Return to smooth drilling to 13ft.
2340										
	10									
2335										
						POORLY GRADED GRAVEL with SAND (GP); medium dense; varied dark grey with purple, red, and yellowish brown; fine to coarse angular GRAVEL, COBBLES, and BOUDLERS; fine to coarse grained SAND --FILL--*(continued)* ▽				Rig chatter
	15									
2330						BOUDLER				Driller indicates hard rock at 18ft.
	20									
2325						ALLUVIUM				Driller indicates smooth, consistent drilling 22-25ft.
	25	▣ ◫	S-01 S-02	50/3 100/4	0	BOUDLER, basalt				
2320										
		◫	S-03	100/4		VOLCANIC SILTSTONE; reddish purple; slightly weathered to fresh; weak to moderately strong; very thinly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS)?-- **TOTAL DEPTH = 28.3 FEET**				
	30									

Project: **Klamath River Renewal Project**
Project Location: **Copco and Iron Gate Reservoirs**
Project Number: **60537920**

Log of Soil and Core Boring B-19

Sheet 1 of 3

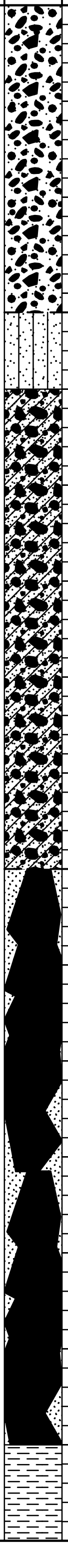
Date(s) Drilled	**10/11/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch #6 HQ bit**	Total Depth of Borehole	**37.5 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2346 feet**
Groundwater Level	**15.0 feet below ground surface (10/11/2018)**	Sampling Methods	**2.5-inch ID ModCal, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Scotch Creek**	Coordinate Location	**N 2603261 E 6442042**

		ROCK CORE								SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	**MATERIAL DESCRIPTION**	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	**FIELD NOTES AND TEST RESULTS**
2346	0								2.5-inches ASPHALT roadway GRAVEL --ROAD BASE--						Start 10/11/2018; hollow stem auger 0-23ft.
	1								SANDY LEAN CLAY (CL); medium stiff to stiff; reddish brown; 80-90% medium plasticity FINES; 10-20% fine to coarse grained SAND; occasional GRAVEL and COBBLE --FILL--						
2344	2														
	3														
2342	4														
	5								SANDY SILT (ML); stiff; light reddish brown; non to medium plasticity FINES; fine to medium grained SAND --FILL--		S01	9 8 10			S-01 One liner retained (6-6.5ft.) SA: S=30%; F=70%
2340	6														
	7														
2338	8														
	9														
2336	10								FAT CLAY with SAND (CH); medium stiff; light reddish brown; high plasticity FINES; fine to medium grained SAND --FILL--		S02	9 7 7			S-02 One liner retained (11-11.5ft.) LL=54; PL=22
	11														
2334	12														
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-19

Sheet 2 of 3

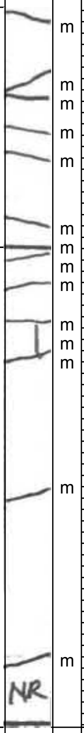


Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13							POORLY GRADED GRAVEL with SAND (GP); medium dense; dark grey with some yellow brown; fine to coarse angular GRAVEL, COBBLES, and BOUDLERS; fine to coarse grained SAND; trace to little low plasticity FINES; moist to wet --FILL--*(continued)*						Rig chatter
	14													
2332														
	15							∇			6			S-03 One liner retained (16-16.5ft.) SA: G=6%; S=42%; F=52%
										S03	4			
	16													
2330								SANDY SILT (ML); soft to medium stiff; dark grey; fine grained SAND; low plasticity FINES; trace GRAVEL; wet			4			
	17							CLAYEY GRAVEL with SAND (GC); medium dense; dark grey with some yellow brown; fine to coarse angular GRAVEL, COBBLES, and BOUDLERS; fine to coarse grained SAND; low plasticity FINES; moist to wet						Continued rig chatter
	18													
2328														
	19													
	20													
2326											12			S-04 One liner retained (21-21.5ft.) SA: G=40%; S=34%; F=26%
	21									S04	21			
											12			
	22							ALLUVIUM						
2324														
	23							BOUDLER, basalt						
	24													
2322														Switch to rotary wash drilling with 3 7/8-inch tricone bit; yellowish brown clayey cuttings with rounded gravel 24.5-28ft.
	25													
	26													
2320														
	27													
	28							VOLCANIC SILTY CLAYSTONE/SILTSTONE; reddish purple; slightly weathered; weak; very thinly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						Reddish purple clayey and rock cuttings
2318														
	29													

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-19

Sheet 3 of 3



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29								VOLCANIC SILTY CLAYSTONE/SILTSTONE; reddish purple; slightly weathered; weak; very thinly laminated --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
2316	30		1		0		m		Becomes weak to moderately strong	◫	S05	50/3		1150	Switch to HQ rock coring with 3 7/8-inch diamond bit; all breaks mechanical
	31	1		100	0	100	m m m m							[8]	
2314	32				0		m m m m							1208 1215	
	33				0		m m m								
2312	34				0										
	35	2		86	0	86	m							[13]	
2310	36				0		m								0.7 ft. of core slipped out of core barrel; left in hole prior to grouting
	37				NA									1238	
									TOTAL DEPTH = 37.5 FEET						
2308	38														
	39														
2306	40														
	41														
2304	42														
	43														
2302	44														
	45														

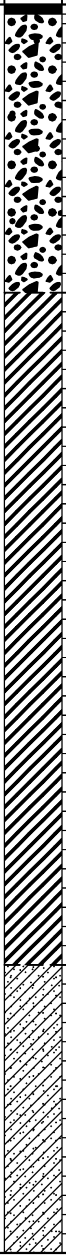
Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-19

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-20

Sheet 1 of 4

Date(s) Drilled	**10/10/2018**	Logged By	**P. Respess**	Reviewed By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger, Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 3 7/8-inch #6 HQ bit**	Total Depth of Borehole	**47.0 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2340 feet**
Groundwater Level	**14.5 feet below ground surface 10/10/2018**	Sampling Methods	**2.5-inch ID ModCal, SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Camp Creek**	Coordinate Location	**N 2602768 E 6443160**



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								2.5-inches Aggregate base						Start 9:00 10/10/2018; hollow stem auger 0-28ft.
2340									POORLY GRADED GRAVEL (GP); dense; fine to coarse GRAVEL and COBBLES, little no plasticity FINES; moist --FILL--						
	1														
	2														
2338															
	3								FAT CLAY (CH); medium stiff; brown; medium plasticity FINES; trace fine grained SAND; occasional GRAVEL and COBBLES; moist						
	4														
2336															
	5											3			S-01 One liner retained (5.5-6ft.) LL=87; PL=24
	6										S01	5			
2334												6			
	7														
	8														
2332															
	9														
	10								SANDY LEAN CLAY (CL); medium stiff; brown; medium plasticity FINES; fine to coarse grained SAND; rare GRAVEL; moist			4			S-02 One liner retained (10.5-11ft.) SA: G=3%; S=33%; F=64%
2330											S02	4			
	11											6			
	12														
2328															
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-20

Sheet 2 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13								SANDY LEAN CLAY (CL); medium stiff; brown; medium plasticity FINES; fine to coarse grained SAND; rare GRAVEL; moist --FILL--*(continued)*						
	14								SANDY CLAY to CLAYEY SAND (CL-SC); medium stiff; olive brown; ~ 50% medium plasticity FINES; ~50% fine to coarse grained SAND and fine GRAVEL ∇						
2326															
	15										S03	7 8 7			S-03 One liner retained (16-16.5ft.)
	16														
2324															
	17								POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse grained SAND; fine to coarse GRAVEL with COBBLES and BOULDERS, wet --ALLUVIUM--						
	18														
2322															
	19														
	20								CLAYEY SAND (SC); medium dense; fine to coarse grained SAND; fine GRAVEL with COBBLES and BOULDERS, wet --ALLUVIUM--		S04	4 5 6			S-04 One liner retained (21-21.5ft.) SA: G=14%; S=42%; F=44%
2320															
	21														
	22														
2318															
	23														
	24														
2316															
	25										S05	22 24 18			S-05 One liner retained (26-26.5ft.)
	26														
2314															
	27														
	28								BOULDER: 28-29.5 ft.						Switch to rotary wash drilling with 3 7/8-inch tricone bit at 28ft.
2312															
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-20

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Elevation, feet	Depth, feet	ROCK CORE Run No.	 Box No.	 Recovery, %	 Fractures per Foot	 R Q D, %	 Fracture Drawing	 Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	 Number	 Blows / 6 in.	 Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29									BOULDER: 28-29.5 ft. --ALLUVIUM--*(continued)*						
										POORLY GRADED GRAVEL with SAND (GP); medium dense to dense; fine to coarse grained SAND; fine to coarse GRAVEL with COBBLES and BOULDERS						
	30															Skip sample; rig behavior indicates gravel and cobbles
2310																
	31									BASALT; dark grey; slightly weathered; moderately strong; with Fe staining around joints; chlorite and quartz infilling; numerous healed fractures --TERTIARY to QUATERNARY INTRUSIVE BASALT--						
	32															
2308																
	33															
	34															
2306																
	35															Skip sample; rig behavior indicates gravel and cobbles
	36															
2304																
	37															
	38															
2302																
	39															
	40		1		3			1 2 3			▭	S06	60/1.5		1305	Switch to HQ rock coring with 3 7/8-inch diamond bit UCS = 343 psi
2300																
	41	1		100	2	30		m 4 5							[7]	
	42				2			1 6		1: 60, J, N, Fe+Ch, Pa, Wa-Pl, SR 2: 70-90, J, VN, Fe, Pa, Wa, SR 3: 70, J/V, Vn, Qz, Pa, Wa, SR 4: 60, V, VN, Qz, Pa-Sp, Wa-Pl, SR 5: 40, J/V, N, Qz+Ch, Fi, Wa, ? 6: 40, J, VN, Ch, Pa-Su, Pl-Wa, SR					1328	
2298															1338	
	43				0											
	44				1											
2296																
	45	2		100		79		1		1: 40, J, VN, Ch, Fi, Pl, ?					[12]	

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-20

Sheet 4 of 4

Elevation, feet	Depth, feet	ROCK CORE							Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number			Type	Number	Blows / 6 in.	Recovery, %		
	45		1		1			2	▨	BASALT; dark grey; slightly weathered; moderately strong; with Fe staining around joints; chlorite and quartz infilling; numerous healed fractures --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*						UCS = 7517 psi
	46				2			3		2: 60, J/V, W (20mm), Ch, Fi, Wa, ? 3: 60, J, N, Ch, Sp, SR, ? 4: 70, J, VN, Ch, Sp, SR						
2294								4							1400	
	47									**TOTAL DEPTH = 47.0 FEET**						
	48															
2292																
	49															
	50															
2290																
	51															
	52															
2288																
	53															
	54															
2286																
	55															
	56															
2284																
	57															
	58															
2282																
	59															
	60															
2280																
	61															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-201

Sheet 1 of 4

Date(s) Drilled	**8/23/2018 - 8/24/2018**	Logged By	**T. Vande Voorde**	Checked By	**B. Kozlowicz/K. Zeiger**
Drilling Method	**Rotary Wash; HQ-3 Rock Core**	Drill Bit Size/Type	**5-inch tricone; 5-inch rock bit; 4-inch #2 diamond coring bit**	Total Depth of Borehole	**50.5 feet**
Drill Rig Type	**Track Mounted Fraste XL**	Drilling Contractor	**Pitcher Drilling Company**	NAVD 88 Ground Surface Elevation	**2334 feet**
Groundwater Level	**Not encountered before rotary wash drilling**	Sampling Methods	**2.5-inch ID ModCal; SPT; HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir; S of Klamath River**	Coordinate Location	**N 2601064 E 6460697**

		ROCK CORE								SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								SANDY FAT CLAY (CH); very stiff; very dark greyish brown (10YR 3/4) with mottled yellow; 52% high plasticity FINES; 42% medium to coarse grained SAND; 6% angular GRAVEL up to 1 1/4-inch; trace organics (roots); dry --ALLUVIUM--						Start 10:00 8/23/2018 Trash barrel drilling to 3.5ft.
	1														
2332															Trash barrel sample at 1.5ft bagged.
	2														
	3								Becomes brown (10YR 4/3); GRAVEL is volcanic tuff and basalt						Trash barrel sample at 3-3.5ft bagged.
2330															Begin rotary wash drilling at 3.5ft with 5-inch tricone bit
	4														
	5								With streaks of very pale brown (10YR 8/4); GRAVEL up to 1/2-inch			7			Switch to 5-inch rock bit at 5ft.
2328	6										S01	13	50		2 liners retained LL=52; PL=23 SA: G=6.1% S=42.4%; F=51.5%
												17			
	7														
2326															
	8								FAT CLAY (CH); medium stiff; brown (10YR 4/3); 85% high plasticity FINES; 15% fine grained SAND; trace angular GRAVEL up to 1/4-inch; moist; cohesive						Rig chatter
	9														
2324															
	10											2			
											S02	3	33		
	11											4			
2322															
	12														
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-201

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Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2320	13								▨	FAT CLAY (CH); medium stiff; brown (10YR 4/3); 85% high plasticity FINES; 15% fine grained SAND; trace angular GRAVEL up to 1/4-inch; moist; cohesive --ALLUVIUM-- *(continued)*						
	14								▨							
2318	15								▨	Becomes 100% high plasticity FINES; with trace organic material (rodent bone) and black laminations	◪	S03	3 7 5	89		3 liners retained LL=64; PL=26 SA: S=14%; SILT=36.6% CLAY=43.4%
	16								▨							
2316	17								▨							
	18								▨							
2314	19								░	CLAYEY GRAVEL with SAND (GC); medium dense; brown (10YR 4/3); 55% angular basaltic GRAVEL up to 1 1/4-inch; 30% angular coarse grained SAND; 15% low plasticity FINES; wet						
	20								░		▯	S04	7 10 16	33		Possible slough
2312	21								░							
	22								●	BOULDERS and COBBLES; dark bluish grey with white filled vesicles; round to angular COBBLES; some fine to coarse grained SAND; trace FINES; GRAVEL is slightly weathered, strong to very strong basalt --RIVER ALLUVIUM--						Rig chatter Some water loss Basalt fragments in cuttings 22-23ft.
2310	23				NA				●		▯	S05	50	50		Advance 5-inch casing to 23ft. Switch to HQ coring with 4-inch #2 diamond bit at 23.5ft.
	24	1	1	70	NA	NA	NR		●						1231 [4] 1248	
2308	25	2		90	NA	NA	NR		●						1258 [4] 1314	
	26	3		85	NA	NA			●	Round to angular basaltic GRAVEL and COBBLES up to 5-inches; occasional brecciated tuff					1323 [7] 1341	High water take 25.5ft to 29.5 ft.
2306	27				NA		NR		●							
	28	4		100	1	NA			●						1349 [5] 1402	
	29	5		100		80		m 1	×	BASALT (see next page) 1: 25, J, VN, Fe, Su, Pl, SR 2: 25, J, W, Fe+Sd, Fi, Pl, R					1422 [4]	

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-201

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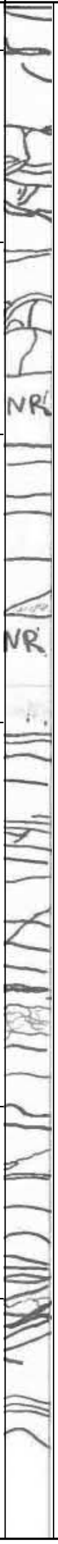
ROCK CORE

Run No.	Box No.	Recovery, %	R Q D, %
5	1	100	80
6		100	40*
7		60	0
8		57	0
9	2	100	25*
10		100	20*
11		100	60*

Depth, feet	Elevation, feet	Fractures per Foot
29		1
	2304	
30		5
31		4
	2302	
32		>6
33		NA
	2300	
34		0
35		NA
	2298	
36		NA
37		4
	2296	
38		3
39		5
	2294	
40		4
41		4
	2292	
42		5
43		5
	2290	
44		0
45		



Fracture Number: 2 3 4 1 2 3 1 4 m 1 2 2 3 4 5 m m m m m 1 m 1 1 1 1 1 1 1 2 2 2 3 2 2 4 m 1 2 2 3 4 m 4 5 1 4 2 2 3

MATERIAL DESCRIPTION

BASALT; moderate bluish grey; slightly weathered; moderately strong to very strong; highly fractured; fine grained; with CaCO3 filled vesicles and occasional green phenocrysts
--TERTIARY to QUATERNARY INTRUSIVE BASALT--

1: 20, J, VN, Fe, Su, Pl, R
2: 80-90, J, VN, Fe, Su, Wa, SR
3: 50, J, N-MW, Fe+Cl, Su+Fi, Pl, SR
4: 60, J, N, Fe, Su, Pl. SR

Becomes slightly to moderately weathered with brown staining along joints; intensely fractured

Becomes light bluish grey; moderately to highly weathered/altered; moderately strong; with 1/2-inch wide Calcite vein
1: 30, J, ?, Fe+Sd, Su+Pa, Pl, R
2: 65, J, VN, Fe+Sd+Ca, Fi, Pl
3: 80, J, VN, H+Fe, Su, Pl, ?
4: 15, J, MW, Fe+Ca, Pa, Ir, VR
5: 70, J, VN, H+Fe+Sd, Fi, Pl

Becomes highly to completely weathered, highly oxidized, yellowish brown

Brown, moderately weathered, moderately strong

Becomes dark yellowish brown to pale tan, completely weathered, very weak, highly fractured, granular, partially decomposed to clay
1: 50, J, ?, No, No, Pl, R (possibly mechanical)

Becomes moderately to highly weathered, moderately strong to strong, fine grained matrix

1: 10-20, J, VN-N, Fe + some are H, Fi-Pa, Pl
2: 20-30, J, N, H+Fe, Fi, Pl
3: 5, J, MW, Fe+Cl, Su+Pa, Ir, R
4: 50, J, N, Fe+Sd, Su+Sp, Pl, R

Intensely fractured/broken, abundant oxidation

Becomes light bluish grey, slightly to locally moderately weathered, strong to very strong, irregular calcite filled vesicles
1: 20, J, N, Fe, Su, Pl, R
2: 15, J, N-VN, H+Fe, Pl, ?
3: 30, J, VN, No, No, Pl, ? (possibly mechanical)
4: 15, J, N, Fe, Su, Pl, R

Becomes moderately strong
5: 20, J, ?, Fe, Su, Pl, R
Intensely fractured

1: 30, J, VN, H+Fe, Fi, Pl
2: 10, J, N-VN, H+Fe, Pl
3: 60, J, VN, H+Fe, Su, Pl, SR
4: 60, J, VN, H+Fe, Fi, Pl

Becomes bluish grey with brownish orange staining along fractures, strong, fine grained, with irregular Calcite filled vesicles and veins

SOIL SAMPLES: Type | Number | Blows / 6 in. | Recovery, %

Drill Time [Rate, ft/hr]

[4]
1436
1459
[5]
1521
0830
[2]
0940
0958
[4]
1045
1055
[4]
1154
1206
[4]
1234
1246
[8]

FIELD NOTES AND TEST RESULTS

Less
but continued water take

Caving borehole at 26 ft.

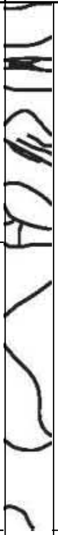
End of day 8/23/2018
Begin day 8/24/2018

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-201

Sheet 4 of 4

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45		2				5							
2288					4		6 6 6							
	46	11		100	4	60*	7 8						[8]	
	47						9 10 m						1323 1332	
2286					3									
	48				1		1							
	49	12		100		100	2						[11]	
2284					1		m							
	50				NA		3						1349	
	51													
2282	52													
	53													
2280	54													
	55													
2278	56													
	57													
2276	58													
	59													
2274	60													
	61													



MATERIAL DESCRIPTION

BASALT; bluish grey; slightly to locally moderately weathered; strong; highly fractured; fine grained with calcite filled vesicles; brownish orange oxidation along fractures
--TERTIARY to QUATERNARY INTRUSIVE BASALT--
(continued)

5: 10-15, J, N, Fe, Su, Pl
6: 10, J, N-W, Fe, Su, Ir, VR
7: 80, J, N-MW, Fe+Ca, Su+Pa, Pl, SR
8: 55, J, N, Fe, Su, Pl, SR with 1-inch weathered rind
9: 20, V, N, Ca, Fi, Pl
10: 40, J, ?, Fe, Su, Pl-Ir, VR

Becomes dark bluish grey, slightly weathered, very strong, with white, round to angular infilling, possible flow direction of ~60°

1: 40, J, MW, Ca+Fe, Fi+Su, Pl, SR
2: 80-90, J, VN, Fe+Ca, Su+Pa, Pl-Ir, R
3: 60, J, N-MW, Fe+Ca, Su+Fi, Pl, R

TOTAL DEPTH = 50.5 FEET

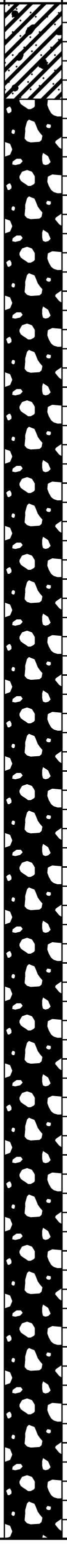
Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-202

Sheet 1 of 7

Date(s) Drilled	**8/18/2018 - 8/22/2018**	Logged By	**T. Vande Voorde**	Checked By	**B. Kozlowicz/K. Zeiger**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 4-inch #6 diamond coring bit; 4-inch carbonado coring bit**	Total Depth of Borehole	**100.5 feet**
Drill Rig Type	**Track Mounted Fraste XL**	Drilling Contractor	**Pitcher Drilling Company**	NAVD 88 Ground Surface Elevation	**2332 feet**
Groundwater Level	**4.8 feet bgs 8/23/2018**	Sampling Methods	**HQ Core Barrel**	Inclination from Horizontal/True North Bearing	**60°/205°**
Borehole Completion	**Two VWPs with neat cement grout to ground surface**	Location	**Iron Gate Reservoir; S/SE of Daggett Rd**	Coordinate Location	**N 2601406 E 6460935**

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	0								SANDY FAT CLAY with GRAVEL (CH); stiff; dark brown (10YR 3/3) to very dark greyish brown (10YR 3/2); 70% high plasticity FINES; 15% angular GRAVEL up to 1/4-inch; 15% coarse grained SAND; dry; GRAVEL is volcanic tuff; some organics (grass and roots) --ALLUVIUM--			6-inch trash barrel to 8.5ft.
2332												
	1											
	2											
2330	3											
	4											
2328	5								▼ With increasing SAND; becomes brown (10YR 4/3); dry to moist			
	6											
	7											
2326												
	8											Advance 4-inch casing to 9ft. Switch to rotary wash drilling with 3 7/8-inch tricone bit.
	9											
2324	10											
	11											
2322	12											
	13											



Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	13-14								With increasing GRAVEL and decreasing SAND; abundant grey to black basaltic COBBLES fragments			Rig chatter; possible boulder at 13-14ft.
2320	14-15.5	1	1	53	NA NA	NA	NR		BOULDERS and COBBLES; bluish grey; 60% angular GRAVEL up to 2-inches; 30% medium to coarse grained SAND; 10% medium plasticity FINES; BOUDLERS (fragments) and COBBLES are fresh to slightly weathered, rounded, very strong porphyritic BASALT up to 10-inches; MATRIX is fine grained with quartz and trace pyrite phenocrysts weathered to a POORLY GRADED SAND with GRAVEL and CLAY; --RIVER ALLUVIUM--		1301 [8] 1312	Switch to HQ coring at 14ft with 4-inch #6 diamond coring bit
2318 2316	15.5-19	2		66	NA NA NA NA	NA	NR				1324 [6] 1357	Coarse material from Run 1 - 14 retained in core box
	19-20.5	3		100	NA NA	NA			With basaltic BOULDERS (fragments) up to 1-foot; rounded to angular GRAVEL, coarse grained SAND, and medium plasticity FINES		1413 [6] 1429	
2314	20.5-23	4		56	NA NA	NA	NR				1438 [14] 1449	Driller notes softer material at 21.5ft. Minor fluid loss.
2312	23-24.5	5		87	NA NA	NA	NR				1457 [7] 1510	Driller notes material is alternating soft and hard.
	24.5-25.5	6		100	NA	NA					1521 [10] 1527	
2310	25.5-28	7		100	NA NA NA	NA					1535 [11] 1549	Minor fluid loss.
2308	28-29	8		68	NA	NA			with basaltic BOULDERS (fragments) and COBBLES up to 5-inches; abundant rounded GRAVEL		0750 [6]	End of day 8/18/2018 Begin day 8/19/2018

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
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Log of Core Boring B-202

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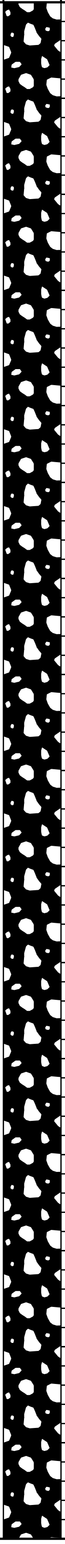
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number
	29–30.5	8	1	68	NA NA	NA	NR	
2306	30.5–32.5	9		100	NA NA NA	NA		
2304	32.5–34.5	10		100	NA NA NA	NA		
2302	34.5–36.5	11		85	NA NA	NA	NR	
2300	36.5–39	12		12	NA NA NA	NA	NR	
2298	39–40.5	13		0	NA	NA	NR	
2296 2294	40.5–45	14		8	NA NA NA NA NA	NA	NR	



MATERIAL DESCRIPTION

BOULDERS and COBBLES; bluish grey; 60% angular GRAVEL up to 2-inches; 30% medium to coarse grained SAND; 10% medium plasticity FINES; BOULDERS (fragments) and COBBLES are fresh to slightly weathered, rounded, very strong BASALT up to 10-inches; MATRIX is fine grained with quartz and trace pyrite phenocrysts weathered to a POORLY GRADED SAND with GRAVEL and CLAY; with boulders and cobbles up to 8-inches at 28.2'
--RIVER ALLUVIUM--*(continued)*

(32.5) Becomes round to angular COBBLES up to 4-inches, abundant fine GRAVEL, coarse grained SAND, with some brown, no plasticity FINES

(40.5) With basalt and very strong brecciated tuff COBBLES

Depth, feet	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
29–30.5	[6] 0814	Increasing fluid loss. Advance 4-inch casing to 29.5ft.
30.5–32.5	1102 [8] 1117	Swivel breaks at 32.5ft; End of day 8/19/2018
32.5–34.5	0934 [7] 0951	Begin day 8/20/2018
34.5–36.5	1002 [4] 1031	Drill fluid becomes brownish grey. Some fluid loss.
36.5–39	1046 [7] 1108	
39–40.5	1126 [6] 1142	Switch to 4" carbonado bit at 40.5ft; pale brown, tuff-like material in bit
40.5–45	1216 [13]	Drill fluid becomes light grey

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	45	14		8	NA	NA	 NA		△ △	VOLCANIC BRECCIA; light grey; highly to completely weathered; very weak with strong clasts; slightly fractured; locally friable; fine grained matrix with angular to subrounded strong, black clasts up to 3/4-inch and extremely weak, green clasts up to 1 1/4-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		1240 1252	
	45.5		2					m					
2292	46	15		65	NA	0						[8]	
	47				NA		NR	m				1307 1321	
	48							1		1: 15, J, N, No, No, Pl, R-VR (likely mechanical) Becomes pale greenish grey, weak to locally extremely weak, highly weathered, increased percentage of clasts in a fine grained matrix			
					0			m					Minor fluid loss.
2290	49	16		100		0						[7]	
					0			m					
	50												
					0			m 1				1347 1403	
2288	51				0			2		1: 10, J, N-VN, Ch?, Pa, Pl, R (mechanical) 2: 0, J, N-MW, No, No, Ir, VR (mechanical) 3: 15, J, VN-N, No, No, Pl, R (mechanical)			
	52				0			3					
	53	17		100		0						[10]	
2286					0								
	54				0					With green, clayey clasts elongated vertically			
	55							1					
					1			m				1434 1303	End of day 8/20/2018 Begin day 8/21/2018
2284	56									Light bluish grey, completely weathered, extremely weak, with coarse grained SAND and fine GRAVEL			
					0								
	57							1 m		Increasingly cohesive, extremely weak, highly to completely weathered, with smaller clasts			
					NA								
2282	58	18		44		0	NR.			1: 55, J, VN-N, No, No, Pl		[14]	
					NA								
	59												
					NA								
	60												
2280					1			m m 1		60.5-61.4ft: completely weathered to a residual soil, extremely weak, friable, with soil-like texture, clasts up to 1/2-inch		1325 1340	
	61												

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	61	19	3	80	0	0	m	△ △	VOLCANIC BRECCIA; light bluish grey; completely weathered; extremely weak with strong clasts; slightly fractured; locally friable; fine grained matrix with angular to subrounded strong, black clasts up to 3/4-inch and extremely weak, green clasts up to 1 1/4-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*			
	62				0			△ △				
2278	63				0		1 m m m	△ △	Highly weathered, with strong, black clasts up to 3/4-inch and very soft, green clasts up to 1 1/4-inch, extremely weak/friable 63.6-64.2'		[15]	
	64				NA		NR	△ △	1: 0, J, MW, No, No, Pl/Ir, R (mechanical)			
2276	65				NA		NR m m	△ △	Weaker zone		1400	
	65.5	20		100		0		△ △	Becomes highly to completely weathered; increased clast size and percentage, larger subrounded basaltic clasts		1412	
	66				0			△ △			[9]	
2274	67				0			△ △			1429	
	68	21		100	0	0	m	△ △	With subangular clasts		1442	
2272	69				0			△ △	1 to 2-inch thick, planar green clast		[7] 1505	
	70.5	22		100	0	0	m	△ △	Becomes very light bluish grey, with basaltic clasts up to 1.5-inch and filled vesicles		1517	0.1' of Run 20 recovered with Run 21
2270	71		4		0		1	△ △	Planar green clast			
	72				0			△ △				
2268	73				0			△ △	1: 50-60, J, VN, No, No, Pl, SR (mechanical) 2: 5, J, VN, No, No, Pl, SR (mechanical)		[7]	
	74				0			△ △	Planar green clast			
	75				0		2 m m m	△ △			1600	
2266	75.5	23		100	0	0		△ △	Becomes light greenish grey; decreasing percentage of clasts		0722 [8]	End of day 8/21/2018 Begin day 8/22/2018 0.2' of Run 20 recovered with Run 21
	77											

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
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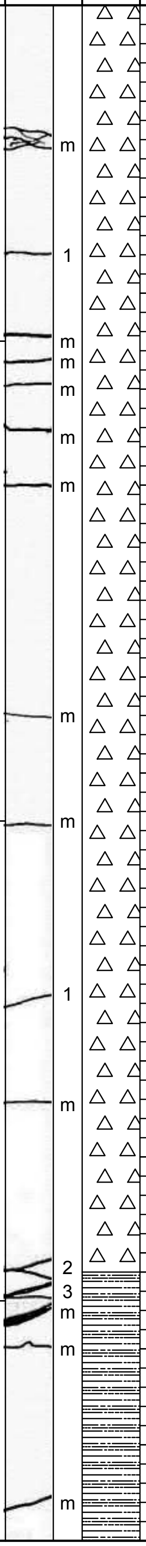
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	77		4		0				
	78	23		100	0	0	m	[8]	
2264	79				0		1		
	80				0		m m	0802 0817	
2262	81				0		m m		UCS 82.0-82.8 = 614 psi
	82				0		m		Top of Run 24 mechanically broke when transferring to core box
	83	24		100	0	0		[10]	
2260	84		5		0		m		
	85				0		m	0847 0900	
2258	86				0				
	87				1		1		
2256	88	25		100	0	6	m	[30]	
	89				0				
2254	90				1		2 3 m	0910 0923	
	91				0		m		
	92	26		86	0	86	m	[19]	
2252	93								



MATERIAL DESCRIPTION

VOLCANIC BRECCIA; light greenish grey; highly to completely weathered; extremely weak with strong clasts; slightly fractured; locally friable; fine grained matrix with angular to subrounded strong, black clasts and extremely weak, green clasts up
--TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated) --*(continued)*

With increased clast size and percentage; matrix is extremely weak matrix with strong basaltic clasts and decomposed green clasts

1: 0-5, J, N, No, No, Pl, SR (mechanical)

With stronger matrix

With weaker matrix

1: 30, J/V, N-MW, Ca, Fi, Pl, SR-R (vuggy with Calcite crystals)

2: 10-40, Contact, rough
3: 55, J, N?, Ca?, Pa, Pl, SR-S

VOLCANIC MUDSTONE; dusky to very dusky red (2.5 YR 3/2 TO 2.5/2); slightly weathered; weak to very weak; slightly fractured; fine grained with occasional gravel up to 1/2-inch

Becomes dark reddish brown

Project: Klamath River Renewal Project
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Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	93		5		2		1	VOLCANIC MUDSTONE; dusky to very dusky red (2.5 YR 3/2 TO 2.5/2); slightly weathered; weak to very weak; slightly fractured; fine grained with occasional gravel up to 1/2-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated) --*(continued)*			
	94	26		86	NA	86	2 2 m	With trace gravel		[19]	
2250	95				NA		m	1: 40, J, N, Cl, Fi, Pl, ? 2: 20-30, J, N-W, Cl + Gravel, Pa-No, Ir-Pl, R		0939	
	95.5	27	6	100		100	1	Without gravel; increasing strength 1: 10, J/V, N-MW, H+Cl, Fi, Pl, ? 2: 70, J, ?, No, No, Pl. ? (mechanical)		0955 [8] 1003	
	96				0		m 2 m 1	1: 40, J, W, Cl+Sd, Pa, Pl, R		1017	
2248	97				0						
	98	28		93	0	86				[13]	
2246	99				NA						
	100				NA					1035	

TOTAL DEPTH = 100.5 FEET
Televiewer and caliper survey by NorCal Geophysics 8/22/2018.
Install two VWPs at 28ft and 72ft with neat cement grout to ground surface with 3ft above-ground monument.

Depth scale: 101, 102, 103, 104, 105, 106, 107, 108, 109; Elevation: 2244, 2242, 2240

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
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Log of Soil and Core Boring B-203

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Date(s) Drilled	**1/8/2019-1/11/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3-7/8-inch tricone, 3 3/4-inch diamond coring bit #10**	Total Depth of Borehole	**120.0 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2305 feet**
Groundwater Level	**25 feet above ground surface**	Sampling Methods	**SPT, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Completion	**Bentonite cement grout to ground surface**	Location		Coordinate Location	**N 2601762 E 6461124**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0							SILTY SAND with GRAVEL and COBBLES (SM); various lithologies; shell fragments; rounded clasts --ALLUVIUM (Qal)--			1	20 54			Mudline is 24' below reservoir level
2304	1														
	2		1		NA		NR							0906	End of day 1/8/2019 Begin day 1/9/2019 Mudline is 25' below reservoir level Tricone to 2' switch to HQ-3
2302	3	1		16	NA	NA		BASALT COBBLE						[15]	
	4				NA		NR	VOLCANICLASTIC BRECCIA; yellow-brown; highly weathered; very weak; angular clasts up to 1/4"-1" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						0916 0923	Yello-brown cuttings 0% Water Circulation Return (WCR)
2300	5	2		0	NA	0	NR								
	6				NA									0923	
2298	7				NA						2	18 38 50/5"	71		
	8				NA									1239	Advance 5" HWT casing to 8'; good WCR
2296	9	3		0	NA	0	NR	Becomes grayish blue-green (5BG5/2)						[10]	Blue-gray cuttings
	10				NA									1252	0% WCR to 13' Change HQ drill bit; no advancement; change to tricone advancement
2294	11				NA										
	12				NA										
2292	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
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Log of Soil and Core Boring B-203

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Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13		1		NA			VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); highly weathered; very weak; angular clasts up to 1/4"-1" --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						1410	Good WCR; blue-green clayey cuttings
	14				NA										
2290	15	4		0		0	NR							[16]	
	16				NA										
	16.5				NA		M							1423 1443	Change HQ drill bit to increase recovery
2288	17				NA										
	18				NA										Blue-green clayey cuttings
2286	19	5		20		0	NR							[75]	
	19.5				NA										
	20.5				NA		M M								
2284	21						M	Broken							
	21.5				NA		M	Becomes slightly weathered; moderately strong; slightly fractured						1447 1455	
	22.5				0										
2282	23	6		100		0	M							[30]	
	23.5				0		M								
	24						M							1500 1503	
	24.5				0										
2280	25	7		100		0								[38]	
	25.5				0										
	26.5				0		M M		PT#1 26.5'-46.5'					1507 1510	
2278	27						M,M	Moderately weathered; weak							
	27.5				0										
	28	8		100		0								[38]	
	28.5				0										
2276	29						M								

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
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Log of Soil and Core Boring B-203

Elevation, feet	Depth, feet	ROCK CORE						MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number			Type	Number	Blows / 6 in.	Recovery, %		
	29		1					VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); slightly weathered; moderately strong; angular clasts up to 1/4"-1"; slightly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							Good WCR
					0										
	30	8		100		0								[38]	
					0										
2274							M								
	31														
			2		0		M	Becomes moderately weathered; weak to very weak						1518 1526	
	32						M								
2272					0		M M	Broken							
	33														
					0										
	34	9		100		0								[38]	
					0			Becomes very to extremely weak							
2270	35														
					1		M,1								
	36							1: 50°, J, N, Ca, Pa, Ir-Wa, SR Broken							
					NA									1534 1539	
2268	37						M M,M	Becomes weak to very weak							
					0										
	38						M								
					0										
2266	39	10		92		0	M							[43]	
					0										
	40						M M								
2264					1		1	1: 40°, J, N, Ca, Pa, Ir-Wa, SR							
	41						M M								
					NA									1546 1550	
	42						M								
2262					0		M								
	43														
					0										
	44	11		92		0		BASALT; grayish red purple (5RP4/2); highly weathered; very to extremely weak						[38]	
2260					0		M M								Red-brown cuttings
	45														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
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Log of Soil and Core Boring B-203

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Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45		2				M	BASALT; grayish red purple (5RP4/2); highly weathered; very to extremely weak; slightly fractured; mechanically broken to 47.8' --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*	PT #2 45.5'-65.5'						
		11		92	NA	0									
	46													1558	End of day 1/9/2019
					NA		M							1020	Begin day 1/10/2019
2258	47		3												
					NA		M								
	48							VOLCANICLASTIC BRECCIA; dark greenish gray to greenish gray (5G4/1-6/1); slightly weathered; weak; slightly fractured; angular clasts up to 1/4"-1"; abundant calcite inclusions and veinlets							
		12		100	0	73	M							[40]	
2256	49						M								
					1		1	Becomes moderately fractured 1: 30°, J/V, VN-N, Ca, Pa, Ir-Wa, SR							
	50							Mechanically broken							50% WCR
					NA		M							1026	
2254	51							BASALT; medium bluish gray (5B5/1) to dark gray (N3); slightly weathered; moderately strong; abundant calcite inclusions						1033	
					0		M								
	52														
					0										
2252	53	13		96		96								[33]	
					1		1	1: 70°, J, N, Cl, Fi, Pl-Wa							
	54						M								
					0		M								
2250	55														
					NA		1	Becomes dark gray (N3); highly to moderately fractured 1: 70°, J, VN, No, No, Pl-Wa, SR 2: 35°, J, VN, No, No, Pl-Wa, SR 3: 60°, J, N, Ca, Pa, Pl-Wa, SR 4: 50°, J, VN, No, No, Pl-Wa, SR 5: 20°, J, VN, No, No, Pl-Wa, SR						1042	
	56						2 3							1051	
					2		4								
2248	57														
					1		5								
	58	14		100		86								[43]	0% WCR
					0										
2246	59														
					1		6	6: 30°, J, VN-N, Ca (Ch?), Pa, Pl-Wa, SR							
	60						M M M,M	Overdrilled							
					NA		M							1058	
2244	61	15	4	100		100	M,M							1108	

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-203

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Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61	15	4	100	1	100	1	VOLCANICLASTIC BRECCIA; dark greenish gray to greenish gray (5G4/1-6/1); slightly weathered; moderately strong, angular clasts up to 1/4"-2"; hihgly to moderately fractured; abundant calcite inclusions and veinlets --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						[25]	Continued 0% WCR
	62				0		M	1: 40°, J, N, Ca, Pa, Ir-St, SR-R							
2242	63	16		80	1	80	M 1							1114 1120	
	64				1		1	1: 35°, J, VN-N, No, No, Pl-Wa, SR	PT#3 65.5'-85.5'					[38]	
2240	65						M								
		17		100	NA	100	M 1,M	1: 60°, J, VN-N, No, No, Wa, SR						1124 1306	
	66				0										
2238	67				1			BASALT; dark gray (N3); slightly weathered; moderately strong; highly to locally intensely fractured; abundant calcite inclusions							
	68				1		2 3	2: 60°, J, VN, No, No, Wa, SR 3: 70°, J, N-MW, Ca, Pa, Wa, SR						[38]	
2236	69				1		M								
	70						4	4: 70°, J/Sh, VN, Ca, Pa, Pl-Wa, S-Slk Mechanically broken							
2234		18		100	NA	92	M 1,2							1314 1321	
	71				1		M 3	1: 80°, J, VN-N, Ca+Ch?, Pa, Pl-Wa, S-SR 2: 60°, J, VN-N, Ca+Ch?, Pa, Wa, SR 3: 50°, J, VN, No, No, Pl-Wa, SR-S 4: 50°, J, VN-N, Ca, Pa, Wa, SR 5: 60°, J, VN, Ca, Pa, Pl, S							
	72				2		M 4 4								
2232	73				0		M							[50]	
	74				1		5	Becomes medium dark gray (N4)							
2230	75				2		M M 5								
		19	5	100		76	M	Becomes dark gray (N3)						1327 1332	
	76				NA		1 2 M	1: 80°, J, N, Ca, Sp, Pl-Wa, S-SR 2: 50°, J, VN, Ca, Sp, Pl-Wa, S-SR Weak; mechanically broken							
2228	77														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-203

Sheet 6 of 8

		ROCK CORE								SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	77		5		6		M 3 4	BASALT; dark gray (N3); slightly weathered; moderately strong; highly to locally intensely fractured; abundant calcite inclusions; with numerous healed fractures (not logged) --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							Continued 0% WCR
	78	19		100		76	5 M 6	3: 55°, J, VN, Ca, Sp, Wa, S-SR 4: 60°, J, VN-N, Ca, Sp, Wa, S-SR 5: 40°, J, VN, Ca, Sp, Pl-Wa, SR 6: 30°, J, VN, Ca, Sp, Pl-Wa, SR 7: 40°, J, VN-N, Ca, Sp, Pl-Wa, SR 8: 40°, J, VN-N, Ca, Sp, Pl-Wa, SR 9: 50°, J, VN-N, Ca, Sp, Pl-Wa, SR 10: 75°, J, VN-N, Ca, Sp, Pl-Wa, SR						[60]	
2226	79				3 3		7 8								
	80				5		M 9 10 M	Weak; mechanically broken						1337 1342	
2224	81				3		1 2 M 3	1: 30°, J, VN, Ca, Sp, Pl-Wa, SR 2: 50°, J, N, Ca, Sp, Pl-Wa, SR 3: 30°, J, N, Ca, Sp, Pl-Wa, SR							
	82				0										
2222	83	20		100	3	90	3 4 3	4: 25°, J, N, Ca, Sp, Pl-Wa, SR						[60]	
	84				2		M								
2220	85				NA		M	Mechanically broken	PT#4 85.5'-105.5'					1347 1454	
	86				NA			Weak; intensely fractured with slickensides (shear zone)							
2218	87				3		1								
2216	88	21		100	7	50	2 M 3 4 3	1: 60°, J, N, Ca, Sp, Pl-Wa, SR 2: 75°, J, N, Ca, Sp, Pl, S 3: 20°, J, VN-N, Ca, Sp, Wa, SR 4: 50°, J, VN, Ca, Sp, Pl-Wa, SR 5: 40°, J, N, Ca, Sp, Wa, SR						[30]	
	89				6		5 2								
2214	90		6		2		3 M 1							1504 1510	
	91				5		2 2 2 2 2 2	1: 60°, J, N, Ca, Sp, Pl-Wa, S-SR 2: 35°-45°, J, VN-N, Ca, Sp, Pl-Wa, S-SR							
2212	92	22		100	1	86								[38]	
	93														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-203

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Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	93		6		2		M,2 M	VOLCANICLASTIC BRECCIA; grayish blue-green (5BG5/2); slightly weathered; moderately strong; highly to moderately fractured; abundant calcite inclusions and veinlets; with numerous healed fractures (not logged) --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*	▨						Continued 0% WCR
	94	22		100	2	86	3,M	3: 70°, J, VN-N No, No, Wa-Ir, SR	▨					[38]	
2210	95				0		M		▨					1518 1524	
	96				2		1 1	1: 40°, J, VN-N, No, No, Pl-Wa, S-SR Becomes mottled very dusky purple (5RP2/2) and grayish blue green (5BG5/2)	▨						
2208	97				1		M M 1	Mechanically broken	▨						
	98	23		100	1	94	1 M M		▨					[33]	
2206	99				1		M M 2		▨						
	100				1		M M 1	2: 50°, J, N, No, No, Wa, SR Mechanically broken	▨					1533 1539	
2204	101				2		M,2 3	1: 30°, J, N, No, No, Pl-Wa, SR 2: 40°, J, VN-N, No, No, Pl-Wa, SR 3: 50°, J, N, No, No, Pl-Wa, SR	▨						
	102				NA		M	Mechanically broken	▨						
2202	103	24		62	NA	28			▨					[33]	
	104				4		M 4,4 5 4,4	4: 70°, J, VN-N, Ca, Sp/Pa, Pl, S-SR 5: 70°, V, N, Ca, Fi, Pl, S? 6: 90°, J, N, No, No, Pl-Wa, S-SR PORPHORYTIC BASALT; dark gray to grayish black (N3-N2); slightly weathered to fresh; moderately strong to strong; abundant white phenocrysts (feldspar?) and healed calcite fractures and veins; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*	▨ PT#5 105'-120'						
2200	105				2		6 M		▨					1548 1011	End of day 1/10/2019 Begin day 1/11/2019
	106		7		2		1 2	1: 30°, J, VN-N, No, No, Wa, S-SR 2: 20°, J, VN-N, Ca?+Ch?, Sp, Pl-Wa, SR 3: 80°, J/V, N, Ca?+Ch?, Fi, Pl, S-SR	▨						
2198	107				1		3		▨						
	108	25		78	0	71	M	Becomes slightly fractured	▨					[25]	
2196	109														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-203

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Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	MATERIAL DESCRIPTION	Packer Test Intervals	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	109	25	7	78	NA	71	NR		PORPHORYTIC BASALT; dark gray to grayish black (N3-N2); slightly weathered to fresh; moderately strong to strong; abundant white phenocrysts (feldspar?) and healed calcite fractures and veins; slightly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							Faster drilling 109'-110' Continued 0% WCR
	110							M							1022 1029	
	110.5				0											
2194	111															
	111.5				0			M								
	112															
	112.5	26		80	0	100		M							[30]	
2192								M	Becomes very dark red (5R2/6)							
	113							M								Faster drilling 113'-117'
	113.5				NA				Highly weathered; very to extremely weak; crushed							
	114															
	114.5				NA		NR		VOLCANICLASTIC BRECCIA; very dusky purple (5RP2/2) to grayish blue-green (5BG5/2); highly weathered; weak to very weak; moderately fractured; angular to subangular medium- to coarse-grained sand-sized clasts with occasional to 1/2"; with numerous mechanical fractures --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*							
2190	115						NR								1039 1047	
	115.5				NA			M M								
	116							M M,M	Becomes moderately strong							
	116.5				0			M								
2188	117							M,M								Slower drilling to TD
	117.5	27		92	1	76		M	Becomes very dusky purple (5RP2/2)						[14]	
	118							M,M 1,M	1: 25°, J?, VN, No, No, Pl, S							
	118.5				0			M,M								
2186	119							M M M,M								
	119.5				0			M,M M								
	120								**TOTAL DEPTH = 120.0 FEET**						1109	
2184	121															
	122															
2182	123															
	124															
2180	125															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-205

Sheet 1 of 5

Date(s) Drilled	**9/12/2018**	Logged By	**K. Zeiger**	Checked By	**P. Respess**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch PDC drag bit, 3 3/4-inch carbide tooth bit**	Total Depth of Borehole	**62.0 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2359 feet**
Groundwater Level	**21.7 feet bgs 9/13/2018**	Sampling Methods	**2.5-inch ID ModCal; HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir along Copco Road**	Coordinate Location	**N 2602659 E 6461881**

		ROCK CORE								SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								CLAYEY GRAVEL (GC); dense; dark brown (10YR 3/2); 70% angular GRAVEL up to 1-inch; 25% low plasticity FINES; 5% organics; dry; GRAVEL is volcanic --COLLUVIUM--						Hollow stem auger to 0 to 19ft.
2358	1														
									Boulder (fragments)						
	2														
									Boulder (fragments)						
2356	3														
	4														
2354	5											9			One liner retained (5.8-6.3ft.)
	6										S01	22	87		
												29			
2352	7														
	8								CLAYEY GRAVEL with SAND (GC); medium dense; dark brown (7.5YR 3/2); 35% high plasticity FINES; 40% subangular GRAVEL up to 1-inch; 25% fine grained SAND; dry; cohesive; gravel is chert and rhyolite --COLLUVIUM/RESIDUAL SOIL--						Lithology transition logged from cuttings
2350	9								At 9ft.: becomes moist						
	10								With gravel up to 2.5-inches			19			One liner retained (11-11.5ft.) LL=61; PL=22 SA: G=38.4% S=25.7%; F=34.9%
											S02	14	100		
2348	11											21			
									GRAVELLY FAT CLAY (CH); hard; dark brown (7.5 YR 3/2); 65% high plasticity FINES; 35% subangular GRAVEL to 1-inch; moist; cohesive						
	12														
2346	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-205

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Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2346	13									GRAVELLY FAT CLAY (CH); hard; dark brown (7.5 YR 3/2); 65% high plasticity FINES; 35% subangular GRAVEL to 1-inch; moist; cohesive --COLLUVIUM/RESIDUAL SOIL--*(continued)*						
	14															
2344	15									POORLY GRADED GRAVEL with CLAY and SAND (GP-GC); very dense; light olive grey (5Y 5/2); 60% rounded GRAVEL up to 1 1/2-inches; 30% low plasticity FINES; 10% medium grained SAND; dry; cohesive; gravel is weathered in place --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		S03	23 50/2"	100		Driller reports hard consistent drilling 15.5-19.0ft. Cuttings are dry gravelly
	16															
2342	17															
	18															
2340	19											S04	92/6"	50		Advance 4-inch casing to 19.5ft. Switch to HQ-3 rock coring.
			1		NA			m		VOLCANIC CONGLOMERATE; light olive grey (5Y 5/2); highly weathered; very weak; fine grained with rounded to angular clasts up to 1/2-inch					1406	
	20				NA			m m								
2338	21	1		52		NA									[17]	
					NA		NR			▼						
	22														1415 1438	
					0											
2336	23				0					Becomes medium bluish grey (5B 5/1); moderately weathered; weak to very weak; massive						
	24	2		100	0	34*		m		Becomes highly weathered; very weak					[75]	*Rock does not meet soundness criteria for RQD calculation
2334	25				0					Light olive grey (5Y 5/2)						
	26				0			m								
2332	27				0										1442 1452	
	28	3		100	0 0	0										
2330	29															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-205

Sheet 3 of 5

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2330	29	3	1	100	0	0		VOLCANIC CONGLOMERATE; medium bluish grey (5B 5/1); highly weathered; very weak; massive; fine grained with rounded to angular clasts up to 1/2-inch; chlorite rich matrix (?) --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[100]	
	30		2		0									
2328	31				0									
	32				0								1455 1505	
2326	33				4		1 1 2 3	1: 5, J, MW, No, No, Wa, SR (likely mechanical) 2: 35, J, MW, No, No, Wa, SR (likely mechanical) 3: 20, J, MW, No, No, Wa, SR (likely mechanical)						Run 4 broken during removal from core barrel (all fractures mechanical?)
	34	4		100	2	0							[75]	
2324	35				2		1 2 1							
	36				4		1 1 2 1 1							
2322	37				0								1509 1518	
	38				0		m	Broken while placing in box						
2320	39	5	3	100	0	0	m m						[75]	
	40				0									
2318	41				0									
	42				0			With clasts up to 3/4-inch					1522 1528	
2316	43				0									
	44	6		100	0	0	m	Completely weathered to clay; extremely weak					[60]	
2314	45													

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-205

Sheet 4 of 5

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2314	45	6	3	100	0	0		m		VOLCANIC CONGLOMERATE; medium bluish grey (5B 5/1); highly weathered; very weak; massive; fine grained with rounded to angular clasts up to 3/4-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*						
	46				0											
2312	47				0										1533 1540	47-49.5ft. wrapped for review
	48				5			1 2 3		Fractured zone with iron and manganese staining						
2310	49	7	4	100	3	0				1: 85, J, T, Fe+Mn, Su, Wa, SR 2: 10, J, N, No, No, Wa-Ir, R 3: 25, J, MW, Fe+Mn, Su, Wa, SR					[50]	
	50				0											
2308	51				0											
	52				0										1546 1555	
2306	53	8		86	1	0		m 1		1: 10, J, T, No, No, Wa, SR (contact between weathering zones) Becomes completely weathered; extremely weak; clayey					[42]	
	54				NA		NR	1		Becomes highly weathered; very weak					1559 1626	Soft zone plugged bit during Run 8
2304	55	9		100	0	0		m		1: 35, J, N, No, No, Pl, S					[12]	
	56				0			m							1637 1650	
2302	57				NA		NR	1 2 1		Becomes moderately weathered; weak; intenselt fractured with calcite precipitation						
	58				3			3 4 5		VOLCANIC BRECCIA; dusky brown (5YR 2/2); highly weathered; weak; highly fractured; with angular clasts up to 1-inch; 58.4-58.7' crushed						
2300	59	10	5	96	5	20*		5 6		1: 85, J, N, No, No, Wa, SR 2: 70, J, N, Ca, Pa, Pl, Sr 3: 35, J, N, No, No, Pl, S 4: ~10, J, T, No, No, Wa-Ir, SR-R 5: 10-15, J, N, No, No, Wa-Pl, SR 6: 25, J/Bedding, N-T, No, No, Wa, SR					[33]	
	60				2			5 5								
2298	61															

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-205

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-205

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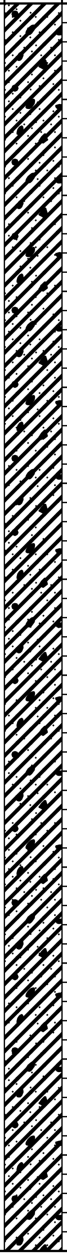
Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2298	61	10	5	96	1	20*		7	△ △ △ △ △ △ △ △	VOLCANIC BRECCIA; dusky brown (5YR 2/2); highly weathered; weak; highly fractured; with angular clasts up to 1-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					1659	
	62									7: 45, J, N, Ca, Sp, Pl, SR **TOTAL DEPTH = 62.0 FEET**						
2296	63															
	64															
2294	65															
	66															
2292	67															
	68															
2290	69															
	70															
2288	71															
	72															
2286	73															
	74															
2284	75															
	76															
2282	77															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-206

Sheet 1 of 7

Date(s) Drilled	**8/14/2018 - 8/16/2018**	Logged By	**T. Vande Voorde**	Checked By	**B. Kozlowicz/K. Zeiger**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**3 7/8-inch tricone; 4-inch #13 diamond coring bit; 4-inch carbonado coring bit**	Total Depth of Borehole	**100.0 feet**
Drill Rig Type	**Track Mounted Fraste XL**	Drilling Contractor	**Pitcher Drilling Company**	NAVD 88 Ground Surface Elevation	**2337 feet**
Groundwater Level	**7.4 feet bgs 8/17/2018**	Sampling Methods	**HQ Core Barrel**	Inclination from Horizontal/True North Bearing	**60°/295°**
Borehole Completion	**Two VWPs with neat cement grout to ground surface**	Location	**Iron Gate Reservoir; W of Fall Creek boat ramp**	Coordinate Location	**N 2602022 E 6461272**



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	0								SANDY FAT CLAY with GRAVEL (CH); dry; dark brown (10YR 3/3) with trace mottled yellow (10YR 7/6); 75% high plasticity FINES; 15% subangular to rounded GRAVEL up to 1 1/4-inch; 10% fine to coarse grained SAND; little organic material (roots) --ALLUVIUM--			Trash barrel to 10ft.
2336	1											
	2											
2334	3											
	4											
2332	5								With angular basaltic and some volcanic tuff GRAVEL up to 1 1/2-inch			
	6											
2330	7								▼			
	8											
	9											
2328	10								▽			Begin rotary wash drilling at 10 ft. with 3 7/8-inch tricone bit; Drill fluid is light grey Rig chatter.
	11											
2326	12											
	13											

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-206

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	13							SANDY FAT CLAY with GRAVEL (CH); dry; dark brown (10YR 3/3) with trace mottled yellow (10YR 7/6); 75% high plasticity FINES; 15% subangular to rounded GRAVEL up to 1 1/2-inch; 10% fine to coarse grained SAND; trace organic material (roots) --ALLUVIUM-- *(continued)*			
	14										
2324											
	15							Weathered light yellow and greenish brown tuff fragments in cuttings			
	16										
2322	17										
	18										
2320	19										
	20		1		NA			Basalt and volcanic tuff fragments in cuttings		1222	Begin HQ rock core at 20ft. with 4-inch carbonado bit.
	21							BOULDER; 2-foot rounded basalt boulder; possible rounded basaltic COBBLES near bottom of run			
2318		1		40	NA	NA				[4]	Run 1 not retained.
	22				NA			BASALT; grey to bluish grey (5B 6/1); slightly to moderately weathered; strong; highly fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch; with 1/2 to 1-inch weathering rind on joints --TERTIARY to QUATERNARY INTRUSIVE BASALT--			
	23				NA					1305 1340	Switch to 4-inch #13 diamond coring bit at 23 ft.
2316	24	2		70	5	0	1 2 3 4 5 6 7	1: 70, J, N, Ca, Fi, Pl, SR 2: 30, J, VN, Fe, Pa+Su, Pl, SR 3: 30, J, VN, H+Fe, Fi, Pl, ? 4: 70, J, VN, Ca+Fe, Pa, Pl, SR 5: 25, J, VN, Fe, Su, Pl, SR 6: 50, J, VN, Fe, Su, Pl, ? 7: 40, J, N, Fe+Ca, Sp, Pl, SR		[3]	
	25				3		1,2 3,4 5 3	Without weathering rings		1416 1442	Reviewer note: All healed veins and fractures were mechanically broken by core handling.
2314	26				3		7 3 3	1: 50, J, ?, Fe, Sp, Pl. ? 2: 40, J, ?, Fe, Sp, Pl, ? 3: 60, J, VN, H+Ca, Fi, Pl, SR 4: 50, J, VN, H+Ca, Fi, Pl, SR 5: 35, J, VN, H+Fe+Ca, Pa, Pl, SR 6: 80-90, J, VN, H+Ca, Fi, Pl, SR 7: 30, J, VN, H+Ca, Fi, Pl, SR 8: 75, J, VN, Ca, Pa, Pl, SR 9: 75, J, VN-T, Ca, Sp, Pl, SR 10: 50, J, VN, Ca, Sp, Pl, SR			
	27	3		100	4	100	6 4 m			[4]	
2312	28				5		7 8 9 10				
	29									1541	

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-206

Sheet 3 of 7

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	29	4	1		3		1 2 3 4		BASALT; grey to bluish grey (5B 6/1); slightly weathered; strong; highly fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*--		1600	
2310	30				2		4 4 4		1: 40, J, VN, Ca, Sp, Pl, SR 2: 60, J, VN, Ca, Fi, Pl, SR 3: 85, J, VN, H+Ca, Sp, ?, ? (possible mechanical) 4: 40-50, J, VN-T, Ca+Mn, Sp, Pl, SR			
	31			96	5	90	4 5 4 6				[11]	
	32				1		4 4		5: 65, J, VN, H+No, No, Ir, ? 6: 60, J, N, Uk, Pa, Pl, SR 7: 30, J, VN, Fe, Su, Pl, SR			
2308	33				4		4 7				1627	
	34	5			5		1 2 3 2		1: 50, J, N, Ca, Sp, Pl, SR 2: 45-50, J, VN-MW, Ca+Mn, Fi, Pl, S + with 90° slk 3: 15, J, N, Ca+Mn, Pa, Ir, ?		0750	End of day 8/14/2018 Begin day 8/15/2018
2306	35				4		2 4 5		4: 55, J, VN, Ca, Sp, Pl, SR (with MN staining) 5: 60, J, N, H+Ca, Fi, Pl, SR (with MN staining) 6: 40, J, VN, Ca, Fi+Sp, Pl, SR (with MN staining)			Drill fluid becomes light grey greenish grey at 35ft.
	36		2	100	3	80	6 6 2				[8]	
2304	37				3		2 7		With wider fractures with more infilling 7: 70, J, VN-MW, H+Ca, Fi, Pl, ?			
	38				5		2,8 2 9		8: 5, J, N, Ca, Fi, Pl, ? 9: 80, J, ?, Ca+Mn, Sp, Pl, ?		0829	
	39	6			>6		m 1 2 m		1: 25, J, N, Ca, Pa, Pl, SR 2: 70-80, J, Mn, Sp, St/Ir, R Crushed; likely mechanical		0853	
2302	40			83	4	52	3		3: 40, J, T-VN, Ca?, Sp, Pl, SR 4: 60, J, No, No, Pl, S-SR 5: 60, J/Sh, MW, CR+Sd+Ca, Fi, Pl, SR		[6]	
	41				3		3 4				0925	
2300	42	7		100	>6	0	m 1 2 m		Becomes intensely fractured 1: 50, J, Ca?, Sp, Ir, R 2: 80, J, VN, H+Uk, Fi, Wa, ?		0932 [1] 1015	Lost all circulation at 42.5 ft.
	43	8			>6		m 1 4,2 2 3		1: 45, J, Mn?, Su, Pl, R 2: 50-60, J, VN-MW, H+Ca, Fi, Pl, SR 3: 55, J, Ca, Fi-Pa, Pl, SR 4: 60, V, ?, Ca?, Fi, Pl, ? 5: 70, J, ?, Ca, Pa, Pl, SR		1029	
2298	44			100	>6	40	2 2 3 2 2				[5] 1053	
	45											

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-206

Sheet 4 of 7

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	45		2		>6		2 5 1 1 2	BASALT; grey to bluish grey (5B 6/1); slightly weathered; strong; intensely fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*--		1107	
2296	46				>6		3 3 3 1	1: 45, J, VN, Ca, Fi, Pl, S-SR 2: 60-90, J, VN, H+Uk, Fi, Pl, ? 3: 30-40, J, VN, H+Ca, Fi, Pl, ? 4: 30, J, VN, H+Fe?, Fi, Ir, ? 5: 80, J, VN-N, Ca+Fe, Fi, Pl, ?			
	47	9	3	100	6	50	4 5 5 1 6	Becomes moderately fractured; with healed fractures		[7]	47.4-48.7ft.: Mohs Hardness = 3-4; UCS = 20,886 psi
	48				1		7	6: 60, J, N, Fe+Ca, Pa, Pl, ? 7: 40, J, N, H+Uk, Fi, Pl, ?			
2294	49				1		7			1148	
	50				1		m 1			1159	
2292	51				1		2 2	1: 40, J, N, H+Ca+Mn+Fe, Fi+Su, Pl, SR 2: 75; J, N, Fe+Mn+Ca, Su+Pa, Pl, SR 3: 50, J, T, H+No, No, Pl 4: 85, J, VN-N, Ca+Fe, Fi-Pa, Pl-Wa, SR			
	52	10		100	0	100				[12]	
2290	53				1		3				
	54				1		4 m m m			1224	
	55				1		m 1	1: 90, J, T, H+Fe?, Fi, Wa, ? 2: 35, J, VN, Ca?, Pa-Sp, Pl, SR 3: 70, J, VN-N, Ca+Fe, Fi, Pl, ?		1239	
2288	56	11		83	3	50	2 3 3	Becomes highly fractured		[10]	
	57				4		4 5 m	4: 20, J, VN, Ca?, Pa, Pl, SR 5: 85, J, VN, Ca/Ch?, Pa, Pl, SR		1254	
	57.5						1 5 m			1306	
2286	58				2			1: 80, J, N, Ca?, Pl, Pa, SR 2: 75, J, N, H+Ca+Mn, Fi+Sp, Pl, SR 3: 65, J, VN, Ca?, Sp, Pl, SR			
	59	12		100	2	100	2 3 m			[14] 1317	
2284	60	13	4	98	0	90				1332 [11]	
	61										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-206

Sheet 5 of 7

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	61	13	4	98	1	100	1		BASALT; grey to bluish black (5B 2.5/1); slightly weathered; strong; moderate to highly fractured; abundant healed joints with calcite infilling; aphanitic matrix with feldspar phenocrysts up to 1/4-inch --TERTIARY to QUATERNARY INTRUSIVE BASALT--*(continued)*--			
	62				2		2 3				[11]	
2282	63				2		4		1: 70, J, VN, H+Ca?, Fi, Pl, ? 2: 55, J, N, Ca, Fi, Pl, ? 3: 80, J, T-N, H+Ca?, Fi, Pl, ? 4: 60, J, N, Ca+Fe; Fi+Sp, Pl, SR 5: 50, J, VN, H+No, No, Pl, ? 6: 80, J, VN, H+Ca, Fi, Pl, ? 7: 85, J, VN, Ca, Pa, Pl, ?			
	64				2		5 6 7				1359	
2280	65	14		100	2	100	m 1 m		1: 55, J, N, Ca?, Su, Ir, ? 2: 45, J, VN, Ca, Sp, Pl, SR 3: 45, J, VN, Ca, Pa, Pl, SR		1411	65.2-66.5: Mohs Hardness = 3-4; UCS = 15,739 psi
	66				1		2				[7]	
	67				4		3 m		With small, calcite infilled vesicles oriented at 30 degrees		1434	
2278	67.5	15		100		100					1454	
	68				2		1 2 2 3		1-inch diameter calcite nodule 1: 90, J, VN-T, H+Ca, Fi, Pl, ? 2: 75, J, T, H+Ca?, Fi, Pl. ? 3: 65, J, VN, Fe, Su, Pl, SR		[9]	
	69				1				Becomes slightly fractured		1510	
2276	70	16		96	0	96	m 1 2 2		1: 70, J, T, H+Ca?, Fi, Pl, ? 2: 35, V, T, Ca?, Fi, Pl, ? 3: 40, V, N, Ca/Qz?, Fi, Pl, ? 4: 60, J, T, H+Ca?, Fi, Pl, ?		1524	
	71				0							
2274	72				1		3 4		5: 60, J, VN-N, Ca?, Sp, Pl, ? (possibly mechanical) 6: 70, J, N, H+Ca, Fi, Pl, SR (Contact between Basalt and Tuff Breccia) 7: 30, J, N, Ca?, Sp, Pl, ? (possibly mechanical)		[9]	
	73		5		4		5 6 6 7					
2272	74				0		m		VOLCANIC BRECCIA; greenish grey with grey and black clasts; moderately weathered; moderately strong to strong; slightly to highly fractured; medium grained matrix with angular clasts up to 1-inch; some calcite veins --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--		1556	
	75	17		100	3	100*	m m 1 1				0727	End of day 8/15/2018 Begin day 8/16/2018
2270	76				4		1 2 2 3 2		1: 20-30, J, VN, H+Uk, Fi-Sp, Ir, SR 2: 85, J, MW, Ca, Fi, Pl, SR 3: 75, V, N-MW, Ca, Fi, Pl-Wa, ?		[7]	*Rock does not meet soundness criteria for RQD calculation
	77											

Report: GEO_CORE_OAK_C; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-206

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-206

Sheet 6 of 7

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
	77	17	5	100	3	100*	m 4 4	△ △	VOLCANIC BRECCIA; greenish grey with grey and black clasts; moderately weathered; moderately strong to strong; highly fractured; medium grained matrix with angular clasts up to 1-inch; some calcite veins --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*		[7]	
	78				3		5	△ △	4: 50-60, J, VN-T, Ca?, Fi, Pl, ? 5: 70, V, MW, Uk, Fi, Pl, ? With planar, 70° fabric			
2268	79				2		6 m m m	△ △	6: 70, J, VN, Ca, Pa, Pl, SR Becomes highly weathered/altered; weak to very weak; locally crushed		0810	
	80	18		46	4	16	m 1 1	△ △	1: 30, J, VN, No, No, Pl, ? (possibly mechanical)		0825	Packer test #2 from 75.0 to 85.0
2266	81				NA			△ △				
	82				NA			△ △			[9]	
2264	83				2		2 m	△ △	Becomes slightly weathered; moderately strong to strong; with light bluish grey and dark grey clasts 1/8-inch to 1-inch 2: 60, J, N, No, No, Pl, R			
	84				NA			△ △	Weak rock in shoe		0858	
	85	19		92	0	91*	m	△ △	Becomes moderately weathered; moderately strong; medium to coarse grained matrix with strong black and grey clasts and soft clayey green clasts		0923	
2262	86				3		1 2 m 2	△ △	1: 40, J, VN-T, No, No, Ir, ? 2: 60, J, N-VN, H+Ca, Fi-Pa, Pl, SR		[5]	
	87							△ △			0951	
	87.5	20		88	1	75*	m 1	△ △	1: 30-40, J, VN-N, Ca, Pa, Pl, SR 2: 10, J, ?, No, No, Pl, R With more abundant soft, green clasts		1050	Switch to 4-inch carbonado bit
2260	88		6		3		1 1 2	△ △			[8]	
	89				NA		m	△ △	With decreasing clast size		1110	
	90	21		100	0	75*	m m	△ △	Becomes locally moderately strong to strong; moderately to locally highly weathered/altered; intensely fractured		1123	Packer test #1 from 85.0 to 95.0
2258	91				2		1 1 1 1 1	△ △	With fewer breccia clasts			
	92				2		2 1 1 3	△ △	1: 0-10, J, VN, No, No, Pl-Ir, ? (possibly mechanical) 2: 25, J, Vn, Mn?, Fi, Pl, ? (surface staining around joint) 3: 0, J, VN, Mn?, Su, St-Pl, ? (surface staining around joint)		[7]	
	93											

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Core Boring B-206

Sheet 7 of 7

		ROCK CORE											
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	Packer Test Intervals	Drill Time, 24-hr [Drill Rate, ft/hr]	FIELD NOTES AND OTHER TESTS
2256	93		6		1				△ △	VOLCANIC BRECCIA; greenish grey with grey and black clasts; moderately to highly weathered; moderately strong; moderately fractured; medium to coarse grained matrix with angular clasts up to 1/2-inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*			
	94	21		100		75*		3	△ △			[7]	
					0			m m m	△ △	At 94.3ft.: becomes browish grey; weak to moderately strong			
	95								△ △	With 45° fabric		1208 1215	
2254					1				△ △				
	96							1	△ △				
					3			1 1	△ △	Becomes slightly weathered; strong to moderately strong; with enlongated inclusions along fabric			
	97								△ △	1: 0, J, VN-MW, Ca?, Sp, Pl, SR 2: 0, J, MW, Cl+Sd, Fi, Pl, ? 3: 50, J, MW, H+Uk, Fi, Pl, ?			
2252		22		100	0	100*		m	△ △			[7]	
	98				2			2 1	△ △	Becomes very light bluish grey; moderately strong; matrix supported			
	99				3			1 m m 3	△ △	Becomes brownish grey; fewer clasts			
2250	100									**TOTAL DEPTH = 100.0 FEET** **Televiewer and caliper survey by NorCal Geophysics 8/16/2018.** **Install two VWPs at 25ft and 92ft with neat cement grout to ground surface with 12" flush mount monument.**		1300	
	101												
	102												
2248													
	103												
	104												
2246													
	105												
	106												
2244	107												
	108												
	109												

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-207

Sheet 1 of 6

Date(s) Drilled	**9/13/2018-9/18/2018**	Logged By	**K. Zeiger/B. Kozlowicz**	Checked By	**P. Respess**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**2 7/8-inch ID HQ Bit**	Total Depth of Borehole	**81.1 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2359 feet**
Groundwater Level	**23.1 feet bgs 9/14/2018**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir along Copco Road**	Coordinate Location	**N 2602272 E 6461618**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								CLAYEY GRAVEL (GC); loose; brown (7.5YR 4/3); 70% angular to rounded GRAVEL up to 2 inches; 30% low plasticity FINES; dry; gravel is chert, rhyolite, and other volcanics; abundant roots --ROAD FILL--						Start 12:00 9/13/2018 with Hollow Stem Auger to 15.2ft.; K. Zeiger logging
2358	1														
	2														
2356	3														
	4														
2354	5								GRAVELLY LEAN CLAY (CL); medium stiff; brown (10YR 4/3); 60% low plasticity FINES; 40% angular GRAVEL up to 1 inch; dry; with roots and rootlets --COLLUVIUM/RESIDUAL SOIL--		S-01	9 7 2	100		
	6														
2352	7														
	8														
2350	9														
	10								SANDY LEAN CLAY with GRAVEL (CL); stiff; brown (10YR 4/3); 55% low plasticity FINES; 25% angular GRAVEL; 25% fine grained SAND; dry; gravel is highly weathered; with rootlets --COMPLETELY WEATHERED VOLCANIC BRECCIA--		S-02	8 10 8	100		One liner retained (11.0-11.5ft.)
2348	11														
	12														
2346	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-207

Sheet 2 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13							△ △	VOLCANIC BRECCIA; grey (7.5YR 5/1); slightly weathered; strong; cemented fine grained matrix with angular volcanic clasts up 4 inches; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--						
	14							△ △							
2344	15		1		NA		1 2	△ △	1: 10, J, N, No, No, Wa, SR 2: 50, J, N, Fe, Sp, Wa, R 3: 20, J, N?, Ca, Sp, Wa, SR (run break)	◣	S-03	50/3.5"	100	1400	Switch to HQ coring with 2 7/8 inch HQ bit at 15.2ft.
	16	1		94	2	61		△ △						[20]	
2342	17				1		3	△ △						1405 1411	
	18				>6		1 2 3	△ △	Becomes light yellowish brown (10YR 6/4), highly waethered, weak, locally crushed						
2340	19	2		100	>6	26	3 3	△ △	1: 60, J, N, No, No, Pl, SR 2: 60, J, MW, rootlet, Sp, Pl, S-SR 3: 20-40, J, N, Fe, Su+Sp, Wa, SR 4: 80, J, MW, Fe, Su, Wa, SR-R					[25]	
	20				4		4 3	△ △	With clasts weathering out of matrix						
2338	21				2		3	△ △							0.3ft. of Run 2 recovered with Run 3; HQ inner barrel stuck in rods after Run 2 pull rods to retrieve.
	22				0		m	△ △	1: 20, J, T, No, No, Wa, SR 2: 45, J, N, Ca?, Pa, Pl, S+Slk 3: 10, J, N, No, No, Wa, SR 4: 35, J, N, No, No, Pl, S					1423 1518	
2336	23				2		1	△ △	▼						
	24	3		96	4	0	2	△ △	With fracturing along clast boundaries					[20]	
2334	25				>6		2 3	△ △							
	26				NA		3 3 4 3	△ △	Completely weathered, extremely weak					1533 1541	
2332	27				0			△ △	Becomes moderately weathered, moderately strong						
	28	4		100	>6	46*	1 2 3	△ △	1: 50, J, N, No, No, Wa, SR 2: 60, J, MW, Fe+Mn, Su, Wa-St, SR-R 3: 10, J, T, Fe, Sp, Wa-Pl, SR						
2330	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-207

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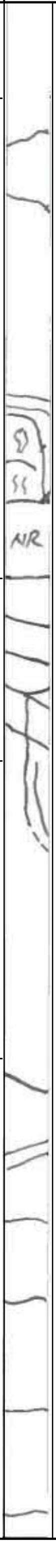
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	4	1	100	>6	46*	3 4 3 5	VOLCANIC BRECCIA; light yellowish brown (10YR 6/4); moderately weathered; moderately strong; locally crushed; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*					[18]	
	30				0									
-2328	31		2		2		6 6	4: 55, J, N, No, No, Pl, S (clast boundary) 5: 80, J, MW, Fe+Mn, Su, Wa-Ir, SR_R 6: 20, J, N, No, Wa, SR						
	32	5		100	>6	0	1 2 1	Becomes highly weathered, weak, intensely fractured					1558 1605	
-2326	33				>6		3 4 3	1: 85, JN, No, No, Wa, SR 2: 20, J, T, Fe+Mn, Su, Wa, SR 3: 30, J, N, No, No, Wa, SR 4: 40, J, N, Fe+Mn, Su, Pl, SR 5: 65, J, N, Fe+Mn, Su, Pl, SR 6: 35, J, N, Fe+Mn, Su, Wa, SR						
	34				>6		3						[16]	
-2324	35				>6		5 5 6	Highly to completely weathered						Lost all circulation at 35.0ft.
	36	6		67	NA	0							1622 1637 [5] 1644	
-2322	37	7		56	>6	10	1 2 3	Highly to completely weathered, crushed Becomes moderately weathered, moderately strong					0859	End of day 9/13/2018 Begin day 9/14/2018
	38				2		1							Driller noted 'harder' drilling conditions
-2320	39				NA		3 3 4	Becomes completely weathered to a CLAYEY SAND, extremely weak					[23]	
	40				NA									
-2318	41				NA									
	42	8		40	NA	0							0912 1203	1500 gallons of water used in Run 7
-2316	43				NA									Advance 4-inch casing to 29ft.
	44				NA								[19]	
-2314	45													

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	8	2	40	>6	0		△ △	VOLCANIC BRECCIA; light yellowish brown (10YR 6/4); completely weathered to a CLAYEY SAND; extremely weak; locally crushed --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
	46				>6		1 2	△ △	At 46ft.: becomes very dark greenish grey (5BG 3/1) and greenish grey (5G 6/1); moderately weathered; moderately strong; intensely fractured 1: 20, J, N, Sa, Pa, Pl, S 2: 50, J, T, No, No, Pl, S						
2312	47	9		100	3	18	1 1 m 1 2	△ △	At 47ft.: becomes very dark greenish grey (5BG 3/1), highly weathered, very weak, with angular clasts weathering out of soft matrix					1219 1241	
	48				1		m m	△ △							
2310	49		3		2		3 4	△ △	Slightly weathered, strong clast					[17]	
	50				2		4 5	△ △	1: 10, J, N, No, No, Wa, SR 2: 45, J, N, No, No, Wa, SR 3: 55, J, T, No, No, Wa, SR 4: 30, J, N?, No, No, Pl, S (clast boundary) 5: 20, J, T, No, No, Wa, SR						
2308	51				0			△ △							
	52	10		66	>6	0	1	△ △	Crushed With calcite veins					1259 1309	
2306	53				3		1 2	△ △							
	54				2		3	△ △	1: 65, J, N, No, No, Wa, SR 2: 30, J, N, No, No, Wa-St, SR 3: 10, J, T, No, No, Wa-Pl, SR					[13]	
2304	55				NA			△ △							
	56				NA			△ △							
2302	57	11		100	>6	90	1 2 3 4	△ △	Becomes slightly to moderately weathered, moderately strong Crushed Becomes slightly fractured					1333 1341	
	58				2		5	△ △							
2300	59				0		m	△ △	Clast weathering out of matrix					[15]	
	60				0			△ △	1: 85, J, MW, No, No, Wa-St, R 2: 10, J, MN, No, No, Wa-St, R 3: 15, J, N, No, No, Wa, SR 4: 50, V, N, H+Ca, Fi, Ir, ? 5: 30, V, MW, H+Ca, Fi, Wa, ?						
2298	61														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-207



Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Fracture Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61	11	3	100	0	90			△ △	VOLCANIC BRECCIA; very dark greenish grey (5BG 3/1) and greenish grey (5G 6/1); slightly to locally moderately weathered; moderately strong; slightly fractured; fine grained matrix with angular to subangular clasts of porphyritic basalt up to 1.5 inches --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						
	62		4		1			1	△ △						1401 0840	End of day 9/14/2018 Begin day 9/18/2018 B. Kozlowicz logging Water level at 28.8 ft. 9/18/2018
2296	63				0			m	△ △	1: 30-40, J, N, No, No, Ir, R 2: 30, J/Sh, MW, Ca, Sp, Pl, SR 3: 90, J/Sh, MW, Ca, Sp, Pl, SR						
	64	12		82	0	52			△ △						[10]	50% fluid circulation
2294	65				4			2 2 3	△ △	Becomes moderately weathered, weak to very weak along fracture zones with irregular, subvertical anastomosing calcite veins and small, angular clasts						
	66				NA				△ △	Extremely weak, completely weathered/altered to a CLAYEY SAND						
2292	67				2			1 1	△ △	Becomes highly fractured with clasts up to 2.5 inches					0909 0919	
	68	13		94	NA	47		1 2	△ △	1: 30, J, VN, No, No, Pl, R 2: 80-90, J, N, No, No, Pl, SR with very weak, friable zone along fracture					[9]	
2290	69				2			1	△ △	Becomes slightly fractured, strong					0932 0955	
	70	14		100	0	74			△ △	1: 80-90, J, N, No, No, Pl, SR-R					[10]	
2288	71				0				△ △							
	72				2			1	△ △	Very strong, dark gray basalt with calcite					1013 1032	
2286	73				2			1 2	△ △	Very strong, dark gray porphyritic basalt						
	74	15		100	0	88		m	△ △						[9]	
2284	75				0			m	△ △	1: 45, J, VN, No, No, Pl, R (possibly mechanical) 2: 10, J, VN, No, No, Ir, SR-R						
	76				0			m	△ △							
2282	77														1107	

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-207

Sheet 6 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	77		5		0				△ △	VOLCANIC BRECCIA; very dark greenish grey (5BG 3/1) to greenish grey (5G 6/1) and dark grey; slightly weathered; strong; slightly fractured; fine grained matrix with angular to subangular clasts of porphyritic basalt up to 1 inch --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*					1128	
	78				0			1 m	△ △	1: 75-90. V, MW, H+Ca, Fi, Ir-St, ? 2: 40, J, VN, No, No, Pl, SR-R (possibly mechanical)						
2280	79	16		100	2	85		2	△ △	Very strong, dark grey porphyritic basalt					[14]	
	80				0			2	△ △							
2278	81									**TOTAL DEPTH = 81.1 FEET**					1146	
	82															
2276	83															
	84															
2274	85															
	86															
2272	87															
	88															
2270	89															
	90															
2268	91															
	92															
2266	93															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-208

Sheet 1 of 6

Date(s) Drilled	**9/18/2018-9/21/2018**	Logged By	**B. Kozlowicz/T. Vande Voorde**	Checked By	**B. Kozlowicz**
Drilling Method	**Hollow Stem Auger, HQ-3 Rock Core**	Drill Bit Size/Type	**6-inch flight auger, 4-inch diamond core bit, 4-inch drag bit**	Total Depth of Borehole	**80.0 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2338 feet**
Groundwater Level	**14.1 feet bgs 9/19/2018**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir; Dagget Road**	Coordinate Location	**N 2601173 E 6460942**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2338	0								CLAYEY SAND with GRAVEL (SC); loose to medium dense; dark brown (10YR 3/3); 40% low plasticity FINES; 40% fine to coarse grained SAND; 20% angular to subrounded GRAVEL and COBBLES up to 3 inches; dry --ALLUVIUM--						Start 15:50 9/18/2018 with Hollow Stem Auger; B. Kozlowicz logging
	1														
2336	2														
	3														
2334	4														
	5														
2332	6														
	7								SANDY LEAN CLAY (CL); very stiff; 70% medium plasticity FINES; 30% fine to medium grained SAND; trace small GRAVEL; moist --ALLUVIUM--						
2330	8														
	9														
2328	10									▯	S-01	16 11 16	20		
	11														
2326	12								▽						
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-208

		ROCK CORE								SOIL SAMPLES					
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13								SANDY LEAN CLAY (CL); very stiff; 70% medium plasticity FINES; 30% fine to medium grained SAND; trace small GRAVEL; moist --ALLUVIUM--*(continued)*						
2324	14								▼						
	15										S-02	6 6 8	33		
2322	16								SANDY LEAN CLAY with GRAVEL (CL); medium still; with rounded to subangular GRAVEL; wet						
	17														Rig chatter
									GRAVEL and COBBLES with SANDY LEAN CLAY/CLAYEY SAND; washed, rounded COBBLES and BOULDERS (fragments) up to 6 inches --RIVER ALLUVIUM--						
2320	18														
	19														
2318	20	1	1	100	NA	NA	NR				S-03	50/5"	71		Switch to HQ coring with 4-inch #2 diamond bit at 2.0ft. Advance 4.5-inch casing to 19.0ft; End of Day 9/18/2018
	21				NA									1143	
2316	22				NA		NR								Begin Day 9/19/2018; T. VandeVoorde logging; 0% fluid return
	23	2		32	NA	NA								[18]	
2314	24				NA				With washed, subrounded to rounded GRAVEL; some angular to coarse grained SAND; COBBLES are vesicular up to 6-inches						Advance 4.5-inch casing to 24ft.
	25				NA										
2312	26													1200 1302	
		3		100	NA	NA								[26]	
	27				NA										
2310	28													1306 1311	
		4		15	NA	NA	NR								
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-208

Sheet 3 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	4	1	15	NA	NA	NR		GRAVEL and COBBLES with SANDY LEAN CLAY/CLAYEY SAND; washed, rounded vesicular COBBLES and BOULDERS (fragments) up to 6 inches; washed, subrounded to rounded GRAVEL; some angular to coarse grained SAND --RIVER ALLUVIUM--*(continued)*					[66]	Advance 4.5-inch casing to 29ft.
2308	30				NA				At 30ft: With vesicular, basaltic GRAVEL and COBBLES up to 3 inches						Angular coarse grained SAND recovered from cuttings possibly from no recovery zones
	31				NA									1314 1316	Cuttings bagged for review
2306	32				NA										Driller notes sandy loose drilling conditions
	33	5		14	NA	NA	NR							[100]	
2304	34				NA				COBBLES become angular to rounded						Initially no recovery for Run 5; run recored and bagged for review
	35				NA										
2302	36				NA				Coarse black and light brown SAND in cuttings					1319 1535	
	37				NA										
2300	38	6		0	NA	NA	NR							[33]	Cuttings bagged for review
	39				NA										Driller notes change in cuttings with increased brown fine grained SAND or FINES; change in color of drilling fluid from grey to brown
2298	40				NA										
	41				NA									1544 1615	
2296	42				NA		NR								
	43	7		34	NA	NA								[27]	
2294	44				NA				With rounded, basaltic COBBLES; angular, vesicular basaltic GRAVEL; some medium to coarse grained SAND						
	45														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-208

Sheet 4 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing	Number	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45	7	1	34	NA	NA			GRAVEL and COBBLES with SAND; rounded, basaltic COBBLES; angular, vesicular basaltic GRAVEL; some medium to coarse grained SAND; 45-46 ft. fine-grained, basaltic BOUDLER with 1-2 mm feldspar phenocrysts --RIVER ALLUVIUM--*(continued)*						Continued 20-30% fluid return
2292	46				NA									1626 1704	
	47				NA		NR								
2290	48	8		56	NA	NA			With more rounded COBBLES and BOULDERS; variable volcanic lithologies of basaltic, andesite, and tuff					[13]	
	49				NA										Drilling fluid becomes dark brown
2288	50				NA									1727	
	51	9		0	NA	NA	NR							1737 [6] 1744 1748	
2286	52				NA		NR								
	53	10		84	NA	0		m m m m	VOLCANIC BRECCIA; dark, dusky purple and bluish grey; moderately weathered; extremely weak; fine grained matrix with strong clasts --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--					[12]	
2284	54				NA									1803	Advance 4.5-inch casing to 54ft.
	55	11		17	NA	0	NR		Strong, volcanic breccia clast in shoe					0931 [7] 0941	End of day 9/19/2018 Begin day 9/20/2018
2282	56		2		NA									0949	
	57	12		0	NA	0	NR							[7]	
2280	58	13		50	NA	0	NR		Becomes very dusky red (2.5YR 2.5/2) to dark reddish brown (2.5YR 2.5/4); moderately to highly weathered, very weak breccia clasts in a friable, completely weathered, extremely weak matrix; locally recovered as CLAYEY SAND with GRAVEL					1006 1008 [3] 1021	
	59				NA		NR				S-04 S-05	31 50/3" 70/2"	44 100	1128	Switch to new #2 diamond bit at 59ft.
2278	60	14		73	NA	0		m m m						[7] 1141	
	61														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: KLAMATH_MASTER.GPJ; 6/20/2019 B-208

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61		2		0			△ △	VOLCANIC BRECCIA; dark brown to dusky purple; moderately to highly weathered; extremely weak; fine grained, sandy matrix with basaltic breccia clasts --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					1152	Continued 20-30% fluid return; hard drilling (1500psi down pressure)
2276	62				0		m m	△ △							
	63	15		100	0	0	m	△ △						[15]	
2274	64				0		m	△ △							
	65	16		100	0	0	m m m m m	△ △	With breccia clasts up to 1/2 inch; locally very weak					1208 1236 [20]	Switch to 4-inch drag bit at 65ft.
2272	66				0			△ △	Becomes moderately weathered; moderately strong; locally extremely weak; moderately fractured					1239 1225	
	67				0			△ △							
2270	68	17		90	1	0	1	△ △	Medium to coarse grained VOLCANIC SANDSTONE; brownish purple to greenish grey (10GY 5/1)					[8]	Drilling fluid becomes light grey
	69				0		2 m m?	△ △	1: 60, J, W, Sd, Sp, Pl, SR 2: 80-90, V, N-MW, H+Ca, Fi, Pl 3: 30, V, N, H+Ca, Fi, Pl						Drilling fluid becomes brown/purple
2268	70				0		3 2	△ △	Greenish grey to dark greenish grey						
	71				0		1 2 3 m	△ △	1: 65-90, V, MW-W, Ca, Fi, Pl, S-SR 2: 0, V, MW, Ca, Fi, Pl, SR 3: 70, V, N, Ca, Fi, Pl, ? 4: 80-90, V, N, Ca, Fi, Wa, ? 5: 50, J, VN, H+Ca, Fi, Pl 6: 60-65, V, VN, Ca, Fi, Pl					1302 1311	
2266	72		3		0		3	△ △							
	73	18		100	2	0	4 5 5	△ △	With increasing number of breccia clasts					[38]	
2264	74				0		6	△ △	Greenish grey						
	75				0		m m	△ △							
2262	76	19		86	>6	20	m m 1,1 1,1 2	△ △	Becomes highly to intensely fractured; matrix becomes clayey 1: 0-20, J, VN-W, No, No, Pl-Ir, SR 2: 60, V, VN, Ca, Fi, Pl, ?					1319 1325	
	77														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring B-208

Sheet 6 of 6

Elevation, feet	Depth, feet	ROCK CORE							Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number			Type	Number	Blows / 6 in.	Recovery, %		
	77	19	3	86	3	20		1 3 4 4 m	△ △	VOLCANIC BRECCIA; dark reddish grey (10YR 3/1); moderately weathered; extremely weak; highly fractured --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)* 3: 65, J, VN, No, No, SR, Pl 4: 10, J, W, No, No, Ir, SR					[29]	
2260	78				0		NR		△ △						1331	
	79	20		38	NA	0	NR		△ △	Becomes <10% clasts; 90% clayey matrix					1420 [22] 1423	
2258	80									TOTAL DEPTH = 80.0 FEET						
	81															
2256	82															
	83															
2254	84															
	85															
2252	86															
	87															
2250	88															
	89															
2248	90															
	91															
2246	92															
	93															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-01

Sheet 1 of 2

Date(s) Drilled	**2/5/2018 - 2/6/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**30.4 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2597 feet**
Groundwater Level(s)	**12.3 feet above ground surface (2/5 at 15:15)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2608898 E 6476516**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0	◣	S01	1 1 0	100		SILT with SAND and GRAVEL (ML); very soft; very dark gray to black (2.5Y 3/1 to 2.5/1); fine to coarse grained SAND; subangular to rounded GRAVEL; sand and gravel consist of diatomite clasts --RECENT LAKE SEDIMENT--				Sampler fell 18 inches on last blow
2595											Advance 6-inch casing to 6 feet with hammer (hard/stiff at about 3.5 feet)
	5										
2590		◣	S02	4 3 4	100		Becomes soft; dark olive brown (2.5Y 3/3) to very dark grayish brown (2.5Y 3/2) with trace gravel	43	8		Advance 6-inch casing to 8 feet with hammer LL=33; PL=25
	10						DIATOMITE; light olive brown (2.5Y 5/4); highly weathered; extremely weak; highly fractured; friable --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2585		◣	S03	7 6 6	80			99			
											End of day 16:45,Begin day 08:30 Advance 6-inch casing to 11 feet with hammer
	15										
2580											
	20										
2575		◣	S04	3 2 5	93		Becomes soft with iron staining on irregular subvertical fractures	93	34	99	LL=85; PL=51 SA: G=0%; S=1%; F=99%
	25										
2570											
							BASALT; black (10Y 2.5/1); highly to completely weathered; friable --TERTIARY to QUATERNARY INTRUSIVE BASALT--				Cuttings become dark greenish gray sandy clay; slower drilling
		◣	S05	31 50/6"	60						
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-01

Sheet 2 of 2

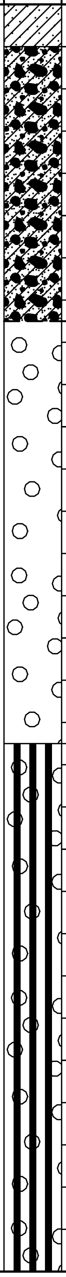
Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30		S06	50/5"	100	▨					
							TOTAL DEPTH = 30.4 FEET				
2565											
	35										
2560											
	40										
2555											
	45										
2550											
	50										
2545											
	55										
2540											
	60										
2535											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-02

Sheet 1 of 2

Date(s) Drilled	**2/5/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**64.6 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2600 feet**
Groundwater Level(s)	**9.4 feet above ground surface (2/5 at 9:00)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT, 3-inch Shelby Tube**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2608331 E 6476958**



Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0		S01	2 10 12	85		SANDY LEAN CLAY (CL); very soft; very dark gray (2.5Y 3/1) to black (2.5Y 2.5/1); trace fine rounded gravel --RECENT LAKE SEDIMENT--			28	Drove sampler for extra 6 inches (last three blowcounts reported) SA: G=52%; S=20%; F=28% Advance 6-inch casing to 3.8 feet with hammer
							CLAYEY GRAVEL with SAND (GC); stiff/medium dense; very dark grayish brown (10YR 3/2); subangular to rounded fine to coarse gravel up to 2 inches in diameter; fine to coarse sand --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2595	5		S02	5 5 10	13		← Black angular basalt cobble				
			S03	18 10 10	60						Drove sampler for extra 6 inches (last three blowcounts reported) Advance 6-inch casing to 8.8 feet with hammer
							DIATOMITE; olive to olive yellow (5Y 4/3 to 2.5Y 6/6); moderately to highly weathered; extremely weak; highly fractured; with sub-horizontal bedding and irregular sub-vertical fractures; friable --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2590	10		S04	11 9 9	53						
							Becomes light yellowish brown (2.5Y 6/4); extremely weak/clayey; moderately fractured				
2585	15		S05	4 4 6	80			84	46	99	LL=105; PL=59 SA: S=1%; F=99%
							DIATOMITE with ELASTIC SILT; greenish gray (10Y 5/1); soft to extremely weak; highly fractured; friable --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2580	20		S06	200 psi	100			148			TX-ICU About 50% WCR
2575	25		S07	3 2 3	93						S-07: Two liners retained (25-25.5ft., 25.5-26ft)
											About 25% to 50% WCR
2570	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-02

Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE; olive to olive yellow (5Y 4/3 to 2.5Y 6/6); moderately to highly weathered; extremely weak; highly fractured; with sub-horizontal bedding and irregular sub-vertical fractures; friable --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2565	35	☒	S08	200 to 500 psi	84			149			TX-ICU
2560	40										Cuttings become very dark gray
							Increase in plasticity; soft; olive (5Y 5/3) and very dark gray to black (2.5Y 2.5/1 to 2.5Y 3/1) in ~2.5-inch beds; sub-horizontal bedding				
2555	45	◣	S09	3 3 4	100			178	102	100	LL=187; PL=85 SA: S=1%; F=99% S-09: Two liners retained (45-45.5ft., 45.5-46ft)
2550	50										
2545	55	◣	S10	2 3 5	100			171			S-10: Two liners retained (55-55.5ft., 55.-56 ft.)
2540	60										
							BASALT; black (10Y 2.5/1); slightly weathered; strong; recovered as angular gravel up to 1-inch in diameter --TERTIARY to QUATERNARY INTRUSIVE BASALT--				Harder drilling, small black basalt chips in cuttings
		▯	S11	50/3"	100						
2535	65										

TOTAL DEPTH = 64.6 FEET

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-03

Sheet 1 of 3

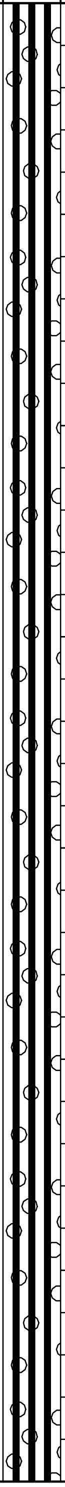
Date(s) Drilled	**2/6/2018 - 2/7/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**96.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2584 feet**
Groundwater Level(s)	**24.3 feet above ground surface (2/6 at 12:00)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT, 3-inch Shelby Tube, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2606643 E 6474657**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						ORGANIC SILT WITH SAND (OL); very soft; very dark grayish brown (2.5Y 3/2) --RECENT LAKE SEDIMENT--				
			S01	1 2 3	2		SANDY LEAN CLAY (CL); soft; black (5Y 2.5/2); fine grained sand; trace rounded gravel; small angular rock fragments; and fine rootlets --COLLUVIUM/RESIDUAL SOIL--	35	NP	67	Sampler settled to 1-foot; drove sampler for extra 6 inches (last three blowcounts reported) LL=48; PL=25 SA: G=3%; S=30%; F=67%
2580							Without gravel				Advanced 6-inch casing to 4 feet (stiff from 3 feet)
	5		S02	4 3 2	0.6			25			
							POORLY GRADED GRAVEL with CLAY (GP-GC); subrounded gravel up to 2.5-inch in diameter of varied volcanic lithology and clayey infill --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Hard chattering drilling Switch to rock core bit with SPT sampler
2575	10		R1								
							DIATOMITE; light olive brown (2.5Y 5/3); very soft; locally clayey with vessicular basalt GRAVEL; bedding/fractures not present --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Faster drilling from 10.5 to 11.5 feet
			S03	6 3 2	0.1						
											Return fluid becomes olive Advanced 6-inch casing to 14 feet with hammer
2570	15		R2								
			S04	6 4 5	1.0		Becomes olive brown to dark greyish brown (2.5Y 4/3 to 4/2), extremely weak, massive				Switch back to tricone bit
2565	20										
							DIATOMITE with ELASTIC SILT; dark grayish brown (2.5Y 4/2); massive/soft to very soft --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2560	25		S05	3 3 4	1.3			80	NP	100	LL=69; PL=59 SA: F=100%
2555	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-03

Sheet 2 of 3

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; dark grayish brown (2.5Y 4/2); massive/soft to very soft --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2550	35										
2545	40	☒	S06	200 to 400 psi	2.5			85 90			TX-ICU TX-ICU
2540	45										Cutting very dark greenish gray
2535	50										
2530	55										
2525	60										
2520	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-03

Sheet 3 of 3

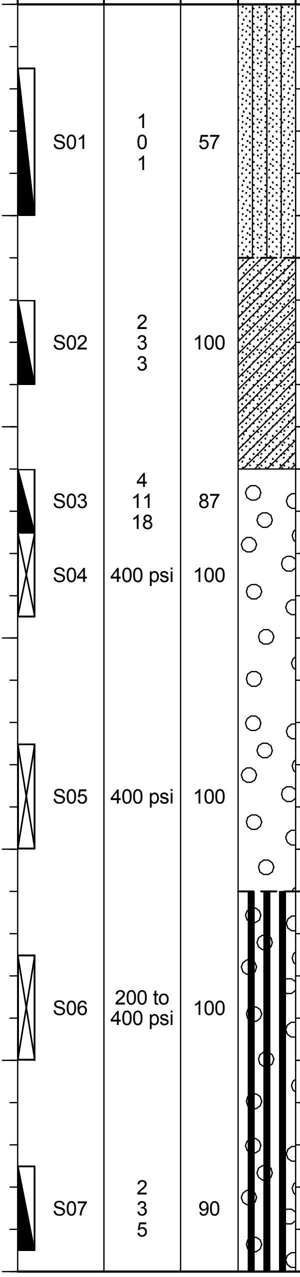
Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	65		S07	5 5 7	1.5		DIATOMITE with ELASTIC SILT; dark greenish gray (10Y 4/1); massive/soft to very soft; 1 to 2-inch beds/lenses of very dark gray to black clay --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				End of day 2/6/2018 Begin day 2/7/2018 Cuttings greenish black
2515	70										
2510	75										
2505	80		S08	100 psi	0						
2500	85		S09		0.25		With trace rounded GRAVEL (possibly slough)				
2495	90		S10		1.0			120			TX-ICU
2490	95		S11	4 5 5	0.2						Driller out of rods
							TOTAL DEPTH = 96.5 FEET				
2485	100										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-04

Sheet 1 of 3

Date(s) Drilled	**2/1/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**73.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2597 feet**
Groundwater Level(s)	**11.8 feet above ground surface (2/1)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT, 3-inch Shelby Tube**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2604812 E 6472949**



Elevation feet	Depth, feet	SAMPLES Number	Sampling Resistance	Recovery (feet)	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0				SILTY SAND (SM); very loose; very dark brown (10YR 2/2); trace subangular diatomite GRAVEL up to 0.75 inches in diameter --RECENT LAKE SEDIMENT--				6-inch casing settles to 1.5 feet
2595								44	SA: G=5%; S=51%; F=44%
		S01	1 0 1	57	Becomes organic rich and softer/looser with increased nonplastic fines				Sampler advanced 1 foot on first blow and 2.5 feet on second blow
	5								Advance 6-inch casing to 5.5 feet with hammer
2590					CLAYEY SAND (SC); very loose; very dark brown (10YR 2/2); trace fine GRAVEL and coarse organics --RECENT LAKE SEDIMENT--			58	SA: G=3%; S=39%; F=58%
		S02	2 3 3	100					Drove sampler for extra 6 inches (last three blowcounts reported)
	10								Advance 6-inch casing to 11 feet (resistance at 11 feet)
2585		S03	4 11 18	87	WEAKLY CEMENTED DIATOMITE GRAVEL; medium dense; light olive brown (2.5Y 5/4); angular diatomite GRAVEL; weakly cemented and friable with sub-horizontal bedding and sub-vertical fractures --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--			41	Advance 6-inch casing to 12.5 feet with hammer SA: G=9%; S=50%; F=41%
		S04	400 psi	100		61 54			TX-ICU TX-ICU
	15								
2580									100 percent WCR
		S05	400 psi	100		105			TX-ICU
	20								
2575					DIATOMITE with ELASTIC SILT; soft to completely weathered; light greenish gray (5GY 7/1) --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
		S06	200 to 400 psi	100		155			TX-ICU
	25								Lost circulation to 27.5 feet
2570									
		S07	2 3 5	90	Becomes mottled with very pale brown (10YR 8/3) and light greenish gray (5GY 7/1) with 10 degree bedding				Drove sampler for extra 6 inches (last three blowcounts reported) About 50% WCR
	30								

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; soft to completely weathered; light greenish grey (10YR 8/3) mottled with very pale brown (10YR 8/3) and light greenish gray (5GY 7/1) with 10 degree bedding --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2565											
			S08	200 to 500 psi	60			117	35	99	LL=120; PL=85 SA: S=1%; F=99% Consol TX-ICU LL = 60 PL = 24 PI = 36 1% Sand 99% Fines About 75% WCR
	35										
2560											
							Becomes completely weathered to a FAT CLAY; with 0.25-inch very dark gray (5Y 3/1) 10-degree beds (varves?)				
	40										
2555											
											About 50% to 75% WCR
			S09	1 1 1	100		With vertical dark grey stained (Mn?) fractures				
	45										
2550											
	50										
2545											
			S10	200 to 400 psi	100			154			TX-UU TX-ICU
	55										
2540											
	60						DIATOMITE; highly to completely weathered; pale yellow to olive yellow (2.5Y 6/6 to 2.5Y 8/4) with orange oxidation stain/mottling; fine grained vitreous gypsum crystals along very dark gray (5Y 3/1) sub-vertical fractures --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2535											
			S11	2 2 2							Final hammer blow advanced sampler 2-inches
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-04

Sheet 3 of 3

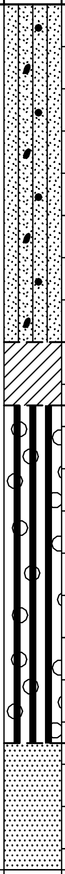
Elevation feet	Depth, feet	SAMPLES				Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
		Type	Number	Sampling Resistance	Recovery (feet)						
	65						DIATOMITE; highly to completely weathered; pale yellow to olive yellow (2.5Y 6/6 to 2.5Y 8/4) with orange oxidation stain/mottling; fine grained vitreous gypsum crystals along very dark gray (5Y 3/1) sub-vertical fractures --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2530											
	70						ANDESITE(?); dark grey and reddish brown; moderately to highly weathered; medium strong; fine to medium grained --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Hard drilling, very dark gray to black volcanic fragments in cuttings
2525											
			S12	30 50/5"							
							TOTAL DEPTH = 73.5 FEET				
	75										
2520											
	80										
2515											
	85										
2510											
	90										
2505											
	95										
2500											
	100										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-05

Sheet 1 of 1

Date(s) Drilled	**2/2/2018, 2/8/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**20.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2601 feet**
Groundwater Level(s)	**8.2 feet (2/2 at 11:00) and 6.6 (2/8 at 12:15) feet above ground surface**	Sampling Method(s)	**2.5-inch ID ModCal, SPT, 3-inch Shelby Tube**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2604139 E 6474515**



Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
2600	0		S01	0 0 0	35		SILTY SAND with GRAVEL (SM); very loose; very dark grayish brown (2.5Y 3/2); greenish gray clayey diatomite GRAVEL up to 1-inch in diameter; nonplastic FINES --RECENT LAKE SEDIMENT--				Sampler advanced 2 feet under hammer weight Advance 6-inch casing to 5 feet with hammer
2595	5										
			S02	4 10 20			Clayey gravel made up of mostly DIATOMITE clasts up to 0.75 inches in diameter LEAN CLAY (CL); very stiff; very dark gray to very dark greenish gray (10Y 3/1 to 2.5Y 3/1); low to medium plasticity FINES; trace highly to completely weathered GRAVEL of diatomite and organics --FLUVIO-LACUSTRINE TERRACE DEPOSIT WITH GRAVEL (Qtg)--				Drove sampler for extra 6 inches (last three blowcounts reported) Advance 6-inch casing to 8.5 feet (refusal) End of day 2/2/18 at 9.0 ft. Begin day 2/8/18
2590	10		S03	2 1 1	100		DIATOMITE with ELASTIC SILT; extremely weak/very soft; greenish gray (5GY 6/1); 20-degree bedding and 90-degree fractures; with fine roots at 11ft. --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				
2585	15		S04	200 to 400 psi	100		Becomes medium stiff to stiff with olive yellow (2.5Y 6/6) with angular clasts; friable	135 30			TX-ICU TX-ICU
							VOLCANIC SANDSTONE; yellowish brown(10YR 5/6); highly to completely weathered; very weak; locally clayey --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Harder drilling with yellowish to reddish brown rock chips in cuttings
2580	20		S05	32 50/5"			**TOTAL DEPTH = 20.5 FEET**				
2575	25										
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-06

Sheet 1 of 1

Date(s) Drilled	**2/2/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**15.4 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2578 feet**
Groundwater Level(s)	**29.2 feet above ground surface (2/2 at 13:00)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2605112 E 6476050**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						--RECENT LAKE SEDIMENT--				Advance 6-inch casing to 5ft. with hammer from 2 to 5ft.
							LEAN CLAY with SAND (CL); stiff; olive gray to dark olive gray (5Y 4/2 to 5Y 3/2); 20% fine grained SAND; 80% low to medium plasticity FINES; trace fine angular volcanic GRAVEL and wood debris/roots up to 1-inch --COLLUVIUM--				
2575											
	5		S01	5 9 14	100						
							VOLCANIC SANDSTONE; dark greenish gray to black (5GY 4/1 to GLEY1 2.5/N); moderately to slightly weathered --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Harder drilling with gravelly cuttings
2570											
	10		S02	50/4"	100						Hard, slow drilling at 15ft.
2565											
	15		S03	50/4"							
							TOTAL DEPTH = 15.4 FEET				
2560											
	20										
2555											
	25										
2550											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-07

Sheet 1 of 1

Date(s) Drilled	**2/2/2018 - 2/3/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**15.9 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2581 feet**
Groundwater Level(s)	**26.2 feet above ground surface (2/2 at 15:30)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2605439 E 6477039**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						--RECENT LAKE SEDIMENTS--				
2580			S01	0 0 0	100		FAT CLAY with SAND (CH); medium stiff; very dark gray (10YR 3/1); fine to medium grained SAND; medium to high plasticity FINES; trace rootlets --COLLUVIUM/RESIDUAL SOIL--				Sampler advanced 2ft. with weight of hammer Advance 6-inch casing to 2 ft.
			S02	5 7 8	67		← Wood/roots up to 1-inch in size	34	NP	65	LL=60; PL=24 SA: G=15%; S=20%; F=65%
	5										End of day 2/2/2018 Begin day 2/3/2018 Advance 6-inch casing to 5 ft. with hammer
2575											
			S03	2 5 4	40		CLAYEY SAND (SC); loose; very dark grayish brown (10YR 3/2); medium to coarse grained SAND; medium plasticity FINES; trace fine GRAVEL with some diatomite clasts --COLLUVIUM/RESIDUAL SOIL--				Angular diatomite gravel and wood fibers in cutting to about 13 ft.
	10										Advance 6-inch casing to 10 ft. with hammer
2570							POORLY GRADED SAND with SILT and GRAVEL (SP-SM); loose to medium dense; coarse grained SAND; dark greenish gray (10Y 4/1) subrounded to rounded diatomite GRAVEL up to 1-inch in diameter in shoe --COLLUVIUM/RESIDUAL SOIL--				
			S04	9 9 7	100					8	SA: G=27%; S=65%; F=8%
	15		S05	20 50/4"			With shell hash VOLCANIC SANDSTONE; very weak; light olive brown to strong brown (2.5Y 5/4 to 7.5YR 5/8); highly to completely weathered; with irregular 5 to 10-degree bedding --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Hole caving; advanced 6-inch casing to 14ft. with hammer
2565							**TOTAL DEPTH = 15.9 FEET**				
	20										
2560											
	25										
2555											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-08

Sheet 1 of 1

Date(s) Drilled	**2/3/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone, 2 7/8-inch drag bit**	Total Depth of Borehole	**11.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2586 feet**
Groundwater Level(s)	**22.2 feet above ground surface (2/3 at 14:00)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2605190 E 6480346**

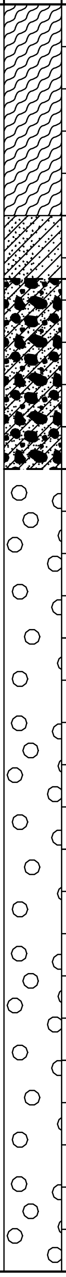
Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0					≈	ORGANIC SILT to ORGANIC CLAY (OL/OH); very soft; dark olive gray (5Y 3/2) with coarse organic debris				Advance 6-inch casing to 3 feet with hammer
2585		◩	S01	4 8 11	87	▨	FAT CLAY with SAND (CH); stiff; black (5Y 2.5/2); fine grained SAND; medium plasticity FINES; trace angular to subrounded GRAVEL up to 1.5 inches in diameter --COLLUVIUM/RESIDUAL SOIL--	31	NP		LL=56; PL=24
2580	5	▯	S02	22 29 37	47	⁘	WELL GRADED GRAVEL with SAND (GW); very dense; very dark grayish brown to black (10YR 3/2 to 10YR 2/1); broken rounded GRAVEL up to 1.5 inches in diameter; medium to coarse grained SAND; trace low plasticity FINES --FLUVIO-LACUSTRINE TERRACE DEPOSIT WITH GRAVEL (Qtg)--				Very hard drilling with volcanic rock chips in cuttings; switched to 2 7/8-inch drag but Blow counts affected by large particles
2575	10						**TOTAL DEPTH = 11.5 FEET**				
2570	15										
2565	20										
2560	25										
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-08a

Sheet 1 of 3

Date(s) Drilled	**2/14/18**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**85.2 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2583 feet**
Groundwater Level(s)	**25.3 feet above ground surface (2/14 at 10:00)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2605249 E 6480346**



Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						ORGANIC SILT (OL); very soft; very dark brown (10YR 2/2) --RECENT LAKE SEDIMENT--				
2580											Sampler sank to 4ft.; drove sampler for extra 18 inches (last three blowcounts reported, previous blows were 2-2-7)
	5		S01	9 20 50/4"	67		CLAYEY SAND to SANDY LEAN CLAY (SC-CL); loose/medium dense; black (10YR 2/1); fine to medium grained SAND; medium plasticity FINES; trace fine rounded GRAVEL --COLLUVIUM/RESIDUAL SOIL--				
			S02	50/8"	80		CLAYEY GRAVEL with SAND (GC); very dense; dark yellowish brown to very dark gray (10YR 4/6 to 10YR 3/1); subangular to rounded GRAVEL and COBBLES up to 3 inches in diameter in a SANDY LEAN CLAY to CLAYEY SAND matrix --FLUVIO-LACUSTRINE TERRACE DEPOSIT WITH GRAVEL (Qtg)--				Hard chattering drilling from 7 to 11ft. Advance 6-inch casing to 8ft. with hammer
2575											
	10										
							DIATOMITE; light yellowish brown (2.5Y 6/4); extremely weak; with irregular 45 to 90-degree fractures with some iron staining and 0 to 15-degree fractures --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Fast smooth drilling with olive brown diatomite cuttings
2570											
	15										Advance 6-inch casing to 14ft. with hammer
2565											
			S03	3 4 5	80						
	20										
2560											
	25										
2555											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-08a

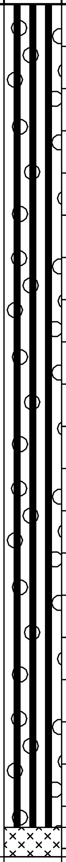
Sheet 2 of 3

Elevation feet	Depth, feet	SAMPLES				Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
		Type	Number	Sampling Resistance	Recovery (feet)						
	30										
							DIATOMITE WITH ELASTIC SILT; olive gray (5Y 4/2) and greenish black (10Y 2.5/1); very soft/extremely weak; 0.25 to 0.5-inch alternating beds --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Cuttings become greenish gray
2550											
		◩	S04	2 4 4	0						
	35										
2545											
	40										
2540											
	45										
2535											Cuttings become olive gray and greenish gray
	50										
2530											
	55	◩	S05	2 2 3	100			179	112	99	LL=200; PL=88 SA: S=1%; F=99%
2525											
	60										
2520											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-08a

Sheet 3 of 3



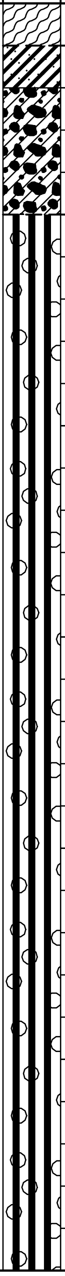
Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	65					DIATOMITE WITH ELASTIC SILT; olive gray (5Y 4/2) and greenish black (10Y 2.5/1); very soft/extremely weak; 0.25 to 0.5-inch alternating beds --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2515										
	70									
2510										
			S06	1 2 4		With 0.1-0.2-inch irregular subhorizontal bedding With 0.5-inch dark reddish brown (5YR 2.5/2) CLAY bed at 20°				
	75									
2505										
	80									
2500										
										Harder drilling
	85		S07	50/3"	50	BASALT; black (10Y 2.5/1); slightly weathered; strong; recovered as angular gravel up to 1-inch in diameter --TERTIARY to QUATERNARY INTRUSIVE BASALT-- **TOTAL DEPTH = 85.2 FEET**				Tricone refusal
2495										
	90									
2490										
	95									
2485										
	100									

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-09

Sheet 1 of 3

Date(s) Drilled	**2/13/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch Tricone, 4-inch diamond #2 bit**	Total Depth of Borehole	**70.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2602 feet**
Groundwater Level(s)	**5.8 feet above ground surface (2/13 at 9:00)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT, 3-inch Shelby Tube, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2602526 E 6483561**



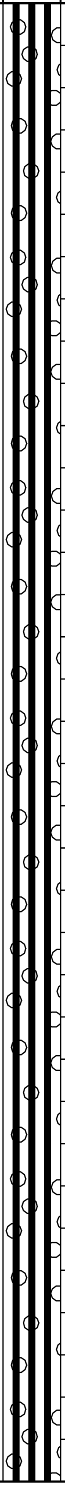
Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0					--RECENT LAKE SEDIMENT--				Sampler advanced 2 feet under weight of hammer
			S01	0 0 0	50	FAT CLAY with SAND (CH); medium stiff; brown (10YR 4/3) --ALLUVIUM/RESIDUAL SOIL--				
2600										
			R01		70	CLAYEY GRAVEL (GC); dark gray (10YR 4/1) and yellowish brown (10YR 5/6); cored and wash subrounded to rounded basalt GRAVEL and COBBLES; some CLAYEY SAND matrix observed --FLUVIO-LACUSTRINE TERRACE DEPOSIT WITH GRAVEL (Qtg)--				Set casing to 2 feet; hard driving at 2 feet (casing bouncing); switched to core bit
			R02		0					
	5		S02	4 2 7	67	DIATOMITE with ELASTIC SILT; medium stiff/weak; dark yellowish brown (10YR 4/4); trace fine grained SAND --LACUSTRINE DIATOMACEOUS DEPOSIT (Ql)--				
2595										Advance 6-inch casing to 4.5 feet
			S03	9 9 7	67					
	10									
2590						Becomes greenish gray (10Y 5/1); extremely weak/soft				
			S04	3 3 4	80					
	15									
2585										
	20									
2580										
			S05	200 psi	74		80	21	100	TX-UU LL=74; PL=53 SA: F=100% TX-ICU
	25									
2575										
	30									

Report: GEO_10B1_OAK; File: KLAMATH_MASTER.GPJ; 6/20/2019 BC-09

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-09

Sheet 2 of 3

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; extremely weak/soft; greenish gray (10Y 5/1); trace fine grained SAND --LACUSTRINE DIATOMACEOUS DEPOSIT (Ql)--*(continued)*				
2570											
			S06	3 3 4	0						
	35										
2565											
			S07	3 3 5	90						Sampler advanced an additional 6 inches by pushing
	40										
2560											
	45										
2555											
	50										
2550											
			S08	200 psi	0						
	55										
2545											
	60										
2540											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-09

Sheet 3 of 3

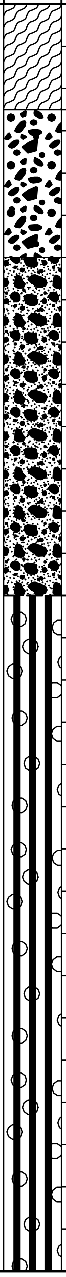
Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	65						DIATOMITE with ELASTIC SILT; extremely weak/soft; greenish gray (10Y 5/1); trace fine grained SAND --LACUSTRINE DIATOMACEOUS DEPOSIT (Ql)--*(continued)*				
2535											
		☒	S09	200 to 400 psi	100			92 96			Consol TX-ICU TX-ICU
	70										
							TOTAL DEPTH = 70.5 FEET				
2530											
	75										
2525											
	80										
2520											
	85										
2515											
	90										
2510											
	95										
2505											
	100										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-10

Sheet 1 of 2

Date(s) Drilled	**2/7/2018 - 2/8/2018**	Logged By	**B. Kozlowicz**	Checked By	**D. Simpson**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**43.0 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2579 feet**
Groundwater Level(s)	**29.3 feet above ground surface (2/7 at 14:40)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT, 3-inch Shelby Tube**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to 10 feet bgs**	Borehole Location	**Copco Reservoir**	Coordinate Location	**N 2604959 E 6472871**



Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0					--RECENT LAKE SEDIMENT--				Set 6-inch casing to 4 feet (very soft to 2.5 feet)
						--COLLUVIUM/RESIDUAL SOIL/SLOPE WASH--				
2575										
	5									
						WELL GRADED GRAVEL with SAND (GW); dense; dark brown (10YR 3/3); subangular to rounded GRAVEL up to 3 inches in diameter consisting of various volcanic lithologies --FLUVIO-LACUSTRINE TERRACE DEPOSIT WITH GRAVEL (Qtg)--				Hard, chattering drilling
2570										
	10		S01	25 26 19	100				1	SA: G=85%; S=15%; F=<1% Advance 6-inch casing to 9 feet with hammer
										Tricone bit refusal; rock core barrel used to advance
2565										
						DIATOMITE with ELASTIC SILT; olive (5Y 5/3); medium stiff/extremely weak; with trace oxidation --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--				Clayey diatomite curring; switched back to tricone bit Advance 6-inch casing to 14 feet with hammer
	15		S02	10 5 5	27					
2560										
	20									
2555										
						Becomes light olive brown (2.5Y 5/4) and olive brown (5Y 5/3) with 0.1 to 0.5 inch 10-degree bedding and some oxidation stains				
	25		S03	5 4 6	80					
2550										
	30									

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-10

Sheet 2 of 2

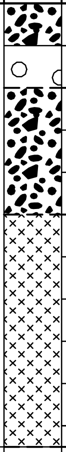
Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE with ELASTIC SILT; medium stiff/extremely weak; light olive brown (2.5Y 5/4) and olive brown (5Y 5/3); with 0.1 to 0.5 inch 10-degree bedding and some oxidation stains --LACUSTRINE DIATOMACEOUS TERRACE (Ql)--*(continued)*				
2545											
	35										
2540							VOLCANIC CINDER; very dark brown (10YR 2/2); very weak/dense to very dense; medium to coarse grained weakly welded sand; friable with corestones and weakly expressed 10 to 15-degree bedding --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				Harder drilling
	40		S05	200 to 400 psi	75						
			S04	6 20 37	60		ANDESITE; reddish brown (5YR 5/3); strong brown (7.5YR 5/6); and dusky purple; highly to completely weathered; very weak; coarse grained --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				
2535							**TOTAL DEPTH = 43.0 FEET**				
	45										
2530											
	50										
2525											
	55										
2520											
	60										
2515											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-11

Sheet 1 of 1

Date(s) Drilled	**10/18/2018**	Logged By	**B. Kozlowicz**	Checked By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger/Direct Push**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**10.5 feet**
Drill Rig Type	**Truck Mounted Marl M2.5 DP**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2617 feet**
Groundwater Level(s)	**Not encountered**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Geoprobe Hydraulic Hammer**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Copco Road/Reservoir Rim**	Coordinate Location	**N 2606419 E 6479490**



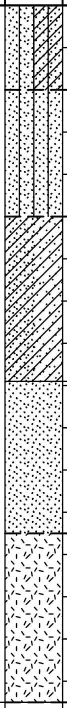
Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						ROAD BASE				Start 10/18/2018 with hollow stem auger
							DIATOMITE; pale yellow (2.5Y 7/3); moderately weathered; with occasional subvertical fractures and trace small rootlets --QUATERNARY DIATOMITE (Qd)--				
2615							POORLY GRADED GRAVEL? (GP); very dark grey; with slightly weathered basalt fragments --RESIDUAL SOIL/COLLUVIUM--				Rig chatter at2ft.
			S01		57						Auger refusal at 3.5ft; move 30ft. west of initial boring location and redrill
	5		S02		100		VOLCANIC BEDROCK?; olive grey and reddish to yellowish brown; completely weathered; extremely weak; friable --COMPLETELY WEATHERED VOLCANIC BEDROCK--				
2610											
	10		S03				Becomes yellowish red				
							TOTAL DEPTH = 10.5 FEET				
2605											
	15										
2600											
	20										
2595											
	25										
2590											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-12

Sheet 1 of 1

Date(s) Drilled	**10/17/2018**	Logged By	**B. Kozlowicz**	Checked By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger/Direct Push**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**16.5 feet**
Drill Rig Type	**Truck Mounted Marl M2.5 DP**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2642 feet**
Groundwater Level(s)	**Not encountered**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Geoprobe Hydraulic Hammer**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Road/Reservoir Rim**	Coordinate Location	**N 2605101 E 6481855**



Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY to CLAYEY SAND with GRAVEL (SM-SC); medium dense; brown (10YR 5/5); with angular GRAVEL up to 3-inches --ROAD BASE--				Start 14:00 10/18/2018 with hollow stem auger
2640							SILTY SAND (SM); loose to medium dense; dark brown (10YR 3/3); with occasional small GRAVEL; dry --COLLUVIUM--				
	5	☒	S-01				CLAYEY SAND to SANDY LEAN CLAY (SC-CL); loose to medium dense; dark brown (10YR 3/3); with angular GRAVEL up to 2-cines; low plasticity FINES; moist				S-01 bagged Smooth drilling 0-4.7ft. Rig chatter 4.7-5.5ft. Smooth drilling 5.5-9ft.
2635											
			S-02		100		POORLY GRADED SAND (SP); loose to medium dense; yellowish brown (10YR 5/4); with small, subangular diatomite GRAVEL; fine to medium grained SAND; dry --Fluvio-Lacustrine Terrace Deposit (Qt)--				S-03 Three liners retained (8.5-9, 9-9.5, 9.5-10ft.)
	10										
2630											
							VOLCANIC BEDROCK; very dense; greyish brown (10YR 5/2) to olive brown (2.5Y 4/4); highly to completely weathered; very weak; friable; medium to coarse grained; possibly PORPHYRITIC ANDESITE --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				
	15		S-03		100						
2625							**TOTAL DEPTH = 16.5 FEET**				
	20										
2620											
	25										
2615											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-13

Sheet 1 of 2

Date(s) Drilled	**10/2/2018**	Logged By	**B. Kozlowicz**	Checked By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**42.0 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2673 feet**
Groundwater Level(s)	**Not encountered**	Sampling Method(s)	**3.0-inch Shelby Tube, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Road/Reservoir Rim**	Coordinate Location	**N 2604508 E 6475654**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						2-inches ASPHALT				Start 13:50 10/2/2018 with hand auger
							POORLY GRADED GRAVEL with SAND (GP); dense; brown (10YR 4/4); angular GRAVEL up to 3-inches; dry --ROAD BASE--				
							LEAN CLAY with SAND (CL); stiff; dark brown (10YR 3/3); low to medium plasticity FINES; fine to coarse grained SAND; trace small GRAVEL; with rootlets --RESIDUAL SOIL/ALLUVIUM--				
2670											
							DIATOMACEOUS SAND (SP); loose to medium dense; yellowish brown (10YR 5/4); fine grained --QUATERNARY DIATOMITE--				
	5										Hollow stem auger 5 to 42ft.
		☒	S-01	1600 psi	100		Becomes medium dense to dense with some small, angular gravel				TX-UU
2665											
	10						DIATOMITE; pale yellow (2.5Y 7/3); moderately weathered; with occasional subvertical fractures and trace small rootlets				
		☒	S-02	1560 psi	95			23			TX-ICU
2660											
	15						Becomes pale yellow (2.5Y 7/3), slightly weathered, extremely weak, without fractures or roots				
		☒	S-03	1500 psi	90			30			
2655											
	20										
							With Fe + Mn stained vertical fracture surfaces	59			TX-UU
		☒	S-04	1400 psi	100						
2650											
	25										
2645											Cuttings become moist
	30										

Log of Soil Boring BC-13

Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30	☒	S-05	500 to 1100	100	○	DIATOMITE; pale yellow (2.5Y 7/3); dry; slightly weathered; extremely weak; massive; with trace orange mottling --QUATERNARY DIATOMITE--*(continued)*	72			TX-UU
2640											
	35					▨	LEAN CLAY with SAND (CL); stiff; dark yellowish brown (10YR 3/4); with trace rootlets --COLLUVIUM/RESIDUAL SOIL--				Logged from cuttings
2635											
	40	☒	S-06	500 to 1600	67			21			
		▮	S-07	50/6"	100	▨	CLAYEY SAND (SC); very dense/extremely weak; olive and dark yellowish brown to reddish brown; with weakly expressed 20°foliation/bedding --COMPLETELY WEATHERED VOLCANICLASTIC BEDROCK-- **TOTAL DEPTH = 42.0 FEET**				
2630											
	45										
2625											
	50										
2620											
	55										
2615											
	60										
2610											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-14

Sheet 1 of 1

Date(s) Drilled	**10/2/2018**	Logged By	**B. Kozlowicz**	Checked By	**B. Aldridge**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**6-inch flight auger**	Total Depth of Borehole	**15.4 feet**
Drill Rig Type	**Truck Mounted Mobile B-53**	Drilling Contractor	**Gregg Drilling**	NAVD 88 Ground Surface Elevation	**2663 feet**
Groundwater Level(s)	**Not encountered**	Sampling Method(s)	**3.0-inch Shelby Tube, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Road/Reservoir Rim**	Coordinate Location	**N 2603695 E 6474756**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						3-inches ASPHALT				Start 10:00 10/2/2018 with hand auger 0-5ft.
							POORLY GRADED GRAVEL with SAND (GP); medium dense; dark yellowish brown; with angular GRAVEL up to 3-inches; dry --ROAD BASE--				
							DIATOMITE; very pale brown (10YR 7/4); moderately weathered; medium stiff/dense/very weak; dry; with irregular subvertical, Fe stained fractures --QUATERNARY DIATOMITE--				
2660											
	5	☒	S-01	1200 psi	80			23			Hollow stem auger 5 to 15.4ft. TX-ICU
		☒	S-02	1500 psi	100						TX-UU
2655											
	10	☒	S-03	1600 psi	100			45			TX-UU
		☒	S-04		100			24			TX-ICU
2650											
	15		S-05	50/5	100		VOLCANIC BEDROCK; yellowish to reddish brown; highly to completely weathered; very dense/very weak --BEDROCK--				Drilling becomes hard
							TOTAL DEPTH = 15.4 FEET				
2645											
	20										
2640											
	25										
2635											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-16

Sheet 1 of 2

Date(s) Drilled	**1/14/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**64.8 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2592 feet**
Groundwater Level(s)	**14 feet above ground surface (1/14/2019)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Lake**	Coordinate Location	**N 2604576 E 6472913**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML); soft; wet; grayish brown; apparent mix of diatomite and topsoil/colluvium --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2590											
	5										
							DIATOMITE; greenish gray; soft				
2585											
	10										
2580											
	15										
2575											
	20										
2570											
	25										
2565											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-16

Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES				Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
		Type	Number	Sampling Resistance	Recovery (feet)						
	30						DIATOMITE; greenish gray; soft *--continued--*				
2560											
	35										
2555											
	40										
2550											
	45										
2545											
	50										
2540											
	55										
2535											
	60										
2530											
							VOLCANICLASTIC SANDSTONE; medium gray; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				Harder drilling Rig repair 1315-1335
		◣	1	50/3"	100						Bottom liner retained
	65										

TOTAL DEPTH = 64.8 FEET

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-17

Sheet 1 of 2

Date(s) Drilled	**1/14/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**37.4 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2593 feet**
Groundwater Level(s)	**12.5 feet above ground surface (1/14/2019)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Lake**	Coordinate Location	**N 2603825 E 6474508**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0					▨	SILTY CLAY (CL-ML); soft; wet; brown to grayish brown; apparent mix of diatomite and topsoil/colluvium --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2590						▨					
						○	DIATOMITE; greenish gray; soft				
	5					○					
2585						○					
	10					○					
2580						○					
	15					○					
2575						○					
	20					○					
2570						○					
	25					○					
2565						○					
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-17

Sheet 2 of 2

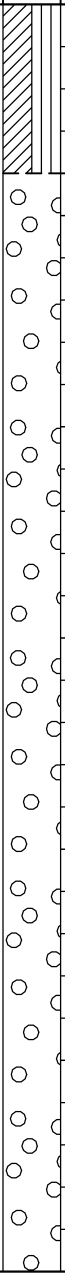
Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30					○	DIATOMITE; greenish gray; soft --*continued*--				
						▒	VOLCANICLASTIC SANDSTONE; grayish brown; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				
2560											
	35										
		◣	1	23 27 50/5"							Bottom liner retained
							TOTAL DEPTH = 37.4 FEET				
2555											
	40										
2550											
	45										
2545											
	50										
2540											
	55										
2535											
	60										
2530											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-18

Sheet 1 of 2

Date(s) Drilled	**1/14/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**34.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2598 feet**
Groundwater Level(s)	**8 feet above ground surface (1/14/2019)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Lake**	Coordinate Location	**N 2604477 E 6475056**



Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML); soft; wet; brown to grayish brown; apparent mix of diatomite and topsoil/colluvium; tree root fragments --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2595											
	4						DIATOMITE; greenish gray to yellowish brown; soft				
	5										
2590											
	10										
2585											
	15										
2580											
	20										
2575											
	25										
2570											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-18

Sheet 2 of 2

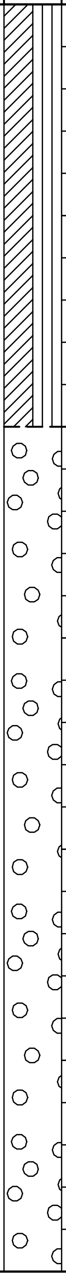
Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30					○	DIATOMITE; greenish gray to yellowish brown; soft *--continued--*				
2565			1	27 23 24		▒	VOLCANICLASTIC SANDSTONE; grayish brown; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				Bottom liner retained
							TOTAL DEPTH = 34.5 FEET				
	35										
2560											
	40										
2555											
	45										
2550											
	50										
2545											
	55										
2540											
	60										
2535											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-19

Sheet 1 of 2

Date(s) Drilled	**1/13/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**37.5 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2599 feet**
Groundwater Level(s)	**7 feet above ground surface (1/13/2019)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Lake**	Coordinate Location	**N 2604654 E 6475303**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL-ML); soft; wet; brown to grayish brown; apparent mix of diatomite and topsoil/colluvium --SLUMPED BANK MATERIAL--				Boring logged from cuttings
2595											
	5										
2590											
	10						DIATOMITE; light gray; soft; occasional fine- to coarse-grained SAND				
2585											
	15										
2580											
	20										
2575											
	25										
2570											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-19

Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	30						DIATOMITE; light gray; soft; occasional fine- to coarse-grained SAND *--continued--*				
2565											
	35										
		◣	1	12 24 29			VOLCANICLASTIC SANDSTONE; light to medium gray; completely to highly weathered; weak; angular to subangular, fine- to medium-grained clasts				Two bottom liners retained
							TOTAL DEPTH = 37.5 FEET				
2560											
	40										
2555											
	45										
2550											
	50										
2545											
	55										
2540											
	60										
2535											
	65										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BC-20

Sheet 1 of 1

Date(s) Drilled	**1/14/2019**	Logged By	**P. Respess**	Checked By	**S. Janowski**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**19.0 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2597 feet**
Groundwater Level(s)	**9 feet above ground surface (1/14/2019)**	Sampling Method(s)	**2.5-inch ID ModCal**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Bentonite cement grout to ground surface**	Borehole Location	**Copco Lake**	Coordinate Location	**N 2606433 E 6479381**

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance	SAMPLES Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						DIATOMITE; greenish gray to light yellowish brown; soft				Boring logged from cuttings
2595											
	5										
2590											
	10										
2585											
	15										
2580											
			1	50/0.5"	100		BASALT?; dark gray to black; hard; aphanitic				Hard drilling
							TOTAL DEPTH = 19.0 FEET				
	20										
2575											
	25										
2570											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil Boring BI-01

Sheet 1 of 1

Date(s) Drilled	**2/20/2018**	Logged By	**K. Zeiger**	Checked By	**B. Kozlowicz**
Drilling Method	**Rotary Wash**	Drill Bit Size/Type	**4-inch Tricone**	Total Depth of Borehole	**22.2 feet**
Drill Rig Type	**Barge Mounted CME-45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2318 feet**
Groundwater Level(s)	**11.8 feet above ground surface (2/20/2018)**	Sampling Method(s)	**2.5-inch ID ModCal, SPT**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir**	Coordinate Location	**N 2600814 E 6450535**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery (feet)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Plasticity Index	Fines Content (%<#200 Sieve)	REMARKS AND OTHER TESTS
	0						LEAN CLAY with ORGANICS (CL); very soft; wet; dark red brown (5YR 3/4); twigs and roots --RECENT LAKE SEDIMENT--				
			S-1	0 0 0	40		LEAN CLAY (CL); stiff; dry; dark red brown (5YR 3/4); trace rootlets; CaCO3 ribbons; developed soil texture --COLLUVIUM/RESIDUAL SOIL--				S-1 Sampler sank under weight of rods 12.5-14.5ft. and pushed 14.-17.5ft.
2315											
	5										
			S-2	4 7 8	100						Advance 5-inch casing 7.5ft.
2310											
	10		S-3	6 8 13	67						Begin rotary wash drilling
			S-4	50/4"	100		BASALT; dark red brown (5YR 2.5/2); fresh; strong --TERTIARY to QUATERNARY INTRUSIVE BASALT--				Driller notes change at 11.5ft., Volcanics in cuttings Driller notes bedrock drilling conditions from 12ft.-17ft.
2305											
	15										
			S-5	50/3"	50		VOLCANIC BRECCIA; mottled dark gray (2.5Y 4/1) and light yellow brown (2.5Y 6/4); slightly weathered; moderately strong; coarse grained with quartz phenocrysts --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--				
2300											
	20										
			S-6	50/3"	100		**TOTAL DEPTH = 22.2 FEET**				
2295											
	25										
2290											
	30										

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-02

Sheet 1 of 5

Date(s) Drilled	**2/22/2018 - 2/23/2018**	Logged By	**K. Zeiger**	Checked By	**B. Kozlowicz**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch solid stem auger, 3-7/8 inch tricone, 4-inch #2 diamond coring bit**	Total Depth of Borehole	**67.0 feet**
Drill Rig Type	**Truck Mounted CME 75**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2334 feet**
Groundwater Level	**4.8 feet below ground surface (2/22/2018)**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir; near Fall Creek Boat Ramp**	Coordinate Location	**N 2602024 E 6461383**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2334	0							▨	SANDY FAT CLAY (CH); stiff; very dark brown (7.5YR 2.5/3); moist; high plasticity fines; 10 percent rounded gravel up to 1-inch in diameter --OLD ALLUVIUM- FLOOD PLAIN DEPOSIT--						4-inch solid stem auger
	1														
2332	2														
	3														
2330	4								▼						
	5										S-1	6 8 13	87	14:30	LL=78; PL=28 SA: G=11%; S=21%; F=68%
2328	6								←2-inch rounded clasts with trace decomposed rootlets						
	7														
2326	8														
	9														
2324	10							▨	SANDY FAT CLAY (CH); stiff; dry; brown (7.5YR 4/3); high plasticity fines; fine grained sand; trace rounded gravel up to 0.25 inches in diameter; CaCO3 ribbons --OLDER ALLUVIUM/RESIDUAL SOIL--		S-2	5 7 12	100	14:40	LL=58; PL=28 SA: G=5%; S=33%; F=62%
	11														
2322	12														
	13														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-02

Sheet 2 of 5

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13							▨	SANDY FAT CLAY (CH); stiff; dry; brown (7.5YR 4/3); low plasticity fines; fine grained sand; trace rounded gravel up to 0.25 inches in diameter; CaCO3 ribbons --OLDER ALLUVIUM/RESIDUAL SOIL-- *(continued)*						
2320	14							▨	▽						First water at 14.0 feet; after 20 minutes at 4.8 feet
	15							▨	SANDY FAT CLAY (CH); medium stiff to stiff; brown (7.5YR 5/4); fine grain sand; high plasticity fines; trace rounded gravel up to 1-inch --OLDER ALLUVIUM/RESIDUAL SOIL--	◣	S-3	6 6 7	100	15:00	LL=51; PL=27 SA: G=8%; S=40%; F=52% Advance 4-inch casing to 14 feet
2318	16							▨							Switch to rotary wash
	17		1					▨							
2316	17.5–21.6	1		17	NA NA NA NA NA	0	NR 1 2	△	VOLCANIC BRECCIA; green gray (10Y 6/1); highly to completely weathered; extremely weak; intensely fractured with angular breccia clasts up to 1-inch; fine to medium grained matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- 1: 60, J, N, No, No, Pl, SR 2: 10, J, MW, No, No, Wa, SR					1549 [21] 1601	Refusal with tricone bit; switch to HQ rock core Clayey volcanics cuttings 100% fluid return
2312	21.6–24.5	2		100	2 3 1	48*	1 2 3 3 1 4 m	△	Becomes moderately to slightly weathered; weak to moderately strong; moderately fractured; rough; irregular fractures likely mechanical along weathered contacts of breccia clasts 1: 10, J, T, No, No, Wa, SR 2: 20-80, J, N, No, No, Ir-St, R 3: 10, J, MW, No, No, Wa, SR 4: 20, J, N, No, No, Wa, SR Run break					1610 [22] 1618	*Rock does not meet soundness criteria for RQD calculation
2310 2308	24.5–27	3		100	2 1	100	1 2 1 1 m	△	1: 30. J, N, No, No, Wa, SR 2: 5, J, T, H+Uk, Pa, Wa, ? Run break					1622 [21] 1629	
2306	27–29	4		100	1 0	100	1 m	△	1: 5, J, N, No, No, Wa, SR					1634 [30]	27.0-27.9ft.: Mohs Hardness = 3 UCS = 841 psi Bulk Density= 141.42pcf

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-02

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29	4	1	100	1	100	2	△ △	VOLCANIC BRECCIA; green gray (10Y 6/1); moderately to slightly weathered; weak to moderately strong; moderately fractured with angular breccia clasts up to 1-inch; medium grained matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					[30]	Mechanically broken from placement in box
2304	30				1		2	△ △	2: 10-15, J, N, No, No, Wa-St, R						100% fluid return
	31				0			△ △							
2302	32	5		100	1	96	m 1	△ △						1644 1647	
	33				2		1 2	△ △							
2300	34		2		1		3	△ △	1: 10, J, N, No, No, Wa,SR 2: 40, J, N, No, No, St, SR 3: 30, J, T, H+Uk, No, No, Wa, ? 4: 10, J, N, No, No, Wa-St, SR					[31]	
	35				1		4	△ △							
2298	36				0			△ △							
	37	6		100	1	100	1	△ △						1657 1701	
2296	38				1		1	△ △							
	39				1		2	△ △	1: 10, J, N, No, No, Wa-St, R 2: 15, J, T, No, No, Wa, SR 3: 30, J, N, No, No, Wa-Pl, SR					[26]	
2294	40				1			△ △							
	41				0		3	△ △							
2292	42	7		100	1	96	1	△ △						1712 1206	End of day 2/22/2018 Begin day 2/23/2018
	43				4		2	△ △	1: 10, J, N, No, No, Wa, SR 2: 10-30, J, T, No, No, Wa, SR						
2290	44				1		1	△ △						[43]	
	45														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-02

Elevation, feet	Depth, feet	ROCK CORE							Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES				Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
		Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number			Type	Number	Blows / 6 in.	Recovery, %		
	45				1			3	△ △	VOLCANIC BRECCIA; green gray (10Y 6/1); moderately to slightly weathered; weak to moderately strong; moderately fractured; angular breccia clasts up to 1-inch; fine to medium grained matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)-- *(continued)*						100% fluid return
2288	46		3		1			4	△ △	3: 10-30, J, MW, No, No, Wa-Ir, SR-R 4: 30, J, N, No, No, Wa-Pl, SR						
	47				0				△ △	Becomes strong; slightly fractured					1213 1216	Brazilian Tensile Strength Test
2286	48				0				△ △							
	49	8		100	1	100		1 2	△ △	1: 20, J, MW, H+Ca, Fi, Wa, ? 2: 15, J, N, No, No, Wa-St, R					[25]	48.9-50.3ft.: Mohs Hardness = 3 UCS = 1 736 psi Bulk Density=149.67pcf
2284	50				0				△ △							Punch Penetration Index Test
	51				1			2	△ △							Cerchar Abrasiveness Test
2282	52				0				△ △						1228 1232	Brazilian Tensile Strength Test
	53				0				△ △							
2280	54	9		100	1	98		1	△ △						[23]	Mechanically broken from placement in box
	55				0			m	△ △	1: 30, J, N, No, No, St, R 2: 20, J, N, No, No, Wa-St, SR						55.4-56.3ft.: Mohs Hardness = 3 UCS = 2 288 psi Bulk Density=148.46pcf
2278	56				1			m 2	△ △							
	57				1			1	△ △						1245 1250	Packer test #1 from 47.0 to 67.0
2276	58				0				△ △							
	59	10		100	1	96		2	△ △	1: 20, J, N, No, No, Wa, SR 2: 10, J, N, No, No, Wa-St, R					[20]	
2274	60				0				△ △							100% fluid return
	61															

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-02

Sheet 5 of 5

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61		4		1		m m 3	△ △	VOLCANIC BRECCIA; green gray (10Y 6/1); moderately to slightly weathered; weak to strong; slightly fractured; angular breccia clasts up to 1-inch; fine to medium grained matrix --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					1305	
2272	62				0			△ △	3: 5, J, N, No, No, Wa, SR					1311	Mechanically broken from placement in box
	63				1		1 2	△ △							
2270	64	11		100	0	72		△ △	1: 30, V, N-T, H+Ca, Fi, Wa, ? 2: 10, J, N, No, No, Wa-St, SR-R 3: 60, J/V, MW, Ca, Pa, Wa-Pl, SR 4: 60-70, J/V, N, H+Ca, Fi, Wa, ?					[19]	
	65				1		3	△ △							
2268	66				3		4 4 m	△ △							
	67								**TOTAL DEPTH = 67.0 FEET**					1327	
2266	68														
	69														
2264	70														
	71														
2262	72														
	73														
2260	74														
	75														
2258	76														
	77														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-03

Sheet 1 of 3

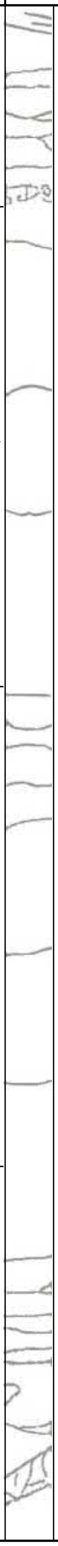
Date(s) Drilled	**2/21/2018**	Logged By	**K. Zeiger**	Checked By	**B. Kozlowicz**
Drilling Method	**Rotary Wash, HQ-3 Rock Core**	Drill Bit Size/Type	**4-inch solid stem auger, 3-7/8 inch tricone, 4-inch #2 diamond coring bit**	Total Depth of Borehole	**35.1 feet**
Drill Rig Type	**Barge Mounted CME 45**	Drilling Contractor	**Taber Drilling**	NAVD 88 Ground Surface Elevation	**2306 feet**
Groundwater Level	**25.3 feet above ground surface (2/21)**	Sampling Methods	**2.5-inch ID ModCal, HQ Core Barrel**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout to ground surface**	Borehole Location	**Iron Gate Reservoir**	Coordinate Location	**N 2601812 E 6461399**

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								POORLY GRADED GRAVEL with SILT and SAND (GP-GM); dark green gray (N 4/1); wet; loose; subangular to subrounded gravel up to 0.25-inch --RIVER ALLUVIUM--						Advance 5-inch casing to 3ft.
	1														
2304	**2**														
	3														
2302	**4**								VOLCANIC BRECCIA; green gray (5G 6/1). highly weathered; weak to very weak; fine to medium grained matrix with angular to subrounded clasts up to 0.75 inches --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--	◩	S-1	12 50/2.5"	47	10:10	LL=41; PL=26 SA: G=61%; S=30%; F=9% Advance 5-inch casing to 4ft.
	5														
2300	**6**		1		>6		1 2		Becomes moderately weathered; weak; intensely fractured to locally crushed; most rough; irregular fractures likely mechanical due to weathering on clasts/matrix boundaries					1059	Refusal with tricone bit; switched to HQ rock core
	7				>6		3 4 2 5								
2298	**8**	1		89	>6	0	4 4		1: 60, J, N, No, No, St, R 2: 40, J, T, No, No, St, R 3: 50-60, J, T, No, No, St, R 4: 30, J, MW, No, No, St, R 5: 10, J, N, No, No, St, R 6: 40, J, N, No, No, Wa, SR 7: 70, J, T, No, No, Wa, SR,					[13]	
	9				>6		6 4 7								
2296	**10**				NA		5							1120 1143	LL=58; PL=28 SA: G=5%; S=33%; F=62%
	11				NA		1								
2294	**12**				4		2 3 3		1: ~10, J, N, No, No, Wa, SR 2: 30, J, N-T, No, No, Wa-St, SR 3: 40-50, J, N, No, No, Wa-St, SR-R 4: 20, J, MW, No, Wa, St, SR-R						
	13	2		100	5	14*	4 3 4 2							[19]	*Rock does not meet soundness criteria for RQD calculation

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-03

Sheet 2 of 3

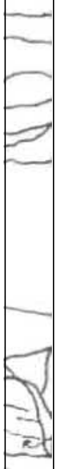


Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2292	13	2	1	100	5	14*	5 2 2	△ △	VOLCANIC BRECCIA; green gray (5G 6/1); moderately weathered; weak; intensely fractured to locally crushed; fine to medium grained matrix with angular to subrounded clasts up to 0.75-inches --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--(continued)						
	14				5		1 2 2	△ △	5: 30, J, N, No, No, Wa-Pl, SR						
2290	15	3		100	3	100*	1	△ △	Becomes slightly fractured; moderately strong					1159 1215	LL=51; PL=27 SA: G=8%; S=40%; F=52% Packer test #1 from 15.1 to 35.1ft.
	16				0			△ △							
2288	17				1		2	△ △	1: 35, J, N, No, No, St, R 2: 30, J, N, No, No, Wa, SR 3: 20, J, T, No, No, Wa, SR					[23]	17.4-18.4ft.: UCS = 221 psi *Rock does not meet soundness criteria for RQD calculation 17.4-18.4ft.: Mohs Hardness = 3 UCS = 221 psi Bulk Density=138.44pcf Brazilian Tensile Strength Test
	18				1		3	△ △							
2286	19				0			△ △							
	20	4	2	100	3	86*	1 2 3	△ △	Becomes highly fractured 1: 10, J, MW, No, No, Wa, SR 2: 25, J, T, No, No, Wa-St, SR-R 3: 10, J, MW, No, No, Wa, SR-R					1228 1239	
2284	21				2		3 2	△ △	Becomes moderately fractured						21.5-22.9ft.: Mohs Hardness = 3 UCS = 352 psi Bulk Density=134.96pcf
	22				1		3	△ △						[18]	Brazilian Tensile Strength Test
2282	23				0			△ △							
	24				1		3	△ △							Punch Penetration Index Test
2280	25	5		100	0	48*		△ △						1256 1301	Cerchar Abrasiveness Test
	26				5		1 2 3 3	△ △	Moderately to highly weathered; weak to very weak; fractures 1; 2; 3 are likely mechanical						Clayey coating 26.5-27.2ft. is from when return hose got disconnected during run
2278	27				5		3 3 4 5	△ △	1: 15, J, T, No, No, Wa, SR 2: 40, J, T, No, No, Wa-St, SR 3: 5-10, J, MW, No, No, Wa, SR 4: 80, J, N, No, No, Wa-Ir, SR 5: 30, J/V, T, Ca, Pa, Pl-Wa, SR					[15]	
	28				>6		6	△ △	Crushed zone 6: 65, J, MW, Sd, Pa, Wa, SR						
	29														

Project: Klamath River Renewal Project
Project Location: Copco and Iron Gate Reservoirs
Project Number: 60537920

Log of Soil and Core Boring BI-03

Sheet 3 of 3

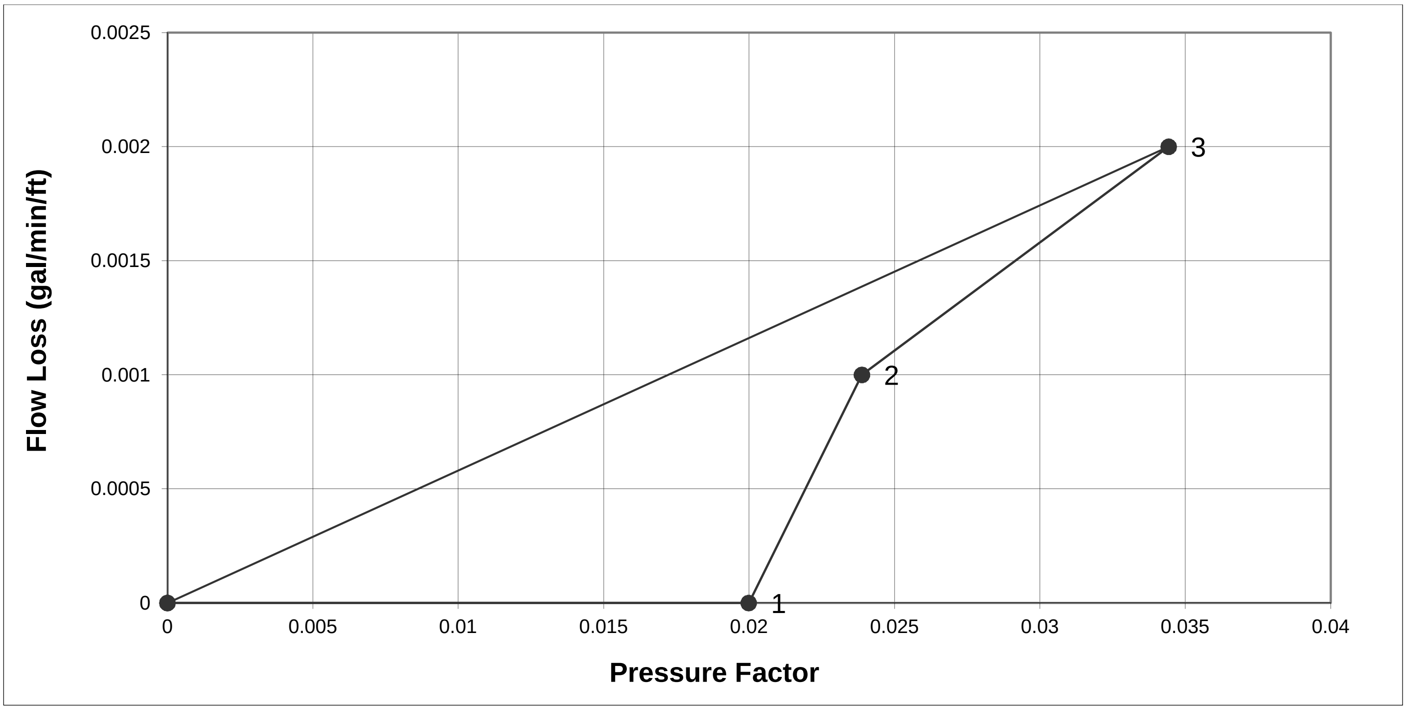
Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing	Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
2276	29	5	2	100	0	48*			△ △	VOLCANIC BRECCIA; green gray (5G 6/1); moderately to highly weathered; weak to moderately strong; moderately fractured; fine to medium grained matrix with angular to subrounded clasts up to 0.75-inches --TERTIARY VOLCANICS (BOGUS MOUNTAIN BEDS, undifferentiated)--*(continued)*					1321	
	30	6		100	2	54*		1 1	△ △	At 30.1ft: Becomes intensely fractured, weak to moderately strong, locally very weak to weak					1327	
2274	31				4			2 2 3 1	△ △	1: 5, J, N, No, No, Pl-Wa, SR 2: 20, J, N-MW, No, No, Wa, SR 3: 35, J, N, Ca+Sd, Pa, Pl, S 4: 30, J, N, No, No, Pl, SR						
	32				0				△ △						[15]	
2272	33				3			4 3	△ △							*Rock does not meet soundness criteria for RQD calculation
	34				4			5 6	△ △	Becomes highly weathered; weak; crushed along a fracture? 5: 65, J, MW-W, Fe+Sd, Su+Pa, Pl, SR-R with ~0.75-inch Fe stained highly weathered rind 6: 10-20, J, T, No, No, Wa-Pl, SR					1347	
	35									**TOTAL DEPTH = 35.1 FEET**						
2270	36															
	37															
2268	38															
	39															
2266	40															
	41															
2264	42															
	43															
2262	44															
	45															

APPENDIX B PACKER TEST DATA

Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	1
Test Interval Center Elevation (ft)	2268.5
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	62.0
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	0

Top of Test Elevation (ft)	2278.5
Bottom of Test Elevation (ft)	2258.5
Top of Test Depth (ft)	26.5
Bottom of Test Depth (ft)	46.5
Angle from Vertical (deg)	0

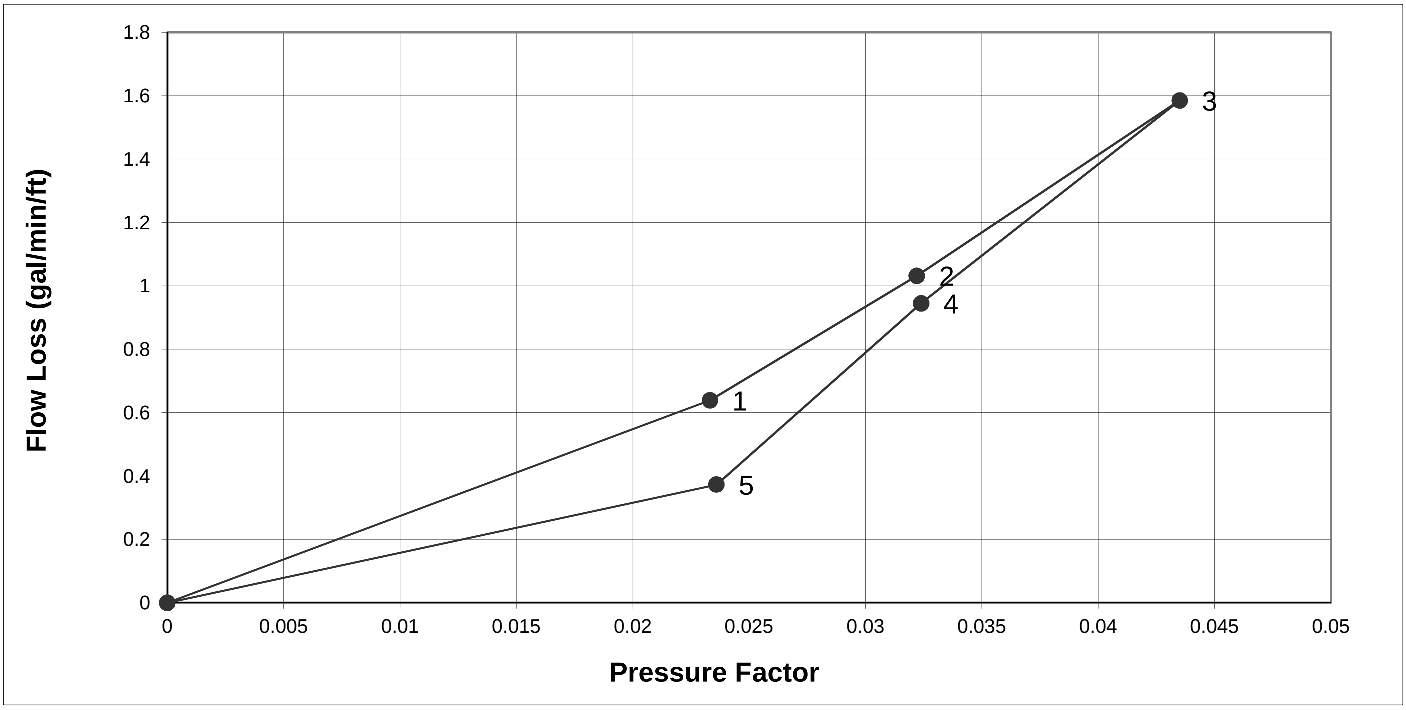
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	36.00	0.019990005	0.00	0.0000	0
2	75%	43.00	0.02387695	0.02	0.0010	0
3	100%	62.00	0.034427231	0.04	0.0020	0
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	2
Test Interval Center Elevation (ft)	2249.5
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	78.3
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	36

Top of Test Elevation (ft)	2259.5
Bottom of Test Elevation (ft)	2239.5
Top of Test Depth (ft)	45.5
Bottom of Test Depth (ft)	65.5
Angle from Vertical (deg)	0

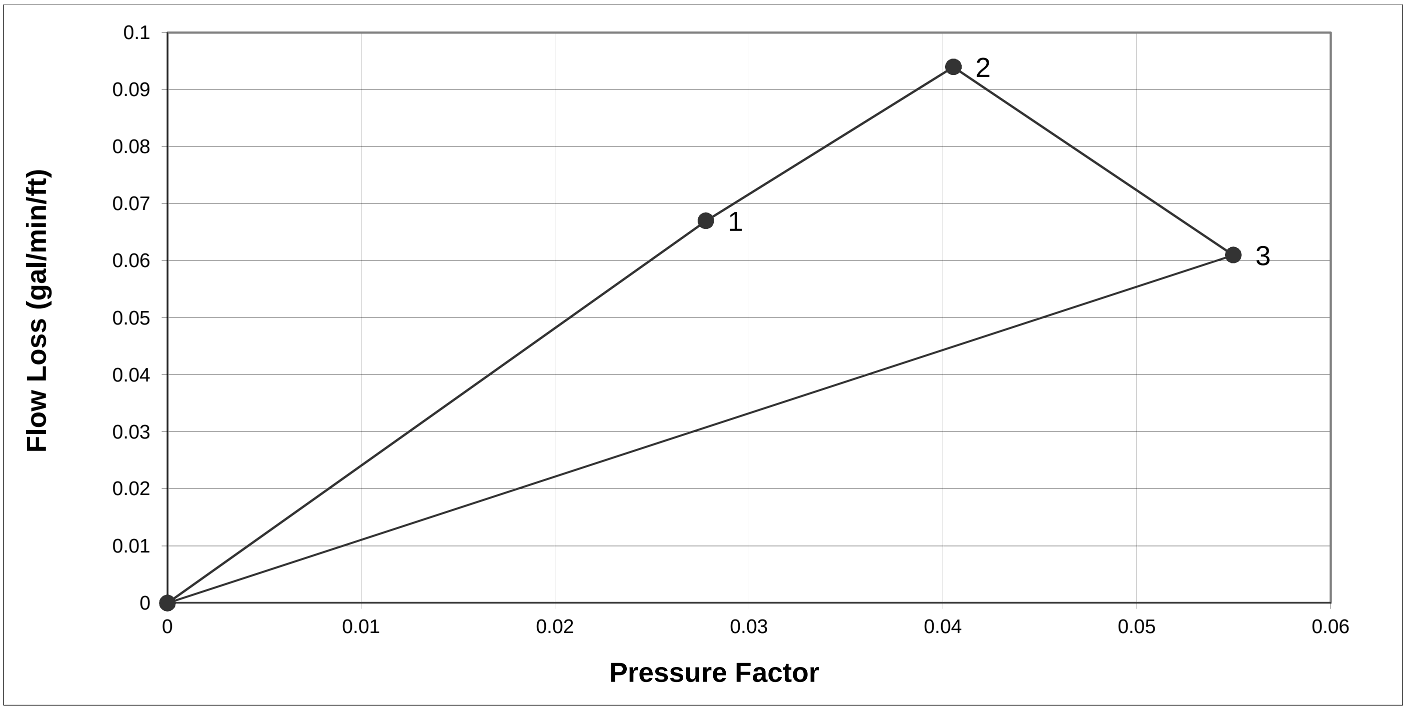
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	42.00	0.023321672	12.78	0.6390	27
2	75%	58.00	0.032206119	20.64	1.0320	32
3	100%	78.33	0.04349677	31.70	1.5850	36
4	75%	58.33	0.032391212	18.90	0.9450	29
5	50%	42.50	0.023599311	7.46	0.3730	16
0	0		0	0	0	



Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	3
Test Interval Center Elevation (ft)	2229.5
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	99.0
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	1

Top of Test Elevation (ft)	2239.5
Bottom of Test Elevation (ft)	2219.5
Top of Test Depth (ft)	65.5
Bottom of Test Depth (ft)	85.5
Angle from Vertical (deg)	0

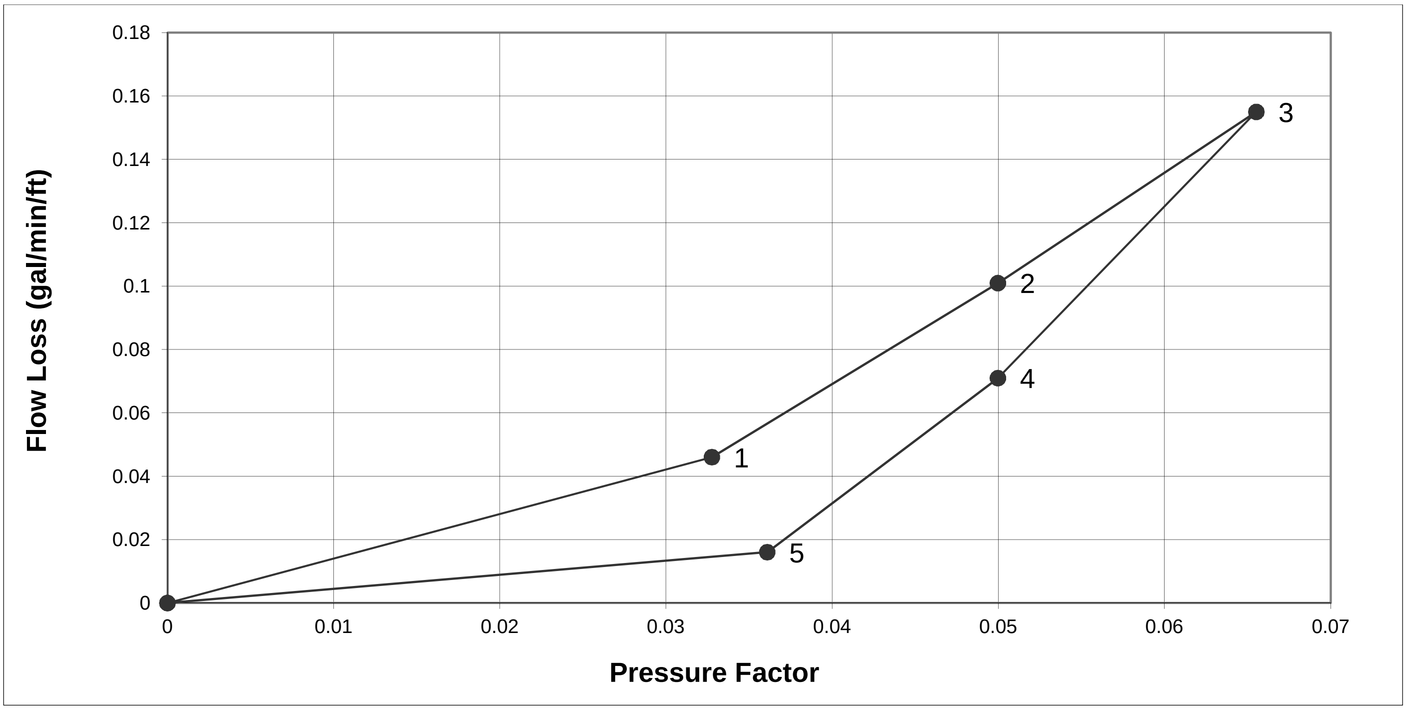
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	50.00	0.027763896	1.34	0.0670	2
2	75%	73.00	0.040535288	1.88	0.0940	2
3	100%	99.00	0.054972514	1.22	0.0610	1
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	4
Test Interval Center Elevation (ft)	2209.5
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	118.0
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	2

Top of Test Elevation (ft)	2219.5
Bottom of Test Elevation (ft)	2199.5
Top of Test Depth (ft)	85.5
Bottom of Test Depth (ft)	105.5
Angle from Vertical (deg)	0

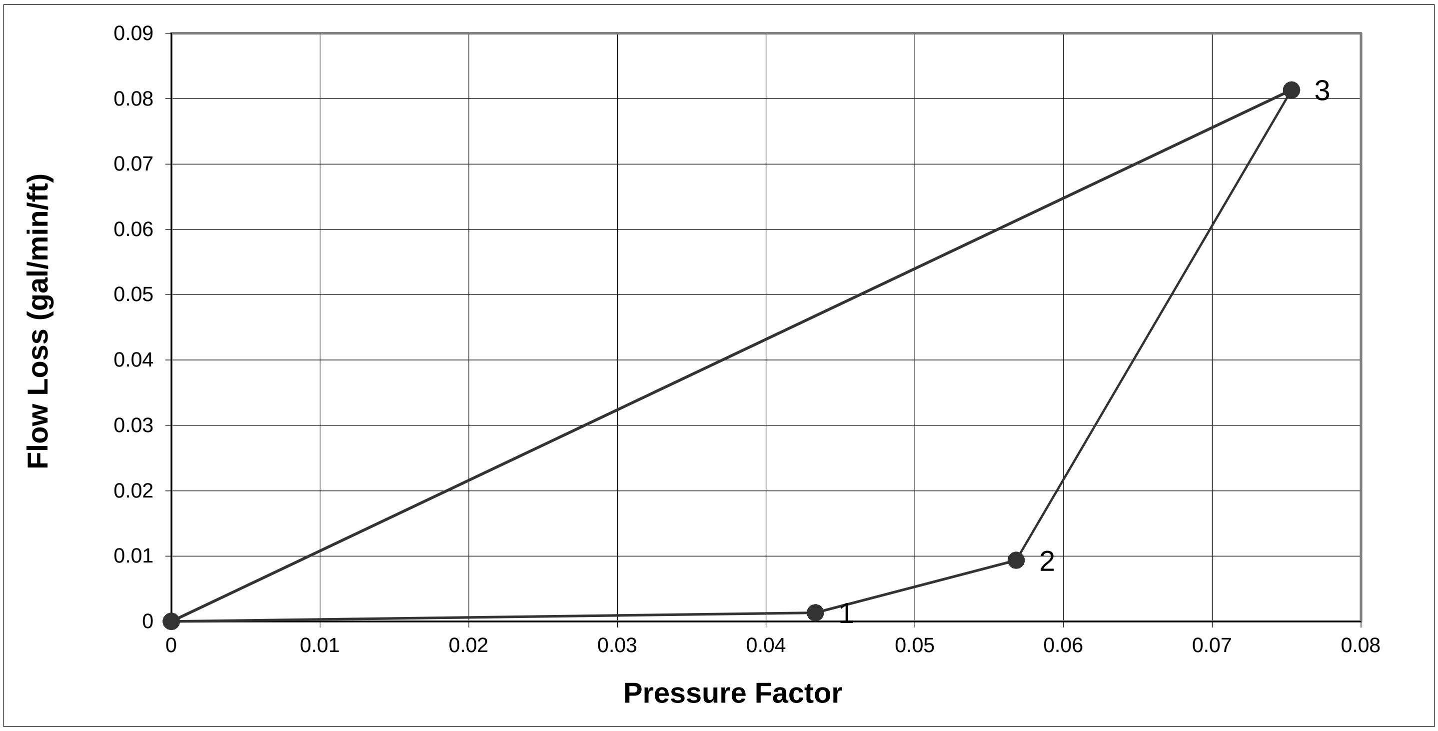
Step No.	%P_{MAX}	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	59.00	0.032761397	0.92	0.0460	1
2	75%	90.00	0.049975012	2.02	0.1010	2
3	100%	118.00	0.065522794	3.10	0.1550	2
4	75%	90.00	0.049975012	1.42	0.0710	1
5	50%	65.00	0.036093065	0.32	0.0160	0
0	0		0	0	0	



Boring	B-203
Surface El. (ft)	2305
Groundwater El. (ft)	2330
Test No.	5
Test Interval Center Elevation (ft)	2192.5
Test Interval Length, L (ft)	15.0
Max. Measured Pressure, P_{MAX} (psi)	135.7
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	1

Top of Test Elevation (ft)	2200.0
Bottom of Test Elevation (ft)	2185.0
Top of Test Depth (ft)	105
Bottom of Test Depth (ft)	120
Angle from Vertical (deg)	0

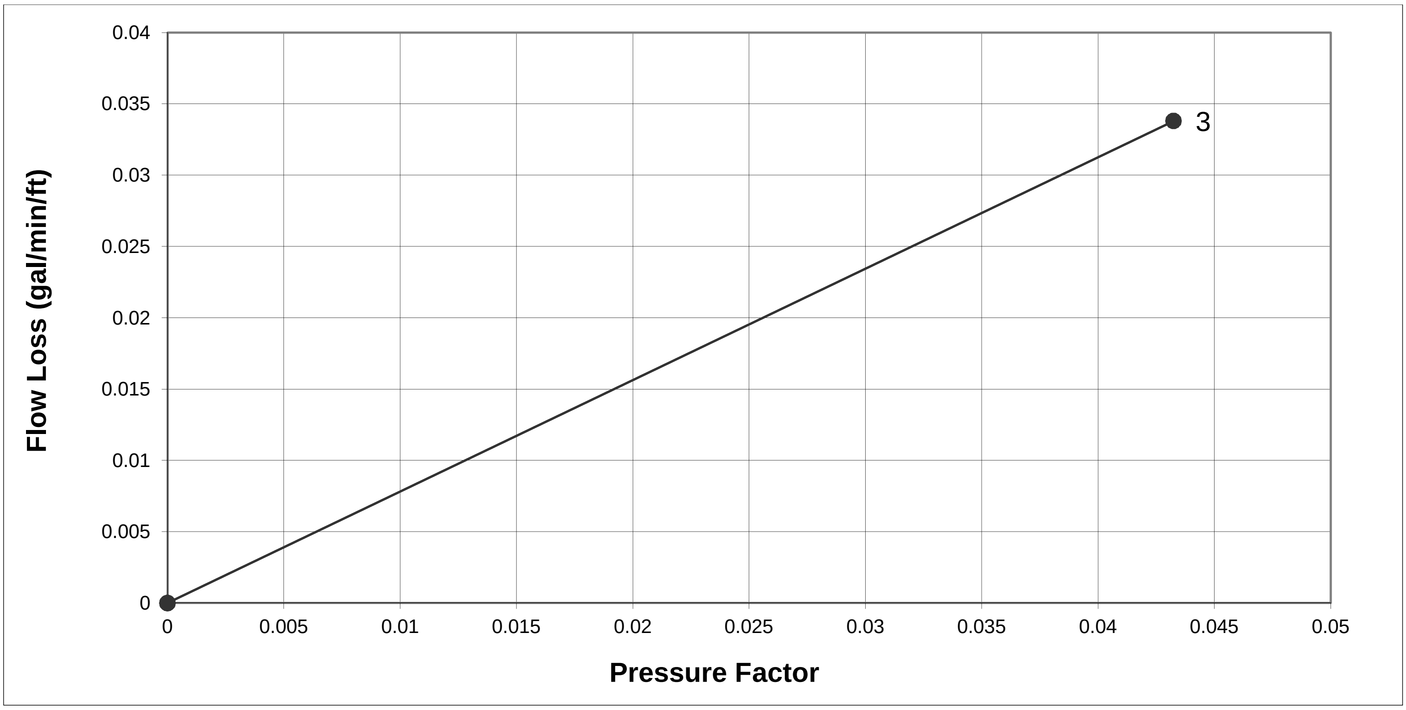
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	78.00	0.043311677	0.02	0.0013	0
2	75%	102.33	0.05682344	0.14	0.0093	0
3	100%	135.67	0.075332704	1.22	0.0813	1
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	B-206
Surface El. (ft)	2336.62231
Groundwater El. (ft)	2328.02231
Test No.	1
Test Interval Center Elevation (ft)	2258.7
Test Interval Length, L (ft)	10.0
Max. Measured Pressure, P_{MAX} (psi)	77.9
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	1

Top of Test Elevation (ft)	2263.0
Bottom of Test Elevation (ft)	2254.3
Top of Test Depth (ft)	85
Bottom of Test Depth (ft)	95
Angle from Vertical (deg)	30

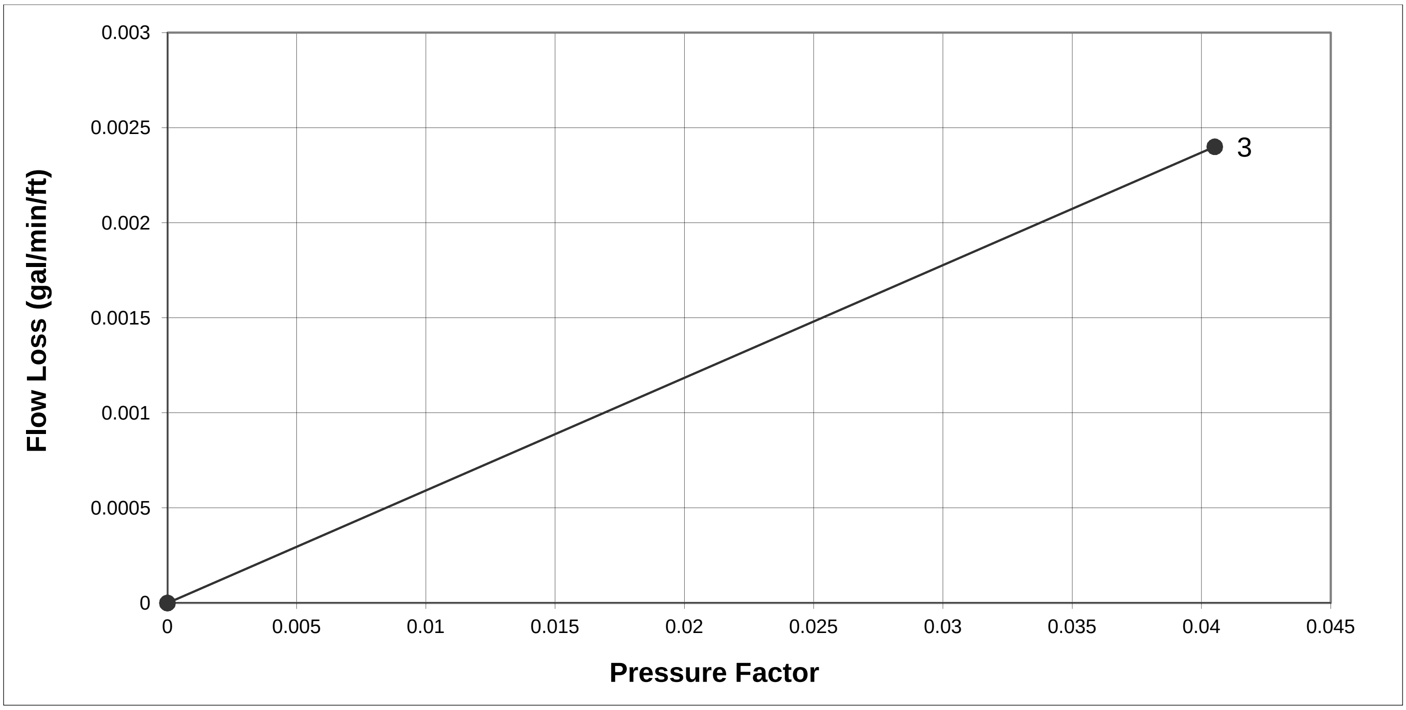
Step No.	%P_{MAX}	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%		#N/A			
2	75%		#N/A			
3	100%	77.88	0.043245044	0.34	0.0338	1
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	B-206
Surface El. (ft)	2336.62231
Groundwater El. (ft)	2328.02231
Test No.	2
Test Interval Center Elevation (ft)	2267.3
Test Interval Length, L (ft)	10.0
Max. Measured Pressure, P_{MAX} (psi)	73.0
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	0

Top of Test Elevation (ft)	2271.7
Bottom of Test Elevation (ft)	2263.0
Top of Test Depth (ft)	75
Bottom of Test Depth (ft)	85
Angle from Vertical (deg)	30

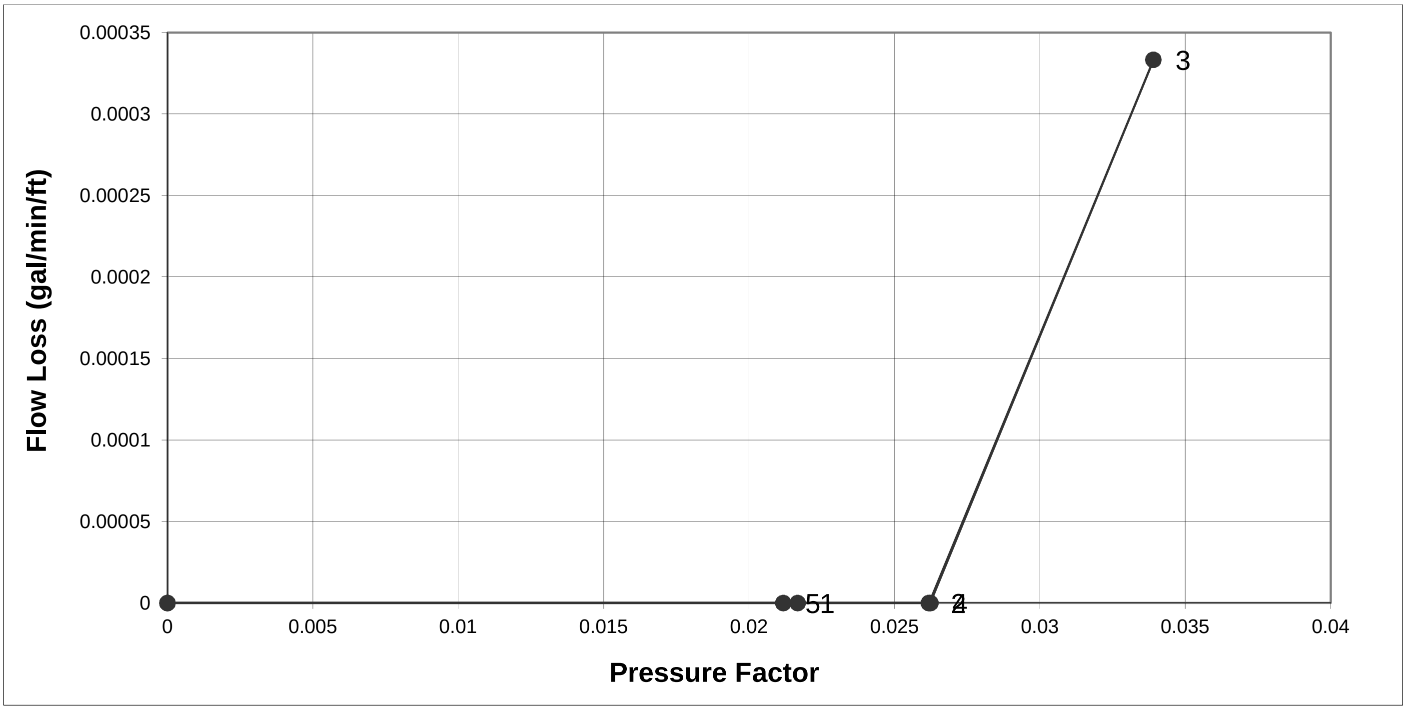
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%		#N/A			
2	75%		#N/A			
3	100%	72.96	0.040513077	0.02	0.0024	0
4	75%		#N/A			
5	50%		#N/A			
0	0		0	0	0	



Boring	BI-02
Surface El. (ft)	2334.3
Groundwater El. (ft)	2329.5
Test No.	1
Test Interval Center Elevation (ft)	2277.3
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	61.1
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	0

Top of Test Elevation (ft)	2287.3
Bottom of Test Elevation (ft)	2267.3
Top of Test Depth (ft)	47
Bottom of Test Depth (ft)	67
Angle from Vertical (deg)	0

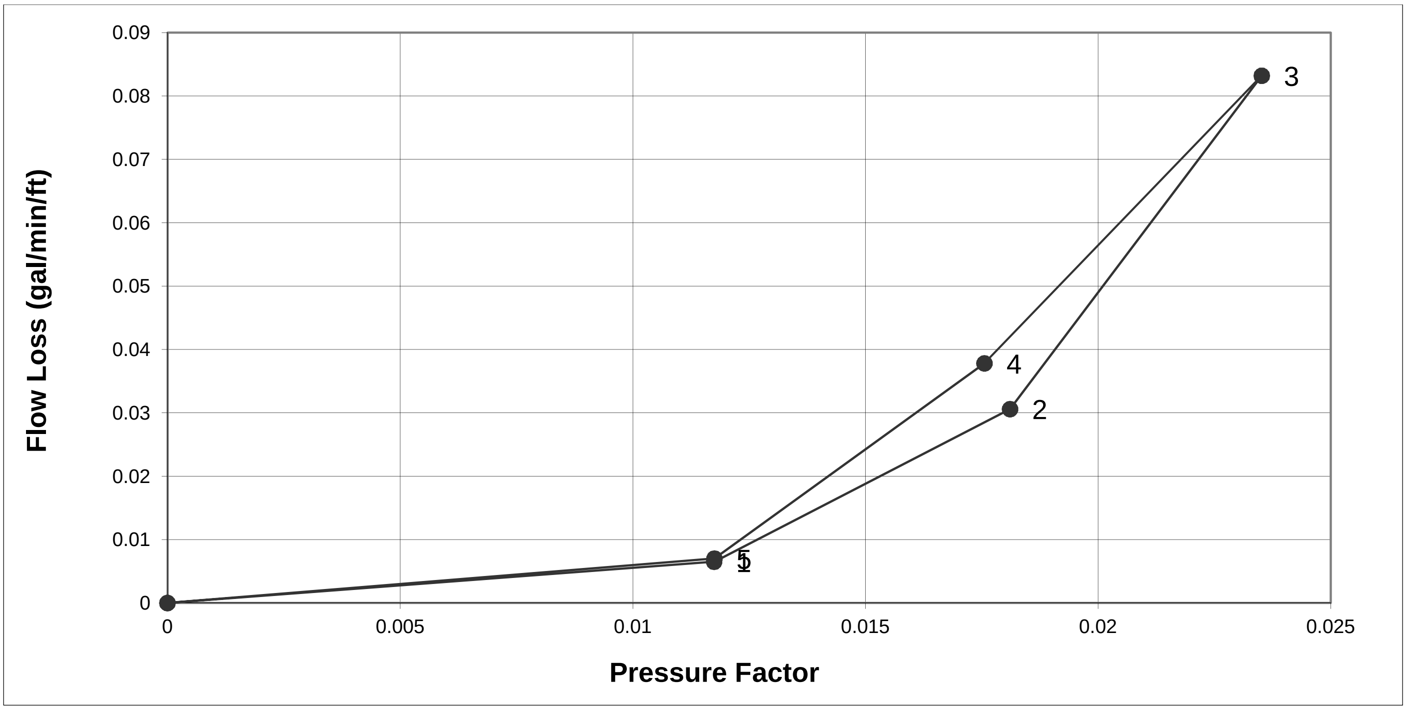
Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	39.02	0.021669027	0.00	0.0000	0
2	75%	47.15	0.026180984	0.00	0.0000	0
3	100%	61.06	0.033903789	0.01	0.0003	0
4	75%	47.24	0.026232069	0.00	0.0000	0
5	50%	38.13	0.021173117	0.00	0.0000	0
0	0		0	0	0	



Boring	BI-03
Surface El. (ft)	2302.2
Groundwater El. (ft)	2327.5
Test No.	1
Test Interval Center Elevation (ft)	2277.1
Test Interval Length, L (ft)	20.0
Max. Measured Pressure, P_{MAX} (psi)	42.4
Reference Pressure, P_0 (psi)	145
Representative Lugeon Value	4

Top of Test Elevation (ft)	2287.1
Bottom of Test Elevation (ft)	2267.1
Top of Test Depth (ft)	15.1
Bottom of Test Depth (ft)	35.1
Angle from Vertical (deg)	0

Step No.	$\%P_{MAX}$	Measured Pressure (psi)	Pressure Factor, ψ	Flow, q (gal/min)	Flow loss (gal/min/ft)	Lugeon
0	0		0	0	0	-
1	50%	21.16	0.011748459	0.13	0.0065	1
2	75%	32.61	0.018106835	0.61	0.0306	2
3	100%	42.36	0.023519129	1.66	0.0832	4
4	75%	31.62	0.017556	0.76	0.0378	2
5	50%	21.16	0.01175168	0.14	0.0070	1
0	0		0	0	0	



APPENDIX C TELEVIEWER DATA

NORCAL
GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

October 11, 2018

AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612, USA

Subject: Borehole Televiewer Logging Survey
Klamath River Project
Iron Gate Reservoir
Siskiyou County, California

NORCAL Job No: NS185074

Attention: Ben Kozlowicz

This report presents the findings of a borehole geophysical investigation performed by NORCAL Geophysical Consultants, Inc. at the Klamath River Project at the northeast end of Iron Gate Reservoir. This investigation was part of a geotechnical study to assess subsurface conditions along a propose water tunnel alignment. The survey was performed on two separate mobilizations during the period of August 16 through 23, 2018 by NORCAL Professional Geophysicist William J. Henrich PGp 893. Logistical support and safety information were provided onsite by Mr. Tim VandeVoorde, Engineering Geologist of AECOM.

1.0 SITE DESCRIPTION

Our work concerned 2 boreholes situated near the north and south shore at the very northeastern end of Iron Gate Reservoir (see Plate 1, Borehole Location Map). The purpose of this investigation was to help determine rock mass characteristics that included orientations and depth distribution of bedrock discontinuities. The site was underlain by unconsolidated river deposits, basalt flows and tuff breccia.

2.0 SCOPE

Geophysical borehole logging was conducted in two drilled boreholes labeled as B-202 and B-206. The geophysical logging methods consisted of acoustic televiewer and caliper. The scope of work included a report detailing analysis, methods, and presentation of results.

3.0 BOREHOLE CONDITIONS

Both boreholes were inclined 60 degrees from horizontal. They contained shallow Hwt. 4.5- inch diameter steel conductor casings from depths of 9 to 29.5-ft bgs. The casing was installed to prevent caving from unconsolidated river deposits. Below the conductor casing the boreholes were advanced with a HQ- diamond coring method. The HQ open bore diameter was approximately 3.82-inches. The principle rock types consisted of relatively hard, well consolidated basalt and highly weathered, weak tuff breccia. The latter geologic unit tended to cave and create washouts of the borehole wall. This impeded the advancement of the acoustic televiewer in Borehole B-202.

4.0 GEOPHYSICAL LOGGING EQUIPMENT AND METHODOLOGY

NORCAL conducted geophysical borehole logging using a digital ***MICROLOGGER2*** System manufactured by **Robertson Geologging, Ltd.** This system consisted of the following components:

- control console,
- computer,
- motorized cable winch,
- Televiewer (acoustic)
- caliper

4.1 TELEVIEWER

Complete descriptions of the methodology, data acquisition and data analysis procedures are presented in Appendix A.

4.2 CALIPER

Caliper logs are a measure of the borehole diameter versus depth. The tool was used both as a survey technique to assess the relative consolidation of bedrock and provide parameter input to a computer program that calculates discontinuity dip. The caliper tool consists of three interconnected mechanical arms that are spring loaded against the borehole wall. The horizontal deflections of the arms gauge the borehole diameter in units of inches with depth. The logging measurement was made in the up hole direction at a speed of approximately 12-ft per minute. The data sampling rate for this instrumentation was every 0.2-ft.

5.0 RESULTS AND INTERPRETATION

Caliper and televiewer field logs are presented in Appendix B. Specific interpreted log plots (Televiewer Analysis of Dips) from the televiewer logging are presented in Appendix C. Supporting numerical tables (Discontinuity Tables) that tabulated depth, dip angles, dip azimuths, aperture thickness where applicable and fracture classification are presented in Appendix D.

Over 95 percent of all discontinuities subjected to orientation analysis were classified as fractures. The remaining percentage were attributed to lithologic contacts between basalt and tuff breccia. Fracture classifications are discussed in Appendix A. The discontinuities classified as fractures were present only in the basalt unit in Borehole B-206. No discontinuities in the tuff breccia in the lower portion of this borehole and the entire logged open borehole section of B-202 were observed. This is because this unit, based on very low BHTV amplitude returns and variable borehole diameters (washouts), is highly weathered and poorly consolidated. As a result, this geologic unit was not capable of supporting brittle fractures. Note that not all visible fractures-joints on the televiewer images were chosen for orientation analysis. This was because these non-selected features were either too fragmented or feint to be considered representative. We did subdivide or classify the fractures-joints based on the appearance of the televiewer image and related caliper responses.

6.0 STANDARD OF CARE

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the standard of care ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.

Thank you for the opportunity to participate on this project.

Sincerely,

NORCAL Geophysical Consultants, Inc.

William J. Henrich
Professional Geophysicist PGp 893

William J. Henrich
10/11/2018
No. 893

Donald J. Kirker

Donald J. Kirker
Professional Geophysicist PGp 997

Donald Kirker
No. 997
10-11-18

WJH/DJK/tlt
Enclosures:

Appendix A: Borehole Imaging Televiewer Surveying and Data Processing
Appendix B: Field Logs Televiewer and Caliper Survey, Boreholes B-202 and B-206
Appendix C: Interpreted Televiewer Plot, Borehole B-206
Appendix D: Discontinuity Table Borehole B-206

NORCAL
GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

Appendix A:

Televiewer Analysis Boreholes B-202 and B-206

APPENDIX A

BOREHOLE TELEVIEWER SURVEY

1.0 METHODOLOGY

Televiewers are downhole tools that are used to produce radial images of the interior of a borehole. The images are composited sequentially using computer software to produce continuous color images. These images are like unfolded, or unwrapped, cylinders displayed on a two-dimensional surface. The "unwrapped" radial images are referenced to magnetic north by an on-board magnetic compass. In addition, an on-board three-axis magnetic inclinometer determines the inclination and azimuth of the borehole.

Televiewer images can be used to detect bedrock discontinuities (joints, fractures, bedding planes, geologic contacts, etc.) in boreholes and determine their frequency, depths and orientations. Interpretable discontinuities appear as thin sinusoidal forms that stretch across the image. Interactively fitting lines to these sinusoids provides data that computer software uses to determine the orientation and dip of the discontinuities. The midpoint or half amplitude of the sinusoid is taken as the depth of the discontinuity.

There are two types of televiewers; optical and acoustic. Optical televiewers (OPTV) use a digital optical sensor to produce radial images to a vertical resolution as fine as 0.004 feet and a radial resolution to 720 pixels. However, they can only be used in dry holes or in water filled holes with sufficient clarity to create an interpretable high resolution image. Acoustic televiewers (BHTV) require a water column to act as a medium for the transmission and reception of acoustic signals. The water does not have to be optically clear. In operation the BHTV transmits an ultrasonic signal into the borehole fluid and detects ultrasonic energy that is reflected from the borehole wall. Sidewall borehole images are created by measuring variations in the two-way travel time of the ultrasonic pulses as well as variations in the amplitude of the reflected signals.

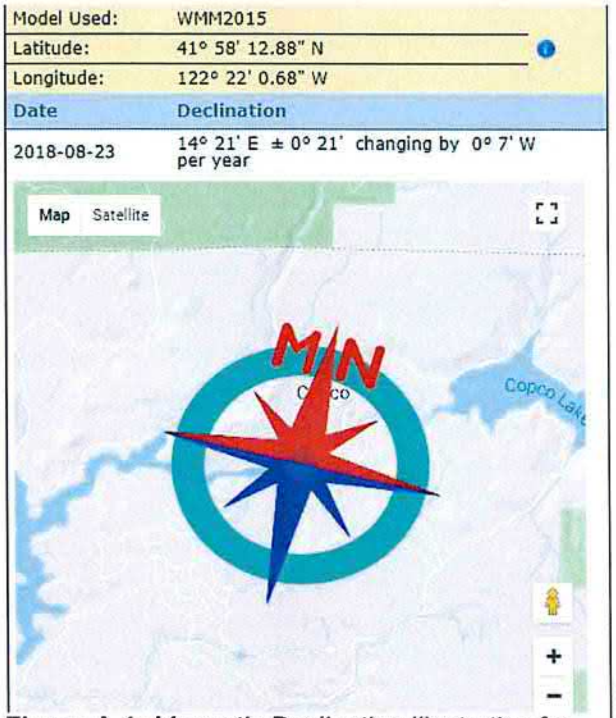
2.0 DATA ACQUISITION

Prior to Televiewer logging we checked the correct operation of the onboard tool compass of bearing direction against the readings provided by a Brunton Compass. This procedure involves setting the probe vertically in a jig with a bar situated in the south (magnetic) direction and recording a time-drive record so that the bar forms a straight line down the center of the waterfall image. Alternately, we incline the probe (greater than 45 degrees from vertical) in an arbitrary direction and compare the bearing displayed in test mode to the bearing indicated on the Brunton compass face. Variations of 1 to 2 degrees in azimuth between the tool display and Brunton Compass bearing confirms the tools compass is operating satisfactory.

Given that all boreholes maintained a shallow fluid level, image logging was accomplished with the acoustic method. We acquired acoustic BHTV data at a rate of approximately 1000 two-way pulses times per second. The tool was raised/lowered at a rate of 4.5-ft per minute. This resulted in a BHTV depth sample interval of 0.006 ft. Two logs were acquired in each borehole; one in the up direction and one in the down direction. This allowed us to demonstrate the tools compass stability by comparing the orientations of common features between the two logs.

3.0 DATA ANALYSIS

We used the computer program ***WELLCAD*** (Version 5.1, ALT, and Luxemburg) to display BHTV images and to calculate the orientations of interpreted discontinuities (e.g. fractures, joints, bedding). Corrections for the magnetic declination in the survey area required adding 14.3 degrees to the magnetic compass bearings in order to orient the borehole images to true north (see Figure A-1 below). Since borehole diameter is a major reduction parameter in determining dip magnitude, we input caliper log measurements. In each borehole, discontinuity analyses were performed interactively on sections of the unwrapped optical or acoustic amplitude images as viewed on a computer monitor. An interpretable discontinuity on a two-dimensional unwrapped borehole televiewer log appears as a recognizable sinusoidal trace that usually extends across the full width of the borehole image. The sinusoidal shape is a manifestation of planar discontinuities intercepting a three-dimensional cylindrical borehole. Planar discontinuities can be geologic features that include discrete fractures or joints, bedding planes and planar intrusions such as veins and geologic contacts. The traces of discontinuities identified on the image logs were



Model Used:	WMM2015
Latitude:	41° 58' 12.88" N
Longitude:	122° 22' 0.68" W
Date	Declination
2018-08-23	14° 21' E ± 0° 21' changing by 0° 7' W per year

Figure A-1: *Magnetic Declination Illustration for Eastern Iron Gate Reservoir.*

fitted with a bendable sinusoid overlying the trace, as shown in Figure A-2. This provided data that were used by ***WELLCAD*** to calculate a plane representing the orientation of the discontinuity in terms of dip direction and dip magnitude. This process was repeated for every significant discontinuity until the entire borehole was interpreted. At this stage, the apparent dip direction and dip magnitude of the identified discontinuities were converted to true geographic dip azimuth and dip magnitude by factoring the borehole tilt (inclination) and azimuth at the depth of the discontinuity.

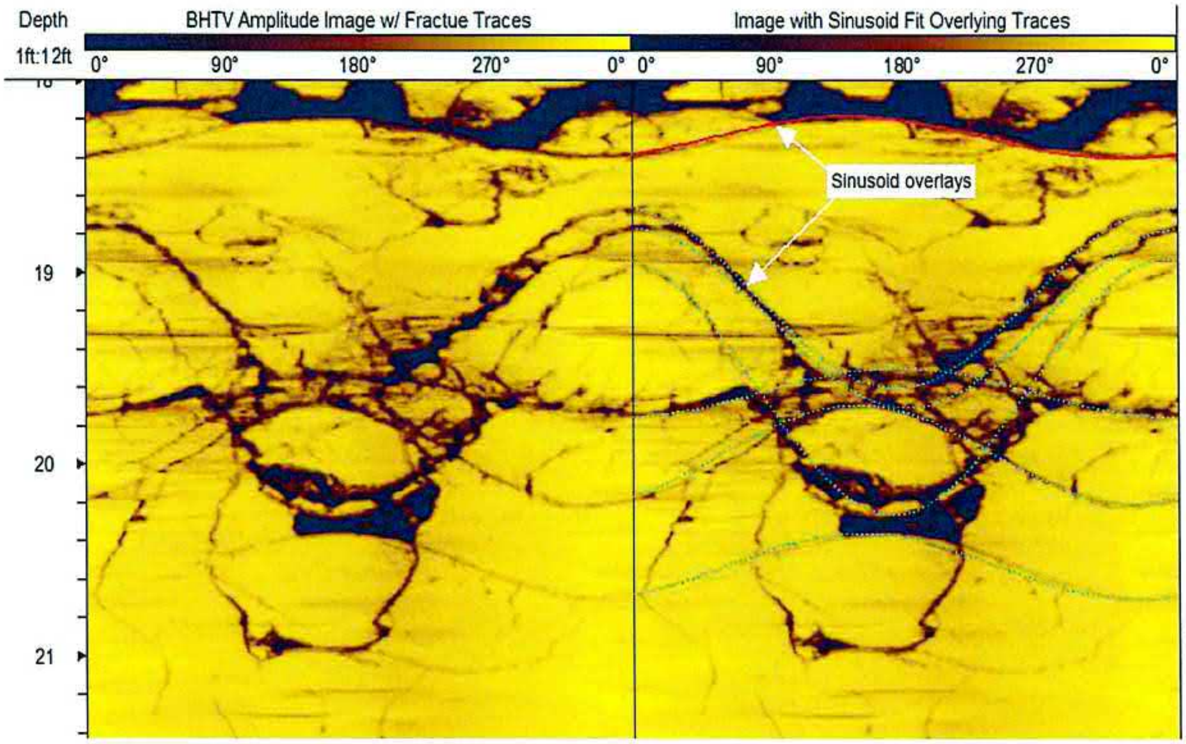


Figure A-2: *A sample BHTV section showing observable discontinuity traces (left) versus the same image (right) with the addition of interpreted sinusoidal overlays (solid red and green colored traces).*

Based on observations of the core and discussions with the on-site geologist, as well as our own experience identifying planar features in acoustic televiewer images, we classified discontinuity features into three fracture/joints categories as follows:

1) “Open continuous fractures”. These have characteristics that are relatively wide (measureable >> 1mm) apparent apertures, continuous sinusoidal traces across the circumference of the borehole wall and show relief/breakage along the borehole wall. This relief is usually shown as diameter enlargements on the caliper log.

2) “Thin partial to continuous fracture”. These features are “thin” (indicative of very small apertures 1 mm or less) partial or discontinuous across the full 360 degrees span of the image to continuous. Feature traces can be irregular (non-sinusoidal) especially if the dip angles are greater than 60 degrees.

3) “Lithologic Contacts”. Boundaries between basalt and tuff breccia.

We did not tabulate (interpret) cemented or highly discontinuous or fragmented fractures.

4.0 PRESENTATIONS

Field Logs showing the two completed BHTV logging runs referenced to magnetic North are presented in Appendix B. Two televiewer images are presented to show the stability of the compass orientation of common fracture features between separate logging runs. The Televiewer Analysis for B-206 referenced to true geographic North, is presented in Appendix C. This plot is several pages long, with header information presented at the top of the first page only. The plot contains several columns of information described, from left to right, as follows:

COLUMN 1 – DEPTH AXIS

The depth axis indicates the relative vertical distance below the ground surface. Ground surface was set equal to zero feet. Depth values are positive and increase in the downward direction.

COLUMN 2 - TELEVIEWER IMAGE

This is an unwrapped false color (BHTV) image representing the interior of the borehole wall. On the BHTV images the relationship between color and signal amplitude is indicated by the color bar at the top of the header. Dark shades (blue) indicate relatively low amplitude and the brighter shades (yellow) indicate relatively high amplitudes. BHTV images are oriented relative to true North as indicated by the azimuth information presented in the header where North, East, South and West correspond to 0°, 90°, 180° and 270°, respectively. The diameter of the borehole is indicated by the white dashed line superimposed on the image. Solid and dashed color lines superimposed on sinusoidal fracture/joint traces depict interpreted discontinuities. The colors of the lines relate to the fracture/joint classification as follows, red = open continuous fractures, teal = "thin", partial to complete fractures and blue = lithologic contacts. Note, that due to the wide apparent thickness of some fractures, we expanded the line trace into a broader hachured sinusoidal section.

COLUMN 3 - DIPS PLOT

The Dips Plot indicates the dip of discontinuities and their direction of maximum dip. These parameters are indicated by small symbols called "tadpoles" which consist of colored circles or squares with a straight line (tail) extending from them. The position of the tadpole indicates the degree of dip, from 0° on the left to 90° on the right, according to the scale shown at the top of the column. The direction that the tail is pointing indicates the direction of dip where straight up is true north and 90° to the right indicates due east. The tadpole symbol colors relate to the three classifications of fractures and joints. A Discontinuity Legend in the sub-header related the colors to the classification. The numerical values of dip azimuth and dip angle are also presented in discontinuity tables presented at the end of this appendix.

COLUMN 4 - CORE PLOT

This plot is a graphic rendering of the BHTV image into a 3-D core based on amplitude variations. This is basically what the image shown in Column 2 would look like if it was re-wrapped to form a cylinder where the vertical center line of the cylinder represents true north (0°), the right edge represents west (270°) and the left edge represents east (90°). South (180°) is out of view behind the core. Although the color spectrum of the core is the same as that used for the BHTV image, the core reconstruction tends to compress the amplitude spectrum into a darker range. This has the effect of making the core appear to be reddish rather than yellow. Planes drawn through the interpreted discontinuities illustrate the relative dip and dip direction of the discontinuities.

COLUMN 5 - BOREHOLE DEVIATION

This plot indicates the azimuth and tilt of the borehole. The solid blue line represents the dip direction, from 0° to 360°, according to the header scale labeled "Azimuth". The dotted green line represents the angle of the borehole from true vertical according to the header scale labeled "Tilt". This scale ranges from 0° to 4°.

5.0 DISCONTINUITY TABLES

The dip azimuth and dip angle of all interpreted discontinuities from the televiewer analysis plot are tabulated Appendix D. The tables present 5 column headers listed left to right as follows: Depth, Dip Azimuth, Dip Angle, Corrected Aperture and Discontinuity Classification. A brief description of the meaning of these terms is presented below.

Depth – relates to the center of discontinuity's sinusoid in feet below ground surface.

Dip Azimuth – dip direction of the discontinuity in degrees from true North.

Dip Angle – inclination of the plane of the discontinuity in degrees from horizontal.

Corrected Aperture – true thickness of fracture/joint corrected for dip measured in tenths of inches. In this survey, we used this processing facility to indicate the true thickness of weathered/altered fractures.

Discontinuity Classification – number designating classification type of fracture/joint (see Legend for explanation).

Appendix B:

Field Logs Televiewer and Caliper Survey
Boreholes B-202 and B-206

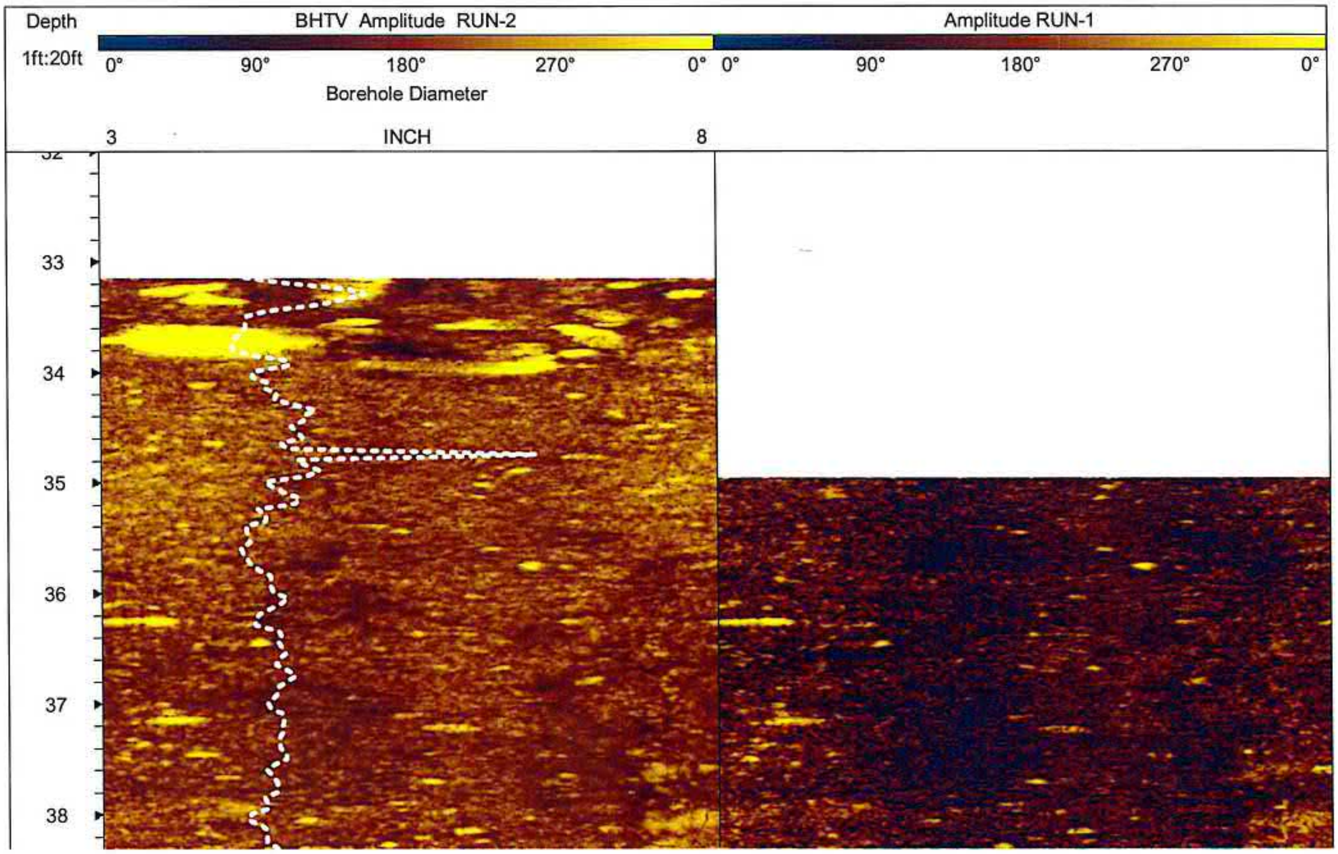
NORCAL GEOPHYSICAL CONSULTANTS, INC.

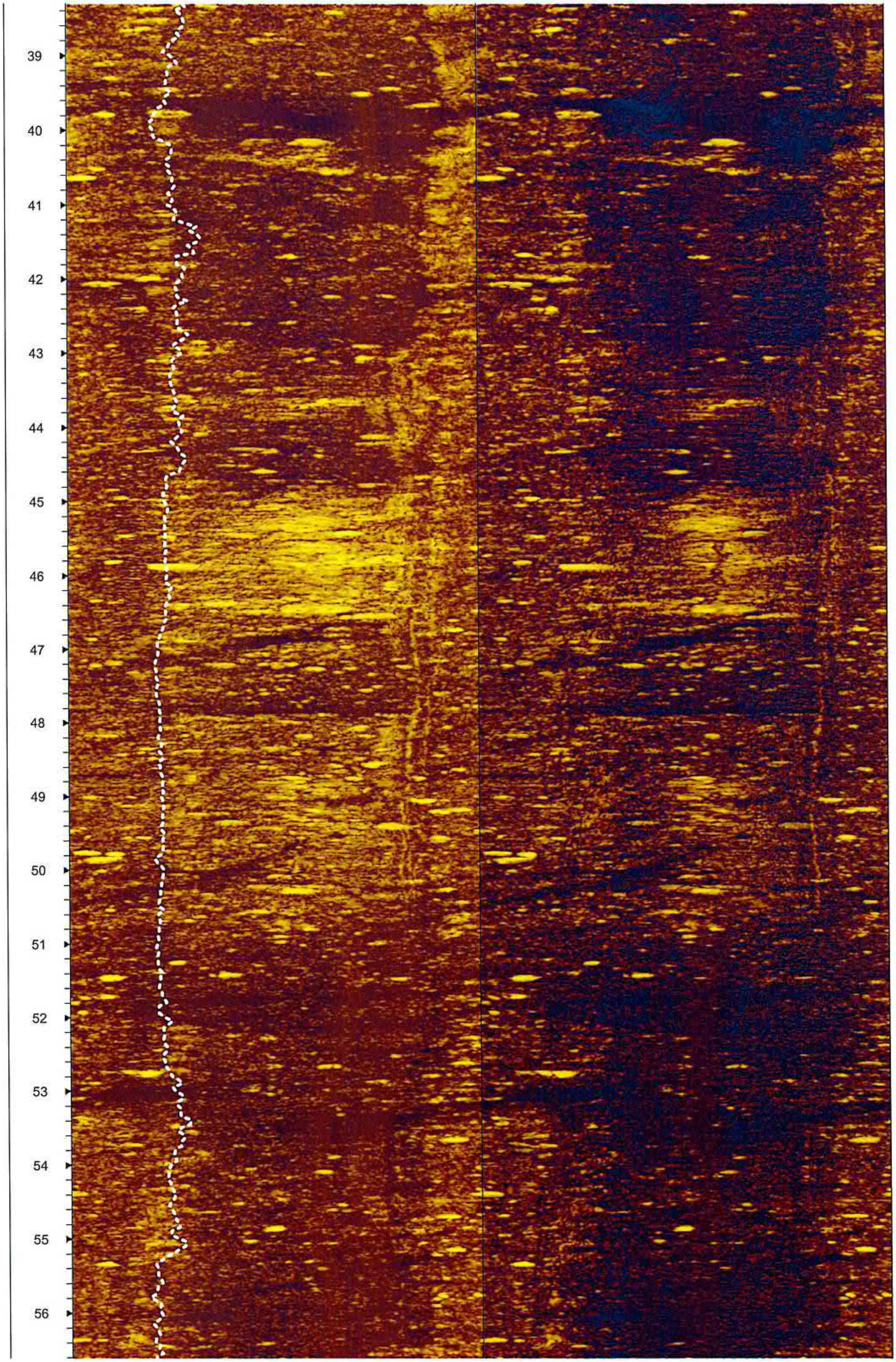
ACOUSTIC TELEVIEWER, CALIPER LOGS

CO AECOM
WELL B-202
FLD IRON GATE RESERVOIR
CTY SISKIYOU CO.
STE CA
FILING No NS185074

COMPANY	AECOM		
WELL ID	B-202		
FIELD	IRON GATE RESERVOIR		
COUNTRY	USA	STATE	CA
LOCATION	LAT 41.97048 LONG -122.37038		OTHER SERVICES
SEC	TWP	RGE	
PERMANENT DATUM	GROUND SURFACE	ELEVATION ~2300' msl	K.B.
LOG MEAS. FROM	GROUND SURFACE	ABOVE PERM. DATUM	D.F.
DRILLING MEAS. FROM	GROUND SURFACE		G.L.
DATE	AUGUST 23, 2018	TYPE FLUID IN HOLE	water w/ polymer
RUN No	RUNS 1 through 3	SALINITY	na
TYPE LOG	CALIPER AND BHTV (3)	DENSITY	
DEPTH-DRILLER	100	LEVEL	11
DEPTH-LOGGER	97.8' bgs	MAX. REC. TEMP.	na
BTM LOGGED INTERVAL	BHTV 82' BGS		
TOP LOGGED INTERVAL	BHTV 18.06' BGS		
OPERATING RIG TIME	3		
RECORDED BY	W HENRICH		
WITNESSED BY	Tim VerdeVoorde		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1	4.25"	0	29.5 ft	4.25"	Hwt	0	29.5
2	HQ 3.825"	29.5	100 ft				

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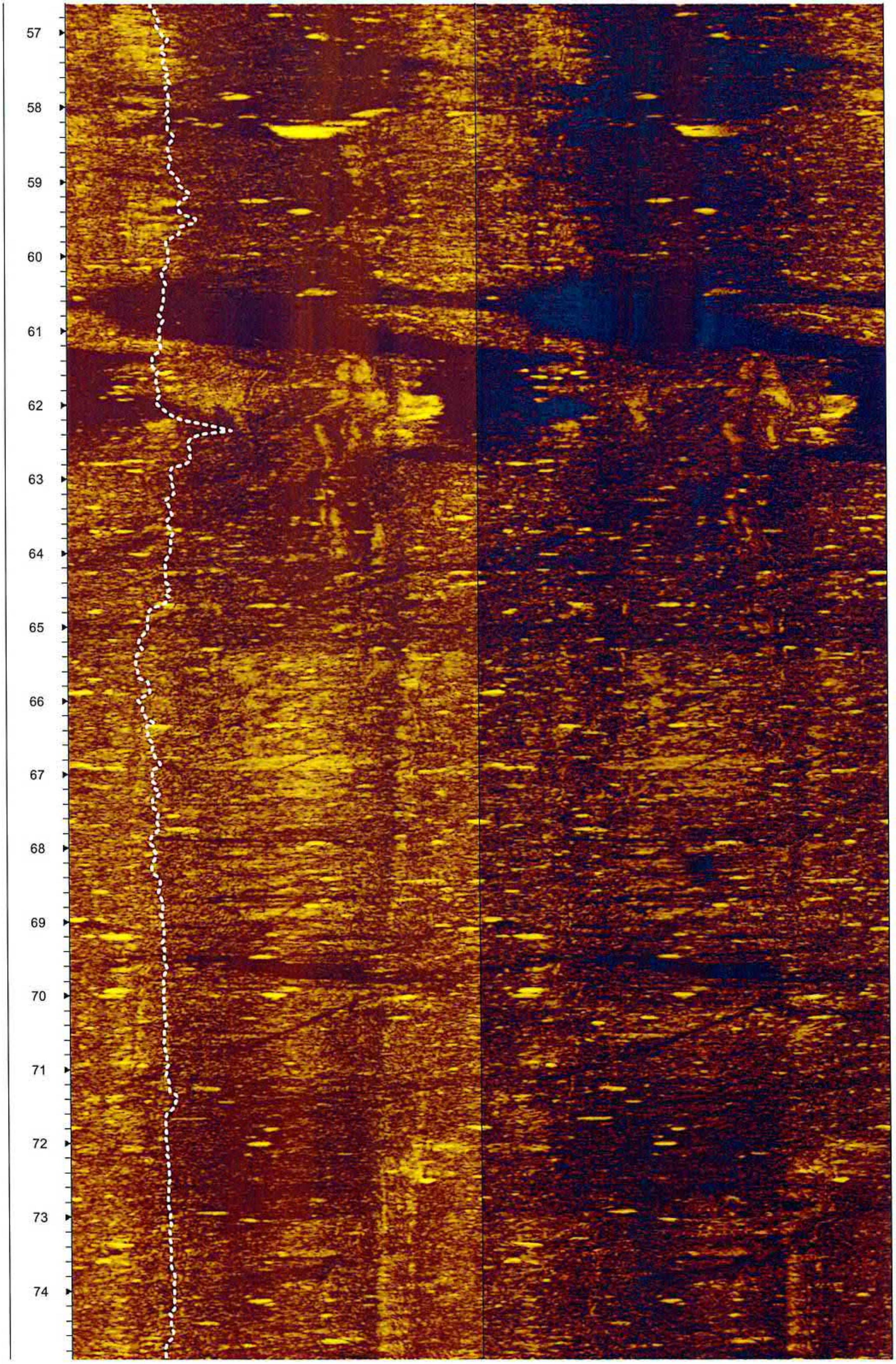
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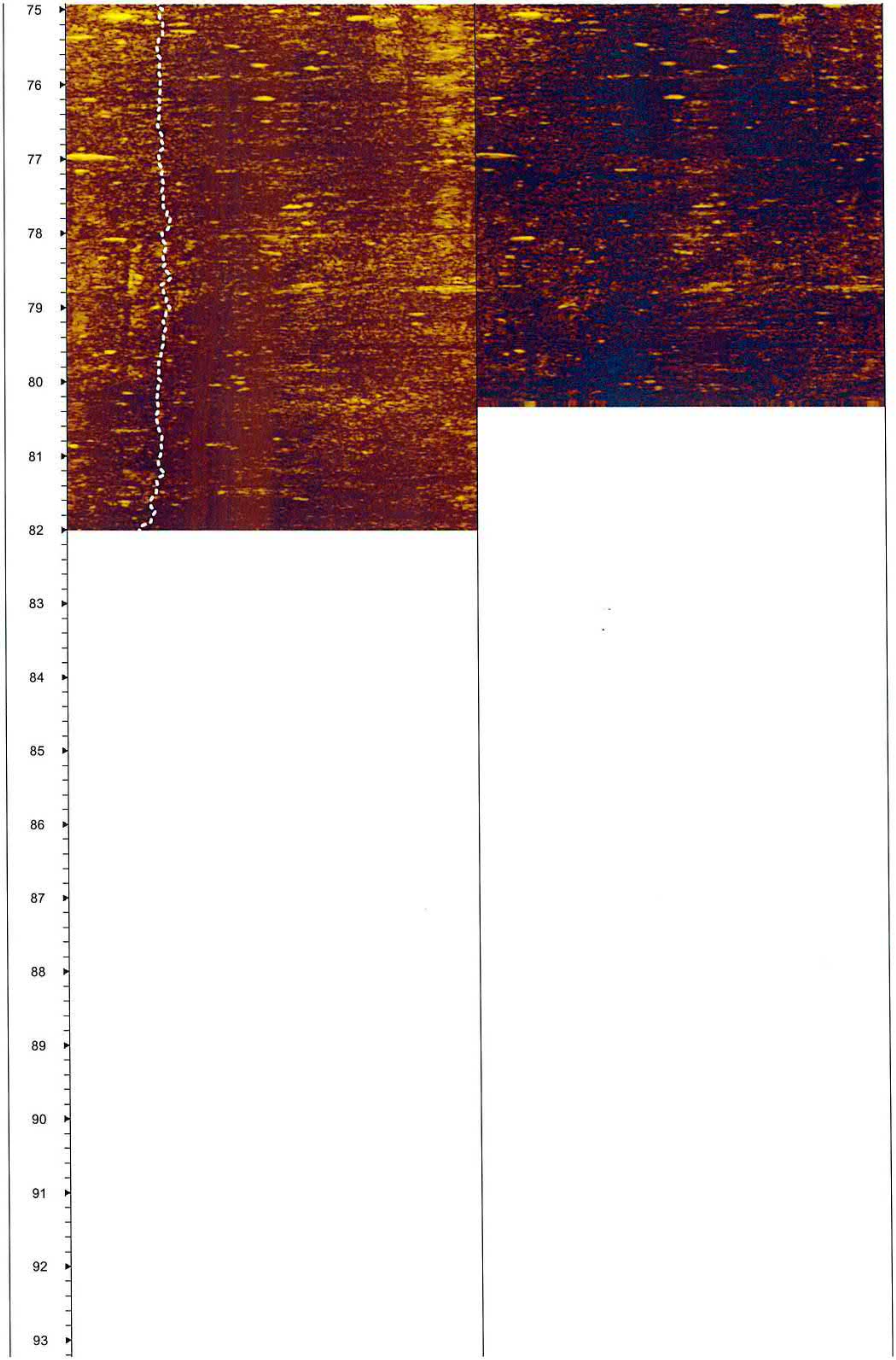
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NORCAL

NORCAL GEOPHYSICAL CONSULTANTS, INC.

ACOUSTIC TELEVIEWER, CALIPER LOGS

CO AECOM
WELL B-206
FLD IRON GATE RESERVOIR
CTY SISKIYOU CO.
STE CA
FILING No NS185074

COMPANY AECOM
WELL ID B-206
FIELD IRON GATE RESERVOIR
COUNTRY USA STATE CA

LOCATION
LAT 41.972184
LONG -122.36915

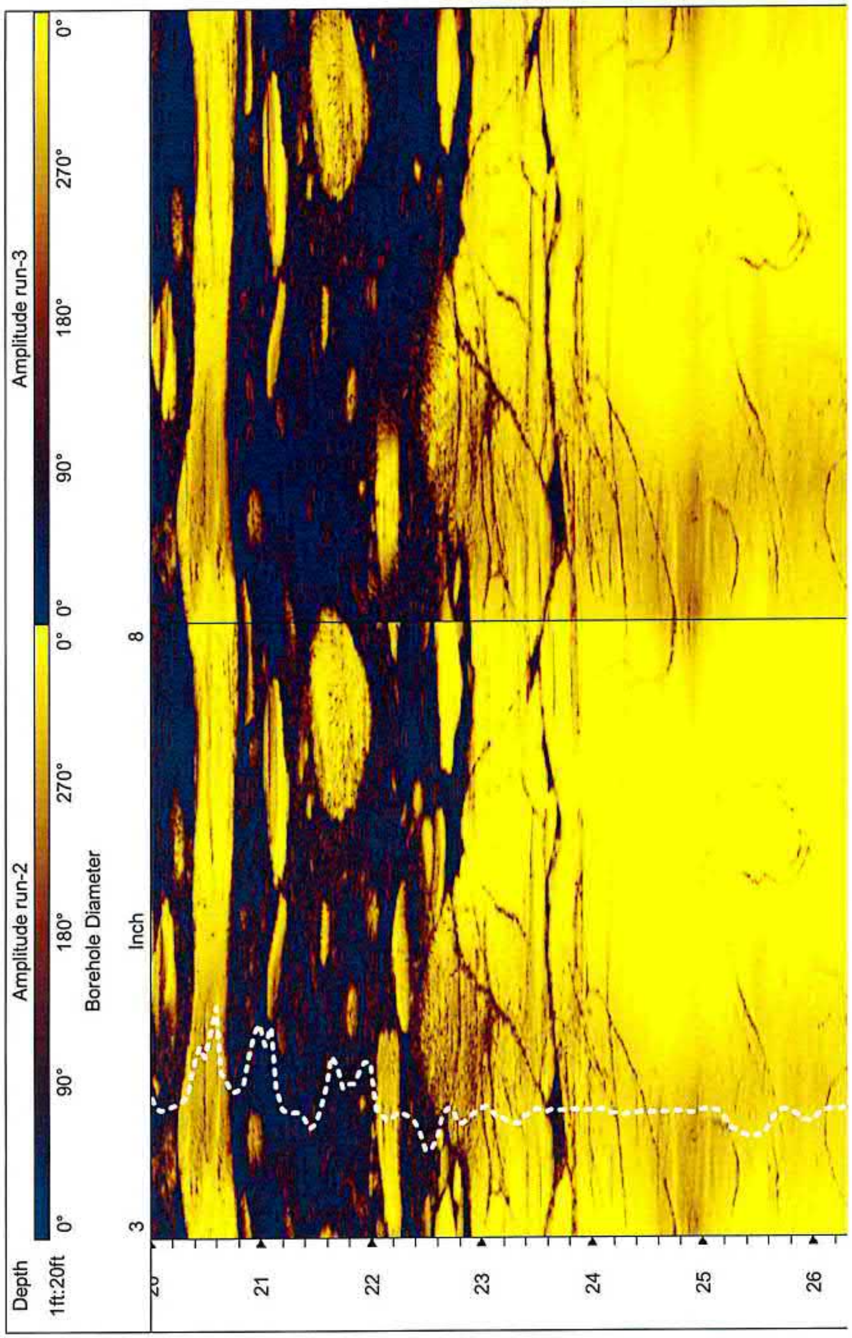
SEC TWP RGE

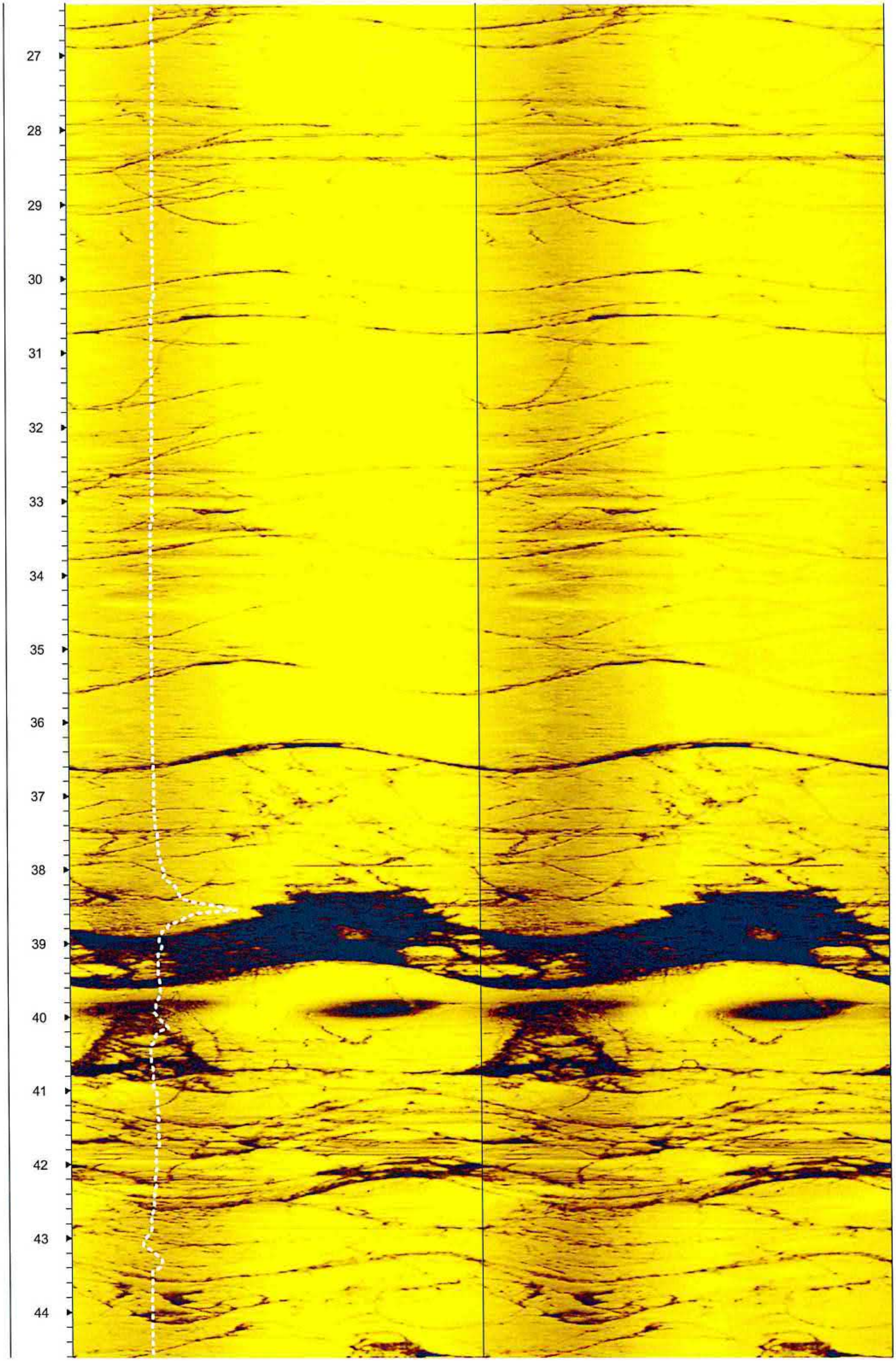
OTHER SERVICES

PERMANENT DATUM	GROUND SURFACE	ELEVATION	~2300' msl	K.B.
LOG MEAS. FROM	GROUND SURFACE	ABOVE PERM. DATUM		D.F.
DRILLING MEAS. FROM	GROUND SURFACE			G.L.

DATE	AUGUST 18, 2018	TYPE FLUID IN HOLE	
RUN No	RUNS 1 through 4	SALINITY	na
TYPE LOG	CALIPER AND BHTV (3)	DENSITY	
DEPTH-DRILLER	100	LEVEL	10
DEPTH-LOGGER	98.45	MAX. REC. TEMP.	na
BTM LOGGED INTERVAL	98.5		
TOP LOGGED INTERVAL	BHTV 18.06' BGS		
OPERATING RIG TIME	3		
RECORDED BY	W HENRICH		
WITNESSED BY	Tim VerdeVoorde		

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
1	4.25"	0	9 ft	4.25	Hwt	0	9
2	HQ 3.825"	9	100 ft				

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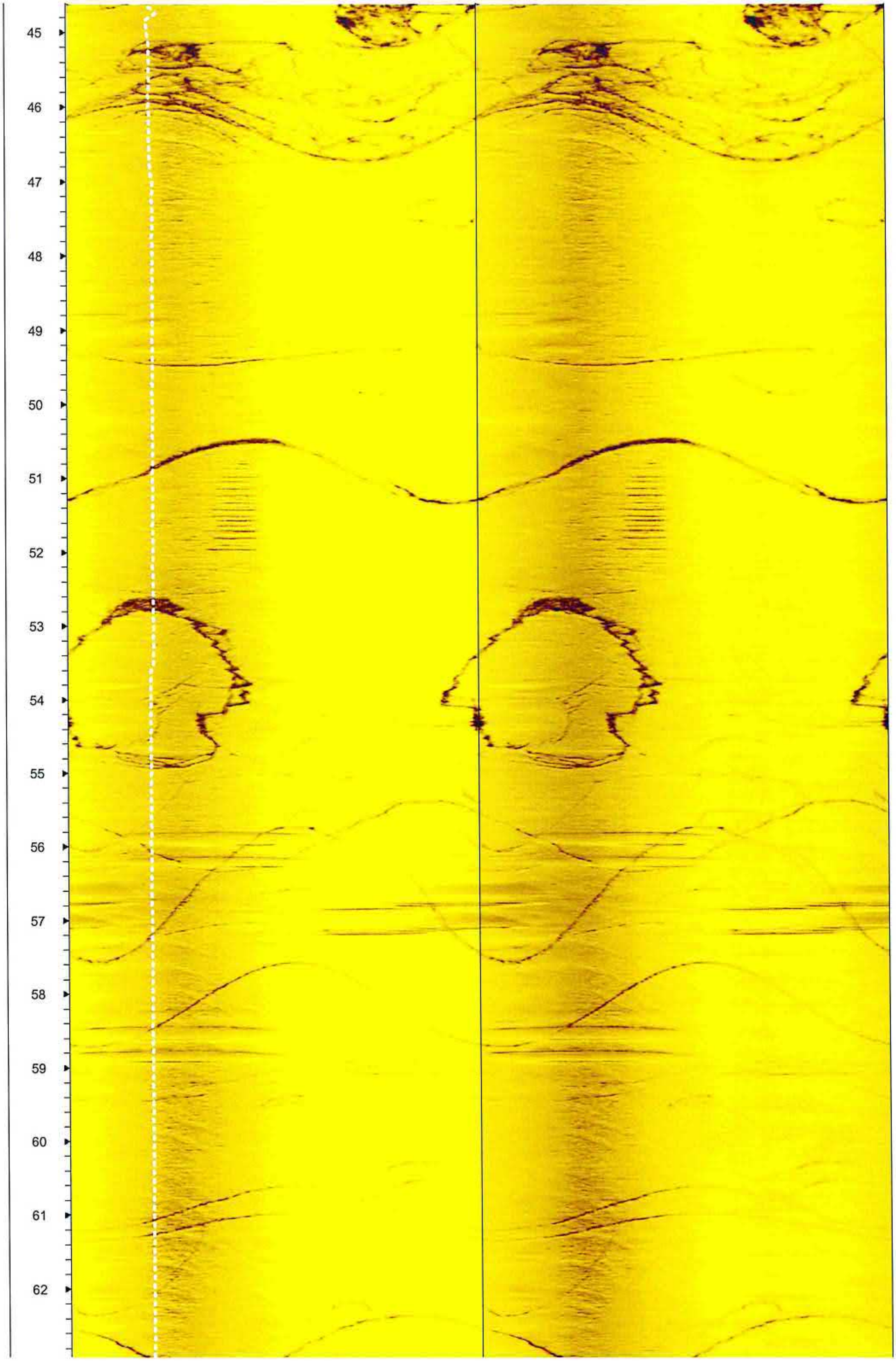
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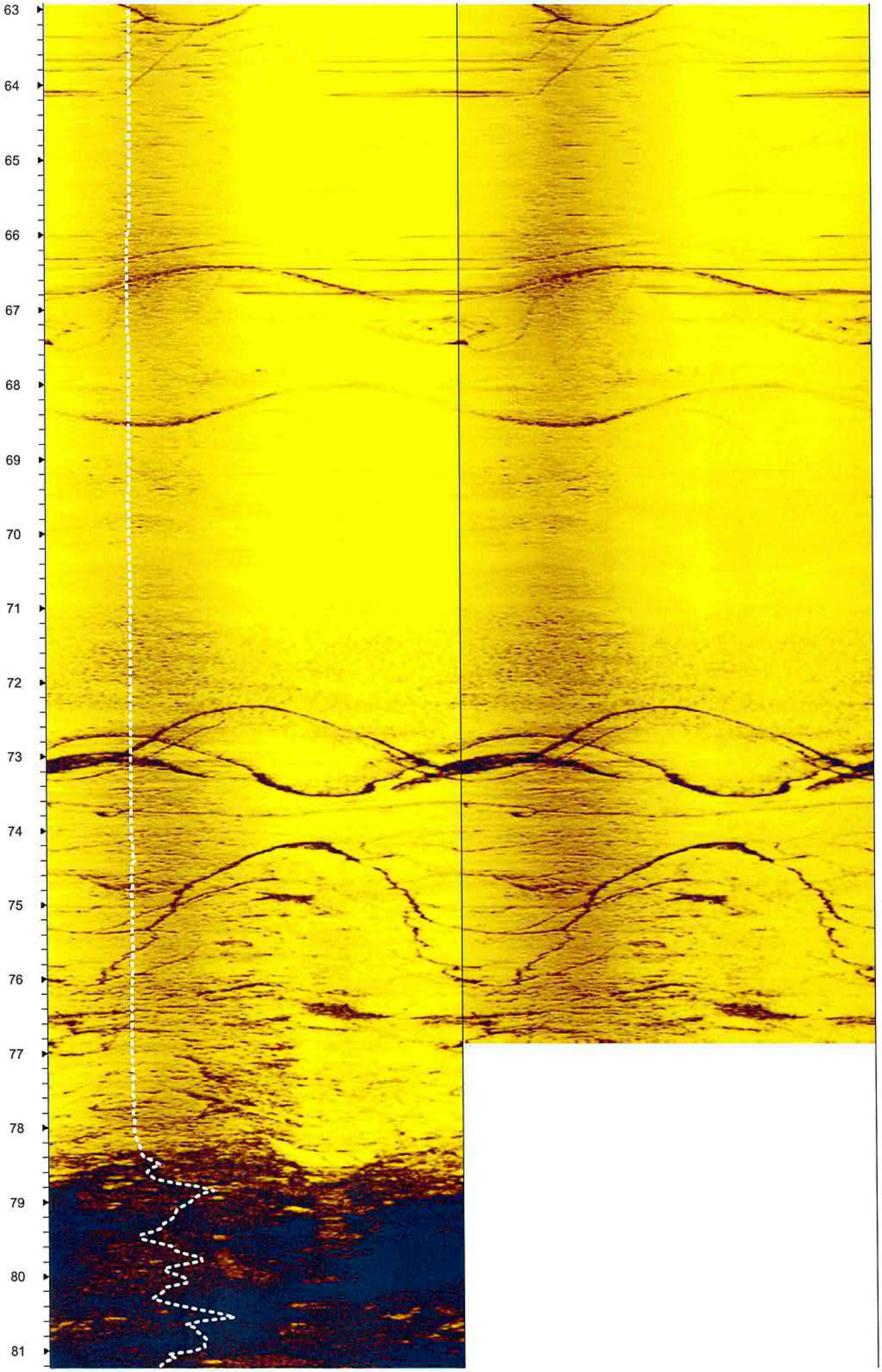
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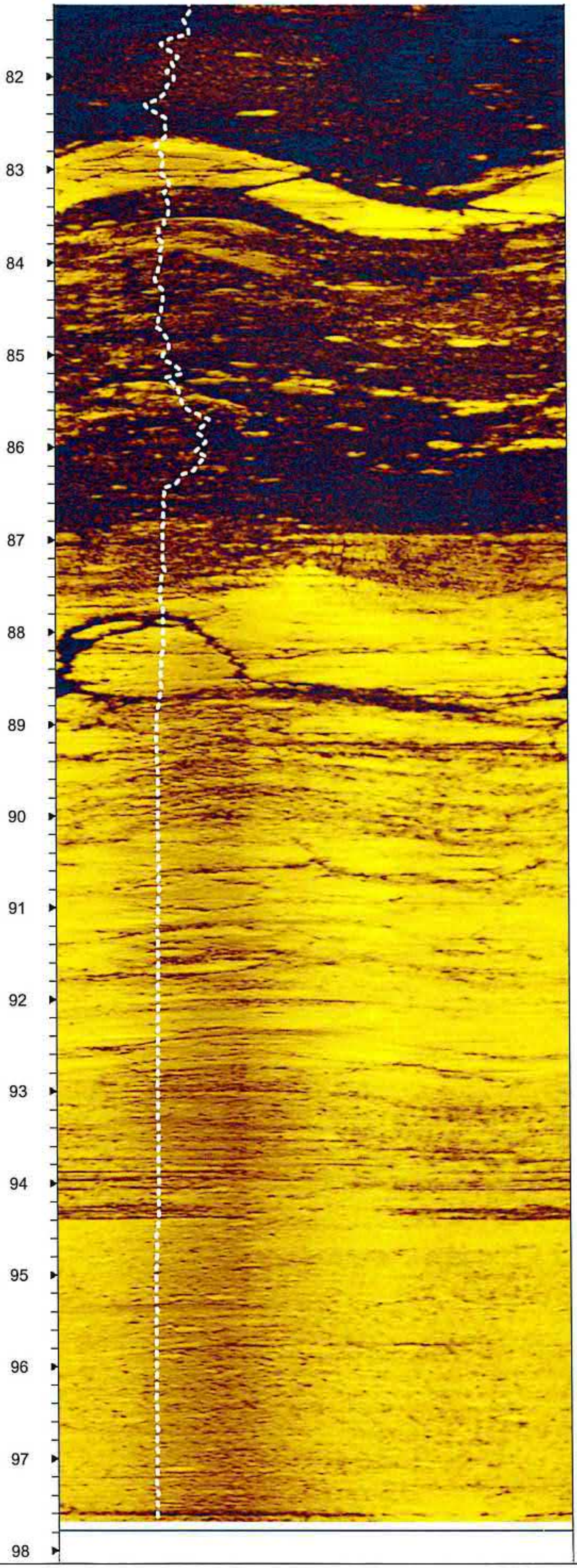
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Appendix C:

Televiewer Analysis Plot
Borehole B-206

NORCAL GEOPHYSICAL CONSULTANTS INC.
A Terracon COMPANY

TELEVIEWER ANALYSIS

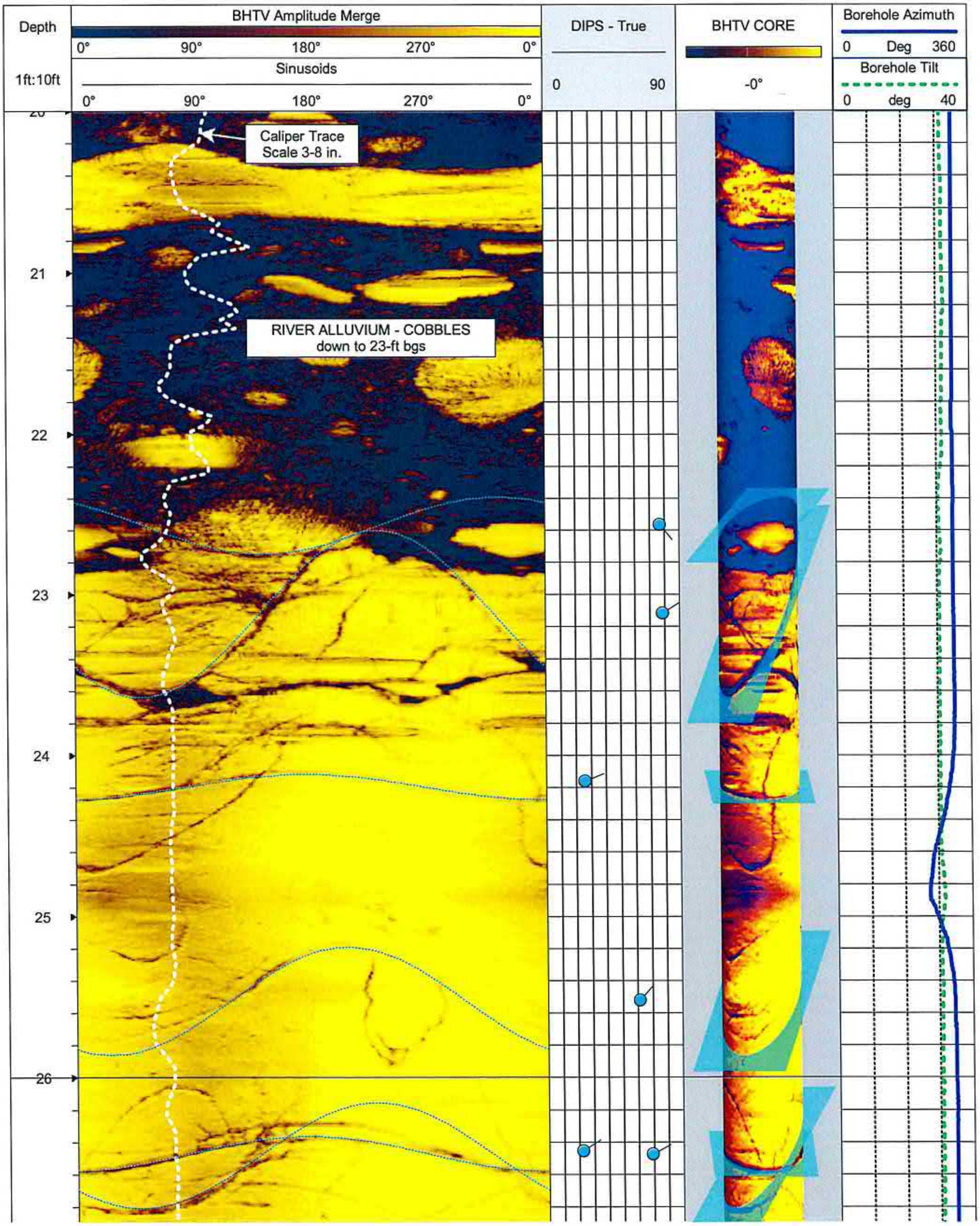
COMPANY: AECOM
WELL ID: B-206
FIELD: Iron Gate Reservoir
COUNTY: Siskiyou

DATE: 8-16-2018
CASING: Steel to 9 ft-bgs
JOB NO. NS185074
STATE: CA

NOTES:

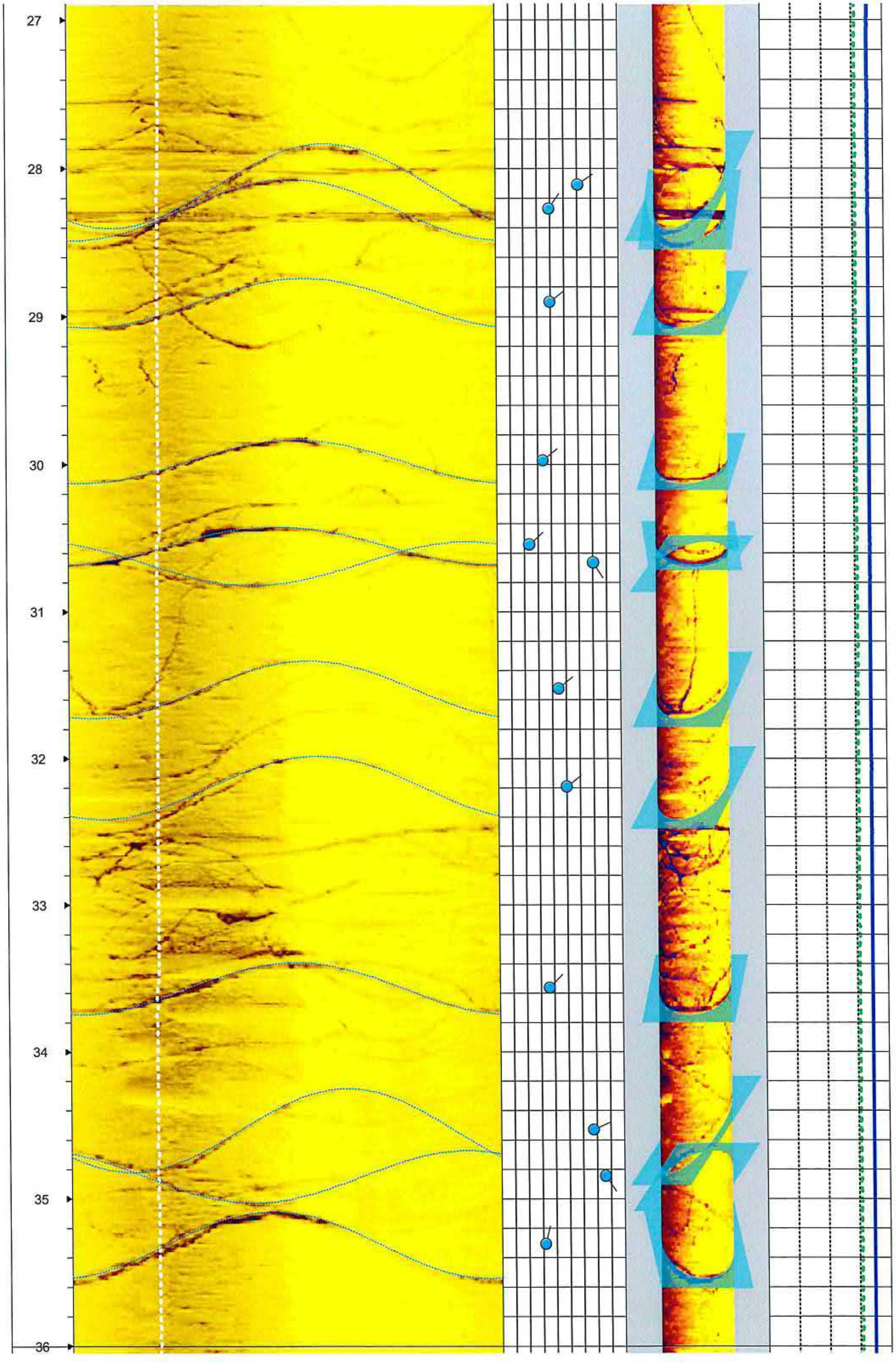
DISCONTINUITY LEGEND

Code	Tadpole	Sine Wave	Name
1	●	———	Open, continuous fracture
2	●	- - - - -	Thin, partial to continuous fracture
3	●	———	Lithologic contact



Caliper Trace
Scale 3-8 in.

RIVER ALLUVIUM - COBBLES
down to 23-ft bgs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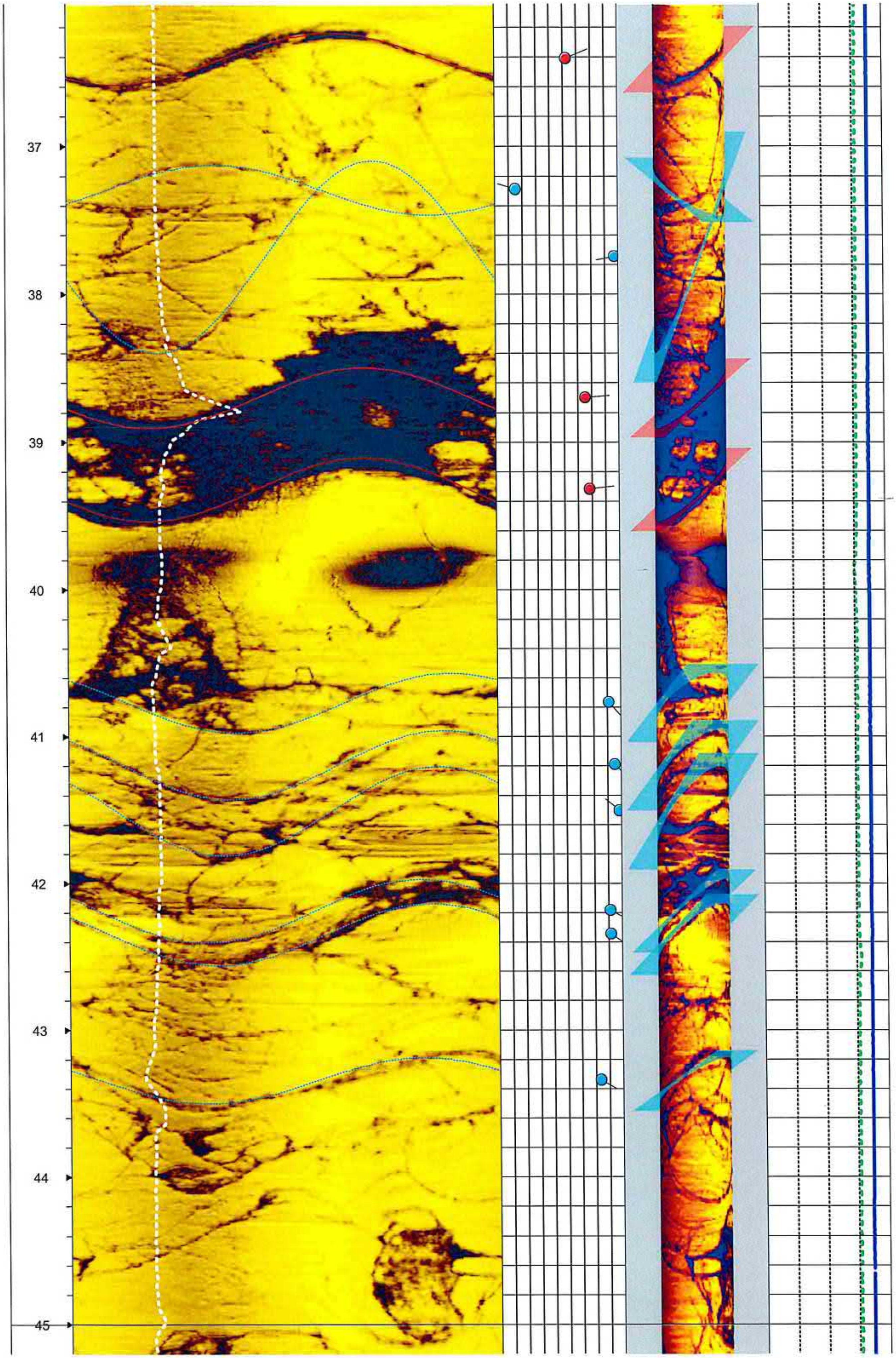
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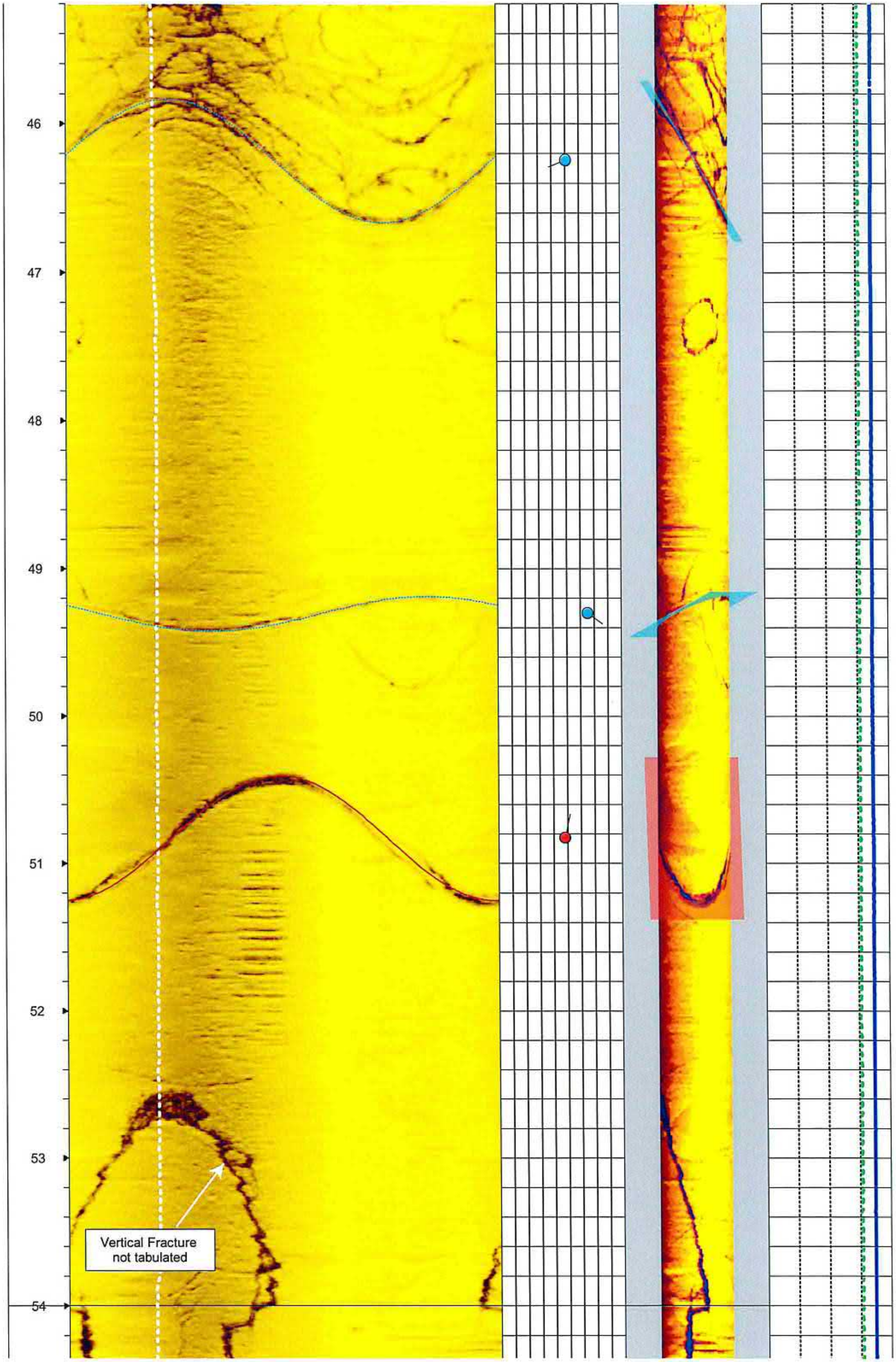
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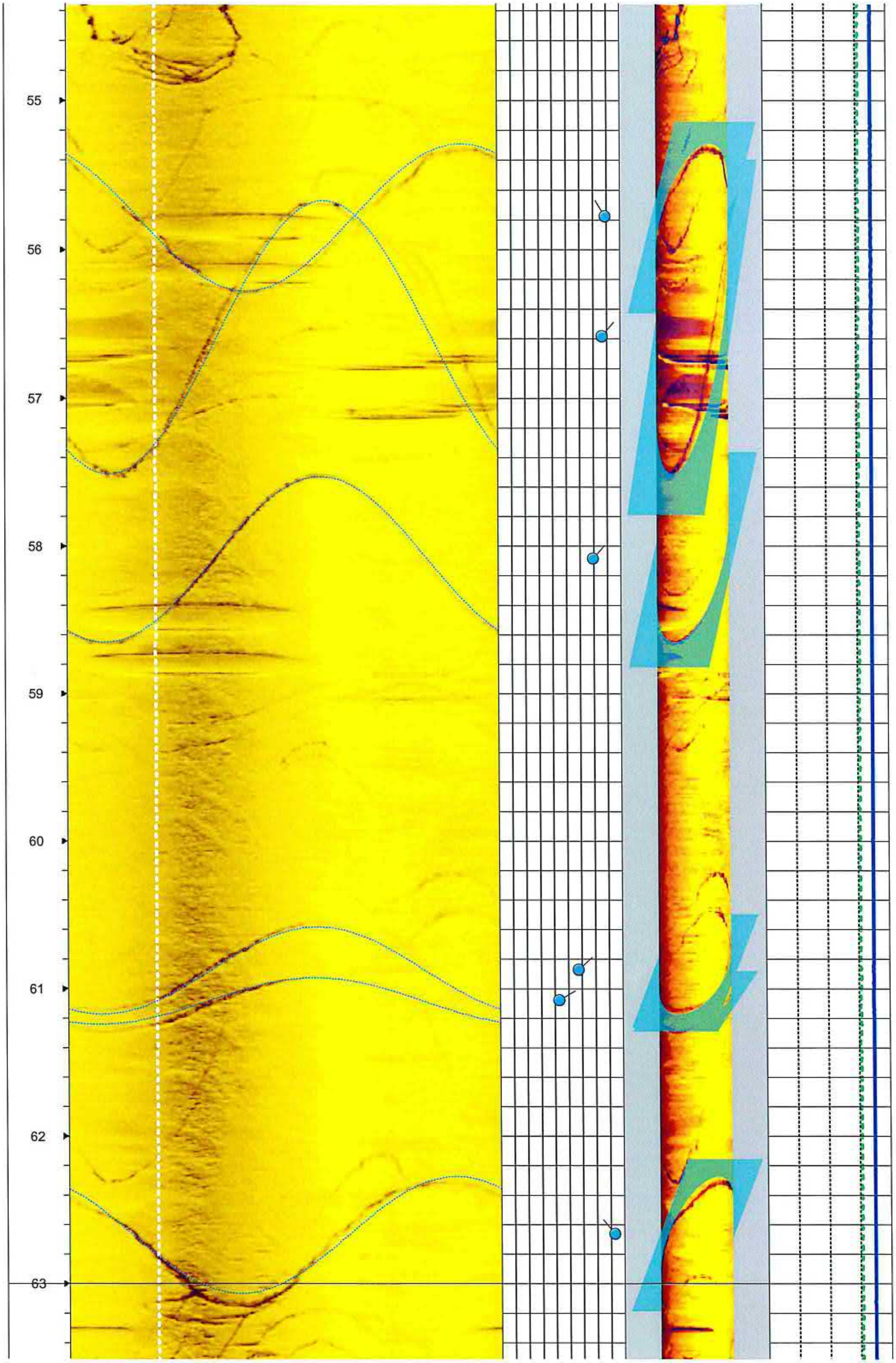
Vertical Fracture not tabulated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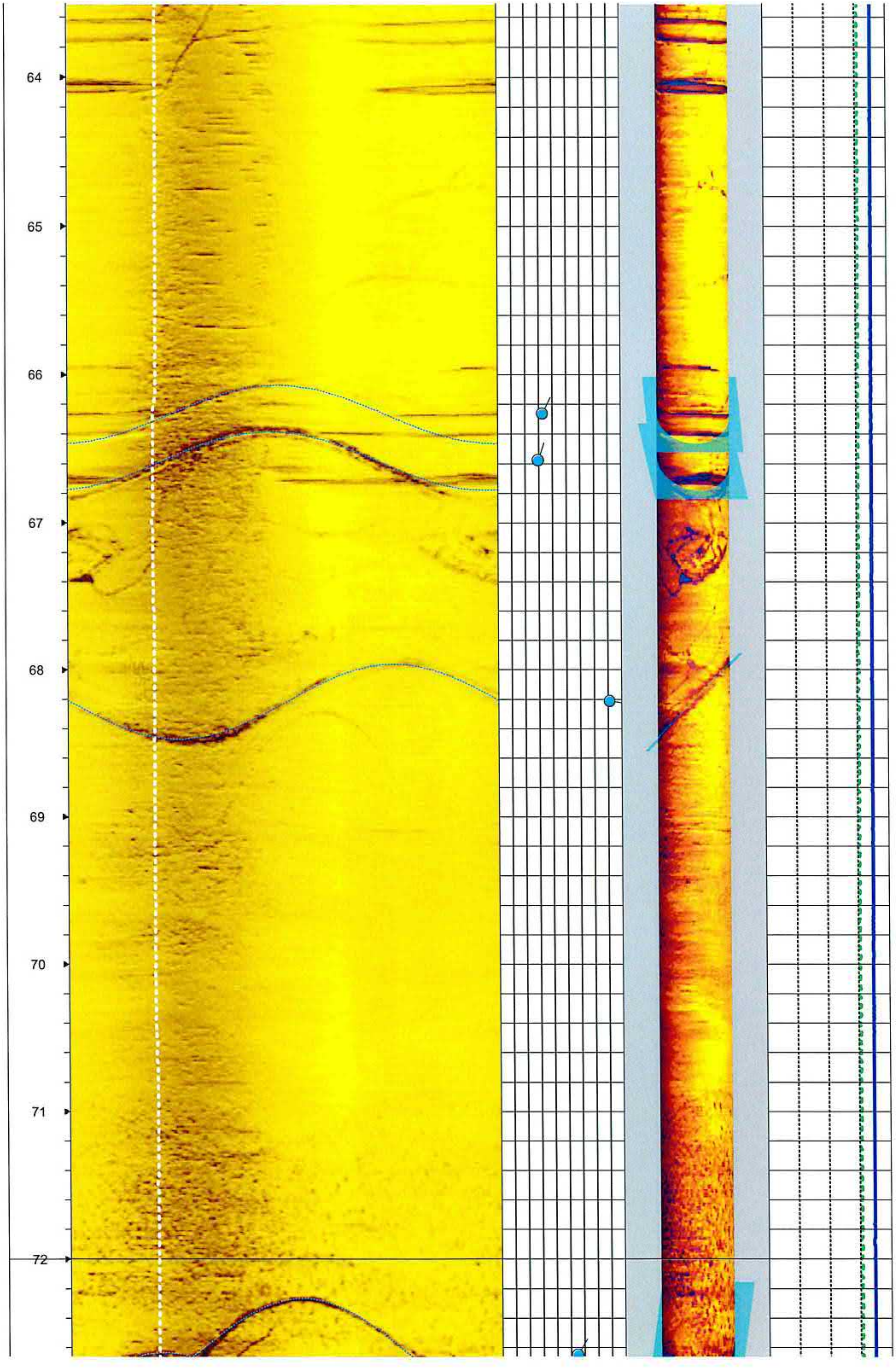
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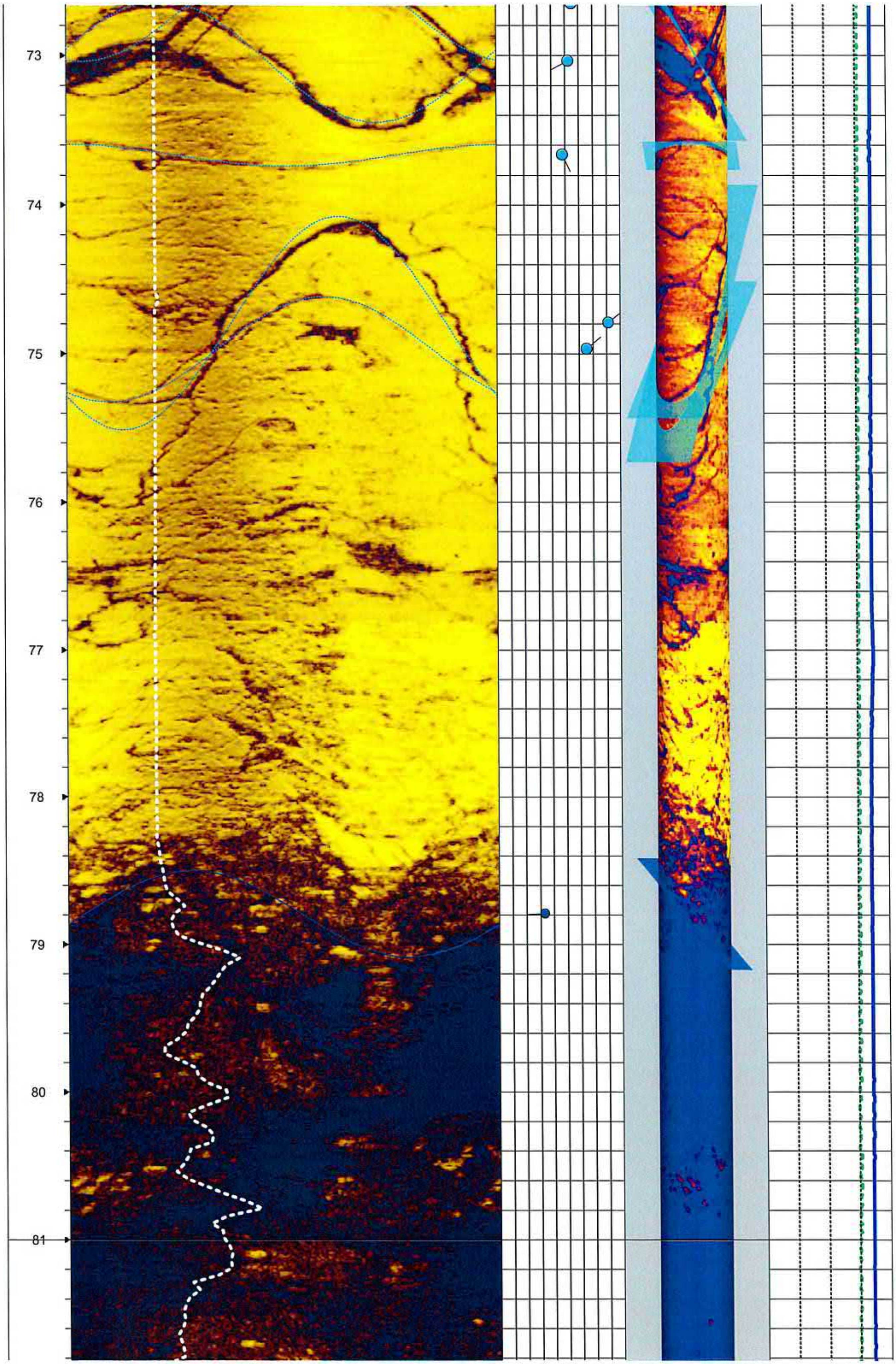
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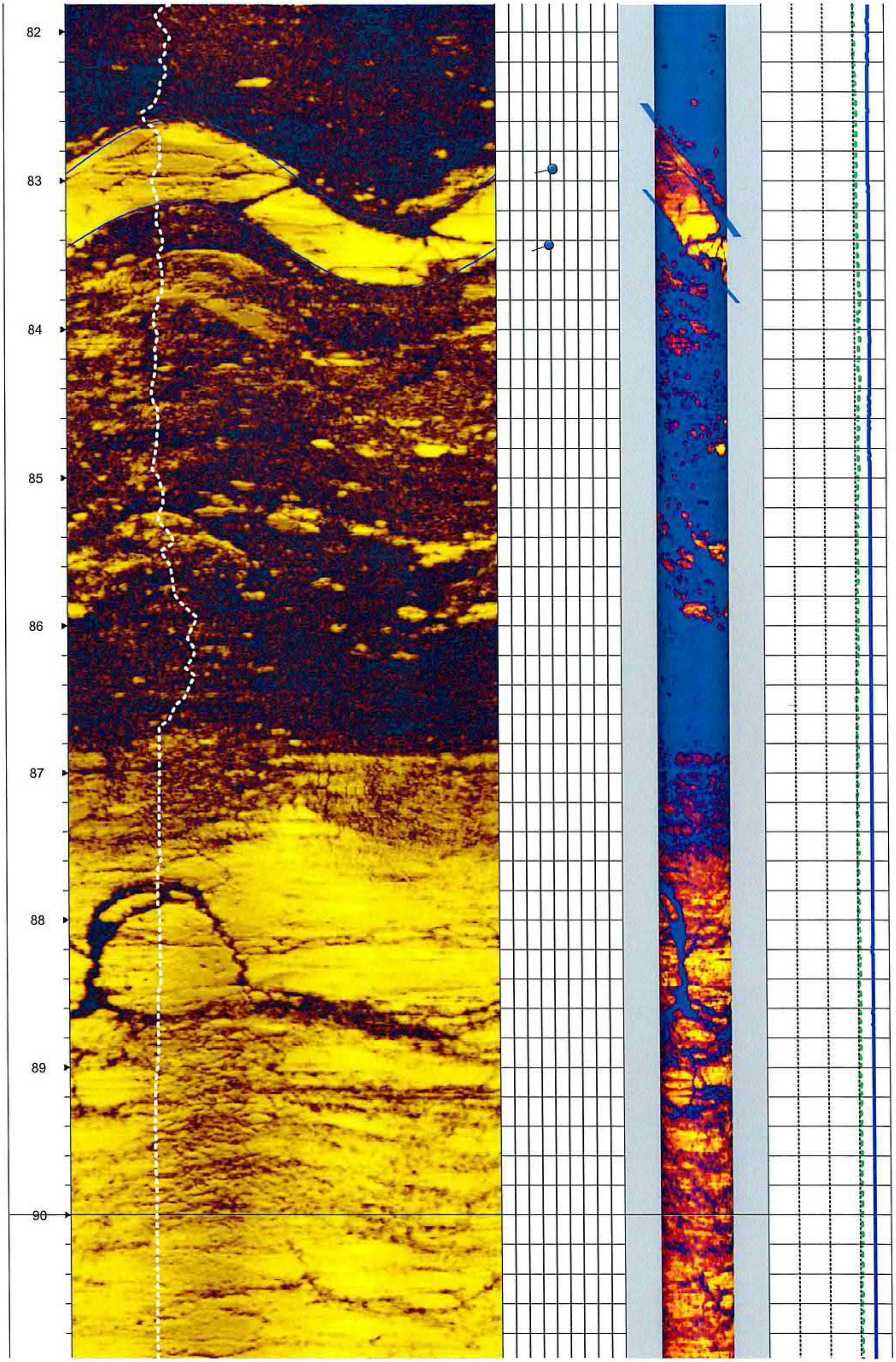
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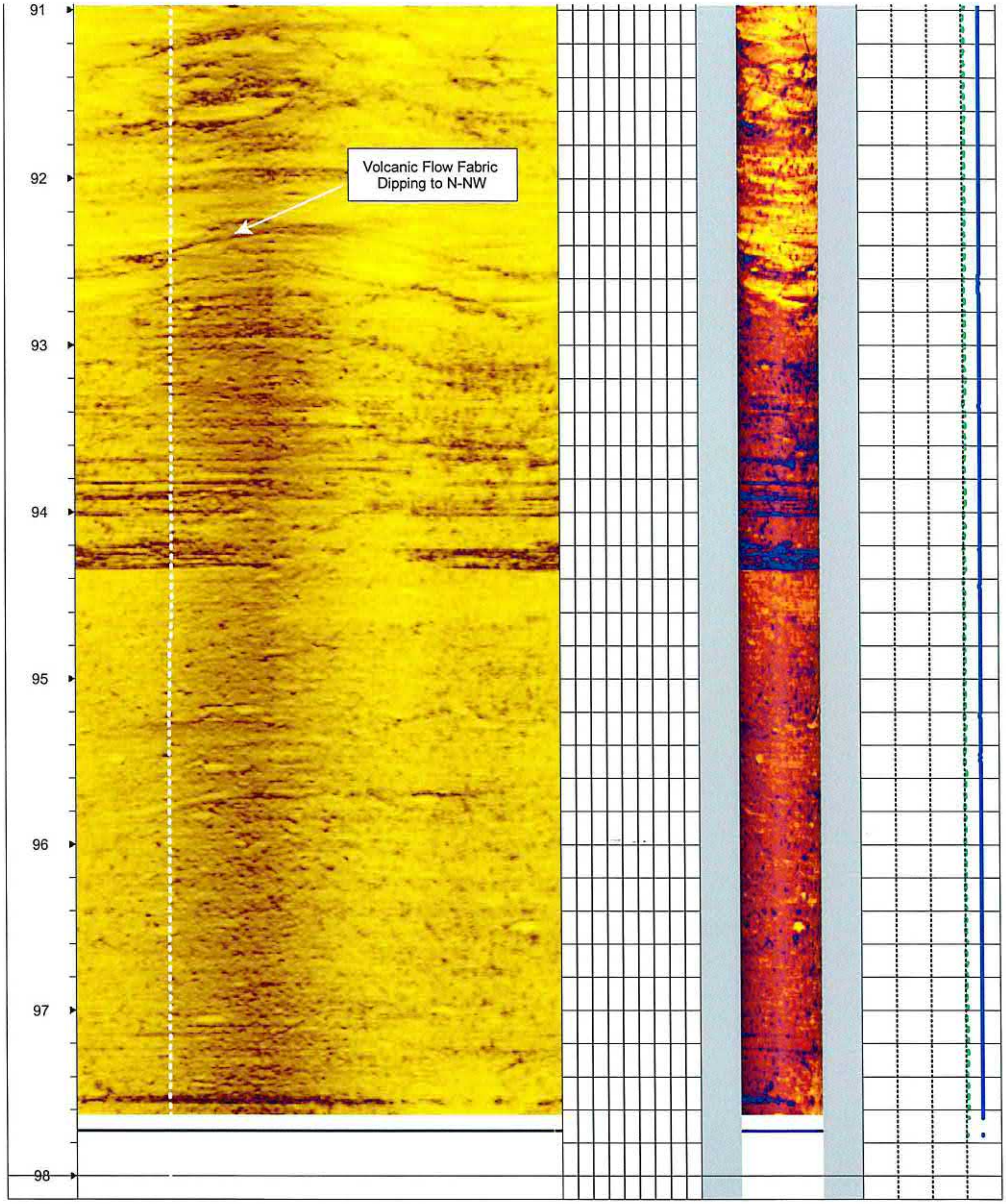
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Volcanic Flow Fabric Dipping to N-NW

Appendix D:

Discontinuity Table
Boreholes B-206

Borehole-B-206 Borehole Discontinuity Orientations from Televiewer Analysis
Klamath River Project, Siskiyou Co., CA
NORCAL JOB NO. NS185074

DISCONTINUITY LEGEND			
Code	Tadpole	Sine Wave	Name
1	●	———	Open, continuous fracture
2	●	- - - - -	Thin, partial to continuous fracture
3	●	———	Lithologic contact

Field work conducted in July, 2018				
Depth	Dip Azimuth	Dip Angle	Vein Thickness	Discontinuity Classification
ft	deg	deg	1/10 inches	(see Explanation)
22.57	140.32	76.75	na	2
23.12	58.29	78.68	na	2
24.16	67.97	25.98	na	2
25.52	42.73	61.45	na	2
26.46	57.25	22.54	na	2
26.48	62.09	69.06	na	2
28.11	53.72	60.46	na	2
28.27	35.86	39.18	na	2
28.9	52	39.62	na	2
29.97	51.76	33.87	na	2
30.54	46.92	23.86	na	2
30.67	148.32	70.68	na	2
31.53	49.6	44.6	na	2
32.19	52.06	49.96	na	2
33.56	43.07	36.46	na	2
34.53	65.47	67.69	na	2
34.85	146.65	76.34	na	2
35.31	13.66	32.06	na	2
36.41	68.13	52.28	na	1
37.29	286.06	15.36	na	2
37.74	258.54	87.17	na	2
38.7	85.98	65.14	0.47	1
39.32	82.73	68.45	0.34	1
40.77	138.04	81.09	na	2
41.19	134.45	85.46	na	2
41.51	309.75	88.64	na	2
42.19	118.19	81.57	na	2
42.35	126.15	81.88	na	2
43.34	120.37	73.78	na	2
46.25	249.1	50.56	na	2
49.3	124.62	65.04	na	2
50.83	11.82	48.04	na	1
55.78	328.96	79.19	na	2
56.58	41.25	76.59	na	2
58.08	41.73	69.34	na	2

60.87	46.4	57.42	na	2
61.08	59.22	43.18	na	2
62.66	321.44	82.92	na	2
66.26	26.68	32.79	na	2
66.58	18.98	29.74	na	2
68.21	99.31	81.31	na	2
72.65	29.26	54.98	na	2
73.03	242.35	52.54	na	2
73.66	155.6	48.28	na	2
74.79	53.08	81.3	na	2
74.97	50.2	65.09	na	2
78.79	266.85	33.13	na	3
82.92	257.8	41.65	na	3
83.43	251.52	38.95	na	3

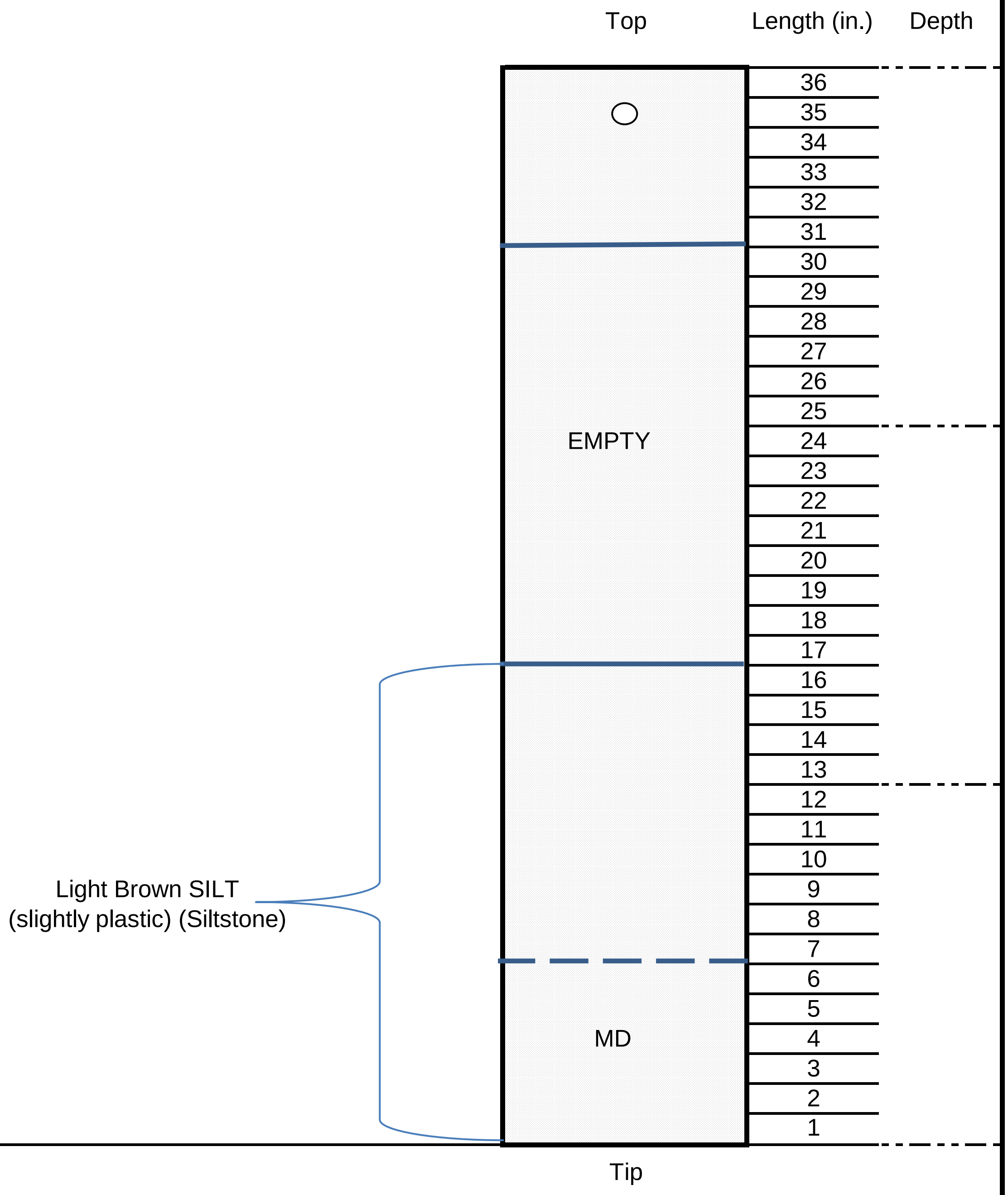
Note: "na" = true thickness of discontinuty aperture not determined

APPENDIX D LABORATORY TEST DATA

Log of Shelby Tube

CTL No.: 020-272
Company Name: AECOM
Project Name: Klamath River Dam
Project No.: 60537920
Boring: **BC-13**
Sample: **S03**
Depth (ft.): **17'**

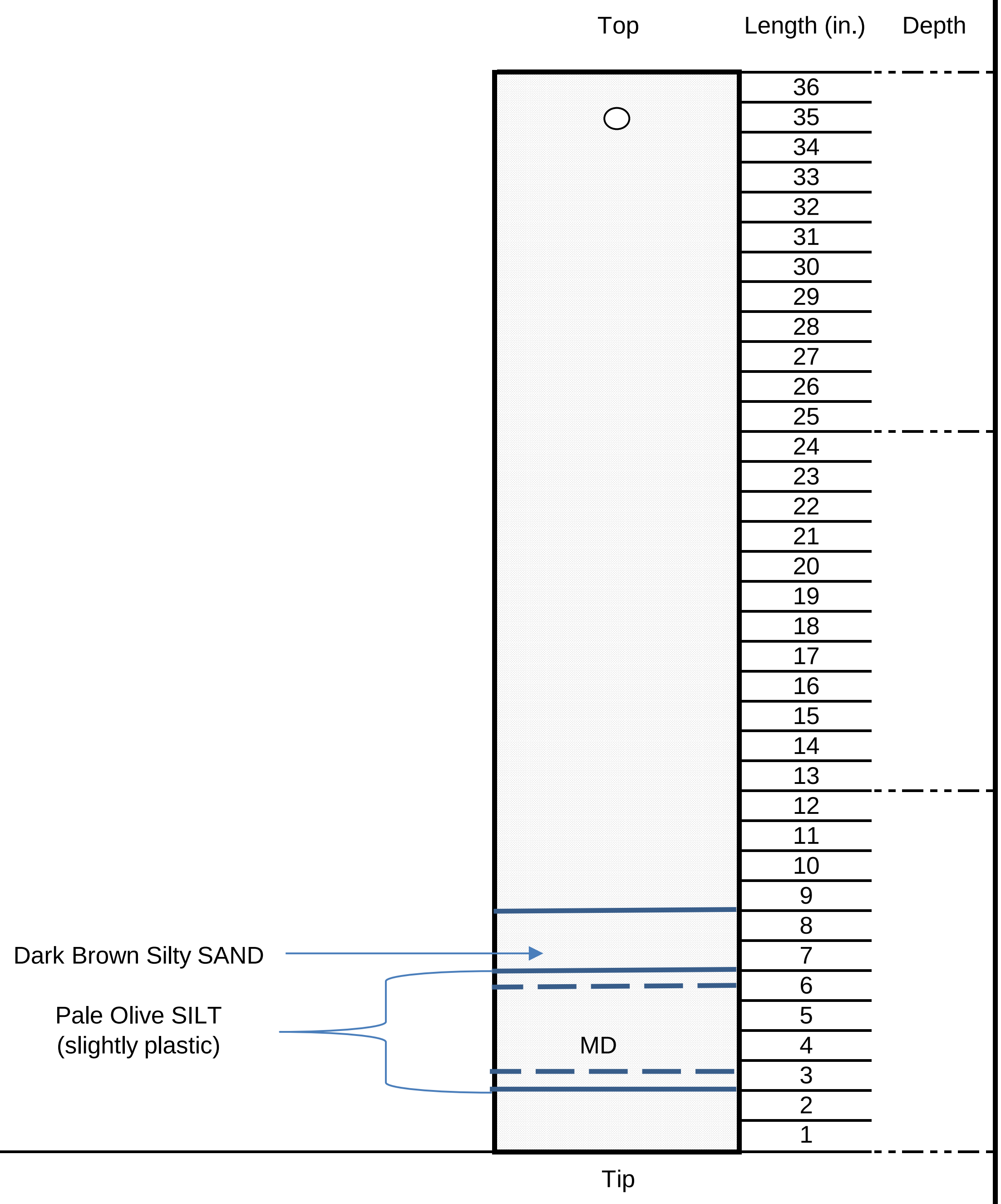
Date: 1/15/2019
Run By: MD
Reduced By: RU



NOTE: All descriptions are visual descriptions unless classification tests were performed on that portion of the tube. Dashed lines indicate zones where listed tests were performed.

Log of Shelby Tube

CTL No.: 020-272
Company Name: AECOM
Project Name: Klamath River Dam
Project No.: 60537920
Boring: **BC-13**
Sample: **S04**
Depth (ft.): **22'**
Date: 1/15/2019
Run By: MD
Reduced By: RU

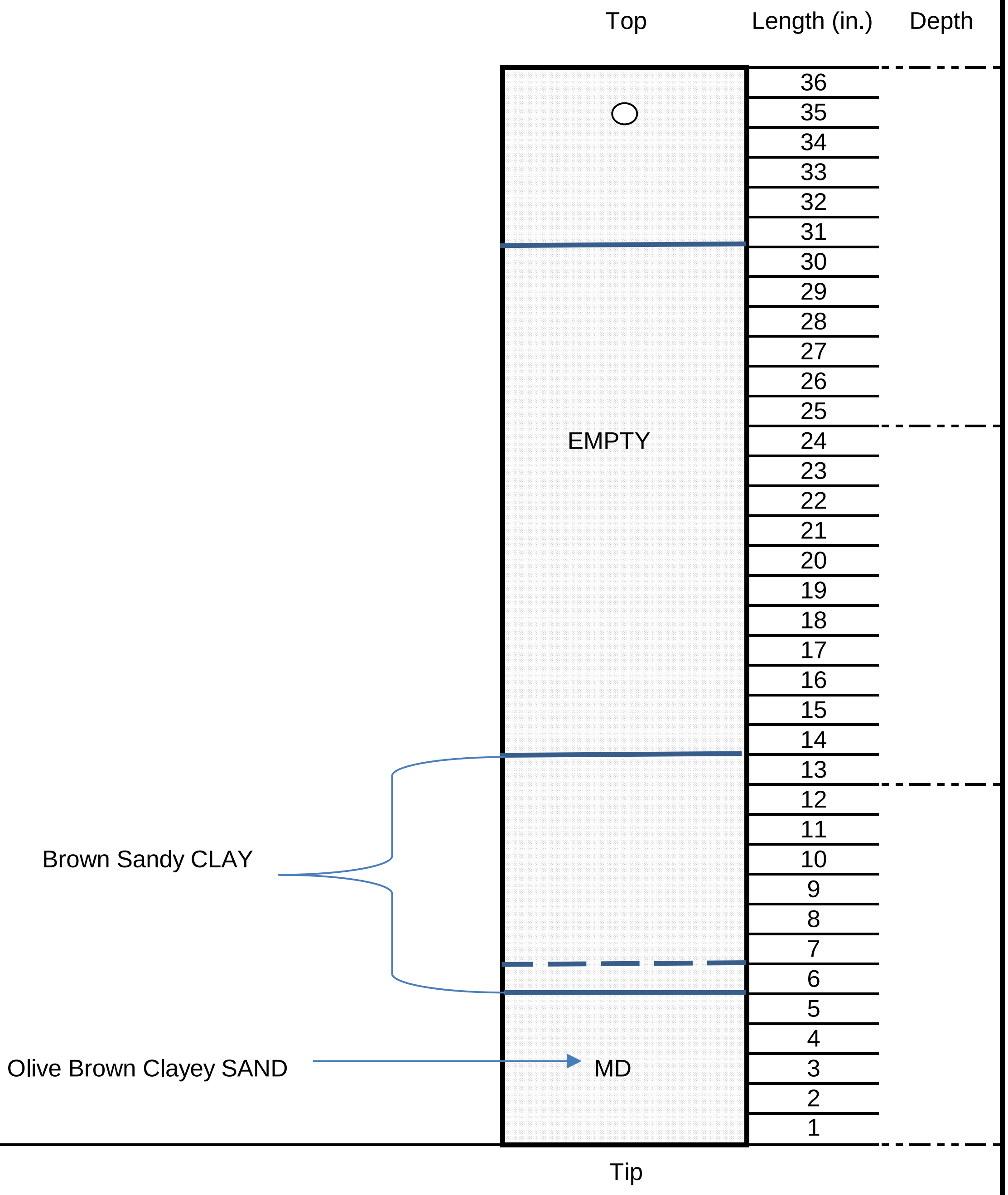


NOTE: All descriptions are visual descriptions unless classification tests were performed on that portion of the tube. Dashed lines indicate zones where listed tests were performed.

Log of Shelby Tube

CTL No.: 020-272
Company Name: AECOM
Project Name: Klamath River Dam
Project No.: 60537920
Boring: **BC-13** Sample: **S06** Depth (ft.): **40'**

Date: 1/15/2019
Run By: MD
Reduced By: RU



NOTE: All descriptions are visual descriptions unless classification tests were performed on that portion of the tube. Dashed lines indicate zones where listed tests were performed.

California State Certified Laboratory No. 2153

CERCO
analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 **462 2771** Fax. 925 **462 2775**
www.cercoanalytical.com

22 February, 2019

Job No. 1902023
Cust. No. 12259

Mr. John Hunt
Inspection Services Inc.
1798 University Avenue
Berkeley, CA 94703-1514

Subject: Project No.: 60537920
Project Name: Klamath River Dam Removal Project
Corrosivity Analysis – CalTrans Test Methods

Dear Mr. Hunt:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on February 05, 2019. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurements, Sample No.003 is classified as "severely corrosive" and the remaining samples are classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentrations reflect none detected with a reporting limit of 15 mg/kg.

The sulfate ion concentrations reflect none detected & 26 mg/kg and are determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at these locations.

The pH of the soils ranged from 7.84 to 8.97, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc. at (925) 927-6630.*

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.

J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Client: Inspection Services, Inc.
Client's Project No.: 60537920
Client's Project Name: Klamath River Dam Removal Project
Date Sampled: 1-Feb-19
Date Received: 5-Feb-19
Matrix: Soil
Authorization: Signed Chain of Custody

Date of Report: 22-Feb-2019

Job/Sample No.	Sample I.D.	Moisture (%)	pH	Min.Resistivity (ohms-cm)**	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
1902023-001	B-6, S-01 @ 5-6.5'	-	8.97	840	-	N.D.	N.D.
1902023-002	B-19, S-01 & S-02 @ 5-11.5'	-	7.97	980	-	N.D.	26
1902023-003	B-20, S-01 & S-02 @ 5-11.5'	-	7.84	470	-	N.D.	N.D.

Method:	CT 226 (a)	CT 643 (b)	CT 643 (b)	-	CT 422 (c)	CT 417 (c)
Reporting Limit:	-	-	-	50	15	15
Date Analyzed:	-	8-Feb-2019	14-Feb-2019 & 19-Feb-2019	-	8-Feb-2019	8-Feb-2019

* Results Reported on an "As Received" Basis

N.D. - None Detected

(a) Rev. July 2010 (b) Rev. June 2007 (c) Rev. November 2006

Cheryl McMillen
Laboratory Director

<u>Quality Control Summary</u> - All laboratory quality control parameters were found to be within established limits

Chain of Custody

1100 Willow Pass Court
Concord, CA 94520-1006
925 462 2771
Fax: 925 462 2775
CERCO analytica

Page of

Job No. 1902093
CU# 12259
Client Project I.D. 60537920

Schedule
Analyte CalTrans w/Brief Evalation

Date Sampled
Date Due

Full Name John Hunt
Fax
Phone
Company IST Berkeley
Cell 510-809-5130 ☒
Sample Source Klamath River Dam Removal Project

ANALYSIS

Lab No.	Sample I.D.	Date	Time	Matrix	Contain.	Size	Preserv.	Qty.	pH	Sulfate	Chloride	Resistivity-Minimum	Brief Evaluation
001	B-6 S-01 5-6.5'	2-1				Baggie			x	x	x	x	X
002	B-19 S-01 5-11.5' S-02	2-1				baggie			X	X	X	X	X
003	B-20 S-01 5-11.5' S-02	2-1				Baggie			X	X	X	X	X

MATRIX
DW - Drinking Water
GW - Ground Water
SW - Surface Water
WW - Waste Water
Water
SL - Sludge
S - Soil
Product

ABBREVIATIONS
HB - Hosebib
PV - Petcock Valve
PT - Pressure Tank
PH - Pump House
RR - Restroom
GL - Glass
PL - Plastic
ST - Sterile

SAMPLE RECEIPT
Total No. of Containers
Rec'd Good Cond/Cold
Conforms to Record
Temp. a t Lab -°C
Sampler

Relinquished By: Date 2/5/19 Time 1213
Received By: Date 2/5/19 Time 1213
Relinquished By: Date Time
Received By: Date Time
Relinquished By: Date Time
Received By: Date Time

Comments:
THERE IS AN ADDITIONAL CHARGE FOR METAL/POLY TUBES

jhunt@inspectionservices.net

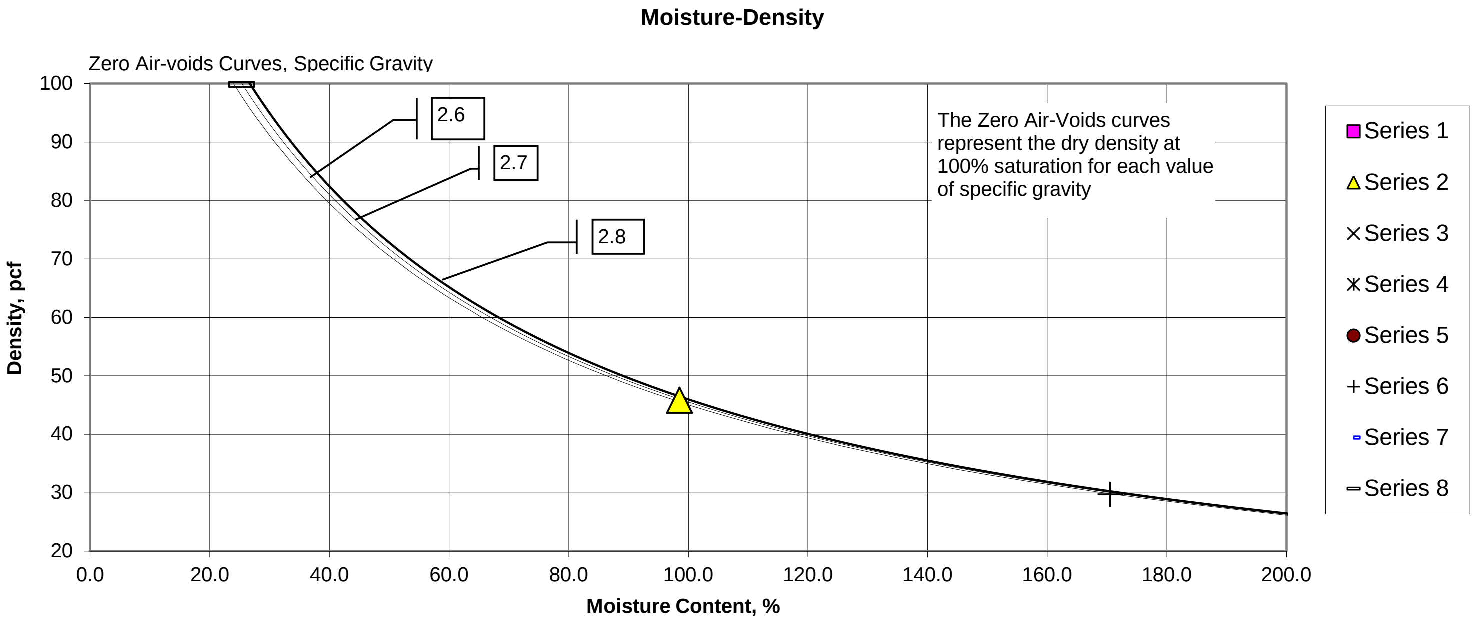
COOPER
TESTING LABORATORY

Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 020-251a
Project No. 60537920
By: RU
Client: AECOM
Date: 06/13/18
Project Name: Klamath River Dam Removal Project
Remarks:

Boring:	BC-01	BC-01	BC-01	BC-02	BC-02	BC-02	BC-03	BC-03
Sample:	S-02	S-03	S04	S05	S09	S10	S-01	S-02
Depth, ft:	6.5	12.5-13	21.5	14.5	44.5	54.8-55.3	1	5.5-6.0
Visual Description:	Dark Olive Gray Sandy SILT	Light Yellowish Brown Sandy CLAY	Gray Elastic SILT	Gray Elastic SILT	Gray Elastic SILT	Black CLAY	Dark Olive Brown Sandy Lean CLAY	Dark Olive Brown Sandy CLAY w/ Gravel
Actual G_s								
Assumed G_s		2.70				2.70		2.70
Moisture, %	43.1	98.6	92.9	83.7	177.8	170.6	34.7	25.4
Wet Unit wt, pcf		91.0				80.3		125.2
Dry Unit wt, pcf		45.8				29.7		99.9
Dry Bulk Dens.pb, (g/cc)		0.73				0.48		1.60
Saturation, %		99.3				98.3		99.4
Total Porosity, %		72.8				82.4		40.8
Volumetric Water Cont,Өw,%		72.3				81.0		40.6
Volumetric Air Cont., Өa,%		0.5				1.4		0.2
Void Ratio		2.68				4.68		0.69
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.



Moisture-Density-Porosity Report

Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 020-251b **Project No.** 60537920 **By:** RU

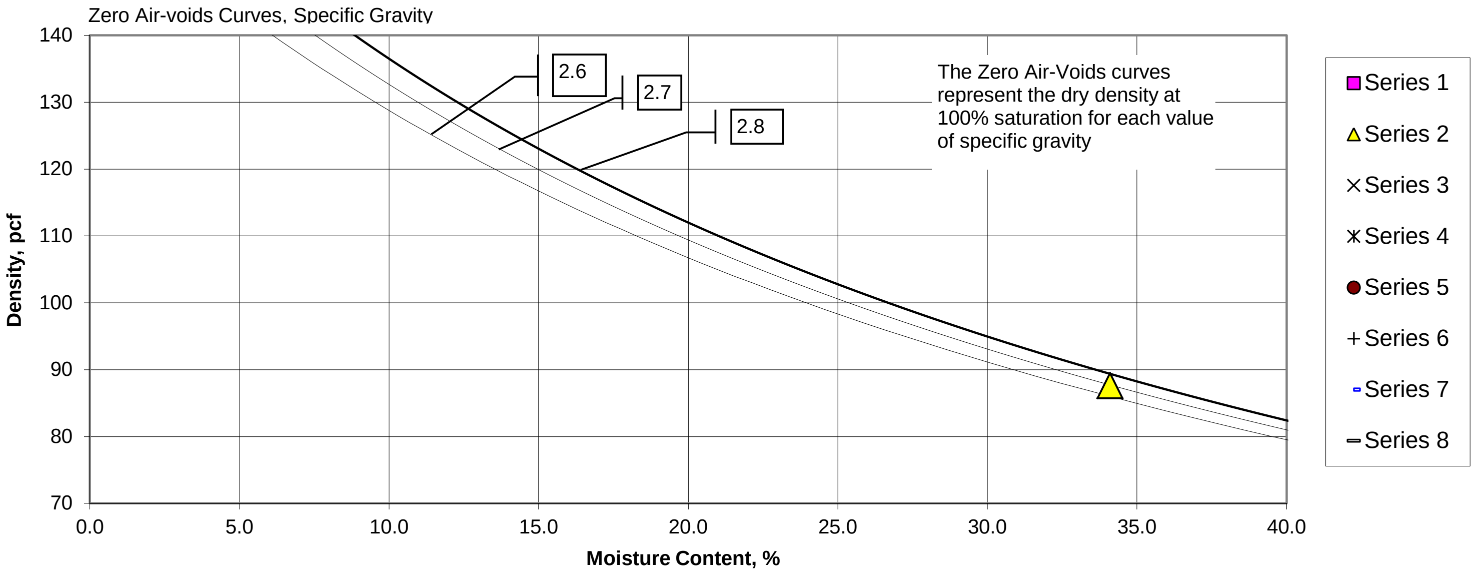
Client: AECOM **Date:** 06/13/18

Project Name: Klamath River Dam Removal Project **Remarks:**

Boring: **Sample:** **Depth, ft:**	BC-03 S05 24.5	BC-07 S-02 4-4.5	BC-08 S-01 3	BC-08A S05 54	BI-02 S1 5	BI-02 S2 10	BI-02 S3 15	BI-03 S-1 3.5
Visual Description:	Light Olive Brown Elastic SILT	Very Dark Olive Brown Sandy Fat CLAY w/ Gravel	Dark Reddish Brown Sandy Fat CLAY	Light Olive Brown Elastic SILT	Dark Reddish Brown Sandy Fat CLAY	Yellowish Brown Sandy Fat CLAY	Yellowish Brown Sandy Fat CLAY	Olive Gray Poorly Graded GRAVEL w/ Silt & Sand
Actual G_s								
Assumed G_s		2.70						
Moisture, %	80.3	34.1	31.4	178.6	27.8	28.7	38.4	12.0
Wet Unit wt, pcf		117.5						
Dry Unit wt, pcf		87.6						
Dry Bulk Dens.pb, (g/cc)		1.40						
Saturation, %		99.5						
Total Porosity, %		48.1						
Volumetric Water Cont,Θw,%		47.8						
Volumetric Air Cont., Θa,%		0.2						
Void Ratio		0.93						
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

Moisture-Density

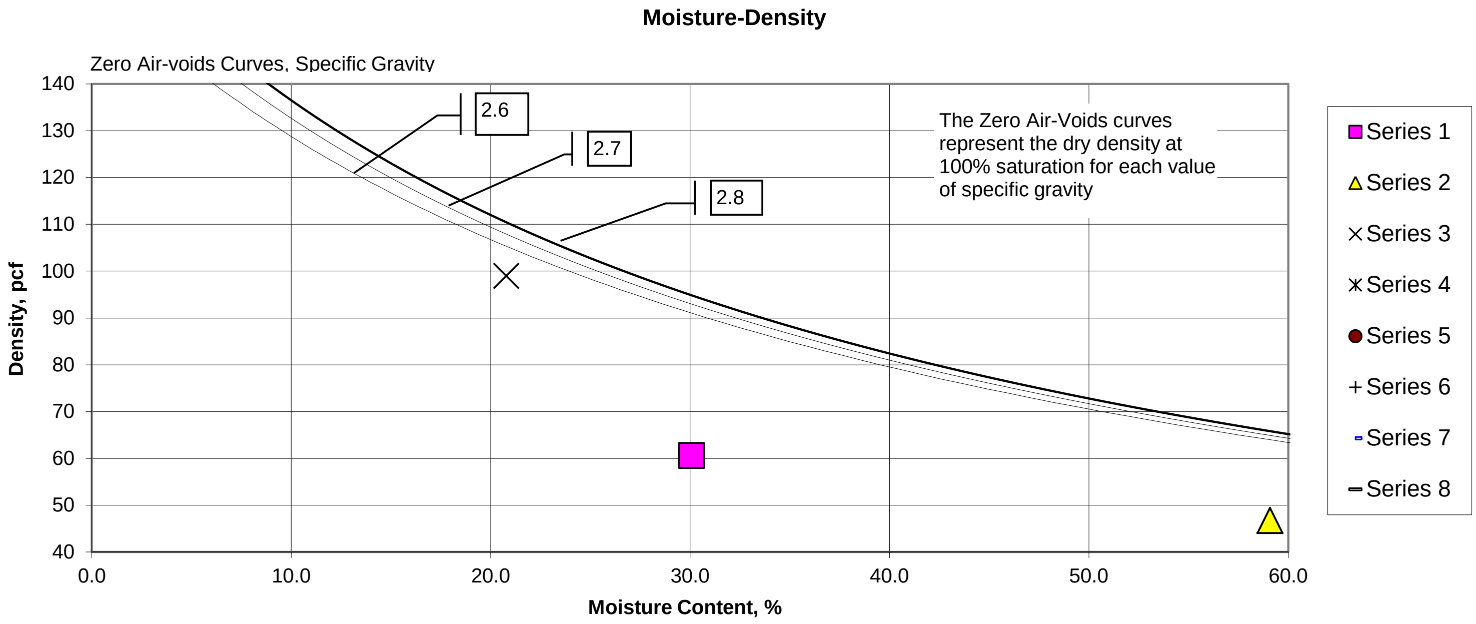


Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 020-272
Project No. 60537920
By: RU
Client: AECOM
Date: 01/18/19
Project Name: Klamath
Remarks:

Boring:	BC-13	BC-13	BC-13					
Sample:	S03	S04	S06					
Depth, ft:	17	22	40					
Visual Description:	Light Brown SILT (Siltstone) (slightly plastic)	Pale Olive SILT (slightly plastic)	Olive Brown Clayey SAND					
Actual G_s								
Assumed G_s	2.70	2.70	2.70					
Moisture, %	30.1	59.1	20.8					
Wet Unit wt, pcf	78.8	74.4	119.6					
Dry Unit wt, pcf	60.6	46.8	99.0					
Dry Bulk Dens.pb, (g/cc)	0.97	0.75	1.59					
Saturation, %	45.5	61.2	79.7					
Total Porosity, %	64.1	72.3	41.3					
Volumetric Water Cont,Θw,%	29.2	44.2	32.9					
Volumetric Air Cont., Θa,%	34.9	28.0	8.4					
Void Ratio	1.79	2.61	0.70					
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.

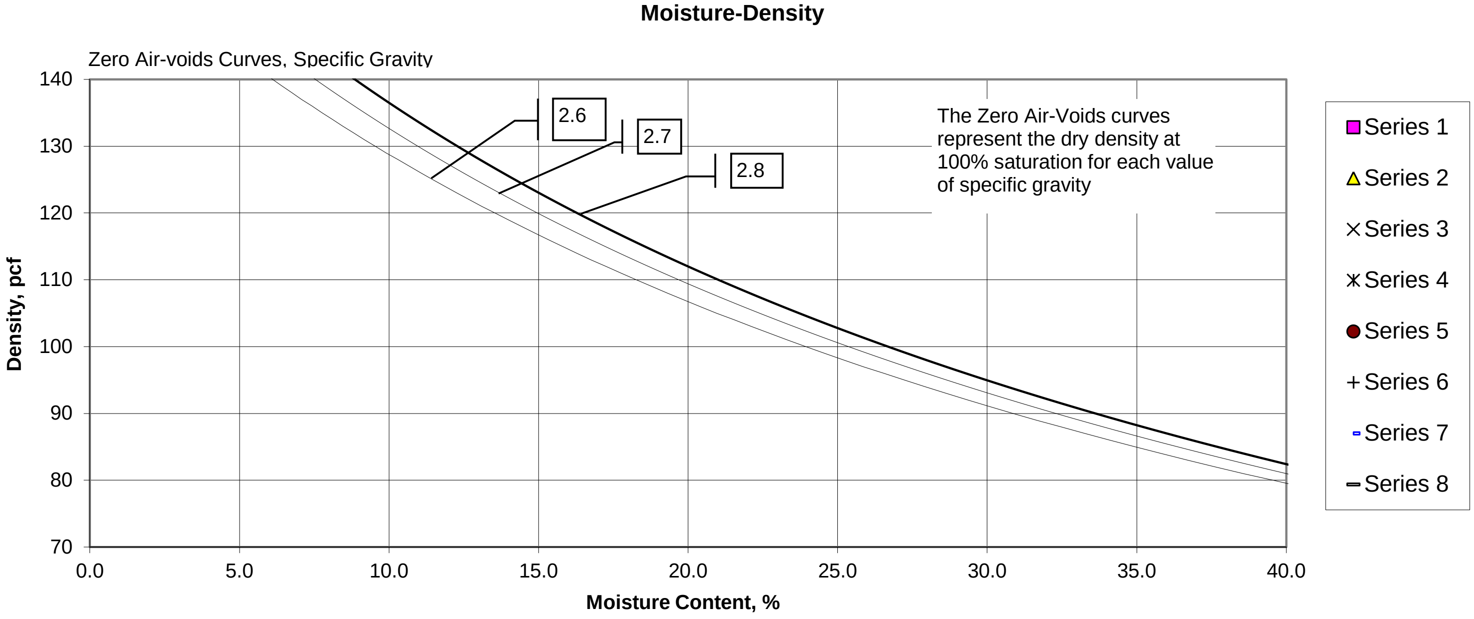


Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 020-251b **Project No.** 60537920 **By:** RU
Client: AECOM **Date:** 06/13/18
Project Name: Klamath River Dam Removal Project **Remarks:**

Boring:					BI-02	BI-02	BI-02	BI-03
Sample:					S1	S2	S3	S-1
Depth, ft:					5	10	15	3.5
Visual Description:					Dark Reddish Brown Sandy Fat CLAY	Yellowish Brown Sandy Fat CLAY	Yellowish Brown Sandy Fat CLAY	Olive Gray Poorly Graded GRAVEL w/ Silt & Sand
Actual G_s								
Assumed G_s								
Moisture, %					27.8	28.7	38.4	12.0
Wet Unit wt, pcf								
Dry Unit wt, pcf								
Dry Bulk Dens.pb, (g/cc)								
Saturation, %								
Total Porosity, %								
Volumetric Water Cont,Θw,%								
Volumetric Air Cont., Θa,%								
Void Ratio								
Series					1	2	3	4

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.



MOISTURE & DENSITY TEST

Client : AECOM

Project : Klamath River Dam Removal Project

ISI Lab No.: G-63174

Job no : 60537920

Boring #	B-2	B-4	B-5	B-6	B-6	B-6	B-6	B-6
Sample #	S-01	S-01	S-02	S-02	S-03	S-04	S-05	S-06
Depth (ft.)	27-27.5	5-6.5	7.5-9	10-11.5	15-16.5	30-31.5	40-41.5	45-46.5
Soil type: (visual)	Gray silty sand with gravel	Grayish brown sandy clay with gravel	Grayish brown clayey gravel with sand	Grayish brown silty sand with organics	Dark gray clayey sand	Reddish brown clayey gravel with sand	Grayish brown gravel with sand	Gray gravel
1. Date tested:	01/23/19	01/26/19	01/26/19	01/23/19	01/26/19	01/26/19	01/26/19	01/26/19
2. Tested by:	JH	JH	JH	JH	JH	JH	JH	JH
3. Specimen height (in.)		5.17		5.37		5.98		
4. Wt. of specimen + tare (gm)		805.91		824.75		1173.34		
5. Tare wt. (gm)		0.00		206.10		203.70		
6. Diameter (in.)		2.42		2.42		2.42		
7. Wet wt. of soil + dish wt. (gm)	1157.51	1002.84	453.90	446.32	384.60	1323.52	974.35	825.39
8. Dry wt. of soil + dish wt. (gm)	1032.81	912.52	437.81	359.22	317.89	1209.09	945.10	788.49
9. Wt. of dish (gm)	166.03	200.96	83.11	187.89	84.88	361.35	187.94	188.28
10. Dish ID								

Wet Density (pcf)		129.0		95.3		134.2		
Dry Density (pcf)		114.5		63.2		118.2		
Moisture Content (%)	14.4	12.7	4.5	50.8	28.6	13.5	3.9	6.1

Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Void Ratio		0.472		1.666		0.425		
Saturation (%)		72.6		82.4		85.7		

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

MOISTURE & DENSITY TEST

ISI Lab No.: G-63174

Client : AECOM

Project : Klamath River Dam Removal Project

Job no : 60537920

Boring #	B-7	B-8	B-8	B-8	B-8	B-10	B-19	B-19
Sample #	S-02	S-01	S-02	S-03	S-04	S-02	S-01	S-03
Depth (ft.)	16.5-18	13-14.5	16-17.5	20-21.5	25-25.5	25.5-27	5-6.5	15-16.5
Soil type: (visual)	Gray clayey sand with organics			Grayish brown clay with sand	Dark grayish brown clayey sand	Grayish brown clayey sand		Mottled grayish brown sandy clay
1. Date tested:	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19
2. Tested by:	JH	JH	JH	JH	JH	JH	JH	JH
3. Specimen height (in.)							5.67	
4. Wt. of specimen + tare (gm)							788.65	
5. Tare wt. (gm)							0.00	
6. Diameter (in.)							2.42	
7. Wet wt. of soil + dish wt. (gm)	359.80	113.16	124.99	133.28	499.55	457.34	237.77	1074.57
8. Dry wt. of soil + dish wt. (gm)	269.65	100.69	95.27	113.85	469.95	428.90	204.03	939.01
9. Wt. of dish (gm)	85.87	50.55	50.56	51.16	188.28	85.30	50.63	356.12
10. Dish ID								

Wet Density (pcf)							115.1	
Dry Density (pcf)							94.4	
Moisture Content (%)	49.1	24.9	66.5	31.0	10.5	8.3	22.0	23.3

Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Void Ratio							0.786	
Saturation (%)							75.6	

Additional data:

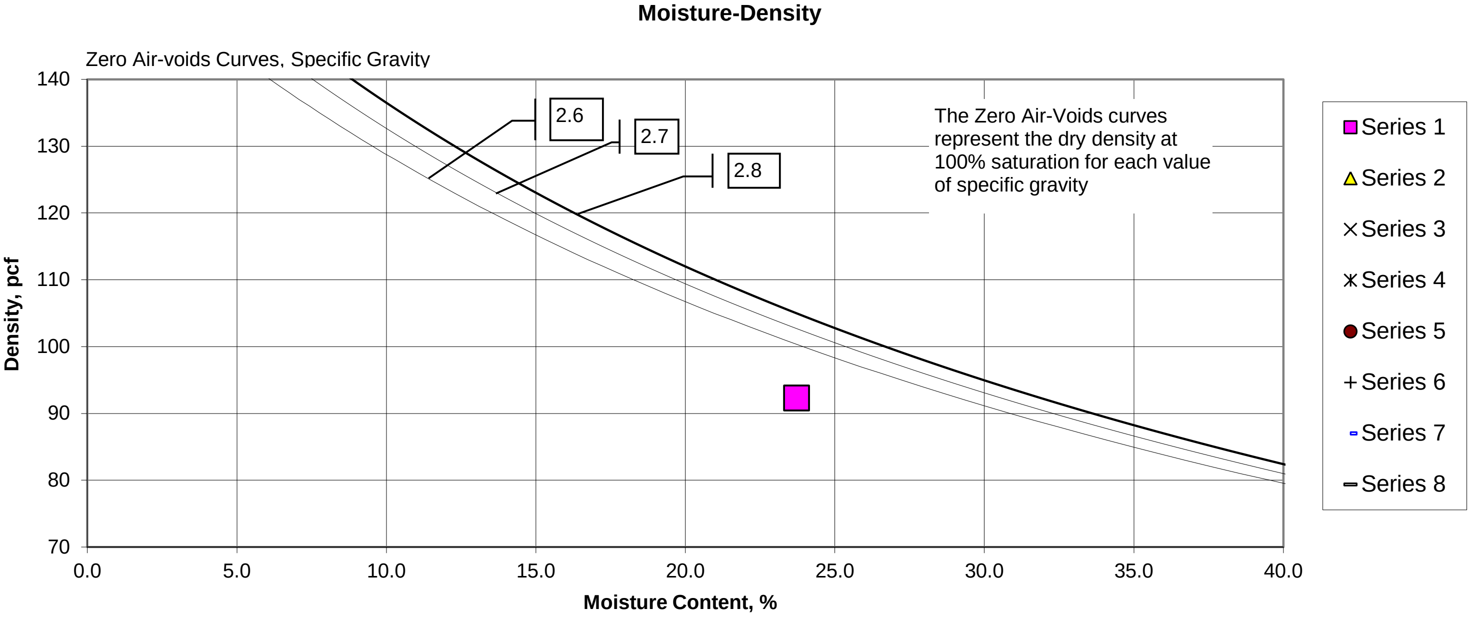
Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

Moisture-Density-Porosity Report
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 020-277
Project No. 60537920
By: RU
Client: AECOM
Date: 03/21/19
Project Name: Klamath River Renewal Project
Remarks:

Boring: **Sample:** **Depth, ft:**	B-15 S1 5-5.5							
Visual Description:	Brown Sandy Fat CLAY							
Actual G_s								
Assumed G_s	2.70							
Moisture, %	23.7							
Wet Unit wt, pcf	114.1							
Dry Unit wt, pcf	92.3							
Dry Bulk Dens.pb, (g/cc)	1.48							
Saturation, %	77.3							
Total Porosity, %	45.3							
Volumetric Water Cont,Өw,%	35.0							
Volumetric Air Cont., Өa,%	10.3							
Void Ratio	0.83							
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered approximate.



MOISTURE & DENSITY TEST

ISI Lab No.: G-63174

Client : AECOM
Project : Klamath River Dam Removal Project
Job no : 60537920

Boring #	B-19	B-20	B-20	B-20				
Sample #	S-04	S-03	S-04	S-05				
Depth (ft.)	20-21.5	15-16.5	20-21.5	25-26.5				
Soil type: (visual)	Grayish brown clayey gravel with sand	Grayish brown sandy clay	Grayish brown clayey sand	Grayish brown clayey sand with gravel				
1. Date tested:	01/26/19	01/26/19	01/26/19	01/26/19				
2. Tested by:	JH	JH	JH	JH				
3. Specimen height (in.)								
4. Wt. of specimen + tare (gm)								
5. Tare wt. (gm)								
6. Diameter (in.)								
7. Wet wt. of soil + dish wt. (gm)	1187.41	680.92	765.13	630.86				
8. Dry wt. of soil + dish wt. (gm)	1024.76	550.85	657.31	563.27				
9. Wt. of dish (gm)	311.57	186.22	188.13	187.57				
10. Dish ID								

Wet Density (pcf)								
Dry Density (pcf)								
Moisture Content (%)	22.8	35.7	23.0	18.0				

Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Void Ratio								
Saturation (%)								

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

COOPER
TESTING LABORATORY

#200 Sieve Wash Analysis
ASTM D 1140

Job No.: 020-251
Client: AECOM
Project: Klamath River Dam Removal Project
Project No.: 60537920
Date: 6/14/2018
Run By: MD
Checked By: DC

Boring:	BC-02	BC-03	BC-04	BC-04				
Sample:	S-01	S-01	S-01	S02				
Depth, ft.:	1-2	1	1.5	7				
Soil Type:	Dark Olive Brown Clayey GRAVEL w/ Sand	Dark Olive Brown Sandy Lean CLAY	Dark Olive Brown Clayey SAND	Dark Olive Brown Sandy CLAY				
Wt of Dish & Dry Soil, gm	1247.4	707.6	696.3	656.3				
Weight of Dish, gm	175.6	175.8	172.4	173.0				
Weight of Dry Soil, gm	1071.8	531.8	523.9	483.3				
Wt. Ret. on #4 Sieve, gm	556.7	16.7	22.3	15.6				
Wt. Ret. on #200 Sieve, gm	774.5	177.4	291.7	205.6				
% Gravel	**51.9**	**3.1**	**4.3**	**3.2**				
% Sand	**20.3**	**30.2**	**51.4**	**39.3**				
% Silt & Clay	**27.7**	**66.6**	**44.3**	**57.5**				

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

COOPER
TESTING LABORATORY

#200 Bulk Sieve Wash Analysis

ASTM D 1140m

Job No.: 020-251
Project No.: 60537920
Run By: MD
Client: AECOM
Date: 6/14/2018
Checked By: DC
Project: Klamath River Dam Removal Project

Boring:	BC-07							
Sample:	S-02							
Depth, ft.:	4-4.5							
Soil Type:	Very Dark Olive Brown Sandy Fat CLAY w/ Gravel							
Bulk Sample wt. lb.	218.0							
Wt of Dish & Dry Soil <#4,gm	389.5							
Weight of Dish, gm	171.0							
Weight of Dry Soil <#4, gm	218.5							
Wt. Ret. on #4 Sieve, lb	33.1							
Wt. Ret. on #200 Sieve, gm	52.3							
% Gravel	**15.2**							
% Sand	**20.3**							
% Silt & Clay	**64.5**							

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

ASTM D-1140
PERCENT PASSING NO. 200 SIEVE REPORT

Method A
Specimens Soaked Overnight without Deflocculating Agent
Dry Mass Determined Directly

Client Name AECOM
Project Name Klamath River Dam Removal Project
Project Number 60537920

Boring Number	B-6	B-6	B-8	B-10	B-20
Sample Number	S-03	S-05	S-04	S-02	S-03
Depth (ft)	15-16.5	40-41.5	25-25.5	25.5-27	15-16.5
Percent of Soil Finer than No. 200 Sieve	36.2	2.4	27.6	15.7	67.8
Visual Classification	Dark gray clayey sand	Grayish brown gravel with sand	Dark grayish brown clayey sand	Grayish brown clayey sand	Grayish brown sandy clay

Date	01/26/19	01/26/19	01/26/19	01/26/19	01/26/19
Weight of Dry Soil + Pan (before wash)	317.9	945.1	470.0	428.9	550.9
Weight of Dry Soil + Pan (after wash)	233.5	927.2	392.2	375.1	303.7
Weight of Pan	84.9	187.9	188.3	85.3	186.2

COOPER
TESTING LABORATORY

#200 Sieve Wash Analysis
ASTM D 1140

Job No.: 020-277
Project No.: 60537920
Run By: MD
Client: AECOM
Date: 3/26/2019
Checked By: DC
Project: Klamath River Renewal Project

Boring:	B-15							
Sample:	S3							
Depth, ft.:	15-16.5							
Soil Type:	Brown Clayey GRAVEL w/ Sand							
Wt of Dish & Dry Soil, gm	687.3							
Weight of Dish, gm	172.2							
Weight of Dry Soil, gm	515.1							
Wt. Ret. on #4 Sieve, gm	218.3							
Wt. Ret. on #200 Sieve, gm	357.6							
% Gravel	**42.4**							
% Sand	**27.0**							
% Silt & Clay	**30.6**							

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

ASTM D-1140

PERCENT PASSING NO. 200 SIEVE REPORT

Method A

Specimens Soaked Overnight without Deflocculating Agent

Dry Mass Determined Directly

Client Name AECOM

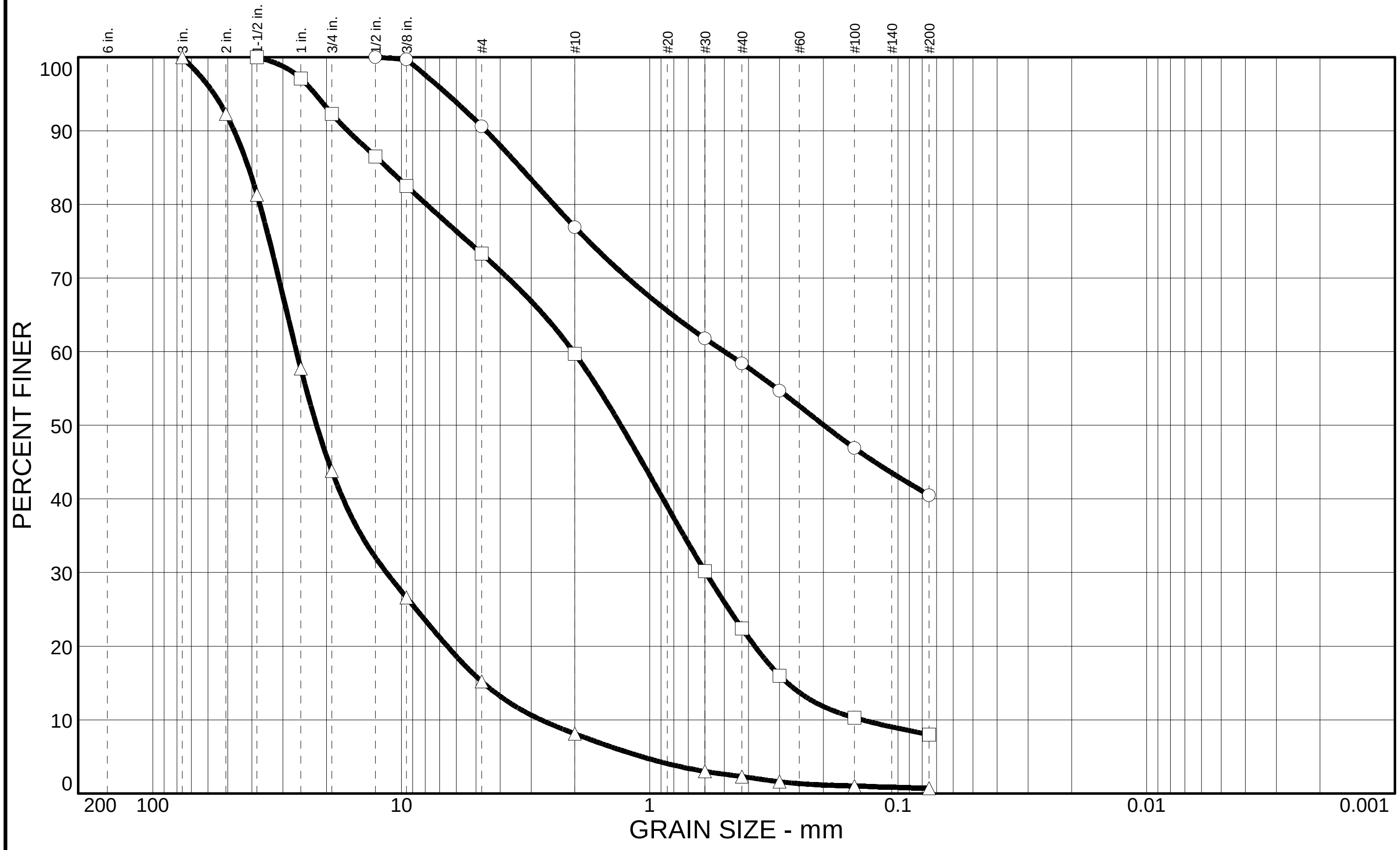
Project Name Klamath River Dam Removal Project

Project Number 60537920

Boring Number	B-20				
Sample Number	S-05				
Depth (ft)	25-26.5				
Percent of Soil Finer than No. 200 Sieve	23.1				
Visual Classification	Grayish brown clayey sand with gravel				

Date	01/26/19				
Weight of Dry Soil + Pan (before wash)	563.3				
Weight of Dry Soil + Pan (after wash)	476.3				
Weight of Pan	187.6				

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		9.4	50.1	40.5					
□		26.7	65.3	8.0					
△		84.8	14.5	0.7					

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
3			100.0
2			92.3
1.5"		100.0	81.3
1"		97.1	57.7
3/4"		92.3	43.8
1/2"	100.0	86.5	
3/8"	99.7	82.5	26.6
	GRAIN SIZE		
D_{60}	0.500	2.03	26.4
D_{30}		0.595	11.5
D_{10}		0.139	2.74
	COEFFICIENTS		
C_c		1.25	1.82
C_u		14.56	9.65

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
#4	90.6	73.3	15.2
#10	76.9	59.7	8.1
#30	61.8	30.2	3.0
#40	58.4	22.4	2.3
#50	54.7	16.0	1.6
#100	46.9	10.3	1.0
#200	40.5	8.0	0.7

SOIL DESCRIPTION

○ Reddish Brown Clayey SAND

□ Dark Olive Brown Well-Graded SAND w/ Silt & Gravel

△ Dark Olive Brown Well-Graded GRAVEL

REMARKS:

○

□ Due to the small sample size, relative to the largest particle size, this data should be considered to be approximate.

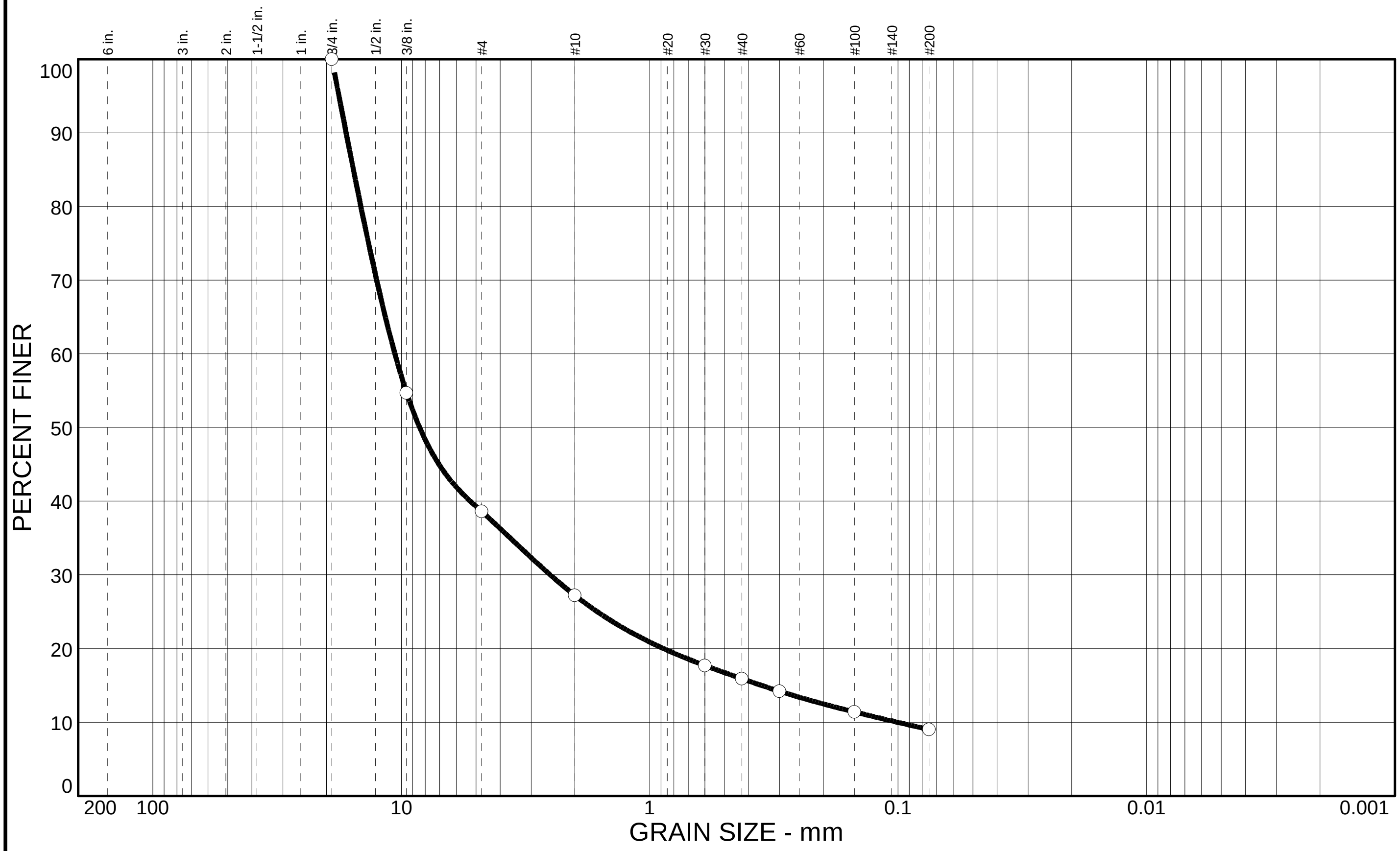
△

○ Source: BC-04 Sample No.: S-03 Elev./Depth: 11-12.5'
□ Source: BC-07 Sample No.: S-04 Elev./Depth: 13'
△ Source: BC-10 Sample No.: S-01 Elev./Depth: 9.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920
Project No.: 020-251
Figure

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		61.4	29.6	9.0		GP-GM		26	41

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
3/8"	54.7		
	GRAIN SIZE		
D_{60}	10.6		
D_{30}	2.52		
D_{10}	0.101		
	COEFFICIENTS		
C_c	5.92		
C_u	105.44		

SIEVE number size	PERCENT FINER ○		
#4	38.6		
#10	27.2		
#30	17.7		
#40	15.9		
#50	14.2		
#100	11.4		
#200	9.0		

SOIL DESCRIPTION

○ Olive Gray Poorly Graded GRAVEL w/ Silt & Sand

REMARKS:

○

○ Source: BI-03 Sample No.: S-01 Elev./Depth: 3.5'

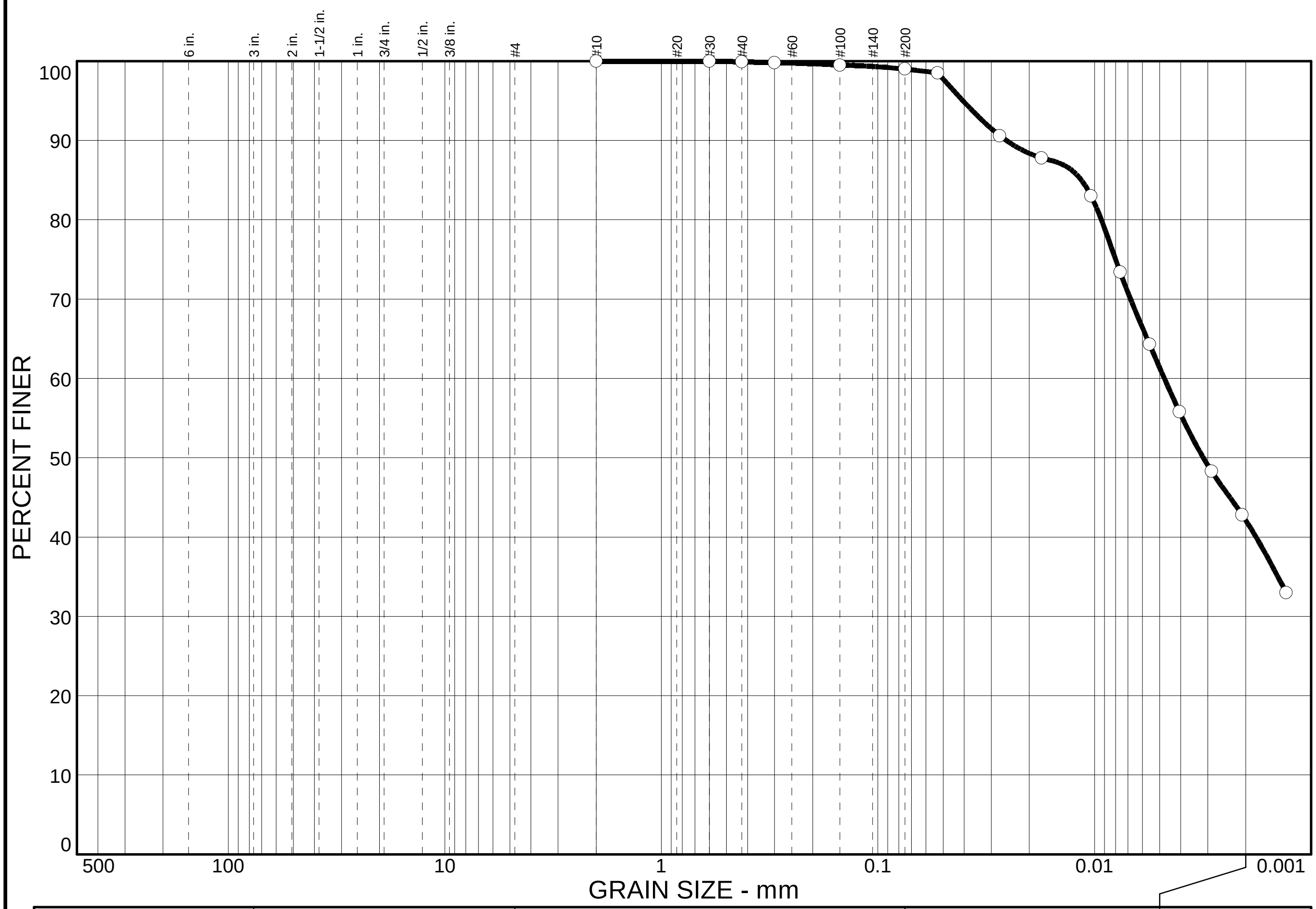
COOPER TESTING LABORATORY

Client: AECOM

Project: Klamath River Dam Removal Project - 60537920

Project No.: 020-251 Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	1.0	56.9	42.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	100.0		
#40	99.9		
#50	99.8		
#100	99.5		
#200	99.0		
#270	98.5		
0.0274 mm.	90.6		
0.0176 mm.	87.8		
0.0104 mm.	83.0		
0.0076 mm.	73.4		
0.0056 mm.	64.3		
0.0041 mm.	55.8		
0.0029 mm.	48.3		
0.0021 mm.	42.8		
0.0013 mm.	33.0		

* (no specification provided)

Soil Description

Olive Gray Elastic SILT

Atterberg Limits

PL= 51 LL= 85 PI= 34

Coefficients

D_{85}= 0.0115 D_{60}= 0.0048 D_{50}= 0.0031
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

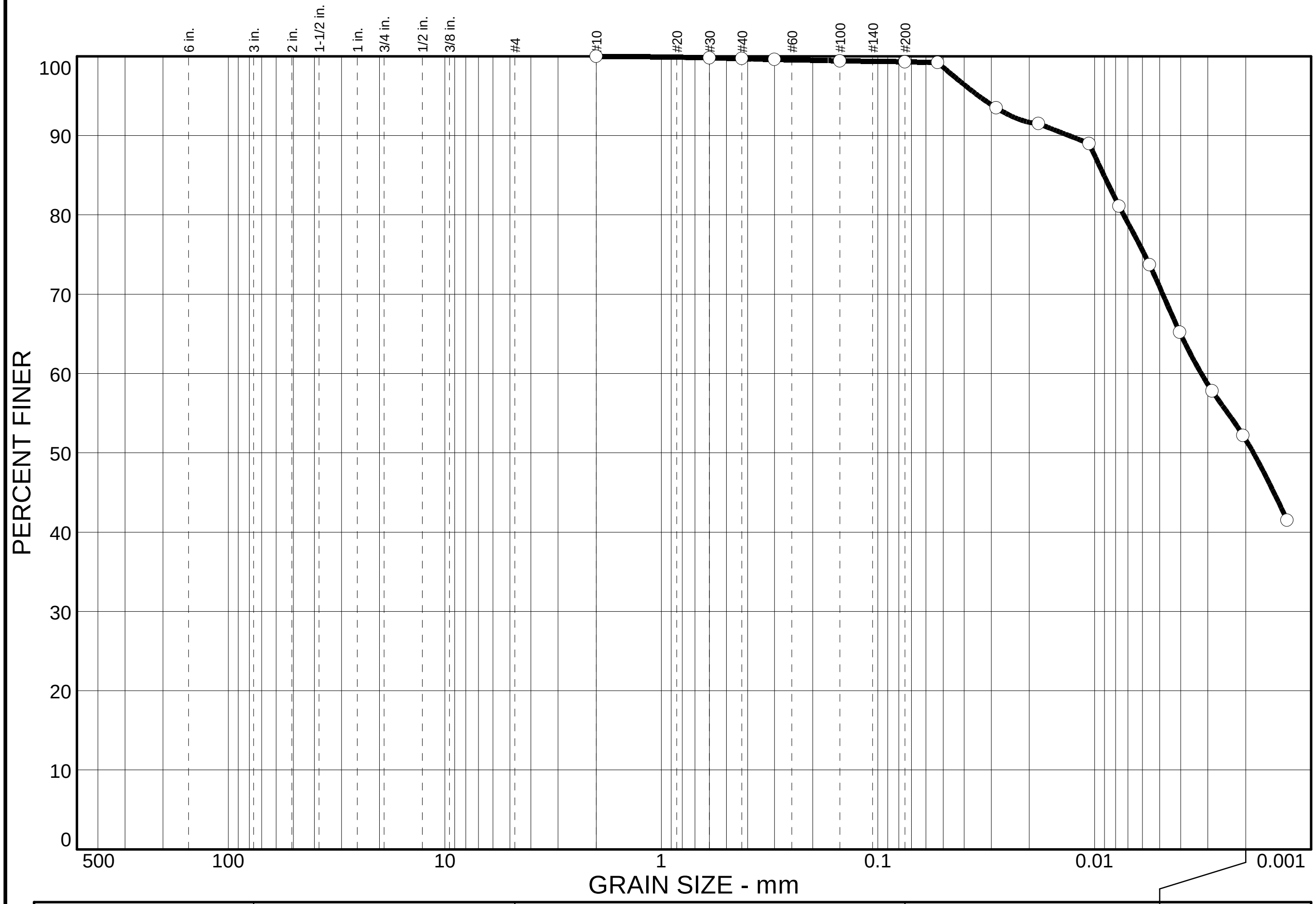
Sample No.: S-04 **Source of Sample:** BC-01 **Date:** 6/5/18
Location: **Elev./Depth:** 21.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.7	47.7	51.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.8		
#40	99.7		
#50	99.6		
#100	99.4		
#200	99.3		
#270	99.2		
0.0285 mm.	93.5		
0.0182 mm.	91.5		
0.0106 mm.	89.0		
0.0077 mm.	81.1		
0.0056 mm.	73.7		
0.0040 mm.	65.2		
0.0029 mm.	57.8		
0.0021 mm.	52.2		
0.0013 mm.	41.5		

* (no specification provided)

Soil Description

Gray Elastic SILT

Atterberg Limits

PL= 59 LL= 105 PI= 46

Coefficients

D_{85}= 0.0090 D_{60}= 0.0032 D_{50}= 0.0018
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

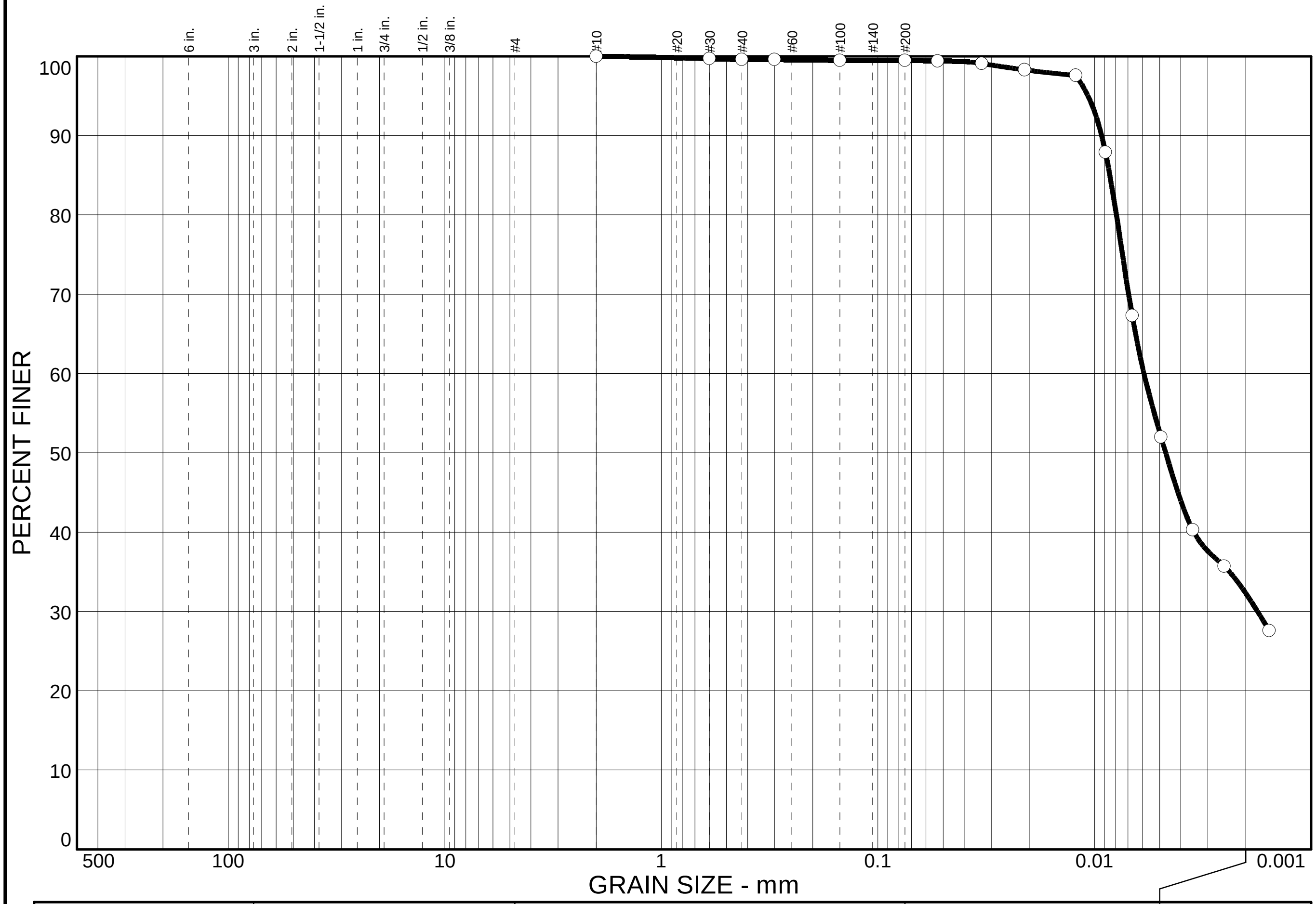
Sample No.: S-05 **Source of Sample:** BC-02 **Date:** 6/5/18
Location: **Elev./Depth:** 14.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.5	67.2	32.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.7		
#40	99.6		
#50	99.6		
#100	99.5		
#200	99.5		
#270	99.4		
0.0331 mm.	99.1		
0.0210 mm.	98.3		
0.0122 mm.	97.6		
0.0089 mm.	87.9		
0.0067 mm.	67.3		
0.0049 mm.	52.0		
0.0035 mm.	40.3		
0.0025 mm.	35.7		
0.0016 mm.	27.6		

* (no specification provided)

Soil Description

Gray Elastic SILT

Atterberg Limits

PL= 85 LL= 187 PI= 102

Coefficients

D_{85}= 0.0085 D_{60}= 0.0059 D_{50}= 0.0047
D_{30}= 0.0018 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

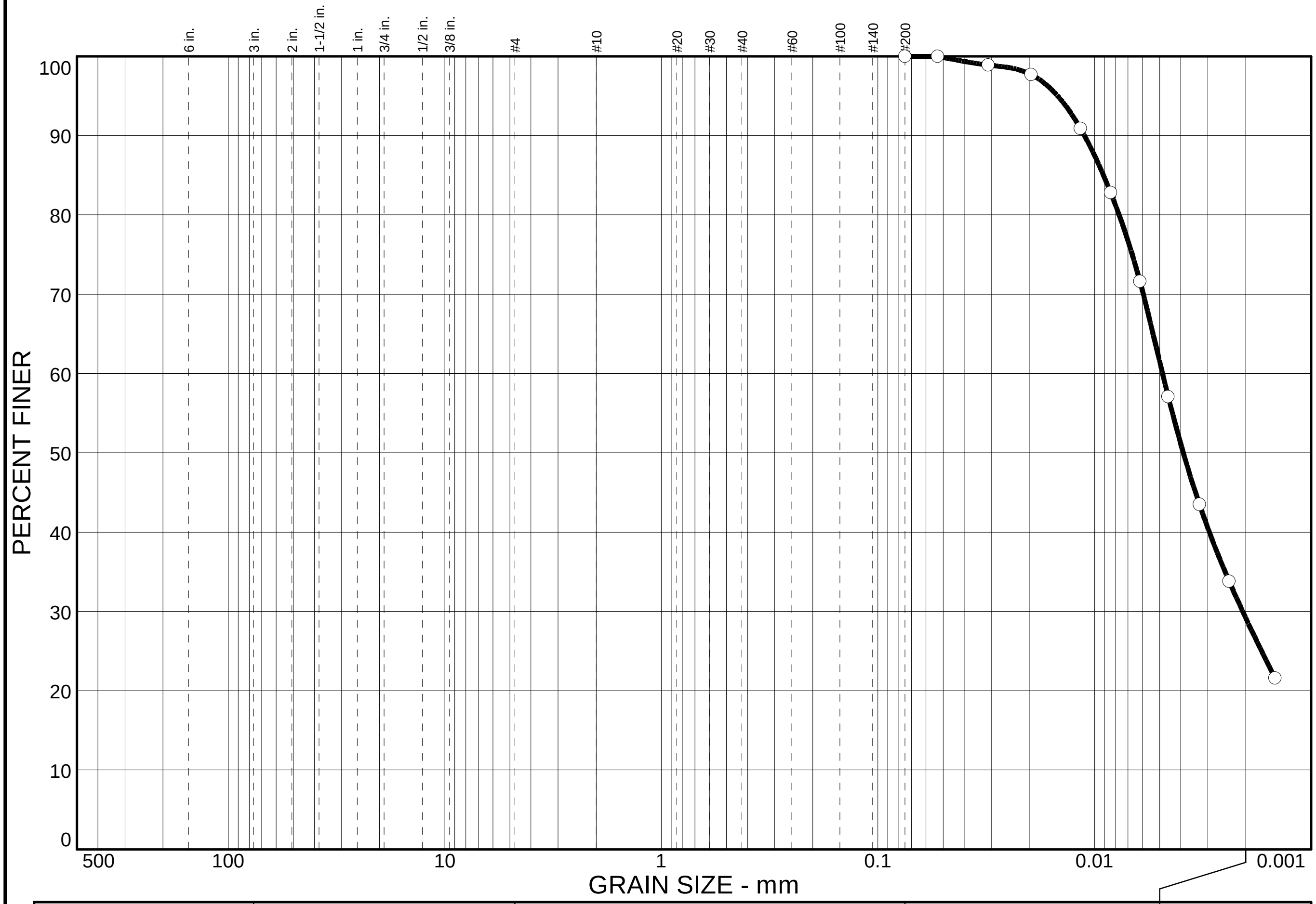
Remarks

Sample No.: S-09 **Source of Sample:** BC-02 **Date:** 6/5/18
Location: **Elev./Depth:** 44.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920
Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.0	70.9	29.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	100.0		
#270	100.0		
0.0309 mm.	98.9		
0.0196 mm.	97.7		
0.0116 mm.	90.9		
0.0084 mm.	82.8		
0.0062 mm.	71.6		
0.0046 mm.	57.1		
0.0033 mm.	43.5		
0.0024 mm.	33.8		
0.0015 mm.	21.6		

* (no specification provided)

Soil Description

Light Olive Brown Elastic SILT

Atterberg Limits

PL= 59 LL= 69 PI= 10

Coefficients

D_{85}= 0.0091 D_{60}= 0.0049 D_{50}= 0.0039
D_{30}= 0.0021 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

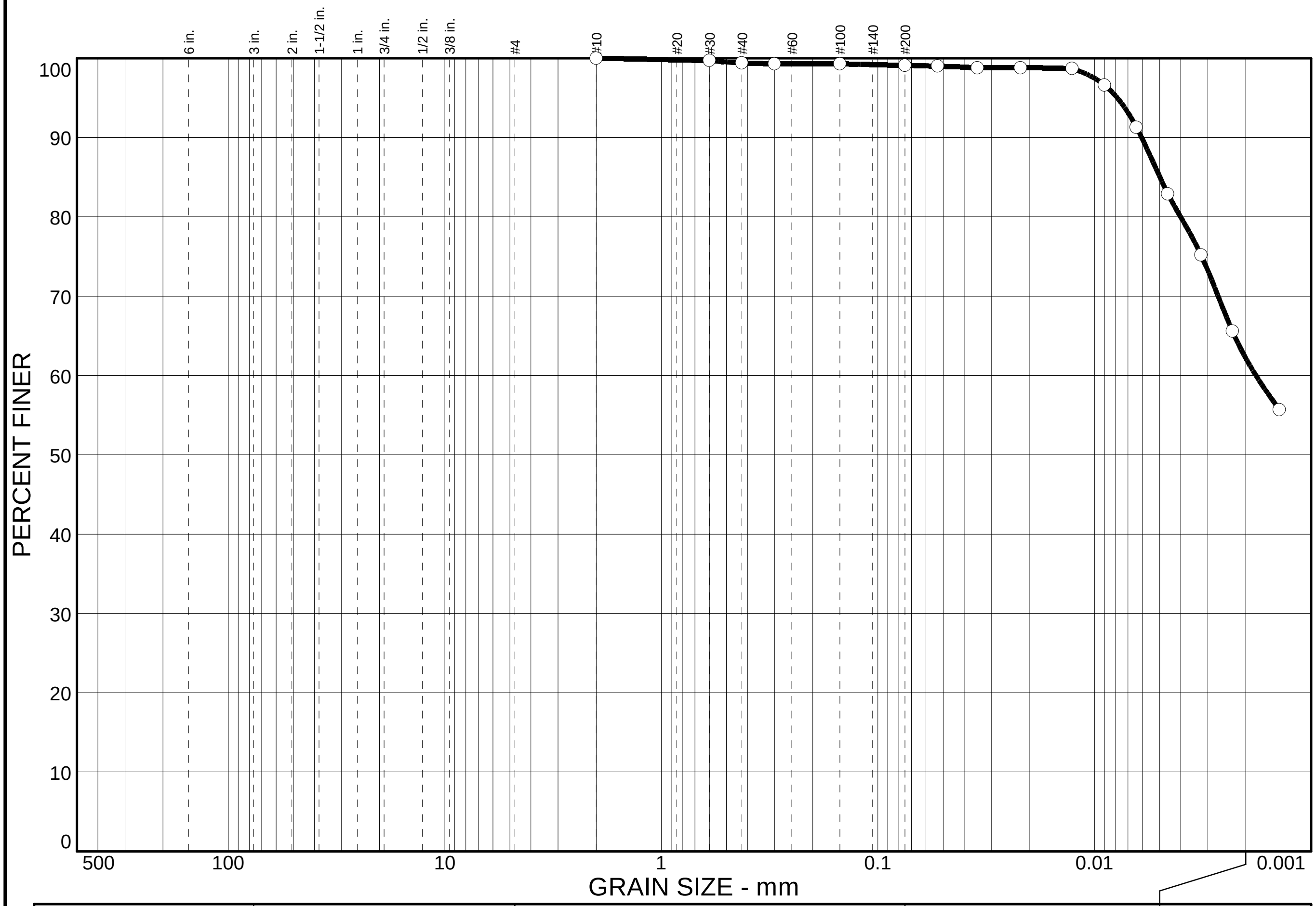
Sample No.: S-05 **Source of Sample:** BC-03 **Date:** 6/5/18
Location: **Elev./Depth:** 24.5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.9	37.0	62.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.7		
#40	99.4		
#50	99.3		
#100	99.3		
#200	99.1		
#270	99.0		
0.0347 mm.	98.8		
0.0219 mm.	98.8		
0.0127 mm.	98.7		
0.0090 mm.	96.6		
0.0064 mm.	91.3		
0.0046 mm.	82.9		
0.0032 mm.	75.2		
0.0023 mm.	65.6		
0.0014 mm.	55.7		

* (no specification provided)

Soil Description

Pale Brown Mottled Gray Elastic SILT

Atterberg Limits

PL= 85 LL= 120 PI= 35

Coefficients

D_{85}= 0.0050 D_{60}= 0.0018 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

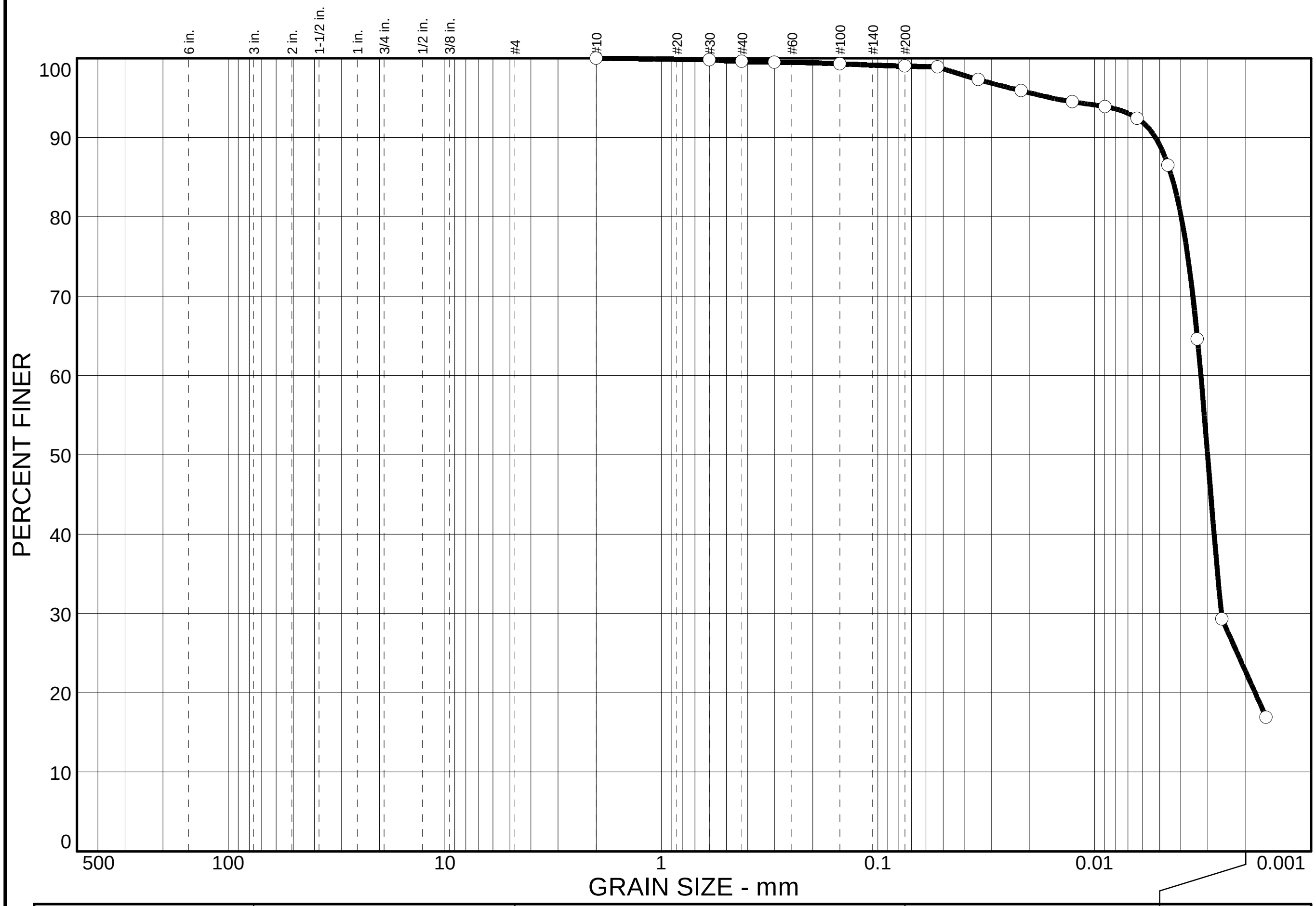
Sample No.: S-08 **Source of Sample:** BC-04 **Date:** 5/16/18
Location: **Elev./Depth:** 32.5(Tip-16")

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	1.0	76.4	22.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.8		
#40	99.6		
#50	99.5		
#100	99.3		
#200	99.0		
#270	98.9		
0.0343 mm.	97.3		
0.0218 mm.	95.9		
0.0126 mm.	94.5		
0.0089 mm.	93.9		
0.0063 mm.	92.4		
0.0046 mm.	86.5		
0.0034 mm.	64.6		
0.0026 mm.	29.3		
0.0016 mm.	16.9		

* (no specification provided)

Soil Description

Light Olive Brown Elastic SILT

Atterberg Limits

PL= 88 LL= 200 PI= 112

Coefficients

D_{85}= 0.0044 D_{60}= 0.0032 D_{50}= 0.0030
D_{30}= 0.0026 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

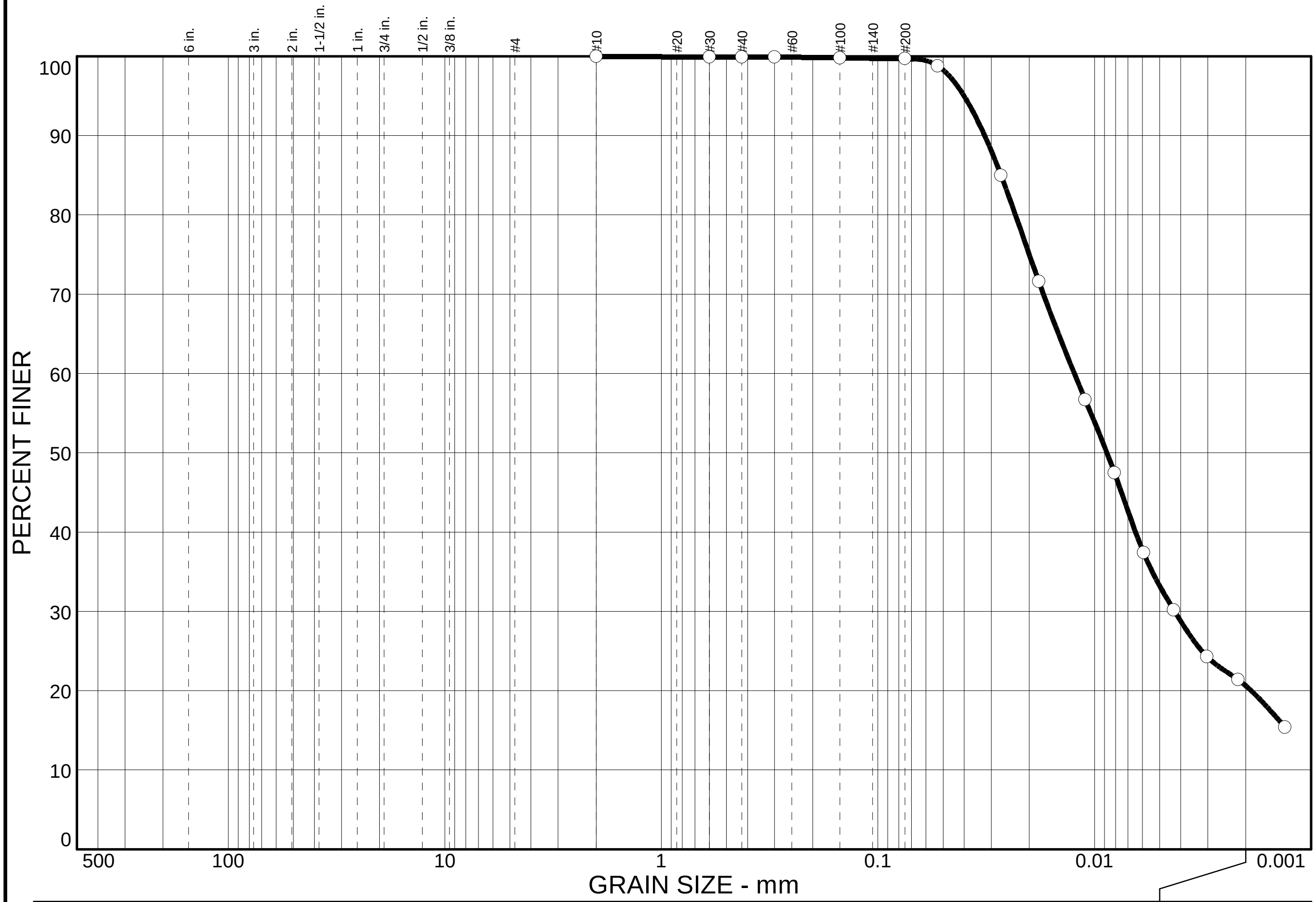
Sample No.: S-05 **Source of Sample:** BC-08A **Date:** 6/5/18
Location: **Elev./Depth:** 54'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	0.3	79.1	20.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	99.9		
#40	99.9		
#50	99.9		
#100	99.8		
#200	99.7		
#270	98.8		
0.0270 mm.	85.0		
0.0181 mm.	71.6		
0.0110 mm.	56.7		
0.0081 mm.	47.5		
0.0059 mm.	37.4		
0.0043 mm.	30.2		
0.0030 mm.	24.3		
0.0022 mm.	21.4		
0.0013 mm.	15.4		

* (no specification provided)

Soil Description

Dark Gray Elastic SILT

Atterberg Limits

PL= 53 LL= 74 PI= 21

Coefficients

D_{85}= 0.0270 D_{60}= 0.0124 D_{50}= 0.0088
D_{30}= 0.0043 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

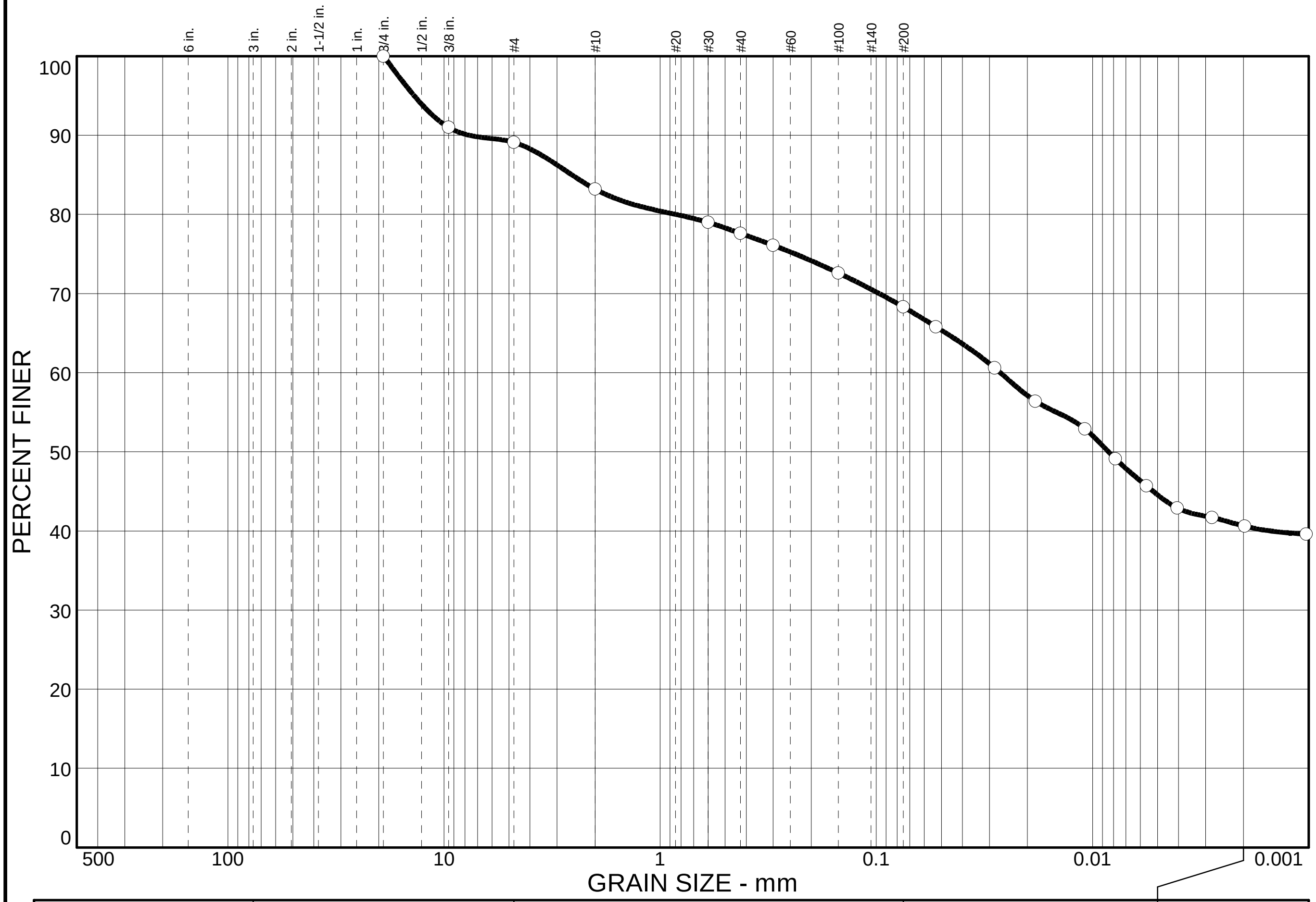
Sample No.: S-05 **Source of Sample:** BC-09 **Date:** 6/5/18
Location: **Elev./Depth:** 23(Tip-5")

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	10.9	20.8	27.7	40.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	91.0		
#4	89.1		
#10	83.2		
#30	79.0		
#40	77.6		
#50	76.1		
#100	72.6		
#200	68.3		
#270	65.8		
0.0284 mm.	60.6		
0.0184 mm.	56.4		
0.0108 mm.	52.9		
0.0078 mm.	49.1		
0.0056 mm.	45.7		
0.0041 mm.	42.9		
0.0028 mm.	41.7		
0.0020 mm.	40.6		
0.0010 mm.	39.6		

* (no specification provided)

Soil Description

Dark Reddish Brown Sandy Fat CLAY

Atterberg Limits

PL= 28 LL= 78 PI= 50

Coefficients

D_{85}= 2.56 D_{60}= 0.0267 D_{50}= 0.0084
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

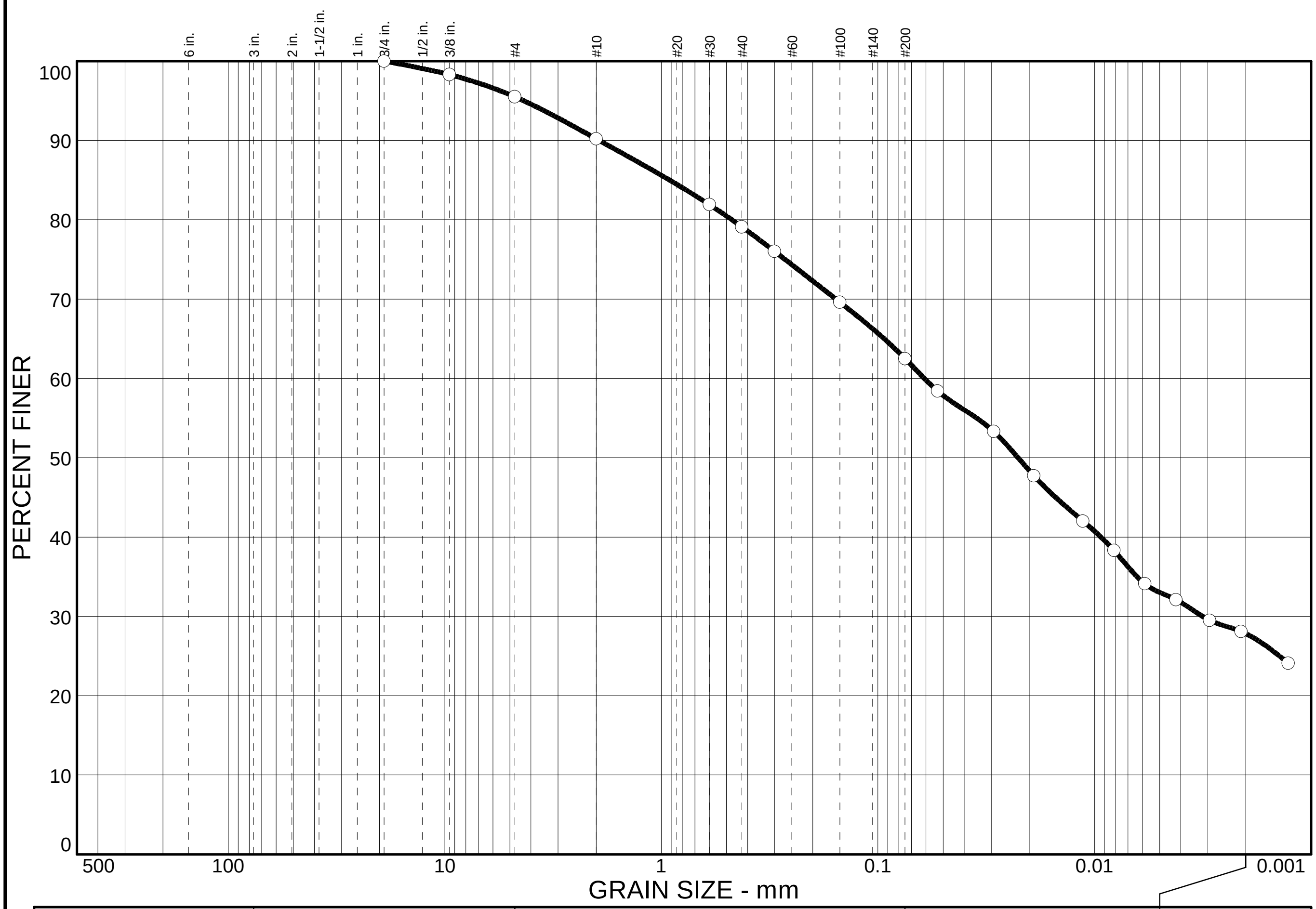
Sample No.: S-01 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.5	33.0	34.7	27.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	98.3		
#4	95.5		
#10	90.2		
#30	81.9		
#40	79.1		
#50	76.0		
#100	69.6		
#200	62.5		
#270	58.4		
0.0292 mm.	53.3		
0.0190 mm.	47.7		
0.0113 mm.	42.0		
0.0081 mm.	38.3		
0.0059 mm.	34.1		
0.0042 mm.	32.1		
0.0029 mm.	29.5		
0.0021 mm.	28.1		
0.0013 mm.	24.1		

* (no specification provided)

Soil Description

Yellowish Brown Sandy Fat CLAY

Atterberg Limits

PL= 28 LL= 58 PI= 30

Coefficients

D_{85}= 0.917 D_{60}= 0.0612 D_{50}= 0.0226
D_{30}= 0.0032 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

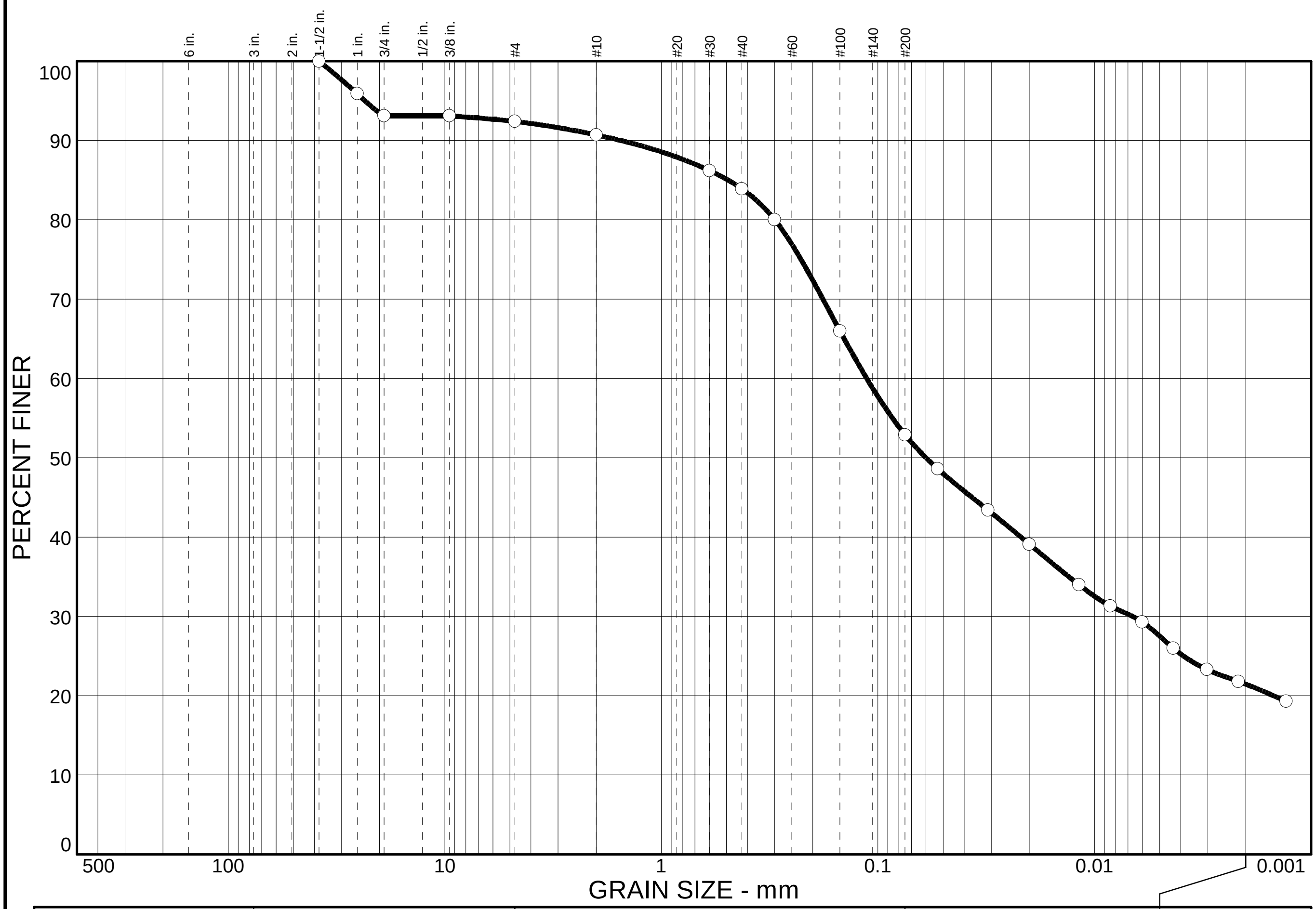
Sample No.: S-02 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 10'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.6	39.5	31.5	21.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	95.9		
3/4 in.	93.1		
3/8 in.	93.1		
#4	92.4		
#10	90.7		
#30	86.2		
#40	83.9		
#50	80.0		
#100	66.0		
#200	52.9		
#270	48.6		
0.0311 mm.	43.4		
0.0200 mm.	39.1		
0.0118 mm.	34.0		
0.0084 mm.	31.3		
0.0060 mm.	29.3		
0.0043 mm.	26.0		
0.0030 mm.	23.3		
0.0022 mm.	21.8		
0.0013 mm.	19.3		

* (no specification provided)

Soil Description

Yellowish Brown Sandy Fat CLAY

Atterberg Limits

PL= 27 LL= 51 PI= 24

Coefficients

D_{85}= 0.492 D_{60}= 0.113 D_{50}= 0.0601

D_{30}= 0.0067 D_{15}= D_{10}=

C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

Due to the small sample size, relative to the largest particle size, this data should be considered to be approximate.

Sample No.: S-03 **Source of Sample:** BI-02 **Date:** 6/6/18

Location: **Elev./Depth:** 15'

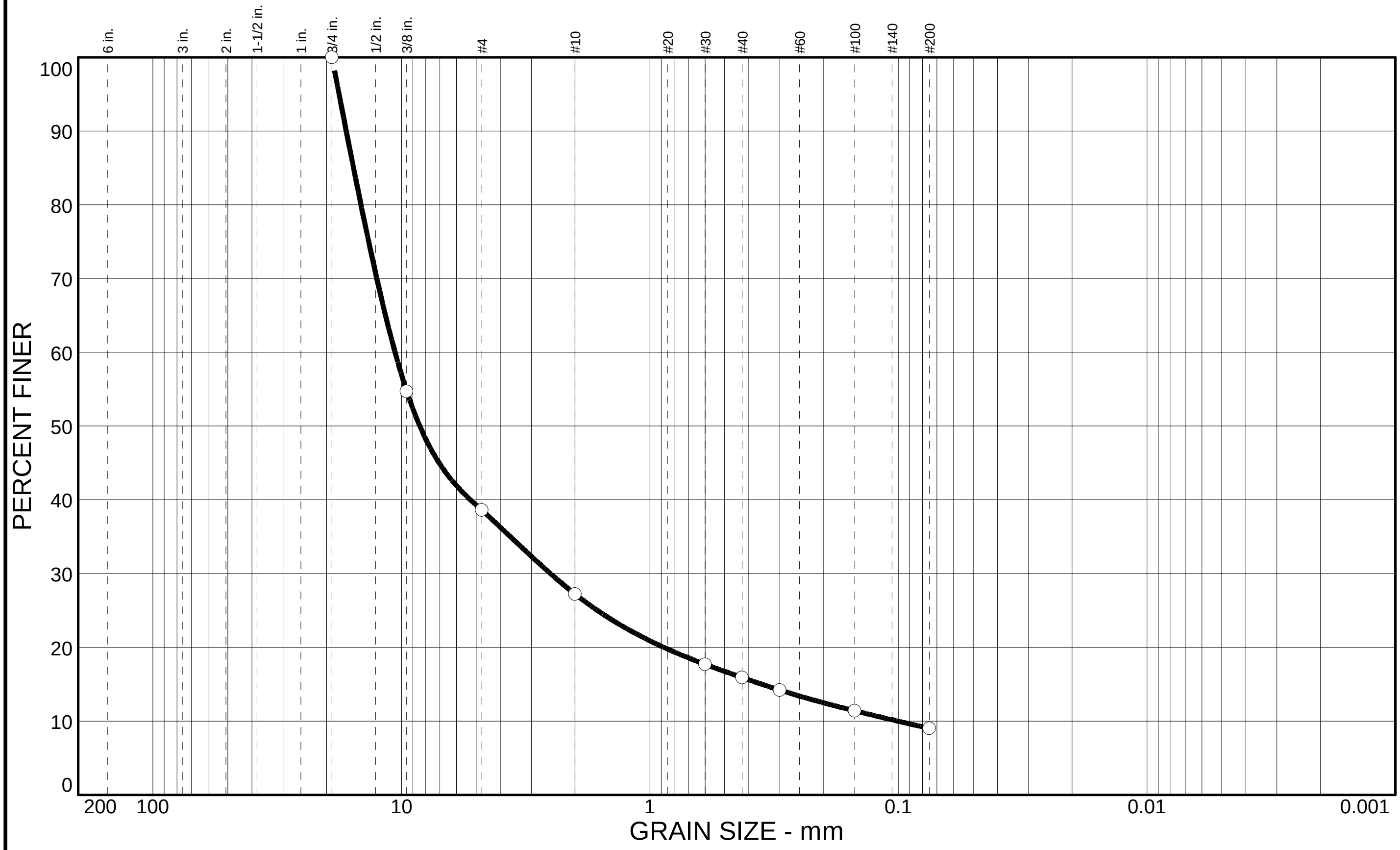
COOPER TESTING LABORATORY

Client: AECOM

Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		61.4	29.6	9.0		GP-GM		26	41

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
3/8"	54.7		
	GRAIN SIZE		
D_{60}	10.6		
D_{30}	2.52		
D_{10}	0.101		
	COEFFICIENTS		
C_c	5.92		
C_u	105.44		

SIEVE number size	PERCENT FINER ○		
#4	38.6		
#10	27.2		
#30	17.7		
#40	15.9		
#50	14.2		
#100	11.4		
#200	9.0		

SOIL DESCRIPTION

○ Olive Gray Poorly Graded GRAVEL w/ Silt & Sand

REMARKS:

○

○ Source: BI-03 Sample No.: S-01 Elev./Depth: 3.5'

COOPER TESTING LABORATORY

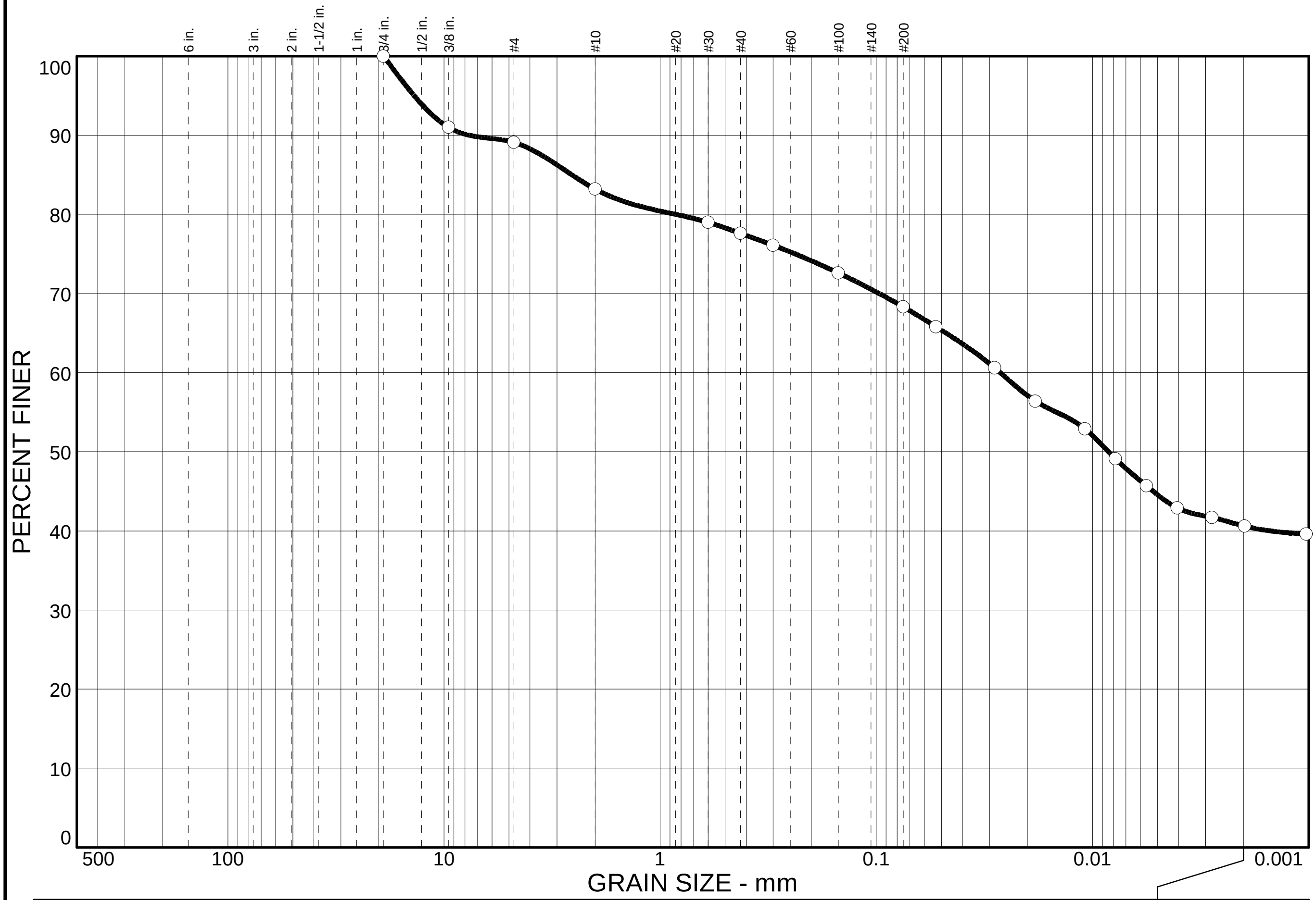
Client: AECOM

Project: Klamath River Dam Removal Project - 60537920

Project No.: 020-251

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	10.9	20.8	27.7	40.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	91.0		
#4	89.1		
#10	83.2		
#30	79.0		
#40	77.6		
#50	76.1		
#100	72.6		
#200	68.3		
#270	65.8		
0.0284 mm.	60.6		
0.0184 mm.	56.4		
0.0108 mm.	52.9		
0.0078 mm.	49.1		
0.0056 mm.	45.7		
0.0041 mm.	42.9		
0.0028 mm.	41.7		
0.0020 mm.	40.6		
0.0010 mm.	39.6		

* (no specification provided)

Soil Description

Dark Reddish Brown Sandy Fat CLAY

Atterberg Limits

PL= 28 LL= 78 PI= 50

Coefficients

D_{85}= 2.56 D_{60}= 0.0267 D_{50}= 0.0084
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

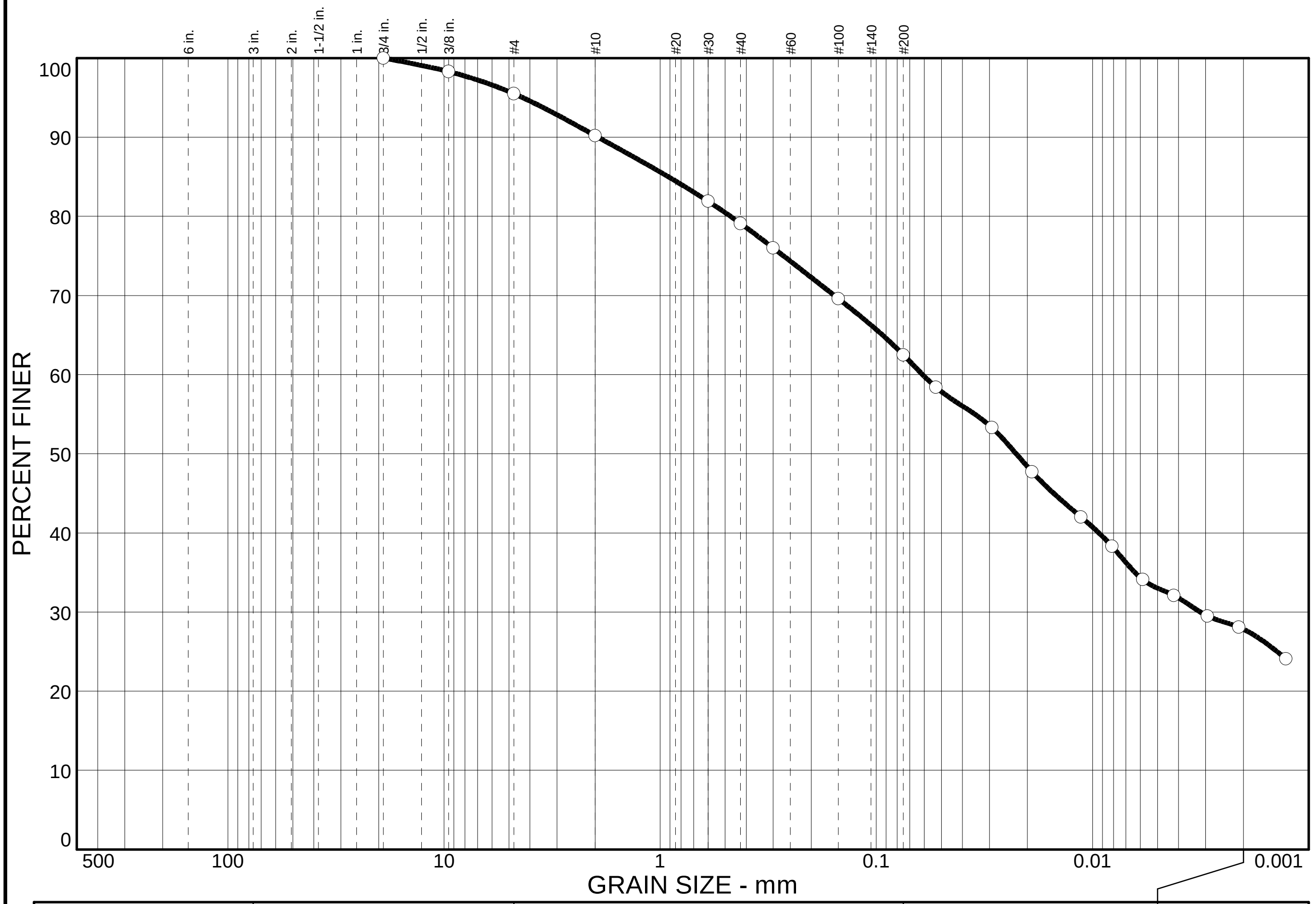
Sample No.: S-01 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 5'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.5	33.0	34.7	27.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	98.3		
#4	95.5		
#10	90.2		
#30	81.9		
#40	79.1		
#50	76.0		
#100	69.6		
#200	62.5		
#270	58.4		
0.0292 mm.	53.3		
0.0190 mm.	47.7		
0.0113 mm.	42.0		
0.0081 mm.	38.3		
0.0059 mm.	34.1		
0.0042 mm.	32.1		
0.0029 mm.	29.5		
0.0021 mm.	28.1		
0.0013 mm.	24.1		

* (no specification provided)

Soil Description

Yellowish Brown Sandy Fat CLAY

Atterberg Limits

PL= 28 LL= 58 PI= 30

Coefficients

D_{85}= 0.917 D_{60}= 0.0612 D_{50}= 0.0226
D_{30}= 0.0032 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

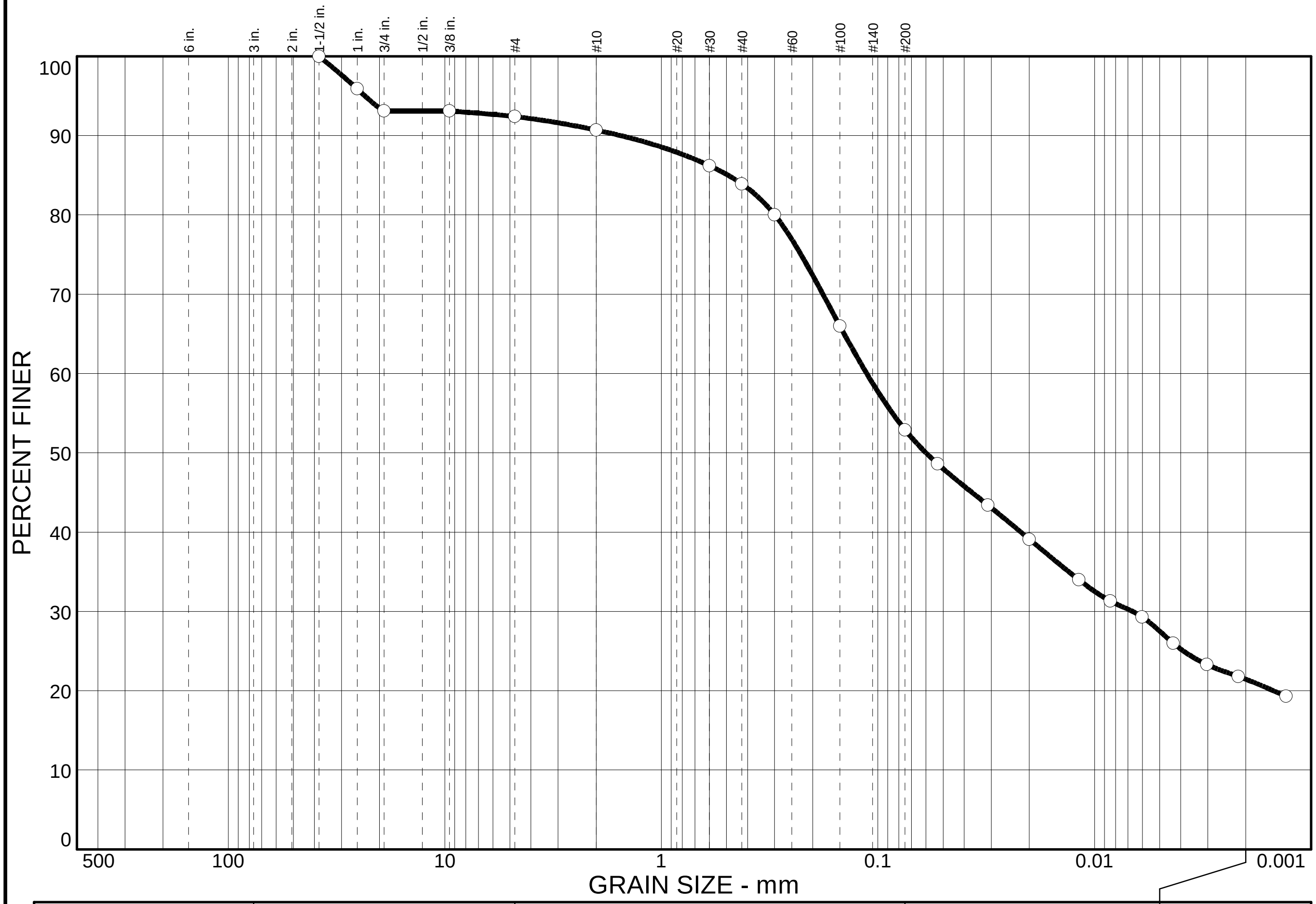
Sample No.: S-02 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 10'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.6	39.5	31.5	21.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	95.9		
3/4 in.	93.1		
3/8 in.	93.1		
#4	92.4		
#10	90.7		
#30	86.2		
#40	83.9		
#50	80.0		
#100	66.0		
#200	52.9		
#270	48.6		
0.0311 mm.	43.4		
0.0200 mm.	39.1		
0.0118 mm.	34.0		
0.0084 mm.	31.3		
0.0060 mm.	29.3		
0.0043 mm.	26.0		
0.0030 mm.	23.3		
0.0022 mm.	21.8		
0.0013 mm.	19.3		

* (no specification provided)

Soil Description

Yellowish Brown Sandy Fat CLAY

Atterberg Limits

PL= 27 LL= 51 PI= 24

Coefficients

D_{85}= 0.492 D_{60}= 0.113 D_{50}= 0.0601
D_{30}= 0.0067 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

Due to the small sample size, relative to the largest particle size, this data should be considered to be approximate.

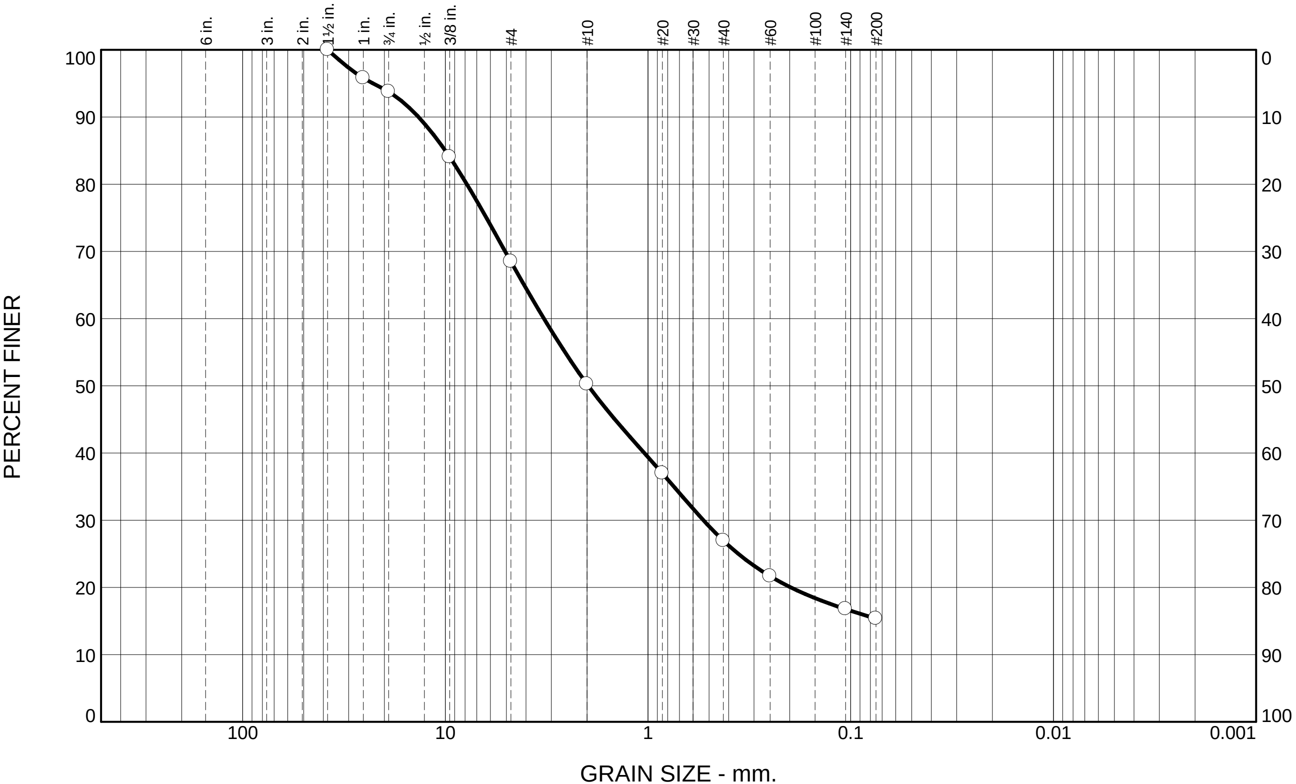
Sample No.: S-03 **Source of Sample:** BI-02 **Date:** 6/6/18
Location: **Elev./Depth:** 15'

COOPER TESTING LABORATORY

Client: AECOM
Project: Klamath River Dam Removal Project - 60537920

Project No: 020-251 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	6	26	18	23	12	15	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100		
1	96		
3/4	94		
3/8	84		
#4	68		
#10	50		
#20	37		
#40	27		
#60	22		
#140	17		
#200	15		

* (no specification provided)

Soil Description

Gray silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 13.5779 D_{85}= 10.0161 D_{60}= 3.2642
D_{50}= 1.9723 D_{30}= 0.5334 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

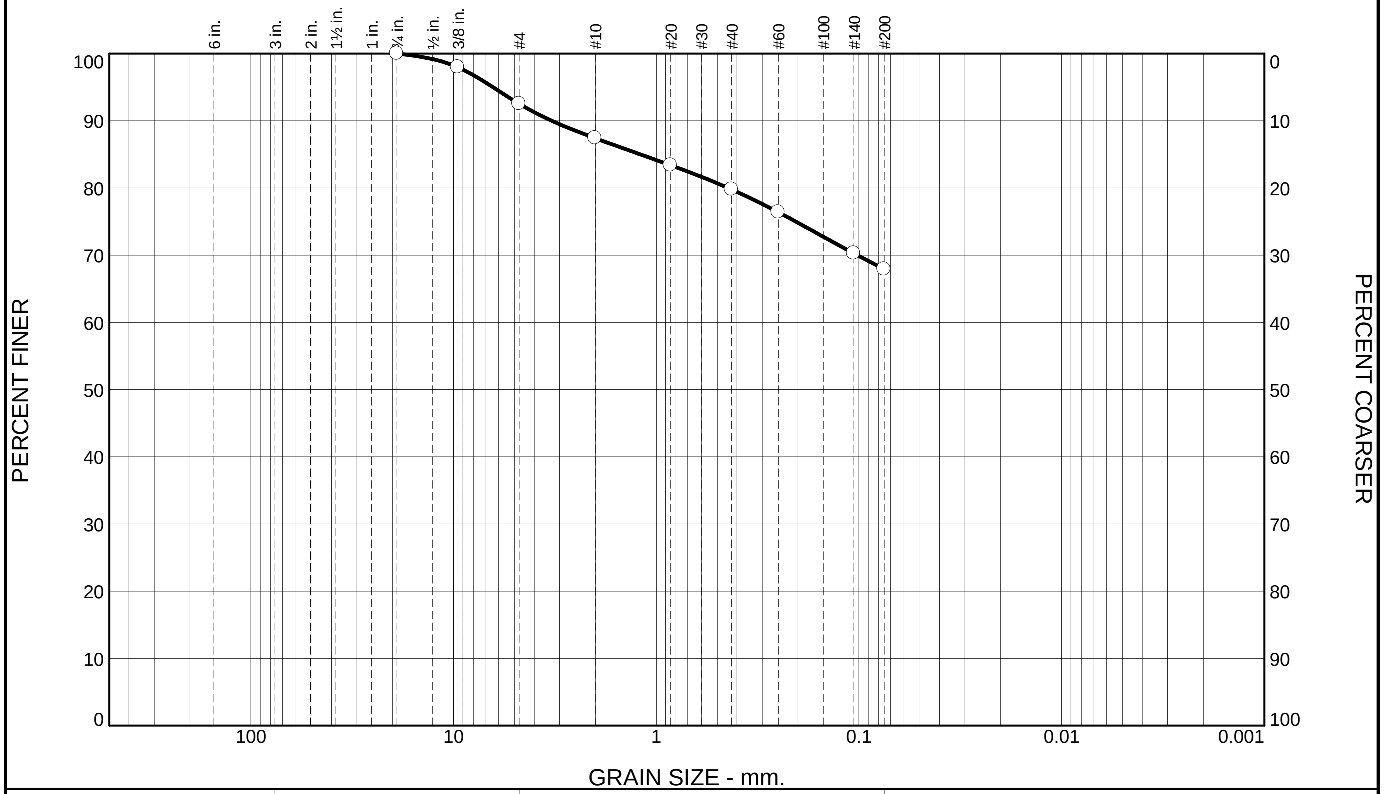
Source of Sample: B-2 **Depth:** 27-27.5
Sample Number: S-01

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	7	6	7	12	68	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	98		
#4	93		
#10	87		
#20	83		
#40	80		
#60	76		
#140	70		
#200	68		

* (no specification provided)

Soil Description

Brown clay with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.2821	D_{85}= 1.2011	D_{60}=
D_{50}=	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Classification

USCS= CL AASHTO=

Remarks

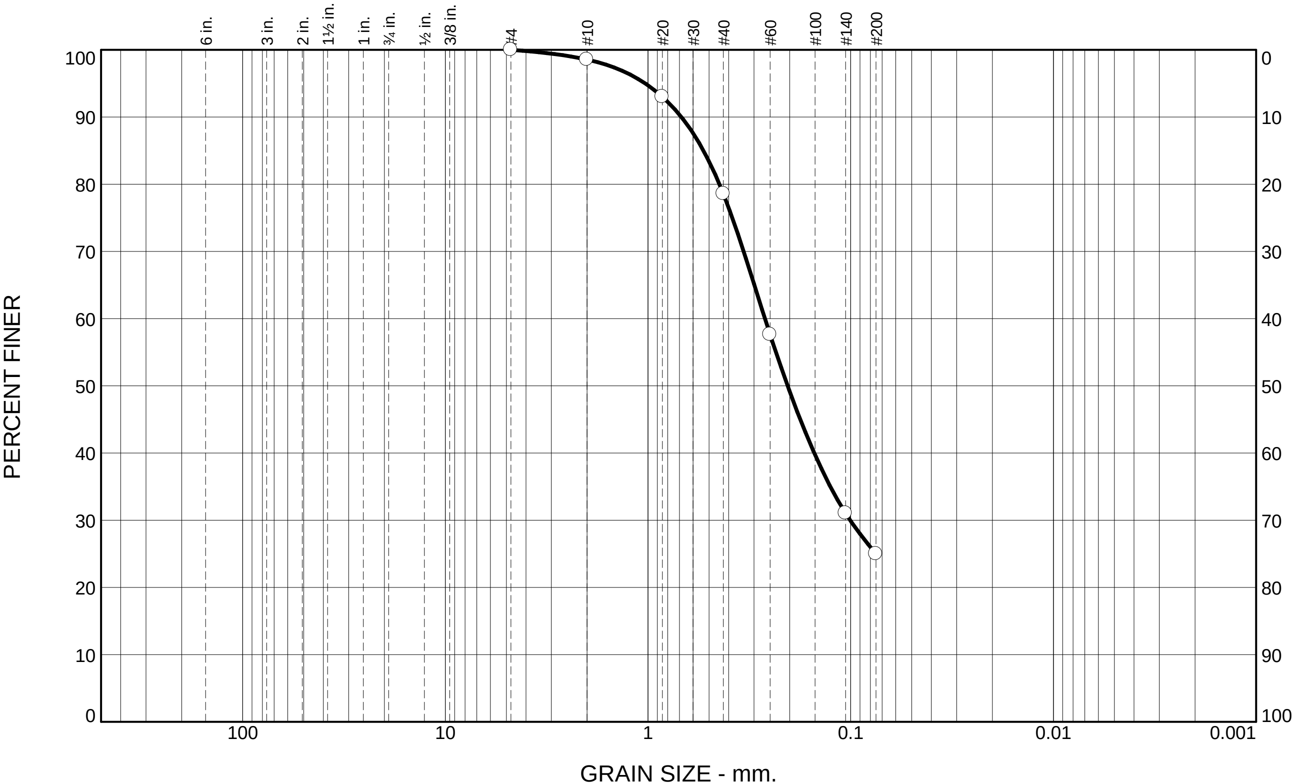
Source of Sample: B-5 **Depth:** 5-6.5
Sample Number: S-01

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	20	54	25	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	99		
#20	93		
#40	79		
#60	58		
#140	31		
#200	25		

* (no specification provided)

Soil Description

Grayish brown silty sand with organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6851 D_{85}= 0.5329 D_{60}= 0.2650

D_{50}= 0.2048 D_{30}= 0.1007 D_{15}=

D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Source of Sample: B-6 **Depth:** 10-11.5

Sample Number: S-02

Date: 2-1-19

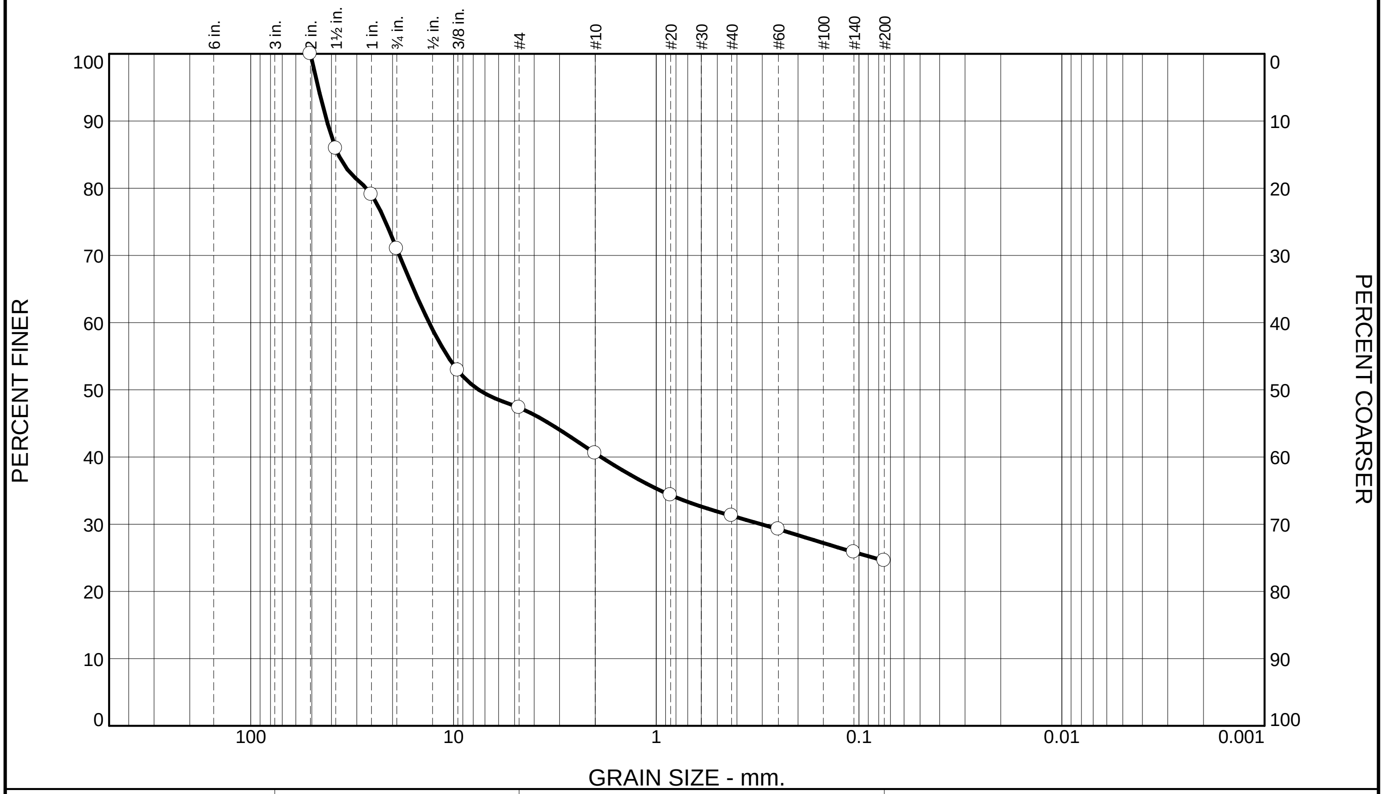
Client: AECOM

Project: Klamath River Dam Removal Project
60537920

Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	29	24	6	10	6	25	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100		
1.5	86		
1	79		
3/4	71		
3/8	53		
#4	47		
#10	41		
#20	34		
#40	31		
#60	29		
#140	26		
#200	25		

* (no specification provided)

Soil Description

Reddish brown clayey gravel with sand

Atterberg Limits

PL=	LL=	PI=

Coefficients

D_{90}= 42.1617	D_{85}= 36.9884	D_{60}= 13.2018
D_{50}= 7.5052	D_{30}= 0.3044	D_{15}=
D_{10}=	C_u=	C_c=

Classification

USCS= GC

AASHTO=

Remarks

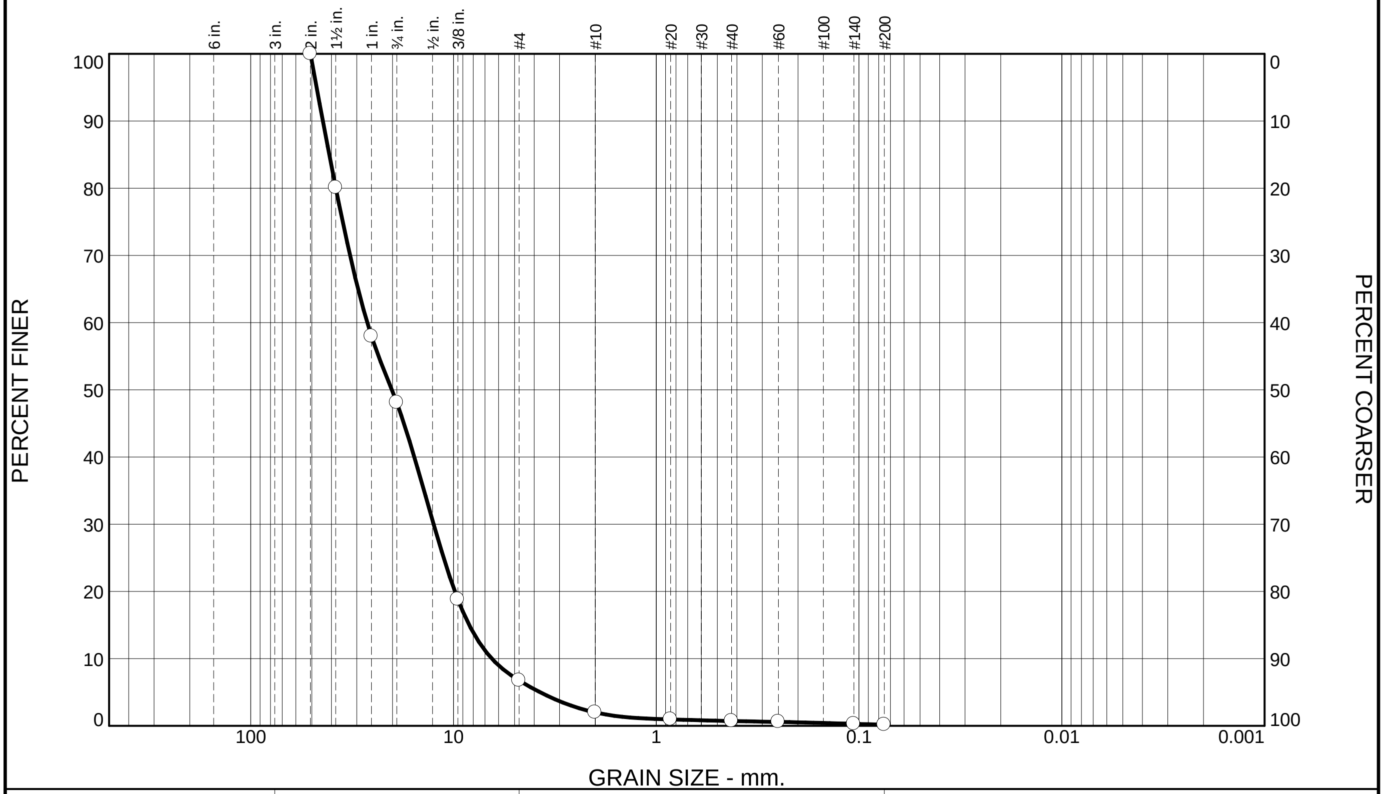
Source of Sample: B-6 **Depth:** 30-31.5
Sample Number: S-04

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	52	41	5	1	1	0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100		
1.5	80		
1	58		
3/4	48		
3/8	19		
#4	7		
#10	2		
#20	1		
#40	1		
#60	1		
#140	0		
#200	0.2		

* (no specification provided)

Soil Description

Gray gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 44.0963 D_{85}= 41.0141 D_{60}= 26.6693
D_{50}= 20.1288 D_{30}= 12.5388 D_{15}= 8.3745
D_{10}= 6.4815 C_u= 4.11 C_c= 0.91

Classification

USCS= GP AASHTO=

Remarks

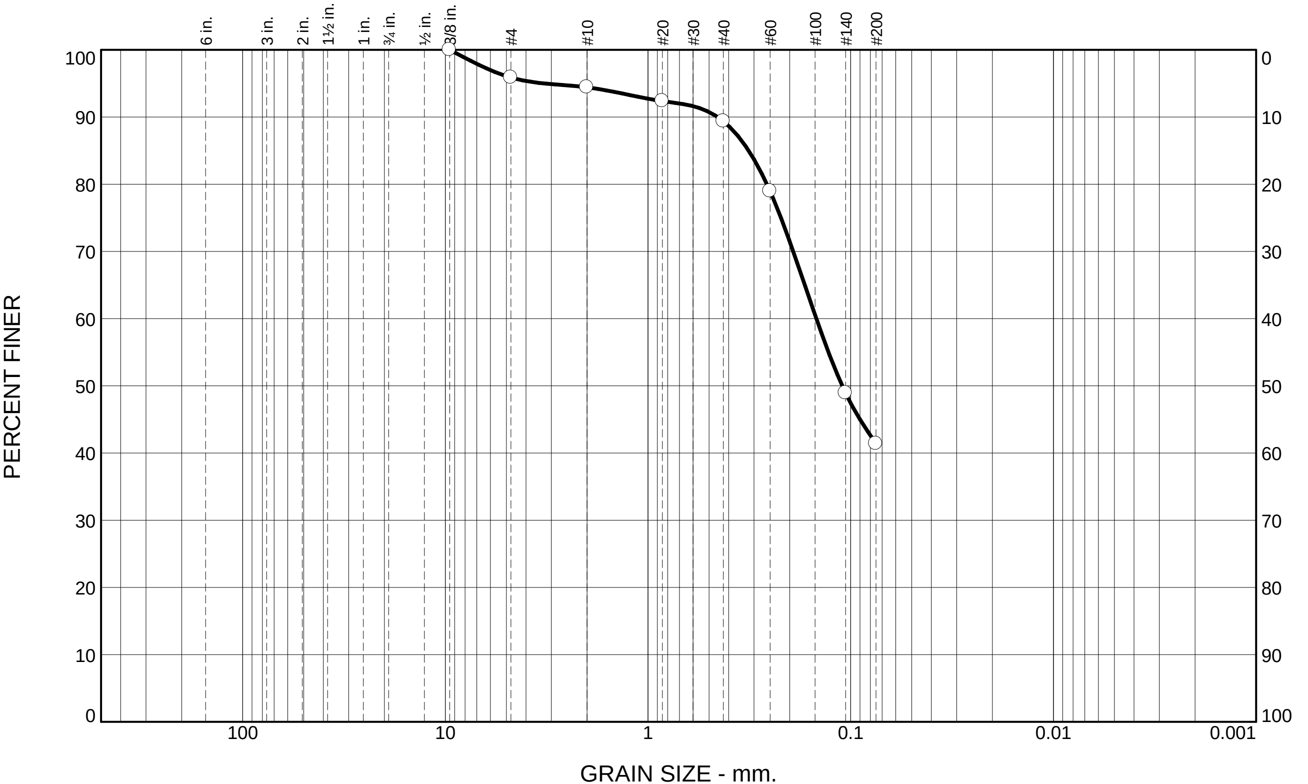
Source of Sample: B-6 **Depth:** 45-46.5
Sample Number: S-06

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	4	2	5	48	41	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100		
#4	96		
#10	94		
#20	92		
#40	89		
#60	79		
#140	49		
#200	41		

* (no specification provided)

Soil Description

Gray clayey sand with organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4544 D_{85}= 0.3191 D_{60}= 0.1478
D_{50}= 0.1102 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

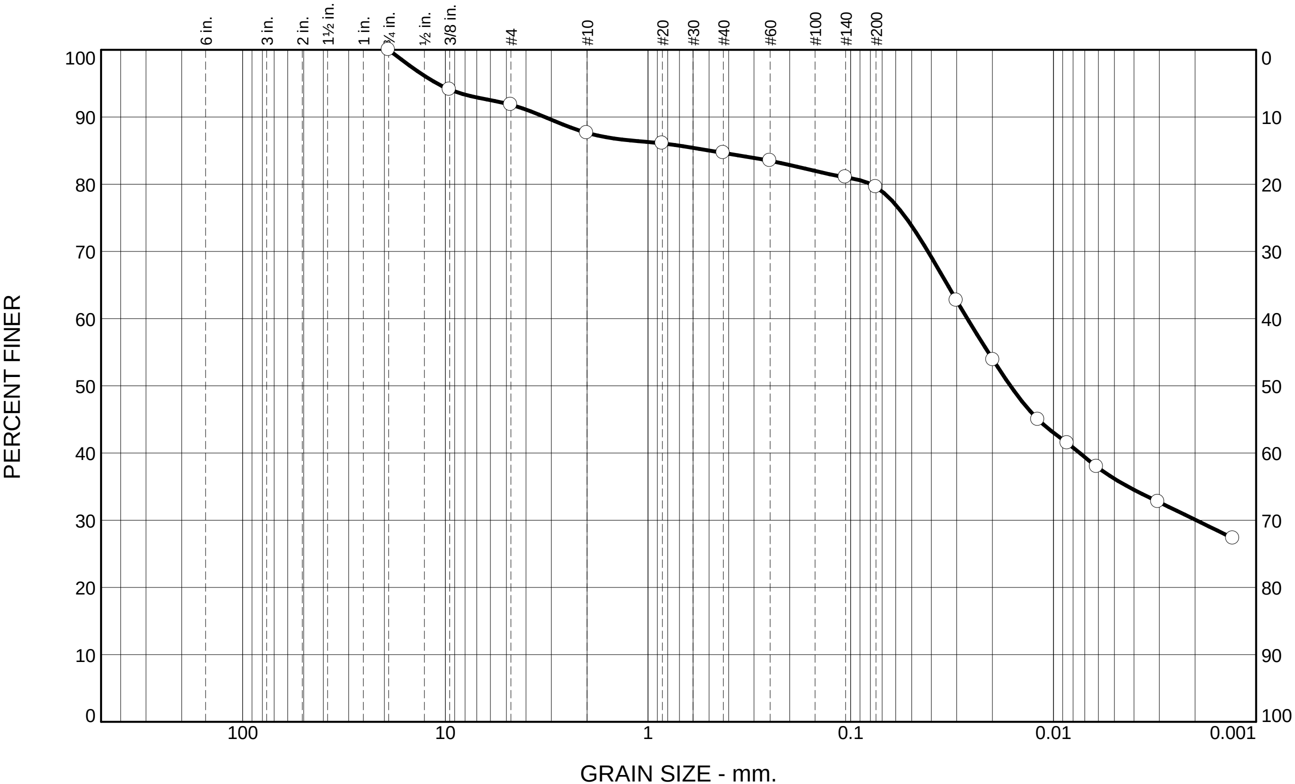
Source of Sample: B-7 **Depth:** 16.5-18
Sample Number: S-02

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	8	4	3	5	44	36

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	94		
#4	92		
#10	88		
#20	86		
#40	85		
#60	83		
#140	81		
#200	80		
0.0301 mm.	63		
0.0198 mm.	54		
0.0119 mm.	45		
0.0085 mm.	41		
0.0061 mm.	38		
0.0030 mm.	33		
0.0013 mm.	27		

* (no specification provided)

Soil Description

Black silt with sand and organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.2357 D_{85}= 0.4971 D_{60}= 0.0266
D_{50}= 0.0163 D_{30}= 0.0020 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

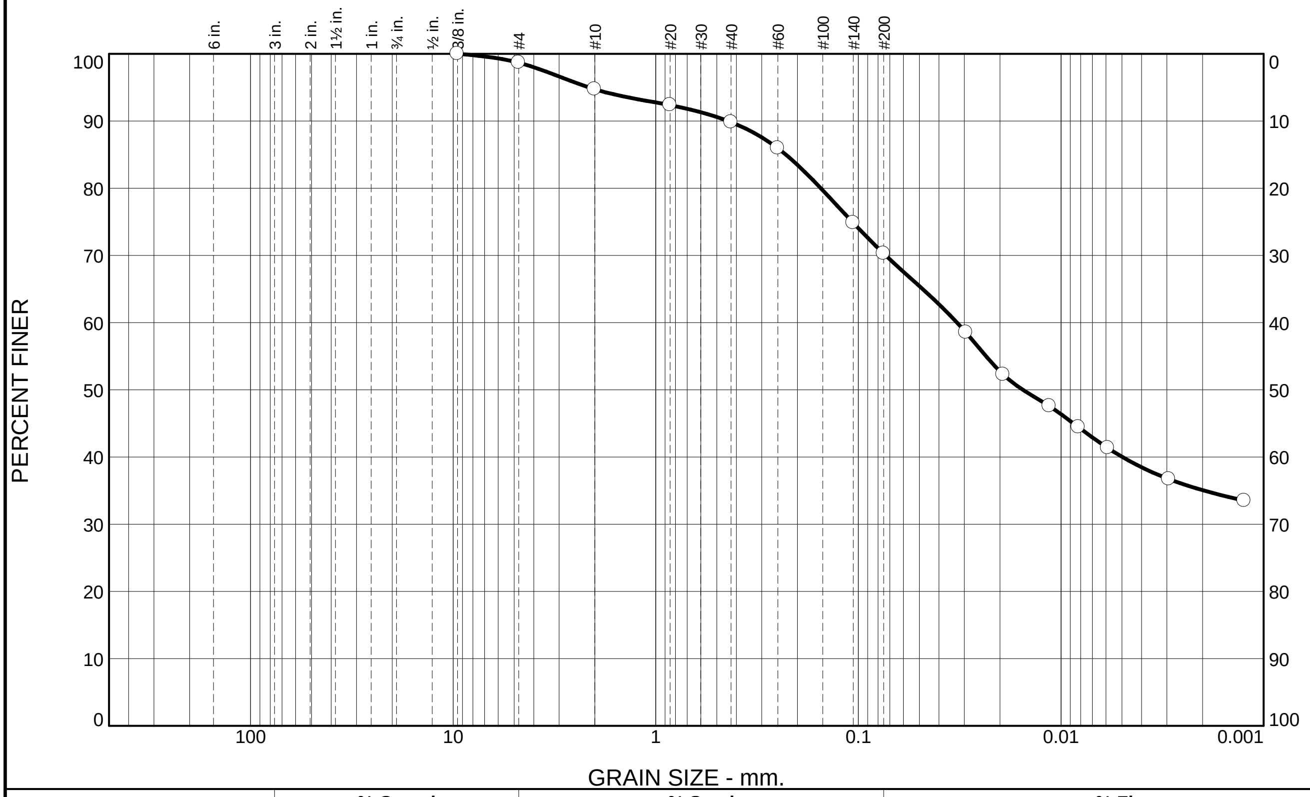
Source of Sample: B-8 **Depth:** 16-17.5
Sample Number: S-02

Date: 2-11-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	4	5	20	30	40

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100		
#4	99		
#10	95		
#20	92		
#40	90		
#60	86		
#140	75		
#200	70		
0.0294 mm.	59		
0.0193 mm.	52		
0.0114 mm.	48		
0.0082 mm.	44		
0.0059 mm.	41		
0.0029 mm.	37		
0.0012 mm.	33		

* (no specification provided)

Soil Description

Brown sandy clay

Atterberg Limits

PL= 22 LL= 62 PI= 40

Coefficients

D_{90}= 0.4406 D_{85}= 0.2283 D_{60}= 0.0326
D_{50}= 0.0154 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(27)

Remarks

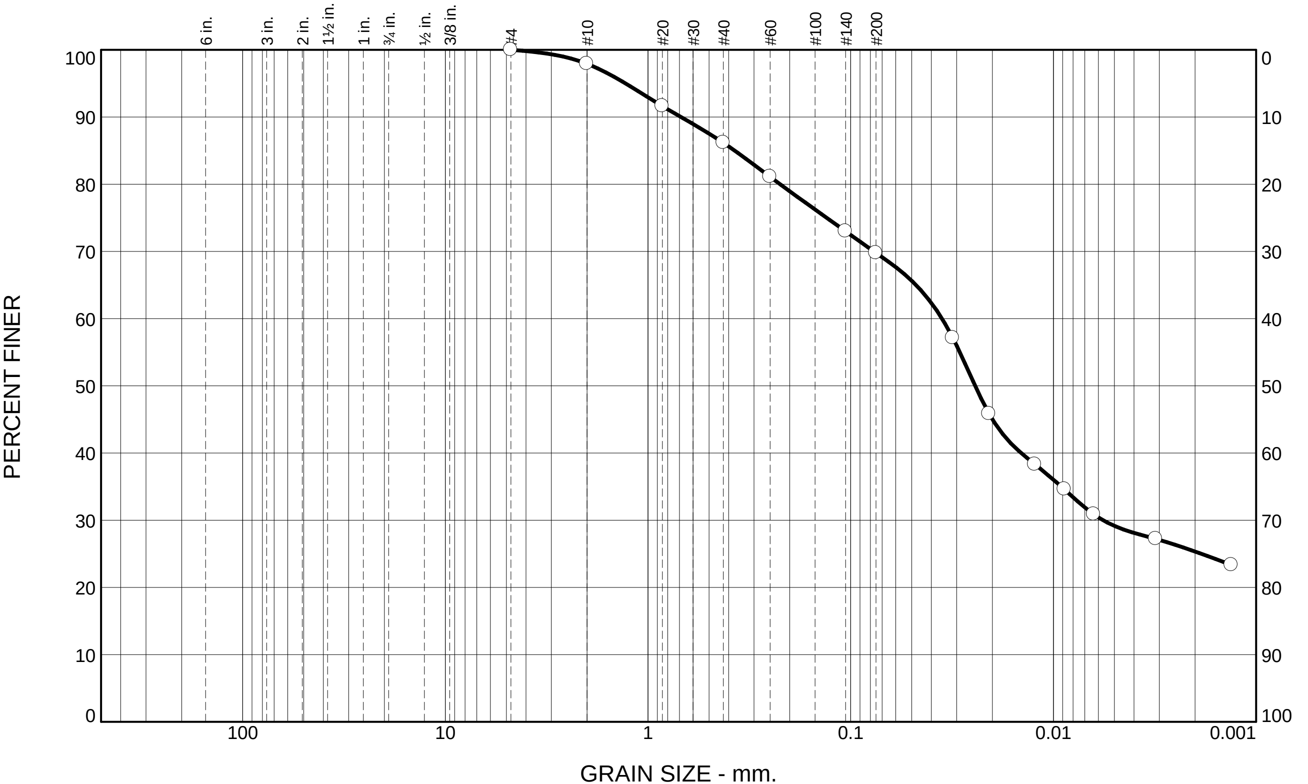
Source of Sample: B-14 **Depth:** 6.4-7.9
Sample Number: S-01

Date: 2-11-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	2	12	16	41	29

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	98		
#20	92		
#40	86		
#60	81		
#140	73		
#200	70		
0.0313 mm.	57		
0.0207 mm.	46		
0.0123 mm.	38		
0.0088 mm.	35		
0.0063 mm.	31		
0.0031 mm.	27		
0.0013 mm.	23		

* (no specification provided)

Soil Description

Brown sandy silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6889 D_{85}= 0.3736 D_{60}= 0.0355
D_{50}= 0.0243 D_{30}= 0.0057 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

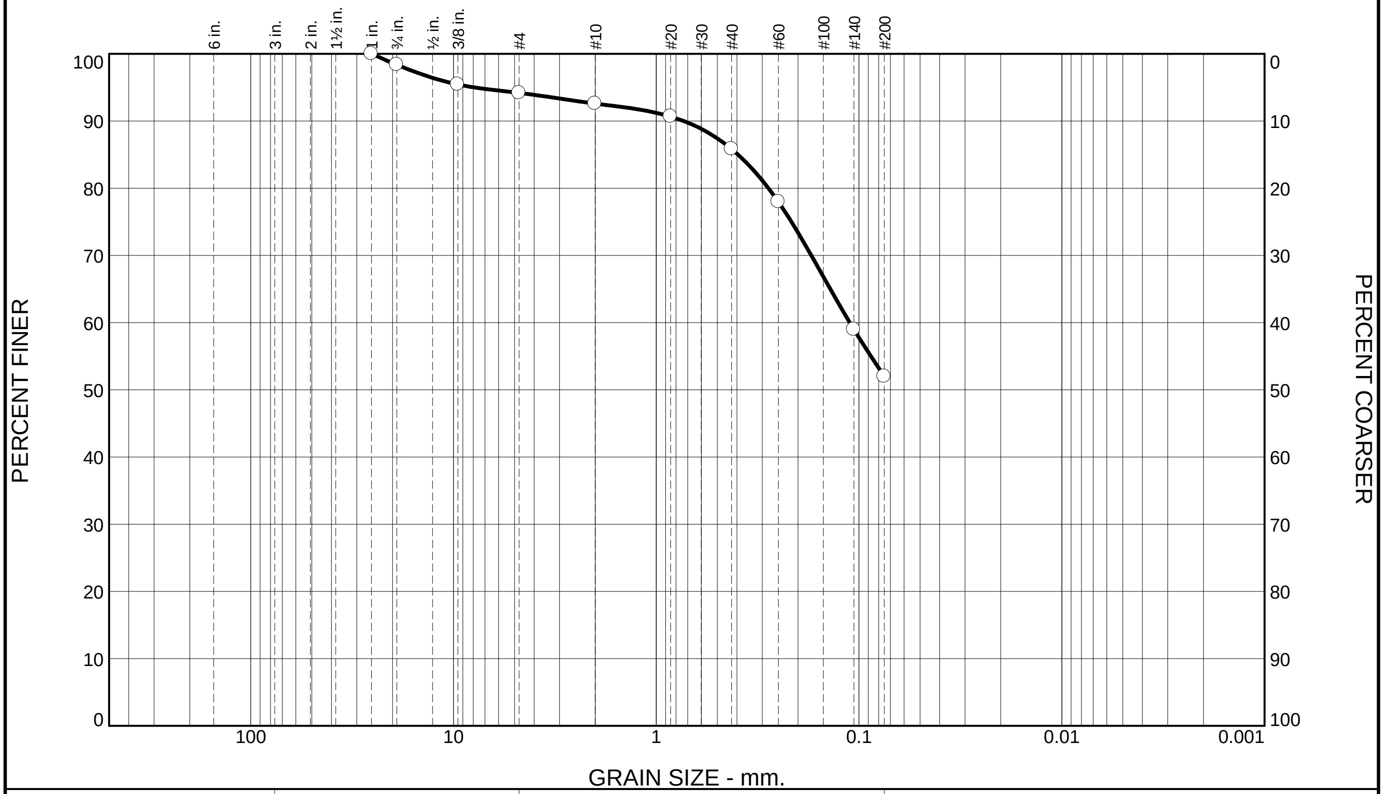
Source of Sample: B-19 **Depth:** 5-6.5
Sample Number: S-01

Date: 2-11-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	4	1	7	34	52	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100		
3/4	98		
3/8	95		
#4	94		
#10	93		
#20	91		
#40	86		
#60	78		
#140	59		
#200	52		

* (no specification provided)

Soil Description

Mottled grayish brown sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.7332 D_{85}= 0.3954 D_{60}= 0.1112
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

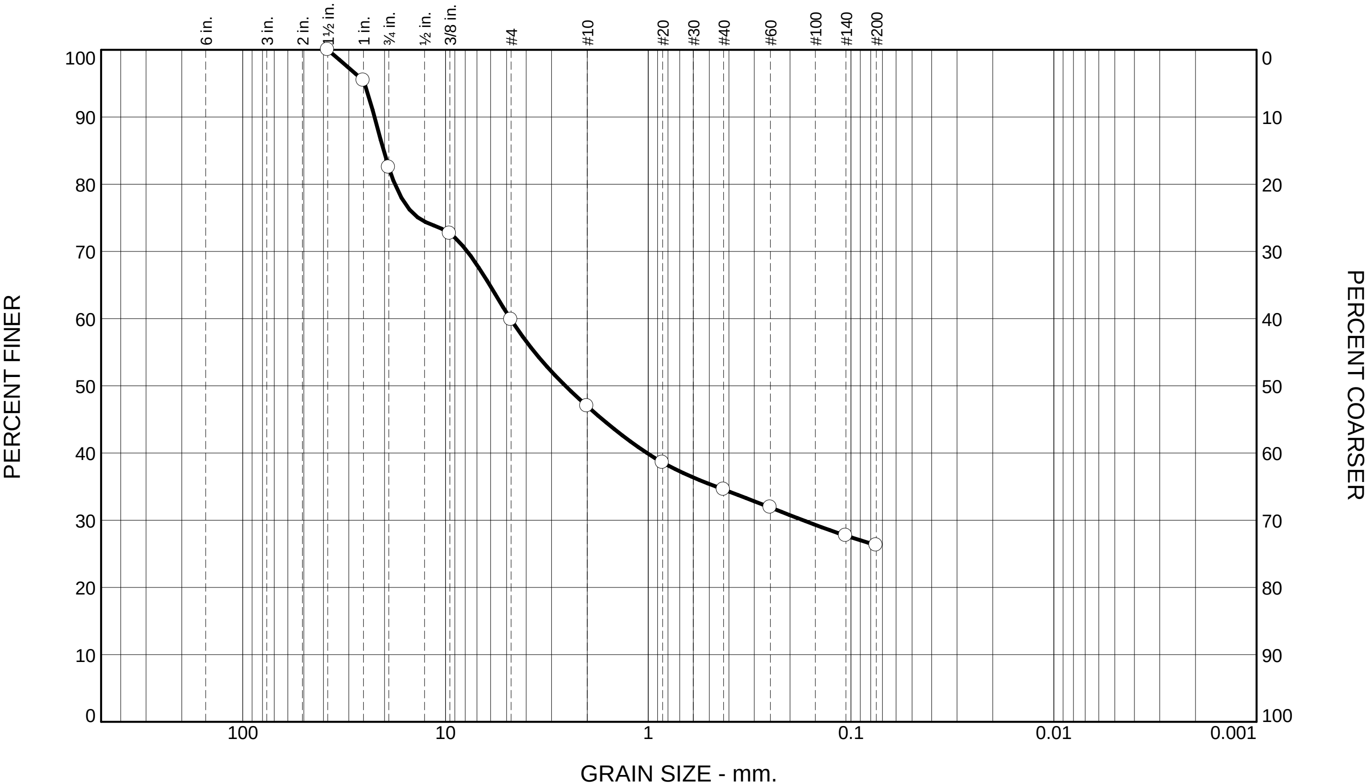
Remarks

Source of Sample: B-19 **Depth:** 15-16.5
Sample Number: S-03 **Date:** 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	18	22	13	12	9	26	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100		
1	95		
3/4	82		
3/8	73		
#4	60		
#10	47		
#20	39		
#40	35		
#60	32		
#140	28		
#200	26		

* (no specification provided)

Soil Description

Grayish brown clayey gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 22.3903 D_{85}= 20.1845 D_{60}= 4.7896
D_{50}= 2.5659 D_{30}= 0.1726 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO=

Remarks

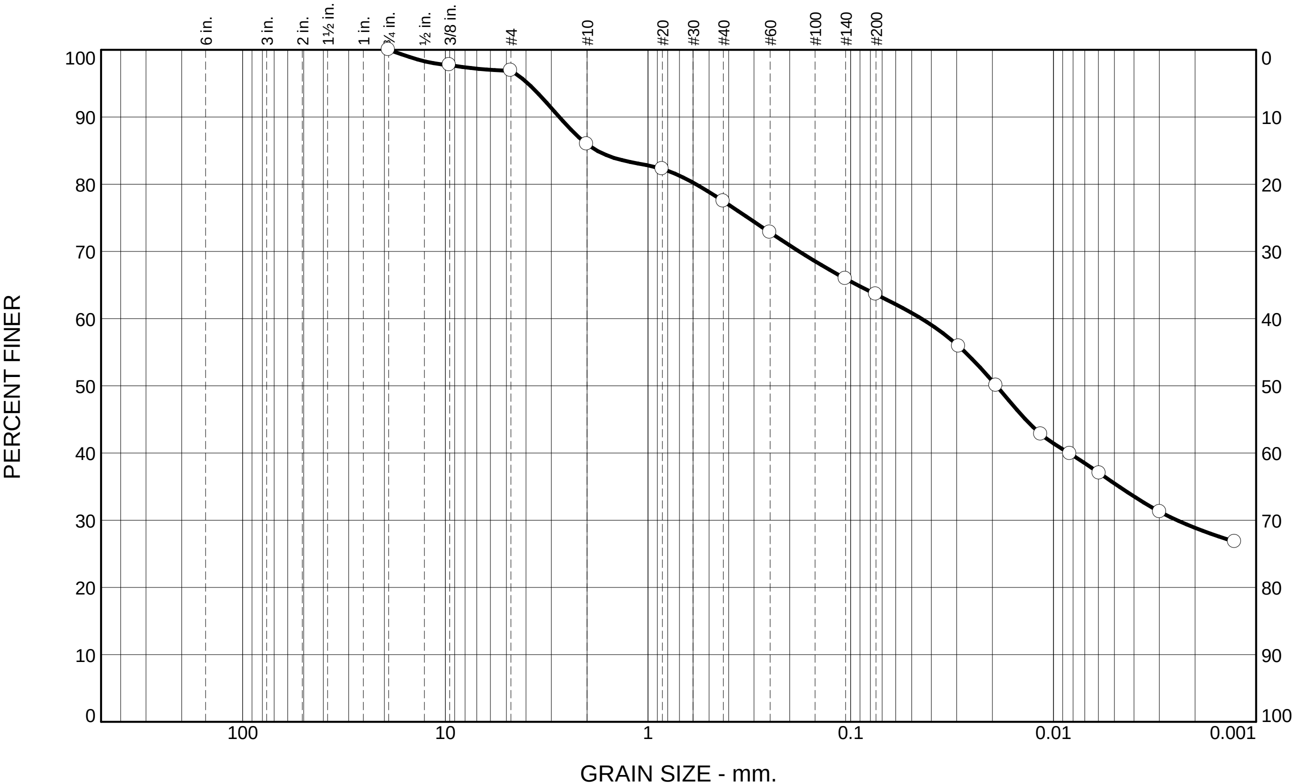
Source of Sample: B-19 **Depth:** 20-21.5
Sample Number: S-04

Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	11	9	13	29	35

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	98		
#4	97		
#10	86		
#20	82		
#40	77		
#60	73		
#140	66		
#200	64		
0.0292 mm.	56		
0.0191 mm.	50		
0.0115 mm.	43		
0.0083 mm.	40		
0.0059 mm.	37		
0.0030 mm.	31		
0.0013 mm.	27		

* (no specification provided)

Soil Description

Brown sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.7420 D_{85}= 1.7874 D_{60}= 0.0448
D_{50}= 0.0191 D_{30}= 0.0025 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO=

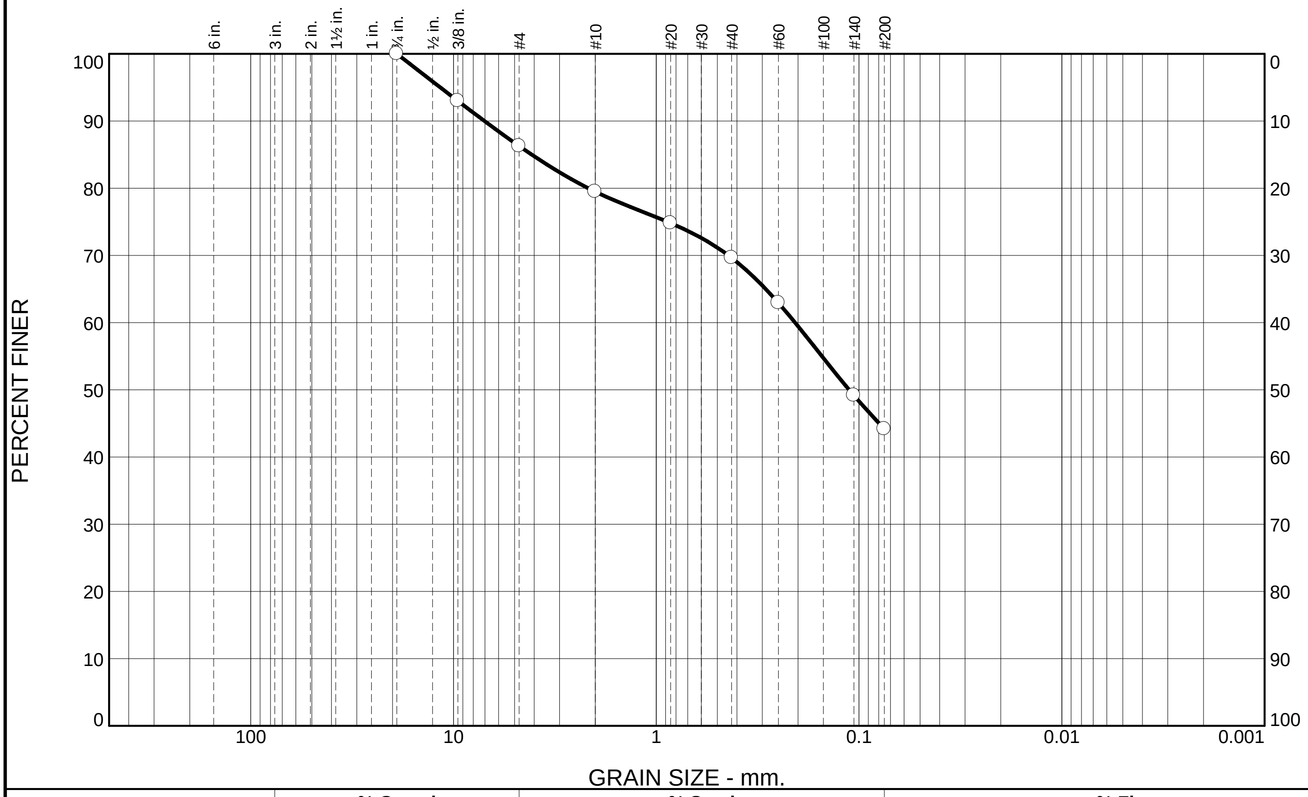
Remarks

Source of Sample: B-20 **Depth:** 10-11.5
Sample Number: S-02 **Date:** 2-11-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	14	7	9	26	44	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	93		
#4	86		
#10	79		
#20	75		
#40	70		
#60	63		
#140	49		
#200	44		

* (no specification provided)

Soil Description

Grayish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 7.0418 D_{85}= 4.1173 D_{60}= 0.2068
D_{50}= 0.1119 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

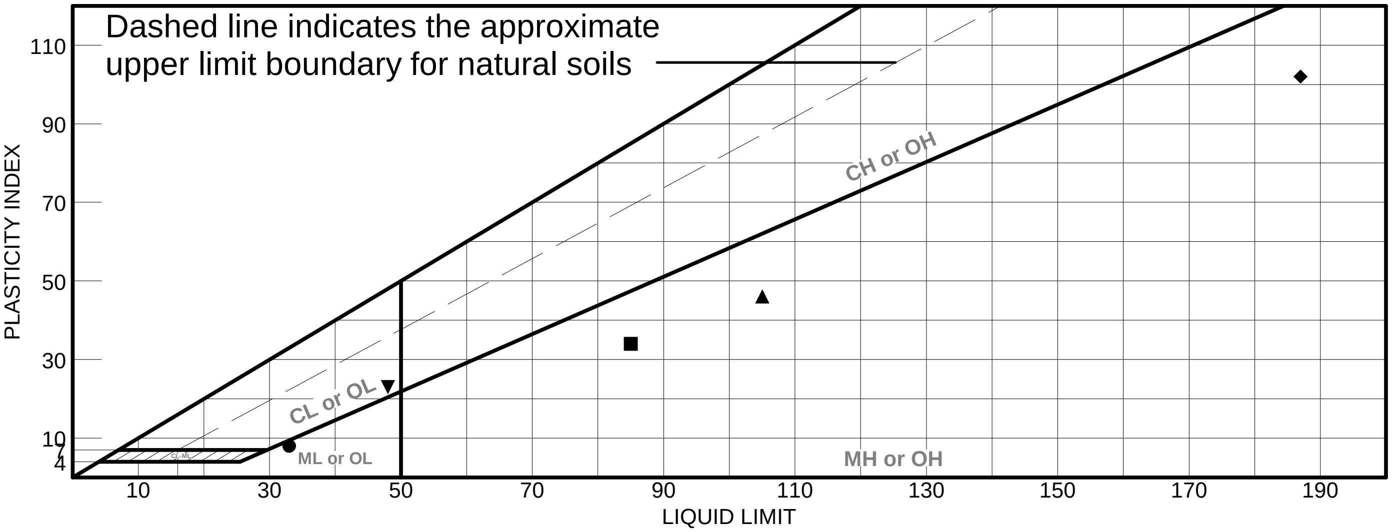
Source of Sample: B-20 **Depth:** 20-21.5
Sample Number: S-04

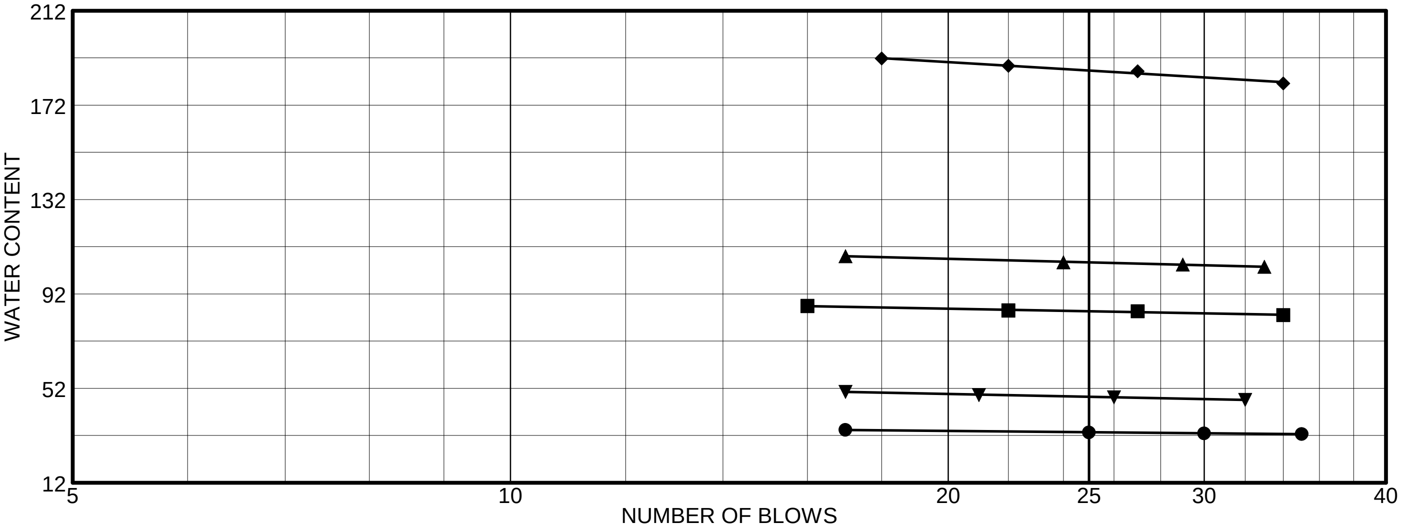
Date: 2-1-19

Client: AECOM
Project: Klamath River Dam Removal Project
60537920
Project No: 2301-069.0 **Figure**

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Olive Gray Sandy SILT	33	25	8			
■	Olive Gray Elastic SILT	85	51	34	99.9	99.0	MH
▲	Gray Elastic SILT	105	59	46	99.7	99.3	MH
◆	Gray Elastic SILT	187	85	102	99.6	99.5	MH
▼	Dark Olive Brown Sandy Lean CLAY	48	25	23			

Project No. 020-251 **Client:** AECOM

Project: Klamath River Dam Removal Project - 60537920

● **Source:** BC-01 **Sample No.:** S-02 **Elev./Depth:** 6.5'
■ **Source:** BC-01 **Sample No.:** S-04 **Elev./Depth:** 21.5'
▲ **Source:** BC-02 **Sample No.:** S-05 **Elev./Depth:** 14.5'
◆ **Source:** BC-02 **Sample No.:** S-09 **Elev./Depth:** 44.5'
▼ **Source:** BC-03 **Sample No.:** S-01 **Elev./Depth:** 1'

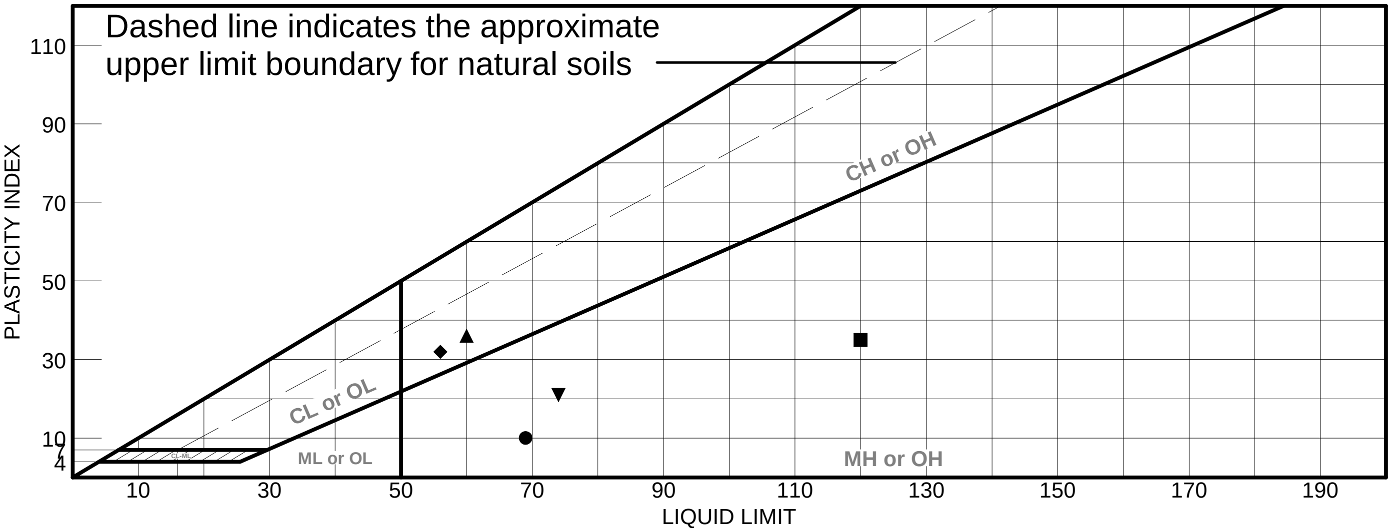
Remarks:
●
■
▲
◆
▼

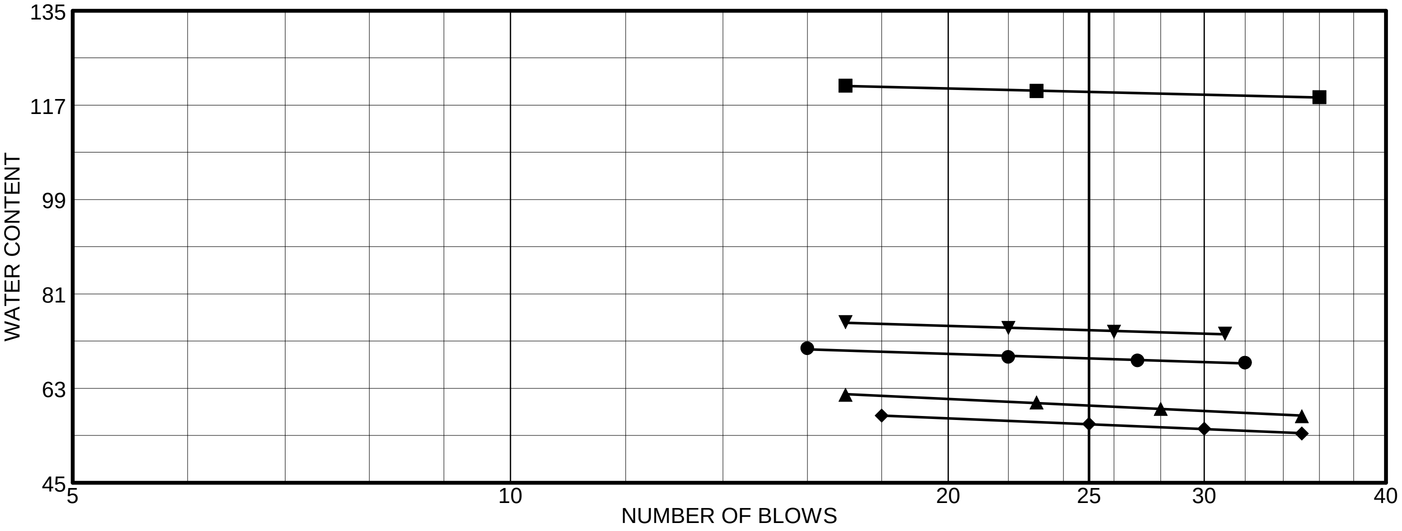
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light Olive Brown Elastic SILT	69	59	10	100.0	100.0	MH
■	Pale Brown Mottled Gray Elastic SILT	120	85	35	99.4	99.1	MH
▲	Very Dark Olive Brown Sandy Fat CLAY w/ Gravel	60	24	36			
◆	Dark Reddish Brown Sandy Fat CLAY	56	24	32			
▼	Dark Gray Elastic SILT	74	53	21	99.9	99.7	MH

Project No. 020-251 **Client:** AECOM

Project: Klamath River Dam Removal Project - 60537920

● **Source:** BC-03 **Sample No.:** S-05 **Elev./Depth:** 24.5'
■ **Source:** BC-04 **Sample No.:** S-08 **Elev./Depth:** 32.5(Tip-16")
▲ **Source:** BC-07 **Sample No.:** S02 **Elev./Depth:** 4-4.5'
◆ **Source:** BC-08 **Sample No.:** S-01 **Elev./Depth:** 3.0'
▼ **Source:** BC-09 **Sample No.:** S-05 **Elev./Depth:** 23(Tip-5")

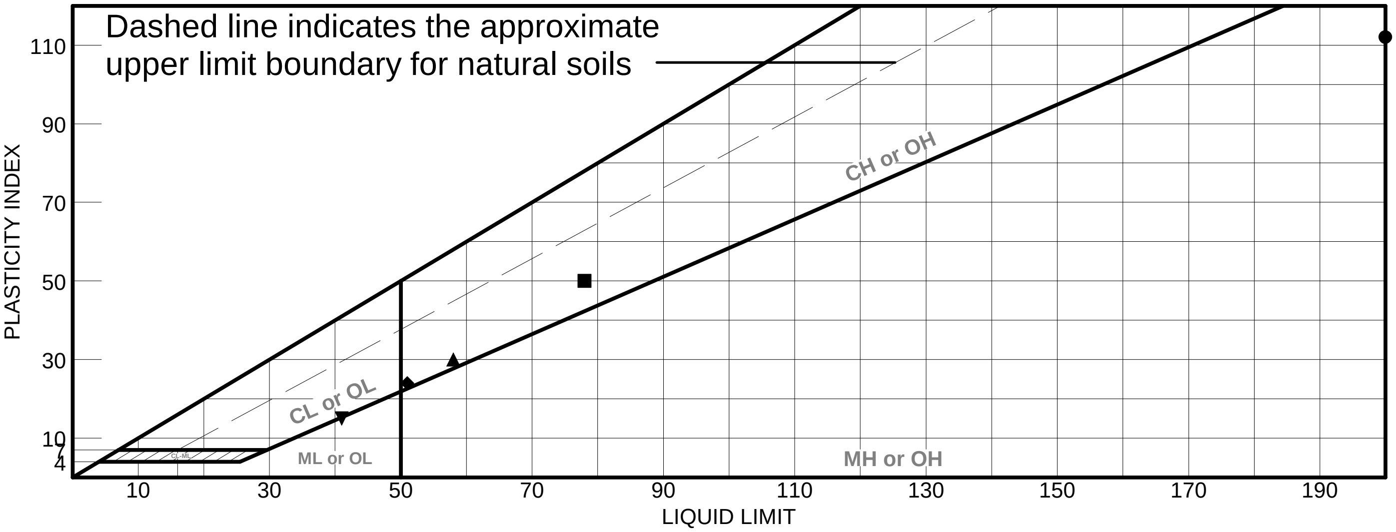
Remarks:
●
■
▲
◆
▼

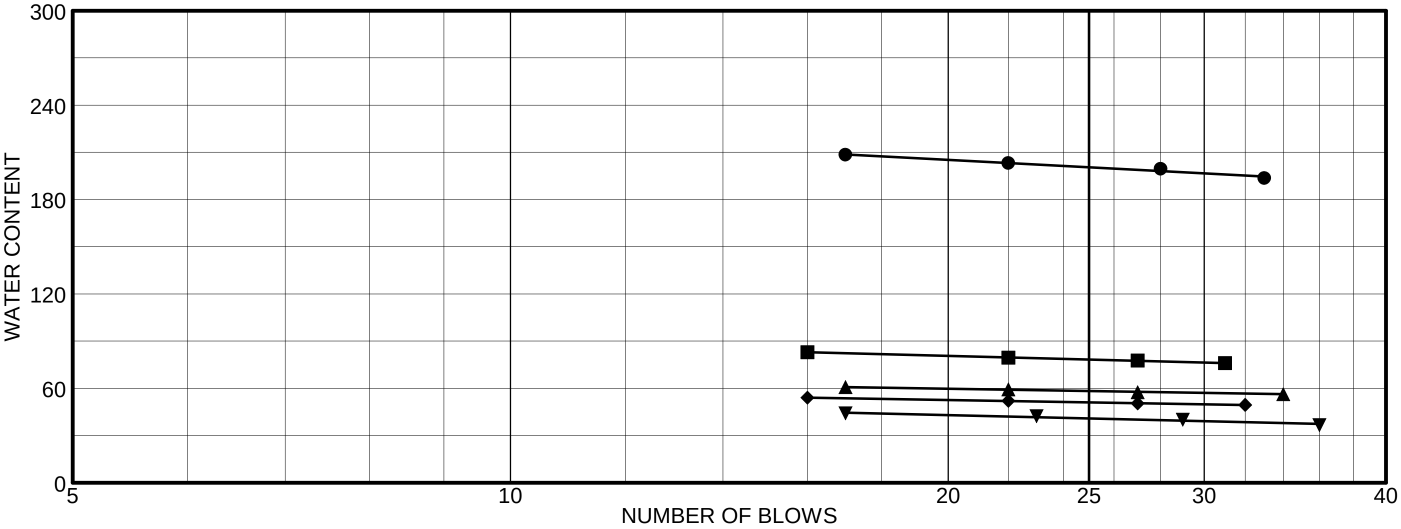
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light Olive Brown Elastic SILT	200	88	112	99.6	99.0	MH
■	Dark Reddish Brown Sandy Fat CLAY	78	28	50	77.6	68.3	CH
▲	Yellowish Brown Sandy Fat CLAY	58	28	30	79.1	62.5	CH
◆	Yellowish Brown Sandy Fat CLAY	51	27	24	83.9	52.9	CH
▼	Olive Gray Poorly Graded GRAVEL w/ Silt & Sand	41	26	15	15.9	9.0	GP-GM

Project No. 020-251 **Client:** AECOM

Project: Klamath River Dam Removal Project - 60537920

● **Source:** BC-08A	**Sample No.:** S-05	**Elev./Depth:** 54'
■ **Source:** BI-02	**Sample No.:** S-01	**Elev./Depth:** 5'
▲ **Source:** BI-02	**Sample No.:** S-02	**Elev./Depth:** 10'
◆ **Source:** BI-02	**Sample No.:** S-03	**Elev./Depth:** 15'
▼ **Source:** BI-03	**Sample No.:** S-01	**Elev./Depth:** 3.5'

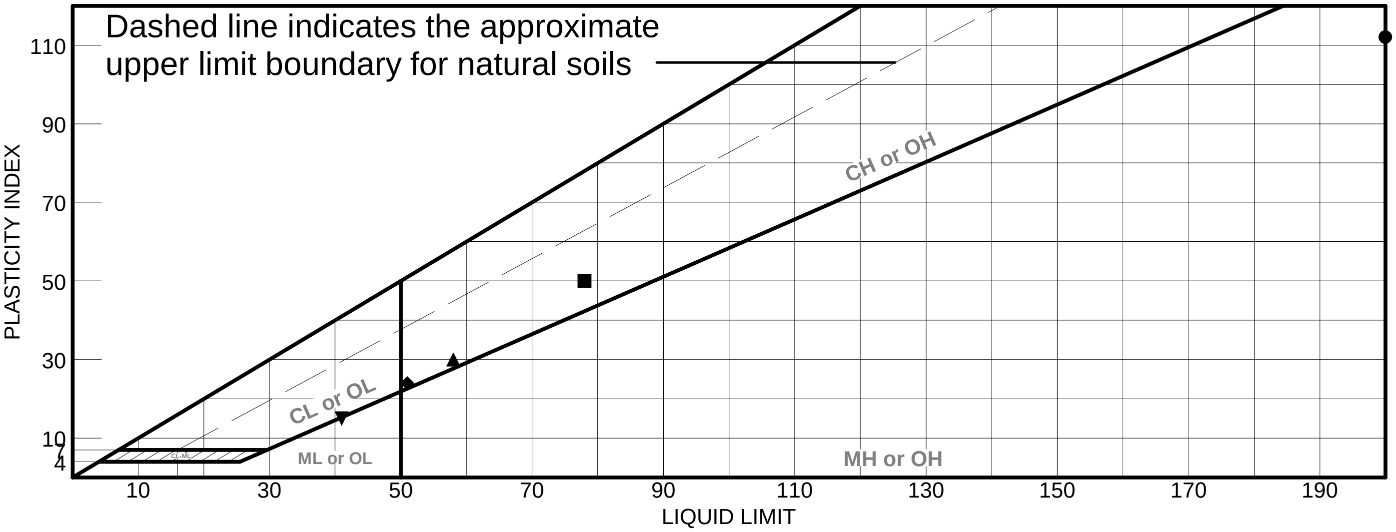
Remarks:
●
■
▲
◆
▼

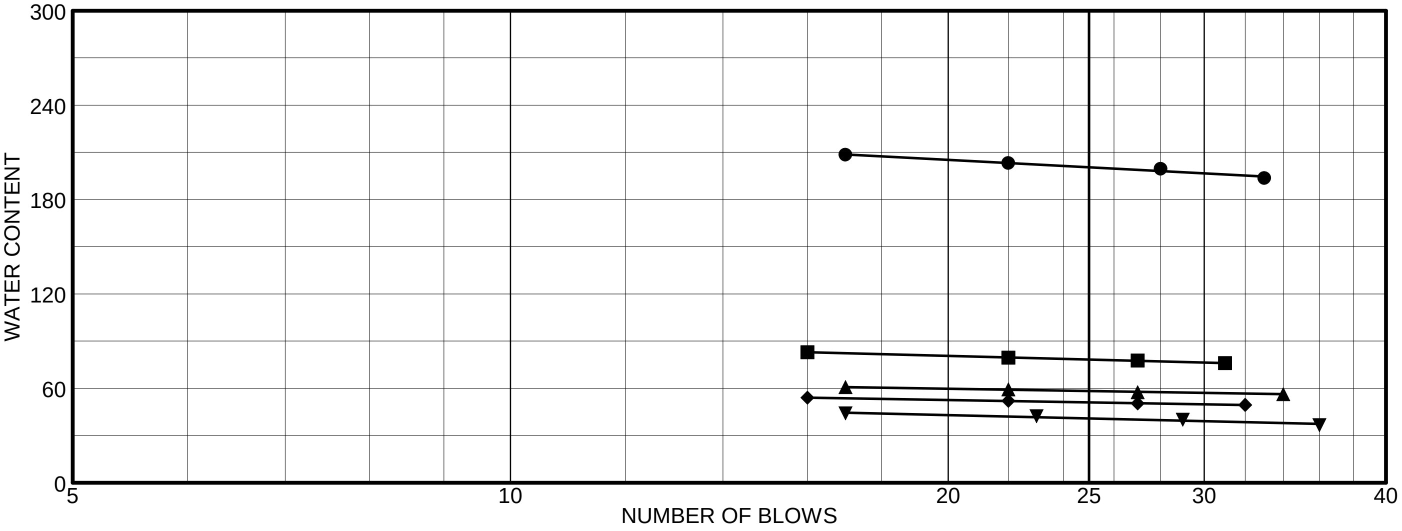
LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light Olive Brown Elastic SILT	200	88	112	99.6	99.0	MH
■	Dark Reddish Brown Sandy Fat CLAY	78	28	50	77.6	68.3	CH
▲	Yellowish Brown Sandy Fat CLAY	58	28	30	79.1	62.5	CH
◆	Yellowish Brown Sandy Fat CLAY	51	27	24	83.9	52.9	CH
▼	Olive Gray Poorly Graded GRAVEL w/ Silt & Sand	41	26	15	15.9	9.0	GP-GM

Project No. 020-251 **Client:** AECOM

Project: Klamath River Dam Removal Project - 60537920

● **Source:** BC-08A **Sample No.:** S-05 **Elev./Depth:** 54'
■ **Source:** BI-02 **Sample No.:** S-01 **Elev./Depth:** 5'
▲ **Source:** BI-02 **Sample No.:** S-02 **Elev./Depth:** 10'
◆ **Source:** BI-02 **Sample No.:** S-03 **Elev./Depth:** 15'
▼ **Source:** BI-03 **Sample No.:** S-01 **Elev./Depth:** 3.5'

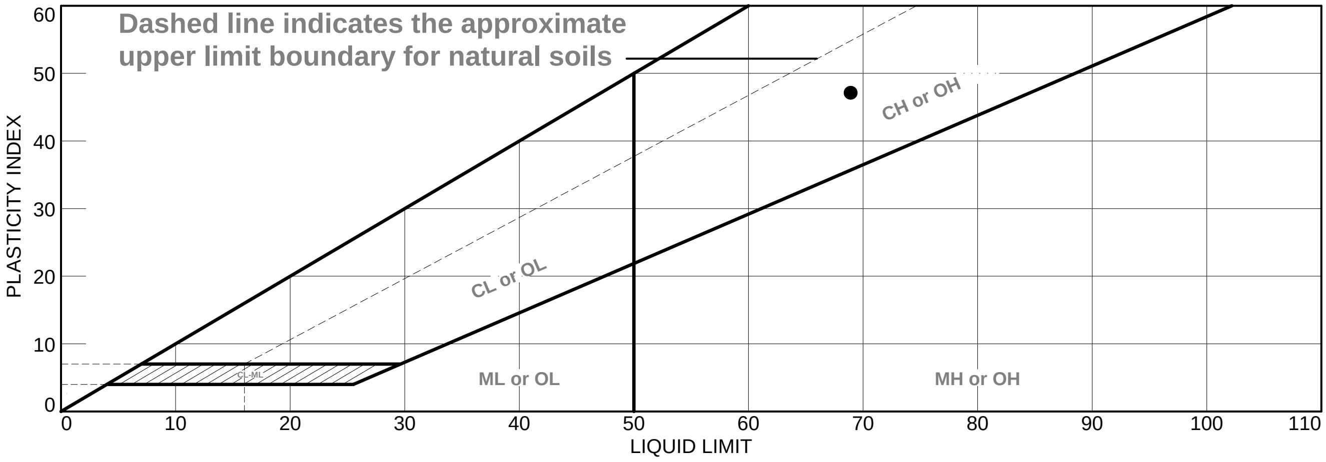
Remarks:
●
■
▲
◆
▼

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown clay with sand	69	22	47			CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project
60537920

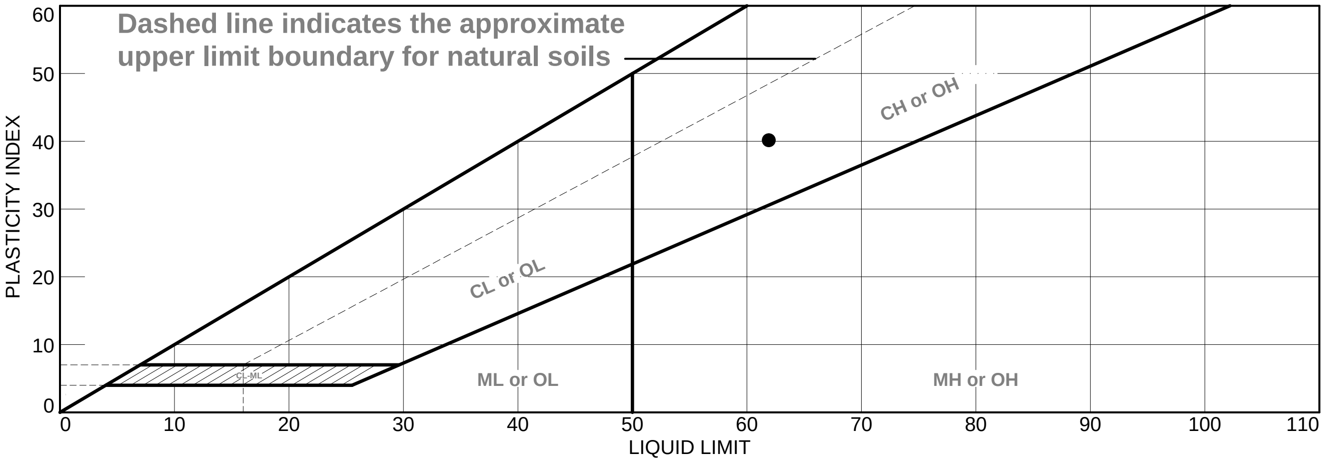
● **Source of Sample:** B-8 **Depth:** 13-14.5 **Sample Number:** S-01

Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown sandy clay	62	22	40	90	70	CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project

60537920

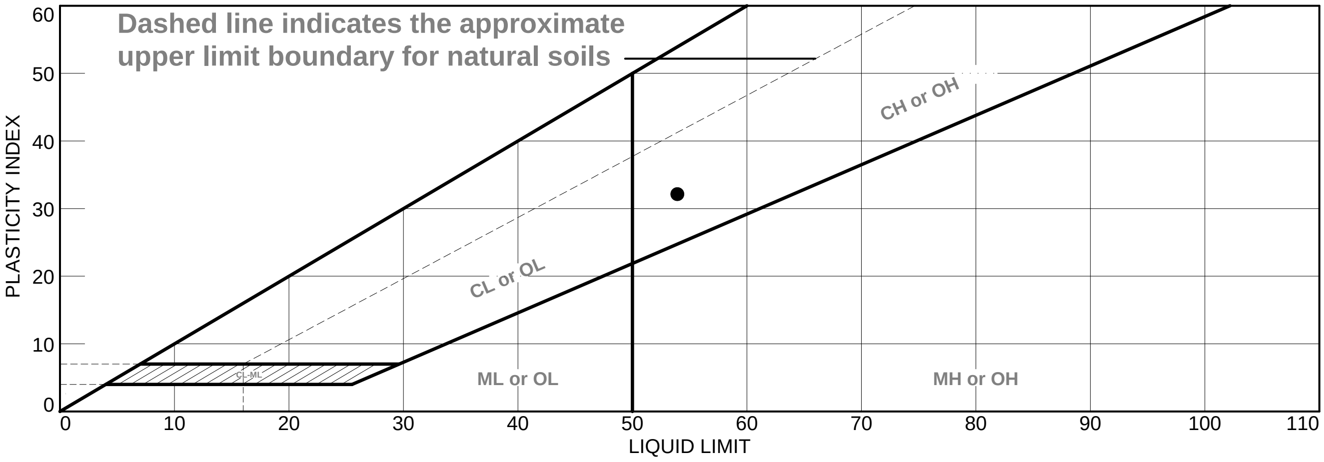
● **Source of Sample:** B-14 **Depth:** 6.4-7.9 **Sample Number:** S-01

Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay	54	22	32			CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project

60537920

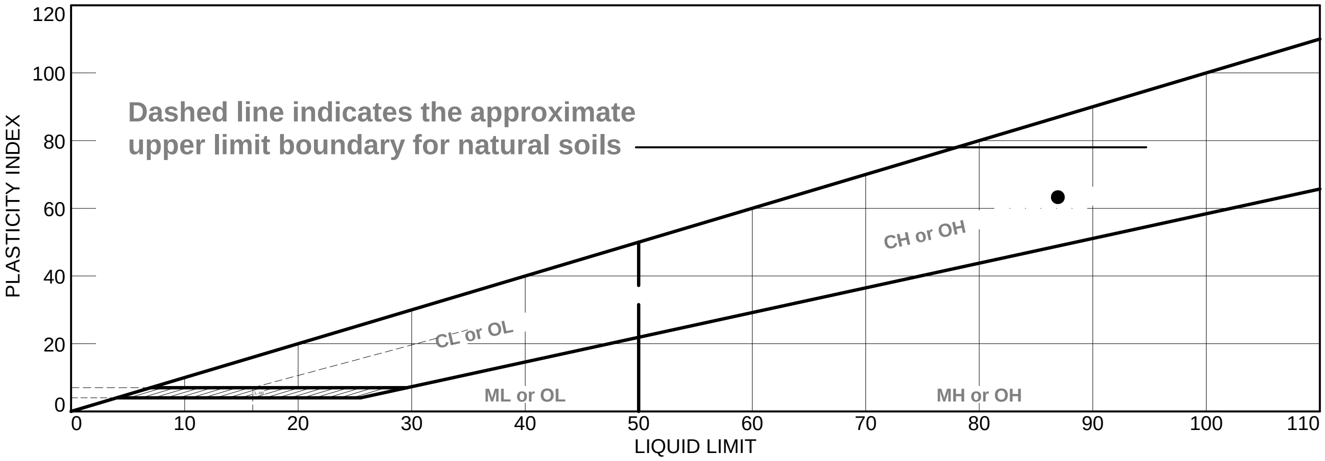
● **Source of Sample:** B-19 **Depth:** 10-11.5 **Sample Number:** S-02

Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay	87	24	63			CH

Project No. 2301-069.0 **Client:** AECOM

Project: Klamath River Dam Removal Project

60537920

● **Source of Sample:** B-20 **Depth:** 5-6.5 **Sample Number:** S-01

Remarks:

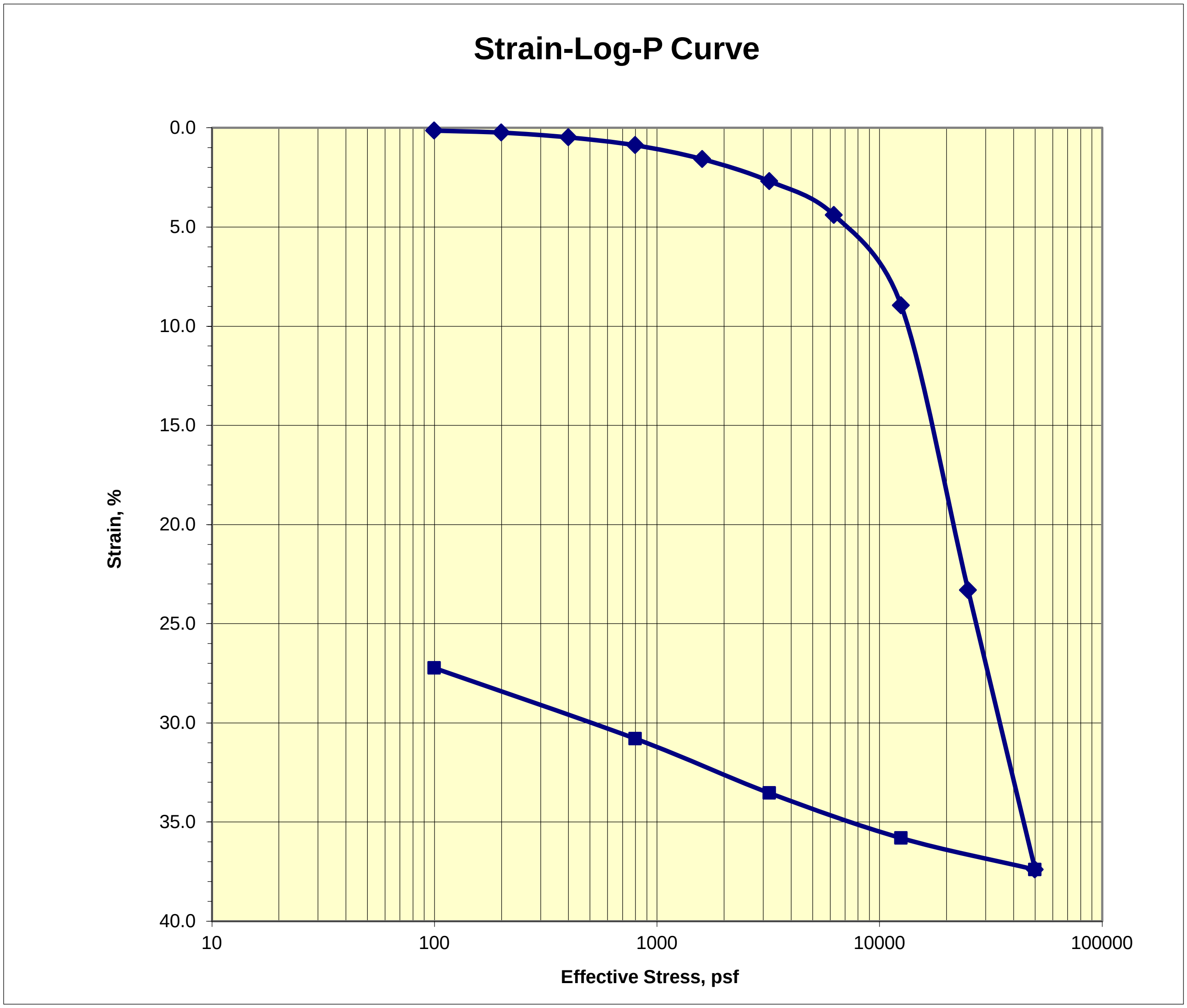
Figure

Tested By: JH **Checked By:** JH

Consolidation Test

ASTM D2435

Job No.:	020-251	**Boring:**	BC-04	**Run By:**	MD
Client:	AECOM	**Sample:**	S-08	**Reduced:**	PJ
Project:	60537920	**Depth, ft.:**	32.5(Tip-2")	**Checked:**	PJ/DC
Soil Type:	Pale Brown Mottled Gray Elastic SILT			**Date:**	6/1/2018



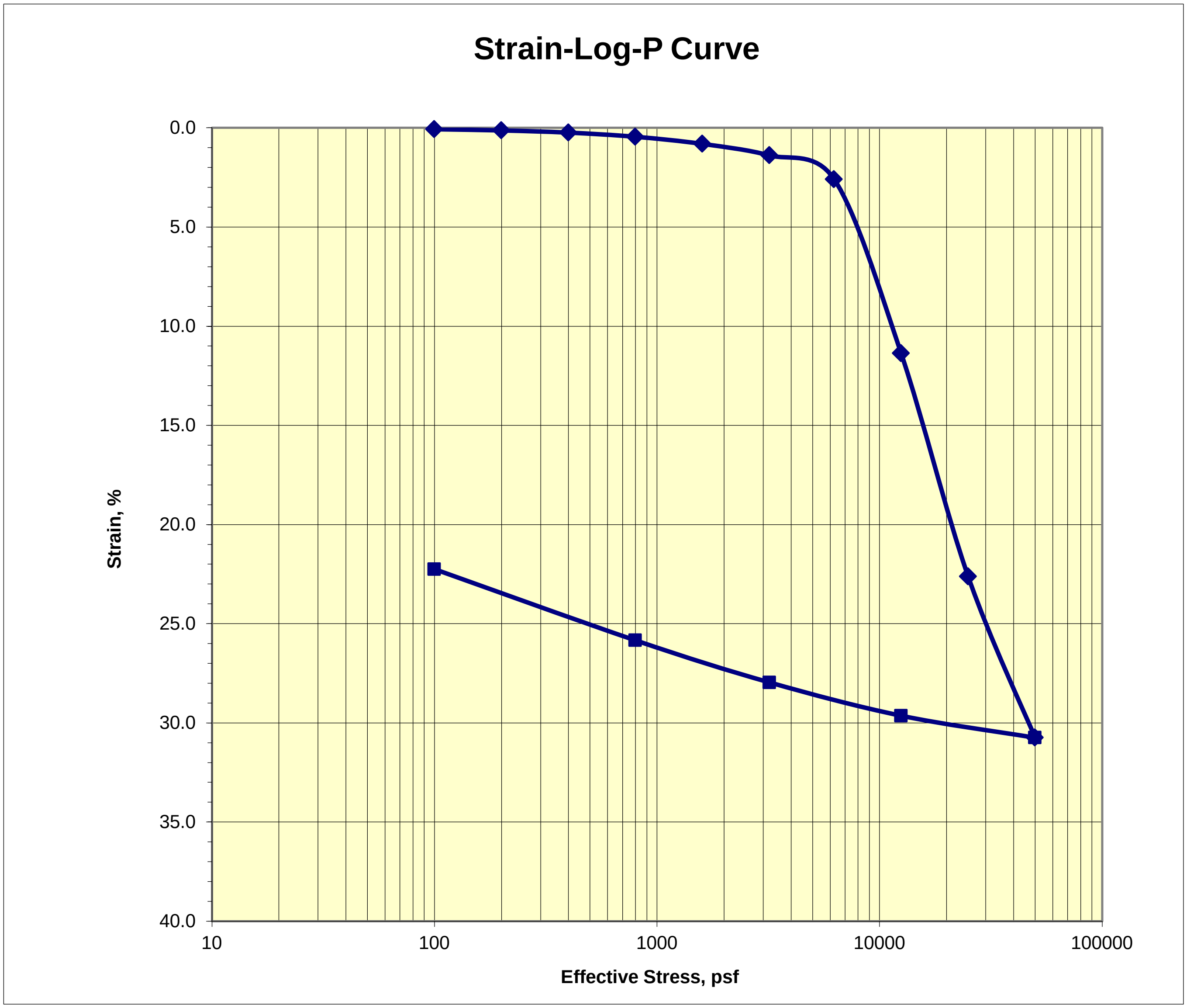
Assumed Gs 2.6	**Initial**	**Final**
Moisture %:	149.5	104.4
Dry Density, pcf:	32.1	43.7
Void Ratio:	4.058	2.715
% Saturation:	95.8	100.0

Remarks:

COOPER
TESTING LABORATORY

Consolidation Test
ASTM D2435

Job No.:	020-251	**Boring:**	BC-09	**Run By:**	MD
Client:	AECOM	**Sample:**	S-09	**Reduced:**	PJ
Project:	60537920	**Depth, ft.:**	68-70.5(Tip-20")	**Checked:**	PJ/DC
Soil Type:	Dark Greenish Gray CLAY (Silty)			**Date:**	6/1/2018

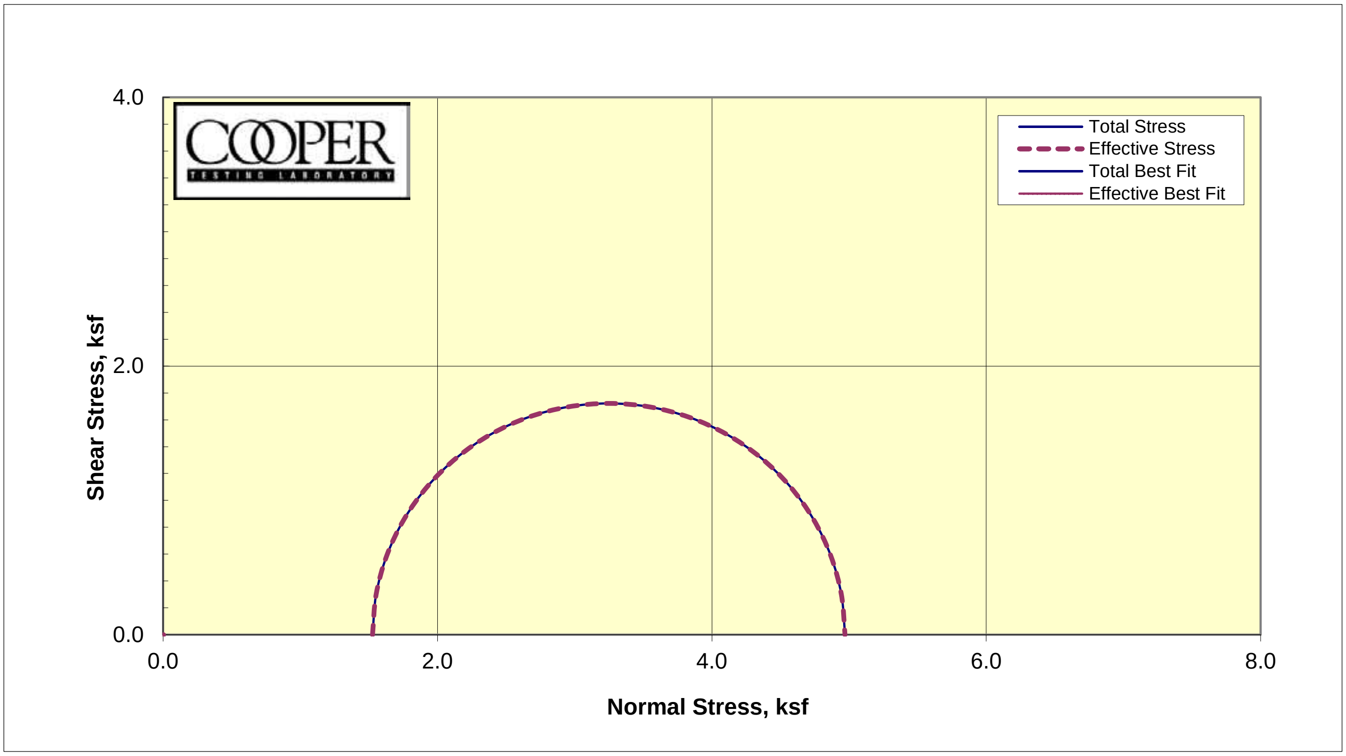


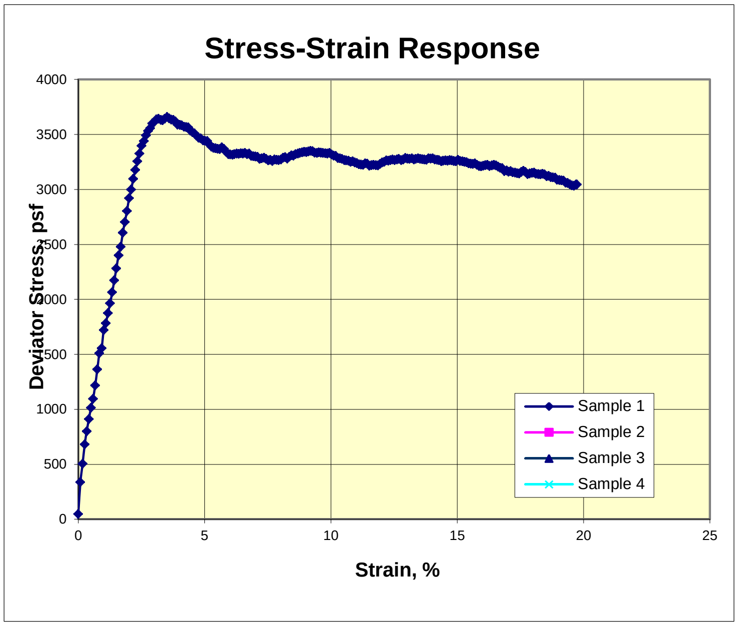
Assumed Gs 2.6	Initial	Final
Moisture %:	88.4	60.3
Dry Density, pcf:	48.6	63.2
Void Ratio:	2.340	1.568
% Saturation:	98.2	100.0

Remarks:

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





Job No.: 020-251 **Date:** 5/24/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-04_S-10 @ 52.5(Tip-18") Bluish Gray CLAY (Silty)

Sample 2)

Sample 3)

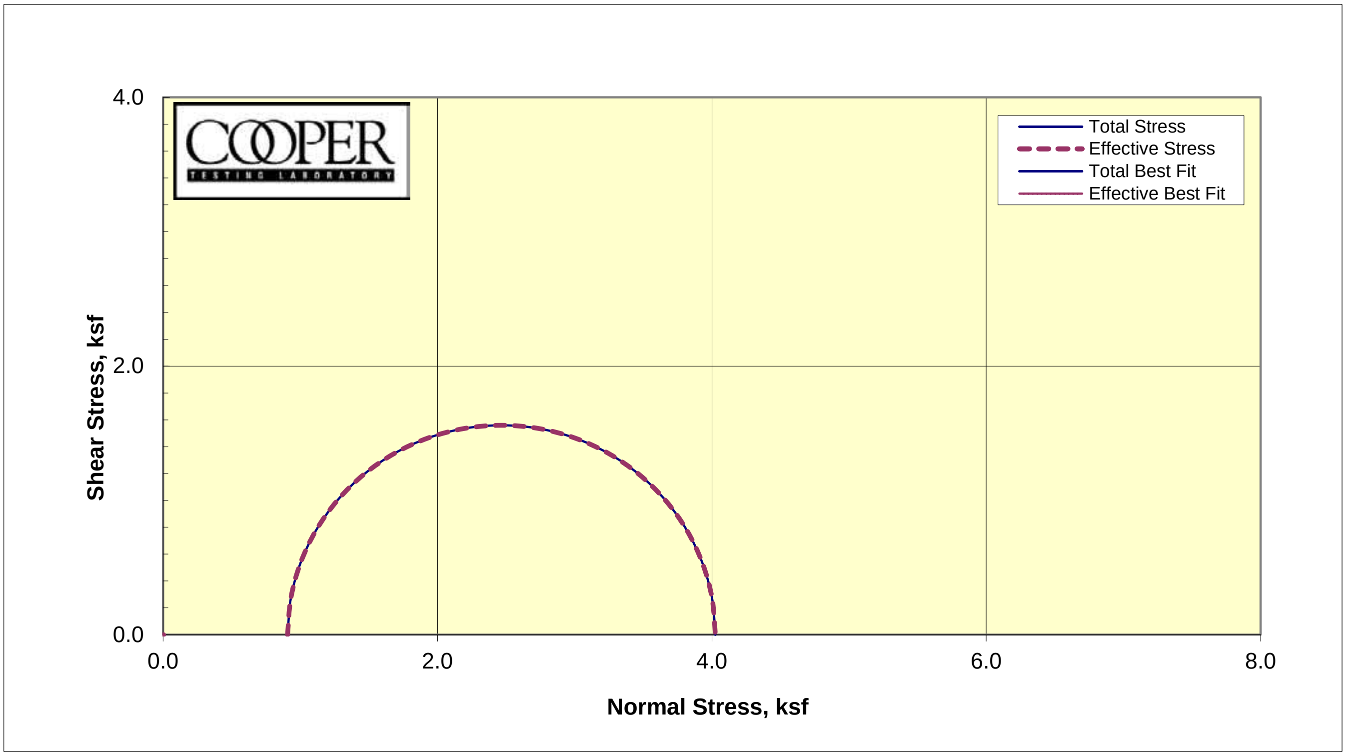
Sample 4)

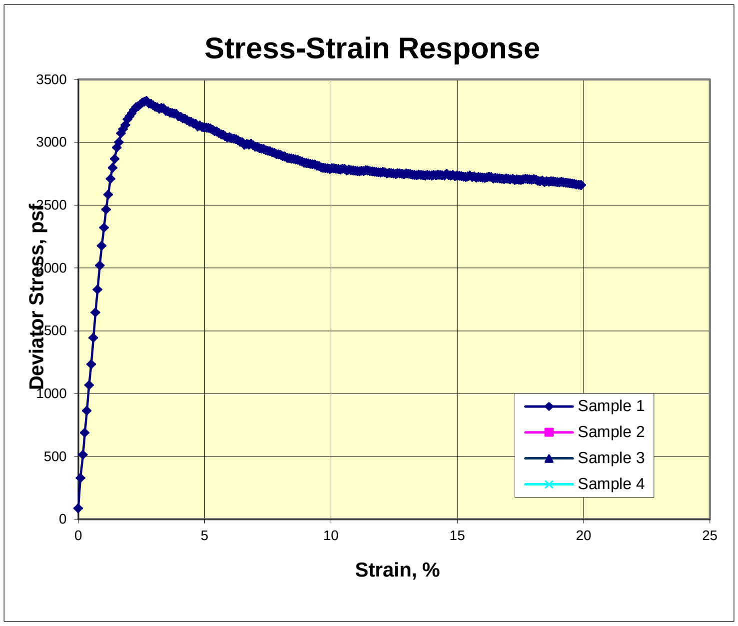
REMARKS: Strengths picked at 5% strain.
*Sample was back-pressure saturated prior to shear.

Sample:	**1**	**2**	**3**	**4**
MC, %	160.5			
Dry Dens, pcf	30.5			
Sat. %	95.9			
Void Ratio	4.519			
Diameter in	2.87			
Height, in	6.08			
	Final			
MC, %	163.5			
Dry Dens, pcf	31.1			
Sat. %	100.0			
Void Ratio	4.414			
Diameter, in	2.84			
Height, in	6.08			
Cell, psi	49.1			
BP, psi	38.5			
	Effective Stresses At:			
Strain, %	5.0			
Deviator ksf	3.444			
Excess PP	0.000			
Sigma 1	4.970			
Sigma 3	1.526			
P, ksf	3.248			
Q, ksf	1.722			
Stress Ratio	3.256			
Rate in/min	0.0588			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





Sample:	1	2	3	4
MC, %	76.3			
Dry Dens, pcf	54.0			
Sat. %	97.1			
Void Ratio	2.121			
Diameter in	2.87			
Height, in	6.05			
	Final			
MC, %	76.6			
Dry Dens, pcf	54.9			
Sat. %	100.0			
Void Ratio	2.068			
Diameter, in	2.85			
Height, in	6.03			
Cell, psi	54.8			
BP, psi	48.5			
	Effective Stresses At:			
Strain, %	5.0			
Deviator ksf	3.118			
Excess PP	0.000			
Sigma 1	4.025			
Sigma 3	0.907			
P, ksf	2.466			
Q, ksf	1.559			
Stress Ratio	4.437			
Rate in/min	0.0588			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-251 **Date:** 5/25/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-09_S-05 @ 23(Tip-13") Dark Gray Elastic SILT

Sample 2)

Sample 3)

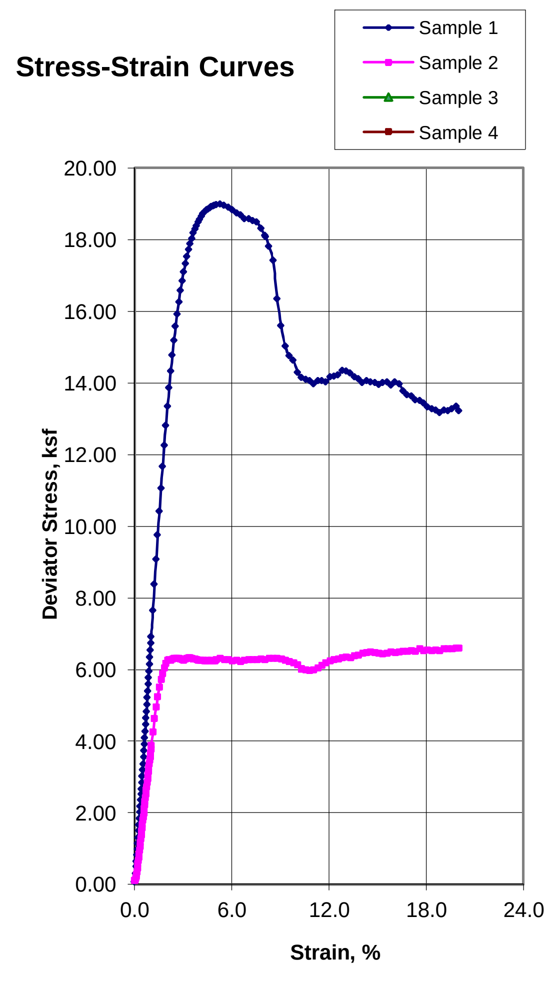
Sample 4)

REMARKS: Strengths picked at 5% strain.
*Sample was back-pressure saturated prior to shear.

COOPER TESTING LABORATORY

Unconsolidated-Undrained Triaxial Test

ASTM D2850



Sample Data

	1	2	3	4
Moisture %	76.6	34.4		
Dry Den,pcf	48.3	70.8		
Void Ratio	2.363	1.293		
Saturation %	84.3	69.3		
Height in	6.06	6.04		
Diameter in	2.86	2.85		
Cell psi	12.4	3.8		
Strain %	10.00	10.00	10.00	10.00
Deviator, ksf	14.642	6.188		
Rate %/min	1.00	1.00		
in/min	0.061	0.060		
Job No.:	**020-272**			
Client:	**AECOM**			
Project:	**60537920**			
Boring:	BC-13	BC-14		
Sample:	S04	S02		
Depth ft:	22(Tip-12')	7(Tip-1")		

Visual Soil Description

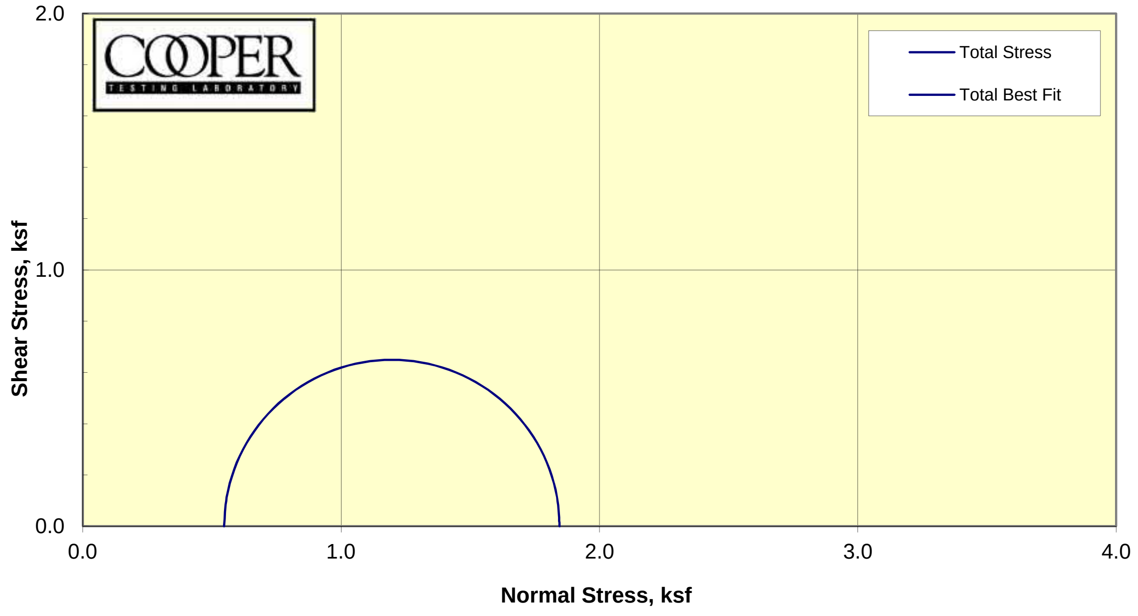
Sample #	
1	Olive Brown CLAY w/ Sand
2	Light Yellowish Brown Sandy CLAY w/ Claystone
3	
4	

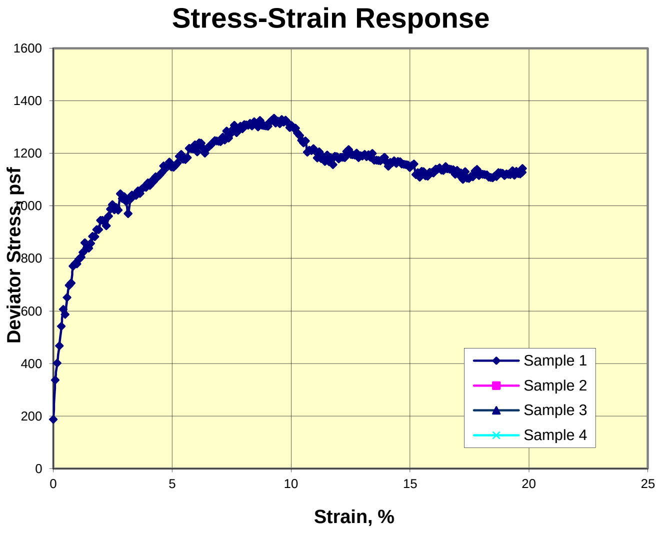
Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





Sample:	1	2	3	4
MC, %	21.9			
Dry Dens, pcf	77.6			
Sat. %	52.3			
Void Ratio	1.090			
Diameter in	2.87			
Height, in	6.09			
	Final			
MC, %	39.9			
Dry Dens, pcf	79.6			
Sat. %	100.0			
Void Ratio	1.038			
Diameter, in	2.84			
Height, in	6.09			
Cell, psi	92.8			
BP, psi	89.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	1.299			
Excess PP	0.000			
Sigma 1	1.846			
Sigma 3	0.547			
P, ksf	1.196			
Q, ksf	0.649			
Stress Ratio	3.373			
Rate in/min	0.0600			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-272 **Date:** 12/19/2018

Client: AECOM BY:MD/DC

Project: 60537950

Sample 1) BC-13_S01 @ 7(Tip-4") Olive Brown Silty SAND (Weathered Rock)

Sample 2)

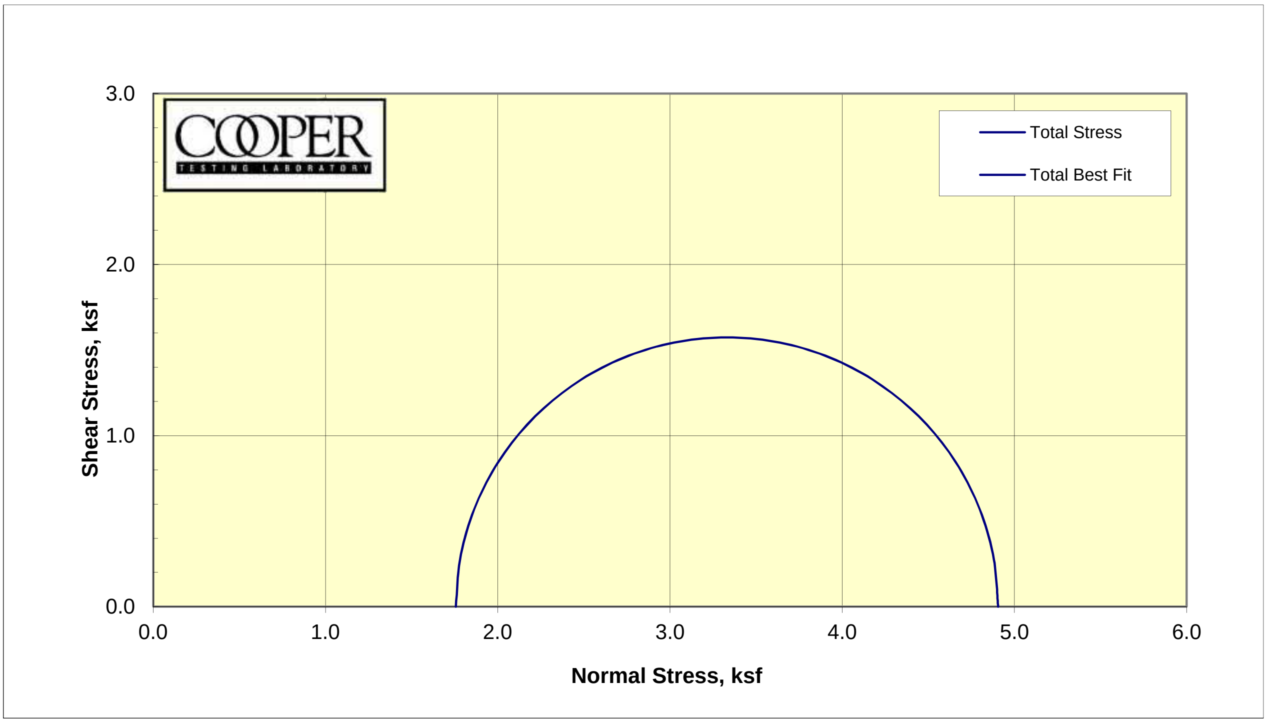
Sample 3)

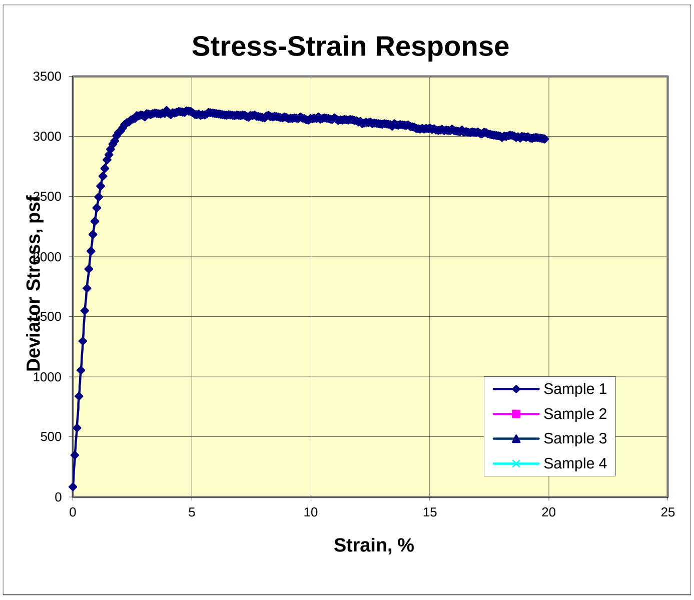
Sample 4)

REMARKS: Strengths picked at 10% strain.
*Sample was back-pressure saturated prior to shear.

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





Sample:	1	2	3	4
MC, %	28.4			
Dry Dens, pcf	74.3			
Sat. %	62.4			
Void Ratio	1.184			
Diameter in	2.87			
Height, in	6.08			
	Final			
MC, %	42.6			
Dry Dens, pcf	77.0			
Sat. %	100.0			
Void Ratio	1.108			
Diameter, in	2.83			
Height, in	6.06			
Cell, psi	91.2			
BP, psi	79.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	3.148			
Excess PP	0.000			
Sigma 1	4.905			
Sigma 3	1.757			
P, ksf	3.331			
Q, ksf	1.574			
Stress Ratio	2.792			
Rate in/min	0.0592			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-272 **Date:** 12/19/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-13_S04 @ 22(Tip-18.5") Olive Brown Silty SAND/ Clayey SAND (Weathered Rock)

Sample 2)

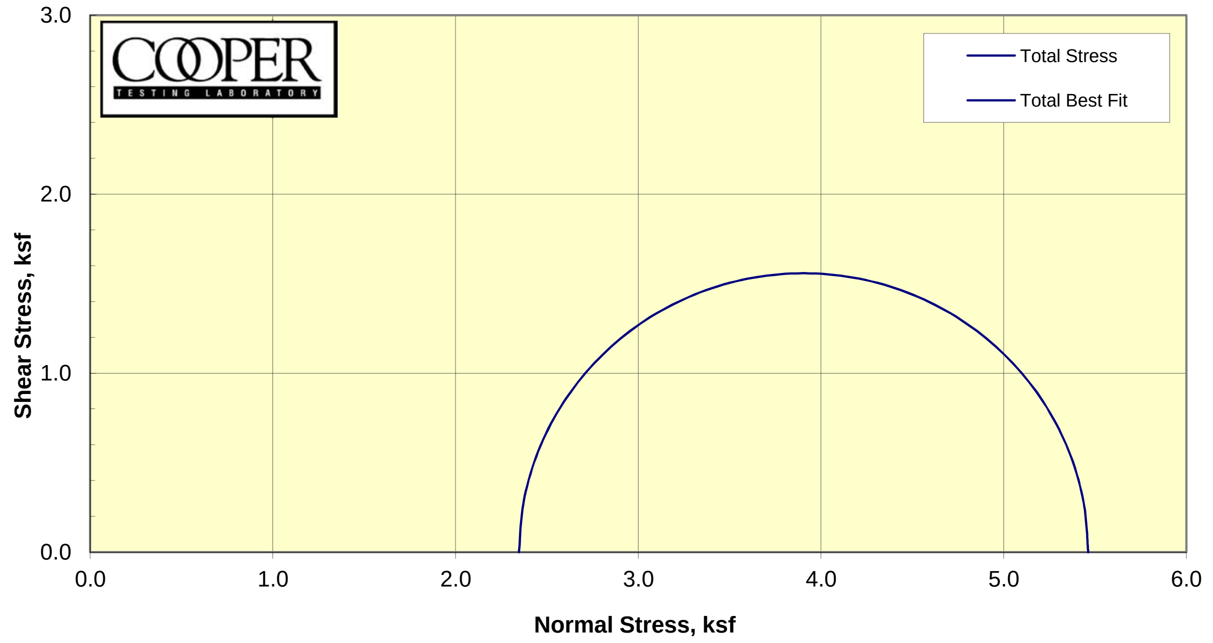
Sample 3)

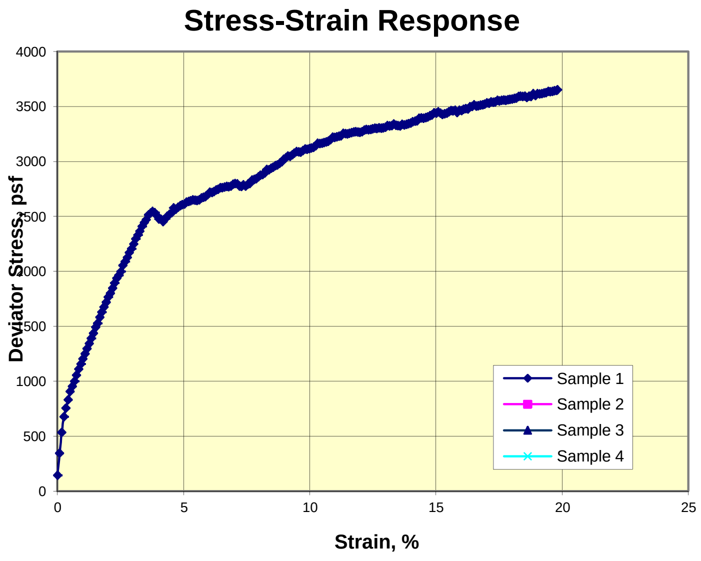
Sample 4)

REMARKS: Strengths picked at 10% strain.
*Sample was back-pressure saturated prior to shear.

Triaxial Unconsolidated-Undrained

(ASTM D2850m)





Sample:	1	2	3	4
MC, %	72.2			
Dry Dens, pcf	39.4			
Sat. %	60.3			
Void Ratio	3.116			
Diameter in	2.87			
Height, in	6.08			
	Final			
MC, %	112.3			
Dry Dens, pcf	41.4			
Sat. %	100.0			
Void Ratio	2.919			
Diameter, in	2.81			
Height, in	6.06			
Cell, psi	95.3			
BP, psi	79.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	3.116			
Excess PP	0.000			
Sigma 1	5.463			
Sigma 3	2.347			
P, ksf	3.905			
Q, ksf	1.558			
Stress Ratio	2.327			
Rate in/min	0.0588			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-272 **Date:** 12/19/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-13_S05 @ 30.5(Tip-11") Pale Brown SILT (slightly plastic) w/ CaCO3 deposits (Weathered Rock)

Sample 2)

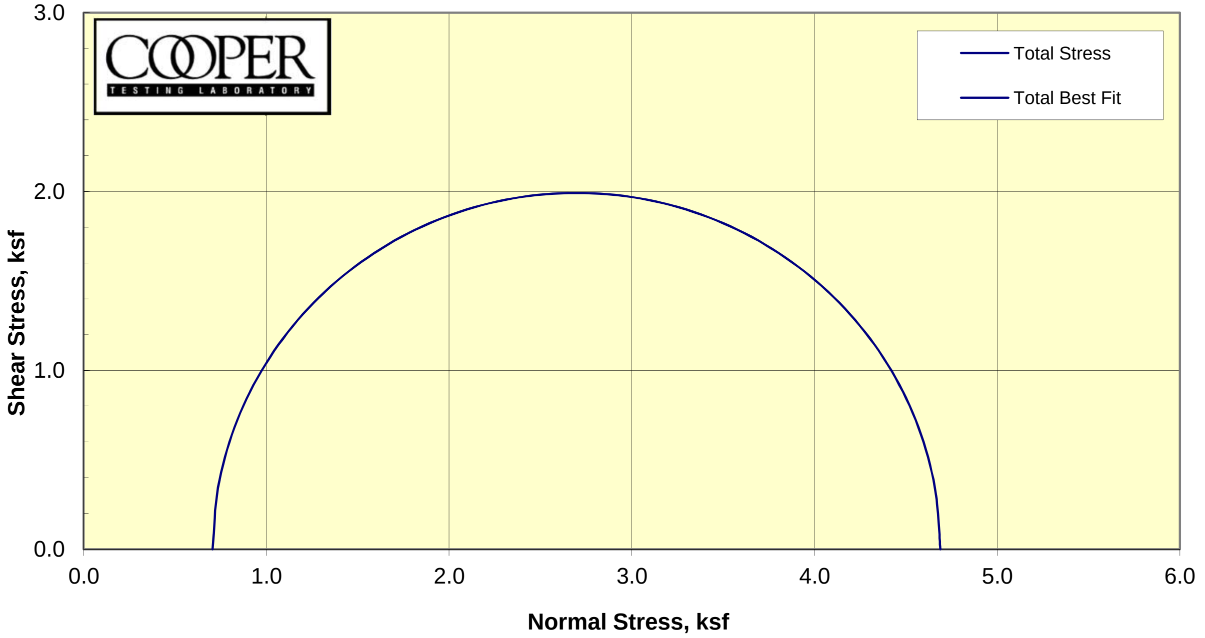
Sample 3)

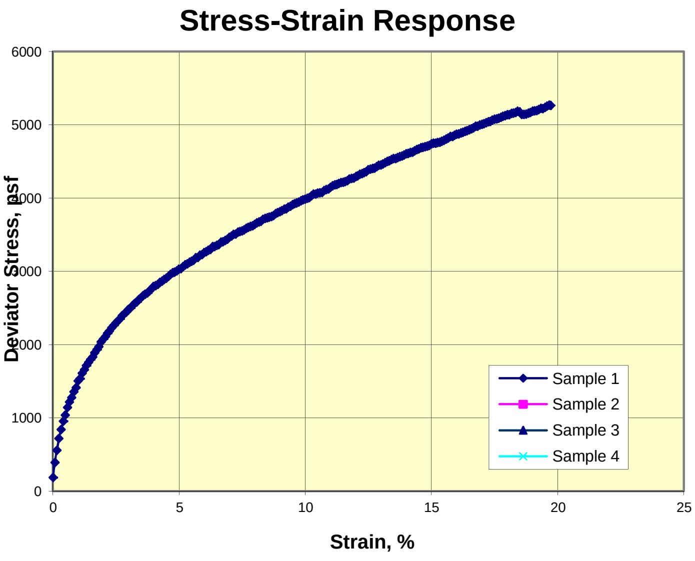
Sample 4)

REMARKS: Strengths picked at 5% strain.
*Sample was back-pressure saturated prior to shear.

Triaxial Unconsolidated-Undrained

(ASTM D2850m)




Stress-Strain Response

Sample:	**1**	**2**	**3**	**4**
MC, %	45.1			
Dry Dens, pcf	54.7			
Sat. %	59.6			
Void Ratio	1.968			
Diameter in	2.87			
Height, in	6.09			
	Final			
MC, %	72.9			
Dry Dens, pcf	56.0			
Sat. %	100.0			
Void Ratio	1.895			
Diameter, in	2.84			
Height, in	6.09			
Cell, psi	73.9			
BP, psi	69.0			
	Effective Stresses At:			
Strain, %	10.0			
Deviator ksf	3.984			
Excess PP	0.000			
Sigma 1	4.690			
Sigma 3	0.706			
P, ksf	2.698			
Q, ksf	1.992			
Stress Ratio	6.646			
Rate in/min	0.0587			
Total C	N/A	ksf		
Total Phi	N/A	Degrees		
Eff. C	N/A	ksf		
Eff. Phi	N/A	Degrees		

Job No.: 020-272 **Date:** 12/19/2018

Client: AECOM BY:MD/DC

Project: 60537920

Sample 1) BC-14_S03 @ 9(Tip-1") Olive Brown Clayey GRAVEL w/ Sand (Weathered Rock)

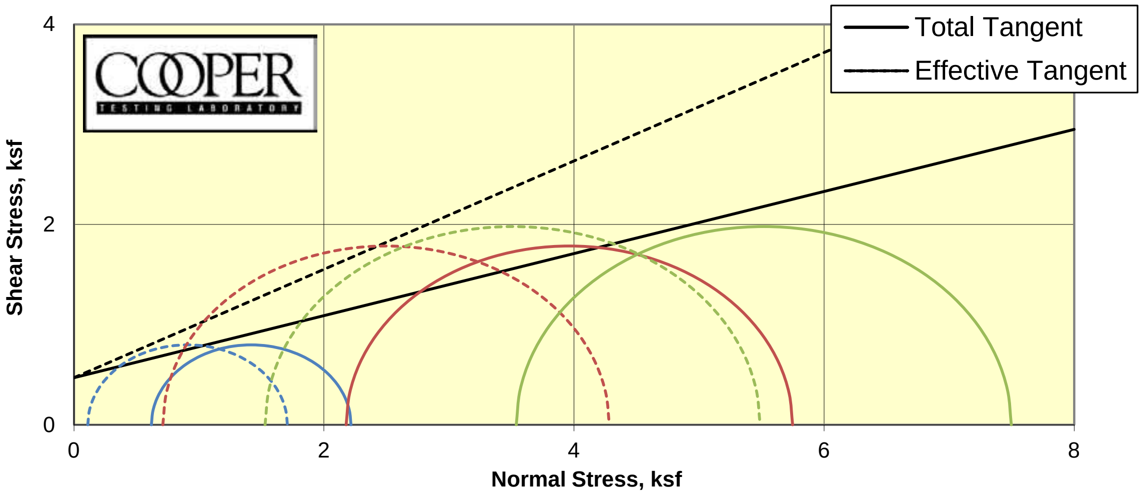
Sample 2)

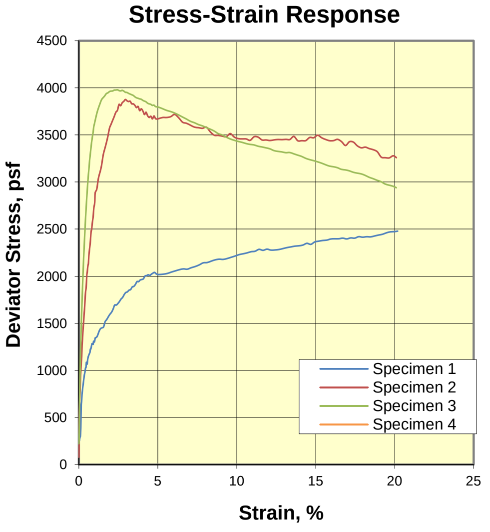
Sample 3)

Sample 4)

REMARKS: Strengths picked at 10% strain.
*Sample was back-pressure saturated prior to shear.

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767



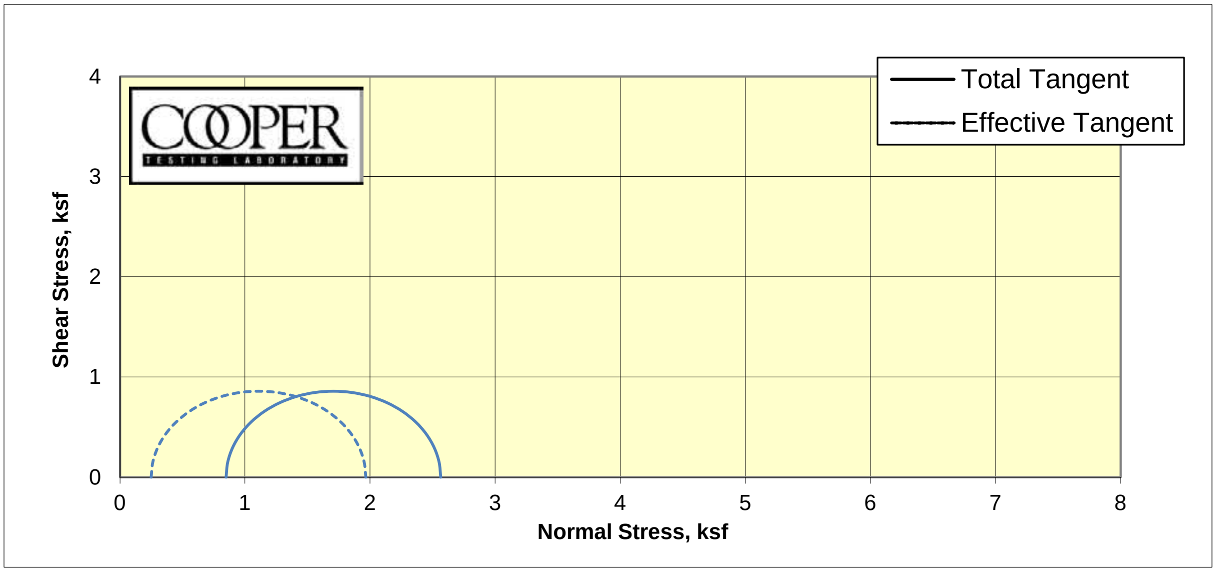


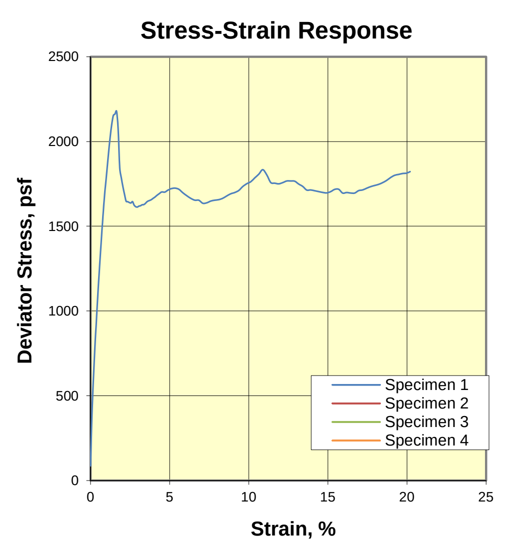
CTL Number:	020-232		
Client Name:	AECOM		
Project Name:	Klamath		
Project Number:	60537920		
Date:	9/25/2017	By:	MD/DC
Total C	**0.470**	**ksf**	
Total phi	**17.2**	**degrees**	
Eff. C	**0.470**	**ksf**	
Eff. Phi	**28.4**	**degrees**	©

Remarks: The sample was delivered as singular 13" x 16" block. The specimens were trimmed into a brass tube 2" x 4". The orientation of the outcrop block was unknown. All samples were trimmed in the same approximate orientation. The material is highly structured and cemented. It disperses when exposed to water. All three specimens behaved differently during shear.

Specimen	**1**	**2**	**3**	**4**
Boring	Outcrop #1	Outcrop #1	Outcrop #1	
Sample				
Depth				
Visual Description	Pale Brown Siltstone (Diatomite)	Pale Brown Siltstone (Diatomite)	Pale Brown Siltstone (Diatomite)	
MC (%)	8.2	7.1	5.9	
Dry Density (pcf)	53.1	56.9	58.0	
Saturation (%)	10.2	9.7	8.4	
Void Ratio	2.176	1.961	1.907	
Diameter (in)	1.86	1.86	1.85	
Height (in)	4.00	4.00	4.00	
	Final			
MC (%)	78.4	73.5	71.9	
Dry Density (pcf)	54.1	56.5	57.3	
Saturation (%)	100.0	100.0	100.0	
Void Ratio	2.116	1.984	1.942	
Diameter (in)	1.85	1.87	1.87	
Height (in)	3.96	3.98	3.98	
Cell Pressure (psi)	124.0	135.0	144.9	
Back Pressure (psi)	119.7	119.8	120.4	
	Effective Stresses At:			
Strain (%)	2.0	2.0	2.0	
Deviator (ksf)	1.596	3.571	3.959	
Excess PP (psi)	3.5	10.2	14.0	
Sigma 1 (ksf)	1.708	4.282	5.488	
Sigma 3 (ksf)	0.111	0.712	1.529	
P (ksf)	0.909	2.497	3.509	
Q (ksf)	0.798	1.785	1.980	
Stress Ratio	15.338	6.018	3.589	
Rate (in/min)	0.0003	0.0003	0.0003	

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

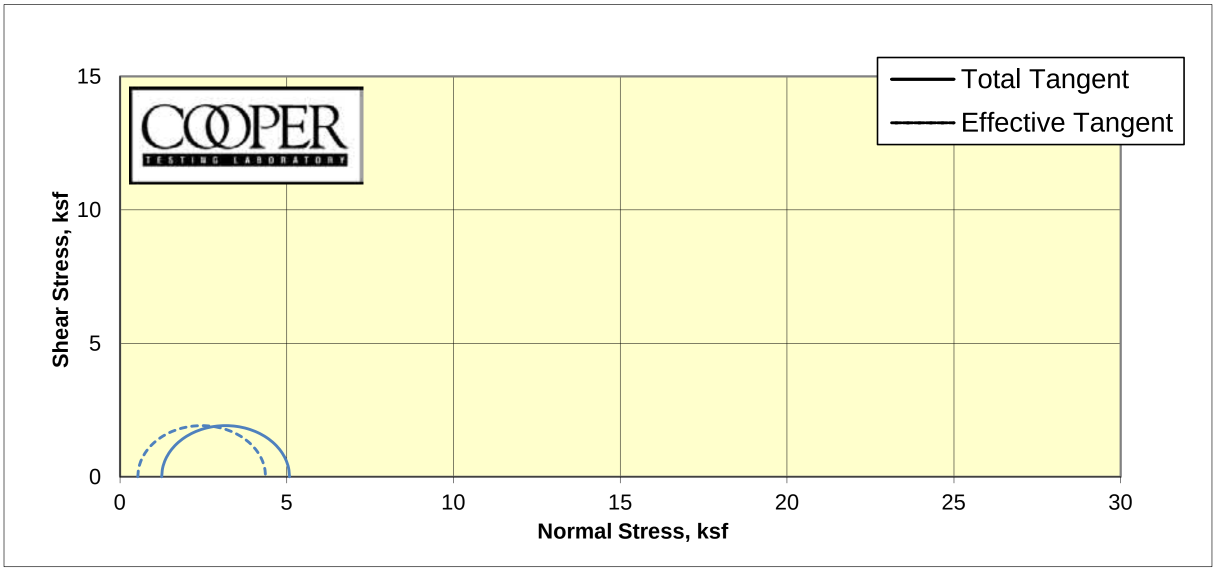


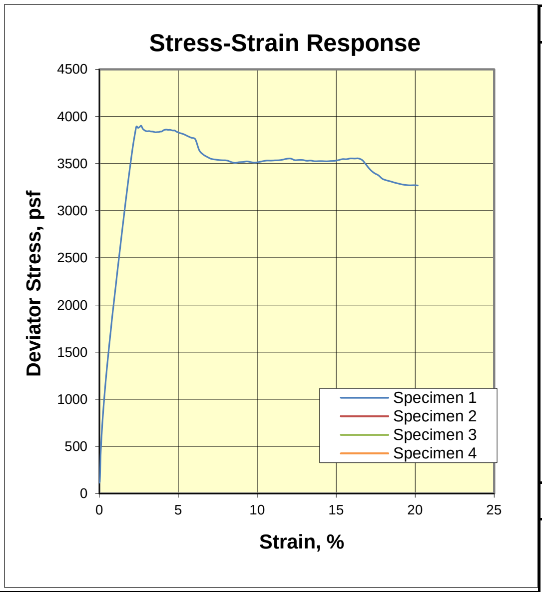


CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/30/2018	By:	MD/DC
Total C	#DIV/0!	ksf	
Total phi	#DIV/0!	degrees	
Eff. C	#DIV/0!	ksf	
Eff. Phi	#DIV/0!	degrees	©

Specimen	**1**	**2**	**3**	**4**
Boring	BC-02			
Sample	S-06			
Depth	19.5(Tip-2")			
Visual Description	Gray CLAY (Silty)			
MC (%)	147.5			
Dry Density (pcf)	31.6			
Saturation (%)	92.6			
Void Ratio	4.139			
Diameter (in)	2.86			
Height (in)	6.07			
	Final			
MC (%)	147.6			
Dry Density (pcf)	33.6			
Saturation (%)	100.0			
Void Ratio	3.838			
Diameter (in)	2.79			
Height (in)	6.02			
Cell Pressure (psi)	86.4			
Back Pressure (psi)	80.5			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	1.716			
Excess PP (psi)	4.2			
Sigma 1 (ksf)	1.966			
Sigma 3 (ksf)	0.250			
P (ksf)	1.108			
Q (ksf)	0.858			
Stress Ratio	7.869			
Rate (in/min)	0.0005			

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767





Specimen	**1**	**2**	**3**	**4**
Boring	BC-02			
Sample	S-08			
Depth	34.5(Tip-6")			
Visual Description	Pale Brown CLAY (Silty)			
MC (%)	148.8			
Dry Density (pcf)	32.7			
Saturation (%)	96.6			
Void Ratio	4.158			
Diameter (in)	2.87			
Height (in)	6.07			
	Final			
MC (%)	148.5			
Dry Density (pcf)	33.6			
Saturation (%)	100.0			
Void Ratio	4.010			
Diameter (in)	2.84			
Height (in)	6.02			
Cell Pressure (psi)	88.8			
Back Pressure (psi)	80.1			
	Effective Stresses At:			
Strain (%)	5.0			
Deviator (ksf)	3.832			
Excess PP (psi)	5.0			
Sigma 1 (ksf)	4.368			
Sigma 3 (ksf)	0.536			
P (ksf)	2.452			
Q (ksf)	1.916			
Stress Ratio	8.153			
Rate (in/min)	0.0005			

CTL Number:	020-251		
Client Name:	AECOM		
Project Name:	Klamath River Dam Removal Project		
Project Number:	60537920		
Date:	5/14/2018	By:	MD/DC
Total C	**#DIV/0!**	**ksf**	
Total phi	**#DIV/0!**	**degrees**	
Eff. C	**#DIV/0!**	**ksf**	
Eff. Phi	**#DIV/0!**	**degrees**	©